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MINERALS YEARBOOK

1964

Volume III of Four Volumes

AREA REPORTS:

Domestic

Prepared by staff of the
BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • Stewart L. Udall, Secretary

BUREAU OF MINES • Frank C. Memmott, Acting Director

Created in 1849, the Department of the Interior—a Department of Conservation—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.

U.S. GOVERNMENT PRINTING OFFICE
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FOREWORD

The 1964 MINERALS YEARBOOK is the second annual review to be presented in four volumes, the fourth volume portraying international mineral industry events on a country-by-country basis. The general content of the four-volume edition follows:

Volume I, Metals and Minerals (Except Fuels), contains chapters on metal and nonmetal mineral commodities except mineral fuels. In addition, it includes a chapter reviewing these mineral industries, a statistical summary, and chapters on mining and metallurgical technology, employment and injuries, and technologic trends.

Volume II, Mineral Fuels, contains a chapter on each mineral fuel and on such related products as helium, carbon black, peat, coke and coal chemicals, and natural gas liquids. Also included are data on employment and injuries in the fuel industries and a mineral-fuels review summarizing recent economic and technological developments.

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

Volume IV, Area Reports: International, contains chapters presenting the latest available mineral statistics for more than 130 foreign countries and areas. A separate chapter reviews minerals in the world economy. In its first year—1963—the international review volume presented considerable background information on the mineral resources of individual countries, which has been omitted from the 1964 issue. Thus the length of volume IV has been greatly reduced.

The Bureau of Mines' continuous effort to enhance the Yearbook's value to its wide readership can be aided by constructive comments and suggestions of its users. Such comment is particularly invited during the formative years of the new International review volume.

FRANK C. MEMMOTT, *Acting 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: Department of Natural Resources.
Arizona: Arizona Bureau of Mines.
Arkansas: Geological and Conservation Commission; Arkansas Oil and Gas Commission; Department of Revenue.
California: Division of Mines and Geology; The Public Utility Commission.
Colorado: The Oil and Gas Conservation Commission and the Coal Mines Inspections Department.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Geological Survey of Georgia.
Hawaii: Department of Land and Natural Resources.
Idaho: Bureau of Mines and Geology.
Illinois: State Geological Survey Division.
Indiana: Geological Survey, Department of Conservation.
Iowa: Iowa Geological Survey.
Kansas: Conservation Division, State Corporation Commission and State Geological Survey of Kansas.
Kentucky: Kentucky Geological Survey, Department of Mines and Minerals.
Louisiana: Louisiana Geological Survey and Louisiana Department of Conservation.
Maine: Geological Survey of Maine.
Maryland: Department of Geology, Mines, and Water Resources.
Michigan: Geological Survey Division, Department of Conservation.
Mississippi: Mississippi Geological Survey; Mississippi State Oil and Gas Board; and Oil and Gas Severance Tax Division, Mississippi State Tax 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.
Nevada: Nevada Bureau of Mines.
New Hampshire: New Hampshire State Planning and Development Commission.
New Jersey: Bureau of Geology and Topography.
New York: New York State Science Service.
North Carolina: Geological Survey of North Carolina.
North Dakota: North Dakota Geological Survey.
Ohio: Department of Natural Resources and Department of Industrial Relations.
Oklahoma: Oklahoma Geological Survey and Oil and Gas Conservation Department; Oklahoma Corporation Commission, 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: Geological Survey of South Carolina.

South Dakota: State Geological Survey.
Tennessee: Department of Conservation and Commerce.
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.
Virginia: Division of Mineral Resources.
Washington: Division of Mines and Geology, Department of Conservation and Development.
West Virginia: West Virginia Geological and Economical Survey.
Wisconsin: Wisconsin Geological Survey.
Wyoming: The Geological Survey of Wyoming.

Except for the two review 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, Donald O. Kennedy; Area III, Ottey Bishop; Area IV, Robert S. Sanford; Area V, Robert W. Geehan; Area VI, D. R. Irving (acting); Area VII, Mark L. Wright; Area VIII, Jared A. Herdlick.

The preparation and the coordination of chapters with those in other volumes was under the general direction of Paul F. Yopes, Assistant to the Chief, Division of Minerals. The manuscripts upon which this volume is based have been reviewed by a staff under the direction of Kathleen J. D'Amico to insure statistical consistency among the tables, figures, and text, between this volume and other volumes, 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.

CHARLES W. MERRILL,
Chief, Division of Minerals

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Statistical Summary

By Kathleen J. D'Amico [1]

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THIS SUMMARY appears in Minerals Yearbook volumes I 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 several commodity and area chapters 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.

TABLE 1.—Value of mineral production in the United States,[1] by mineral groups [2]

(Millions

Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total	Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total
1925	$2,910	$1,187	$715	$4,812	1945	$4,569	$888	$774	$6,231
1926	3,371	1,219	721	5,311	1946	5,090	1,243	729	7,062
1927	2,875	1,201	622	4,698	1947	7,188	1,338	1,084	9,610
1928	2,666	1,163	655	4,484	1948	9,502	1,552	1,219	12,273
1929	2,940	1,166	802	4,908	1949	7,920	1,559	1,101	10,580
1930	2,500	973	507	3,980	1950	8,689	1,822	1,351	11,862
1931	1,620	671	287	2,578	1951	9,779	2,079	1,671	13,529
1932	1,460	412	128	2,000	1952	9,616	2,163	1,617	13,396
1933	1,413	432	205	2,050	1953	10,257	2,350	1,811	14,418
1934	1,947	520	277	2,744	1954	9,919	2,733	1,518	14,170
1935	2,013	564	365	2,942	1955	10,780	3,076	2,055	15,911
1936	2,405	685	516	3,606	1956	11,741	3,391	2,358	17,490
1937	2,798	711	756	4,265	1957	12,709	3,387	2,137	18,233
1938	2,436	622	460	3,518	1958	11,589	3,466	1,594	16,649
1939	2,423	754	631	3,808	1959	11,950	3,861	1,570	17,381
1940	2,662	784	752	4,198	1960	12,142	3,868	2,022	18,032
1941	3,228	989	890	5,107	1961	12,357	3,946	1,927	18,230
1942	3,568	1,056	999	5,623	1962	12,784	4,117	1,937	18,838
1943	4,028	916	987	5,931	1963	r13,295	r4,318	r2,002	r19,615
1944	4,574	836	900	6,310	1964	13,585	4,622	2,265	20,472

r Revised.
[1] Excludes Alaska and Hawaii, 1925–53.
[2] Data for 1925–46 are not strictly comparable with those for subsequent years, since for earlier years value of heavy clay products has not been replaced by value of raw clays used for such products.

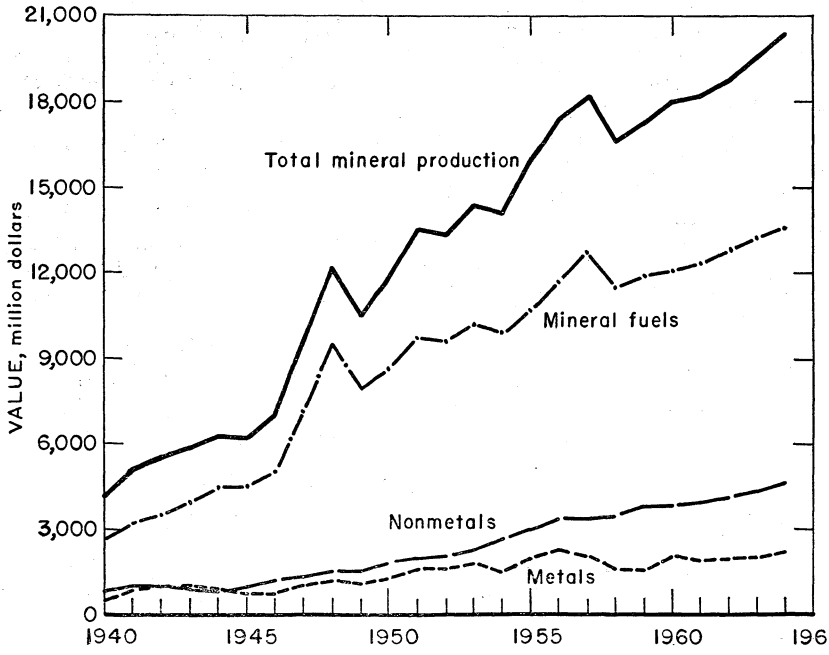


FIGURE 1.—Value of mineral production in the United States.

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

Mineral	1961		1962		1963		1964	
	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	1,558,792	$12,818	1,647,063	$14,601	1,632,645	$8,383	1,935,344	$10,038
Carbon dioxide, natural (estimate) thousand cubic feet	545,354	82	1,144,107	146	1,295,545	178	1,236,816	166
Coal:								
Bituminous and lignite [2]—thousand short tons	402,977	1,844,563	422,149	1,891,553	458,928	2,013,309	486,998	2,165,582
Pennsylvania anthracite—do	17,446	140,338	16,894	134,094	18,267	153,503	17,184	148,648
Helium—thousand cubic feet	551,785	10,263	599,519	20,905	627,344	21,957	667,440	23,360
Natural gas—million cubic feet	13,254,025	1,996,241	13,876,622	2,145,301	14,746,663	2,328,030	15,546,592	2,387,689
Natural gas liquids:								
Natural gasoline and cycle products thousand gallons	6,105,463	412,019	6,244,522	444,817	6,534,967	439,173	7,000,181	463,600
LP gases—do	9,085,465	370,186	9,409,083	353,334	10,302,250	359,770	10,743,591	362,792
Peat—short tons	531,067	5,036	566,441	5,186	546,621	5,423	630,365	6,181
Petroleum (crude)—thousand 42-gallon barrels	2,621,758	7,565,582	2,676,189	7,774,051	2,752,723	7,965,743	2,786,822	8,017,078
Total mineral fuels	XX	12,357,000	XX	12,784,000	XX	r 13,295,000	XX	13,585,000
Nonmetals (except fuels):								
Abrasive stone [3]—short tons	2,495	238	2,653	260	2,693	255	3,186	292
Aplite—long tons	97,465	651	125,156	912	(4)	(4)	(4)	(4)
Asbestos—short tons	52,814	4,347	53,190	4,677	r 66,396	r 5,108	101,092	8,143
Barite—do	697,804	9,300	860,312	9,820	823,615	r 9,402	829,741	9,796
Boron minerals—do	602,613	46,936	646,613	49,336	700,183	54,981	776,000	60,871
Bromine—thousand pounds	180,798	44,517	190,747	46,617	203,333	48,558	286,813	65,316
Calcite (optical grade)—pounds							4	2
Cement:								
Portland—thousand 376-pound barrels	314,821	1,048,832	325,476	1,070,371	342,036	1,095,884	374,230	1,145,108
Masonry—thousand 280-pound barrels	19,275	55,737	19,998	57,405	20,997	59,599	22,397	63,305
Natural and slag—thousand 376-pound barrels	269	968	402	1,611	352	1,407	283	1,057
Clays—thousand short tons	47,389	156,829	47,797	163,012	r 50,135	r 180,810	52,853	192,537
Emery—short tons	6,180	106	4,316	71	6,732	119	9,214	172
Feldspar—long tons	496,808	5,120	492,476	5,076	548,954	5,525	629,894	6,132
Fluorspar—short tons	197,354	8,940	206,026	9,166	r 199,948	r 9,001	217,137	9,723
Garnet (abrasive)—do	12,057	1,036	14,166	1,172	14,626	1,412	16,123	1,622
Gem stones (estimate)	(5)	1,309	(5)	1,296	(5)	1,421	(5)	1,474
Gypsum—thousand short tons	9,500	34,996	9,969	36,343	10,388	38,138	10,684	38,874
Lime—do	13,249	177,403	13,752	186,754	14,521	199,389	16,089	223,167
Magnesium compounds from sea water and brine (except for metals) short tons, MgO equivalent	356,384	25,545	408,129	28,742	r 520,699	r 39,323	599,698	42,177

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued								
Mica:								
Scrap, short tons	99,044	$2,417	107,702	$2,639	109,323	$2,776	114,729	$3,353
Sheet, pounds	526,007	3,386	363,016	1,299	102,961	13	242,662	58
Perlite, short tons	310,338	2,664	320,330	2,663	325,132	2,727	349,867	3,073
Phosphate rock, thousand long tons	18,559	130,535	19,382	134,304	19,855	139,861	22,960	161,067
Potassium salts, thousand short tons, K_2O equivalent	2,732	104,464	2,452	94,359	r 2,864	r 110,164	2,897	114,100
Pumice, thousand short tons	2,463	6,799	2,271	6,301	2,618	6,578	2,776	6,443
Pyrites, thousand long tons	988	7,418	916	6,809	825	5,698	847	5,471
Salt, thousand short tons	25,707	160,223	28,807	174,841	r 30,641	r 184,589	31,623	200,706
Sand and gravel, do	751,784	751,301	776,701	794,725	r 821,850	r 847,272	868,779	894,092
Sodium carbonate (natural), short tons	805,828	20,444	977,584	24,330	1,119,081	27,616	1,274,745	30,451
Sodium sulfate (natural), do	465,814	9,296	457,881	9,092	435,257	8,392	575,033	10,989
Stone [6], thousand short tons	611,938	947,359	656,954	1,025,697	688,366	1,068,108	725,269	1,134,335
Sulfur:								
Frasch process mines, thousand long tons	5,082	117,884	4,917	107,069	4,995	99,014	5,859	117,228
Other mines, long tons	177,549	1,694	150,550	1,439	1,371	15	794	8
Talc, soapstone, and pyrophyllite, short tons	762,380	5,277	771,728	5,278	804,358	5,505	889,949	6,218
Tripoli, do	54,641	225	61,732	244	66,635	266	64,613	268
Vermiculite, thousand short tons	206	3,350	205	3,293	226	3,572	226	3,613
Value of items that cannot be disclosed: Calcium-magnesium chloride, diatomite, epsom salts from epsomite (1961–63), graphite, iodine, kyanite, lithium minerals, magnesite, greensand marl, olivine, staurolite, wollastonite, and values indicated by footnote 4	XX	r 47,993	XX	r 49,436	XX	r 54,929	XX	60,392
Total nonmetals	XX	3,946,000	XX	4,117,000	XX	4,318,000	XX	4,622,000
Metals:								
Antimony ore and concentrate, short tons, antimony content	689	(7)	631	(7)	645	(7)	632	(7)
Bauxite, long tons, dried equivalent	1,228,032	13,937	1,369,007	15,609	1,524,700	17,234	1,600,722	17,875
Beryllium concentrate, short tons, gross weight	[8] 1,122	(7)	[8] 978	(7)	[8] 751	(7)	(7)	(7)
Chromite, do	[9] 82,000	[9] 2,939						
Copper (recoverable content of ores, etc.), short tons	1,165,155	699,093	1,228,421	756,707	1,213,166	747,310	1,246,780	812,901
Gold (recoverable content of ores, etc.), troy ounces	1,548,270	54,189	1,542,511	53,990	1,454,010	50,889	1,456,308	50,971
Iron ore, usable (excluding byproduct iron sinter), thousand long tons, gross weight	72,378	650,501	69,969	618,242	73,563	678,177	84,300	802,331
Lead (recoverable content of ores, etc.), short tons	261,921	53,956	236,956	43,602	253,369	54,727	286,010	74,935
Manganese ore (35 percent or more Mn), short tons, gross weight	46,088	3,224	24,758	(7)	10,622	(7)	26,058	(7)
Manganiferous ore (5 to 35 percent Mn), do	225,004	1,480	338,501	(7)	543,125	(7)	238,776	(7)
Mercury, 76-pound flasks	31,662	6,257	26,277	5,024	r 19,117	r 3,623	14,142	4,452

Molybdenum (content of concentrate) thousand pounds	66,753	87,925	50,506	69,390	65,839	91,096	65,097	97,121
Nickel (content of ore and concentrate) short tons	13,133	(7)	13,110	(7)	13,394	(7)	15,420	(7)
Silver (recoverable content of ores, etc.) thousand troy ounces	34,794	32,166	36,798	39,929	35,243	45,076	36,334	46,980
Titanium concentrate:								
Ilmenite short tons, gross weight	782,629	13,320	809,037	13,974	890,071	16,529	1,003,997	19,178
Rutile do	7,664	778	8,033	933	11,311	1,262	10,547	1,016
Tungsten ore and concentrate short tons, 60 percent WO_3 basis	8,245	10,565	8,429	11,639	5,657	7,202	9,244	11,251
Uranium ore short tons	8,041,329	148,299	7,052,870	138,294	r 5,645,921	r 115,821	5,666,252	116,297
Vanadium (recoverable in ore and concentrate) do	5,343	19,076	5,211	18,605	[10] 3,862	[10] 13,788	4,362	13,061
Zinc (recoverable content of ores, etc.) do	464,390	106,848	505,491	116,413	529,254	122,533	574,858	156,308
Value of items that cannot be disclosed: Chromite,[9] cobalt, magnesium chloride for magnesium metal, manganiferous residuum, platinum-group metals (crude), rare-earth metal concentrates, tin, zirconium concentrate, and values indicated by footnote [7]	XX	22,582	XX	35,071	XX	36,827	XX	40,357
Total metals	XX	1,927,000	XX	1,937,000	XX	r 2,002,000	XX	2,265,000
Grand total mineral production	XX	18,230,000	XX	18,838,000	XX	r 19,615,000	XX	20,472,000

r Revised. 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] Grindstones, pulpstones, millstones (weight not recorded), grinding pebbles, sharpening stones, and tube-mill liners.

[4] Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."

[5] Weight not recorded.

[6] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table.

[7] Figure withheld to avoid disclosing individual company confidential data; value included with "Metal items that cannot be disclosed."

[8] Includes low-grade beryllium ore as follows: 805 tons in 1961, 760 tons in 1962, and 750 tons in 1963.

[9] Excludes quantity consumed by American Chrome Co.

[10] Final figure; superseded figure given in commodity chapter.

TABLE 3.—Minerals produced in the United States and principal producing States in 1964

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

TABLE 3.—Minerals produced in the United States and principal producing States in 1964—Continued

Mineral	Principal producing States in order of quantity	Other producing States
Mercury	Calif., Nev., Alaska, Ariz	Idaho, Oreg.
Mica:		
Scrap	N.C., Ga., Ala., S.C.	Ariz., Calif., Conn., Idaho, N. Mex., Pa., S. Dak.
Sheet	N.C.	
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., Mo., Mont., Nebr., N.Y., N. Dak., Ohio, Pa., Tenn., 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., Ind., Pa., Wash.	Alaska, Calif., Colo., Conn., Fla., Ga., Idaho, Ill., Iowa, Maine, Md., Mass., Minn., Mont., Nev., N.J., N.Y., N. Dak., Ohio, S.C., Vt., 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., Tenn., Idaho, 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., Wyo.
Pyrites	Tenn., Pa., Colo., Ariz.	S.C.
Rare-earth metals	Calif., Fla.	
Salt	Tex., La., N.Y., Ohio	Ala., Calif., Colo., Kans., Mich., Nev., N. Mex., N. Dak., Okla., Utah, Va., W. Va.
Sand and gravel	Calif., Mich., N.Y., Ohio	All other States.
Silver	Idaho, Ariz., Mont., Utah	Alaska, Calif., Colo., Ky., Mich., Nev., N. Mex., N.Y., Oreg., Pa., S. Dak., Tenn., Wash., Wyo.
Sodium carbonate	Wyo., Calif.	
Sodium sulfate	Calif., Tex., Wyo.	
Staurolite	Fla.	
Stone	Pa., Calif., Ill., Tex.	All other States.
Sulfur (Frasch)	Tex., La.	
Sulfur, ore	Calif., Nev.	
Talc	N.Y., Calif., N.C., Vt.	Ala., Ark., Ga., Md., Mont., Nev., Pa., Tex., Va., Wash.
Tin	Calif., Colo., Alaska	
Titanium	N.Y., Fla., N.J., Va.	Idaho, S.C.
Tripoli	Ill., Okla., Pa.	
Tungsten	Calif., Colo., N.C., Nev.	Ariz., Idaho, Oreg.
Uranium	N. Mex., Colo., Utah, Wash.	Alaska, Ariz., Calif., Mont., Nev., N. Dak., Oreg., S. Dak., Tex., Wyo.
Vanadium	Colo., Utah, Idaho, Ariz.	N. Mex., Oreg., S. Dak., Wyo.
Vermiculite	Mont., S.C., Colo.	
Wollastonite	N.Y., Calif.	
Zinc	Tenn., N.Y., Idaho, Colo.	Ariz., Calif., Ill., Kans., Ky., Mo., Mont., Nev., N.J., N. Mex., Okla., Oreg., Pa., Utah, Va., Wash., Wis.
Zirconium	Fla.	

TABLE 4.—Value of mineral production in the United States and principal minerals produced in 1964

(Thousands)

State	Value	Rank	Percent of U.S. total	Principal minerals in order of value
Alabama	$235,690	20	1.15	Coal, cement, stone, petroleum.
Alaska	65,947	38	.32	Petroleum, sand and gravel, coal, gold.
Arizona	534,364	10	2.61	Copper, sand and gravel, cement, molybdenum.
Arkansas	174,789	26	.85	Petroleum, stone, bauxite, cement.
California	1,560,510	3	7.62	Petroleum, natural gas, cement, sand and gravel.
Colorado	316,011	17	1.54	Petroleum, molybdenum, coal, sand and gravel.
Connecticut	21,850	45	.11	Stone, sand and gravel, lime, feldspar.
Delaware	1,742	50	.01	Sand and gravel, stone, clays.
District of Columbia	82	51	(1)	Clays.
Florida	223,409	21	1.09	Phosphate rock, stone, cement, clays.
Georgia	127,958	28	.63	Clays, stone, cement, sand and gravel.
Hawaii	19,605	46	.10	Cement, stone, sand and gravel, pumice.
Idaho	86,262	32	.42	Silver, lead, zinc, phosphate rock.
Illinois	591,136	8	2.89	Coal, petroleum, stone, sand and gravel.
Indiana	211,783	23	1.03	Coal, cement, stone, petroleum.
Iowa	106,630	29	.52	Cement, stone, sand and gravel, gypsum.
Kansas	513,269	11	2.51	Petroleum, natural gas, cement, natural gas liquids.
Kentucky	444,379	15	2.17	Coal, petroleum, stone, natural gas.
Louisiana	2,785,007	2	13.60	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	17,574	47	.09	Sand and gravel, cement, stone, peat.
Maryland	73,893	36	.36	Stone, cement, sand and gravel, coal.
Massachusetts	36,367	43	.18	Sand and gravel, stone, lime, clays.
Michigan	555,495	9	2.71	Iron ore, cement, copper, sand and gravel.
Minnesota	497,495	13	2.43	Iron ore, sand and gravel, stone, cement.
Mississippi	212,193	22	1.04	Petroleum, natural gas, sand and gravel, cement.
Missouri	189,305	25	.92	Stone, cement, lead, iron ore.
Montana	211,435	24	1.03	Petroleum, copper, sand and gravel, stone.
Nebraska	91,959	31	.45	Petroleum, sand and gravel, cement, stone.
Nevada	85,137	33	.42	Copper, sand and gravel, iron ore, diatomite.
New Hampshire	7,302	48	.04	Sand and gravel, stone, feldspar, clays.
New Jersey	78,172	35	.38	Stone, sand and gravel, zinc, iron ore.
New Mexico	720,124	7	3.52	Petroleum, potassium salts, natural gas, copper.
New York	288,445	18	1.41	Cement, stone, sand and gravel, salt.
North Carolina	56,470	40	.28	Stone, sand and gravel, cement, feldspar.
North Dakota	92,866	30	.45	Petroleum, sand and gravel, natural gas, coal.
Ohio	454,937	14	2.22	Coal, stone, cement, lime.
Oklahoma	881,270	5	4.30	Petroleum, natural gas, natural gas liquids, cement.
Oregon	64,269	39	.31	Sand and gravel, stone, cement, nickel.
Pennsylvania	902,050	4	4.41	Coal, cement, stone, iron ore.
Rhode Island	2,549	49	.01	Sand and gravel, stone, gem stones.
South Carolina	38,713	42	.19	Cement, stone, clays, sand and gravel.
South Dakota	52,824	41	.26	Gold, sand and gravel, cement, stone.
Tennessee	173,965	27	.85	Stone, zinc, cement, coal.
Texas	4,533,078	1	22.14	Petroleum, natural gas, natural gas liquids, cement.
Utah	391,430	16	1.91	Copper, petroleum, coal, uranium.
Vermont	26,127	44	.13	Stone, asbestos, sand and gravel, talc.
Virginia	237,415	19	1.16	Coal, stone, cement, sand and gravel.
Washington	80,977	34	.40	Sand and gravel, cement, stone, zinc.
West Virginia	822,691	6	4.02	Coal, natural gas, natural gas liquids, stone.
Wisconsin	70,007	37	.34	Sand and gravel, stone, cement, zinc.
Wyoming	504,846	12	2.47	Petroleum, natural gas, uranium, iron ore.
Total	20,471,803		100.00	Petroleum, natural gas. coal, cement.

[1] Less than 0.005 percent.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA								
Cement: [2]								
Portland—thousand 376-pound barrels	12,445	$39,027	12,482	$40,164	12,218	$38,417	12,870	$40,108
Masonry—thousand 280-pound barrels	2,006	6,156	2,187	6,521	2,386	7,242	2,574	7,794
Clays [3]—thousand short tons	1,787	2,068	1,632	1,947	1,607	3,003	1,991	4,060
Coal (bituminous)—do	12,915	90,903	12,880	95,149	12,359	91,243	14,435	r 102,267
Gem stones					(4)	2		
Iron ore (usable)—thousand long tons, gross weight	3,597	20,510	2,962	17,838	2,126	11,806	2,106	11,812
Lime—thousand short tons	579	6,871	522	6,298	596	6,974	599	7,118
Natural gas—million cubic feet	56	4	128	13	177	21	166	18
Petroleum (crude)—thousand 42-gallon barrels	6,931	19,060	7,473	19,355	9,175	23,763	8,498	22,095
Sand and gravel—thousand short tons	5,800	6,452	4,655	4,486	5,363	5,778	5,840	6,191
Stone [5]—do	13,651	19,909	12,680	19,667	13,684	22,206	15,852	24,976
Value of items that cannot be disclosed: Native asphalt, bauxite, slag cement, clays (kaolin, bentonite 1964), scrap mica, sheet mica (1961–62), salt, stone (dimension limestone, dimension marble 1961, 1964, shell 1961, 1963–64, crushed sandstone 1961), and talc	XX	7,919	XX	8,347	XX	5,415	XX	9,251
Total	XX	218,879	XX	219,785	XX	215,870	XX	235,690
ALASKA								
Antimony ore and concentrate—short tons, antimony content							14	$18
Coal (bituminous)—thousand short tons	737	$5,868	871	$6,409	853	$5,910	745	5,008
Copper (recoverable content of ores, etc.)—short tons	92	55					11	7
Gold (recoverable content of ores, etc.)—troy ounces	114,216	3,998	165,259	5,784	99,573	3,485	58,416	2,045
Lead (recoverable content of ores, etc.)—short tons	W	W			5	1		
Mercury—76-pound flasks	4,129	816	3,719	711	400	76	303	95
Natural gas—million cubic feet	631	129	2,184	467	4,498	1,111	6,272	1,719
Peat—short tons			64	W			2,350	19
Petroleum (crude)—thousand 42-gallon barrels	6,327	17,652	10,259	31,187	10,740	32,650	11,059	33,627
Sand and gravel—thousand short tons	5,241	4,185	5,731	5,355	16,926	22,005	26,089	18,488
Silver (recoverable content of ores, etc.)—thousand troy ounces	18	17	22	24	14	18	7	9
Value of items that cannot be disclosed: Gem stones, platinum-group metals, stone, tin (1964), uranium ore and vlaues indicated by symbol W	XX	2,033	XX	4,255	XX	2,584	XX	4,912
Total	XX	34,753	XX	54,192	XX	67,840	XX	65,947

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARIZONA								
Beryllium concentrate—short tons, gross weight	8	$4	1	(6)				
Clays [3]—thousand short tons	165	240	139	$184	163	$203	168	$213
Copper (recoverable content of ores, etc.)—short tons	587,053	352,232	644,242	396,853	660,977	407,162	690,988	450,524
Diatomite—do	W	W	W	W	W	W	450	16
Gem stones	(4)	119	(4)	120	(4)	120	(4)	120
Gold (recoverable content of ores, etc.)—troy ounces	145,959	5,109	137,207	4,802	140,030	4,901	153,676	5,379
Gypsum—thousand short tons	W	W	W	W	W	W	147	770
Iron ore (usable)—thousand long tons, gross weight	W	W	W	W	W	W	4	32
Lead (recoverable content of ores, etc.)—short tons	5,937	1,223	6,966	1,282	5,815	1,256	6,147	1,611
Lime—thousand short tons	167	2,686	174	2,914	181	3,048	177	2,920
Mercury—76-pound flasks	148	29	W	W	W	W	77	24
Molybdenum (content of concentrate)—thousand pounds	4,878	6,232	4,412	5,864	5,553	7,584	6,296	9,532
Natural gas—million cubic feet			230	27	1,334	161	2,025	241
Petroleum (crude)—thousand 42-gallon barrels	73	W	39	W	68	W	64	W
Pumice—thousand short tons	745	1,893	756	1,640	800	1,877	880	1,635
Sand and gravel—do	17,688	16,175	15,579	17,404	15,037	14,466	18,116	20,868
Silver (recoverable content of ores, etc.) thousand troy ounces	5,120	4,733	5,454	5,917	5,373	6,873	5,811	7,513
Stone—thousand short tons	3,582	4,626	4,333	6,616	3,257	5,069	3,759	6,283
Tungsten ore and concentrate short tons, 60-percent WO_3 basis			15	14			16	17
Uranium ore—short tons	228,225	4,965	143,196	3,047	150,584	4,844	102,258	3,253
Vanadium (recoverable in ore and concentrate)—do	W	W	632	W	222	W	W	575
Zinc (recoverable content of ores, etc.)—do	29,585	6,804	32,888	7,564	25,419	5,846	24,690	6,716
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite, fire clay), feldspar, helium, manganiferous ore (1961), scrap mica, perlite, pyrites, and values indicated by symbol W	XX	18,925	XX	19,883	XX	r 17,705	XX	16,122
Total	XX	425,995	XX	474,131	XX	r 48,115	XX	534,364

Barite—short tons	277,855	$2,630	258,691	$2,232	236,077	$2,161	233,455	$2,202
Bauxite—long tons, dried equivalent	1,178,898	13,462	1,270,124	14,606	1,478,047	16,701	1,561,984	17,431
Clays—thousand short tons	773	1,758	654	1,693	769	1,763	892	2,152
Coal (bituminous)—do	395	2,888	256	1,809	221	1,505	212	1,503
Gem stones	(4)	19	(4)	15	(4)	42	(4)	33
Gypsum—thousand short tons	167	531	83	261	W	W	W	W
Iron ore (usable)—thousand long tons, gross weight	----	----	43	296	W	W	W	W
Lime—thousand short tons	90	1,196	350	4,542	167	2,237	189	2,814
Natural gas—million cubic feet	59,547	8,039	66,213	9,866	76,101	11,796	76,167	11,806
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	27,889	1,640	29,415	1,673	26,219	1,466	30,082	1,678
LP gases—do	75,157	3,286	69,452	2,432	66,377	2,497	61,616	2,460
Petroleum (crude)—thousand 42-gallon barrels	29,246	80,427	27,649	73,546	27,406	72,900	26,737	71,120
Sand and gravel—thousand short tons	9,389	9,074	10,847	10,006	12,099	13,589	11,794	14,836
Stone—do	12,029	12,402	20,611	19,866	18,913	22,727	20,241	26,172
Zinc (recoverable content of ores, etc.)—short tons	37	9	211	49	----	----	----	----
Value of items that cannot be disclosed: Abrasive stones, bromine, cement, phosphate rock (1963–64), soapstone, and values indicated by symbol W	XX	10,906	XX	11,063	XX	17,900	XX	20,582
Total	XX	148,267	XX	153,955	XX	r 167,284	XX	174,789

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
CALIFORNIA								
Asbestos short tons	W	W	W	W	19,591	$1,547	55,041	$4,419
Barite do	21,203	$295	6,945	$133	5,082	r 31	5,604	45
Boron minerals do	602,613	46,936	646,613	49,336	700,183	54,981	776,000	60,871
Calcite (optical grade) pounds							4	2
Cement thousand 376-pound barrels	[2] 41,090	[2] 129,836	43,667	139,151	46,278	147,656	47,204	149,933
Clays thousand short tons	3,041	6,405	3,137	7,349	3,395	8,031	[3] 3,651	[3] 8,196
Copper (recoverable content of ores, etc.) short tons	1,382	829	1,162	716	916	564	1,035	675
Feldspar long tons	W	W	W	W	75,516	W	102,264	W
Gem stones		(4)	200	(4)	200	(4)	200	(4)
Gold (recoverable content of ores, etc.) troy ounces	97,644	3,418	106,272	3,720	86,867	3,040	71,028	2,486
Gypsum thousand short tons	1,574	3,733	1,747	4,113	1,756	4,222	1,893	4,539
Lead (recoverable content of ores, etc.) short tons	103	21	455	84	823	178	1,546	405
Lime thousand short tons	503	9,062	470	8,454	487	8,932	577	10,312
Magnesium compounds from sea water and bitterns (partly estimated) short tons, MgO equivalent	90,534	6,467	76,445	6,077	82,397	6,135	94,739	7,143
Mercury 76-pound flasks	18,688	3,693	15,951	3,050	13,592	2,575	10,291	3,240
Mica, scrap short tons	950	12	W	W	977	14	W	W
Natural gas million cubic feet	556,241	157,416	564,220	163,624	646,486	189,420	664,051	198,551
Natural gas liquids:								
Natural gasoline and cycle products thousand gallons	762,878	57,645	716,904	54,460	715,303	54,188	720,373	54,088
LP gases do	424,767	21,805	407,378	19,294	393,503	17,329	352,614	15,893
Peat short tons	46,348	501	33,901	331	39,873	450	35,391	443
Petroleum (crude) thousand 42-gallon barrels	299,609	728,050	296,590	741,475	300,908	746,252	300,009	729,022
Pumice thousand short tons	610	2,202	573	2,615	460	2,017	443	1,937
Salt do	1,601	W	1,643	W	1,716	W	1,525	W
Sand and gravel do	110,181	124,111	107,660	124,922	112,185	128,178	112,995	129,333
Silver (recoverable content of ores, etc.) thousand troy ounces	93	86	133	144	157	200	172	222
Stone thousand short tons	33,850	50,327	34,776	54,722	37,977	58,253	45,805	63,566
Sulfur ore long tons	W	W	W	W	785	4	520	3
Talc, soapstone, and pyrophyllite short tons	161,068	1,524	117,912	1,339	120,452	1,427	132,601	1,631
Wollastonite do	4,075	42	W	W	3,000	28	3,625	36
Zinc (recoverable content of ores, etc.) do	304	70	322	74	101	23	143	39
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, carbon dioxide, masonry cement (1961), clays (ball clay, fuller's earth 1964), coal (lignite), diatomite, fluorspar (1961), iodine, iron ore, lithium minerals, magnesite (1961), manganiferous ore (1962), molybdenum, perlite, platinum-group metals (crude), potassium salts, pyrites, (1961–62), rare-earth metal concentrates,								

sodium carbonates and sulfates, tin (1963–64), tungsten concentrate, uranium ore (1960, 1963–64), and values indicated by symbol W	XX	81,051	XX	81,957	XX	r 90,366	XX	113,280
Total	XX	1,435,737	XX	1,467,340	XX	r 1,526,241	XX	1,560,510

COLORADO

Beryllium concentrate—short tons, gross weight	11 819	W	11 782	W	11 751	W	W	W
Carbon dioxide, natural—thousand cubic feet	167,872	$19	148,940	$15	224,856	$38	211,830	$36
Clay—thousand short tons	556	1,241	802	1,573	686	1,334	558	1,275
Coal (bituminous)—do	3,678	22,787	3,379	19,999	3,690	21,888	4,355	23,427
Copper (recoverable content of ores, etc.)—short tons	4,141	2,485	4,534	2,793	4,169	2,568	4,653	3,034
Feldspar—long tons	14,129	99	W	W	W	W	W	W
Gem stones	(4)	36	(4)	45	(4)	63	(4)	80
Gold (recoverable content of ores, etc.)—troy ounces	67,515	2,363	48,882	1,711	33,605	1,176	42,122	1,474
Gypsum—thousand short tons	85	320	108	383	99	346	100	398
Iron ore (usable)—thousand long tons, gross weight	27	190	W	W	W	W	35	231
Lead (recoverable content of ores, etc.)—short tons	17,755	3,658	17,411	3,204	19,918	4,302	20,563	5,388
Lime—thousand short tons	75	1,319	93	1,518	128	2,104	138	2,193
Mica, scrap—short tons	600	10	142	2	440	7		
Molybdenum (content of concentrate)—thousand pounds	47,485	63,582	32,412	45,376	47,977	67,168	46,378	69,207
Natural gas—million cubic feet	108,142	12,544	101,826	11,812	105,705	12,367	114,312	13,489
Natural gas liquids:								
Natural gasoline—thousand gallons	76,880	3,627	60,558	3,826	56,869	3,191	52,400	2,845
LP gases—do	115,410	5,498	100,787	4,411	91,309	4,171	88,916	3,894
Peat—short tons	9,894	44	12,351	68	13,774	98	27,931	188
Petroleum (crude)—thousand 42-gallon barrels	46,759	134,666	42,477	122,334	38,283	110,255	34,755	100,094
Pumice—thousand short tons	44	60	76	82	60	87	61	114
Sand and gravel—do	18,360	16,946	19,313	18,926	20,385	20,929	20,746	22,227
Silver (recoverable content of ores, etc.) thousand troy ounces	1,965	1,817	2,088	2,265	2,307	2,951	2,626	3,396
Stone—thousand short tons	2,451	5,301	2,353	5,597	2,510	5,693	3,217	6,805
Uranium ore—short tons	1,282,462	21,509	1,135,440	18,044	1,014,206	15,864	833,282	13,389
Vanadium (recoverable in ore and concentrate)—do	4,149	W	3,742	W	3,047	W	3,312	9,916
Vermiculite—thousand short tons			W	W	(5)	1	(5)	1
Zinc (recoverable content of ores, etc.)—short tons	42,647	9,809	43,351	9,971	48,109	11,065	53,682	14,602
Value of items that cannot be disclosed: Cement, fluorspar, perlite, pyrites, salt, tin, tungsten, and values indicated by symbol W	XX	36,278	XX	34,209	XX	29,478	XX	18,308
Total	XX	346,208	XX	308,164	XX	r 317,144	XX	316,011

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
CONNECTICUT								
Beryllium concentrate—short tons, gross weight	2	$1	7	$4				
Clays—thousand short tons	[3] 149	[3] 260	[3] 179	[3] 287	189	$339	212	$262
Gem stones	(4)	9	(4)	8	(4)	8	(4)	8
Lime—thousand short tons	33	589	35	635	35	666	39	689
Sand and gravel—do	7,499	6,633	10,208	9,244	10,503	9,343	10,088	9,437
Stone—do	5,206	8,616	5,090	8,816	5,318	9,612	5,864	10,764
Value of items that cannot be disclosed: Clays (kaolin 1961–62) feldspar, scrap mica, sheet mica (1961–62), and peat	XX	491	XX	760	XX	646	XX	690
Total	XX	16,599	XX	19,754	XX	20,614	XX	21,850
DELAWARE								
Clays—thousand short tons	W	W	W	W	13	$13	11	$11
Gem stones—do	(4)	W	(4)	W	(4)	1	(4)	1
Sand and gravel—do	961	$970	1,755	$1,445	1,094	1,136	1,282	1,280
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W	XX	83	XX	86	XX	191	XX	450
Total	XX	1,053	XX	1,531	XX	1,341	XX	1,742
FLORIDA								
Clays—thousand short tons	513	$7,202	487	$6,741	538	$7,777	627	$8,405
Lime—do	W	W	W	W	126	1,996	117	1,814
Natural gas—million cubic feet	29	5	29	6	35	7	40	5
Peat—short tons	26,673	157	20,595	139	21,049	129	19,813	102
Petroleum (crude)—thousand 42-gallon barrels	374	W	419	W	464	W	620	W
Phosphate rock—thousand long tons	13,789	95,590	13,949	94,595	14,592	101,050	17,108	119,667
Sand and gravel—thousand short tons	6,530	5,577	5,924	5,179	7,542	5,823	7,420	6,427
Stone—do	[5] 26,221	[5] 33,671	27,279	32,608	31,900	38,173	33,157	38,362
Value of items that cannot be disclosed: Cement, gem stones (1961, 1963), magnesium compounds, natural gas liquids, rare-earth metals concentrates, staurolite, stone (dimension limestone 1961), titanium concentrate, zirconium concentrate, and values indicated by symbol W	XX	45,919	XX	46,432	XX	46,665	XX	48,627
Total	XX	188,121	XX	185,700	XX	201,620	XX	223,409

GEORGIA

Barite	short tons	106,914	$2,046	108,829	$1,987	117,096	$2,013	109,228	$2,022
Clays	thousand short tons	3,569	42,025	3,801	47,462	4,208	54,024	4,365	58,899
Coal (bituminous)	do	4	22	8	28	5	16	4	15
Feldspar	long tons	31,128	692	35,692	795	W	W	W	W
Gem stones		(4)	W	(4)	W	(4)	1		
Iron ore (usable)	thousand long tons, gross weight	162	835	215	1,118	260	1,304	354	1,752
Mica (sheet)	pounds	349	3	60	1				
Peat	short tons	1,914	W	W	W	W	W	W	W
Sand and gravel	thousand short tons	3,150	3,049	3,429	3,365	3,817	3,922	4,159	4,311
Stone	do	15,854	38,077	19,555	42,037	19,582	46,044	22,730	46,532
Talc	short tons	47,950	98	45,940	96	42,000	93	40,400	135
Value of items that cannot be disclosed: Bauxite, cement, gem stones (1961–63), kyanite (1963–64), manganiferous ore (1961–63), scrap mica, and values indicated by symbol W		XX	9,464	XX	10,816	XX	12,059	XX	14,292
Total		XX	96,311	XX	107,705	XX	119,476	XX	127,958

HAWAII

Cement	thousand 376-pound barrels	1,077	$5,574	1,128	$6,055	1,483	$7,125	1,717	$8,877
Clays	thousand short tons	W	W	W	W	W	W	3	W
Gem stones		(4)	18	(4)	W	(4)	36	(4)	W
Lime	thousand short tons	14	354	15	386	12	428	9	321
Pumice	do	324	626	232	380	274	469	365	603
Salt	do	(5)	4	(5)	W	(5)	W	W	W
Sand and gravel	do	416	758	700	1,122	304	764	407	979
Stone	do	4,429	7,656	4,071	6,883	3,844	6,480	5,282	8,765
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W		XX		XX	18	XX	5	XX	60
Total		XX	14,990	XX	14,844	XX	15,307	XX	19,605

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IDAHO								
Antimony ore and concentrate short tons, antimony content	689	W	631	W	645	W	585	W
Clays thousand short tons	[3] 27	[3] $20	35	$70	[3] 31	[3] $15	[3] 29	[3] $25
Copper (recoverable content of ores, etc.) short tons	4,328	2,597	3,861	2,378	4,172	2,570	4,666	3,042
Gold (recoverable content of ores, etc.) troy ounces	5,718	200	5,845	205	5,477	192	5,677	199
Iron ore (usable) thousand long tons, gross weight	12	70	5	35	6	40	4	33
Lead (recoverable content of ores, etc.) short tons	71,476	14,724	84,058	15,467	75,759	16,364	71,312	18,684
Lime thousand short tons	47	658	68	801	60	874	W	W
Mercury 76-pound flasks	1,073	212			W	W	83	26
Peat short tons	W	W	W	W	W	W	900	8
Phosphate rock thousand long tons	1,440	7,984	1,912	10,635	1,700	10,589	W	W
Pumice thousand short tons	60	95	67	103	161	275	59	100
Sand and gravel do	7,305	6,793	14,321	13,029	12,433	10,615	9,582	8,691
Silver (recoverable content of ores, etc.) thousand troy ounces	17,576	16,249	17,772	19,283	16,711	21,375	16,483	21,313
Stone thousand short tons	1,873	3,111	1,381	2,698	1,168	2,217	1,144	2,773
Titanium concentrate short tons, gross weight	1,873	28	W	W	W	W	W	W
Tungsten concentrate short tons	W	W					11	8
Vanadium do	W	W	W	W	23	W	W	W
Zinc (recoverable content of ores, etc.) do	58,295	13,408	62,865	14,459	63,267	14,551	59,298	16,129
Value of items that cannot be disclosed: Barite, cement, clays (fire clay 1961, 1963–64, bentonite 1961, 1963–64, kaolin 1961, 1963–64), abrasive garnet, gem stones, scrap mica (1963–64), sheet mica (1962), perlite, uranium (1961–62), and values indicated by symbol W	XX	2,885	XX	3,451	XX	r 3,110	XX	15,231
Total	XX	69,034	XX	82,614	XX	r 82,787	XX	86,262

ILLINOIS

Cement:								
Portland thousand 376-pound barrels	8,595	$28,301	9,145	$30,205	9,281	$30,577	9,790	$32,191
Masonry thousand 280-pound barrels	461	1,420	440	1,320	472	1,440	596	2,038
Clays thousand short tons	1,982	4,166	1,929	4,151	1,949	4,368	[3] 2,007	[3] 4,358
Coal (bituminous) do	45,246	177,070	48,487	186,986	51,736	196,518	55,023	208,448
Fluorspar short tons	116,908	5,956	132,830	6,392	132,060	6,547	127,454	6,452
Lead (recoverable content of ores, etc.) do	3,430	707	3,610	664	2,901	627	2,180	571
Natural gas million cubic feet	9,970	1,276	10,650	1,523	9,459	1,220	7,867	905
Natural gas liquids:								
Natural gasoline and cycle products thousand gallons	16,956	1,311	13,315	1,023	14,939	1,077	14,109	1,030
LP gases do	340,284	16,495	327,616	13,812	337,278	14,714	312,173	13,758
Peat short tons	6,597	30	W	W	W	W	W	W
Petroleum (crude) thousand 42-gallon barrels	76,818	229,686	78,796	234,812	74,796	222,892	70,168	205,592
Sand and gravel thousand short tons	31,353	35,098	34,122	38,981	31,746	36,431	34,880	39,966
Stone do	36,361	47,939	41,203	54,411	40,293	52,217	42,987	56,553
Zinc (recoverable content of ores, etc.) short tons	26,795	6,163	27,413	6,305	20,337	4,678	13,800	3,754
Value of items that cannot be disclosed: Clays (fuller's earth 1964), gem stones, lime, tripoli, and values indicated by symbol W	XX	11,775	XX	12,133	XX	13,656	XX	15,520
Total	XX	567,393	XX	592,718	XX	r 586,962	XX	591,136

INDIANA

Abrasive stones short tons	5	$14	5	$15	5	$16	5	$16
Cement [2] thousand 376-pound barrels	13,780	47,024	12,878	42,572	13,165	43,216	15,038	48,695
Clays thousand short tons	1,362	2,446	1,450	2,255	1,546	2,347	1,545	2,264
Coal (bituminous) do	15,106	58,815	15,709	60,079	15,100	57,120	15,075	57,246
Natural gas million cubic feet	382	77	284	60	286	67	200	47
Peat short tons	57,146	502	47,430	272	47,695	412	66,568	543
Petroleum (crude) thousand 42-gallon barrels	11,500	34,270	12,077	35,989	11,902	35,230	11,283	32,157
Sand and gravel thousand short tons	19,577	16,898	21,261	18,692	22,840	20,683	24,416	21,811
Stone do	18,001	33,062	18,709	34,653	19,667	35,616	22,318	39,978
Value of items that cannot be disclosed: Cement (masonry 1961, 1964), gem stones (1961-63), gypsum, and values indicated by symbol W	XX	8,437	XX	8,839	XX	r 9,259	XX	9,026
Total	XX	201,545	XX	203,426	XX	r 203,966	XX	211,783

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IOWA								
Cement:								
Portland—thousand 376-pound barrels	12,108	$41,718	12,261	$42,417	12,495	$42,891	13,607	$46,398
Masonry—thousand 280-pound barrels	557	1,843	568	1,786	551	1,754	585	1,847
Clays—thousand short tons	1,044	1,426	1,039	1,427	1,064	1,405	1,008	1,254
Coal (bituminous)—do	927	3,323	1,130	4,026	1,213	4,244	973	3,447
Gypsum—do	1,239	5,276	1,256	5,318	1,282	5,667	1,287	5,821
Sand and gravel—do	13,391	11,651	13,797	12,474	14,168	12,845	13,890	13,546
Stone—do	22,018	28,916	21,618	28,244	20,904	27,788	23,935	33,038
Value of items that cannot be disclosed: Gem stones, lime, peat, and petroleum	XX	845	XX	869	XX	1,076	XX	1,279
Total	XX	94,998	XX	96,561	XX	97,670	XX	106,630
KANSAS								
Cement:								
Portland—thousand 376-pound barrels	8,028	$25,605	8,058	$25,134	8,201	$25,372	8,483	$25,959
Masonry—thousand 280-pound barrels	379	1,156	392	1,156	387	1,183	384	1,173
Clays—thousand short tons	954	1,225	895	1,091	893	1,104	785	935
Coal (bituminous)—do	664	3,102	915	4,249	1,169	5,311	1,263	5,749
Helium—thousand cubic feet	23,251	434	42,305	1,478	46,177	1,616	47,332	1,657
Lead (recoverable content of ores, etc.)—short tons	1,449	298	970	178	1,027	222	1,185	310
Lime—thousand short tons	15	193	5	59				
Natural gas—million cubic feet	649,083	81,135	694,352	86,100	732,946	97,482	768,246	96,031
Natural gas liquids:								
Natural gasoline—thousand gallons	132,180	5,790	151,360	7,696	165,370	9,811	162,725	8,713
LP gases—do	135,643	5,916	166,769	6,295	395,877	15,481	512,747	18,121
Petroleum (crude)—thousand 42-gallon barrels	112,241	324,376	112,076	326,141	109,107	317,501	106,252	310,256
Salt [3]—thousand short tons	913	11,409	944	11,654	924	11,993	930	11,799
Sand and gravel—do	11,366	7,781	11,552	8,039	12,062	8,676	12,968	9,108
Stone—do	[5] 12,328	[5] 16,411	[5] 13,527	[5] 17,274	13,558	18,483	14,138	18,912
Zinc (recoverable content of ores, etc.)—short tons	2,446	563	3,943	907	3,508	807	4,665	1,269
Value of items that cannot be disclosed: Natural cement, gypsum, pumice, salt (brine), and stone (crushed sandstone 1961–62)	XX	3,204	XX	3,625	XX	3,260	XX	3,277
Total	XX	488,598	XX	501,076	XX	518,302	XX	513,269

KENTUCKY

Barite	short tons	3,304	$30	4,097	$36	5,812	$85	6,014	$96
Clays [3]	thousand short tons	906	2,406	936	2,158	984	2,397	920	1,801
Coal (bituminous)	do	63,032	256,158	69,212	270,875	77,350	295,743	82,747	309,896
Fluorspar	short tons	31,169	1,420	33,830	1,492	35,072	1,537	38,214	1,693
Lead (recoverable content of ores, etc.)	do	656	135	743	137	831	179	858	225
Natural gas	million cubic feet	70,937	17,592	70,241	17,419	74,634	17,838	77,360	18,257
Petroleum (crude)	thousand 42-gallon barrels	18,344	54,482	17,789	52,478	18,344	53,564	19,772	56,746
Sand and gravel	thousand short tons	5,582	5,540	6,137	5,378	6,480	6,071	6,560	6,297
Silver (recoverable content of ores, etc.)	thousand troy ounces	2	2	1	2	2	2	2	2
Stone	thousand short tons	17,085	23,309	19,472	27,682	24,689	34,571	[5] 21,868	[5] 29,594
Zinc (recoverable content of ores, etc.)	short tons	1,147	264	1,172	270	1,461	336	2,063	561
Value of items that cannot be disclosed: Cement, ball clay, gem stones (1961–63), natural gas liquids, and stone (dimension sandstone 1964)		XX	22,450	XX	20,609	XX	20,370	XX	19,211
Total		XX	383,788	XX	398,536	XX	r 432,693	XX	444,379

LOUISIANA

Clays	thousand short tons	645	$645	638	$641	655	$655	780	$797
Lime	do	636	6,292	624	6,519	657	6,862	725	8,312
Natural gas	million cubic feet	3,271,857	611,837	3,525,456	694,515	3,928,427	777,829	4,175,412	793,328
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	931,176	61,714	1,010,137	74,726	1,143,707	81,332	1,352,980	91,931
LP gases	do	806,559	33,214	862,772	29,037	1,113,670	41,043	1,247,484	45,935
Petroleum (crude)	thousand 42-gallon barrels	424,962	1,338,160	477,153	1,502,568	515,057	1,608,120	549,698	1,709,622
Salt	thousand short tons	4,722	23,357	5,248	27,407	6,199	30,450	6,401	36,056
Sand and gravel	do	12,042	14,833	12,040	14,817	12,500	14,701	13,594	15,253
Stone [5]	do	4,641	7,656	5,711	8,067	5,408	7,961	5,459	7,228
Sulfur (Frasch process)	thousand long tons	2,352	55,164	2,262	49,772	2,445	48,905	2,733	54,996
Value of items that cannot be disclosed: Cement, gypsum, and stone (crushed miscellaneous)		XX	15,807	XX	18,554	XX	20,531	XX	21,549
Total		XX	2,168,679	XX	2,426,623	XX	r 2,638,389	XX	2,785,007

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MAINE								
Beryllium concentrate—short tons, gross weight	5	$3	W	W				
Clays—thousand short tons	43	51	48	$63	42	$55	45	$58
Gem stones	(4)	20	(4)	25	(4)	25	(4)	35
Mica:								
Scrap—short tons	80	2	15	(5)				
Sheet—pounds	9,680	88	2,017	16				
Peat—short tons			1,250	47	W	W	6,350	171
Sand and gravel—thousand short tons	8,921	3,796	10,014	4,013	11,195	4,673	13,552	6,463
Stone—do	998	4,694	1,127	4,249	947	3,581	1,414	4,506
Value of items that cannot be disclosed: Cement, feldspar, and values indicated by symbol W	XX	6,961	XX	6,534	XX	5,770	XX	6,341
Total	XX	15,615	XX	14,947	XX	14,104	XX	17,574
MARYLAND								
Clays—thousand short tons	581	$997	593	$899	580	$897	[3] 635	[3] $798
Coal (bituminous)—do	757	2,868	821	3,168	1,162	4,330	1,136	4,511
Gem stones	(4)	3	(4)	3	(4)	3	(4)	3
Natural gas—million cubic feet	3,578	973	2,472	667	1,633	439	1,381	366
Sand and gravel—thousand short tons	12,404	16,894	12,762	16,816	13,310	16,063	15,041	18,071
Stone—do	10,007	20,373	11,610	22,595	13,012	26,407	13,348	26,715
Value of items that cannot be disclosed: Cement, ball clay (1964), diatomite (1962–63), lime, greensand marl, peat, potassium salts, and talc and soapstone	XX	20,750	XX	22,481	XX	22,111	XX	23,429
Total	XX	62,858	XX	66,629	XX	70,250	XX	73,893

MASSACHUSETTS

Clays—thousand short tons	104	$85	125	$96	157	$213	138	$174
Gem stones	(4)	2	(4)	2	(4)	2	(4)	2
Lime—thousand short tons	145	2,307	148	2,337	145	2,426	171	2,703
Sand and gravel—do	18,061	14,958	17,566	15,026	19,905	15,592	21,341	16,794
Stone—do	5,210	13,399	4,985	12,541	5,570	14,396	6,519	16,663
Value of items that cannot be disclosed: Nonmetals	XX	38	XX	33	XX	32	XX	31
Total	XX	30,789	XX	30,035	XX	32,661	XX	36,367

MICHIGAN

Cement:								
Portland—thousand 376-pound barrels	21,948	$75,172	22,682	$73,267	25,016	$76,944	26,745	$84,316
Masonry—thousand 280-pound barrels	1,515	4,467	1,517	4,335	1,684	4,519	1,865	4,954
Clays—thousand short tons	1,817	1,975	1,751	1,917	1,958	2,149	2,385	2,592
Copper (recoverable content of ores, etc.)—short tons	70,245	42,147	74,099	45,645	75,262	46,361	69,040	45,014
Gypsum—thousand short tons	1,295	5,095	1,278	4,791	1,315	4,938	1,421	5,263
Iron ore (usable)—thousand long tons, gross weight	9,384	87,604	9,422	85,597	10,789	107,201	13,871	143,979
Lime—thousand short tons	1,190	15,665	1,153	15,371	1,371	18,431	1,430	19,246
Magnesium compounds from sea water and brine (except for metal)—short tons, MgO equivalent	W	W	W	W	266,740	23,062	306,494	23,385
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	17,083	W			152,957	W		
Natural gas—million cubic feet	27,697	5,844	28,987	6,174	32,850	8,902	31,558	7,984
Peat—short tons	210,376	2,009	257,693	2,277	251,809	2,413	269,074	2,412
Petroleum (crude)—thousand 42-gallon barrels	18,901	55,191	17,114	48,775	15,972	45,520	15,601	43,839
Salt—thousand short tons	3,885	31,284	4,274	33,343	4,244	33,656	4,345	35,711
Sand and gravel—do	54,603	47,790	47,563	42,029	50,458	43,433	51,921	44,405
Silver (recoverable content of ores, etc.) thousand troy ounces			401	436	339	434	349	452
Stone—thousand short tons	28,731	30,103	28,440	29,055	30,316	32,065	34,650	37,002
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones, iodine, natural gas liquids, potassium salts, and values indicated by symbol W	XX	46,306	XX	53,500	XX	42,001	XX	54,941
Total	XX	450,652	XX	446,512	XX	r 492,029	XX	555,495

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MINNESOTA								
Clays—thousand short tons	[3] 176	[3] $241	203	$291	[3] 199	[3] $298	[3] 213	[3] $319
Iron ore (usable)—thousand long tons, gross weight	44,699	407,152	44,295	385,997	45,435	408,486	49,626	449,289
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	181,835	W	292,779	W	347,336	W	188,481	W
Peat—short tons	11,091	181	14,386	307	8,110	294	19,188	405
Sand and gravel—thousand short tons	30,690	24,143	29,399	22,656	30,462	23,318	35,817	25,907
Stone—do	3,957	9,975	3,803	10,360	3,898	11,027	3,588	12,297
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1961, 1963–64), gem stones, lime, and values indicated by symbol W	XX	9,222	XX	9,325	XX	10,120	XX	9,278
Total	XX	450,914	XX	428,936	XX	453,543	XX	497,495
MISSISSIPPI								
Clays—thousand short tons	1,104	$5,034	1,129	$5,742	1,235	$5,968	1,331	$6,130
Natural gas—million cubic feet	172,543	32,093	170,271	32,351	176,807	31,825	181,414	31,385
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	25,135	1,625	25,891	1,616	28,757	1,755	27,485	1,644
LP gases—do	15,510	700	20,401	732	24,541	956	23,277	780
Petroleum (crude)—thousand 42-gallon barrels	54,688	154,220	55,713	154,882	58,619	161,788	56,777	151,595
Sand and gravel—thousand short tons	5,920	5,903	7,001	7,262	6,825	7,056	7,825	8,569
Stone—do	913	1,044	1,199	1,266	1,267	1,267	1,553	1,557
Value of items that cannot be disclosed: Certain nonmetals	XX	7,961	XX	9,030	XX	[r] 9,579	XX	10,533
Total	XX	208,580	XX	212,881	XX	[r] 220,194	XX	212,193

Asphalt, native	short tons	W	W	W	W	1,779	$15	1,522	$13
Barite	do	227,323	$3,052	303,945	$3,994	286,750	3,680	266,814	3,451
Cement:									
Portland	thousand 376-pound barrels	11,839	41,142	12,739	44,004	12,402	41,640	12,378	42,618
Masonry	thousand 280-pound barrels	437	1,398	455	1,457	417	1,345	334	1,046
Clays	thousand short tons	2,132	5,040	2,053	5,033	1,746	4,467	1,966	4,874
Coal (bituminous)	do	2,938	12,567	2,896	12,057	3,174	13,196	3,254	13,285
Copper (recoverable content of ores, etc.)	short tons	1,479	887	2,752	1,695	1,816	1,119	2,059	1,343
Iron ore (usable)	thousand long tons, gross weight	341	3,633	346	3,188	345	3,085	1,116	14,907
Lead (recoverable content of ores, etc.)	short tons	98,785	20,350	60,982	11,221	79,844	17,246	120,148	31,479
Lime	thousand short tons	1,173	13,873	1,176	13,703	1,240	14,386	1,219	14,328
Natural gas	million cubic feet	90	22	92	23	100	27	108	26
Petroleum (crude)	thousand 42-gallon barrels	72	W	55	W	53	150	65	163
Sand and gravel	thousand short tons	9,371	10,688	10,304	11,572	10,653	12,260	11,483	13,380
Silver (recoverable content of ores, etc.)	thousand troy ounces	12	11	491	533	132	168		
Stone	thousand short tons	25,631	36,577	28,876	44,006	30,885	46,130	31,487	47,984
Zinc (recoverable content of ores, etc.)	short tons	5,847	1,345	2,792	642	321	74	1,501	408
Value of items that cannot be disclosed: Cobalt (1961), gem stones (1961–62), nickel (1961), and values indicated by symbol W		XX	703	XX	179	XX		XX	
Total		XX	151,288	XX	153,307	XX	r158,988	XX	189,305

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MONTANA								
Chromite—short tons, gross weight	[9] 82,000	[9] $2,939						
Clays [3]—thousand short tons	55	76	56	$77	38	$45	49	$59
Coal (bituminous and lignite)—do	371	1,207	382	1,140	343	967	346	925
Copper (recoverable content of ores, etc.)—short tons	104,000	62,400	94,021	57,917	79,762	49,133	103.806	67,682
Fluorspar—do	14,905	W	W	W	W	W	W	W
Gold (recoverable content of ores, etc.)—troy ounces	35,377	1,238	24,387	854	18,520	648	29,115	1,019
Iron ore (usable)—thousand long tons, gross weight	34	209	9	62	13	89	15	99
Lead (recoverable content of ores, etc.)—short tons	2,643	544	6,121	1,126	5,000	1,080	4,538	1,189
Lime—thousand short tons	118	986	104	1,049	114	1,290	136	1,385
Manganese ore (35 percent or more Mn) short tons, gross weight	17,515	1,372	24,758	W	5,260	W	20,264	W
Manganiferous ore (5 to 35 percent Mn)—do	2,236	33	2,264	29	1,688	W	3,638	W
Natural gas—million cubic feet	33,901	2,509	29,955	2,217	30,026	2,253	25,188	1,965
Peat—short tons	7,385	112	W	W	W	W	W	W
Petroleum (crude)—thousand 42-gallon barrels	30,906	74,793	31,648	76,690	30,870	75,323	30,647	74,621
Sand and gravel—thousand short tons	14,702	13,506	18,473	17,642	14,319	13,756	16,017	17,840
Silver (recoverable content of ores, etc.) thousand troy ounces	3,490	3,227	4,561	4,948	4,242	5,426	5,290	6,840
Stone—thousand short tons	1,512	1,849	996	1,708	6,109	7,081	7,345	8,477
Uranium ore—short tons	729	10	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.)—do	10,262	2,360	37,678	8,666	32,941	7,576	29,059	7,904
Value of items that cannot be disclosed: Barite, cement, chromite, [9] clays (fire clay, bentonite 1964), gem stones, gypsum, sheet mica (1961–62), natural gas liquids, phosphate rock, pumice (1964), rare-earth metal concentrates (1962), talc, tungsten (1961–62), vermiculite, and values indicated by symbol W	XX	14,863	XX	16,531	XX	[r] 17,351	XX	21,430
Total	XX	184,233	XX	190,656	XX	[r] 182,018	XX	211,435

NEBRASKA

Clays—thousand short tons	146	$148	142	$142	148	$148	143	$143
Gem stones	(4)	5	(4)	5	(4)	5	(4)	5
Natural gas—million cubic feet	15,743	2,629	14,880	2,708	13,051	2,454	11,155	1,707
Natural gas liquids:								
Natural gasoline—thousand gallons	W	W	12,239	809	10,119	687	9,587	627
LP gases—do	W	W	28,718	1,329	25,931	1,207	24,556	1,092
Petroleum (crude)—thousand 42-gallon barrels	24,369	69,452	24,894	70,450	21,846	61,824	19,113	51,605
Sand and gravel—thousand short tons	10,094	8,250	12,853	9,797	11,166	10,680	14,641	15,748
Stone—do	3,622	6,324	3,670	6,626	3,700	6,192	3,779	6,417
Value of items that cannot be disclosed: Cement, lime, pumice, and values indicated by symbol W	XX	18,637	XX	16,507	XX	15,710	XX	14,615
Total	XX	105,445	XX	108,373	----------	r98,907	XX	91,959

NEVADA

Antimony ore and concentrate short tons, antimony content	----------	----------	----------	----------	----------	----------	33	$20
Barite—short tons	129,524	$863	137,727	$954	120,450	$760	148,974	1,261
Copper (recoverable content of ores, etc.)—do	78,022	46,813	82,602	50,883	81,738	50,351	67,272	43,861
Fluorspar—do	18,129	357	W	W	W	W	W	W
Gem stones	(4)	100	(4)	100	(4)	100	(4)	100
Gold (recoverable content of ores, etc.)—troy ounces	54,165	1,896	62,863	2,200	98,879	3,461	90,469	3,166
Gypsum—thousand short tons	729	2,625	817	2,952	890	3,216	799	2,894
Iron ore (usable)—thousand long tons, gross weight	845	4,608	617	3,238	772	3,921	911	5,048
Lead (recoverable content of ores, etc.)—short tons	1,791	369	771	142	1,126	243	809	212
Manganese ore (35 percent or more Mn) short tons, gross weight	28,573	1,852	----------	----------	----------	----------	----------	----------
Mercury—76-pound flasks	7,486	1,480	6,573	1,257	4,944	937	3,262	1,027
Perlite—short tons	29,544	240	25,067	205	22,910	192	15,603	135
Petroleum (crude)—thousand 42-gallon barrels	154	W	141	W	118	W	255	W
Sand and gravel—thousand short tons	7,095	7,443	7,850	9,655	9,688	10,513	14,142	14,427
Silver (recoverable content of ores, etc.) thousand troy ounces	388	359	245	266	215	275	172	223
Stone—thousand short tons	677	1,576	722	1,220	639	1,101	788	1,396
Sulfur ore—long tons	W	W	W	W	586	11	274	5
Talc and soapstone—short tons	3,090	33	6,157	55	4,243	50	5,322	58
Tungsten ore and concentrate short tons, 60-percent WO_3 basis	W	W	156	234	W	W	W	W
Zinc (recoverable content of ores, etc.)—short tons	453	104	281	65	571	131	582	158
Value of items that cannot be disclosed: Clays, diatomite, lime, magnesite, molybdenum, peat (1964), pumice, salt, uranium ore (1961, 1963-64), and values indicated by symbol W	XX	10,815	XX	9,648	XX	r10,215	XX	11,146
Total	XX	81,533	XX	83,074	XX	r85,477	XX	85,137

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW HAMPSHIRE								
Beryllium concentrate—short tons, gross weight	23	$14	7	$4				
Clays—thousand short tons	30	30	37	37	r 47	r $40	46	$40
Feldspar—long tons	10,290	62	W	W	W	W	W	W
Mica:								
Sheet—pounds	105,943	1,009	37,508	396				
Scrap—short tons	669	20	411	11				
Peat—do	15	W						
Sand and gravel—thousand short tons	7,701	3,627	8,260	4,119	7,581	4,376	8,768	4,996
Stone—do	117	684	154	1,368	137	1,566	202	2,138
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W	XX	20	XX	97	XX	109	XX	128
Total	XX	5,466	XX	6,032	XX	r 6,091	XX	7,302
NEW JERSEY								
Clays—thousand short tons	657	$1,681	584	$1,476	498	$1,392	500	$1,441
Gem stones	(4)	9	(4)	9	(4)	9	(4)	10
Peat—short tons	21,257	212	29,099	247	23,685	241	W	W
Sand and gravel—thousand short tons	12,257	20,895	13,728	21,230	16,672	25,245	17,661	27,079
Stone—do	11,315	24,539	14,214	28,979	11,229	25,654	12,326	28,461
Zinc (recoverable content of ores, etc.) [10]—short tons	112	26	15,309	3,559	32,738	7,855	32,926	8,935
Value of items that cannot be disclosed: Iron ore, lime, magnesium compounds, manganiferous residuum, greensand marl, titanium concentrate (ilmenite 1962–64) and values indicated by symbol W	XX	11,908	XX	10,186	XX	12,880	XX	12,246
Total	XX	59,270	XX	65,686	XX	73,276	XX	78,172

Barite	short tons	600	$10	252	$4	600	$6	W	W
Beryllium concentrate	short tons, gross weight	24	12	34	19				
Carbon dioxide, natural	thousand cubic feet	242,903	24	826,810	74	854,339	63	816,168	$61
Clays	thousand short tons	[3] 67	[3] 165	52	156	W	140	[3] 104	[3] 167
Coal (bituminous)	do.	412	2,477	677	2,595	1,945	5,629	2,969	9,763
Copper (recoverable content of ores, etc.)	short tons	79,606	47,764	82,683	50,933	83,037	51,151	86,104	56,140
Fluorspar	do.							137	3
Gem stones		[4]	46	[4]	45	[4]	45	[4]	45
Gold (recoverable content of ores, etc.)	troy ounces	6,201	217	7,529	264	7,805	273	6,110	214
Gypsum	thousand short tons	105	386	151	564	179	656	W	W
Helium	thousand cubic feet	42,224	762	27,377	958	79,624	2,787	84,526	2,958
Iron ore (usable)	thousand long tons, gross weight	[5]	W	9	121	W	W	W	W
Lead (recoverable content of ores, etc.)	short tons	2,332	480	1,134	209	1,014	219	1,626	426
Lime	thousand short tons	25	350	29	403	27	377	25	352
Manganese ore (35 percent or more Mn)	short tons, gross weight			W	W	5,362	137	5,794	149
Manganiferous ore (5 to 35 percent Mn)	do.	W	W	W	W	41,144	W	46,657	300
Mica: Scrap	short tons	1,800	52	5,731	140	W	W	6,922	105
Natural gas	million cubic feet	789,662	86,073	804,612	92,530	808,377	96,197	878,720	101,932
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	301,404	18,619	273,969	16,775	291,388	17,555	356,047	21,570
LP gases	do.	656,751	24,154	661,330	20,359	728,200	21,801	739,190	21,641
Perlite	short tons	245,654	2,159	258,164	2,143	259,113	2,212	286,329	2,568
Petroleum (crude)	thousand 42-gallon barrels	112,553	322,142	109,328	314,883	109,941	316,574	113,863	326,565
Potassium salts	thousand short tons, K_2O equivalent	2,523	96,380	2,208	85,124	r 2,643	r 101,458	2,675	104,866
Pumice	thousand short tons	339	879	308	741	322	850	260	760
Salt	do.	33	284	43	334	r 54	r 472	62	559
Sand and gravel	do.	12,523	10,049	6,889	8,021	8,402	12,843	8,781	10,160
Silver (recoverable content of ores, etc.)	thousand troy ounces	283	261	302	327	256	328	242	313
Stone	thousand short tons	1,853	2,206	2,004	2,782	2,509	4,236	2,760	4,244
Uranium ore	short tons	3,631,036	62,482	3,478,238	63,504	2,304,577	41,372	2,093,350	38,203
Vanadium (recoverable in ore and concentrate)	do.	W	W	W	W	23	W	W	154
Zinc (recoverable content of ores, etc.)	do.	22,900	5,267	22,015	5,063	12,938	2,976	29,833	8,115
Value of items that cannot be disclosed: Cement, fire clay (1961, 1964), molybdenum, magnesium compounds (1961), sheet mica (1962, and values indicated by symbol W		XX	7,213	XX	6,743	XX	8,249	XX	7,791
Total		XX	690,913	XX	675,814	XX	r 688,606	XX	720,124

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW YORK								
Clays—thousand short tons	1,037	$1,373	1,397	$1,618	1,598	$2,186	1,499	$1,993
Emery—short tons	6,180	106	4,316	71	6,732	119	9,214	172
Gem stones	[4]	10	[4]	10	[4]	10	[4]	10
Gypsum—thousand short tons	663	3,441	601	3,122	647	3,339	653	3,321
Iron ore (usable)—thousand long tons, gross weight	1,973	25,548	2,099	24,953	W	W	W	W
Lead (recoverable content of ores, etc.)—short tons	879	181	1,063	196	1,009	218	732	192
Natural gas—million cubic feet	5,742	1,694	4,262	1,198	3,962	1,169	3,125	963
Peat—short tons	11,209	123	14,400	113	21,358	178	32,574	261
Petroleum (crude)—thousand 42-gallon barrels	1,658	7,892	1,589	7,309	1,679	7,707	1,874	8,321
Salt—thousand short tons	4,149	30,761	4,456	32,236	4,782	34,228	4,816	34,216
Sand and gravel—do	28,043	30,471	29,447	31,346	37,381	37,274	39,282	38,583
Silver (recoverable content of ores, etc.) thousand troy ounces	41	37	19	21	20	25	13	17
Stone—thousand short tons	26,951	43,734	27,589	47,256	26,611	44,549	29,141	46,669
Zinc (recoverable content of ores, etc.)—short tons	54,763	12,595	53,654	12,340	53,495	12,304	60,754	16,525
Value of items that cannot be disclosed: Beryllium concentrate (1961), cement, abrasive garnet, lime, talc, titanium concentrate, wollastonite, and values indicated by symbol W	XX	75,867	XX	79,183	XX	115,768	XX	137,202
Total	XX	233,833	XX	240,972	XX	r 259,074	XX	288,445
NORTH CAROLINA								
Abrasive stones (millstones)—short tons	[4]	$3	[4]	$2	[4]	$2		
Clays [3]—thousand short tons	2,603	1,669	2,731	1,782	2,735	1,761	3,199	$2,064
Feldspar—long tons	251,858	2,477	244,708	2,373	267,654	2,821	324,149	3,085
Gem stones	[4]	6	[4]	2	[4]	14	[4]	15
Gold (recoverable content of ores, etc.)—troy ounces	2,094	73	460	16	33	1		
Iron ore (usable)—thousand long tons	W	1	1	13	1	10		
Lead (recoverable content of ores, etc.)—short tons	318	66	219	40	62	13		
Mica:								
Scrap—do	53,615	1,010	61,983	1,384	61,598	1,497	64,010	2,027
Sheet—pounds	390,870	2,237	320,305	867	92,961	13	242,662	58
Phosphate rock—thousand long tons							6	41
Sand and gravel—thousand short tons	9,779	8,467	12,516	11,457	11,028	10,132	11,150	10,404
Silver (recoverable content of ores, etc.) thousand troy ounces	170	157	100	109	27	34		
Stone—thousand short tons	15,921	25,262	19,308	29,533	15,701	25,683	[5] 17,943	[5] 30,378

Talc and pyrophyllite—short tons	90,711	367	100,298	433	106,652	446	106,035	495
Zinc (recoverable content of ores, etc.)—do					13	3		
Value of items that cannot be disclosed: Asbestos, barite (1961), cement (1963–64), clay (kaolin), copper (1961–63), lithium minerals, olivine, stone (crushed and dimension marble and dimension slate 1964), tungsten concentrate, and values indicated by symbol W	XX	8,329	XX	6,586	XX	r 2,095	XX	7,903
Total	XX	50,124	XX	54,597	XX	r 44,525	XX	56,470
NORTH DAKOTA								
Clays—thousand short tons	W	W	98	$124	[3] 5	[3] $10	85	$119
Coal (lignite)—do	2,726	$6,141	2,733	6,135	2,399	5,250	2,637	5,659
Gem stones	[4]	1	[4]	1	[4]	1	[4]	1
Natural gas—million cubic feet	20,100	2,533	25,155	3,446	32,798	6,264	34,700	7,634
Natural gas liquids:								
Natural gasoline—thousand gallons	W	W	16,872	1,085	20,511	1,339	21,368	1,338
LP gases—do	W	W	68,881	2,665	79,653	3,166	84,338	2,960
Petroleum (crude)—thousand 42-gallon barrels	23,652	64,333	25,181	69,248	25,030	68,332	25,731	63,813
Sand and gravel—thousand short tons	9,395	7,507	9,615	7,122	9,529	9,193	10,520	10,142
Stone—do	40	40	19	19	132	132	31	56
Uranium ore—short tons			W	W	5,567	141	W	W
Value of items that cannot be disclosed: Clays (bentonite 1963, miscellaneous clay 1963), peat (1963–64), salt, and values indicated by symbol W	XX	4,370	XX	774	XX	875	XX	1,144
Total	XX	84,925	XX	90,619	XX	r 94,703	XX	92,866
OHIO								
Cement:								
Portland—thousand 376-pound barrels	15,303	$53,251	15,353	$51,006	16,218	$53,244	15,553	$50,647
Masonry—thousand 280-pound barrels	846	2,604	946	2,793	1,023	3,084	1,068	3,127
Clays—thousand short tons	4,923	13,790	4,751	12,979	4,841	13,959	5,005	14,426
Coal (bituminous)—do	32,226	121,343	34,125	127,051	36,790	136,113	37,310	137,776
Gem stones	[4]	4	[4]	3	[4]	3	[4]	3
Lime—thousand short tons	3,048	41,266	3,102	43,792	3,207	45,957	3,664	53,308
Natural gas—million cubic feet	36,423	9,069	36,747	9,407	36,817	8,909	37,309	8,880
Peat—short tons	9,113	123	7,383	106	6,910	109	6,363	83
Petroleum (crude)—thousand 42-gallon barrels	5,639	17,425	5,835	18,089	6,039	19,023	15,859	46,420
Salt—thousand short tons	3,465	25,037	4,187	28,706	4,245	29,682	4,537	31,092
Sand and gravel—do	33,688	41,272	35,204	43,333	37,790	44,368	37,771	45,567
Stone—do	33,652	55,701	34,470	57,202	37,537	62,787	[5] 37,715	[5] 61,814
Value of items that cannot be disclosed: Abrasive stones, gypsum, stone (calcareous marl 1964)	XX	1,566	XX	1,588	XX	1,742	XX	1,794
Total	XX	382,451	XX	396,055	XX	r 418,980	XX	454,937

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
OKLAHOMA								
Clays [3] thousand short tons	792	$801	737	$756	898	$911	835	$854
Coal (bituminous) do	1,032	6,784	1,048	6,978	1,008	5,667	1,028	5,474
Gypsum do	W	W	509	1,668	531	1,462	694	1,899
Helium thousand cubic feet	313,244	5,872	284,214	9,917	237,201	8,302	230,673	8,073
Lead (recoverable content of ores, etc.) short tons	980	202	2,710	499	3,192	689	2,781	729
Natural gas million cubic feet	892,697	108,016	1,060,717	135,772	1,233,883	160,405	1,323,390	166,747
Natural gas liquids:								
Natural gasoline and cycle products thousand gallons	521,237	33,358	552,795	35,764	555,467	35,131	554,053	34,011
LP gases do	817,082	30,141	838,903	25,223	810,894	28,981	880,804	28,055
Petroleum (crude) thousand 42-gallon barrels	193,081	561,866	202,732	591,977	201,962	587,709	202,524	587,320
Salt thousand short tons	3	19	5	25	4	26	6	41
Sand and gravel do	5,310	5,513	4,436	4,736	5,420	6,116	6,680	7,003
Stone do	14,981	16,561	14,666	18,819	13,817	16,160	13,987	15,087
Zinc (recoverable content of ores, etc.) short tons	3,148	724	10,013	2,303	13,245	3,046	12,159	3,307
Value of items that cannot be disclosed: Clay (bentonite), cement, gem stones (1961-62), lime, pumice, tripoli, and values indicated by symbol W	XX	21,920	XX	20,853	XX	22,929	XX	22,670
Total	XX	791,777	XX	855,290	XX	r 877,534	XX	881,270
OREGON								
Clays thousand short tons	294	$357	249	$305	279	$330	196	$262
Copper (recoverable content of ores, etc.) short tons	W	W	W	W	W	W	15	10
Diatomite do			50	2	150	3	W	W
Gold (recoverable content of ores, etc.) troy ounces	1,054	37	822	29	1,809	63	661	23
Lime thousand short tons	82	1,702	78	1,514	87	1,835	95	1,918
Mercury 76-pound flasks	138	27	W	W	W	W	126	40
Nickel (content of ore and concentrate) short tons	12,860	W	13,110	W	13,394	W	15,420	W
Perlite do			3	(6)			5	(6)
Pumice thousand short tons	203	461	W	W	422	664	566	909
Sand and gravel do	12,299	13,680	14,869	14,556	15,715	18,850	18,253	25,158
Silver (recoverable content of ores, etc.) thousand troy ounces	2	2	6	7	58	74	14	19
Stone thousand short tons	17,455	21,202	18,258	20,977	19,692	24,197	16,120	19,296
Tungsten concentrate short tons, 60-percent WO_3 basis							1	1
Uranium ore short tons	2,160	66	2,722	112	1,763	45	27	2

Zinc (recoverable content of ores, etc.)—do	3	1			3	1	W	W
Value of items that cannot be disclosed: Asbestos (1961), cement, gem stones, iron ore (pigment material 1961, 1963), lead (1961, 1963), vanadium (1964), and values indicated by symbol W	XX	15,557	XX	14,956	XX	16,630	XX	16,631
Total	XX	53,092	XX	52,458	XX	62,692	XX	64,269
PENNSYLVANIA								
Cement:								
Portland—thousand 376-pound barrels	36,635	$124,506	38,463	$127,969	38,316	$118,203	37,663	$113,409
Masonry—thousand 280-pound barrels	2,678	7,232	2,565	7,105	2,510	6,611	2,818	7,594
Clays[3]—thousand short tons	2,999	14,402	2,893	12,815	3,191	14,717	3,187	15,814
Coal:								
Anthracite—do	17,446	140,338	16,894	134,094	18,267	153,503	17,184	148,648
Bituminous—do	62,652	323,758	65,315	331,298	71,501	350,085	76,531	388,218
Copper (recoverable content of ores, etc.)—short tons	W	W	W	W	4,434	2,731	3,614	2,356
Gem stones	[4]	5	[4]	4	[4]	4	[4]	4
Lime—thousand short tons	1,093	16,428	1,104	16,647	1,188	17,548	1,440	20,656
Natural gas—million cubic feet	100,427	29,526	90,053	24,494	92,657	24,091	82,166	22,349
Natural gas liquids:								
Natural gasoline—thousand gallons	1,272	74	1,350	75	1,311	78	1,138	64
LP gases—do	1,453	115	1,521	112	1,721	118	1,481	100
Peat—short tons	27,993	291	32,936	369	33,952	339	39,500	397
Petroleum (crude)—thousand 42-gallon barrels	5,643	26,579	5,302	24,230	5,083	23,178	5,113	22,088
Sand and gravel—thousand short tons	12,594	19,766	14,419	23,587	14,066	23,539	16,199	26,414
Stone—do	41,834	71,344	48,144	82,087	49,536	83,450	52,829	91,075
Zinc (recoverable content of ores, etc.)[10]—short tons	23,428	5,408	24,308	5,652	27,389	6,572	30,754	8,345
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, graphite (1961), iron ore, scrap mica, pyrites, pyrophyllite, silver, tripoli, and values indicated by symbol W	XX	25,355	XX	32,966	XX	32,644	XX	34,519
Total	XX	805,127	XX	823,504	XX	r857,411	XX	902,050
RHODE ISLAND								
Gem stones	[4]	W	[4]	W	[4]	$1	[4]	W
Sand and gravel—thousand short tons	1,726	$1,666	2,346	$1,890	1,750	1,838	1,647	$1,613
Stone—do	W	W	[5] 304	[5] 483	442	968	450	935
Value of items that cannot be disclosed: Nonmetals and values indicated by symbol W	XX	1,413	XX	621	XX		XX	1
Total	XX	3,079	XX	2,994	XX	2,807	XX	2,549

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
SOUTH CAROLINA								
Clays—thousand short tons	1,346	$6,169	1,518	$7,165	1,491	$7,589	1,743	$8,309
Mica (sheet)—pounds	12	([6])						
Sand and gravel—thousand short tons	2,904	3,067	3,318	3,670	4,051	4,750	4,622	5,262
Stone—do	6,752	9,827	6,382	10,066	7,262	10,926	[5] 6,109	[5] 9,176
Value of items that cannot be disclosed: Barite, cement, feldspar, gem stones (1962–63), kyanite, scrap mica, peat, pyrites, stone (crushed limestone 1964), and vermiculite	XX	12,311	XX	13,000	XX	13,214	XX	15,966
Total	XX	31,374	XX	33,901	XX	36,479	XX	38,713
SOUTH DAKOTA								
Beryllium concentrate—short tons, gross weight	238	$130	144	$77	([6])	([6])	W	W
Cement:								
Portland—thousand 376-pound barrels	W	W	2,316	7,369	1,869	$5,909	2,001	$6,873
Masonry—thousand 280-pound barrels	W	W	60	197	60	198	57	200
Clays—thousand short tons	[3] 249	[3] 249	249	690	r 240	r $960	245	1,076
Coal (lignite)—do	18	75	18	77	16	62	13	63
Copper (recoverable content of ores, etc.)—short tons					1	([6])		
Feldspar—long tons	29,354	186	29,697	191	25,590	157	26,980	180
Gem stones	([4])	18	([4])	20	([4])	20	([4])	20
Gold (recoverable content of ores, etc.)—troy ounces	557,855	19,525	577,232	20,203	576,726	20,185	616,913	21,592
Gypsum—thousand short tons	22	89	23	93	24	97	19	76
Iron ore (usable)—thousand long tons	22	100	34	113				
Lead (recoverable content of ores, etc.)—short tons			3	1	4	1		
Mica:								
Scrap—short tons	1,054	32	210	6	W	W	996	32
Sheet—pounds	18,086	37	2,085	12	10,000	([6])		
Petroleum (crude)—thousand 42-gallon barrels	233	W	169	W	215	428	247	495
Sand and gravel—thousand short tons	11,324	7,336	15,371	9,207	20,806	16,313	13,770	13,641
Silver (recoverable content of ores, etc.) thousand troy ounces	127	118	113	123	117	150	133	172
Stone—thousand short tons	2,806	6,642	2,852	6,533	2,794	7,339	2,118	6,245
Uranium ore—short tons	43,588	495	29,452	370	72,088	1,931	110,147	1,551

Value of items that cannot be disclosed: Clays (bentonite 1961), lime, lithium minerals (1962–64), molybdenum (1964), vanadium, and values indicated by symbol W	XX	8,975	XX	505	XX	r 366	XX	608
Total	XX	44,007	XX	45,787	XX	r 54,116	XX	52,824

TENNESSEE

Barite—short tons	W	W	13,797	$229	24,082	$404	39,188	$519
Cement:								
Portland—thousand 376-pound barrels	8,357	$26,964	8,509	27,741	8,283	26,760	8,343	26,791
Masonry—thousand 280-pound barrels	1,018	2,753	1,089	2,931	1,161	3,079	1,212	3,228
Clays [3]—thousand short tons	1,040	4,190	1,037	4,597	1,238	5,248	1,310	5,576
Coal (bituminous)—do	5,860	20,681	6,214	22,555	6,121	22,689	5,990	22,674
Copper (recoverable content of ores, etc.)—short tons	12,272	7,363	14,208	8,808	13,717	8,450	13,889	9,056
Gem stones	[4]	1	[4]	1	[4]	[6]		
Gold (recoverable content of ores, etc.)—troy ounces	152	5	158	6	137	5	133	5
Lead (recoverable content of ores, etc.)—short tons			51	9				
Natural gas—million cubic feet	71	13	75	14	90	17	77	15
Petroleum (crude)—thousand 42-gallon barrels	17	W	14	W	16	W	10	W
Phosphate rock—thousand long tons	2,235	18,675	2,418	19,868	2,352	17,876	2,441	18,971
Sand and gravel—thousand short tons	6,232	8,046	6,075	8,018	7,613	9,443	7,972	10,245
Silver (recoverable content of ores, etc.) thousand troy ounces	83	77	112	122	108	138	91	117
Stone—thousand short tons	23,940	35,906	24,398	35,614	26,825	38,113	[5] 26,497	[5] 38,239
Zinc (recoverable content of ores, etc.)—short tons	81,734	18,799	71,548	16,456	95,847	22,045	115,943	31,536
Value of items that cannot be disclosed: Clay (fuller's earth 1961–64), iron ore (1961–63), lime, pyrites, stone (crushed sandstone 1964), and values indicated by symbol W	XX	7,238	XX	7,050	XX	r 6,458	XX	6,993
Total	XX	150,711	XX	154,019	XX	r 160,725	XX	173,965

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
TEXAS								
Cement:								
Portland—thousand 376-pound barrels	25,101	$80,808	26,204	$83,162	29,104	$92,734	30,030	$94,492
Masonry—thousand 280-pound barrels	851	2,529	926	2,774	930	2,858	930	2,805
Clays [3]—thousand short tons	3,786	5,737	3,744	5,634	4,199	6,849	4,156	6,695
Gem stones	(4)	150	(4)	150	(4)	150	(4)	140
Gypsum—thousand short tons	1,074	3,832	1,120	3,956	1,099	3,999	1,131	4,049
Helium—thousand cubic feet	173,066	3,196	245,623	8,552	264,342	9,252	304,909	10,672
Lime—thousand short tons	790	8,703	1,046	11,999	1,131	13,026	1,350	17,201
Natural gas—million cubic feet	5,963,605	733,523	6,080,210	747,866	6,205,034	775,629	6,525,649	809,180
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	3,111,427	214,279	3,205,517	233,345	3,320,416	218,975	3,512,460	232,245
LP gases—do	4,768,222	185,558	5,012,291	189,382	5,366,831	169,695	5,521,236	167,492
Perlite—short tons							300	3
Petroleum (crude)—thousand 42-gallon barrels	939,191	2,791,377	943,328	2,818,709	977,835	2,908,380	989,525	2,928,994
Salt—thousand short tons	4,695	17,682	5,553	19,485	5,965	22,355	6,410	28,797
Sand and gravel—do	27,398	30,691	30,076	33,097	33,256	36,311	29,155	33,394
Stone—do	38,316	45,874	38,067	48,988	43,142	54,007	40,240	52,070
Sulfur (Frasch process)—thousand long tons	2,730	62,720	2,655	57,297	2,550	50,109	3,126	62,232
Talc and soapstone—short tons	78,214	376	73,635	387	72,658	368	89,334	395
Values of items that cannot be disclosed: Native asphalt, barite, bromine, clay (fuller's earth), coal (lignite), feldspar (1961), graphite, iron ore, magnesium chloride (for metal), magnesium compounds (except for metal), pumice, sodium sulfate, and uranium ore	XX	50,923	XX	58,774	XX	62,777	XX	82,222
Total	XX	4,237,958	XX	4,323,557	XX	r 4,427,474	XX	4,533,078
UTAH								
Carbon dioxide, natural—thousand cubic feet	78,136	$5	81,920	$6	100,895	$7	96,432	$7
Clays—thousand short tons	143	1,080	174	1,403	[3] 125	[3] 470	[3] 1,127	[3] 330
Coal (bituminous)—do	5,159	31,126	4,297	23,209	4,360	22,755	4,720	33,184
Copper (recoverable content of ores, etc.)—short tons	213,534	128,120	218,018	134,299	203,095	125,107	199,588	130,131
Fluorspar—do	610	18	399	12	247	7	W	W
Gem stones	(4)	73	(4)	75	(4)	75	(4)	75
Gold (recoverable content of ores, etc.)—troy ounces	342,988	12,005	311,924	10,917	285,907	10,007	287,674	10,069
Iron ore (usable)—thousand long tons, gross weight	3,533	25,493	2,630	18,242	1,881	12,900	2,082	14,306
Lead (recoverable content of ores, etc.)—short tons	40,894	8,424	38,199	7,029	45,028	9,726	40,249	10,545
Lime—thousand short tons	142	2,626	163	2,759	156	2,668	163	2,917
Natural gas—million cubic feet	57,175	8,976	74,128	12,454	77,122	14,036	80,175	10,904

Perlite—short tons	W	W	929	3	1,313	7	2,003	12
Petroleum (crude)—thousand 42-gallon barrels	33,118	91,075	31,029	85,019	33,435	90,943	28,575	74,867
Pumice—thousand short tons	60	95	28	46	28	46	W	W
Salt—do	249	3,187	311	3,349	325	3,462	371	3,848
Sand and gravel—do	18,325	16,979	19,941	20,954	11,709	10,408	10,218	10,405
Silver (recoverable content of ores, etc.) thousand troy ounces	4,798	4,435	4,628	5,022	4,791	6,128	4,552	5,886
Stone—thousand short tons	1,808	3,219	2,118	3,865	2,346	4,040	3,105	6,930
Uranium ore—short tons	1,098,783	25,734	781,955	23,653	743,792	23,852	761,180	26,385
Vanadium (recoverable in ore and concentrate)—do	514	W	525	W	382	W	405	1,214
Zinc (recoverable content of ores, etc.)—do	37,239	8,565	34,313	7,892	36,179	8,321	31,428	8,548
Value of items that cannot be disclosed: Asphalt (gilsonite), barite (1961–62), cement, clay (fire clay 1963–64), gypsum, molybdenum, natural gas liquids, phosphate rock, potassium salts, and values indicated by symbol W	XX	45,554	XX	50,382	XX	40,458	XX	40,867
Total	XX	416,789	XX	410,590	XX	r 385,423	XX	391,430

VERMONT

Gem stones	(4)	$2	(4)	$2	(4)	W	(4)	W
Peat—short tons							286	$4
Sand and gravel—thousand short tons	2,232	1,567	1,430	1,076	2,375	$1,410	1,764	1,494
Stone—do	2,731	18,715	1,715	19,815	2,159	19,193	2,070	20,652
Value of items that cannot be disclosed: Asbestos, clays, lime, talc, and values indicated by symbol W	XX	4,012	XX	4,237	XX	3,788	XX	3,977
Total	XX	24,296	XX	25,130	XX	24,391	XX	26,127

VIRGINIA

Aplite—long tons	97,465	$651	125,156	$912	W	W	W	W
Clays—thousand short tons	1,406	1,332	1,464	1,444	1,410	$1,558	1,440	$1,614
Coal (bituminous)—do	30,332	126,121	29,474	117,560	30,531	120,972	31,654	123,123
Gem stones	(4)	6	(4)	6	(4)	6	(4)	6
Lead (recoverable content of ores, etc.)—short tons	3,733	769	4,059	747	3,500	756	3,857	1,010
Lime—thousand short tons	657	7,375	615	7,668	639	8,058	780	9,781
Natural gas—million cubic feet	2,466	668	2,499	677	2,085	488	1,609	479
Petroleum (crude)—thousand 42-gallon barrels	2	W	3	W	3	W	6	W
Sand and gravel—thousand short tons	9,839	14,697	9,745	16,375	10,400	17,752	10,588	13,722
Soapstone—short tons	W	W	W	W	3,696	9	3,775	9
Stone—thousand short tons	22,934	39,206	25,766	43,121	27,653	45,529	30,407	52,153
Zinc (recoverable content of ores, etc.) [10]—short tons	29,163	6,726	26,479	6,141	23,988	5,725	21,004	5,700
Value of items that cannot be disclosed: Cement, feldspar, gypsum, iron ore (pigment materials), kyanite, sheet mica (1961), pyrites (1961–62), salt, titanium concentrate, and values indicated by symbol W	XX	27,747	XX	27,843	XX	r 28,211	XX	29,818
Total	XX	225,298	XX	222,494	XX	r 229,064	XX	237,415

See footnotes at end of table.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WASHINGTON								
Barite short tons	5,100	$42	W	W				
Clays[2] thousand short tons	145	138	103	$100	134	$123	128	$119
Coal (bituminous) do	191	1,381	235	1,630	190	1,380	68	575
Copper (recoverable content of ores, etc.) short tons	66	40	41	25	W	W	35	23
Lead (recoverable content of ores, etc.) do	8,053	1,659	6,033	1,110	5,374	1,161	5,731	1,502
Peat do	57,393	363	41,962	288	37,248	188	35,609	170
Pumice thousand short tons	W	W	10	130	W	W	W	W
Sand and gravel do	18,994	16,145	19,580	18,145	22,760	20,490	31,920	25,971
Stone do	11,464	14,758	12,749	18,180	12,934	16,346	10,276	14,871
Talc and soapstone short tons	2,927	23	2,835	11	2,969	18	2,080	18
Uranium ore do	175,327	3,582	110,948	2,050	117,286	2,545	147,005	3,601
Zinc (recoverable content of ores, etc.) do	20,217	4,650	21,644	4,978	22,270	5,122	24,296	6,609
Value of items that cannot be disclosed: Abrasive stones (1961–63), carbon dioxide, cement, clays (fire clay, bentonite 1961), diatomite, epsom salts (1961–63), gem stones, gold, gypsum (1961–62), lime (1963–64), magnesite, olivine, petroleum (1961), silver, tungsten (1961), and values indicated by symbol W	XX	23,667	XX	21,827	XX	24,057	XX	27,518
Total	XX	66,448	XX	68,474	XX	71,430	XX	80,977
WEST VIRGINIA								
Clays thousand short tons	475	$2,193	447	$2,086	414	$2,044	[3] 261	[3] $309
Coal (bituminous) do	113,070	558,525	118,499	578,293	132,568	634,794	141,409	693,572
Natural gas million cubic feet	210,556	57,692	210,698	57,942	210,223	55,919	203,872	50,968
Natural gas liquids:								
Natural gasoline thousand gallons	34,095	2,296	32,921	2,216	W	W	W	W
LP gases do	342,646	17,826	344,969	17,475	W	W	W	W
Petroleum (crude) thousand 42-gallon barrels	2,760	11,426	3,470	13,880	3,350	13,367	3,370	12,975
Salt thousand short tons	899	3,510	1,042	4,635	W	W	1,033	3,666
Sand and gravel do	4,882	10,152	5,202	10,942	4,808	10,578	5,472	11,555
Stone[3] do	7,628	13,244	7,506	13,242	9,452	14,489	7,481	13,105
Value of items that cannot be disclosed: Calcium-magnesium chloride, cement, clay (fire clay 1964), gem stones, lime, stone (dimension sandstone) and values indicated by symbol W	XX	13,385	XX	14,753	XX	37,051	XX	36,541
Total	XX	690,250	XX	715,464	XX	r 768,242	XX	822,691

WISCONSIN

Abrasive stones	short tons	[11] 560	[11] $17	[11] 569	[11] $17	[12] 561	[12] $21	W	W
Clays	thousand short tons	126	130	137	156	111	140	119	$147
Iron ore (usable)	thousand long tons, gross weight	1,122	W	1,045	W	938	W	524	W
Lead (recoverable content of ores, etc.)	short tons	680	140	1,394	256	1,116	241	1,742	456
Peat	do	W	W	W	W	2,667	136	3,261	136
Sand and gravel	thousand short tons	39,978	28,457	33,649	24,408	r 35,363	r 24,863	34,348	24,695
Stone	do	13,418	19,686	13,392	19,709	13,583	18,744	13,901	20,232
Zinc (recoverable content of ores, etc.)	short tons	13,865	3,189	13,292	3,057	15,114	3,476	26,278	7,148
Value of items that cannot be disclosed: Abrasive stones (tube-mill liners, 1963), cement, gem stones, lime, and values indicated by symbol W		XX	21,892	XX	20,686	XX	19,220	XX	17,193
Total		XX	73,511	XX	68,289	XX	r 66,841	XX	70,007

WYOMING

Beryllium concentrate	short tons, gross weight	2	$1	1	(6)	(6)	(6)	W	W
Clays	thousand short tons	[3] 859	[3] 10,301	1,141	$11,138	r 1,187	r $12,385	1,271	$12,816
Coal (bituminous)	do	2,529	8,573	2,569	8,198	3,124	9,922	3,101	9,774
Copper (recoverable content of ores, etc.)	short tons	1	1					5	3
Gem stones		(4)	83	(4)	85	(4)	110	(4)	120
Gold (recoverable content of ores, etc.)	troy ounces	1	(6)		4		(6)	6	(6)
Iron ore (usable)	thousand long tons, gross weight	W	W	739	6,441	1,604	17,504	2,056	24,543
Natural gas	million cubic feet	194,674	24,334	204,996	29,929	209,060	29,687	232,878	29,808
Natural gas liquids:									
Natural gasoline	thousand gallons	76,349	4,705	78,780	4,935	86,014	5,523	86,803	5,607
LP gases	do	132,831	5,451	149,438	5,762	150,437	6,203	152,982	6,433
Petroleum (crude)	thousand 42-gallon barrels	141,937	354,843	135,847	338,259	144,407	361,018	138,752	351,043
Pumice	thousand short tons	20	20	42	41	W	W	W	W
Sand and gravel	do	6,669	5,356	7,769	8,104	7,901	7,874	5,632	5,936
Stone	do	2,594	3,315	1,755	3,054	1,940	2,991	2,154	3,671
Uranium ore	short tons	1,521,064	28,218	1,301,784	25,715	r 1,173,420	r 23,849	1,490,353	27,911
Vanadium (recoverable in ore and concentrate)	do	W	W	W	442	W	435	W	359
Value of items that cannot be disclosed: Cement, clays (fire clay 1961, miscellaneous clay 1961), gypsum, lime, sheet mica (1961), phosphate rock, silver (1961, 1964), sodium carbonates and sulfates, vermiculite (1961–63), and values indicated by symbol W		XX	21,046	XX	20,467	XX	24,736	XX	26,822
Total		XX	466,247	XX	462,570	XX	r 502,237	XX	504,846

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] 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] Weight not recorded.

[5] Excludes certain stone, included with "Value of items that cannot be disclosed."

[6] Less than ½ unit.

[7] Includes 805 tons of low-grade beryllium ore in 1961, 760 tons in 1962, and 750 tons in 1963.

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

[9] Excludes quantity consumed by American Chrome Co.

[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 and tube-mill liners.

[12] 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]

Area and mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
American Samoa:								
Pumice thousand short tons			50	$108				
Sand and gravel do			3	4	77	$193	22	$20
Stone do	362	$286	1,103	1,788	944	2,351	157	234
Total	XX	286	XX	1,900	XX	2,544	XX	254
Canal Zone:								
Sand and gravel thousand short tons	75	73	70	77	84	87	84	82
Stone (crushed) do	163	271	207	359	162	281	153	349
Total	XX	344	XX	436	XX	368	XX	431
Canton: Stone (crushed) thousand short tons			(3)	(3)	2	6		
Guam:								
Sand and gravel do	38	49						
Stone do	292	591	82	123	307	439	469	868
Total	XX	640	XX	123	XX	439	XX	868
Johnston:								
Sand and gravel thousand short tons	1	1						
Stone do	1	2						
Total	XX	3						
Midway: Stone (crushed) thousand short tons	11	34						
Virgin Islands: Stone (crushed) do	20	75	21	82	66	329	69	342
Wake: Stone (crushed) do	24	62	5	41	9	51	2	5

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; Midway and Johnston, by U.S. Department of the Navy; Guam, by the Government of Guam; American Samoa, by the Government of American Samoa.

[3] Less than ½ unit.

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

Mineral	1961		1962		1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement----thousand 376-pound barrels	5,931	$16,946	6,347	$20,018	7,217	$22,090	7,926	$23,879
Clays----thousand short tons	184	112	219	131	200	158	341	271
Lime----do	1	15	1	14	4	103	18	574
Salt----do					8	131	5	74
Sand and gravel----do	11,370	10,385	7,378	9,793	7,616	10,407	7,816	11,492
Stone----do	5,049	7,284	5,589	8,551	5,334	8,237	5,504	8,586
Total	XX	34,742	XX	38,507	XX	41,126	XX	44,876

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

TABLE 8.—U.S. imports for consumption of principal minerals and products

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Metal—short tons	r 415,600	r $163,414	394,563	$163,419
Scrap—do	9,306	2,307	8,152	2,038
Plates, sheets, bars, etc—do	r 41,468	r 25,360	50,542	30,366
Antimony:				
Ore (antimony content)—do	9,784	2,675	10,676	3,294
Needle or liquated—do	22	11	31	21
Metal—do	5,717	2,968	3,307	2,481
Oxide—do	2,089	1,038	3,131	3,022
Arsenic: White (As_2O_3 content)—do	14,559	1,058	18,185	1,383
Bauxite: Crude—thousand long tons	r 9,212	r 114,546	10,262	128,787
Beryllium ore—short tons	6,243	1,672	5,425	1,372
Bismuth (general imports)—pounds	1,123,466	2,082	1,238,252	2,372
Boron carbide—do	13,468	39	4,845	19
Cadmium:				
Metal—thousand pounds	991	2,064	1,104	2,870
Flue dust (cadmium content)—do	r 1,104	r 863	1,272	1,545
Calcium:				
Metal—pounds	26,343	32	42,439	42
Chloride—short tons	2,234	67	2,718	92
Chromate:				
Ore and concentrate (Cr_2O_3 content)—do	605,349	20,135	645,693	22,713
Ferrochrome (chromium content)—do	19,945	6,807	17,696	5,783
Metal—do	860	1,308	732	1,109
Cobalt:				
Metal—thousand pounds	10,322	14,677	11,333	16,526
Oxide (gross weight)—do	468	451	1,514	1,422
Salts and compounds (gross weight)—do	94	45	94	43
Columbium ore—pounds	5,909,512	3,144	4,600,800	2,277
Copper (copper content):				
Ore and concentrates—short tons	r 6,490	r 3,714	42,936	19,845
Regulus, black, coarse—do	r 2,756	r 1,647	107	675
Unrefined, black, blister—do	r 21,831	r 13,109	121,365	73,300
Refined in ingots, etc—do	r 122,147	r 70,818	110,273	65,652
Old and scrap—do	r 2,130	r 1,219	5,195	3,118
Old brass and clippings—do	945	558	641	415
Ferroalloys: Ferrosilicon (silicon content)—do	2,376	744	3,044	908
Gold:				
Ore and base bullion—troy ounces	313,280	10,583	314,674	10,988
Bullion—do	967,339	33,831	854,211	29,900
Iron ore:				
Ore—thousand long tons	33,263	323,158	42,408	421,288
Pyrites cinder—long tons	3,511	48	8,635	49
Iron and steel:				
Pig iron—short tons	645,334	28,937	736,471	31,591
Iron and steel products (major):				
Iron products—short tons	r 57,040	r 10,332	46,055	11,242
Steel products—do	r 5,580,447	r 665,026	6,581,845	814,101
Scrap—do	195,383	5,701	259,178	7,781
Tinplate—do	21,824	403	22,561	472
Lead:				
Ore, flue dust, matte (lead content)—do	r 135,445	r 21,534	128,067	21,789
Base bullion (lead content)—do	3,758	1,792	7,043	2,058
Pigs and bars (lead content)—do	220,398	r 40,126	211,140	45,790
Reclaimed, scrap, etc. (lead content)—do	15,405	2,009	1,907	350
Sheets, pipe, and shot—do	2,429	513	1,523	369
Babbitt metal and solder (lead content)—short tons	1,246	3,207	1,619	5,785
Type metal and antimonial lead (lead content)—short tons	3,196	621	(1)	(1)
Manufactures—do	2,295	792	2,276	713
Magnesium:				
Metallic and scrap—short tons	r 1,850	r 733	2,227	890
Alloys (magnesium content)—do	r 485	r 660	474	710
Sheets, tubing, ribbons, wire and other forms (magnesium content)—short tons	18	112	40	70
Manganese:				
Ore (35 percent or more manganese) (manganese content)—short tons	1,124,109	67,406	1,430,431	76,977
Ferromanganese (manganese content)—short tons	115,377	16,974	162,075	25,811
Mercury:				
Compounds—pounds	14,899	37	8,625	30
Metal—76-pound flasks	42,872	6,766	41,153	8,775

See footnotes at end of table.

TABLE 8.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Minor metals: Selenium and salts—pounds	r 339,134	r $1,534	292,938	$1,289
Nickel:				
Ore and matte—short tons	34	3		
Pigs, ingots, shot, cathodes—do	108,127	161,804	104,627	155,973
Scrap—do	703	520	1,343	1,256
Oxide—do	12,887	13,753	16,862	17,504
Platinum group:				
Unrefined materials:				
Grains and nuggets, including crude, dust, and residues—troy ounces	r 51,552	r 3,757	35,916	3,341
Sponge and scrap—do	7,647	560	5,127	487
Osmiridium—do			935	35
Refined metal:				
Platinum—troy ounces	r 382,596	r 28,969	578,652	24,366
Palladium—do	r 505,449	11,088	477,198	13,300
Iridium—do	r 13,216	970	6,615	489
Osmium—do	2,091	50	1,399	113
Rhodium—do	r 36,861	r 4,851	55,804	7,955
Ruthenium—do	r 4,196	r 181	10,356	404
Radium:				
Radium salts—milligrams	44,660	304	(1)	(1)
Radioactive substitutes	(2)	1,081	(2)	1,869
Rare earths: Ferrocerium and other cerium alloys—pounds	16,430	49	9,621	48
Silver:				
Ore and base bullion—thousand troy ounces	41,660	47,708	43,146	54,235
Bullion—do	17,402	19,573	8,528	10,159
Tantalum: Ore—pounds	944,459	2,411	980,702	1,606
Tin:				
Ore (tin content)—long tons	3 793	3,077	4 5,190	11,539
Blocks, pigs, grains, etc—do	r 43,283	r 107,065	31,582	99,378
Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f.—long tons	r 2,683	1,703	1,210	714
Tinfoil, powder, flitters, etc	(2)	731	(2)	300
Titanium:				
Ilmenite—short tons	200,880	5,088	119,819	3,413
Rutile—do	71,990	4,921	110,981	7,724
Metal—pounds	r 2,935,825	2,535	4,111,285	3,711
Ferrotitanium—do	82,113	35	55,450	19
Compounds and mixtures—do	r 51,183,772	r 9,470	81,794,801	15,322
Tungsten: (tungsten content)				
Ore and concentrate—thousand pounds	3,060	1,579	3,148	2,008
Metal—pounds	r 147,837	274	65,418	131
Ferrotungsten—thousand pounds	882	609	195	136
Other alloys—pounds	41,556	40	29,048	27
Zinc:				
Ore (zinc content)—short tons	371,919	30,757	311,435	35,831
Blocks, pigs, and slabs—do	132,332	27,942	134,118	31,898
Sheets—do	1,532	413	1,774	527
Old, dross, and skimmings—do	2,876	446	3,775	652
Dust—do	2,608	589	3,269	797
Manufacturers	(2)	979	(2)	966
Zirconium: Ore, including zirconium sand—short tons	52,543	1,716	44,413	1,184
Nonmetals:				
Abrasives: Diamonds (industrial)—carats	r 11,846,153	r 49,884	14,374,281	60,051
Asbestos—short tons	667,860	61,739	739,361	72,973
Barite:				
Crude and ground—short tons	r 578,394	4,643	601,010	4,837
Witherite—do	2,690	114	2,407	98
Chemicals—do	r 4,647	543	5,190	529
Bromine—pounds	374,012	168	5 897	5 3
Cement—376-pound barrels	4,030,046	10,202	3,633,069	9,228
Clays:				
Raw—short tons	123,456	2,344	133,140	2,525
Manufactured—do	2,029	61	3,852	113
Cryolite—do	26,915	1,808	24,264	1,765
Feldspar: Crude—long tons	68	2	10	1
Fluorspar—short tons	r 559,653	r 14,192	687,933	16,882
Gem stones:				
Diamonds—carats	2,767,261	223,847	2,644,750	258,534
Emeralds—do	190,933	2,081	180,069	3,218
Other	(2)	29,864	(2)	36,634
Graphite—short tons	52,184	2,000	47,195	1,944

See footnotes at end of table.

TABLE 8.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued				
Gypsum:				
Crude, ground, calcined—short tons	5,490,524	$10,949	6,259,066	$13,358
Manufactures	(2)	1,408	(2)	1,329
Iodine, crude—thousand pounds	3,336	2,958	2,592	2,369
Kyanite—short tons	2,624	119	2,386	104
Lime:				
Hydrated—short tons	692	12	843	10
Other—do	90,676	1,005	93,420	1,112
Dead-burned dolomite—do	9,389	455	28,876	1,165
Magnesium:				
Magnesite—short tons	96,562	5,093	69,480	3,673
Compounds—do	13,552	496	12,591	556
Mica:				
Uncut sheet and punch—pounds	1,133,521	1,615	2,267,681	2,434
Scrap—short tons	8,150	132	2,733	71
Manufactures—do	4,353	5,950	4,433	4,566
Mineral-earth pigments: Iron oxide pigments:				
Natural—short tons	2,877	137	2,902	136
Synthetic—do	7,215	1,150	8,829	1,426
Ocher, crude and refined—do	144	8	191	18
Siennas, crude and refined—do	610	62	726	97
Umber, crude and refined—do	2,641	95	3,412	118
Vandyke brown—do	217	18	259	21
Nitrogen compounds (major), including urea—short tons	r 1,532,314	r 56,316	1,536,631	65,838
Phosphate, crude—long tons	160,708	3,651	155,819	3,329
Phosphatic fertilizers—do	64,144	3,302	70,512	4,010
Pigments and salts:				
Lead pigments and compounds—short tons	26,295	4,400	24,250	5,174
Zinc pigments and compounds—do	r 16,502	r 2,954	12,430	2,389
Potash—do	1,041,376	31,137	1,259,134	36,044
Pumice:				
Crude or unmanufactured—short tons	7,576	84	5,499	65
Wholly or partly manufactured—do	150,343	375	104,444	356
Manufactures, n.s.p.f.	(2)	47	(2)	20
Quartz crystal (Brazillian pebble)—pounds	712,897	547	783,940	512
Salt—short tons	r 1,516,159	r 5,112	2,339,877	5,677
Sand and gravel:				
Glass sand—short tons	22,724	69	40,308	128
Other sand and gravel—do	336,547	430	443,213	558
Sodium sulfate—thousand short tons	r 160	r 3,111	290	5,064
Stone and whiting	(2)	18,978	(2)	22,916
Strontium: Mineral—short tons	16,232	372	21,617	506
Sulfur and pyrites:				
Sulfur:				
Ores and other forms, n.e.s.—long tons	1,351,216	23,942	1,462,211	26,100
Pyrites—do	194,171	488	10,202	49
Talc: Unmanufactured—short tons	25,681	1,088	22,714	917
Fuels:				
Carbon black:				
Acetylene—pounds	6,233,224	1,104	6,878,084	1,184
Gas black and carbon black—do	1,261,215	216	1,337,683	225
Coal:				
Anthracite—short tons	[6] 4,625	[6] 44	----------	----------
Bituminous, slack, culm, and lignite—do	267,352	r 2,075	293,059	2,289
Briquets—do	4,620	82	11,593	182
Coke—do	152,595	2,047	103,286	1,509
Peat:				
Fertilizer grade—short tons	255,709	12,040	265,585	11,997
Poultry and stable grade—do	5,622	318	4,834	256
Petroleum—thousand 42-gallon barrels	r 775,036	1,781,685	827,244	2,171,339

r Revised figure.
1 No longer separately classified.
2 Weight not recorded.
3 Data reported as tin content Jan.-Aug.
4 Reported by the Bureau of the Census as gross weight, adjusted by the Bureau of Mines to tin content.
5 Not comparable to 1963.
6 Effective Sept. 1, 1963, data no longer separately classified

Source: Bureau of the Census.

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

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Ingots, slabs, crude—short tons	165,340	r $70,626	208,622	$92,227
Scrap—do	71,040	21,369	68,615	21,476
Plates, sheets, bars, etc—do	53,363	39,276	69,761	50,982
Castings and forgings—do	1,431	4,017	1,832	4,671
Antimony: Metals and alloys, crude—do	14	12	401	223
Arsenic: Calcium arsenate—pounds	186,577	18	1,537,484	96
Bauxite, including bauxite concentrates—long tons	203,196	15,696	293,542	23,300
Aluminum sulfate—short tons	17,576	559	16,511	531
Other aluminum compounds—do	228,076	20,635	240,581	23,334
Beryllium—pounds	100,323	457	170,699	630
Bismuth: Metals and alloys—do	32,293	42	47,958	77
Cadmium—thousand pounds	1,313	3,070	1,439	4,033
Calcium chloride—short tons	36,984	1,527	39,893	1,513
Chrome:				
Ore and concentrates:				
Exports—short tons	9,726	352	6,366	241
Reexports—do	r 63,764	r 2,505	32,116	1,256
Chromic acid—do	936	553	891	523
Ferrochrome—do	2,354	773	10,032	2,504
Cobalt—pounds	2,405,777	2,403	1,453,107	2,002
Columbium metals, alloys, and other forms—pounds	61,163	531	348,107	610
Copper:				
Ore, concentrate, composition metal, and unrefined copper (copper content)—short tons	1,210	638	5,395	2,971
Refined copper and semimanufactures—short tons	344,960	225,649	381,432	262,741
Other copper manufactures—do	5,811	4,273	4,470	3,668
Copper sulfate or blue vitriol—do	851	r 227	1,087	275
Copper base alloys—do	44,494	34,587	80,613	56,705
Ferroalloys:				
Ferrosilicon—pounds	6,260,880	948	11,569,493	1,232
Ferrophosphorus—do	82,722,701	1,302	326,332,849	4,938
Gold:				
Ore and base bullion—troy ounces	30,107	1,140	21,566	755
Bullion, refined—do	5,789,826	202,644	12,056,841	421,989
Iron ore—thousand long tons	r 6,812	r 76,340	6,963	79,670
Iron and steel:				
Pig iron—short tons	70,154	4,479	176,056	10,275
Iron and steel products (major):				
Semimanufactures—short tons	r 1,615,463	r 302,553	2,646,436	422,035
Manufactured steel mill products—short tons	r 1,054,482	r 309,642	1,264,427	440,549
Advanced products—do	(1)	r 165,433	(1)	206,378
Iron and steel scrap: Ferrous scrap, including rerolling materials—short tons	6,363,617	174,611	7,886,469	243,123
Lead:				
Ore, matte, base bullion (lead content)—short tons	4	(2)	19	4
Pigs, bars, anodes—do	1,088	313	10,175	2,813
Scrap—do	2,421	1,034	13,148	2,384
Magnesium:				
Metal and alloys and semimanufactured forms, n.e.c—short tons	r 16,174	r 9,787	16,811	10,202
Powder—do	33	87	8	29
Manganese:				
Ore and concentrates—do	8,296	926	14,444	1,451
Ferromanganese—do	678	155	3,903	670
Mercury:				
Exports—76-pound flasks	187	46	r 188	r 52
Reexports—do	r 40	r 6	196	50
Molybdenum:				
Ore and concentrates (molybdenum content)—pounds	26,545,066	39,360	24,939,780	40,987
Metals and alloys, crude and scrap—do	139,202	179	1,404,502	3,630
Wire—do	30,892	631	30,903	500
Semifabricated forms, n.e.c—do	9,109	110	34,950	290
Powder—do	16,741	58	310,957	1,178
Ferromolybdenum—do	239,034	379	1,745,611	3,328
Nickel:				
Ore—short tons	12	5	8	3
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc—short tons	59,107	27,279	66,108	35,412

See footnotes at end of table.

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

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Nickel—Continued				
Catalysts—short tons	905	$1,749	1,002	$2,013
Nickel-chrome electric resistance wire—do	189	953	445	1,929
Semifabricated forms, n.e.c.—do	714	3,199	939	4,754
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap—troy ounces	51,236	3,650	125,139	9,842
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap)—troy ounces	11,776	507	21,167	1,363
Platinum group manufactures, except jewelry	(1)	2,256	(1)	5,083
Radium metal (radium content)—milligrams	311	7	177	2
Rare earths:				
Cerium ore, metal, and alloys—pounds	128,612	41	1,637,142	400
Lighter flints—do	40,100	182	37,455	139
Silver:				
Ore and base bullion—thousand troy ounces	1,298	1,650	2,676	3,460
Bullion, refined—do	30,187	38,372	106,718	137,937
Tantalum:				
Ore, metal, and other forms—pounds	100,400	861	232,282	1,211
Powder—do	14,146	425	32,217	574
Tin:				
Ingots, pigs, bars, etc.:				
Exports—long tons	1,544	4,225	2,726	9,241
Reexports—do	81	207	1,315	6,225
Tin scrap and other tin-bearing material except tinplate scrap—long tons	5,862	2,423	4,844	2,151
Tin cans finished or unfinished—do	21,595	12,169	23,963	14,244
Titanium:				
Ore and concentrates—short tons	1,212	176	2,161	386
Sponge (including iodide titanium) and scrap—short tons	1,261	1,232	1,817	1,781
Intermediate mill shapes—do	417	2,322	790	3,696
Mill products, n.e.c.—do	77	1,122	75	1,302
Ferrotitanium—do	211	183	541	392
Dioxide and pigments—do	26,702	8,051	29,359	8,287
Tungsten: Ore and concentrate:				
Exports—do	r 49	r 65	77	145
Reexports—do			150	122
Vanadium ore and concentrate, pentoxide, etc. (vanadium content)—pounds	1,071,817	1,641	2,461,193	3,620
Zinc:				
Ore and concentrate (zinc content)—short tons	17	6	39	12
Slabs, pigs, or blocks—do	33,853	7,506	26,515	7,240
Sheets, plates, strips, or other forms, n.e.c.—short tons	3,756	2,742	6,569	3,978
Scrap (zinc content)—do	1,794	539	6,448	1,379
Dust—do	759	261	1,828	542
Semifabricated forms, n.e.c.—do	1,532	1,163	5,666	2,451
Zirconium:				
Ore and concentrate—short tons	1,418	305	2,500	352
Metals and alloys and other forms—pounds	r 298,466	2,500	533,449	3,191
Nonmetals:				
Abrasives:				
Grindstones—short tons	41	34	179	48
Diamond dust and powder—carats	r 1,110,237	r 3,020	1,892,097	4,097
Diamond grinding wheels—do	373,053	2,354	405,328	2,709
Other natural and artificial metallic abrasives and products	(1)	r 30,366	(1)	37,248
Asbestos: Unmanufactured:				
Exports—short tons	9,978	1,289	26,819	3,162
Reexports—do	66	15	328	37
Boron: Boric acid, borates, crude and refined—pounds	677,823,693	27,519	766,200,586	31,289
Bromine, bromides, and bromates—do	r 12,407,580	r 2,590	17,036,442	3,437
Cement—376-pound barrels	460,088	2,072	712,678	3,290
Clays:				
Kaolin or china clay—short tons	111,717	3,314	151,725	4,671
Fire clay—do	264,440	5,184	246,796	5,596
Other clays—do	363,191	12,875	449,537	14,706
Cryolite—do	3,719	689	3,385	744
Fluorspar—do	1,202	157	3,702	158

See footnotes at end of table.

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

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued				
Graphite:				
Amorphous short tons	533	$89	1,326	$194
Crystalline flake, lump or chip do	144	49	229	62
Natural, n.e.c do	222	51	409	77
Gypsum:				
Crude, crushed, or calcined thousand short tons	17	669	21	829
Manufactures, n.e.c	(1)	762	(1)	979
Iodine, iodide, iodates thousand pounds	141	327	147	343
Kyanite and allied minerals short tons	5,050	442	6,080	393
Lime do	17,463	565	29,858	777
Mica:				
Unmanufactured pounds	594,427	148	542,516	161
Manufactured:				
Ground or pulverized pounds	7,244,428	413	8,263,497	478
Other do	204,246	831	281,131	946
Mineral-earth pigments: Iron oxide, natural and manufactured short tons	4,189	1,306	5,097	1,817
Nitrogen compounds (major) do	824,295	41,357	1,182,425	67,636
Phosphate rock long tons	r 4,624,912	r 40,834	5,652,573	52,630
Phosphatic fertilizers (superphosphates) do	601,887	29,220	707,943	33,259
Pigments and compounds (lead and zinc):				
Lead pigments short tons	1,845	620	1,680	608
Zinc pigments do	3,801	963	3,619	899
Lead compounds do	401	135	936	278
Potash:				
Fertilizer short tons	707,039	22,202	1,026,446	32,563
Chemical do	14,703	3,317	22,033	5,024
Quartz crystal (raw)	(1)	525	(1)	558
Radioactive isotopes, etc curie	146,783	2,548	388,112	2,919
Salt:				
Crude and refined short tons	781,135	4,140	594,318	3,373
Shipments to noncontiguous Territories short tons	10,021	881	13,966	1,174
Sodium and sodium compounds:				
Sodium sulfate short tons	45,163	1,379	43,545	1,320
Sodium carbonate thousand short tons	184	5,722	273	8,368
Stone:				
Limestone, crushed, ground, broken short tons	762,658	1,753	1,369,728	2,079
Marble and other building and monumental cubic feet	452,167	1,669	441,312	2,027
Stone, crushed, ground, broken short tons	110,949	2,095	105,504	2,013
Manufactures of stone	(1)	585	(1)	677
Sulfur:				
Crude long tons	1,603,438	33,531	1,920,392	39,651
Crushed, ground, flowers of do	9,199	1,057	7,700	1,287
Talc:				
Crude and ground short tons	56,483	2,690	73,998	3,316
Manufactures, n.e.c do	107	88	128	75
Powders-talcum (face and compact)	(1)	1,140	(1)	1,068
Fuels:				
Carbon black thousand pounds	370,928	r 35,010	333,907	31,929
Coal:				
Anthracite short tons	r 3,357,340	r 43,719	1,575,097	22,060
Bituminous do	47,078,435	429,864	47,969,423	441,216
Briquets do	12,380	207	17,857	210
Coke do	451,241	8,318	523,695	10,093
Petroleum:				
Crude thousand 42-gallon barrels	1,697	4,616	1,361	3,806
Gasoline [4] do	6,418	44,720	7,125	50,070
Kerosine do	513	3,405	160	1,240
Distillate oil do	r 16,934	56,087	6,507	20,498
Residual oil do	15,281	36,411	19,135	41,853
Lubricating oil do	r 17,805	r 228,643	17,628	221,896
Asphalt do	656	3,847	614	4,909
Liquefied petroleum gases do	4,597	13,438	5,365	14,836
Wax do	1,455	29,094	1,736	32,849
Coke do	10,763	38,170	13,618	45,491
Petrolatum do	240	6,202	236	6,146
Miscellaneous do	566	r 15,442	561	16,223

r Revised.
[1] Weight not recorded.
[2] Less than ½ unit.
[3] Excludes 10,275 pounds of spent catalysts, valued at $12,272 and 171,152 pounds of residues, valued at $17,980.
[4] Includes naphtha, but excludes benzol: 1963 (revised figures)—1,752,372 barrels ($19,473,039); 1964—2,078,183 barrels ($22,336,739).

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

Mineral	1963			1964 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
Fuels:						
Carbon black--thousand pounds	NA	2,058,916	NA	NA	2,223,216	NA
Coal:						
Bituminous	1,938,849	456,223	24	2,012,093	484,048	24
Lignite	786,321	2,705	(1)	818,165	2,950	(1)
Pennsylvania anthractie	201,500	18,267	9	205,700	17,184	8
Coke (excluding breeze):						
Gashouse [2]	49,960	160	(1)	48,630	203	(1)
Oven and beehive	307,795	54,278	18	326,602	62,145	19
Fuel briquets and packaged fuel	133,900	565	(1)	129,900	368	(1)
Natural gas (marketable) million cubic feet	NA	14,746,663	NA	NA	15,546,592	NA
Peat	171,200	[3] 579	(1)	183,400	[3] 649	(1)
Petroleum (crude)--thousand 42-gallon barrels	9,537,420	2,752,723	29	10,327,591	2,805,125	27
Nonmetals:						
Asbestos	3,210	66	2	3,540	101	3
Barite	3,190	803	25	3,370	817	24
Cement [4]--thousand 376-pound barrels	2,209,950	368,406	17	2,374,109	385,387	16
China clay	NA	3,164	NA	NA	3,331	NA
Corundum	11			9		
Diamonds--thousand carats	36,661			36,285		
Diatomite	1,690	482	29	1,720	482	28
Feldspar--thousand long tons	1,690	549	32	1,770	630	36
Fluorspar	2,340	200	9	2,770	217	8
Graphite	780	W	W	600	W	W
Gypsum	49,900	10,388	21	51,530	10,684	21
Lime (sold or used by producers)	NA	14,521	NA	NA	16,089	NA
Magnesite	9,200	528	6	10,000	W	W
Mica (including scrap) thousand pounds	400,000	218,749	55	410,000	229,701	56
Nitrogen, agricultural [4] [5]	14,200	3,847	27	15,400	4,414	29
Phosphate rock thousand long tons	50,590	19,855	39	57,910	22,960	40
Potash (K_2O equivalent)	12,100	2,864	24	13,000	2,897	22
Pumice [6]	14,800	2,618	18	14,340	2,776	19
Pyrites--thousand long tons	19,600	825	4	20,000	847	4
Salt [4]	104,700	30,649	29	108,800	31,628	29
Strontium [6]	17			23		
Sulfur, elemental thousand long tons	12,600	5,829	46	13,800	6,250	45
Talc, pyrophyllite, and soapstone	3,330	804	24	3,760	890	24
Vermiculite [6]	327	226	69	343	226	66
Metals, mine basis:						
Antimony (content of ore and concentrate)--short tons	61,600	645	1	68,000	632	1
Arsenic, white [6]	52	W	W	58	W	W
Bauxite--thousand long tons	30,220	1,525	5	33,145	1,601	5
Beryllium concentrate short tons	7,700	751	10	[7] 5,700	W	W
Bismuth--thousand pounds	6,800	W	W	7,200	W	W
Cadmium--thousand pounds	26,600	9,990	38	27,900	10,458	37
Chromite	4,355			4,720		
Cobalt (contained) [6]--short tons	12,900	W	W	14,500	W	W
Columbium-tantalum concentrates [6]--thousand pounds	11,060			10,800		
Copper (content of ore and concentrate)	5,210	1,213	23	5,420	1,247	23
Gold--thousand troy ounces	44,200	1,469	3	46,100	1,469	3
Iron ore--thousand long tons	513,661	73,599	14	566,716	84,836	15
Lead (content of ore and concentrate)	2,805	253	9	2,735	286	10
Manganese ore (35 percent or more Mn)	16,138	11	(1)	16,687	26	(1)
Mercury thousand 76-pound flasks	239	19	8	251	14	6
Molybdenum (content of ore and concentrate)--thousand pounds	90,900	65,011	72	94,400	65,605	69
Nickel (content of ore and concentrate)	395	11	3	427	12	3

See footnotes at end of table.

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

Mineral	1963			1964 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						
Platinum groups (Pt, Pd, etc.) thousand troy ounces	1,545	50	3	2,050	40	2
Silver do	250,800	35,000	14	249,500	37,000	15
Tin (content of ore and concentrate) long tons	190,400	W	W	194,200	W	W
Titanium concentrates:						
Ilmenite [6]	2,186	888	41	2,576	1,001	39
Rutile [6]	222	12	5	212	8	4
Tungsten concentrate (60 percent WO_3) short tons	64,600	5,657	9	64,900	9,244	14
Vanadium (content of ore and concentrate) [6] short tons	7,155	3,853	54	7,600	4,362	57
Zinc (content of ore and concentrate)	4,020	529	13	4,395	575	13
Metals, smelter basis:						
Aluminum	6,080	2,313	38	6,730	2,553	38
Copper	5,480	1,297	24	5,750	1,338	23
Iron, pig (including ferroalloys)	310,121	73,853	24	350,092	87,922	25
Lead	2,750	395	14	2,830	449	16
Magnesium short tons	160,000	75,845	47	165,900	79,488	48
Selenium [6] thousand pounds	2,071	928	45	2,102	929	44
Steel ingots and castings	425,470	109,261	26	480,780	127,076	26
Tellurium [6] thousand pounds	318	201	63	279	145	52
Tin long tons	192,000	[8] 1,650	1	189,300	[8] 5,190	3
Uranium oxide (U_3O_8) [6] short tons	31,020	14,218	46	25,590	11,847	46
Zinc	3,830	893	23	4,055	954	24

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

[1] Less than 0.05 percent.

[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 retrogressed slightly in 1964, as indicated by the 3-percent increase in the frequency rate of all injuries. A slight improvement in the fatality rate was more than offset by the less-favorable rate of occurrence of nonfatal injuries. The overall-operating activity of these industries was lower in 1964 as measured by slight declines in employment and total man-hours of worktime.

Injury Experience.—The rate of occurrence of all disabling work injuries in the mineral industries was 18.00 per million man-hours. This overall rate in 1964 comprised frequencies of 0.29 for fatal injuries and 17.71 for nonfatal work disabilities, which compared with respective rates of 0.30 and 17.20 in 1963. Fatalities totaled 538 or 30 less than in 1963. However, the total nonfatal disabilities of 33,151 in 1964 was 492 higher than in the preceding year.

Injury experience of the various components, making up the total mineral industries in general, showed only slight changes from 1963. The frequency rates of injuries decreased slightly in the coal-mining-and-preparation, sand-and-gravel, coke, and native-asphalt industries. These improvements were more than offset by slightly more-frequent rates of occurrence of injuries in the metal, nonmetal, stone, nonferrous smelters, and oil-and-gas industries. However, in the peat and blast-furnace-slag industries, both relatively small, the injury frequency rates in 1964 were markedly worse than in 1963.

Employment and Worktime.—Of the larger mineral industries, the average number of men working daily increased in varying proportions in the metal, nonmetal, stone, sand-and-gravel, primary-nonferrous-smelting, and coke industries. Employment decreased slightly in coal mining and there was an indicated moderate decline in the oil and gas industries.

Worktime was increased in 1964 in each of the larger mineral industries, except the oil and gas—in which a decline was noted.

State Data.—Injury and employment data by State on the coal, metal, nonmetal, stone, sand-and-gravel, peat, and native-asphalt-mining-and-milling industries are available for the first time in this chapter.

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The mineral industries in West Virginia and Kentucky, in each of which underground coal mining is the dominant mineral industry, had the least-favorable-injury experience. The injury-frequency rate in West Virginia was 53.90 and in Kentucky 49.72 per million man-hours. Mines and mills in Colorado and Idaho, where underground metal mining is the dominant mineral industry, also showed high injury occurrences with respective frequency rates of 42.42 and 42.38.

The largest number of fatalities, 89, occurred in the mineral industries of West Virginia. The next-largest numbers of fatalities were in the mineral industries of the following States: Kentucky with 53, Pennsylvania with 47, and Virginia with 26. The largest numbers of nonfatal injuries occurred in the mineral industries of West Virginia with 4,445, Pennsylvania with 2,901, Kentucky with 1,931, and Virginia with 1,225.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Frequency rate per million man-hours	
							Fatal		Nonfatal			
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
Alabama:												
Coal	5,602	6,017	1,120	1,263	8,874	9,980	8	7	152	195	18.03	20.24
Metal	1,213	1,270	336	353	2,739	2,934	1	1	25	33	9.49	11.59
Nonmetal and native asphalt	845	1,179	214	326	1,721	2,631			33	62	19.17	23.57
Sand and gravel	501	470	122	125	1,023	1,083	1	2	18	17	18.57	17.54
Stone	2,438	2,440	694	717	5,667	5,879	5	1	52	89	10.06	15.31
Total	10,599	11,376	2,486	2,784	20,024	22,507	15	11	280	396	14.73	18.08
Alaska:												
Coal and peat	196	205	50	51	403	414		1	30	28	74.37	70.05
Metal	505	450	70	53	619	467			17	22	27.46	47.11
Sand and gravel	1,338	2,095	162	250	1,458	2,248			19	19	13.03	8.45
Stone	117	115	15	15	120	120		1	2	8	16.67	75.00
Total	2,156	2,865	297	369	2,600	3,249		2	68	77	26.15	24.32
Arizona:												
Metal	10,202	10,555	3,012	3,186	24,100	25,303	5	8	706	656	29.50	26.24
Nonmetal and coal	276	385	69	96	548	774			4	5	7.30	6.46
Sand and gravel	1,006	1,210	245	295	1,963	2,366			65	66	33.11	27.90
Stone	651	660	146	159	1,163	1,262			15	21	12.90	16.64
Total	12,135	12,810	3,472	3,736	27,774	29,705	5	8	790	748	28.62	25.45
Arkansas:												
Coal	149	142	25	26	207	190			4	6	19.37	31.58
Metal	1,616	1,845	531	543	4,249	4,288			55	24	12.94	5.60
Nonmetal	691	630	161	146	1,289	1,167			66	75	51.20	64.27
Sand and gravel	1,215	1,110	294	287	2,447	2,533			43	46	17.57	18.16
Stone	1,531	1,805	417	482	3,511	4,027	1		95	102	27.34	25.33
Total	5,202	5,532	1,428	1,484	11,703	12,205	1		263	253	22.56	20.73
California:												
Metal	1,854	2,045	377	458	3,010	3,660	1		68	95	22.92	25.96
Nonmetal	4,359	4,595	1,169	1,252	9,379	9,957		3	165	175	17.59	17.88
Sand and gravel	5,462	5,465	1,282	1,300	10,342	10,550	9	1	248	237	24.85	22.56
Stone	5,031	4,675	1,419	1,342	11,368	10,793	6	4	187	143	16.98	13.62
Peat and coal	41	38	9	7	74	51			1	4	13.51	78.43
Total	16,747	16,818	4,256	4,359	34,173	35,011	16	8	669	654	20.05	18.91

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Frequency rate per million man-hours	
							Fatal		Nonfatal			
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
Colorado:												
Coal	1,433	1,487	291	297	2,281	2,310	1	3	105	99	46.47	44.16
Metal	4,526	4,645	1,078	1,155	8,616	9,292	3	9	306	422	35.86	46.38
Nonmetal	437	360	82	60	655	475			12	13	18.32	27.37
Sand and gravel	1,047	1,170	226	252	1,836	2,048			50	46	27.23	22.46
Stone	899	940	174	186	1,388	1,482	1		46	70	33.86	47.23
Peat	10	25	2	3	12	22				1		46.36
Total	8,352	8,627	1,853	1,953	14,788	15,629	5	12	519	651	35.43	42.42
Connecticut:												
Nonmetal and peat	109	92	25	26	208	208			4	3	19.23	14.42
Sand and gravel	619	555	140	130	1,173	1,070	1	2	26	16	23.02	16.82
Stone	348	360	92	91	787	791		1	17	17	21.60	22.76
Total	1,076	1,007	257	247	2,168	2,069	1	3	47	36	22.14	18.85
Delaware: Nonmetal, sand and gravel, stone	89	101	18	21	157	177			2	2	12.74	11.30
Florida:												
Metal	281	320	99	78	792	618			2	5	2.53	8.09
Nonmetal	3,056	3,310	940	1,023	7,567	8,035		1	43	102	5.68	12.82
Sand and gravel	354	350	94	92	827	814		1	5	22	6.05	28.26
Stone	2,681	2,610	729	726	6,107	6,308	1	8	92	74	15.23	13.00
Peat	23	21	5	4	40	34						
Total	6,395	6,611	1,867	1,923	15,333	15,809	1	10	142	203	9.33	13.47
Georgia:												
Coal and peat	16	17	4	4	33	30						
Metal	116	90	16	10	132	80			1		7.58	
Nonmetal	2,863	3,425	826	1,063	6,654	8,543		3	183	197	27.50	23.41
Sand and gravel	326	355	79	86	697	759			12	21	17.22	27.67
Stone	2,629	2,625	653	655	5,415	5,621	3	1	133	185	25.12	33.09
Total	5,950	6,512	1,578	1,818	12,931	15,033	3	4	329	403	25.67	27.07
Hawaii:												
Nonmetal	72	130	11	11	83	90			3	1	36.14	11.11

Sand and gravel	48	65	4	6	35	46			2	2	57.14	43.48
Stone	460	475	114	126	917	1,045	2		28	28	32.72	26.79
Total	580	670	129	143	1,035	1,181	2		33	31	33.82	26.25
Idaho:												
Metal	2,571	2,610	611	612	4,889	4,947	6	7	338	262	70.36	54.38
Nonmetal and peat	664	455	190	118	1,526	951	2		14	22	10.48	23.13
Sand and gravel	865	665	190	147	1,523	1,174			14	15	9.19	12.78
Stone	215	190	36	28	291	219			3	3	10.31	13.70
Total	4,315	3,920	1,027	905	8,229	7,291	8	7	369	302	45.81	42.38
Illinois:												
Coal	8,297	8,500	2,005	2,110	15,564	16,770	16	10	619	700	40.80	42.34
Metal	104	75	19	13	149	103			11	6	73.83	58.25
Nonmetal	1,832	1,710	421	388	3,417	3,125		1	88	106	25.75	34.24
Sand and gravel	1,670	1,750	345	363	2,879	3,194	1	1	44	62	15.63	19.72
Stone	3,863	3,990	964	1,033	7,968	8,460	3		112	167	14.43	19.74
Peat	7	17	1	2	9	18						
Total	15,773	16,042	3,755	3,909	29,986	31,670	20	12	874	1,041	29.81	33.25
Indiana:												
Coal	2,953	2,916	656	649	5,039	4,910	2	1	219	220	43.86	45.01
Nonmetal	889	780	236	194	1,880	1,597		1	33	18	17.55	11.90
Sand and gravel	1,052	1,085	251	259	2,238	2,244			46	28	20.55	12.48
Stone	3,514	3,665	873	951	7,185	7,826	1	3	181	155	25.33	20.19
Peat	37	36	7	7	54	58			2		37.31	
Total	8,445	8,482	2,023	2,060	16,396	16,635	3	5	481	421	29.52	25.61
Iowa:												
Coal and peat	403	397	81	80	687	659		1	20	20	29.11	31.87
Nonmetal	855	820	221	201	1,788	1,615			32	54	17.90	33.44
Sand and gravel	1,204	1,100	199	191	1,799	1,658	2	2	25	25	15.01	16.28
Stone	2,460	2,480	653	656	5,612	5,631	2	2	82	98	14.97	17.76
Total	4,922	4,797	1,154	1,128	9,886	9,563	4	5	159	197	16.49	21.12
Kansas:												
Coal	243	231	57	59	439	400			14	21	31.91	52.50
Metal	62	70	13	18	104	146			3	7	28.85	47.95
Nonmetal	1,107	1,105	314	307	2,504	2,457			55	46	21.96	18.72
Sand and gravel	962	1,035	211	226	1,833	1,970			24	24	13.09	12.18
Stone	2,242	2,200	470	475	3,896	3,908		4	39	36	10.01	10.24
Total	4,616	4,641	1,065	1,085	8,776	8,881		4	135	134	15.38	15.54

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Frequency rate per million man-hours	
							Fatal		Nonfatal			
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
Kentucky:												
Coal	26,620	24,000	4,727	4,350	37,488	34,260	36	47	1,954	1,770	53.08	53.04
Nonmetal	407	425	91	89	724	716	----------	1	26	35	35.91	50.28
Sand and gravel	384	350	105	94	1,014	966	----------	1	19	23	18.74	24.84
Stone	2,416	2,135	538	480	4,459	3,960	1	4	123	103	27.81	27.02
Total	29,827	26,910	5,461	5,013	43,685	39,902	37	53	2,122	1,931	49.42	49.72
Louisiana:												
Metal	1,032	905	376	318	3,011	2,546	----------	----------	24	13	7.97	5.11
Nonmetal	1,617	1,770	477	504	4,122	4,361	2	----------	73	132	18.20	30.27
Sand and gravel	1,047	1,140	285	310	2,402	2,612	1	----------	24	20	10.41	7.66
Stone	872	595	280	190	2,325	1,574	1	----------	24	21	10.75	13.34
Total	4,568	4,410	1,418	1,322	11,860	11,093	4	----------	145	186	12.56	16.77
Maine:												
Metal and nonmetal	86	150	16	26	136	297	----------	----------	2	2	14.71	6.73
Sand and gravel	591	715	116	141	971	1,175	----------	----------	43	20	44.29	17.02
Stone	506	505	124	117	1,014	966	----------	----------	40	26	39.45	26.92
Peat	15	37	2	9	15	70	----------	----------	----------	----------	----------	----------
Total	1,198	1,407	258	293	2,136	2,508	----------	----------	85	48	39.79	19.14
Maryland and District of Columbia:												
Coal and peat	509	489	93	91	746	730	----------	1	24	25	32.17	35.62
Nonmetal	264	295	65	71	518	614	----------	----------	26	19	50.19	30.94
Sand and gravel	955	1,270	240	272	2,080	2,350	----------	----------	46	60	22.12	25.53
Stone	1,233	1,470	316	399	2,672	3,478	1	1	59	74	22.46	21.56
Total	2,961	3,524	714	833	6,016	7,172	1	2	155	178	25.93	25.10
Massachusetts:												
Nonmetal and peat	98	112	22	27	176	211	----------	----------	1	----------	5.68	----------
Sand and gravel	1,301	1,395	273	292	2,260	2,423	----------	----------	29	32	12.83	13.21
Stone	1,009	1,070	255	263	2,066	2,123	2	----------	72	61	35.82	28.73
Total	2,408	2,577	550	582	4,502	4,757	2	----------	102	93	23.10	19.55

Michigan:												
Metal	5,092	5,560	1,380	1,547	11,040	12,250	6	1	303	322	27.99	26.37
Nonmetal	4,298	4,355	1,439	1,447	11,549	11,244	1	1	158	45	13.77	4.09
Sand and gravel	2,654	2,750	544	560	4,570	4,654	1	2	59	81	13.13	17.83
Stone	2,988	3,815	864	1,174	6,987	9,351	1		40	46	5.87	4.92
Peat	276	291	45	54	434	495			3	12	6.91	24.26
Total	15,308	16,771	4,272	4,782	34,580	37,994	9	4	563	506	16.41	13.42
Minnesota:												
Metal	8,696	9,790	2,369	2,574	18,952	20,512	3	3	67	40	3.69	2.10
Nonmetal	216	220	56	57	450	460		1	35	28	77.78	63.04
Sand and gravel	2,360	2,550	377	403	3,228	3,441	2	2	43	38	13.94	11.62
Stone	1,623	1,780	414	459	3,426	3,905	1		65	95	19.26	24.33
Peat	63	88	6	6	45	47			1		22.32	
Total	12,958	14,428	3,222	3,499	26,101	28,365	6	6	211	201	8.31	7.30
Mississippi:												
Nonmetal	697	625	175	155	1,408	1,242			32	24	22.73	19.32
Sand and gravel	513	520	136	135	1,193	1,212		1	34	19	28.50	16.50
Stone	225	545	66	151	536	1,211			8	10	14.93	8.26
Total	1,435	1,690	377	441	3,137	3,665		1	74	53	23.59	14.73
Missouri:												
Coal	498	474	121	125	904	840			20	30	22.12	35.71
Metal	2,120	2,285	434	594	3,486	4,803		5	205	254	58.81	53.92
Nonmetal and native asphalt	872	998	170	205	1,369	1,660		1	29	44	21.18	27.11
Sand and gravel	710	765	169	182	1,437	1,549		1	26	32	18.09	21.30
Stone	4,304	4,160	1,085	1,076	8,929	8,832	2	3	168	149	19.04	17.21
Total	8,504	8,682	1,979	2,182	16,125	17,684	2	10	448	509	27.91	29.35
Montana:												
Coal and peat	119	123	13	14	106	112		1	1	1	9.43	17.86
Metal	3,659	3,710	1,061	1,089	8,487	8,809	6	4	163	170	19.91	19.75
Nonmetal	712	785	173	212	1,385	1,690	1	1	46	38	33.94	23.08
Sand and gravel	820	825	178	192	1,423	1,539			46	37	32.22	24.04
Stone	756	740	179	171	1,435	1,372	1		29	32	20.91	23.32
Total	6,066	6,183	1,604	1,678	12,836	13,522	8	6	285	278	22.83	21.00
Nebraska:												
Nonmetal	20	15	5	4	38	33						
Sand and gravel	1,028	1,350	213	279	2,032	2,664	2	4	16	21	8.86	9.38
Stone	570	575	159	165	1,325	1,377		1	12	8	9.06	6.54
Total	1,618	1,940	377	448	3,395	4,074	2	5	28	29	8.84	8.35

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Frequency rate per million man-hours	
							Fatal		Nonfatal			
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
Nevada:												
Metal	1,621	2,040	438	567	3,515	4,505	----------	3	78	110	22.19	25.08
Nonmetal and peat	711	761	204	190	1,633	1,523	----------	----------	29	38	17.76	24.95
Sand and gravel	643	940	143	209	1,144	1,670	----------	----------	24	18	20.98	10.78
Stone	200	125	44	26	355	204	----------	----------	2	3	5.63	14.71
Total	3,175	3,866	829	992	6,647	7,902	----------	3	133	169	20.01	21.77
New Hampshire:												
Nonmetal	87	60	19	10	151	78	----------	----------	6	1	39.74	12.82
Sand and gravel	432	500	92	106	756	875	----------	----------	15	10	19.84	11.43
Stone	132	155	29	34	230	278	----------	----------	8	9	34.78	32.37
Total	651	715	140	150	1,137	1,231	----------	----------	29	20	25.51	16.25
New Jersey:												
Metal	601	590	159	144	1,272	1,159	2	2	79	44	63.68	39.69
Nonmetal	413	420	96	118	771	948	----------	1	19	21	24.64	23.21
Sand and gravel	1,319	1,345	315	330	2,627	2,739	1	----------	56	62	21.70	22.64
Stone	1,129	1,215	286	296	2,360	2,422	----------	1	72	53	30.51	22.30
Peat	13	8	2	2	18	14	----------	----------	1	----------	54.09	----------
Total	3,475	3,578	858	890	7,048	7,282	3	4	227	180	32.63	25.27
New Mexico:												
Coal	298	309	59	61	464	470	----------	----------	12	11	25.88	23.40
Metal	3,864	4,420	928	1,086	7,421	8,687	2	2	341	409	46.22	47.31
Nonmetal	2,801	2,805	932	942	7,465	7,517	1	5	179	217	24.11	29.53
Sand and gravel	632	660	125	131	1,034	1,081	----------	3	27	32	26.11	32.38
Stone	283	355	70	77	562	613	----------	----------	10	22	17.79	35.89
Total	7,878	8,549	2,114	2,297	16,946	18,368	3	10	569	691	33.75	38.16
New York:												
Metal	1,725	1,715	431	465	3,444	3,744	1	----------	28	56	8.42	14.96
Nonmetal	2,318	2,310	610	600	5,027	4,925	1	1	134	141	26.85	28.83
Sand and gravel	1,831	2,000	372	396	3,070	3,212	1	2	88	68	28.99	21.79
Stone	4,064	4,290	1,000	1,021	8,088	8,300	----------	2	80	93	9.89	11.45
Peat	20	28	3	5	26	36	----------	----------	1	2	38.81	55.78

Total	9,958	10,343	2,416	2,487	19,655	20,217	3	5	331	360	16.99	18.05
North Carolina:												
Metal	270	50	9	2	69	12			2		29.06	
Nonmetal	1,535	1,825	345	430	2,764	3,374	3	1	76	79	28.58	23.71
Sand and gravel	914	1,040	193	217	1,638	1,809			26	37	15.87	20.45
Stone	1,877	2,035	381	435	3,162	3,493	1	1	75	69	24.04	20.04
Total	4,596	4,950	928	1,084	7,633	8,688	4	2	179	185	23.97	21.52
North Dakota:												
Coal and peat	320	332	66	67	514	520	1	1	17	15	35.02	30.77
Metal	12	40	1	11	8	82				3		36.59
Nonmetal	40	40	9	9	73	74				1		13.51
Sand and gravel	641	560	123	122	1,032	1,013			15	19	14.53	18.76
Stone	45	45	3	3	27	27						
Total	1,058	1,017	202	212	1,654	1,716	1	1	32	38	19.95	22.73
Ohio:												
Coal	7,954	7,600	1,815	1,789	14,522	14,320	6	6	251	325	17.70	23.11
Nonmetal	2,480	2,585	619	646	4,969	4,962			118	123	23.75	24.79
Sand and gravel	2,304	2,355	505	506	4,218	4,177	3	2	42	70	10.67	17.24
Stone	5,659	5,715	1,583	1,556	12,840	12,675	6	6	150	173	12.15	14.12
Peat	22	19	2	2	15	14				1		69.85
Total	18,419	18,274	4,524	4,499	36,564	36,148	15	14	561	692	15.75	19.53
Oklahoma:												
Coal	369	351	70	72	556	510			32	48	57.53	94.12
Metal	327	270	82	77	659	617			35	6	53.13	9.72
Nonmetal	402	330	88	75	702	599			14	11	19.94	18.36
Sand and gravel	306	375	82	101	682	840			5	16	7.33	19.05
Stone	1,257	1,035	343	271	2,856	2,271	1		53	59	18.91	25.98
Total	2,661	2,361	665	596	5,455	4,837	1		139	140	25.66	28.94
Oregon:												
Metal	148	190	26	31	212	243			11	16	51.95	65.84
Nonmetal and coal	217	184	35	27	282	219			8	6	28.37	27.40
Sand and gravel	1,340	1,485	296	341	2,377	2,711			74	52	31.13	19.18
Stone	1,893	1,945	389	375	3,136	3,045			102	92	32.53	30.21
Total	3,598	3,804	746	774	6,007	6,218			195	166	32.46	26.70

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Frequency rate per million man-hours	
							Fatal		Nonfatal			
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
Pennsylvania:												
Bituminous coal	25,414	27,000	5,334	5,939	42,761	48,070	22	18	959	1,035	22.94	21.91
Anthracite	13,498	13,144	2,912	2,812	21,048	20,368	32	24	1,295	1,342	63.05	67.07
Metal and nonmetal	3,016	3,000	737	778	6,200	6,415	1	2	132	156	21.45	24.63
Sand and gravel	1,162	1,185	245	272	2,068	2,290	1		43	45	21.28	19.65
Stone	8,957	8,920	2,340	2,391	19,154	19,946	4	3	249	321	13.21	16.24
Peat	49	52	10	12	81	95			2	2	24.70	21.01
Total	52,096	53,301	11,578	12,204	91,312	97,184	60	47	2,680	2,901	30.01	30.33
Rhode Island:												
Sand and gravel	91	85	18	17	148	139			4	5	27.03	35.97
Stone	48	45	9	9	73	73		1	1	2	13.70	41.10
Total	139	130	27	26	221	212		1	5	7	22.62	37.74
South Carolina:												
Nonmetal and peat	1,241	1,027	296	266	2,465	2,142			46	45	18.66	21.01
Sand and gravel	343	370	90	93	725	745		1	17	17	23.45	24.16
Stone	796	785	193	199	1,610	1,638	1		35	22	22.36	13.43
Total	2,380	2,182	579	558	4,800	4,525	1	1	98	84	20.63	18.78
South Dakota:												
Coal	8	8	1	1	11	11			1	1	89.45	90.91
Metal	2,088	2,085	612	624	4,894	5,000	3	1	72	73	15.33	14.80
Nonmetal	177	235	39	57	325	469			10	8	30.77	17.06
Sand and gravel	1,615	1,070	283	187	2,321	1,536			41	42	17.66	27.34
Stone	593	725	134	160	1,087	1,317			30	32	27.60	24.30
Total	4,481	4,123	1,069	1,029	8,638	8,333	3	1	154	156	18.18	18.84
Tennessee:												
Coal	2,767	2,972	475	535	3,825	4,300	1	3	90	115	23.79	27.44
Metal	1,088	1,260	266	326	2,132	2,592	2	3	34	83	16.89	33.18
Nonmetal	1,341	1,290	342	339	2,777	2,764			59	48	21.25	17.37
Sand and gravel	694	725	174	182	1,475	1,545		1	33	37	22.37	24.60
Stone	2,911	3,085	747	809	6,143	6,756	2	3	113	99	18.72	15.10
Total	8,801	9,332	2,004	2,191	16,352	17,957	5	10	329	382	20.43	21.83

Texas:												
Coal	108	102	28	29	223	200			3	5	13.46	25.00
Metal	1,387	1,105	422	331	3,376	2,649	1	1	25	22	7.70	8.68
Nonmetal and native asphalt	2,836	2,817	819	808	6,630	6,632	3	3	164	157	25.19	24.13
Sand and gravel	2,566	2,305	682	618	5,854	5,547	3		132	122	23.06	21.99
Stone	5,049	5,200	1,507	1,570	12,646	12,921	1	4	225	316	17.87	24.77
Total	11,946	11,529	3,458	3,356	28,729	27,949	8	8	549	622	19.39	22.54
Utah:												
Coal	1,631	1,692	306	312	2,402	2,430	10	6	101	95	46.21	41.56
Metal	5,075	5,505	1,377	1,406	11,017	11,412	3	3	244	380	22.42	33.56
Nonmetal	662	640	174	146	1,391	1,166	20	1	113	70	95.61	60.89
Sand and gravel	575	500	119	104	959	837			37	26	38.58	31.06
Stone	505	440	135	114	1,086	910	1		21	20	20.26	21.98
Asphalt	250	195	65	47	517	374			23	15	44.52	40.15
Total	8,698	8,972	2,176	2,129	17,372	17,129	34	10	539	606	32.98	35.96
Vermont:												
Nonmetal and peat	276	305	72	84	583	675			18	17	30.87	25.19
Sand and gravel	236	250	54	45	450	369		1	9	9	20.00	27.10
Stone	2,087	2,050	538	530	4,344	4,302	3	1	155	178	36.37	41.61
Total	2,599	2,605	664	659	5,377	5,346	3	2	182	204	34.41	38.53
Virginia:												
Coal	12,483	12,118	2,501	2,486	19,867	19,620	25	23	844	895	43.74	46.79
Metal	333	330	83	83	665	671			29	30	43.63	44.71
Nonmetal	668	850	177	225	1,405	1,792			28	46	19.93	25.67
Sand and gravel	719	730	165	168	1,510	1,537			31	43	20.53	27.98
Stone	3,865	4,005	1,016	1,087	8,431	9,014	4	3	171	211	20.76	23.74
Total	18,068	18,033	3,942	4,049	31,878	32,634	29	26	1,103	1,225	35.51	38.33
Washington:												
Coal	200	207	38	39	300	300			54	51	179.94	170.00
Metal	385	350	104	91	830	738		1	52	24	62.68	33.88
Nonmetal	207	165	38	22	300	173			11	1	36.67	5.78
Sand and gravel	1,382	1,940	291	409	2,330	3,268	1	2	69	55	30.04	17.44
Stone	1,332	1,320	266	269	2,137	2,145			35	46	16.38	21.45
Peat	31	45	4	7	30	58						
Total	3,537	4,027	741	837	5,927	6,682	1	3	221	177	37.46	26.94
West Virginia:												
Coal	44,647	45,200	9,287	9,887	73,442	78,200	123	87	4,292	4,360	60.12	56.87
Nonmetal	1,290	900	399	269	3,195	2,153	1		38	28	12.21	13.01
Sand and gravel	298	340	62	70	549	624	1	1	15	11	29.14	19.23
Stone	1,346	1,505	324	375	2,733	3,148	1	1	52	46	19.39	14.93
Total	47,581	47,945	10,072	10,601	79,919	84,125	126	89	4,397	4,445	56.59	53.90

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Frequency rate per million man-hours	
							Fatal		Nonfatal			
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
Wisconsin:												
Metal	286	300	72	77	575	616	----------	3	34	23	59.14	42.21
Nonmetal	75	65	16	13	132	110	----------	----------	1	2	7.58	18.18
Sand and gravel	2,210	2,125	397	383	3,375	3,253	2	----------	43	58	13.33	17.83
Stone	1,907	2,060	397	425	3,323	3,605	1	1	94	83	28.59	23.30
Peat	12	15	1	3	12	23	----------	----------	----------	2	----------	86.08
Total	4,490	4,565	883	901	7,417	7,607	3	4	172	168	23.59	22.61
Wyoming:												
Coal	405	421	70	71	541	550	1	----------	19	18	37.00	32.73
Metal	1,472	1,535	378	376	3,124	3,123	----------	1	80	96	25.61	31.06
Nonmetal	896	1,145	251	273	2,031	2,195	----------	----------	27	33	13.29	15.03
Sand and gravel	442	315	78	56	624	445	----------	----------	21	21	33.65	47.19
Stone	434	915	88	141	713	1,143	----------	----------	10	9	14.03	7.87
Total	3,649	4,331	865	917	7,033	7,456	1	1	157	177	22.47	23.87
United States totals:												
Coal	157,126	156,444	32,200	33,216	253,185	261,428	284	240	11,133	11,432	45.09	44.65
Metal	65,860	69,500	17,568	18,697	140,985	150,180	46	59	3,485	3,745	25.05	25.33
Nonmetal	49,302	50,800	13,442	13,854	108,483	111,020	33	24	2,333	2,440	21.81	22.19
Sand and gravel	52,804	55,400	11,400	11,951	95,786	100,760	33	33	1,894	1,905	20.12	19.23
Stone	91,960	94,600	23,553	24,462	193,685	201,790	61	61	3,468	3,780	18.22	19.03
Peat	674	781	110	133	957	1,122	----------	----------	11	24	11.49	21.39
Native asphalt	417	369	108	94	873	762	2	2	35	30	42.41	41.97
Primary nonferrous reduction and refining	33,072	34,800	11,240	11,472	90,019	92,350	7	8	927	985	10.38	10.75
Slag (iron-blast furnace)	1,421	1,440	358	380	2,867	3,040	2	1	35	55	12.90	18.42
Petroleum and natural gas	461,021	427,697	NA	NA	974,877	910,525	93	109	9,125	8,551	9.46	9.51
Coke	13,043	13,447	4,596	4,807	36,759	38,418	7	1	213	204	5.98	5.34
Grand total	926,700	905,278	114,575	119,066	1,898,476	1,871,395	568	538	32,659	33,151	17.50	18.00

NA Not available.

[1] All data for 1963 are final. All data for 1964 are preliminary except anthracite, peat, native asphalt, petroleum and natural gas, coke, and slag.

Employment and worktime in the mineral industries was largest in Pennsylvania with 53,301 men and more than 97 million man-hours of work. In West Virginia there were 47,945 men who worked more than 84 million man-hours. The next-ranking States in mineral-industry employment and worktime were Kentucky, Ohio, and Virginia.

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
1931	784,347	1,288,136	1,707	94,021	1.33	72.99
1932	671,343	962,925	1,368	66,028	1.42	68.57
1933	677,722	1,058,246	1,242	70,158	1.17	66.30
1934	739,817	1,167,724	1,429	79,211	1.22	67.83
1935	783,139	1,215,317	1,495	80,070	1.23	65.88
1936	824,514	1,426,234	1,686	90,608	1.18	63.53
1937	859,951	1,482,242	1,759	94,466	1.19	63.73
1938	774,894	1,144,137	1,369	69,940	1.20	61.13
1939	788,925	1,251,169	1,334	73,253	1.07	58.55
1940	801,926	1,385,128	1,716	80,856	1.24	58.37
1941	835,095	1,541,335	1,621	87,911	1.05	57.04
1942 [1]	1,120,450	2,319,214	1,970	100,861	.85	43.49
1943	1,144,831	2,555,620	1,953	101,164	.76	39.58
1944	1,086,103	2,573,453	1,751	98,066	.68	38.11
1945	1,033,035	2,363,783	1,414	87,578	.60	37.05
1946	1,108,517	2,275,961	1,336	86,291	.59	37.91
1947	1,179,835	2,469,257	1,556	91,311	.63	36.98
1948	1,242,241	2,530,418	1,383	86,295	.55	34.10
1949	1,240,330	2,256,418	898	65,909	.40	29.21
1950	1,237,649	2,340,955	952	66,729	.41	28.51
1951	1,223,639	2,418,090	1,122	67,285	.46	27.83
1952	1,230,692	2,383,608	927	61,296	.39	25.72
1953	1,193,182	2,357,971	817	53,992	.35	22.90
1954	1,096,423	2,138,687	671	43,130	.31	20.17
1955 [2]	1,122,393	2,290,058	729	46,197	.32	20.17
1956 [3]	1,113,471	2,294,678	788	45,454	.34	19.81
1957 [4]	1,187,052	2,409,970	810	45,898	.34	19.05
1958 [5]	1,129,638	2,208,298	656	39,925	.30	18.08
1959	1,106,534	2,194,902	597	37,750	.27	17.20
1960	1,045,111	2,082,521	603	36,044	.29	17.31
1961	951,378	1,913,481	542	34,173	.28	17.86
1962	950,876	1,917,475	647	33,067	.34	17.25
1963	926,700	1,898,476	568	32,659	.30	17.20
1964 [p]	905,278	1,871,395	538	33,151	.29	17.71

[p] Preliminary.
[1] Includes oil and gas beginning with 1942.
[2] Clay mines and nonmetal mills included beginning with 1955.
[3] Clay mills included beginning with 1956.
[4] Peat and sand and gravel included beginning with 1957.
[5] Slag included beginning with 1958.

Scope of Report.—Overall data for 1964 on injury experience and the levels of employment, worktime, and operating activity of the mineral industries are shown in the statistical tables of this chapter. The general groupings of the industries are presented in greater detail in volumes I and II of the Minerals Yearbook. A corresponding chapter in volume I contains additional breakdowns of the data on metal, nonmetal, sand and gravel, slag, and stone mines and quarries, together with separate information on the related processing mills and plants including primary nonferrous smelters. The more specific information on the anthracite and bituminous coal, petroleum and natural-gas, peat, and natural-asphalt industries is given in the similar chapter of volume II.

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. The figures for 1964 are preliminary except for anthracite, coke, petroleum and natural gas, native asphalt, and slag, which are final. 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.

Data by States are presented only for the mineral-extractive and processing industries. Similar data for the oil and gas industries are not complete enough to be shown. The State breakdown is not presented for the purely processing industries—coke, primary nonferrous smelting, and blast-furnace slag—but the totals for these industries are included in the summarization of the State table.

Work Stoppages.—A total of 170 work stoppages in certain mineral-industry groups during 1964 resulted in a time loss of approximately 975,000 man-days of work, according to the U.S. Department of Labor, Bureau of Labor Statistics. Comparable data for 1963 were 153 stoppages with an aggregate time loss of about 791,000 man-days. Work stoppages were significant in the mineral industries in 1964 in bituminous coal mining with 111 stoppages and 340,000 man-days lost, in petroleum refining with 14 stoppages and 162,000 man-days lost, and in copper mining with 11 stoppages and 385,000 man-days lost.

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:		
1960	6	9.3
1961	5	4.2
1962	8	14.6
1963	4	3.0
1964	5	(1)
Bituminous:		
1960	120	[2] 137.0
1961	117	90.7
1962	121	191.0
1963	131	[2] 234.0
1964	111	340.0
Petroleum refining		
1960	2	48.2
1961	9	310.0
1962	5	516.0
1963	1	[2] 314.0
1964	14	162.0
Metal mining:		
Iron:		
1960	2	15.2
1961	2	4.2
1962	3	17.4
1963	1	[2] 2.4
1964	3	5.5
Copper:		
1960	1	[2] 361.0
1961	4	106.0
1962	5	129.0
1963	5	27.6
1964	11	385.0
Lead-zinc:		
1960	3	58.0
1961	4	18.0
1962	4	160.0
1963	----------	[2] 91.7
1964	9	14.9
Gold-silver:		
1960	----------	----------
1961	1	2.1
1962	1	8.8
1963	1	16.0
1964	----------	[2] 21.6
Ferroalloy metal ores:		
1960	1	(1)
1961	1	5.5
1962	1	211.0
1963	1	[2] 9.6
1964	----------	----------
Metal mining—Continued		
Miscellaneous metal ores:		
1960	2	2.3
1961	2	44.4
1962	----------	----------
1963	----------	----------
1964	----------	----------
Mining and quarrying of nonmetallic minerals (except fuels):		
Dimension stone:		
1960	1	2.5
1961	1	2.6
1962	3	74.5
1963	1	(1)
1964	1	2.2
Crushed and broken stone:		
1960	13	104.0
1961	7	2.8
1962	4	6.3
1963	5	3.8
1964	8	24.7
Sand and gravel:		
1960	3	1.8
1961	4	4.3
1962	3	2.0
1963	2	(1)
1964	2	(1)
Clay, ceramic and refractory minerals:		
1960	----------	----------
1961	2	1.9
1962	1	(1)
1963	----------	----------
1964	1	(1)
Chemical and fertilizer mineral mining:		
1960	2	7.3
1961	3	17.6
1962	5	169.0
1963	----------	[2] 88.6
1964	4	12.5
Cement, hydraulic:		
1960	2	[2] 3.6
1961	5	4.9
1962	1	(1)
1963	1	(1)
1964	1	7.4

[1] Less than 1,000 man-days.
[2] Includes idleness from stoppages which began in previous year.

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

SAFETY COMPETITIONS

Nationwide safety competitions are conducted annually by the Bureau of Mines to provide incentives for development of safe working conditions and safe working habits at mineral-producing plants. Operations achieving outstanding safety records receive national recognition. Such recognition aids in developing more effective safety programs. All told, 1,854 mineral operations participated in the competitions for 1964.

The National Safety Competition, sometimes termed the "Sentinels of Safety Competition", is sponsored jointly by the Bureau of Mines and the American Mining Congress. A record number of 1,029 mines, pits, and quarries, 66 more than in 1963, participated. A total of 470 or 46 percent of the competing plants had no disabling work injuries during the year. These injury-free plants were worked 32.6 million man-hours, 18 percent of the total worktime at all enrolled operations.

Plants enrolled in the contest are classified into six groups designed to provide comparable competition. These groups were realined in the 1964 contest to more accurately reflect current conditions in the mineral industries.

The Sentinels of Safety trophies and certificates are recognized as the most significant safety awards in the mineral industries. In the 1964 National Safety Competition the following operations, each injury free for the year, achieved the best safety records in each of the six groups:

Coal Mines (Underground).—No. 8 mine, Armco Steel Corp., Twilight, W. Va.

Coal Mines (Surface).—Georgetown No. 12 mine, Hanna Coal Co., Shortcreek, Ohio.

Metal Mines (Underground).—Geneva mine, Pickands Mather & Co., Ironwood, Mich.

Nonmetal Mines (Underground).—Bellefonte mine, National Gypsum Co., Bellefonte, Pa.

Open-Pit Mines.—Hoyt Lakes Mines, Pickands Mather & Co., Hoyt Lakes, Minn.

Stone Quarries.—Calcite Quarry, U.S. Steel Corp., Rogers City, Mich.

The National Sand and Gravel Safety Competition, sponsored solely by the Bureau, had 300 competing plants in 1964. Of these, 206 operations had no disabling injuries during a total worktime of 4.5 million man-hours, 47 percent of the total worktime at all enrolled plants. The Bureau also sponsors a safety contest for Oilwell Drilling Contractors in which 14 companies were participating in 1964.

Four other annual contests are conducted by the Bureau in cosponsorship with national associations representing mineral industries—National Lime Association, National Slag Association, National Limestone Institute, and National Crushed Stone Association. A total of 511 operations participated 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 Avery H. Reed, Jr.[1] and Thomas A. Simpson [2]

ALABAMA'S mineral industry continued to expand. This was a record year for many commodities, with expansion in almost all industries. New records were established for the production of native asphalt, fire clay, miscellaneous clay, kaolin, bentonite, lime, scrap mica, salt, sand and gravel, crushed limestone, crushed marble, and talc. Among the States, Alabama ranked second in the production of bauxite, third in the production of scrap mica and native asphalt, and fifth in iron ore.

The mineral industry of Alabama was dominated by the mining and processing of coal and stone, the manufacture of cement, and the production of crude petroleum, which together comprised 87 percent of the total value of production, compared with 86 percent in 1963. The iron ore industry continued to decline. This was the first year in which consumption of imported iron ore exceeded the consumption of domestic iron ore. The coal industry recovered from the slump caused by the abandonment of red iron ore mining by United States Steel Corp., and production expanded 17 percent, for the best year in coal mining since 1948. During the year, the one-billionth ton of coal was mined within the State.

Trends and Developments.—The Tennessee Valley Authority (TVA) placed in commercial operation the eighth generating unit (500,000 kilowatts) at its Widow's Creek steam plant in Jackson County. The Widow's Creek plant became the largest steam-electric generating plant in the United States with a capacity of 1,750,000 kilowatts. It used as much as 17,500 tons of coal per day.

National Cement Division of Woodward Iron Co. started an extensive expansion and improvement program at its Ragland plant. New equipment will include a kiln, a raw mill, and a finishing mill. The installation will be completed in late 1965.

Vulcan Materials Co. began construction of the first unit of a $2 million plant for processing shale into lightweight aggregate at Parkwood, near Bessemer. The plant was financed by the City of Bessemer from a $2 million revenue bond issue. The new facility will be leased to Vulcan Materials Co. on a long-term lease which will retire the bonds in about 10 years. A second unit will be started

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[2] Chief, Economic Geology Division, Geological Survey of Alabama, Tuscaloosa, Ala.

TABLE 1.—Mineral industry in Alabama [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand 280-pound barrels	2,386	$7,242	2,574	$7,794
Portland thousand 376-pound barrels	12,218	38,417	12,870	40,108
Clays [2] thousand short tons	1,607	3,003	1,991	4,060
Coal (bituminous) do	12,359	91,243	14,435	p 102,267
Iron ore (usable) thousand long tons, gross weight	2,126	11,806	2,106	11,812
Lime thousand short tons	596	6,974	599	7,118
Natural gas million cubic feet	177	21	166	18
Petroleum (crude) thousand 42-gallon barrels	9,175	23,763	8,498	22,095
Sand and gravel thousand short tons	5,363	5,778	5,840	6,191
Stone [3] do	13,684	22,206	15,852	24,976
Value of items that cannot be disclosed: Asphalt (native), bauxite, slag cement, bentonite (1964), kaolin, gem stones (1963), scrap mica, salt, stone (dimension limestone and marble, oystershell, and crushed sandstone 1963), and talc	xx	5,417	xx	9,251
Total	xx	215,870	xx	235,690

xx Not applicable p Preliminary.

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

[2] Excludes bentonite (1964), and kaolin.

[3] Excludes certain stone; included with "Value of items that cannot be disclosed."

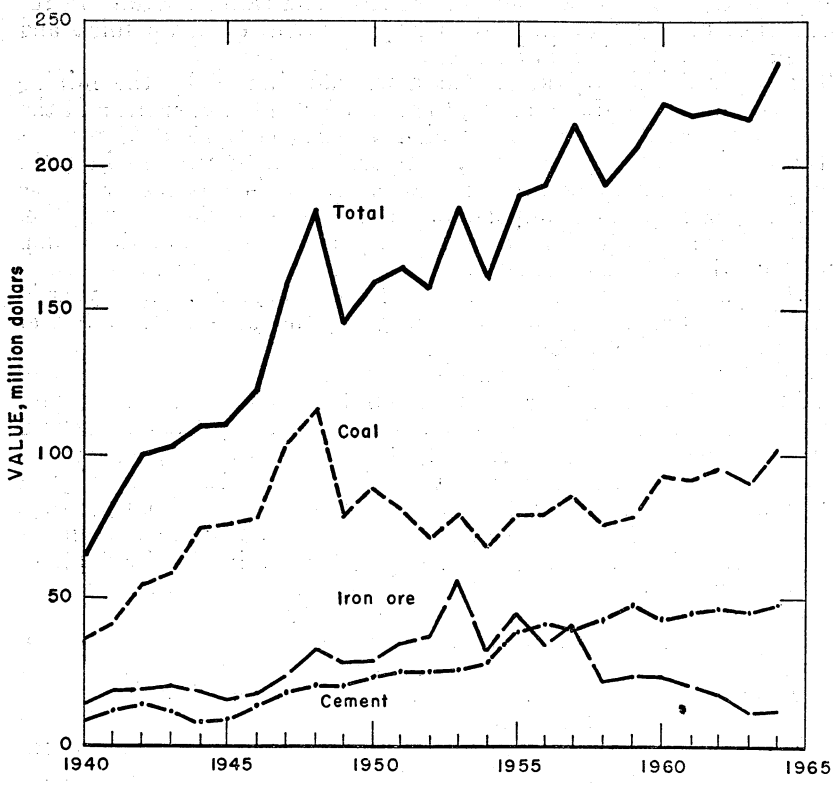


FIGURE 1.—Value of coal, cement, and iron ore, and total value of mineral production in Alabama.

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

Year	Value	Year	Value
1955	$199,343	1960	$225,882
1956	198,712	1961	224,815
1957	213,605	1962	228,652
1958	194,053	1963	r226,802
1959	205,416	1964	247,451

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	5,602	1,120	8,874	8	152	18
Metal	1,213	336	2,739	1	25	9
Nonmetal and native asphalt	845	214	1,721		33	19
Sand and gravel	501	122	1,023	1	18	19
Stone	2,438	694	5,667	5	52	10
Total	10,599	2,486	20,024	15	280	15
1964: p						
Coal	6,017	1,263	9,980	7	195	20
Metal	1,270	353	2,934	1	33	12
Nonmetal and native asphalt	1,179	326	2,631		62	24
Sand and gravel	470	125	1,083	2	17	18
Stone	2,440	717	5,879	1	89	15
Total	11,376	2,784	22,507	11	396	18

p Preliminary.

as soon as the first has been completed. The first kiln will have an initial capacity of 200,000 tons of aggregate per year.

Legislation and Government Programs.—The Bureau of Mines operated the Tuscaloosa Metallurgy Research Center at Tuscaloosa, which has been conducting research on many problems connected with the mineral industries. During the year, the Area II Mineral Resource Field Office (Tuscaloosa) was specifically engaged in projects concerning resources of iron ore, scrap iron, aluminum, and coal in the southeastern States.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt (Native).—Alabama Asphaltic Limestone Co. (Margerum quarry) crushed bituminous limestone in Colbert County for roadstone; production expanded 58 percent and established a new record for the State. Among the States, Alabama ranked second in the production of bituminous limestone.

Coal (Bituminous).—Bituminous coal was mined at 175 mines in 12 counties, compared with 180 mines in 10 counties in 1963. The leading counties were Jefferson, Walker, and Tuscaloosa. The leading companies were Southeastern Electric Generating Co., United States Steel Corp., Alabama By-Products Corp., and Wood-

ward Iron Co., which together supplied 48 percent of the total production of the State. Production increased 17 percent but was 31 percent less than the 1926 record. The average output per mine incresaed from 68,700 tons in 1963 to 82,000. Captive tonnage was 45 percent of the total compared with 58 percent in 1963.

Underground mines produced 72 percent of the total production; strip mines, 27 percent; and auger mines, 1 percent. Eighty-two percent of the coal was shipped by rail or water, 13 percent by truck, and 5 percent by conveyor.

Ninety-three percent of the coal mined underground was mechanically loaded; 85 mobile loading machines loaded 91 percent, and 4 self-loading conveyors and 49 face conveyors loaded 2 percent.

Equipment used at 120 underground mines included 156 cutting machines, which cut 99 percent of the tonnage; 193 power drills, which drilled 99 percent; 137 locomotives; 26 tractors; 173 shuttle cars; and 65 mother conveyors.

Equipment used at 51 strip mines included 86 power shovels, 19 draglines, 5 carryall scrapers, 93 bulldozers, 34 power drills, and 117 trucks. An estimated 69 million cubic yards of overburden was removed.

Five coal-recovery augers, 2 bulldozers, and 34 trucks were used at 4 auger mines.

Of the total production of coal, 81 percent was cleaned at 27 cleaning plants.

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

County	1963		1964	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Bibb	80,018	$443	230,073	$954
Blount	95,808	526	2,596	14
Cullman	11,000	69	8,452	64
Etowah			126,560	672
Jackson	19,073	145	163,809	775
Jefferson	6,691,801	52,471	7,455,316	p 59,774
Marion	354,954	2,025	319,888	1,419
St. Clair			4,000	10
Shelby	544,518	4,758	686,879	5,723
Tuscaloosa	482,735	2,112	1,101,488	4,797
Walker	3,965,282	28,083	4,182,893	27,306
Winston	113,973	611	153,500	759
Total	12,358,962	91,243	14,435,454	p 102,267
Earliest record to date	997,799,000	NA	1,012,234,000	NA

NA Not available. p Preliminary.

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

Natural Gas.—Marketed production of natural gas from Marion County was about the same as in 1962.

Petroleum.—Production of crude petroleum decreased 7 percent below the 1963 record. Leading counties were Mobile and Escambia. During 1964, 17 new producing wells were drilled. The 570 producing wells were located in the following counties: Baldwin, 6; Choctaw, 62;

Clarke, 13; Escambia, 29; and Mobile, 460. During the year 50 wells, totaling 362,028 feet, were drilled.

TABLE 5.—Crude petroleum production, by counties

(42-gallon barrels)

County	1963	1964
Baldwin	42,500	43,350
Choctaw	265,613	265,707
Clarke	128,928	133,931
Escambia	517,639	487,528
Mobile	8,220,320	7,567,484
Total	9,175,000	8,498,000
Earliest record to date	57,378,000	65,876,000

Source: State Oil and Gas Board.

NONMETALS

Cement.—Eight companies produced masonry cement at nine plants in five counties. Leading producers were Southern Cement Co. and Ideal Cement Co. Shipments increased 8 percent but were 1 percent below the 1955 record. Consumption of masonry cement in Alabama was 24 percent of the total shipments. Other shipments were made to Georgia (34 percent), Florida (13 percent), South Carolina (8 percent), Mississippi (6 percent), Louisiana (5 percent), North Carolina (5 percent), Tennessee (4 percent), and other States (1 percent).

Seven companies produced portland cement at eight plants in five counties. Leading producers were Ideal Cement Co. (Mobile plant) and Lone Star Cement Corp. (Birmingham and Demopolis plants). Shipments increased 5 percent but were 1 percent below the 1959 record. Consumption of portland cement in Alabama was 43 percent of shipments. Other shipments were made to Georgia (22 percent), Mississippi (12 percent), Florida (11 percent), South Carolina (5 percent), Louisiana (2 percent), Tennessee (2 percent), and other States (3 percent).

Raw materials used in manufacturing portland cement included limestone and oystershell (56 percent), cement rock (26 percent), clay and shale (11 percent), and other materials (7 percent).

Fifty-seven percent of the portland cement was used for ready-mixed concrete; highway contractors used 15 percent; concrete products manufacturers, 15 percent; building materials dealers, 7 percent; and other users, 6 percent. The annual capacity of portland cement plants was 16.1 million barrels.

Southern Cement Co. and Cheney Lime & Cement Co. produced slag cement at Jefferson and Blount County plants. Shipments increased 1 percent but were 75 percent below the record established in 1952.

Clays.—Thirteen companies mined clay for refractories at 15 mines in 7 counties. Leading producers were Donoho Clay Co. and Russell Coal & Clay Co., with mines in Calhoun and Walker Counties. Production expanded 76 percent and exceeded the previous record year, 1956, by 28 percent. Twenty companies mined 1,604,000 tons of

miscellaneous clay at 23 mines in 12 counties for heavy clay products and for portland cement. Leading counties were Russell and Jefferson. Leading producers were Bickerstaff Brick Co., Inc., and Dixie Brick Co., in Russell County, and Jenkins Brick Co., with plants in Montgomery and Elmore Counties. Production increased 16 percent and was 4 percent greater than the 1960 record. Harbison-Walker Refractories Co. and Thomas Alabama Kaolin Co. mined kaolin in Henry and Marion Counties for a variety of uses. Production more than doubled and was 26 percent more than the 1962 record. American Colloid Co. opened a new mine and produced bentonite, the first time in many years that bentonite has been produced in Alabama.

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

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Foundries and steelworks	167,900	$1,611,293	$9.60	201,593	$1,795,674	$8.91
Firebrick and block	3,342	10,230	3.06	175,204	709,050	4.05
Mortar	7,972	24,480	3.07	W	W	W
Other uses [1]	41,368	109,480	2.65	10,410	76,200	7.32
Total	220,582	1,755,483	7.96	387,207	2,580,924	6.67

W Withheld to avoid disclosing individual company confidential data.
[1] Includes bauxite (1963), high-alumina brick, heavy clay products (1963), and uses indicated by symbol W.

Lime.—Six companies produced quicklime and hydrated lime at seven plants in Shelby and Dallas Counties for building, agricultural, chemical, and industrial uses. Leading producers were Southern Cement Co. (Roberta and Keystone limekilns), and Longview Lime Corp. Production increased 1 percent above the 1963 record. Consumption of lime in Alabama was 57 percent of total shipments. Other shipments were made to Florida (15 percent), Georgia (13 percent), Mississippi (5 percent), Tennessee (4 percent), Louisiana (2 percent), and other States (4 percent).

TABLE 7.—Lime sold or used by producers, in 1964 by uses

Use	Short tons	Value	
		Total	Average per ton
Paper	150,202	$1,737,856	$11.57
Water purification	40,867	553,188	13.54
Steel electric furnaces	33,164	386,477	11.65
Aluminum	22,553	259,871	11.52
Metallurgy	7,230	87,149	12.05
Sugar refining	4,672	60,096	12.86
Other uses [1]	340,459	4,033,732	12.63
Total	599,147	7,118,369	11.88

[1] Includes lime used for construction, agriculture, alkalies, brick sand-lime slag, brick silica, calcium coke, copper, food, magnesium, well drilling, concentration, paint, precipitated calcium, sewage, steel open hearth, tanning, wire drawing, and other uses.

Six companies recovered quicklime at byproduct plants at seven papermills in six counties. Leading producers of regenerated lime were Scott Paper Co. and International Paper Co. operating plants in Mobile County.

Mica.—Dixie Mines, Inc., mined scrap mica at the Dixie mine. Production increased 4 percent and exceeded the record established in 1962. Among the States, Alabama ranked third in the production of scrap mica. Most of the mica was shipped to Texas for further grinding although a small part of the scrap mica was ground in Alabama and shipped to various customers.

Salt.—Olin Mathieson Chemical Corp. produced salt from brine in Washington County. Production increased 10 percent and was 7 percent above the previous record established in 1960.

Sand and Gravel.—Thirty-two companies mined sand and gravel at 35 mines in 23 counties. Leading counties were Montgomery, Mobile, Macon, and Elmore. Leading producers were Birmingham Slag (Montgomery and Macon Counties), Alabama Gravel Co. (Elmore and Montgomery Counties), and Radcliff Materials, Inc. (Mobile County). Production increased 9 percent and was 1 percent above the 1961 record. Virtually the entire production was processed by washing. Of the total production, 50 percent was shipped by truck, 39 percent by rail, and 11 percent by water. Of the total production, 17 percent was produced at portable plants. The size of the plants producing sand and gravel is illustrated by the fact that 51 percent of the plants, with a total production of less than 100,000 tons, accounted for only 13 percent of the total.

Stone.—Thirty-one companies crushed limestone at 43 quarries in 21 counties. Leading counties were Shelby, Jefferson, Madison, and Etowah. Leading producers were Birmingham Slag Co., Madison Limestone Co., Lone Star Cement Corp., and Southern Cement Co. Production increased 16 percent and was 1 percent above the 1961

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

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Autauga	W	W	504	$409
Barbour	18	$31	19	33
Cherokee	W	W	36	45
Clarke	47	53	W	W
Cleburne			9	11
Conecuh	W	W	40	46
Dallas	213	213	239	239
Etowah	138	172	140	202
Macon	706	953	626	849
Mobile	676	675	W	W
Monroe	42	44	45	39
Montgomery	1,292	1,202	1,315	1,202
Russell	137	170	188	189
Undistributed [1]	2,093	2,265	2,679	2,927
Total	5,363	5,778	5,840	6,191

W Witheld to avoid disclosing individual company confidential data.

[1] Includes Chilton, Covington (1963), Dale (1963), Elmore, Escambia, Franklin, Geneva, Houston, Morgan, Talladega (1963), Tuscaloosa, Washington, Winston (1963) 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	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,350	$1,268	$0.94	1,820	$1,703	$0.94
Paving	796	677	.85	1,005	920	.92
Fill	33	28	.84	100	85	.85
Railroad ballast	1	1	.50	11	5	.45
Other uses [1]	205	333	1.63	252	425	1.69
Total	2,385	2,307	.97	3,188	3,138	.98
Gravel:						
Paving	1,436	1,644	1.14	1,276	1,442	1.13
Structural	1,221	1,486	1.22	1,169	1,403	1.20
Fill	7	9	1.24	W	W	W
Other uses [2]	313	332	1.06	207	208	1.00
Total	2,977	3,471	1.17	2,652	3,053	1.15
Total sand and gravel	5,363	5,778	1.08	5,840	6,191	1.06

W Withheld to avoid disclosing individual company confidential data.

[1] Includes engine, molding, filtration (1963), and other uses.

[2] Includes railroad ballast (1963), other gravel, and uses indicated by symbol W.

record. Of the total production, 56 percent was shipped by truck, 25 percent by rail, 15 percent by conveyor belt, and 4 percent by water.

Alabama Limestone and Sisson Bros. Stone Co. quarried dimension limestone in Franklin and Blount Counties for rough construction, rough architectural, and dressed building stone. Production decreased 6 percent and was 35 percent below the 1956 record.

Thompson-Weinman & Co., Moretti-Harrah Marble Co., and Georgia Marble Co. crushed marble at Sylacauga for paint, putty, terrazzo, rubber, and other uses. Production increased 9 percent above the 1963 record.

Moretti-Harrah Marble Co. and Georgia Marble Co. quarried dimension marble at Sylacauga for rough and dressed building stone and for dressed monumental stone. Production increased 34 percent but was 15 percent below the 1962 record.

Radcliff Materials, Inc., and Southern Oystershell Milling Corp. crushed oystershell from Mobile Bay for concrete and roads, cement, and poultry grit. Production expanded 24 percent but was 36 percent below the 1957 record.

United States Steel Corp., Enos Vann, and Sam P. Acton crushed sandstone for cement, foundries, and refractories. Production expanded 35 percent but was 87 percent below the 1956 record. Brookshire & Kirkland quarried a small quantity of dimension sandstone for rough architectural building stone in Marshall County.

Talc.—American Talc Co. mined and ground talc at Winterboro for a variety of uses. Production expanded 57 percent above the 1963 record.

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

County	1963		1964	
	Short tons	Value	Short tons	Value
Calhoun	W	W	400,000	$511,800
Colbert	1,008,057	$1,281,340	W	W
Cullman			52,987	78,580
Henry	10,000	30 000	7,533	12,800
Jackson	W	W	109,946	211,427
Jefferson	2,927,389	3,329,719	3,054,194	3,384,224
Limestone	65,217	97,825	69,658	104,487
Shelby	4,035,536	5,431,205	4,608,955	6,203,278
Undistributed [1]	5,209,275	5,689,032	7,105,151	7,766,065
Total	13,255,474	15,859,121	15,408,424	18,272,661

W Withheld to avoid disclosing individual company confidential data.

[1] Includes Bibb (1964), Conecuh (1963), Covington, De Kalb, Etowah, Franklin, Madison, Marengo, Marshall, Morgan, St. Clair, Talladega, Tuscaloosa (1964), and Washington Counties, and counties indicated by symbol W.

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

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	6,318,326	$7,929,287	$1.25	8,538,779	$10,771,183	$1.26
Cement manufacture	3,641,747	2,516,619	.69	3,924,981	2,712,369	.69
Lime manufacture	1,029,498	1,409,280	1.37	1,127,469	1,684,809	1.49
Fluxing stone	947,197	1,601,898	1.69	961,491	1,564,160	1.63
Agstone	498,363	845,227	1.70	410,458	681,164	1.66
Riprap	356,580	483,599	1.36	W	W	W
Rock dust for coal mines	78,597	326,108	4.15	W	W	W
Asphalt filler	47,151	203,881	4.32	13,127	66,269	5.05
Stone sand	21,119	26,808	1.27	W	W	W
Other uses [1]	316,896	516,414	1.63	432,119	792,707	1.83
Total	13,255,474	15,859,121	1.20	15,408,424	18,272,661	1.19

W Withheld to avoid disclosing individual company confidential data.

[1] Includes refractory stone, railroad ballast, alkali, paper, mineral food, other uses, and uses indicated by symbol W.

Vermiculite.—Zonolite Co. exfoliated vermiculite at its plant near Birmingham, using crude materials from other States.

METALS

Aluminum.—Reynolds Metals Co. operated the Listerhill aluminun. reduction plant at Sheffield.

Bauxite.—Harbison-Walker Refractories Co., R. E. Wilson Mining Co., and Wilson-Sneed Bauxite Co. mined crude bauxite in Barbour and Henry Counties for refractories and chemicals. Production decreased 12 percent. Among the States, Alabama ranked second in the production of bauxite.

Ferroalloys.—Shipments of ferromanganese, ferrosilicon, and ferrophosphorus amounted to 169,000 tons, valued at $19 million.

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Iron Ore.—Total shipments of iron ore decreased 1 percent and were 76 percent below the 1942 record. Shipments were the lowest since 1932. Of the total shipments, 13 percent was direct-shipping ore, compared with 15 percent in 1963, 31 percent in 1962, and 44 percent in 1961. The number of operating mines decreased from 25 to 22, and the average usable production per mine increased from 85,000 tons to 100,000. Among the States, Alabama ranked fifth in the production of iron ore.

Woodward Iron Co. and Southeastern Coal & Iron Co. mined red iron ore (hematite) at the Pyne mine in Jefferson County and the Dudley mine in Tuscaloosa County. Total production increased 6 percent but was 85 percent below the 1942 record.

Eighteen operators mined brown iron ore (limonite) at 20 mines in 9 counties. Leading counties were Butler, Franklin, and Pike. Leading producers were Glenwood Mining Co., Inc. (Butler and Pike Counties), Shook & Fletcher Supply Co. (Blount and Franklin Counties), and U.S. Pipe & Foundry Co. (Franklin County). Production decreased 3 percent and was 48 percent below the 1942 record.

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

Pig Iron and Steel.—United States Steel Corp., Woodward Iron Co., Republic Steel Corp., and U.S. Pipe & Foundry Co. produced 4,321,000 tons of basic, foundry, and malleable pig iron, compared with 3,899,000 tons in 1963. Value of shipments was $234 million, compared with $217 million in 1963. Imports of iron ore, chiefly from Venezuela and Chile, increased 15 percent but were 1 percent below the 1959 record.

Consumption of iron ore in agglomerating plants, blast furnaces, and steel furnaces was 41 percent domestic ore and 59 percent imported ore. This is the first year in which imports of iron ore have exceeded domestic iron ore. In 1961, imports were 32 percent, in 1962, 38 percent, and in 1963, 50 percent. The Birmingham district, which was founded upon the unique location of vast quantities of iron ore, coking coal, and fluxing stone, has now become dependent upon imports from foreign countries for the majority of its pig iron.

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

	1963		1964	
	Number of mines	Long tons	Number of mines	Long tons
Mine production:				
By varieties:				
Hematite	2	1,285,099	2	1,403 311
Limonite	23	4,247,550	20	4,103,900
By mining methods:				
Open pit	24	4,318,659	21	4,236,523
Underground	1	1,213,990	1	1,270,688
Shipments from mines:				
Direct to consumers	2	327,619	2	275,330
To beneficiation plants	25	5,205,652	22	5,166,449

TABLE 13.—Usable iron ore shipments by counties

County	1963		1964	
	Long tons	Value	Long tons	Value
Butler	458,945	$2,237,324	328,858	$1,634,687
Jefferson	1,054,987	W	1,050,565	W
Pike	176,591	823,050	192,397	938,000
Tuscaloosa	48,370	W	49,798	W
Undistributed [1]	387,020	8,745,300	484,677	9,238,843
Total	2,125,913	11,805,674	2,106,295	11,811,530

W Withheld to avoid disclosing individual company confidential data.

[1] Includes Barbour, Blount, Calhoun, Cherokee, Crenshaw, Franklin, Shelby (1963), and Talladega Counties, and counties indicated by symbol W.

TABLE 14.—Usable iron ore production and shipments

	1963		1964	
	Long tons	Iron content, natural (percent)	Long tons	Iron content, natural (percent)
Production:				
Hematite	1,102,735	38	1,165,795	34
Limonite	1,062,265	47	1,026,050	46
Shipments:				
Direct-shipping ore	327,619	38	275,330	32
Concentrates and sinter	1,798,294	47	1,830,965	41

REVIEW BY COUNTIES

Mineral production was reported from 49 of the 67 counties, compared with 53 in 1963. Leading counties were Jefferson, Mobile, Walker, and Shelby, which together accounted for 77 percent of the total State value, compared to 79 percent for these same counties in 1963.

Autauga.—Dallas Sand & Gravel Co., Inc., mined building and fill sand, and building, paving, and fluxing gravel at Fremont. Production was more than double that of the previous year.

Baldwin.—Production of crude petroleum from six wells increased 2 percent; a new well was drilled to a depth of 6,427 feet. Fairhope Clay Products Co. mined miscellaneous clay for heavy clay products.

Barbour.—B & C Construction Co. and H. D. Loflin mined brown iron ore; production increased 96 percent. Wilson-Sneed Mining Co. and R. E. Wilson Mining Co. mined bauxite for chemicals and refractories. McKenzie Construction Co. mined building and paving sand and building gravel at Eufaula.

Bibb.—Nine coal mines were active; leading producers were Alabama Fuels Sales Co. (Piper No. 2 strip mine), Bibb Mining Co. (Bibb No. 1 strip mine), and C & C Coal Co., Inc. (No. 1 strip mine). Alamet Corp. opened a new quarry and crushed limestone which was used for refractories and for lime which was used in the manufacture of metallic magnesium.

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

County	1963	1964	Minerals produced in 1964 in order of value
Autauga	W	$409,000	Sand and gravel.
Baldwin	W	W	Petroleum, miscellaneous clay.
Barbour	W	W	Iron ore, bauxite, sand and gravel.
Bibb	$443,454	W	Coal, limestone.
Blount	1,437,366	W	Iron ore, cement, fire clay, limestone, coal.
Butler	2,237,324	1,634,687	Iron ore.
Calhoun	W	W	Fire clay, limestone, miscellaneous clay, iron ore.
Cherokee	W	W	Sand and gravel, iron ore.
Chilton	W	W	Sand and gravel.
Choctaw	W	W	Petroleum.
Clarke	W	W	Petroleum, sand and gravel.
Clay	45	----	
Cleburne	60	11,000	Sand and gravel.
Colbert	W	W	Limestone, native asphalt.
Conecuh	W	46,000	Sand and gravel.
Coosa	370	----	
Covington	W	W	Limestone.
Crenshaw	W	W	Iron ore.
Cullman	69,040	142,477	Limestone, coal.
Dale	W	----	
Dallas	W	W	Lime, sand and gravel.
De Kalb	W	W	Limestone.
Elmore	W	W	Sand and gravel.
Escambia	W	W	Petroleum, sand and gravel, miscellaneous clay.
Etowah	W	W	Limestone, coal, sand and gravel, fire clay.
Franklin	2,904,820	3,252,514	Iron ore, limestone, sand and gravel, fire clay.
Geneva	W	W	Sand and gravel.
Henry	W	W	Bauxite, kaolin, limestone.
Houston	W	W	Sand and gravel.
Jackson	W	986,325	Coal, limestone.
Jefferson	86,298,859	94,916,276	Coal, cement, iron ore, limestone, miscellaneous clay, sandstone, fire clay.
Lee	45	----	
Limestone	97,825	104,487	Limestone.
Lowndes	----	W	Bentonite.
Macon	952,612	849,000	Sand and gravel.
Madison	W	W	Limestone, miscellaneous clay.
Marengo	W	W	Cement, limestone.
Marion	W	W	Coal, kaolin.
Marshall	W	W	Limestone, sandstone.
Mobile	W	W	Petroleum, cement, oystershell, sand and gravel, miscellaneous clay.
Monroe	44,118	38,000	Sand and gravel.
Montgomery	W	W	Sand and gravel, miscellaneous clay.
Morgan	W	W	Limestone, sand and gravel.
Pike	823,050	938,000	Iron ore.
Randolph	W	W	Mica.
Russell	565,965	727,500	Miscellaneous clay, sand and gravel.
St. Clair	W	W	Cement, limestone, fire clay, miscellaneous clay, coal.
Shelby	23,922,751	25,819,543	Cement, lime, limestone, coal, miscellaneous clay.
Talladega	W	W	Marble, limestone, talc, iron ore.
Tallapoosa	65	----	
Tuscaloosa	W	W	Coal, iron ore, sand and gravel, limestone.
Walker	W	W	Coal, fire clay, miscellaneous clay.
Washington	W	W	Salt, limestone, sand and gravel.
Winston	W	759,125	Coal.
Undistributed	r 96,072,231	105,056,066	
Total	215,870,000	235,690,000	

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: Bullock, Chambers, Coffee, Fayette, Greene, Hale, Lamar, Lauderdale, Lawrence, Perry, Pickens, Sumter, and Wilcox.

Blount.—Shook & Fletcher Supply Co. mined brown iron ore at the Champion mine. Cheney Lime & Cement Co. produced masonry and slag cements at the Graystone mill. At its Thermal mine, Harbison-Walker Refractories Co. mined fire clay, which was used for refractories. Sisson Bros. Stone Co. produced dimension limestone for rough architectural building stone. Cowden Gap Coal Co. produced a small quantity of coal at the No. 2 mine.

Butler.—Seven companies mined brown iron ore. Leading producers were Pigeon Creek Mining Co., Glenwood Mining Co. Inc., and Raygene Mining Co. Production declined 28 percent.

Calhoun.—Donoho Clay Co., Dixie Clay Co., and Leroy Lackey mined fire clay. Hodges & Co. crushed limestone for concrete and roads, railroad ballast, blast furnace, and agricultural stone (agstone). Frame Brick & Tile Co. mined miscellaneous clay for heavy clay products at three separate mines. Pope Mining Co. produced a small quantity of brown iron ore.

Cherokee.—Cherokee Sand Co., The State highway department, and Wolf Creek Sand Co. mined building gravel and building, paving, and molding sand. Trotter and Ingram Mining Co. mined a small quantity of brown iron ore.

Chilton.—Wade Sand & Gravel Co. mined building sand and gravel.

Choctaw.—Crude petroleum production from 62 wells was about the same as in 1963. Eight new wells totaling 40,104 feet were drilled during the year. Marathon Southern Corp. produced regenerated lime for use in paper manufacture.

Clark.—Production of crude petroleum from 13 wells increased 4 percent; 8 new wells were drilled which totaled 44,977 feet. Jackson Sand & Gravel Co. mined building sand and gravel.

Cleburne.—The U.S. Forest Service mined paving gravel for use on roads in the National Forest.

Colbert.—Birmingham Slag (Tuscumbia quarry), Alabama Asphaltic Limestone Co. (Maloney quarry), and Ralph Rogers & Co., Inc. (Tuscumbia quarry), crushed limestone for concrete and roads, railroad ballast, stone sand, and agricultural lime; production decreased 16 percent. Alabama Asphaltic Limestone Co. produced native asphalt which was used for roads.

Conecuh.—Castleberry Gravel Co. mined building sand and gravel.

Covington.—Miller Lime Pit crushed limestone at Florala for concrete and roads and for agstone.

Crenshaw.—McGhee & Merrill Co. mined brown iron ore.

Cullman.—The State highway department crushed limestone for concrete and roads. C & M Coal Co. (No. 3 mine) was the only active coal producer.

Dallas.—Alabama Metallurgical Corp. produced lime, which was used by the company in the manufacture of magnesium metal. C. Pierson Cosby mined building and engine sand and other gravel. Five dry oil wells totaling 28,275 feet were drilled during the year.

De Kalb.—Birmingham Slag and Pearsall Limestone Inc. crushed limestone for concrete and roads and for agstone.

Elmore.—Alabama Gravel Co. mined building and paving sand and paving gravel. Jenkins Brick Co. mined miscellaneous clay at Coosada for heavy clay products.

Escambia.—Crude petroleum production from 29 oil wells decreased 6 percent; 2 new wells totaling 16,950 feet were drilled during the year. Dixie Sand & Gravel Co., Flomaton Gravel Co., Inc., and the U.S. Forest Service mined building and paving sand and gravel. Keego Clay Products Co. mined miscellaneous clay at Brewton for heavy clay products. Container Corp. of America recovered regenerated lime for use in paper manufacture.

Etowah.—Republic Steel Corp. produced pig iron at Gadsden. Birmingham Slag, operating two quarries at Glencoe, and Alabama Aggregate, operating a quarry at Cobb City, crushed limestone for riprap, fluxing stone, and concrete and roads; production was more than triple that of the previous year. Robbins Coal Co., Inc., (South View strip mine) and Alabama Coal & Ore Co. (Hopewell strip mine) mined bituminous coal; these mines operated near the county line and were in the adjoining county last year.

Southside Sand Co. mined building, paving, and fill sand and gravel. R&F Sand Co. mined a small quantity of fire clay.

Franklin.—Shook & Fletcher Supply Co. (Blackburn mine), U.S. Pipe & Foundry Co. (Russellville No. 15 mine), and Hester & Farned mined brown iron ore; production expanded 32 percent. Birmingham Slag and Alabama Limestone crushed limestone for asphalt filler, riprap, concrete and roads, and agstone. Tennessee Valley Sand & Gravel Co. and North Alabama Sand Co., Inc., mined building and paving sand and gravel. Alabama Limestone quarried dimension limestone for rough construction, rough architectural, and dressed building stone; production decreased 3 percent. Tennessee Valley Sand & Gravel Co. mined fire clay.

Geneva.—B&H Sand Co. mined building and fill sand.

Henry.—Harbison-Walker Refractories Co. and Wilson-Sneed Mining Co. mined bauxite for refractories and chemicals. Harbison-Walker also mined kaolin. Abbeville Lime Co. crushed limestone for agstone.

Houston.—L. C. Smith Sand & Gravel Co. mined building sand at Dothan.

Jackson.—Four coal mines were active; the leading producer was Farco Co., Inc., which opened a new mine on Sand Mountain, the Fies No. 1 strip mine, and shipped coal to the Widow's Creek powerplant of TVA. The State highway department reactivated the old Proctor quarry and produced crushed limestone for concrete and roads.

Jefferson.—Sixty coal mines were active; leading mines were the Concord No. 1 mine (U.S. Steel Corp.), the Maxine mine (Alabama By-Products Corp.), and the Mulga mine (Woodward Iron Co.). Coal production increased 11 percent.

Universal Atlas Cement, Lehigh Portland Cement Co., Lone Star Cement Corp., and Alpha Portland Cement Co. produced masonry and portland cements. Southern Cement Co. produced masonry and slag cements. Production of masonry cement increased 4 percent, and production of portland cement increased 8 percent; slag cement production was about the same as in the previous year.

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

Dolcito Quarry Co., United States Steel Corp., Alpha Portland Cement Co., Lehigh Portland Cement Co., Universal Atlas Cement, Lone Star Cement Corp., and U.S. Pipe & Foundry Co. crushed limestone for fluxing stone, cement, concrete and roads, agstone, asphalt filler, metallurgical uses, and rock dust for coal mines. Production of crushed limestone increased 4 percent.

Lehigh Portland Cement Co., Universal Atlas Cement, Lone Star Cement Corp., Natco Corp., Watkins Brick Co., and W. S. Dickey Clay Mfg. Co. mined miscellaneous clay for cement and heavy clay products.

Universal Atlas Cement, Enos Vann, and Sam P. Acton produced crushed sandstone for cement, foundries, and refractory uses.

Bibby Coal, Shale & Clay Co. mined a small quantity of fire clay.

Zonolite exfoliated vermiculite at its Birmingham plant.

Limestone.—The county highway department crushed limestone for concrete and roads.

Lowndes.—American Colloid Co. opened a new mine at Sandy Ridge and mined bentonite. This is the first recorded production of bentonite in the State in many years.

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

Madison.—Madison Limestone Co. crushed limestone for concrete and roads at three quarries, the Pulaski Pike quarry, the Airport quarry, and a new quarry called the Madison quarry, which was opened during the year. Alabama Brick & Tile Co. and Huntsville Brick & Tile Co. mined miscellaneous clay for heavy clay products.

Marengo.—Lone Star Cement Corp. produced portland cement at Demopolis, and operated a quarry for crushed limestone which was used in the manufacture of cement. Gulf States Paper Corp. produced regenerated lime for use in the manufacture of paper.

Marion.—Coal production decreased 10 percent; the number of active mines decreased from 36 to 26; leading producers were Coalite, Inc. (Brilliant strip mine), Liberty Coal Co. (Liberty No. 2 mine), and Box Bros. Coal Co., Inc. (No. 3666 mine). Thomas Alabama Kaolin Co. mined and processed kaolin at Hackelburg for a variety of uses. A small quantity of natural gas was produced. One new well was drilled to a depth of 855 feet; the well was dry.

Marshall.—C. A. Langford & Co. crushed limestone for concrete and roads. Brookshire & Kirkland Sandstone Co. quarried a small quantity of dimension sandstone, which was used for rough architectural building stone.

Mobile.—Production of crude petroleum from 460 wells decreased 8 percent; 14 new wells totaling 163,033 feet were drilled. Ideal Cement Co. produced masonry and portland cements from oystershell. Radcliff Materials, Inc., and Southern Oystershell Milling Corp. dredged oystershell from Mobile Bay for cement, concrete and roads, and poultry grit; production expanded 24 percent. Radcliff Materials, Inc., and Hicks Sand Co. produced building, paving, and fill sand, and building and paving gravel. Ideal Cement Co. mined miscellaneous clay for cement. Scott Paper Co. and International Paper Co. produced regenerated lime for use in their paper plants.

Monroe.—Mannings Sand & Gravel Co. mined building sand and building and paving gravel.

Montgomery.—Birmingham Slag, Alabama Gravel Co., the county highway department, and Deep South Construction Co., Inc., mined building, paving, molding, and engine sand, and paving gravel; production increased 2 percent. Jenkins Brick Co. mined miscellaneous clay for heavy clay products.

Morgan.—Trinity Stone Co., Inc., and Waters Quarries Inc., crushed limestone for riprap, roadstone, and agstone. Decatur Sand & Gravel Co. mined building and paving sand and gravel at Decatur.

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

Randolph.—Dixie Mines, Inc., mined scrap mica at the Dixie mine. Most of the material was shipped to other States for grinding, but a small quantity was ground at the mine.

Russell.—Bickerstaff Brick Co., Inc., Dixie Brick Co., and Bickerstaff Co., Inc., mined miscellaneous clay for heavy clay products. Consolidated Gravel Co., Inc., mined building, paving, and railroad ballast sand, and building and paving gravel.

St. Clair.—National Cement Co. produced portland and masonry cements at the Ragland mill; masonry cement production increased 6 percent, and production of portland cement increased 8 percent. National Cement Co. crushed limestone for cement. Riverside Clay Co. (McAffee and Pell City mines) mined fire clay. Ragland Brick Co. and National Cement Co. mined miscellaneous clay for heavy clay products and for cement. Fulgham (Margaret strip mine) mined a small quantity of coal.

Shelby.—Southern Cement Co. produced masonry and portland cement at the Calera mill; masonry cement production increased 18 percent, and production of portland cement was about the same. Southern Cement Co., Longview Lime Corp., United Cement Co., Inc., Cheney Lime & Cement Co., and Alabaster Lime Co. produced quicklime and hydrated lime for building, agricultural, chemical, and industrial uses.

Birmingham Slag (Calera quarry), Southern Cement Co. (Roberta quarry), Longview Lime Corp. (Saginaw A quarry), Southern Rock Products Co., Inc. (Ryan quarry), Alabaster Lime Co. (Scott Rock quarry), United Cement Co., Inc. (Calera quarry), Montevallo Limestone Co. (Montevallo No. 1 quarry), and Cheney Lime & Cement (Landmark quarry) crushed limestone for riprap, fluxing stone, paper, coal dust, lime, asphalt filler, mineral food, cement, agstone, alkali, and other chemicals.

Twelve 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). 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; production increased 9 percent. Moretti-Harrah Marble Co. and Georgia Marble Co. quarried dimension marble for rough exterior building stone, for sawed, dressed interior building stone, and for sawed and dressed monumental stone; production increased 34 percent. Talladega Materials Co., Inc., crushed limestone for concrete and roads. American Talc Co. mined and ground talc at Winterboro for paint, paper, and toilet preparations. Rucker Mining Co. mined a small quantity of brown iron ore. Kimberly-Clark Corp. produced regenerated lime for use in their paper plant.

Tuscaloosa.—Ten coal mines were active; leading producers were Peabody Coal Co. (Seminole strip mine), Taylor & Son Coal Co. (Taylor strip mine), and C. L. Abston Coal Co. (No. 1 strip mine);

production more than doubled, primarily because of the reopening of the Riverbank strip mine by Peabody Coal Co. Southeastern Coal & Iron Co. mined red iron ore (hematite) at the Dudley mine. Yazoo Gravel Co., Inc., and Tuscaloosa Sand & Gravel Co. mined building and paving sand and gravel. Waters Quarries, Inc., opened a large new quarry at Vance and crushed limestone for concrete and roads. Gulf States Paper Corp. produced regenerated lime for use in its papermill at Tuscaloosa. A dry wildcat oil well was drilled to a depth of 5,019 feet.

Walker.—Forty-seven coal mines were active; leading producers were Southern Electric Generating Co. (Segco No. 1 mine), Alabama Power Co. (Gorgas mine), and Peabody Coal Corp. (Tiger strip mine). Production increased 5 percent. Natco Corp., Taft Coal and Clay Co., Contract Mining, Inc., and Aaron Clay Co. mined fire clay. K & S Coal & Clay Corp. mined miscellaneous clay, which was sold to manufacturers of heavy clay products.

Washington.—Olin Mathieson Alabama Chemical Corp. recovered salt from brine at the McIntosh plant. Lone Star Cement Corp. crushed limestone at the St. Stephens quarry and transported it to New Orleans for use in the manufacture of cement. Faith & Hayes Sand & Gravel Co. and Mid-South Materials, Inc., mined building and paving sand and gravel. Four dry wildcat oil wells were drilled, totaling 45,580 feet.

Wilcox.—A dry wildcat oil well was drilled to a depth of 4,128 feet.

Winston.—McCoy Coal Co. (Winston strip mine) and Backwater Coals Inc. (No 1 strip mine) mined bituminous coal.

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] and Phil R. Holdsworth [2]

DEVELOPMENTS in the oil and gas industry, discovery of a possibly huge deposit of low-grade iron at Chenik Mountain 200 miles southwest of Anchorage, and the first steps toward opening of the Ruby Creek copper deposit in northwestern Alaska featured the news of the mineral industry in 1964. New oil discoveries, or confirmation of previously made discoveries, in offshore Cook Inlet formations were of major significance at both the State and the National level.

A drop in the value of mineral production to $65.9 million from the $67.8 million figure of 1963 was due largely to a change in the unit value of sand and gravel by Federal and State agencies. With the exception of the 1944 war year, gold production was the lowest in 70 years of Alaska gold mining. Shutdown of one of the large dredging operations in the Yukon River region was a significant factor in the decrease.

TABLE 1.—Mineral production in Alaska [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate short tons, antimony content			14	$18
Coal (bituminous) thousand short tons	853	$5,910	745	5,008
Copper (recoverable content of ores, etc.) short tons			11	7
Gold (recoverable content of ores, etc.) troy ounces	99,573	3,485	58,416	2,045
Lead (recoverable content of ores, etc.) short tons	5	1		
Mercury 76-pound flasks	400	76	303	95
Natural gas million cubic feet	4,498	1,111	6,272	1,719
Peat short tons			2,350	19
Petroleum (crude) thousand 42-gallon barrels	10,740	32,650	11,059	33,627
Sand and gravel thousand short tons	16,926	22,005	26,089	18,488
Silver (recoverable content of ores, etc.) thousand troy ounces	14	18	7	9
Value of items that cannot be disclosed: gem stones, lead, platinum-group metals, stone, tin and uranium ore	XX	2,584	XX	4,912
Total	XX	67,840	XX	65,947

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

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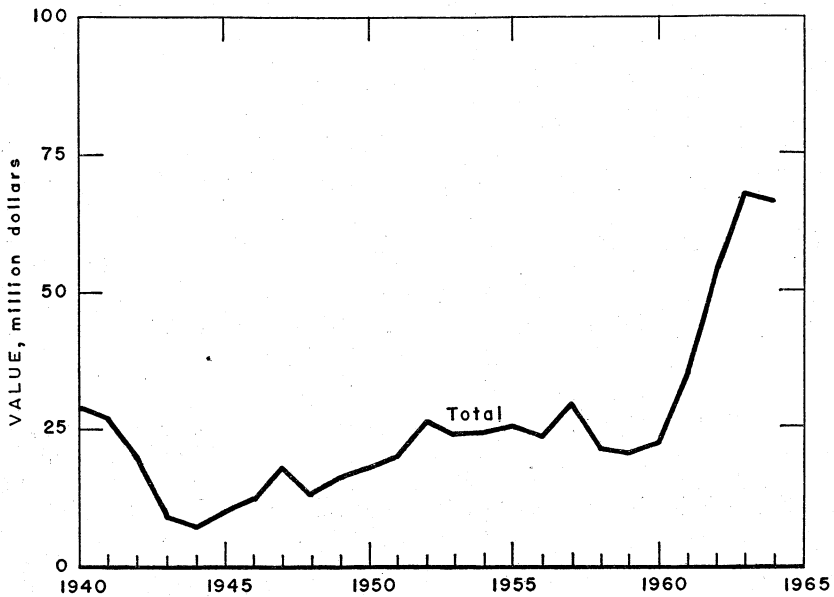


FIGURE 1.—Total value of mineral production in Alaska.

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

(Thousands)

Year	Value	Year	Value
1953	$24,535	1959	$20,644
1954	25,551	1960	22,198
1955	25,940	1961	r 34,978
1956	23,487	1962	r 53,564
1957	28,596	1963	r 67,318
1958	21,642	1964	64,765

r Revised.

Legislation and Government Programs.—Upon the expiration of the term of the Federal Reconstruction and Development Planning Commission (created on April 2, 6 days after the Good Friday earthquake) on October 2, the President signed a new Executive order for long-range planning in Alaska. The responsibility for continued Federal activity in connection with the earthquake was transferred to the Office of Emergency Planning. The new order established a Federal field committee for Alaska composed of representatives of Defense; Interior; Agriculture; Commerce; Health, Education and Welfare; Housing and Home Finance; Federal Aviation Agency; Federal Power Commission; and Small Business Administration; and two public members to be appointed by the President. The order also established a cabinet-level review-committee to give guidance to the field committee. The former also was to have two public members. Among the duties of the field committee were making or fostering surveys and studies to provide data for a program on economic and

resources development. The resources development programs were to be chosen in cooperation with representatives of the State designated by the Governor.

TABLE 3.—Expenditures by major companies for exploration and prospecting

(Thousand dollars)

Type and region	1963	1964
Metals exploration:		
Southeastern Alaska	$120	$30
Copper River and Prince William Sound	70	320
Kuskokwim River and Yukon River	200	110
Northwestern Alaska	720	810
Other	[1] 390	[1] 330
Total metals	1,500	1,600
Oil and gas:		
Exploration	54,030	61,000
Development drilling	4,635	696
Production	1,594	1,758
Refinery construction and maintenance	5,600	2,200
Total oil and gas	65,859	65,654
Grand total	67,359	67,254

[1] Including southwestern Alaska.

Source: Division of Mines and Minerals, Department of Natural Resources, Alaska.

The U.S. Army Corps of Engineers began initial test work on the Snettisham hydroelectric project, 40 miles south of Juneau. Snettisham was the first Corps of Engineers hydroelectric project authorized in Alaska. Installation of a construction camp at the site and diamond drilling to obtain test cores for engineering and geological studies comprised the 1964 work. The Congress included in the public works appropriation bill $750,000 for preconstruction planning on the project. Construction was expected to begin in the spring of 1966 with the first power to be on the line in 1969. The project was designed to provide 60,000 kilowatts for the Juneau-Douglas area; cost was estimated at $42 million.

Studies of the Rampart Dam project, which tentatively had been scheduled to reach Congress in the summer of 1964, were not completed. The Fish and Wildlife Service (FWS) of the Department of the Interior released an auxiliary report in May covering the anticipated effects of the Rampart project on fish and wildlife. The FWS report was strongly unfavorable to construction of Rampart, stating "nowhere in the history of water development in North America have the fish and wildlife losses anticipated to result from a single project been so overwhelming." Following hearings held at Anchorage, Fairbanks, and Fort Yukon, the Secretary of the Interior approved a powersite classification of the Rampart Dam and reservoir area. The order, covering almost 9 million acres, withdrew the area from all forms of appropriation under the public land laws while permitting oil and gas and other mineral leasing to proceed.

The Office of Minerals Exploration (OME) contracted with Bonanza Gold, Inc., of Spokane, Wash., for exploration on an iron deposit near the old Jumbo Basin copper mine on Hetta Inlet, Prince of Wales Island. Total cost of the work as originally proposed was $60,150 of

which OME was to contribute 50 percent. Exploration of the high-grade gold lodes in the Chandalar district continued under an OME contract. Keystone Mines, Inc., Fairbanks, continued work on a group of small lode gold properties in the Fairbanks district. Work in which OME participated was largely shaft sinking and station cutting; the contract was approved late in 1963.

Gas and oil interests, along with coal interests, were invited by the Defense Department to bid on the fuel requirements for the Anchorage military bases, a market hitherto reserved for coal. Alaska Pipeline Co. was the apparent low bidder for contracts to supply Fort Richardson and Elmendorf Air Force Base over a 5-year period; the company bid $0.29 per million B.t.u. Defense Department recommended that the two military bases be converted to gas, citing a conversion cost estimated at $1.4 million and annual savings of more than $1 million. Loss of the military contracts by coal producers was seen as a serious setback to the coal industry and the economy of the Matanuska Valley.

In an effort to assist oil companies exploring areas adjacent to Naval Petroleum Reserve No. 4, a bill was enacted and signed authorizing sale of Umiat oil for fuel and other uses in exploratory work. Umiat oil can be produced from relatively shallow wells; two of the wells drilled for the Navy in the early 1950's were considered as capable of supplying the estimated 100,000 barrels of oil per year needed to fuel exploratory drill rigs. Past practice had been to fly in fuel oil from Fairbanks, a distance of 350 miles, or to barge it from Norman Wells on the Mackenzie River in the Northwest Territories. Costs ranged from $0.93 to $1.30 per gallon. On the strength of the new law, the Navy announced plans to award a contract to Yukon Services, Inc., Fairbanks, to produce and sell the Umiat crude. Yukon would be required to sell at $0.28 per gallon with the Government receiving 61 percent of the gross proceeds. Umiat oil was suitable as a diesel fuel as it came from the well.

TABLE 4.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal and peat	196	50	403	----	30	74
Metal	505	70	619	----	17	27
Sand and gravel	1,338	162	1,458	----	19	13
Stone	117	15	120	----	2	17
Total	2,156	297	2,600	----	68	26
1964: p						
Coal and peat	205	51	414	1	28	70
Metal	450	53	467	----	22	47
Sand and gravel	2,095	250	2,248	----	19	8
Stone	115	15	120	1	8	75
Total	2,865	369	3,249	2	77	24

p Preliminary

Wages and Hours.—Mines in Alaska operated an average of 129 days. This low figure for days operated resulted from the seasonal nature of many mining operations and the number of men employed in prospecting and assessment work.

For the mineral industries covered by the Employment Security Act (operators with hired labor), monthly earnings averaged $912. Monthly earnings in metal mining were $680, in nonmentals $871, in coal mining $1,022, and in oil and gas (production and exploration) $938. The figures for 1963 were $873, $702, $897, $946, and $911 respectively.

Transportation.—The Alaska earthquake, which left operating facilities of the mining and petroleum industries almost untouched, caused catastrophic damage to port and land transport installations in the Cook Inlet, Prince William Sound, and Gulf of Alaska areas. The Alaska Railroad suffered major damage to roadbed, terminal facilities, and rolling stock; rail service between Seward and Anchorage was not restored until mid-September after the March 27th quake. Tidal action generated by the quake wreaked havoc on port and dock facilities in Cook Inlet and Prince William Sound and on the Gulf. Whittier, Seward, Valdez, Cordova, and many of the small ports on the Kenai Peninsula and Kodiak Island were particularly hard hit. In some cases permanent changes in land elevations left docking facilities high and dry or, at the other extreme, docks and even parts of port settlements were flooded at high tides; the entire port city of Valdez was in the process of being relocated following the quake. The Port of Anchorage came through with relatively little damage. Roads and highways in all affected areas required extensive repairs.

TABLE 5.—Coastwise receipts and foreign mineral trade

(Short tons)

Commodity	1962			1963		
	Coastwise receipts	Imports	Exports	Coastwise receipts	Imports	Exports
Anthracite, bituminous coal and lignite, coal and coke briquettes, and coke	623	20	----	403	10	----
Motor fuel and gasoline	312,969	----	94	320,324	737	----
Gas, oil, distillate, and residual fuel oil	803,693	4,693	90	947,436	488	62
Petroleum asphalt	18,388	----	----	13,328	----	----
Lubricating oil and greases	9,280	5,756	1	4,173	10	----
Petroleum products, not elsewhere classified	9,514	1	----	27,186	11,564	----
Building cement	31,591	3,386	----	49,246	18,497	----
Building, monument, and other stone manufactures, not elsewhere classified	6,300	----	----	13,978	----	----
Clays and earths	6,411	107	----	193	----	----
Brick and tile	1,165	----	----	1,178	1	----
Sulfur	----	6,854	----	20	7,935	----
Sand, gravel, and crushed rock, including limestone	172,250	----	----	20,854	448	----
Iron ore and concentrates	94	----	----	----	----	----
Iron and steel scrap	5	2	----	58	----	8,399
Iron and steel products	16,804	6,170	----	18,388	2,282	----
Aluminum metal and alloys in crude and semifabricated forms	194	----	----	22	----	----
Copper semifabricated forms	323	----	----	452	----	----
Lead and lead-base alloys in crude and semifabricated forms	10	----	----	11	----	----
Other nonferrous ores, concentrates, metals and scrap, except precious, in crude and semifabricated forms	1,181	----	25,718	----	----	12,627
Fertilizer materials	2,483	3,043	----	2,962	----	----

Source: Waterborne Commerce of the United States, Part 4, Pacific Coast, Alaska, and Pacific Islands, calendar years 1962-63, by the U.S. Army Corps of Engineers.

Transcontinental Freight Bureau, made up of railroads serving the States to the south, filed with the Interstate Commerce Commission the first system of through route, single factor rates on commodities moving to Alaska. The new tariffs, effective in June, required but one bill of lading for items moving from any point in the United States to destinations in Alaska and were expected to result in significantly lower freight costs. General Services Administration, which was active in negotiating the new rate, called the tariff changes a "tremendous" improvement in freight costs to Alaska. The new rates, however, were no lower than those which had been available to Alaskans over the preceding 2 years through utilizing the Canadian National Railways service via Prince Rupert, British Columbia.

Late in the year, a survey of ocean shipping to Alaska, which had the potential of resulting in an entirely new cargo rate schedule, was ordered by the Federal Maritime Commission. The Commission instructed its staff to make a detailed study of the rate structure and of overall conditions in the Alaska trade. Major changes in ocean shipping procedures, including the expansion of hydrotrain rail-barge service by Puget Sound-Alaska Van Lines, entry into the trade by Sea-Land Service with freighters equipped to carry both vans and break-bulk cargo, and modification of vessels of Alaska Steamship Co. to handle containerized cargo, all contributed to the need for reassessment of rates and conditions in the Alaska trade. Additionally, the Alaska earthquake and growth of the State had changed many of the factors bearing on ocean trade.

Canadian National Railways, which pioneered barge-rail service to Alaska in 1962 with its aquatrain service, added a 30-railcar barge and tug to the Port Whittier-Prince Rupert run. Washington Tug and Barge Co. of Seattle operated the oceangoing leg of the Canadian carrier's service from the United States to southcentral Alaska ports.

Hydrotrain service by Puget Sound-Alaska Van Lines, started in mid-1963, was also expanded with the launching of three additional units to the 1963 fleet. Under the hydrotrain service, commodities could be loaded anywhere in the United States in any type of railcar and shipped directly to Alaska without extra handling along the way. All major U.S. railroads allowed use of their equipment on the hydrotrains. Less than carload shipments were being accepted in 1964.

Sea-Land Service, Inc., and an East Coast truck and water carrier, entered the Alaska service with two converted C–4 freighters providing Seattle to Anchorage and Kodiak service. The new carrier contracted for an icebreaker to allow maintenance of winter service to the port of Anchorage. Sea-Land also announced plans to enter into overland hauling into Alaska through purchase of Alaska Freight Lines, Inc.; approval of the purchase and transfer of the Alaska Freight motor-carrier authority to truck from Seattle to Alaska was under study by the Interstate Commerce Commission at yearend.

Alaska Trainship Corp. also entered the Alaska trade during 1964. Trainship, operating out of Delta Alaska Terminal, New Westminster, British Columbia, supplied railcar service to Port Whittier with the 56-car capacity SS *Alaska*.

TABLE 6.—Freight rates, Seattle to selected Alaskan cities, 1964 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.

In southeastern Alaska, the ferry service between Prince Rupert, British Columbia, and southeast Alaska ports, continued to develop as an important auxiliary freight carrier for the region. An important boon to the area was the speed, ease, and low cost of moving mobile construction and industrial equipment from one section of the region to another.

Early in 1964 a pioneering operation to supply wildcat drill rigs on the North Slope of the Brooks Range was successfully carried out through the use of tractor-train from Dunbar, on the Alaska Railroad, to the northern sites over frozen terrain. Temperatures on the initial run ranged from 20° F above to minus 60° F. According to operators experienced in the area, the test run proved the feasibility of moving heavy-duty oil field trucks and equipment under Arctic conditions. Movement of all supplies and gear needed for oil exploration including a complete drill rig by truck-tractor supported by crawler-type tractors strategically located was seen as feasible over a properly managed and maintained supply road.

In anticipation of an accelerated oil exploration on the Arctic Slope, Alaska Airlines announced plans to purchase two Hercules C–130 Airfreighters. The C–130, a commercial version of a military plane proved over an 8-year service span, had a payload of 25 tons and could be airborne with less than 6,500 feet needed for takeoff. The equipment, if acquired, was expected to solve many of the logistic problems of oil companies operating in the Arctic regions.

Work on a comprehensive study to develop an integrated system of primary and secondary highways in Alaska, authorized by the Congress in 1963, was well along at yearend. Private consultants, working under contract with the Department of Commerce, were preparing a report for the Congress.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Coal production dropped 13 percent and value of production was 15 percent less than in 1963 as the unit value of $6.72 per ton reached an 18 year low. The U.S. Armed Forces were again the chief consumers of Alaska coals. Military contracts for the fiscal year 1965 totaled 638,029 tons compared with 652,884 for fiscal year 1964. Usibelli Coal Mine, Inc., a strip mine operator in the Nenana (Healy River) field, was again the leading contractor with 341,000 tons. Other contractors in the Nenana field were Vitro Minerals Corp. with 25,000 tons and Yutan Construction Co. with 10,000 tons. Vitro Minerals, a joint venture of Vitro Corporation of America and Rochester & Pittsburgh Coal Co. had acquired in 1963 the coal mine formerly operated by Cripple Creek Coal Co. The 1964 contract was Vitro's first since taking over the Cripple Creek operation. Evan Jones Coal Co. contracted for 262,000 tons from the Matanuska field. The company was the only contractor in the Matanuska field.

TABLE 7.—Coal production by major fields

(Thousand short tons and thousand dollars)

Year	Matanuska		Nenana		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1960	300	$3,434	422	$2,884	722	$6,318
1961	226	2,443	511	3,425	737	5,868
1962	309	2,871	562	3,538	871	6,409
1963	293	2,378	560	3,532	853	5,910
1964	283	2,152	462	2,856	745	5,008

Except for minor quantities from small fields, all Alaska coal was strip-mined from the Nenana and Matanuska deposits. The shift to all strip coal, completed in 1963, was reflected in the continued downtrend in the price of Alaska coals. Spurred by competition from natural gas from the Kenai Peninsula-Cook Inlet region, and aided by acquisition of modern pit equipment, Alaska operators were able to reduce unit value to $6.72 per ton, a value below that of any year since 1946. Thus, 1964 was the 6th successive year of price reduction for the industry and the 11th year in the downward trend that began in 1954. Despite this record, a bid by Alaska Pipeline Co. to supply Kenai unit gas to Fort Richardson and Elmendorf Air Force Base was the lowest among bids of coal, oil, and gas suppliers. Special Congressional legislation was required to permit the military to convert the bases from coal to gas fuel.

An estimated 88 percent of coal sold was used for heat and power at the Fort Wainwright and Eielson Air Force Base near Fairbanks, at Fort Richardson and Elmendorf Air Force Base near Anchorage, at Clear Missile Tracking Station near Nenana, and at other military installations in Alaska. Additional quantities were sold to local utility companies for heat and power and to consumers for heating and cooking.

Three strip operations produced coal in the Matanuska field and two in the Nenana field. Of total tonnage mined, 57 percent was cleaned compared with 44 percent in 1963. Vitro Minerals proceeded with preparations to reopen the Cripple Creek mine 1 mile east of Usibelli in the Nenana field. Blasting and stripping of overburden from the No. 1 high volatile subbituminous coalbed, erection of a tipple on the railroad, and construction of a pit to tipple road were accomplished. The No. 1 seam was approximately 50 feet thick and dipping about 30° to the northwest.

Usibelli Coal Mine, Inc., of Fairbanks was the successful bidder on two tracts of coal lands in the Nenana field offered for lease by the State. Usibelli paid $251,000 for a 1,893-acre tract and $100,000 for a 320-acre tract. Vitro Minerals Corp. also bid for the leases offered. Lease terms called for the successful bidder to spend $75,000 in development over the ensuing 3 years, rental payments of $0.50 per-acre per-year, and royalty, less rental payments, of $0.10 per ton.

The Greater Anchorage Area Power Corp. (GAAP) continued in its effort to arrange for construction of a mine-mouth power plant in the Sutton area. GAAP was negotiating with the Matanuska Electric Association, a Rural Electrification Administration cooperative, for purchase of power from the proposed plant on terms consistent with REA policies. Clarification of some of the conditions necessary to make a final agreement between GAAP and the Matanuska Cooperative acceptable to REA was accomplished late in the year. The Matanuska Electric Association had REA loans of about $8 million outstanding.

REA approved an $18.9 million loan to Golden Valley Electric Association, Inc., of Fairbanks to finance a 22,000 kilowatt mine-mouth steam generating plant at Healy. The loan was also to serve for nine diesel standby generating units (eight at Fairbanks, one at Nenana), 115 miles of 138 kilovolt transmission line from Healy to Fairbanks, and substations at Fairbanks and Nenana.

Bureau of Mines investigations of the coalbeds in northwestern Alaska in the Cape Beaufort-Point Lay area were continued. The region between Cape Beaufort and the Kokolik River was reconnoitered and samples of coal obtained from tractor trenches and open cuts at Cape Beaufort and along the Kokolik River. The samples were shipped to the Bureau's Denver Coal Research Laboratory for coking and other studies. The Bureau also sampled the Castle Mountain mine coal seam near Chickaloon in the Matanuska field. The samples were also shipped to Denver for coking studies.

Petroleum and Natural Gas.—Offshore exploratory drilling in Cook Inlet was highly successful in 1964, resulting in significant additions to oil and gas reserves. At Middle Ground Shoal, in the center of the inlet and almost due west of the Swanson River field, Pan American Petroleum Corp. brought in Middle Ground Shoal-State No. 4 at a reported flow of 5,100 barrels per day from eight zones in an 1,500-foot pay section. The well was the most productive found up to that time in Alaska. Phillips Petroleum Co., Sinclair Oil & Gas Co., and Skelly Oil Co. were associated with Pan American in the venture. In the Cook Inlet-State field, Shell Oil Co. reported 2,270 barrels of oil and 842 thousand cubic feet (Mcf) of gas per day from North Cook

Inlet-State No. 1. Richfield Oil Corp. was a partner with Shell in the drilling. Pan American also brought in a producer in the Cook Inlet-State field. Cook Inlet-State No. 1–A, drilled as a control well in 1963 to kill the Cook Inlet-State No. 1 blowout, was deepened to 12,676 feet. The well was reported as flowing 554 barrels of condensate (56°API) and 4,700 Mcf of gas per day. In the Middle Ground Shoal structure, Pan American also drilled a successful gas well with Middle Ground Shoal-State No. 6. In addition to the Cook Inlet drilling, BP Exploration Co. (Alaska), Inc., drilled the East Umiat No. 1 in the East Umiat unit on the Arctic Slope. The well was completed as a shut-in gas well at 3,347 feet; flow was 3,500 Mcf. All five of the above wells were classed as wildcat or stepout wells.

TABLE 8.—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	6,272	1,719

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.

Total drilling footage for the year was 184,609 feet of which 7,499 was classed as development and 177,110 as stepout or wildcat. In 1963 the total (revised) was 215,585 feet with 135,248 classed as exploratory and 80,337 classed as development. Completion of development in the Swanson River field on the Kenai Peninsula accounted for the large decline in development drilling. With both Shell Oil Co. and Pan American Petroleum Corp. scheduled to press forward with exploitation of the Cook Inlet oil finds, development drilling in 1965 was expected to increase materially over that of 1964.

Shell installed a huge drilling platform with 146-foot tubular legs in 90 feet of water at Middle Ground Shoal. Designed for year-round operations, the platform had two decks, quarters for a crew of 50, a 173-foot drilling tower, and other support facilities. The tubular legs of the installation were designed to provide oil storage when the rig was in operation. The platform was to serve as a permanent drilling and production site for the Shell Middle Ground Shoal lease. Shell planned to drill 32 wells from the platform, with initial drilling scheduled to begin shortly after the start of 1965.

Pan American announced plans for a $9 million permanent platform on its Middle Ground Shoal holdings and a $12 million pipeline from the production platform to the East Forelands area of the Kenai Peninsula, a distance of 9 miles. The crude was to be shipped to the West Coast for refining and marketing in the western States.

TABLE 9.—Oil and gas lease acreage under Federal supervision

Year	Thousand acres	Year	Thousand acres
1955–59 (average)	14,803	1962	19,550
1960	33,287	1963	14,053
1961	26,808	1964	11,600

Source: 1954–58 Bureau of Land Management; 1959–64 Geological Survey, U.S. Department of the Interior.

The oil and gas fields on the Kenai Peninsula came through the Good Friday earthquake with very little damage. The refinery at Nikiski and the 20-mile Kenai pipeline connecting it with the Swanson River field suffered only minor damage as did the 80-mile gasline connecting the Union Oil Co.-Marathon Oil Co. Kenai unit gasfield with Anchorage. Storage and marketing facilities at Anchorage and other south-central points, however, were badly damaged. Union Oil set its first estimate of damage at $4 million; Standard of California said its losses would run to several million. Both the Swanson River field and the Kenai unit were back to normal operations within a week of the Good Friday quake.

A gas well, on Naval Petroleum Reserve No. 4 near Barrow, drilled under contract for the Navy for the purpose of supplying natural gas for civilian consumption at Barrow was successfully tested in May. The new well carried the total load of Government-and-contractor installations during a 12-hour test with satisfactory results; shut-in pressures ranged from 980 to 995 psi gauge. Barrow Utilities, Inc., a native cooperative made up of Barrow residents, was awarded a contract for distribution and sale of the gas. The Bureau of Indian Affairs approved a $200,000 loan from Indian revolving funds to Barrow Utilities to finance the project. In December the first hookup on the system, manned entirely by native Eskimos of the Barrow area, was made. Use of the gas was expected to reduce fuel costs at Barrow by at least 30 percent.

METALS

Antimony.—Stibnite concentrate produced from ores from the Stampede mine in the Kantishna district was shipped to Samin Corp., Bombay, India. Some work was done on the Tillicum Mining Co. holdings in the Ketchikan area; there was no production of record. An antimony deposit near Murphy Dome, 18 miles north of Fairbanks, was reported as sold to Nelson, British Columbia interests.

Beryllium.—Exploration on beryllium deposits continued during the year. In southeastern Alaska, the Bureau of Mines diamond-drilled on the I and L and the Atom Marietta claims at Bokan Mountain, Prince of Wales Island. On the Seward Peninsula the Bureau was active as were private interests. The Bureau drilled 16 holes totaling 2,554 feet in the Camp Creek and Bessie and Maple areas. Samples were taken for metallurgical tests. The Geological Survey had a two-man plane table party detailing geological formations from Camp Creek to the Bessie and Maple deposits and a geologist studying the entire York Mountain area.

United States Smelting, Refining and Mining Co. continued its exploration for beryllium on the Peninsula; the company cut trenches at numerous locations and sampled the bedrock exposures. United States Steel Corp. sponsored a party of four geologists and geophysicists, supported by field aides. The company ran magnetometer and self-potential grids and a few lines by induced polarization. Some soil sampling was done. The basic interest was apparently the tin deposits of the area, but interest in the beryllium showing was indicated also. U.S. Steel took a purchase option on the Lost River tin mine, the Bessie and Maple group of claims, and the Camp Creek group owned by Grothe and Pearson.

Copper.—At the beginning of the year, Bear Creek Mining Co. announced purchase of the Ruby Creek copper deposit near Kobuk in northwestern Alaska. The purchase price was reported as $3 million for mining claims covering about 4,000 acres. Kennecott shipped shaft sinking equipment and surface plant and camp gear to the Ruby Creek site preparatory to opening up the deposit.

The State Division of Mines and Minerals listed two copper prospects among the four discoveries made by State geologists in the 1963 season. In the Healy quadrangle at the head of the south fork of Pass Creek (147°09′ W and 63°08′ N), strong copper mineralization over a 33-foot width showed 2.9 percent copper. In the Mt. Hayes quadrangle, east of Denali in the Maclaren River area, an extensive iron-stained formation of folded argillites cut by igneous intrusives showed chalcopyrite and molybdenite.

Moneta Porcupine Mines, Ltd. (with Sunshine Mining Co., Dome Mines, and Tennessee Corp.) staked the Maclaren River showing and accomplished considerable exploratory work in the 1964 field season. Trenching disclosed a number of high-grade zones over a strike length of 1,500 feet and width of 500 feet with depth and length not determined. The relationship between individual exposures was also undetermined. Toward the close of the season, a diamond drill was moved to the property and some drilling done with results reported as not encouraging. Additional drilling and trenching were planned for the 1965 season.

Bear Creek Mining Co. continued work on the Orange Hill copper deposits near Nabesna in the Chisana district. Large deposits running 0.40 percent copper and 0.02 percent molybdenum were known in the area. Bear Creek made public no reports of the Orange Hill work.

Gold.—Output and value of gold again dropped sharply. Shutdown of major dredging operations in the Fairbanks district was a factor in the decreases. The 10-year record of Alaska gold production, from 1955 to 1964, showed an almost unbroken decline from 249,300 ounces valued at $8.7 million at the start to 58,400 ounces valued at $2 million in 1964. Production over this period had been almost entirely from placer mines; Alaska had had no significant lode-mine production since World War II conditions forced the closing of the gold mines.

United States Smelting, Refining and Mining Co. (U.S.S.R. & M.) continued its dredging operations at Chicken Creek in the Fortymile district and at Hogatza River in the Hughes district. The company dredged out a remnant of thawed ground on Cripple Creek in the

Fairbanks district, left over from 1963 operations, and then suspended dredging operations at Fairbanks. The Chicken and Hogatza operations were expected to continue for a few years. U.S.S.R. & M. had long been a leading gold producer in Alaska and in the Nation. The shutdown of the great Nome dredge fields in 1962 and of those of Fairbanks in 1964 marked the end of an era in Alaska gold mining.

TABLE 10.—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)
1955–59 (average)	3	110	3,289	207,882	$7,276
1960	6	92	234	168,197	5,887
1961	8	86	645	114,216	3,998
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

Year	Silver (lode and placer)		Other		Total value (thousands)
	Troy ounces	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	27,156	$25	11	$6	$7,307
1960	25,934	23	64	32	5,942
1961	18,485	17	116	60	4,075
1962	22,199	24			5,808
1963	14,010	18	5	1	3,504
1964	7,336	9	11	7	2,061

[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 11.—Fifteen leading gold-producing mines in 1964, in order of output

Rank in 1964	Rank in 1963	Mine	District	Region	Operator	Source of gold
1	2	Hogatza River	Hughes	Yukon River	United States Smelting Refining and Mining Co.	Dredge (1).
2	3	Chicken Creek	Fortymile	do	do	Dredge (1).
3	1	Fairbanks Unit	Fairbanks	do	do	Do.
4	4	Nyac	Aniak	Kuskowim River.	New York-Alaska Gold Dredging Corp.	Do.
5	6	Prince Creek	Iditarod	Yukon River	Prince Creek Mining Co.	Nonfloat.
6	9	Otter Creek	do	do	Otter Dredging Co.	Dredge (1).
7	(1)	Spruce Creek	Innoko	do	Spruce Creek Mining Co.	Nonfloat.
8	8	Flat Creek	Iditarod	do	Flat Creek Placers	Do.
9	(1)	Kougarok River	Fairhaven	Seward Peninsula.	Robert Smith	Do.
10	5	Woodchopper Creek	Circle	Yukon River	Mathews Mining Co.	Dredge (1).
11	13	Yankee Creek	Innoko	do	Rosander and Reed	Nonfloat.
12	14	Taylor Creek	Kougarok	Seward Peninsula.	N. B. Tweet & Sons	Dredge (1).
13	(1)	Livengood Creek	Tolovana	Yukon River	Redstone Mine	Nonfloat.
14	11	Moore Creek	Kantishna	do	Stuver and Magnuson	Do.
15	(1)	Inmachuk	Fairhaven	Seward Peninsula.	Fred Parker	Do.

[1] Not among the 15 highest in 1963.

Other important dredging operations were in the Kuskokwim River region, Yukon River region, and the Seward Peninsula region.

There was no recorded production of gold from the offshore placer deposits made available for leasing in 1961, by new State regulations, but interest in exploration of these placers continued. On the Seward Peninsula an offshore prospecting permit on lands in the Bluff-Daniels Creek area was converted to the first production lease (20 years) issued under the new regulations. The operator planned to work the deposit with a small suction dredge. Gold values were reported to occur in a very thin sand layer—approximately 2 inches thick—on a hard bedrock with no overburden. Previous attempts to work submerged placer deposits in the Bluff area had met with indifferent success.

TABLE 12.—Gold produced at placer mines, by methods of recovery

Method and year	Mines producing [1]	Material treated (thousand cubic yards)	Gold recovered		
			Troy ounces	Value	Average value per cubic yard
Bucketline dredging:					
1955–59 (average)	12	13,238	166,066	$5,812,324	$0.439
1960	15	12,988	138,620	4,851,700	.374
1961	16	10,315	94,488	3,307,080	.320
1962	16	8,061	147,766	5,171,810	.642
1963	15	5,614	83,994	2,939,790	.524
1964	12	2,772	40,539	1,418,865	.512
Nonfloating washing plants:					
1955–59 (average)	76	2,313	39,348	1,377,166	.595
1960	60	1,229	26,602	931,070	.758
1961	57	773	16,209	567,315	.734
1962	37	741	14,942	522,970	.705
1963	46	620	12,537	438,795	.708
1964	43	538	12,447	435,645	.810
Hydraulicking:					
1955–59 (average)	10	52	767	26,859	.517
1960	11	43	1,447	50,645	1.178
1961	10	39	2,673	93,555	2.378
1962	7	41	2,194	76,790	1.861
1963	4	17	1,049	36,715	r 2.160
1964	3	1	24	840	.840
Small-scale hand:					
1955–59 (average)	12	20	637	22,281	1.114
1960	6	1	153	5,355	5.366
1961	3	1	87	3,045	2.643
1962	6	3	64	2,240	.844
1963	6	13	624	21,840	r 1.680
1964	29	(2)	3,274	114,590	----------
Underground placers (drift):					
1955–59 (average)	1	(3)	8	294	3.675
1960–62	----------	----------	----------	----------	----------
1963	1	(3)	158	5,530	6.913
1964	----------	----------	----------	----------	----------
Grand total placers:					
1955–59 (average)	111	15,622	206,826	7,238,924	.463
1960	92	14,261	166,822	5,838,770	.409
1961	86	11,128	113,457	3,970,995	.357
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	.594

r Revised.
[1] Excludes itinerant prospectors, "snipers," "highgraders," and others, who gave no evidence of legal right to property.
[2] No yardage reported.
[3] Less than ½ unit.

Lode deposits in the Chandalar district (north of the Arctic Circle) and in the Fairbanks district were under exploration with assistance from the Office of Minerals Exploration (OME). Little Squaw Mining Co. continued work, with OME participation, on the Chandalar lodes; underground work, trenching, road building, and airfield improvements to allow use of C–46 and C–82 type cargo planes were accomplished. Keystone Mines, Inc., continued underground work on the Nordale group of gold lode claims in the Fairbanks district. The company mined and milled ores from upper levels of the workings. Exploration of a gold placer at Van Curlers Bar on the Chena River 80 miles east of Fairbanks was completed with OME assistance. An application was filed for an OME contract to explore and evaluate bench placers adjacent to the stream deposits of Dan Creek in the Nizina district.

Besides the OME work noted above, there was some interest in gold lodes in other parts of the State. In the Willow Creek district, at Fairbanks, and in southeastern Alaska, examinations were made or prospecting done on some of the former gold producers. In the Wolf Creek area of the Fairbanks district, the Vetter brothers produced and milled several hundred tons of gold ore.

Iron.—The chief interest in iron during the year centered around the discovery by Pan American Petroleum Corp., an exploration subsidiary of Standard Oil Co. of Indiana, of titaniferous magnetite deposits at Chenik Mountain 200 miles southwest of Anchorage where the Alaska Peninsula joins the mainland. The Pan American discovery, made in connection with oil exploration work in Cook Inlet, was reported as containing more than 1 billion tons of recoverable iron in seven large deposits averaging 15 percent iron content. The company filed almost 500 claims covering approximately 10,000 acres in the Chenik Mountain-Lake Iliamna area. A spokesman for Pan American described the deposits as the second largest ever found in the United States and one of the seven or eight largest discovered anywhere. The iron-bearing rock was described as coarse-grained and sulfur and phosphorus free. The location, near an ice-free deep-water cove on Cook Inlet within 130 miles of Pan American's Cook Inlet gas reserves, was cited as a major factor in future exploitation. Pan American anticipated that the Chenik discoveries might represent an economically attractive source of supply for West Coast or Japanese steelmakers within 10 or 15 years.

TABLE 13.—Mercury production

Year	Number of producing mines	76-pound flasks	Value [1]	Year	Number of producing mines	76-pound flasks	Value [1]
1955–59 (average)	2	3,181	$767,776	1962	2	3,719	$711,110
1960	3	4,459	939,779	1963	2	400	75,780
1961	2	4,129	815,932	1964	3	303	95,381

[1] Value calculated at average New York price.

In southeastern Alaska, Bonanza Gold, Inc., of Spokane, Wash., negotiated an OME contract for work on a magnetic iron deposit near the old Jumbo Basin copper mine on Hetta Inlet, Prince of Wales Island. Bonanza set up camp facilities, continued geologic studies, ran more than 3 miles of geophysical lines, and accomplished 1,700 feet of diamond drilling in the 1964 field season. Copper and molybdenum were reported as occurring with the iron.

Mercury.—Lessees at the Red Devil mine produced a small quantity of mercury as did the operator of the Alice and Bessie mine and a lessee at the White Mountain deposit in the Kuskokwim River region 70 miles southeast of McGrath.

The sharp climb in mercury prices to over $500 per flask occurred too late in the year to have any significant effect on Alaska operations.

Molybdenum.—A. J. Industries, Inc. (formerly Alaska Juneau Gold Mining Co.) leased the Shakan molybdenum deposit on Koskiusko Island in southeastern Alaska to interests based in Ketchikan. The Shakan deposit was developed during World War I by the old Alaska Treadwell Gold Mining Co. Reserves were estimated at 10,000 to 20,000 tons containing 1.5 percent MoS_2. At Orange Hill in the Nizina district, Bear Creek Mining Co. was exploring a copper deposit containing some molybdenum.

Nickel.—Activity in nickel was confined to prospecting and assessment work. Some work was done at the Rainbow Mountain deposit near McCallum, Yukon River region; at the Spirit Mountain deposit near Chitina, Copper River region; and at the Rick deposit on the Salcha River, Yukon River region. Deposits in southeastern Alaska were less intensively explored than in previous years.

An application for patents was made on a number of claims in the Nunatak group of the nickel-copper deposit at Brady Glacier. The claims were in the Glacier Bay National Park. The applicant was John D. McKee reportedly acting for Newmont Exploration, Ltd., an exploration subsidiary of Newmont Mining Corp. Bureau of Land Management was processing the application at yearend.

Platinum-Group Metals.—Goodnews Bay Mining Co. continued its dredging on the Salmon River in the extreme southwestern part of the Kuskokwim River region.

Scrap Metals.—Small quantities of ferrous and nonferrous scrap were shipped from the State. Ferrous scrap was shipped to Japan through the port of Anchorage. The nonferrous scrap, from various points in Alaska, was shipped to Seattle. A West Coast auctioneering firm purchased the remaining surface and underground machinery and equipment of the Alaska-Juneau mine of A. J. Industries, Inc. The firm was salvaging both used machinery and scrap at the Juneau site.

Silver.—Alaska silver production was almost entirely a byproduct of gold. Interest in silver was stirred by increased price and stimulated by the OME action in increasing government participation in silver exploration to 75 percent.

Uranium.—In the early part of the year, the Standard-Bay West Venture mined and shipped uranium ore from the Ross-Adams deposit at Bokan Mountain, Prince of Wales Island. The ore was treated at the Mexican Hat mill in Utah. As a result of the Atomic

Energy Commission stretch-out program, and a subsequent change of ownership in the Mexican Hat mill, Standard-Bay West lost the market for its ores. The deposit was shut down for an indefinite period in the early summer.

NONMETALS

Barite.—Early in the year, Alaska Barite Co. of Tacoma, Wash., made plans to mine and ship barite from the Red Cliff Lode property on Castle Island, 25 miles west of Petersburg. The property was under lease from A. J. Industries, Inc. (formerly Alaska Juneau Gold Mining Co.). Alaska Barite planned to contract open pit mining of the barite and to ship the crude ore to Seward for processing into a product suitable as drilling fluid additive for use in the Kenai Peninsula and Cook Inlet oilfields. Milling equipment was obtained from the former chromite mines at Jakolof Bay on the Kenai Peninsula. With the loss of a barge load of the milling equipment, enroute to Seward, from earthquake induced tidal waves, the plans were suspended. The company gave no indication of its future intentions for the project.

Gem Stones.—Raw jade, most of it from Dahl Creek, a tributary of the Kobuk River (Shungnak district, northwestern Alaska region) was produced. A minor quanity of carnelian was also reported from the Shungnak-Kobuk area. Natural gold for specimens and jewelry was reported from the Seward Peninsula and Yukon River regions. Soapstone from the Willow Creek district, Cook Inlet-Susitna region, was produced and sold for carvings and mineral specimens.

Sand and Gravel.—Physical volume of sand and gravel increased more than 50 percent but total value declined because the unit value was only $0.71 per ton compared with $1.30 in 1963. Twenty-seven commercial producers accounted for 17 percent of output and 22 percent of value. Average value of commercial production was $0.94 per ton. Commercial operators washed 887,000 tons (20 percent) of output valued at $1.9 million or $2.17 per ton. Unwashed product was 3,514,000 tons valued at $0.63 per ton. Commercial producers included The Alaska Railroad, an agency of the U.S. Department of the Interior. The railroad was classed as commercial producer to permit comparability with data published for other States.

Twelve Federal, State, and municipal agencies, or their contractors, produced sand and gravel. For the Government agencies, output was 21.7 million tons valued at $14.4 million or $0.66 per ton. Washed or otherwise prepared product was 1.3 million tons with a unit value of $3.06. Untreated product amounted to 20.4 million tons at $0.51 per ton. The Alaska Department of Highways, the U.S. Army Corps of Engineers, and the Bureau of Public Roads were the major producers. The Alaska Department of Highways furnished 94 percent of the tonnage and 87 percent of the value credited to Government agencies.

Of total production, 92 percent was used as fill, 5 percent for paving, 2 percent in building construction, and 1 percent as railroad ballast. There was no recorded production of industrial sand.

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	1963		1964	
	Quantity	Value	Quantity	Value
Construction:				
Building:				
Sand	166	$528	213	$810
Gravel	315	880	380	1,212
Paving:				
Sand	441	746	108	259
Gravel	1,192	4,109	1,091	3,083
Fill:				
Sand	23	14	188	366
Gravel	14,724	15,673	23,749	12,332
Railroad ballast:				
Gravel	30	7	350	406
Other:				
Sand			2	6
Gravel				
Total construction	16,891	21,957	26,081	18,474
Miscellaneous gravel	35	48	8	14
Grand total	16,926	22,005	26,089	18,488
Commercial:				
Sand	146	453	353	898
Gravel	469	1,120	4,048	3,223
Government-and-contractor:[1]				
Sand	484	835	158	543
Gravel	15,827	19,597	21,530	13,824

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

Stone.—Output of stone, reflecting the effects of the Good Friday earthquake, increased almost fourfold over that of 1963; value was more than three times greater. The Alaska Railroad, faced with a tremendous rebuilding job after the quake, was the chief producer in both physical volume and in value. Commercial producers accounted for 40 percent of volume and 28 percent of value compared with 4 percent and 2 percent, respectively, in 1963. The Alaska Railroad, owned and operated by the Federal Government, was classed as a commercial producer. Railroad figures were included in commercial production to make stone figures for Alaska comparable with those of other States.

Among the Government-and-contractor producers, the U.S. Army Corps of Engineers was the leader in volume and second in value of product. The Corps had a major responsibility in emergency construction and rehabilitation following the earthquake. The Alaska Department of Highways, with a physical volume only slightly less than that of the Corps, was the leader in value of production. Other important Government-and-contractor producers included the U.S. Naval Station at Adak, the Bureau of Public Roads, and the cities of Juneau and Anchorage.

REVIEW BY REGIONS

Aleutian Islands.—Sand and gravel, and stone were produced for military installations. Quantities were minor. There was no other mineral production from the region.

Cook Inlet-Susitna.—Sand and gravel, coal, and stone were the leading mineral commodities, supplying practically all of the $11.3 million production.

TABLE 15.—Value of mineral production in Alaska, by regions[1]

(Thousand dollars)

Region	1963	1964	Minerals produced in 1964 in order of value
Alaska Peninsula	----	$3	Sand and gravel.
Aleutian Islands	$638	540	Stone, sand and gravel.
Cook Inlet-Susitna	9,206	11,300	Sand and gravel, coal, stone, gold, gem stones, silver, copper.
Copper River	3,527	3,809	Sand and gravel, stone, copper, silver, gold, lead.
Kenai Peninsula	33,801	35,370	Petroleum, natural gas, sand and gravel.
Kodiak	13	10	Sand and gravel.
Kuskokwim River	1,206	1,210	Platinum-group metals, gold, mercury, silver.
Northern Alaska	159	1,129	Sand and gravel, natural gas.
Northwestern Alaska	25	7	Sand and gravel, gem stones.
Seward Peninsula	1,675	948	Sand and gravel, gold, tin, stone, silver.
Southeastern Alaska	1,697	2,197	Sand and gravel, stone, uranium.
Yukon River	15,893	9,424	Sand and gravel, coal, gold, stone, gem stones, peat, antimony, silver, lead.
Total	67,840	65,947	

[1] No production reported in Bristol Bay and Bering Sea regions.

Value of sand and gravel and stone, reflecting increased construction activity due to rehabilitation after the Good Friday earthquake, increased appreciably over the figures for 1963. The Alaska Railroad, which suffered heavy damage in the quake, was a major producer of sand and gravel and stone. Rebuilding of the road and southern terminal facilities was accomplished and service restored by mid-September.

All coal was strip mined. Evan Jones Coal Co. was again the leading producer in the Matanuska field. Mrak Coal Co., Inc., and Alaska Matanuska Coal Co. (operating the Premier mine) were other producers. Mrak Coal Co., Inc., was being reorganized under the Federal Bankruptcy Act. The mine shut down in mid-June with a court-appointed trustee overseeing company affairs subject to court approval.

In exploratory oil drilling in the Lake Louise area, Mobil Oil Co. drilled Salmon Berry Lake No. 1 to 7,913 feet; the well was plugged and abandoned as a dry hole.

Copper River.—Sand and gravel and stone accounted for more than 99 percent of total value of production. Roadbuilding and reconstruction following the earthquake were the chief uses for the materials. Valdez and Cordova both suffered severe damage as a result of the quake.

Kenai Peninsula.—Oil and gas from the Swanson River oilfield accounted for more than 99 percent of the value of output.

The Swanson River field, on a routine operating basis throughout the year, produced 11.0 million barrels of crude oil valued at $33.9 million. The 1963 figures were 10.7 and $32.7 million respectively. The field had 37 wells flowing and 17 on gas lift at yearend. Repressuring of Swanson River, begun in November 1962, continued. Standard Oil Co. of California, operator for the field in a joint venture with Richfield Oil Corp., was injecting gas into the Hemlock zone through three wells at rates from 9,900 to 18,700 Mcf per day and pressures to 6,000 psi. Injected gas totaled 5.5 million Mcf in 1964;

cumulative gas injected to January 1, 1965 was 12.0 million Mcf. Union Oil Co. of California, operator of the Kenai unit gasfield in a joint venture with Marathon Oil Co., contracted to furnish more than 100,000 Mcf per day to Standard for repressuring. The Kenai unit gas, along with dry gas and associated gas produced from the Swanson River field itself, was expected to maintain operating pressures at satisfactory levels.

Volume of natural gas produced and sold from the Peninsula was 4.7 million Mcf valued at $1.2 million. The Kenai unit, jointly owned by Union Oil and Marathon Oil, furnished the bulk of the gas produced. The Union-Marathon group was unsuccessful in an attempt to extend the limits of the Kenai unit field. Kenai unit 13–8, drilled to 5,506 feet, was plugged and abandoned as a dry hole.

Union-Marathon continued negotiations toward the shipment of Kenai unit gas to Tokyo Gas Co., Ltd. (Japan) in the form of liquefied methane. Progress was made in the engineering and technical factors involved in the liquefaction and shipment to market. In September Marathon announced it had acquired land north of the city of Kenai for use in establishing facilities for reducing the gas for transport. The site was near Standard Oil Co. of California's Kenai oil refinery.

Kuskokwim River.—Platinum, from the Salmon River dredging operations of Goodnews Bay Mining Co., was the leading mineral commodity in the region. Physical volume of output increased appreciably over that of 1963 and value of product, reflecting both the increased production and the improved prices for the platinum-group metals, was correspondingly greater than the 1963 figure. Improved prices for platinum and associated metals in 1964 led to speculation on the economics of working the deep placer deposits held by the company along the Salmon River. A company official stated that these probably could be strip mined but at a platinum price considerably higher than that prevailing even in late 1964.

There was no activity in the offshore placer deposits in Goodnews Bay. Some geological work was done in the vicinity of the settlement of Platinum. The Goodnews Bay Mining Co. reported no success in the search for the lode source (or sources) of the Salmon River placer deposits. It was felt, however, that further geophysical and geochemical work should be done before abandoning the search.

In gold placering, New York-Alaska Gold Mining Co. was again the leading gold producer in dredging deposits along the Tuluksak River in the southwestern part of the region. Other gold producers include Marvel Creek Mining Co. and Canyon Creek Mining Co., both in the Aniak district and W. E. Gates in the McGrath district. Goodnews Bay Mining Co. was also among the gold producers with byproduct metal from its platinum operations.

Production of mercury remained at the low level of 1963 when the Red Devil mine of Alaska Mines and Minerals, Inc., was shut down. Two or three small operations contributed the production of 303 flasks, which was less than 10 percent of the annual average over the years 1956 to 1962 when the Red Devil mine was operating.

Noteworthy in the Alaska mercury picture was the first production from the White Mountain deposit 60 miles southeast of McGrath. The operator chlorided rich showings, upgrading the ore in a small

gravity plant. The concentrate was flown out in a small private aircraft.

Northern Alaska.—Gas wells on Naval Petroleum Reserve No. 4 supplied 248 million cubic feet of natural gas valued at $124,000 and used at Government agencies, at plants of contractors, and for private use in the city of Barrow. In the South Barrow gasfield, a new well was drilled by a U.S. Navy contractor to supply fuel to residents of Barrow. The well struck gas at 2,300 feet with a flow almost double that of the best of the three wells previously drilled. B. P. Exploration Co. (Alaska), Inc., brought in the wildcat East Umiat No. 1 as a gas producer. The well was east of the Coleville River about 12 miles from the Umiat oilfield.

Northwestern Alaska.—With the purchase of the Ruby Creek copper deposit early in the year, Kennecott Copper Corp. transferred operations at Ruby Creek from Bear Creek Mining Co., an exploration subsidiary, to the New Mines Division. The Ruby Creek deposit had been under exploration by Bear Creek Mining Co. since 1957. Establishment of a new camp and post office, known as Bornite, was underway at yearend. Kennecott planned to sink a shaft on the deposit and to explore laterally; upon confirmation of surface drilling results, a 500-ton-per-day plant was to be built. The deposit was rated, subject to additional exploration, as a small-to-medium tonnage operation. By the end of the year the company had moved sinking gear and supplies to Onion Portage, 6 to 8 miles below the mouth of the Ambler River on the Kobuk. The overland haul to Ruby Creek was scheduled for shortly after the first of the year.

Seward Peninsula.—Four small gold dredging operations were active. N. B. Tweet and Sons, dredging in the Kougarok, was the leading dredger. Others operating dredges were Nugget Mining Co. in the Council district, Lucky Syndicate in the Kougarok, and Engstrom and Son Dredging Co. at Nome. Among the leading nonfloat operators were Fred Parker and Robert Smith, both in the Fairhaven district, Ralph DeLong in the Nome district, Orville Dickman in the Port Clarence district, and P. J. Bliss in the Koyuk district.

For the first year since 1955, the Seward Peninsula had recorded production of tin. A small quantity of concentrate recovered from placer operations in the Lost River area was shipped to the Wah Chang smelter at Texas City, Tex. Interest in the tin and beryllium deposits in the Lost River-Rapid River area at the western end of the Peninsula was high. United States Steel Corp. sponsored a field party making geological, geophysical, and geochemical examinations in the area. The corporation optioned the Lost River tin mine, the Bessie and Maple claims, and the Camp Creek group. Both the Bureau of Mines and the Geological Survey had field parties active in the western part of the Peninsula.

Southeastern Alaska.—The State's only producing uranium mine, the Ross-Adams deposit at Bokan Mountain, Prince of Wales Island, was shut down by Standard Metals Corp., the operator. The stretch-out of the Atomic Energy Commission's purchase program and a change in ownership in the Utah mill processing the Ross-Adams ore were responsible for the shutdown. The deposit was reported as having ore blocked out and ready to mine; there was some prospect that the

mine might resume shipments under a new contract in 1966. Standard Metals had been mining at Bokan Mountain by underground methods.

The Federal Geological Survey announced discovery of a small but rich iron deposit in the mountains 40 miles east of Wrangell. The ore was described as high-grade magnetite with 50 to 65 percent iron in several ore bodies.

Yukon River.—The region dropped to third rank behind the Kenai Peninsula and Cook Inlet-Susitna. A decrease in the value of output of gold was the chief factor in the drop. U.S.S.R. & M. operated a dredge on Cripple Creek in the Fairbanks district for a few weeks at the start of the season and later suspended dredging in the Fairbanks fields. U.S.S.R. & M. dredges operated on the Hogatza River in the Hughes district and at Chicken in the Fortymile district. Others operating dredges in the region included Otter Dredging Co. (Iditarod), Matthews Mining Co. (Circle), Minalaska, Inc. (Innoko), and Glenn Association (Iditarod). Among the leading nonfloat operators were Prince Creek Mining Co. (Iditarod), Spruce Creek Mining Co. (Innoko), Flat Creek Placers (Iditarod), Rosander and Reed (Innoko), Redstone Mine (Tolovana), and Stuver and Magnuson (Kantishna).

Coal, all of it strip mined, was produced from the Nenana field (Healy River) by Usibelli Coal Mine, Inc., and Arctic Coal Co., Inc. Vitro Minerals Corp. devoted the year to development and plant setup; at yearend the operation was ready to go into production.

In lode gold activity, Keystone Mines, Inc., exploring claims in the Fairbanks district under an Office of Minerals Exploration contract, had appreciable production of lode gold. Arctic Alaska Resources, Inc., worked the Silversmith claim, also in the Fairbanks district, and recorded a small production. Vetter Brothers exposed more than 600 feet along the strike of a new vein discovered at the head of Wolf Creek, Fairbanks district. The Brothers planned a large scale mill test to evaluate the discovery.

Silver Ridge Mining Co. of Nelson, British Columbia, was reported to have purchased 32 antimony claims from Taylor and O'Hara of Fairbanks. The antimony occurrences were discovered in the 1964 season in the course of prospecting in the Eagle Creek area about 25 miles north of Fairbanks.

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 Paul Biggs [2]



MINERAL production in Arizona in 1964 was valued at $534.4 million, an 11-percent increase above that of 1963. The greater value was due to the higher output and rise in the price of copper and to increased production of sand and gravel. Increased copper production was reflected in the output of gold, silver, and molybdenum—primarily byproducts of the copper industry. Because supplies of copper throughout the United States and the free world were tight through most of the year, producers' inventories were reduced, and shortages developed. In the fourth quarter, three major domestic producers limited copper shipments to their customers.

Mineral production in the State centered on the metals group, which represented 90.8 percent of the total value of mineral output. Copper was the dominant metal produced and with its associated metals accounted for 89 percent of the total value of mineral output and 98 percent of the value of the metals. Metals production occurred mainly in Pima, Pinal, Greenlee, and Gila Counties.

Sand and gravel output was ranked second in value of mineral commodities produced, accounting for 3.9 percent of the total value of mineral output and 44 percent of the nonmetals value. Used extensively by the construction industry, this commodity increased 20 percent in output. Production of cement was an important factor in the value of output of nonmetallic mineral commodities, because its output required the purchase or mining of clay, gypsum, iron ore, stone, and other commodities.

The mineral-fuels sector, entirely from Apache County, represented 0.4 percent of the total value of mineral commodities produced in the State. Helium output accounted for most of the value, followed by natural gas and petroleum.

Mineral output was reported from all 14 counties. Pima and Pinal Counties, reporting the largest production value, accounted for $268 million, or 50 percent of the total output. All but two of the counties—Graham and Santa Cruz—had production valued at more than $1 million.

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TABLE 1.—Mineral production in Arizona [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	163	$203	168	$213
Copper (recoverable content of ores, etc.) short tons	660,977	407,162	690,988	450,524
Diatomite do	W	W	450	16
Gem stones	(3)	120	(3)	120
Gold (recoverable content of ores, etc.) troy ounces	140,030	4,901	153,676	5,379
Gypsum thousand short tons	W	W	147	770
Iron ore (usable) thousand long tons, gross weight	W	W	4	32
Lead (recoverable content of ores, etc.) short tons	5,815	1,256	6,147	1,611
Lime thousand short tons	181	3,048	177	2,920
Mercury 76-pound flasks	W	W	77	24
Molybdenum (content of concentrate) thousand pounds	5,553	7,584	6,296	9,532
Natural gas (marketed) million cubic feet	1,334	161	2,025	241
Petroleum (crude) thousand 42-gallon barrels	68	W	64	W
Pumice thousand short tons	800	1,877	880	1,635
Sand and gravel do	15,036	14,466	18,116	20,868
Silver (recoverable content of ores, etc.) thousand troy ounces	5,373	6,873	5,811	7,513
Stone thousand short tons	3,257	5,069	3,759	6,283
Tungsten concentrate (60-percent WO_3 basis) short tons			16	17
Uranium ore do	150,584	4,844	102,258	3,253
Vanadium do	222	W	W	575
Zinc (recoverable content of ores, etc.) do	25,419	5,846	24,690	6,716
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite and fire clay), feldspar, helium, mica (scrap), perlite, pyrites, and values indicated by symbol W	XX	r [4] 17,705	XX	[5] 16,122
Total	XX	r 481,115	XX	534,364

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] Excludes bentonite and fire clay; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Value of metals and mineral fuels, $2,360,000; value of nonmetals, $15,345,000.
[5] Value of mineral fuels, $1,796,000; value of nonmetals, $14,326,000.

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

(Millions)

Year	Value	Year	Value
1953	$263	1959	$317
1954	256	1960	380
1955	313	1961	r 414
1956	359	1962	r 450
1957	359	1963	r 454
1958	339	1964	473

r Revised.

Legislation and Government Programs.—The Office of Minerals Exploration (OME) approved a contract with Archean Exploration Corp. to explore for iron in Gila County. Under the exploration assistance program, funds furnished by the Government represented 50 percent of the cost of specified exploration and were to be repaid by a royalty on production.

OME was also authorized to increase assistance from 50 to 75 percent for exploration of silver deposits. The new maximum applied to all silver exploration contracts executed after September 30.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	10,202	3,012	24,100	5	706	29
Nonmetal and coal	276	69	548		4	7
Sand and gravel	1,006	245	1,963		65	33
Stone	651	146	1,163		15	13
Total	12,135	3,472	27,774	5	790	29
1964: p						
Metal	10,555	3,186	25,303	8	656	26
Nonmetal and coal	385	96	774		5	6
Sand and gravel	1,210	295	2,366		66	28
Stone	660	159	1,262		21	17
Total	12,810	3,736	29,705	8	748	25

p Preliminary.

REVIEW BY MINERAL COMMODITIES

METALS

Copper.—Stimulated by the high level of business activity in the United States and abroad, the demand for copper increased sharply. Output from mines in the States was accelerated, and new levels of production were established. More than 55 percent of the domestic production of primary domestic output and 15 percent of the free world output originated at mines in Arizona.

After 3 years of relative price stabilization, the domestic primary selling prices moved upward in mid-March from 31 cents to 32 cents per pound. In late September the price advanced to 34 cents per pound after similar price movements abroad. The increase in price, resulting from the adjustments, accounted for 57 percent of the $43 million increase in value for the output of copper in the State.

Production in the State was 5 percent (30,011 short tons) higher than in 1963. Free world production of primary copper (excluding secondary) indicated that output rose approximately 5 percent, from 4.3 million tons in 1963 to 4.5 million tons in 1964. In the United States, production increased 2 percent. Mines in Arizona accounted for 89 percent of this increase. Strikes at mines in other States tended to increase the Arizona share of new production. Most of the new production resulted in greater output at established mines rather than from mines that came on stream during the year.

Large porphyry open-pit mines containing from 0.6 to 1.1 percent copper yielded most of the copper. Open-pit mines in Cochise, Gila, Greenlee, Pima, and Pinal Counties supplied 75 percent of the output; underground mines including Christmas, Copper Queen (Cyprus Mines), Copper Queen (Phelps Dodge), Magma, Miami, Old Dick, and San Manuel accounted for 24 percent; and the remaining 1 percent was produced at small mines.

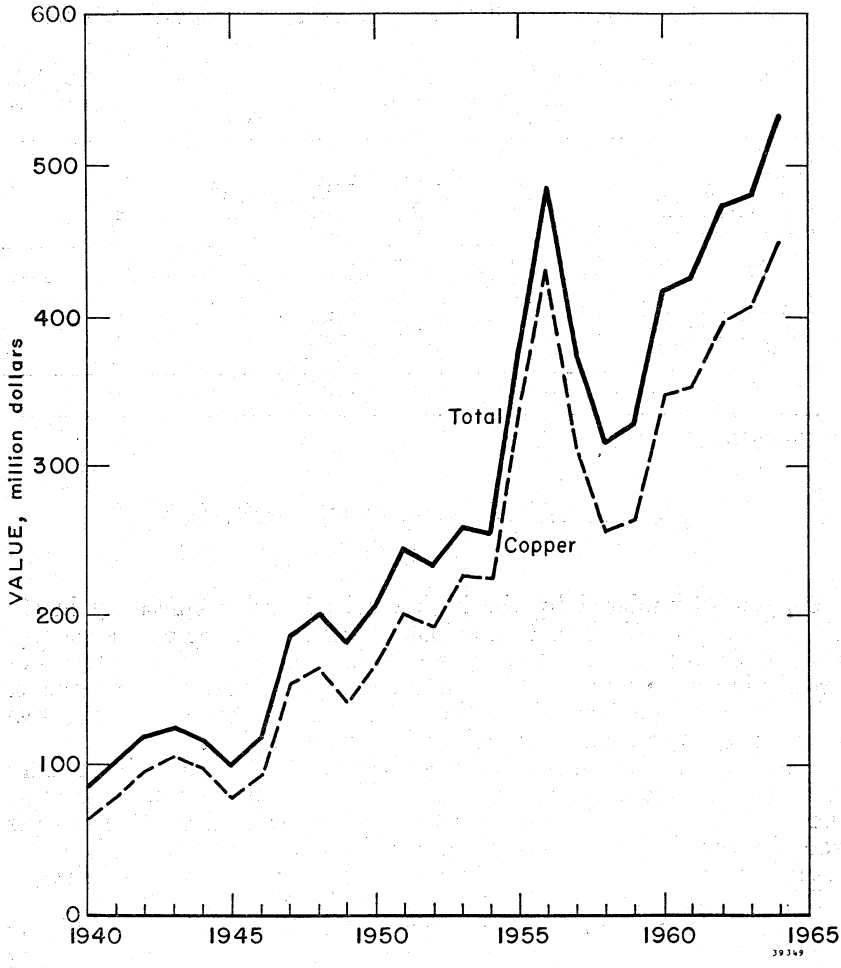


FIGURE 1.—Value of mine production of copper and total value of mineral production in Arizona.

Eighty-four producers reported production from 74 mines. The five largest properties reported output of 425,228 tons, representing 62 percent of the State total; the first 10 major producers accounted for 595,593 tons or 86 percent; and the first 15 producers accounted for 673,953 tons or 98 percent of the total output.

To produce 491,383 tons of copper at the 10 largest open-pit mines, 148 million tons of leach and waste material and 68 million tons of ore were moved. The ratio of waste and leach material removed to that of ore was 2.2:1, approximately the same as in 1963. The ratio of waste material to leach material removed was reduced from approximately 5.9:1 in 1963 to 4.8:1.

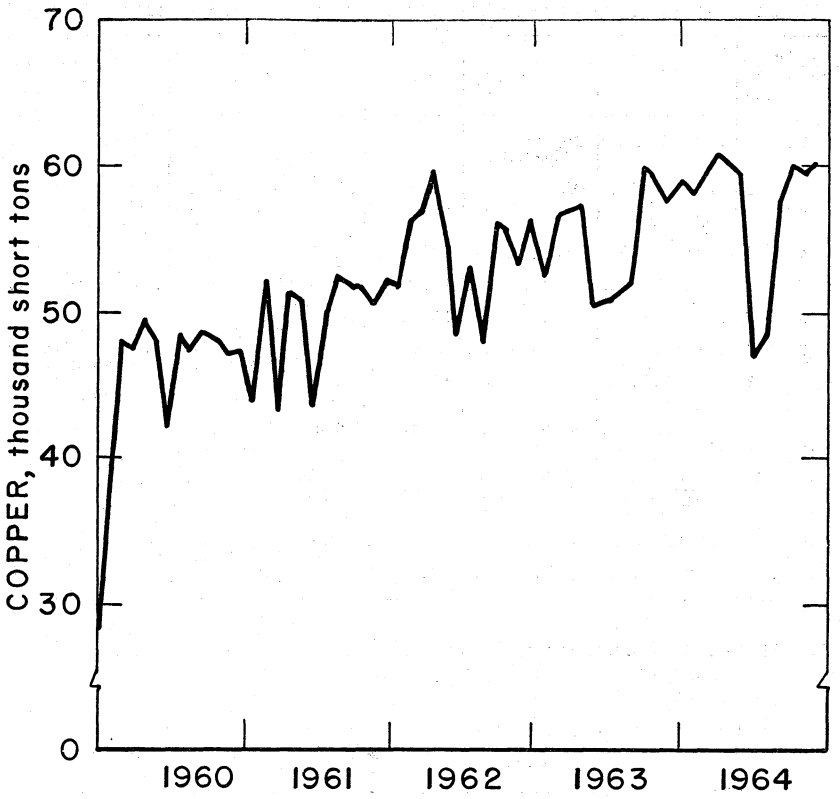


FIGURE 2.—Mine production of copper in Arizona, by months, in terms of recoverable metal.

In 1964, 65,414 tons of copper precipitates was recovered from the leaching of waste dump and ore in place at 16 mines in 6 counties. The precipitates contained 69 percent copper, approximately 45,400 tons.

Output of copper during the first 6 months averaged 59,600 tons per month. In July output fell to 47,000 tons because of strikes and vacations; production, however, reached 60,200 tons per month at year-end.

Gold.—The 10-percent increase in the output of gold during the year reflected directly the increased production of copper. Eighty-seven percent of the gold was a byproduct of copper, 12 percent a by-product of other base-metals, and the remaining 1 percent derived mainly from gold and silver ores.

Six mining operations—Copper Queen, New Cornelia, and Morenci Branches, Phelps Dodge Corp.; Iron King, Shattuck Denn Mining Corp.; San Manuel, San Manuel Division, Magma Copper Co.; and Christmas, Inspiration Consolidated Copper Co.—furnished 84 percent of the gold output. Increased production was reported for all but one of these mines.

TABLE 4.—Fifteen leading copper-producing mines in 1964, in order of output

Rank in 1964	Rank in 1963	Mine	District	County	Operator	Source of copper in 1964
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	Lavender Pit, Copper Queen.	Warren	Cochise	Phelps Dodge Corp	Copper ore, copper precipitates.
4	4	New Cornelia	Ajo	Pima	do	Copper ore, gold-silver ore.
5	5	Ray	Mineral Creek	Pinal	Kennecott Copper Corp.	Copper ore, copper precipitates.
6	6	Mission	Pima	Pima	American Smelting and Refining Co.	Copper ore.
7	7	Inspiration	Globe-Miami	Gila	Inspiration Consolidated Copper Co.	Copper ore, copper precipitates.
8	8	Silver Bell	Silver Bell	Pima	American Smelting and Refining Co.	Copper ore, copper precipitates, copper cleanup.
9	14	Pima	Pima	do	Pima Mining Co	Copper ore.
10	9	Esperanza	do	do	Duval Corp	Copper ore, copper precipitates.
11	10	Copper Cities	Globe-Miami	Gila	Miami Copper Co	Do.
12	11	Bagdad	Eureka	Yavapai	Bagdad Copper Corp	Do.
13	12	Magma	Pioneer	Pinal	Magma Copper Co	Copper ore, gold-silver ore.
14	15	Christmas	Banner	Gila	Inspiration Consolidated Copper Co.	Copper ore.
15	------	Miami	Globe-Miami	do	Miami Copper Co	Copper precipitates.

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

(Short tons)

Mine	Ore mined		Waste and leach material removed		Total copper produced from all sources [1]	
	1963	1964	1963	1964	1963	1964
Open pit:						
Morenci	17,141,000	18,632,000	27,985,000	30,068,000	121,220	129,406
New Cornelia	9,370,000	10,371,000	16,703,000	18,973,000	67,206	70,818
Ray	7,123,102	6,889,503	14,899,836	13,330,083	62,930	58,235
Mission	7,318,100	7,560,700	26,194,200	27,960,700	[2] 50,476	[2] 53,810
Inspiration	5,487,483	5,836,968	6,005,629	9,293,169	46,937	48,908
Lavender	5,347,000	6,001,000	15,781,000	19,017,000	38,266	41,508
Daisy-Pima	1,993,000	2,850,000	[3] 6,386,303	[3] 4,717,646	[2] 23,000	[2] 30,000
Silver Bell	2,948,100	3,033,000	r 6,374,000	6,974,000	[4] 23,589	[4] 24,142
Esperanza	4,364,029	4,291,634	r 6,627,541	6,071,392	[4] 23,393	[4] 22,550
Copper Cities	3,149,260	3,163,565	5,119,846	6,266,089	[4] 21,834	[4] 21,453
Bagdad	r 2,093,081	2,063,484	r 10,892,000	12,062,755	[4] 17,658	[4] 19,632
Underground:						
San Manuel	12,555,000	12,442,752	----------	----------	88,536	92,588
Copper Queen	715,000	749,000	----------	----------	33,071	32,525
Magma	310,039	377,575	----------	----------	14,131	17,064
Christmas	r 658,609	953,231	----------	----------	10,116	12,476
Miami	(5)	(5)	----------	----------	[6] 9,263	[6] 9,037

r Revised.
[1] Includes copper recovered from leaching of material in place and in dumps.
[2] Gross metal in concentrate shipped.
[3] Cubic yards.
[4] Gross metal in concentrate and precipitates shipped.
[5] All production from in-place leaching.
[6] Gross metal in precipitates shipped.

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

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)
1955–59 (average)	142	5	56,885	138,756	$4,857	4,735	$4,285
1960	106	5	66,800	143,064	5,007	4,775	4,322
1961	96	4	72,537	145,959	5,109	5,120	4,733
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	7,513
1890–1964	NA	NA	NA	13,170,610	348,467	381,071	302,601

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	478,401	$319,816	11,229	$3,067	29,605	$6,972	$338,997
1960	538,605	345,784	8,495	1,988	35,811	9,239	366,340
1961	587,053	352,232	5,937	1,223	29,585	6,804	370,101
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
1890–1964	19,778,651	8,328,420	633,706	123,821	963,282	232,730	9,336,039

NA Not available.

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, 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.

Phelps Dodge Corp., the largest producer, accounted for about 63 percent of the total output. According to the company annual report, the combined output of byproduct gold recovered from the refining of copper and gold-silver ores obtained from mining operations totaled 97,000 troy ounces, compared with 89,000 ounces in 1963 and 90,000 ounces in 1962. Magma Copper Co., second largest producer in the State, recovered gold as a byproduct of the refining of copper and gold-silver ores. According to the company annual report, the company produced 31,824 troy ounces of gold—20,746 ounces at the San Manuel Division and 11,078 ounces at the Superior Division in Pinal County. Shattuck Denn Mining Corp. recovered gold from the lead-zinc ores obtained from the Iron King mine in Yavapai County. According to the company annual report, production of gold at the Iron King mine totaled 18,749 troy ounces in 1964.

Iron Ore.—Arkota Steel Corp., the largest producer of iron ore in the State, mined magnetite-bearing sands from the Omega open-pit mine in the Black Mountain mining district of Pinal County. The sands were processed by magnetic separators at the company concentrator and sold to Ray Mines Division, Kennecott Copper Corp., for use in the leach-precipitation-flotation plant at Hayden. Production was reported of smaller quantities of hematite ore by Swartz & Stephens from the Iron Chancellor mine in Yavapai County and of magnetite ore by H. M. Seitz from the Margaret-Howard mine in Gila County.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	9		6,776,600	43,945	$1,538,075	829,037	$1,071,945
Coconino	[3] 6		[3] [4] 780,013	[3] 133	[3] 4,655	[3] 85,258	[3] 110,238
Gila	12		10,289,126	4,784	167,440	260,236	336,485
Greenlee	3		18,632,848	11,163	390,705	499,400	645,724
Maricopa	4		426	21	735	8,898	11,505
Mohave	(3)		(3)	(3)	(3)	(3)	(3)
Navajo			(5)				
Pima	13		27,960,838	41,395	1,448,825	2,429,256	3,141,028
Pinal	14		19,782,138	33,259	1,164,065	771,148	997,094
Santa Cruz	6		8,608	118	4,130	36,657	47,398
Yavapai	15		2,509,382	18,848	659,680	890,389	1,151,273
Yuma	3	1	2,283	10	350	231	299
Total:							
1964	85	1	86,742,262	153,676	5,378,660	5,810,510	7,512,989
1963	90	4	81,214,517	140,030	4,901,050	5,373,058	6,872,786

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Cochise	74,365	$48,485,882	13	$3,419	19	$5,100	$51,104,421
Coconino	[3] 2,613	[3] 1,703,383			[3] [6]	[3] 54	[3] 1,818,330
Gila	94,203	61,420,486					61,924,411
Greenlee	129,419	84,380,862					85,417,291
Maricopa	21	13,953					26,193
Mohave	(3)	(3)			(3)	(3)	(3)
Navajo	37	23,863					23,863
Pima	198,572	129,469,270	74	19,401	1,442	392,224	134,470,748
Pinal	168,362	109,772,187					111,933,346
Santa Cruz	35	22,755	478	125,236	152	41,480	240,999
Yavapai	23,333	15,213,181	5,573	1,460,074	23,077	6,276,822	24,761,030
Yuma	28	18,354	9	2,384			21,387
Total:							
1964	690,988	450,524,176	6,147	1,610,514	24,690	6,715,680	471,742,019
1963	660,977	407,161,832	5,815	1,256,040	25,419	5,846,370	426,038,078

[1] Operations at miscellaneous cleanups not counted as a producing mine; various uranium mines from which copper was recovered as a byproduct not included as they were in the mine count of uranium.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Production of Coconino and Mohave Counties combined to avoid disclosing individual company confidential data.
[4] Excludes tonnage of uranium ore milled.
[5] Byproduct of uranium ore.
[6] Less than ½ unit.

Production of sponge iron produced in the smelting process and from the treating of pyrite declined during the year; Ray Mines and Phelps Dodge Corp. both reported lower output.

Lead.—Lead production in Arizona totaled 6,147 tons, obtained mainly from the processing of lead-zinc ores from deposits in Yavapai County. The Iron King mine operated by Shattuck Denn Mining Corp. was the leading producer. E. W. McFarland, second largest producer in the State, operated the Hardshell mine in Santa Cruz County. Arivaca Mining Corp., operator of the Arizona (Idiho) mine, was ranked third. Yavapai County with six operations led the State with 5,573 tons, 91 percent of the total output. Santa Cruz County with five operations was second, accounting for 8 percent of the production. The remaining 1 percent was produced from operations in Cochise, Pima, and Yuma Counties.

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	6	199	138	272	900	1,000	100
Dry gold-silver	5	105,687	279	5,673	1,742,700	----------	----------
Dry silver	11	8,744	4	5,499	8,100	----------	----------
Total	22	114,630	421	11,444	1,751,700	1,000	100
Copper	39	86,132,039	133,983	4,915,362	1,279,898,700	42,000	1,343,800
Copper-lead-zinc and copper-zinc [2]	3	114,314	229	47,707	6,724,000	179,900	14,614,000
Lead	7	3,157	29	23,814	8,700	958,700	60,900
Lead-zinc	3	314,187	18,413	769,397	777,500	11,053,800	31,608,800
Zinc	4	15,714	2	3,426	33,500	46,500	1,747,700
Total	56	86,579,411	152,656	5,759,706	1,287,442,400	12,280,900	49,375,200
Other "lode" material:							
Gold mill cleanup	(3)	[4] 139	[4] 32	[4] 23,690	[4] 1,476,000	[4] 7,000	[4] 3,600
Gold tailings	1	4	6	2	----------	----------	----------
Gold-silver and silver tailings [2]	3	46,143	514	13,743	131,700	----------	----------
Silver cleanup	(3)	(4)	(4)	(4)	(4)	(4)	(4)
Copper cleanup	(3)	1,908	37	1,824	373,400	----------	500
Copper precipitates	16	65,414	----------	----------	90,800,800	----------	----------
Lead cleanup	(3)	27	----------	100	----------	5,100	600
Uranium ore	----------	----------	----------	(4)	(4)	----------	----------
Total	20	113,635	589	39,359	92,781,900	12,100	4,700
Total "lode" material	85	86,807,676	153,666	5,810,509	1,381,976,000	12,294,000	49,380,000
Placer	1	----------	10	1	----------	----------	----------
Total, all sources	86	86,807,676	153,676	5,810,510	1,381,976,000	12,294,000	49,380,000

[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] From properties not classed as mines.
[4] Gold mill cleanup, silver cleanup, and uranium ore combined to avoid disclosing individual company confidential data.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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: Tailings	6	2	----------	----------	----------
Concentration and smelting of concentrates: Ore [1]	138,669	5,430,425	[2] 1,256,462,300	11,355,200	49,315,400
Direct-smelting:					
Ore	14,408	363,485	32,117,200	926,700	59,900
Cleanings	69	2,854	376,800	12,100	4,700
Copper precipitates	----------	----------	90,800,800	----------	----------
Old tailings	514	13,743	131,700	----------	----------
Total	14,991	380,082	123,426,500	938,800	64,600
Other: Leaching of copper ore	----------	----------	2,087,200	----------	----------
Placer	10	1	----------	----------	----------
Grand total	153,676	5,810,510	1,381,976,000	12,294,000	49,380,000

[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.

Mercury.—Output of mercury from four mines in the Mazatzal Mountains north of Sunflower in Maricopa and Gila Counties, the State principal producing area, totaled seventy-seven 76-pound flasks, valued at $24,000. The mercury content of ore mined averaged 0.26 percent, and ranged from 0.19 to 0.30 percent. Sixty-one percent of the 1,256 tons mined was retorted; the balance was furnaced. The Pine Mountain mine, Maricopa County, operated by Bacon & Brunson, was the leading producer, followed in descending order by the National mine, Maricopa County, operated by Big Sam Mines, Inc. and the Baker Mountain and the Ord mines, Gila County, operated by Gordon K. Grimes.

Molybdenum.—Molybdenum concentrate, output as a byproduct of copper increased 13 percent. Shipments of molybdenum concentrate from seven mines in six counties contained 6.3 million pounds of molybdenum valued at $9.5 million. The average price of molybdedum in concentrate was $1.51 per pound, compared with $1.37 in 1963. Exports of molybdenum concentrate from mines in Arizona totaled 1.8 million pounds contained molybdenum or 29 percent of the total shipments. Listed in decreasing order of production, the mines and operators were San Manuel, Magma Copper Co.; Esperanza, Duval Corp.; Inspiration, Inspiration Division, Inspiration Consolidated Copper Co.; Silver Bell, American Smelting and Refining Co. (Asarco); Morenci, Phelps Dodge Corp.; Bagdad, Bagdad Copper Corp.; and Mineral Park, Duval Corp. Major production continued to be from Pinal County.

In November, Asarco began full-scale operation at the $1.4 million molybdenum-zinc byproducts plant at the Mission mine, 20 miles south of Tucson. Built by Western-Knapp Construction Co., the plant was designed to handle copper concentrate from the adjacent Mission mill.

Duval Corp. began production operations in November at its new $28 million Mineral Park property, 15 miles north of Kingman. The company reported [3] that minimum startup difficulties were experienced; performance indicated superior metallurgical results in both the copper and molybdenum sections. Ore milling capacity was well in excess of designed capacity of 12,000 tons per day. Molybdenum production from the company properties at Esperanza and Mineral Park totaled 1.5 million pounds; 77,000 pounds was produced at Mineral Park.

Silver.—Production of silver increased 437,452 troy ounces (8 percent), principally because of larger outputs from the Pima and Daisy mines operated by Pima Mining Co. and the Lavender Pit and New Cornelia mines operated by Phelps Dodge Corp. The four leading silver-producing companies in the State—Phelps Dodge Corp., Asarco, Shattuck Denn Mining Corp., and Magma Copper Co.—accounted for 76 percent of the total State output; in 1963 these companies supplied 75 percent. Seventy-seven percent of the silver was recovered from copper ores; 13 percent was from lead-zinc ores; and the remainder was from complex ores of copper, lead, zinc, gold, and silver, and miscellaneous materials. Counties in which production

[3] Duval Corporation. Copper. 1964 Annual Report, pp. 5–6.

occurred, listed in order of descending output, were Pima, Yavapai, Cochise, Pinal, Greenlee, Gila, Mohave, Santa Cruz, Coconino, Maricopa, and Yuma.

Uranium.—Thirty operations in Apache, Coconino, Mohave, and Navajo Counties were active, compared with 38 in 1963. Major production continued to come from Coconino and Apache Counties; only a small quantity was derived from mines in Mohave and Navajo Counties. Shipments of uranium ore to processing plants at Tuba City; Mexican Hat and Salt Lake City, Utah; and Shiprock, N. Mex., totaled 102,258 tons valued at $3.3 million, a decrease of 32 percent in quantity and 33 percent in value. The f.o.b. mine value of the ore produced ranged from $4.84 per ton for crude ore containing 0.11 percent uranium oxide (U_3O_8) to $42.60 per ton for crude ore containing 0.48 percent U_3O_8. The average grade of ore shipped from mines in Arizona during the year was 0.37 percent U_3O_8, virtually the same as that shipped in 1963. The Orphan Lode mine on the south rim of the Grand Canyon and owned by Western Equities, Inc., was the principal producer.

Vanadium.—Vanadium was recovered as a byproduct from uranium ores. Vanadium-bearing ores of Arizona origin were processed at Shiprock, N. Mex., by Vanadium Corporation of America (VCA). The quantity of vanadium oxide recovered declined.

Zinc.—Production of zinc in Arizona totaled 24,690 tons, 3 percent below that of 1963. More than one-half of the production was derived in concentrate form from lead-zinc ores mined and milled by Shattuck Denn Mining Corp. at the Iron King mine in the Big Bug mining district of Yavapai County. Zinc concentrate recovered at the company mill was shipped by rail to the Asarco smelter at Amarillo, Tex. Other producers in the State included the Old Dick and Copper Queen mines, Cyprus Mines Corp.; the Atlas mine, B S & K Mining Co.; and the Mission mine, Asarco.

New development—planned, underway, or completed during the year—included the Continental Materials Corp. plan to open an underground mine in the San Xavier district 15 miles south of Tucson, near the Mineral Hill properties on the north and Twin Buttes to the south. Deposits were reported to occur as a series of flat-lying lenses at a depth of 500 to 1,000 feet, and ranging in thickness from 10 to 50 feet. The company also was planning a 500-ton-per-day mill at the property to produce copper and zinc concentrates. Asarco completed construction and operations of a plant for recovering zinc concentrate adjacent to its mill at the Mission mine.

NONMETALS

Asbestos.—Asbestos production came from mines in the Salt River Valley in Gila County. The leading producer was Jaquays Mining Corp., operator of the Regal and Chrysotile mines. Selectively mined chrysotile asbestos ore was hand-sorted at the mine and shipped to the company asbestos mill at Globe. Production also was reported by Metate Asbestos Corp. from the Lucky Seven mine and by Asbestos Manufacturing Co. from the Asbestos Peak and Ash Creek mines.

Cement.—Portland and masonry cements were produced by Arizona Portland Cement Co., a division of California Portland Cement Co., in its plant at Rillito, Pima County, and by Phoenix Cement Co., a division of American Cement Corp., in its plant at Clarksdale, Yavapai County. Portland-cement clinker produced in the Rillito and Clarksdale plants was used in manufacturing masonry cement. Most of the portland cement produced was types I and II (general use and moderate heat), and only a small part was type III (high-early-strength). Shipments of finished portland and prepared masonry cements were mainly within the State. Only a small percentage of the entire output was bagged; most of the cement was shipped in bulk by truck or rail.

Clays.—Output of clays from pits in Arizona declined slightly. Miscellaneous clay accounted for most of the production. Miscellaneous clay mined from pits in Maricopa, Pima, and Yavapai Counties was consumed in manufacturing building brick, portland and masonry cements, and heavy clay products; bentonite from Apache and Yavapai Counties was used as a catalyst in oil refining and for pelletizing; fire clay from a pit in Gila County was used for art pottery, flower pots, and glaze slips by the ceramic industry. Phoenix Cement Co. was the largest producer of clay in the State.

Diatomite.—Production of diatomite, all sold as a filler and filtration media, was reported from Maricopa and Pinal Counties. Operated by Arizona Gypsum Corp., the White Cliffs mine near Mammoth, Pinal County, was the principal producer; William L. Hostetter supplied the balance of the production from the Lake Pleasant mine in Maricopa County.

Feldspar.—Production of feldspar, from mines in Mohave and Pima Counties, was below that of 1963. The Taylor mine near Kingman in Mohave County, operated by a contractor for Industrial Minerals Division, International Minerals & Chemical Corp., was the principal producer; San Antonio Mine Co., Pima County, supplied the balance of the production from the San Antonio mica mine. All of the potash feldspar produced under contract to Industrial Minerals and ground in the company mill near Kingman was used in manufacturing pottery. Shipments of ground feldspar were made principally to consumers in California; some shipments were made to Ohio, Texas, Washington, Wisconsin, Philippine Islands, and Mexico.

Gypsum.—Output of crude gypsum for agricultural use increased. Two new properties were opened in 1964. Three mines were operated in Pinal County and one each in Mohave, Yavapai, and Yuma Counties. Arizona Gypsum Corp. operated two properties, one in sec 26, T 6 S, R 16 E, San Carlos mining district, 11 miles south of Winkelman in Pinal County, and the other in Yavapai County, 5 miles east of Camp Verde, in secs. 1, 2, 11, 12, T 13 N, R 5 E. The principal market for the output from the Arizona Gypsum Corp. Winkelman property was the cement plant at Rillito, operated by Arizona Portland Cement Co., and the principal market for the output from the Verde property was the cement plant at Clarkdale, operated by Phoenix Cement Co. The remainder was sold for use in treating alkali soils resulting from extensive irrigation. Arizona Gypsum Corp. and American Diatom, Inc., were merged bringing bentonite,

clay, diatomite, and gypsum into the same mining and marketing operation. The company was to retain the name of Arizona Gypsum Corp.

National Gypsum Co., the largest producer in the State, operated the Winkelman quarry in sec. 33, T 6 S, R 16 E, near Mammoth, Pinal County. Output from the property was shipped to the company plant at Phoenix for use in manufacturing wallboard and lath.

Gypsum for use as a soil supplement also was produced by Garcia Gypsum Corp., Inc., from the Thunderbird mine near Coolidge, Pinal County; by Sam Bowman, from the Dixie Belles and Extension mines, Mohave County; and by Harquahala Gypsum Co. from an underground mine in the Harquahala Mountains 15 miles southeast of Salome, Yuma County. With the exception of the Harquahala underground mine near Salome, all mines were open pits. The average value of the crude gypsum produced in the State was $5.25 per ton, compared with $5.32 per ton in 1963.

Lime.—The quantity of quick and hydrated lime sold or used declined 2 percent or 4,000 tons. The entire output came from six plants: Paul Lime Plant, Inc. (Cochise County); Hoopes & Co. and Ray Mines (Gila County); Morenci (Greenlee County); San Manuel (Pinal County); and U.S. Lime Division, The Flintkote Co. (Yavapai County). Morenci, Ray Mines, and San Manuel used lime in the concentration of copper ores. Most of the remainder was sold by producers for consumption as mason's lime and for use in treatment of base-metal ores, soil stabilization, steel (electric furnaces), water treatment, and manufacturing coke and gas. A smaller quantity of lime was used by the food and food products and insecticide industries and for the treatment of sewage and other wastes.

Mica.—Mica produced by the Buckeye Mica Co. was ground in the company plant at Buckeye and shipped to manufacturers of roofing material.

Perlite.—Production of crude perlite, from three mines, increased 13 percent. Arizona Perlite Roofs, Inc., operated the Adams and Iberri quarries near Superior in Pinal County. Harborlite Corp., operating the Harborlite perlite mine in Pinal County, shipped crude perlite to company-owned and other expanding plants out-of-State. Expanded perlite produced by Supreme Perlite, Inc., at its expanding plant near Phoenix was used as an aggregate replacing sand in plaster, for loose-fill insulation, concrete aggregate, and as a soil conditioner. Crude perlite sold for $6 to $10 per ton.

Pumice.—Arizona led all other States in the production of pumice or pumicite materials, supplying the Nation with 32 percent of the domestic output. The quantity of pumice or pumicite materials sold or used by producers was slightly greater than in 1963. The Atchison, Topeka & Santa Fe Railway Co., the principal producer, obtained volcanic cinder from the Darling volcanic cinder pit near Winona, Coconino County, for use as railroad ballast. Pumice produced for use as road base and surfacing material at county highway department projects in Apache and Coconino Counties offset the loss of production of volcanic cinders for use in road construction from the W. R. Skousen property in Navajo County. Output and value of pumice

produced by commercial firms for use as concrete admixtures and aggregates declined 32 percent.

Production of pumice from deposits in Apache, Cochise, Coconino, Graham, and Yavapai Counties was reported by nine operators, including one individual, six companies, and two Government agencies. Accounting for 88 percent of the production, Coconino County was the leading producer of pumice and pumicite materials in the State; Apache County, with no reported production in 1963, was second with 11 percent of the output, followed in order by Cochise, Graham, and Yavapai Counties.

Pyrite.—Pyrite was recovered as a byproduct of copper at Hayden and at Superior. Ray Mines purchased the entire output of pyrite by Superior and used it together with its own production for manufacturing sulfuric acid and sponge iron. The sulfuric acid and sponge iron produced were used in the company copper concentrator at Hayden for leaching and precipitating the copper occurring in the ore as copper oxide minerals. Pyrite produced during the year contained approximately 44.8 percent sulfur.

Sand and Gravel.—Sand and gravel ranked second in value among all minerals produced.

TABLE 10.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Apache	1,385	$2,017	Pima	2,216	$2,573
Cochise	W	W	Pinal	1,609	1,736
Coconino	1,372	1,536	Santa Cruz	73	109
Gila	126	168	Yavapai	353	490
Graham	4	6	Yuma	1,075	1,044
Greenlee	1	1	Undistributed	454	539
Maricopa	7,966	8,922			
Mohave	729	858	Total	18,116	20,868
Navajo	753	869			

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

Sand and gravel and stone were used chiefly by contractors for the Federal Bureau of Public Roads and Arizona State Highway Department and crews of county highway departments in constructing interstate, State, and county highways. A report [4] showed that from July 1, 1956, to December 31, 1964, Arizona completed to full or acceptable standards 378.8 miles of road, plus 248.5 miles of highway improved to standards adequate for present traffic; a total of 622.3 miles was open to traffic. Work in progress with interstate funds included 90 miles under construction and 403.9 miles in engineering or right-of-way status, a total of 493.9 miles. In mileage completed, Arizona was ranked 8th in the Nation; in total underway it was 14th. The Arizona State highway contracting program [5] in 1964 included $600,000 in State-financed roads, $12.4 million in the Federal-aid primary and secondary (ABC) contracts, and $42 million in interstate high-

[4] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65–10, Feb. 11, 1965.

[5] Engineering News-Record. State Highway Contract Awards Will Jump to a Record High. V. 174, No. 12, Mar. 25, 1965, pp. 30–32.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	1,746	$2,265	1,782	$2,346
Paving	586	613	782	912
Railroad ballast	1	1		
Fill	172	112	202	101
Other	(1)	(1)	(1)	(1)
Industrial:				
Blast	1	5	(2)	(2)
Oil (hydrafrac)	14	157	161	348
Other	4	24		
Total	2,524	3,177	2,927	3,707
Gravel:				
Construction:				
Building	2,182	2,247	2,484	3,149
Paving	1,696	1,690	4,117	4,881
Railroad ballast	(1)	(1)	(1)	(1)
Fill	637	526	698	373
Miscellaneous	1,079	1,091	18	28
Total	5,594	5,554	7,317	8,431
Total sand and gravel	8,118	8,731	10,244	12,138
Government-and-contractor operations:				
Sand:				
Building	7	7		
Paving	846	554	1,167	1,373
Fill	22	13	64	49
Total	875	574	1,231	1,422
Gravel:				
Building	17	17	16	16
Paving	6,026	5,144	6,625	7,292
Total	6,043	5,161	6,641	7,308
Total sand and gravel	6,918	5,735	7,872	8,730
All operations:				
Sand	3,399	3,751	4,158	5,129
Gravel	11,637	10,715	13,958	15,739
Total	15,036	14,466	18,116	20,868

[1] Withheld to avoid disclosing individual company confidential data; included with "Fill."
[2] Withheld to avoid disclosing individual company confidential data; included with "Oil (hydrafrac)."

way contracts for a total of $55 million. Planned for 1965 were $600,000 in State-financed roads, $12.4 million in ABC contracts, and $52 million in contracts for interstate roads. This projection totaled $65 million—an increase of 24 percent in interstate contracts and an overall 18-percent increase in outlay for road construction in 1965.

Stone.—Output of stone from 92 operations contributed 1 percent of the total value of mineral production in the State.

Basalt was quarried and processed in Coconino and Navajo Counties for use as roadstone and in concrete by contractors for the Federal Forest Service and in Pinal County for use as riprap by contractors for the Pinal County Highway Department.

Sanner Construction Co., Maricopa County, produced crushed granite for use as roadstone and in concrete. Allen Granite Co., active

during 1963, was idle during the year. Noncommercial granite was produced and crushed for riprap in Yuma County by 10 contractors for the Federal Bureau of Reclamation.

Limestone was quarried and crushed by 10 operators in 8 counties. Output was 2 percent more than in 1963. Crushed limestone was used for manufacturing cement and lime, as a flux in the copper industry, as an aggregate in cements, and in mineral foods. Almost all of the crushed limestone was produced by commercial firms. Commercial crushed limestone was priced at $1.36 per ton.

TABLE 12.—Stone production in 1964, by counties

County	Short tons	Value	County	Short tons	Value
Apache	41,324	$80,905	Pima	764,708	$1,070,097
Cochise	426,205	1,220,835	Pinal	100,396	176,514
Coconino	581,143	863,361	Santa Cruz	5,299	6,624
Gila	121,352	179,653	Yavapai	542,637	641,177
Graham	W	W	Yuma	821,485	1,343,334
Greenlee	W	W	Undistributed	300,290	531,953
Maricopa	10,816	34,774			
Mohave	43,525	133,720	Total	3,759,180	6,282,947
Navajo	W	W			

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

TABLE 13.—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
1960	647,441	$651,845	W	W	1,782,967	$2,079,263	W	W
1961	285,371	285,850	7,155	$7,155	2,099,455	2,458,371	4,513	$60,732
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

Year	Sandstone		Slate		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1960	490,339	$1,175,090	----------	----------	1,328,560	$1,200,710	4,249,307	$5,106,908
1961	334,557	942,155	----------	----------	851,276	872,217	3,582,327	4,626,480
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	----------	----------	1,107,096	1,811,973	3,759,180	6,282,947

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

Miscellaneous noncommercial crushed stone was produced by contractors for the Arizona State Highway Department, Federal Bureau of Reclamation, Navajo County Highway Department, and Graham County Board of Supervisors for use in road construction. Production totaled 126,495 tons valued at $193,804. Miscellaneous commercial crushed stone was produced by eight producers in six counties for use as riprap, concrete aggregate and roadstone, and in agriculture. A small tonnage of dimension miscellaneous stone also was produced.

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

Use		1963		1964	
		Quantity	Value	Quantity	Value
Dimension stone:					
Rough construction	short tons	3,309	$37,288	2,355	$23,957
Rubble	do.	1,767	14,296	380	1,634
Rough architectural	cubic feet	2,510	2,545	23,935	14,192
Dressed architectural	do.	8,776	17,541	34,962	57,226
Flagging	do.	67,412	58,416	106,211	122,612
Total (approximate, in short tons)		11,000	130,086	15,300	219,621
Crushed and broken stone:					
Riprap	short tons	14,128	35,848	977,720	1,618,123
Metallurgical	do.	496,504	947,990	526,962	1,147,114
Concrete and roadstone	do.	1,172,851	1,568,326	676,340	925,825
Other	do.	[1] 1,562,117	[1] 2,386,900	[2] 1,562,897	[2] 2,372,264
Total	do.	3,245,600	4,939,064	3,743,919	6,063,326
Total stone (approximate, in short tons)		3,256,600	5,069,150	3,759,200	6,282,947

[1] Includes stone used in abrasives, cement, cleansers, enamel, landscaping, lime, porcelain, pottery, roofing granules, terrazzo, tile, and unspecified use.
[2] Includes stone used in abrasives, agriculture, animal feed, cement, ceramics, cleansers, exposed aggregates, gunite, landscaping, lime, marble fines, mineral food, porcelain, pottery, roofing granules, terrazzo, and tile.

Marble quarried and prepared by six producers in four counties was used as building stone, terrazzo, roofing granules, gunnite, landscaping, animal feed, and whiting.

Sandstone was quarried in 11 counties. Output of dimension sandstone increased 35 percent; crushed sandstone was 10 percent above that of the previous year. Government-and-contractor operations accounted for 56 percent of the crushed sandstone produced; commercial operators quarried the remainder. Crushed sandstone was used primarily as road construction material, smelter flux, and as a refractory stone. Commercial crushed sandstone was valued at $2.71 per ton; noncommercial crushed sandstone at $1.25. Averaging about $15 per ton, dimension sandstone quarried and prepared in 6 counties by 15 producers was used as rough construction material, rubble, rough architectural stone, sawed stone, dressed stone, and flagging.

MINERAL FUELS

Helium.—Helium-bearing gas from the Pinta Dome field in Apache County was processed by Kerr-McGee Oil Industries, Inc., at its Navajo plant. The Arizona Oil and Gas Conservation Commission reported an output from 10 active wells of 554 million cubic feet of helium-bearing natural gas containing 8.5 to 9 percent helium. Assuming 97- to 98-percent recovery of the contained helium, the quantity of grade A helium recovered would be approximately 46 million cubic feet; at $35 per 1,000 cubic feet, established by the Federal Bureau of Mines for sales of Government-produced gas to Government and industrial consumers, the product would be valued at $1.5 million. Five helium-bearing natural gas wells were completed; four were in the Pinta Dome area in Apache County and one in Navajo County. Footage drilled was 4,795.

Petroleum.—Crude petroleum production was 64,000 barrels, a decline of 6 percent. The Arizona Oil and Gas Conservation Commis-

sion reported production of 1.4 billion cubic feet of oil-well and dry natural gas.

The December report of the Commission showed eight active oil wells in the Bita Peak, Dry Mesa, East Boundary Butte, Twin Falls Creek, and Walker Creek fields.

TABLE 15.—Wildcat- and development-well completions in 1964, by counties

County	Gas	Dry	Total	Footage
Wildcat:				
Apache		11	11	29,200
Coconino		2	2	7,500
Maricopa		2	2	900
Navajo	1	5	6	2,500
Pima		1	1	4,400
Total	1	21	22	44,500
Development: Apache	5	13	[1] 19	42,700
Total all drilling	6	34	[1] 41	87,200

[1] Includes 1 service well.

Source: Oil and Gas Journal.

Although no major oil and gas fields were found in Arizona, oil companies believed there were fields to be found. Lease bonuses paid in Arizona during 1964, mostly for Hopi or Navajo Indian Reservation lands, amounted to $20.6 million.[6]

REVIEW BY COUNTIES

Apache.—Sand and gravel, the principal mineral commodity, accounted for 37 percent of the total value of minerals produced in the county. Most of the sand and gravel was used by Government contractors constructing roads in the county; a small quantity was used for building construction, fill, oil hydrofractionation, and sand blasting.

Apache County led the State in output of bentonite. Filtrol Corp., the major producer, operated the Cheto mine near Sanders and processed the clay for use as a catalytic agent in refining crude petroleum. Arizona Gypsum Corp. produced a small quantity of bentonite from a deposit near Camp Verde and sold it for use in pelletizing ore.

Pierre H. Haumont, Jr., and Isbell Construction Co., contractors for the Arizona State Highway Department, produced a small quantity of miscellaneous stone, and crews of the Apache County Highway Department produced pumice (volcanic cinders) for use in highway construction. Crushed limestone, produced by the Navajo Tribe for the Federal Bureau of Indian Affairs, was used as concrete aggregate and as roadstone.

Output of uranium and associated vanadium declined because of the depletion of ore reserves and the effect of the stretchout program announced by the U.S. Atomic Energy Commission (AEC) in November 1962. Twenty-one uranium mining operations were reported active. Largest mine in the county, and second largest in the

[6] Petroleum Information Corp. 1964 Resume, Oil and Gas Operations in the Rocky Mountain Region. Competitive Leasing, p. 19.

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

County	1963	1964	Minerals produced in 1964 in order of value
Apache	r $4,071,359	$5,483,255	Sand and gravel, helium, vanadium, uranium ore, natural gas, petroleum, clays, pumice, stone.
Cochise	49,409,582	53,727,756	Copper, gold, stone, silver, lime, sand and gravel, pumice, zinc, lead.
Coconino	6,160,997	7,367,976	Uranium ore, sand and gravel, pumice, stone, copper, silver.
Gila	r 58,316,113	64,278,510	Copper, molybdenum, lime, silver, asbestos, stone, sand and gravel, gold, iron ore, mercury, clays.
Graham	94,926	W	Stone, pumice, sand and gravel.
Greenlee	77,360,587	87,325,743	Copper, molybdenum, lime, silver, gold, stone, sand and gravel.
Maricopa	9,139,113	9,088,660	Sand and gravel, clays, stone, mica (scrap), mercury, copper, silver, gold, diatomite.
Mohave	W	2,092,263	Sand and gravel, copper, stone, molybdenum, silver, feldspar, tungsten concentrate, gold, uranium ore, gypsum, zinc.
Navajo	1,403,772	1,004,117	Sand and gravel, uranium ore, copper, stone, vanadium.
Pima	131,656,225	148,899,356	Copper, cement, silver, molybdenum, sand and gravel, gold, stone, zinc, clays, lead, feldspar.
Pinal	111,220,356	119,452,151	Copper, molybdenum, sand and gravel, gold, silver, gypsum, lime, perlite, stone, pyrites, iron ore, diatomite.
Santa Cruz	203,138	356,623	Lead, sand and gravel, silver, zinc, copper, stone, gold.
Yavapai	30,788,349	32,570,543	Copper, zinc, cement, lead, silver, gold, stone, sand and gravel, molybdenum, lime, gypsum, clays, iron ore, pumice.
Yuma	901,902	2,428,721	Stone, sand and gravel, gypsum, copper, lead, gold, silver.
Undistributed [1]	r 388,821	288,271	
Total	r 481,115,000	534,364,000	

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.

State, was the Monument No. 2 mine operated by VCA on the Navajo Indian Reservation. Before shipment to the company uranium-vanadium mill at Shiprock, N. Mex., low-grade ores from this mine and tailings from the concentrator were to be treated in the new leaching plant constructed at the property.

The county continued to be Arizona's only oil- and gas-producing county. Natural gas and helium-bearing natural gas production increased; crude oil production declined. The December report of the Arizona Oil and Gas Commission listed one gas well in the Bita Peak field, two oil wells in the Dry Mesa field, three oil and gas and one gas well in the East Boundary Butte area, one gas well in the North Toh-Atin field, one oil and gas well in the Twin Falls Creek field, and one oil well in the Walker Creek field. Pan American Petroleum Corp. No. 1 Navajo–F oil well was plugged late in the year. Pan American Petroleum Corp. placed its No. 1 Navajo–O oil and gas well (drilled in 1963) in the Bita Peak area on production in July.

Of the 30 wells drilled in Apache County, 5 were completed as helium-producing wells. During 1963, 8 wells were drilled in Apache County with an average depth of 4,475 feet, whereas 30 wells were drilled in 1964 with an average depth of 2,396 feet.

Kerr-McGee Oil Industries, Inc., operated its Navajo helium plant throughout the year. Grade A helium was marketed to consumers on the Pacific Coast. A 60-liter-per-hour helium liquefier was installed, and operation of the unit began in February. Liquid helium was shipped in 250-liter containers for the cryogenic market.

Cochise.—With mining and smelting forming the economic base in the county, the value of mineral production was $54 million. Combined value of copper, gold, and silver output was $51.1 million, 95 percent of mineral output. The Copper Queen Branch, Lavender pit and Copper Queen mines, supplied most of the output. The county was ranked first in the State in gold production, third in silver, and fifth in copper.

Copper Queen Branch, the third largest copper producer in the State, was the largest producer of gold and the second largest producer of silver. According to the company annual report, 749,000 tons of ore was mined from the Copper Queen underground mines and 6 million tons from the Lavender pit at Bisbee. In addition, 19 million tons of waste and leach material was mined from the Lavender pit. The ratio of waste and leach material to ore mined in 1964 was 3.17:1, compared with 2.95:1 in 1963. Part of the ore from the Copper Queen mines was shipped to the company smelter at Douglas; 471,000 tons was treated at the Lavender pit concentrator. Also treated at the concentrator was 6 million tons of ore from the Lavender pit for an average of 20,212 tons per operating day. Output of copper at the Douglas smelter from ores obtained from the underground mines totaled 32,525 tons and from the open pit mine, 41,508 tons.

Significant developments at the Copper Queen Branch during the year included total conversion to truck haulage of waste and leach material and development of a system for filling mined-out areas with sand obtained from concentrator tailings. The tailings replaced the use of underground waste for fill. Improvements to increase the capacity of the sponge-iron plant from 25 to 50 tons per day were substantially completed during the year.

Small quantities of gold, silver, copper, lead, and zinc were recovered from ores mined at several small properties.

Nonmetals production, valued at $2.6 million, was 5 percent of the total value of mineral output. Production of the nonmetal group of minerals increased at a slightly lower rate than that of metals. The change was primarily due to increases in crushed sandstone output by Andrew J. Gilbert Construction Co. and in crushed limestone production by Paul Lime Plant, Inc. Limestone produced by the Paul Lime Plant, Inc., was used primarily for manufacturing lime at the Paul Lime plant and as a flux in smelting copper ores. Most of the lime was used in concentrating copper ores. Sandstone quarried by Andrew J. Gilbert Construction Co. was sold as a smelter flux. Varied colored marble quarried and processed by Dragoon Marble Quarries, Inc., was used for terrazzo and roofing granules. There was a decline in production of volcanic cinders by San Xavier Rock and Sand Co. for use as concrete aggregate and in concrete admixtures.

Coconino.—Value of nonmetals was 53 percent of the total value of all minerals produced in the county. Contractors for the Federal Bureau of Indian Affairs, the Federal Forest Service, the Federal Bureau of Public Roads, and the Arizona State Highway Department, together with Peter Kiewit Sons' Co. and Hagen Construction Co., Inc., supplied all of the sand and gravel output. Scoria deposits in the Flagstaff area were operated by Atchison, Topeka & Santa Fe

Railway Co., the Coconino County Highway Department, Fisher Contracting Co., Superlite Builders Supply Co., and Paul Zanzucchi.

The county was first in the production of uranium. The Orphan Lode mine, operated by Western Equities, Inc., was the only producer. Silver and copper were recovered from uranium ores produced by Western Equities, Inc., at the Orphan mine and from base-metal ores by Oliver Smith, R. Coonrod & Homer R. Schell at the Flamingo mine. Zontelli Western Mining Co. operated its new precipitation plant, completed in 1963, at the Mardun copper deposit in the White Mesa mining district on the Navajo Indian Reservation.

Gila.—Because of the increased value of copper output, value of minerals produced increased 10 percent. This rise in value resulted partly from increased output from the Christmas and Inspiration mines operated by Inspiration Consolidated Copper Co. and partly from a higher average price for copper.

The Inspiration Division operated the Live Oak and Thornton pits for 359 days at an average daily rate of 16,259 tons. According to the company annual report, the division mined 5.8 million tons of ore containing 0.898 percent total copper (0.422 percent oxide copper and 0.476 percent sulfide copper), indicating that the ore was slightly lower in grade than in the past several years. Stripping-to-ore ratio increased (1.59:1 in 1964 from 1.09:1 in 1963) with the higher rate necessary to prepare for mining 20,000 tons per day in 1965. Of the 9.3 million tons of waste mined, 6.3 million tons was removed from the west extension of the Thornton pit. Overall stripping, expected to remain high through 1965, would thereafter tend to decrease. A total of 90.2 million pounds of copper was produced from Inspiration ores, approximately 15.45 pounds of copper per ton of ore mined. Leaching of ores in place accounted for an additional 7.6 million pounds (5.9 million pounds in 1963 and 5.2 million pounds in 1962), raising the total copper output to 97.8 million pounds. New leaching areas, brought into production in 1962, were operated throughout the year accounting for 6.6 million pounds (87 percent) of the copper recovered by in-place leaching. Leaching of old areas, from which production had ceased except that produced by natural drainage, was 1 million pounds in 1964. The leaching plant treated 5.4 million tons of ore and recovered 22 million pounds of copper in cathode form and 18 million pounds by precipitation of copper in scrap. Flotation concentration of leached ore produced 52,416 tons of concentrate with a copper content of 37.58 percent or 39 million pounds. Separate treatment of fine material, removed from the ore before leaching, accounted for 11 million pounds of additional copper. Overall copper recovery, through all of these processes, was 86.03 percent in 1964, compared with 88.04 percent in 1963. The molybdenum content of concentrate produced by the retreatment of copper concentrates totaled 587,014 pounds, the highest on record. The smelter treated 198,888 tons of new copper-bearing material: 124,255 tons was company material; 74,633 tons was purchased or treated on toll. A new 13- by 23-foot Peirce-Smith converter was installed and began operating on August 15. Both reverberatory furnaces were operated most of the years; however, in December, one was shut down for rebuilding.

Operations at the Christmas underground mine were improved but remained difficult. During the year, according to the company annual report, the Christmas mine yielded for treatment 953,231 tons of ore containing 1.493 percent copper. Overall recovery was 87.69 percent, or 25 million pounds of copper. The Christmas ore body had become more difficult to mine than was indicated by early development and experimental work. Contours of the ore body were more irregular, faulting was more extensive, and ground support became a greater problem.

Miami Copper Co. Division, Tennessee Corp. (a subsidiary of Cities Service Co.), recovered copper from leaching operations at Castle Dome and Miami and from mining, milling, and leaching operations at Copper Cities.

Eight other properties yielded ore from which gold, silver, and copper were recovered. Mercury output came from the Ord and Baker Mountain mines operated by Gorden K. Grimes.

Nonmetal production accounted for 2 percent of value of mineral output. Asbestos and lime were the leading nonmetallic minerals produced. Gila County was the only asbestos-producing area in the State; output from three mines was processed at company mills near Globe. Shipments consisted primarily of short-fibered material; only a small quantity of spinning-grade asbestos fiber was produced. The Jaquays Mining Corp. (Regal and Chrysotile mines), Metate Asbestos Corp. (Lucky Seven), and Asbestos Manufacturing Co. (Asbestos Peak and Ash Creek mines) provided all the asbestos produced in the State. Gila Arts Corp., the only producer of fire clay in the State, reported output of plastic fire clay from the Weary pit near Globe for use by the ceramic industry in manufacturing art pottery, flowerpots, and glaze slip.

Limestone produced by Ray Mines and Hoopes & Co. was used in manufacturing lime, as a flux in smelting copper ores, and for road construction.

Graham.—Miscellaneous stone produced by W. A. Morris and Brooks Constuction Co., a contractor for the Graham County Board of Supervisors, accounted for 87 percent of the total mineral production value. Gila Valley Block Co., operating the Pumice and Bluebird mines near Safford, produced pumice and volcanic cinders for use as concrete aggregate. A small quantity of paving gravel was produced by a contractor for the Arizona State Highway Department.

Greenlee.—The economy of the county was based heavily on mining and smelting. The large open-pit copper mine at Morenci and its associated reduction works operated by Phelps Dodge Corp. were of major economic importance to the county and to the State. According to the company annual report, production at the Morenci open-pit mine was at a record rate of 129,406 tons per day. Ratio of waste and leach material to ore was 1.61:1, compared with 1.63:1 in 1963. The concentrator treated 18.5 million tons of ore at a record rate of 57,961 tons per day.

The company abandoned plans to drill an 8-mile water-transmission tunnel in favor of a 30-inch pipeline under the Mogollon Rim from Blue Ridge Dam to the East Verde River. The water transferred by the pipeline was to be exchanged for water drawn from the Black

River for use in the Morenci concentrator. The project implemented an exchange agreement between the company and the Salt River Irrigation Project in central Arizona. As work progressed on the installation of a leach-precipitation-flotation system, substantial changes were made in the concentrator. The changes included construction of a sulfuric acid plant, a concentrate roasting plant, a precipitant manufacturing plant, additional lime-plant capacity, and certain additions and alterations to the powerplant.

The Morenci mine was a significant source of gold, silver, and molybdenum—all byproducts from treating copper ores. A limekiln operated by the company provided lime for metallurgical purposes. Limestone, used as a flux and for manufacturing quicklime, was mined by the company at the Morenci quarry.

Nonmetals accounted for about 1 percent of the total value of mineral production in the county. Crews of the Greenlee County Highway Department furnished the entire production of sand and gravel for highway construction. Phelps Dodge Corp. produced crushed sandstone from quarries near Morenci for use in smelting copper ore. A small quantity of crushed sandstone was quarried by O. Brice Willis at the Harmony quarry for use as a smelter flux.

Maricopa.—The value of mineral production was approximately equal to that of 1963. Increases were reported for silver, copper, clays, and sand and gravel. Ninty-eight percent of the total value of mineral output in the county, $8.9 million, came from sand and gravel output. Commercial production, valued at $7 million, included sand and gravel used for building and road construction, with small quantities used for fill, sand blasting, and railroad ballast. Nineteen commercial operators reported production at 24 operations; Union Rock & Materials Corp. and United Materials, Inc., were major producers. Contractors for the Arizona State Highway Department produced 1.8 million tons of sand and gravel valued at $2 million. Production of crushed stone by six operators in the county included granite, marble, and sandstone. A small quantity of rough and dressed building marble and dressed building sandstone also was produced. Miscellaneous clay used in manufacturing building brick was mined by Phoenix Brick Yard at the Tolleson clay pit west of Phoenix and by Wallapai Brick & Clay Products Corp. near Phoenix. William L. Hostetter produced and sold diatomite from the Lake Pleasant mine near Glendale. Scrap mica, obtained from the Buckeye mine, was ground at a mill near Buckeye. Crude ore obtained from the Adams and Iberri perlite mines in Pinal County was expanded by Supreme Perlite, Inc., for use in manufacturing building plaster and as loose-fill insulation, concrete aggregate, and as a soil conditioner. Big Sam Mines, Inc., and Bacon & Brunson furnaced ores obtained from the National and Pine Mountain mines, respectively, for producing mercury.

Mohave.—Accounting for 82 percent of the total value of mineral output, copper and sand and gravel were the two most important minerals produced in the county. Contractors for the Arizona State Highway Department and Mohave County Highway Department furnished 60 percent of all the sand and gravel produced in the county. Crushed sandstone obtained from the Taylor quarry, operated by Industrial Minerals, and the White Spar, operated by

C. F. Weeks, was used in manufacturing abrasives, cleaners, pottery, porcelain, and tile. A small quantity of miscellaneous stone quarried by Sam Bowman was used as flagging and by Valley Rock & Material Co. as roadstone and aggregate in concrete. Industrial Minerals continued to operate its feldspar mill with ore obtained from its Taylor mine near Kingman; shipments of ground feldspar were to consumers in California, Ohio, Texas, Washington, Wisconsin, Philippine Islands, and Mexico. Gypsum, mined from a recently opened pit in the northern part of the county, was used as a soil supplement.

Metals output of the county represented more than one-half of the total mineral production; whereas in 1963 metals had been insignificant. Production at the Duval Corp. new Mineral Park property began in November. According to the company annual report, no major difficulties were encountered in initial operations. Performance at the end of the year indicated that excellent metallurgical results in the copper and molybdenum sectors were obtained. Ore-milling capacity was in excess of the designed capacity of 12,000 tons per day. Output of copper and molybdenum at Mineral Park totaled 2.7 million pounds of copper and 77,000 pounds of molybdenum in concentrate form. Gold, silver, and zinc also were produced.

A small quantity of uranium ore was produced from the Hacks No. 1 mine by A & B Mining Co. Dye & Bathrick shipped a small quantity of stockpiled concentrate from tungsten ore produced at the Boriana mine to Kennametals, Inc., Fallon, Nev.

Navajo.—Uranium production declined sharply, with the result that the total value of mineral production in the county declined 25 percent. Without the major increase in the production of sand and gravel that occurred during the year total value would have been considerably lower. Three uranium producers reported production. The major producer was Industrial Uranium Co., operating the Moonlight, East Starlight, South Sunlight, and the Sunlight Simpson mines. Properties of A & B Mining Co. and Kimmerle & Redd were also in operation during the year. A small quantity of vanadium was recovered from uranium ores produced by A & B Mining Co.

Sand and gravel supplied $869,000, 87 percent of the $1 million value of mineral production. Contractors for the Arizona State Highway Department and crews of the Navajo County Highway Department accounted for most of the sand and gravel produced. Brimhall Construction Co., Ray Despain, Reidhead Sand & Rock, Inc., and Winslow Sand & Gravel accounted for a total of 83,000 tons of commercial sand and gravel used in building and road construction and for fill. Production of stone was limited to a small quantity of crushed basalt and miscellaneous stone and dimension sandstone. Copper was recovered in the processing of uranium ore.

Pima.—Eighty-seven percent of the total value of mineral output in the county came from the production of copper. This percentage did not include values from byproduct metals recovered by processing copper ores. Five of the largest mines in the State—New Cornelia, Mission, Silver Bell, Pima, and Esperanza—supplied 97 percent of the copper produced in the county and 28 percent of that produced in the State.

The New Cornelia open-pit mine at Ajo, owned and operated by Phelps Dodge Corp., was the leading producer in the county and the fifth largest in the State. According to the annual report issued to stockholders by the parent company, the New Cornelia Branch yielded 70,818 tons of copper. The company removed 10.4 million tons of ore and 18.9 million tons of waste from the open pit. The ratio of waste to ore mined at the Ajo pit was 1.83:1; compared with 1.78:1 in 1963. The concentrator was operated 321 days during the year, treating 10.4 million tons of ore at an average daily rate of 32,248 tons. This record rate resulted from a number of improvements made in the concentrator. In addition to installing four 3,000-kilowatt gas-diesel generators, the company completed relocation of a number of mine buildings.

In its annual report for 1964, Duval Corp. reported producing 45.1 million pounds of copper and 1.4 million pounds of molybdenum in concentrate form from the Esperanza mine. Test drilling was continued on the Seirrita group of mineral claims, located adjacent to the Esperanza property. Removal of waste capping overlying a satellite copper-molybdenum ore body, immediately west of the main Esperanza pit, was continued throughout the year. Stripping operations at the property were to be completed during 1965. Ore from the deposit, known as the West Esperanza ore body, was to be mined and milled concurrently with ore from the main pit.

The 1964 annual report of Asarco stated that production at the Mission mine was at capacity level, slightly higher than in 1963. Of 35.5 million tons of material removed from the pit, 7.6 million tons was ore and 28 million was waste. The concentrator treated 7.6 million tons of ore from which 53,810 tons of copper was recovered in concentrates. Construction of the molybdenum-zinc byproducts plant was completed and began operating late in the year. At the Silver Bell mine, 40 miles northwest of Tucson, Asarco mined and milled 3 million tons of ore obtained from the El Tiro and Oxide pits and recovered 21,715 tons of copper in concentrate form. Dump-leaching operations recovered an additional 2,427 tons of copper. Molybdenum production continued at the same rate as in 1963.

Because of increased mine production toward the end of the year, the company smelter at Hayden was operated at somewhat higher levels than in 1963.

According to the annual report issued by Cyprus Mines Corp., Pima Mining Co. (50-percent owned by Cyprus Mines Corp.) mined and milled 2.9 million tons of ore averaging 1.17 percent copper. In 1963, Pima mined and milled 2 million tons ore averaging 1.34 percent copper. The increased tonnage of ore treated resulted from the first full year of operation of the mill at its new daily rated capacity of about 6,000 tons of ore. Concentrates produced at the mill contained 30,000 tons of copper, compared with 23,000 tons in 1963. Scheduled for completion in the fall of 1965, additional construction began in December to increase the capacity of the milling plant to 12,000 tons per day. The company planned to eventually raise the daily mill capacity to 18,000 or 24,000 tons. Estimates of ore reserves indicated that sufficient ore of adequate grade was available to furnish 20 years

of mill feed for an 18,000-ton-per-day plant or 16 years of mill feed for a 24,000-ton plant.

The 1964 annual report of Banner Mining Co. stated that Pima Mining Co. produced ore from the Daisy mine in accordance with the custom mining and milling agreement of November 1959. Under the agreement, Pima was required to mine and mill the ore from the Daisy mine through 1968 at an annual average rate of 256,670 tons.

Effective April 15, The Anaconda Company acquired a major interest in the remaining Banner Mining Co. properties in Arizona. Development of the Twin Buttes and Helvetia properties was continued. A 960-foot development shaft sunk at Twin Buttes provided access to the ore body below the zone of oxidation, from which bulk samples were to be taken for metallurgical testing. Testing, planning, and engineering studies involving all phases of the prospective operation were being conducted. Anaconda completed a large part of the drilling program for developing the Twin Buttes copper ore body, containing values in molybdenum and silver. The Twin Buttes ore body, at a minimum depth of 460 feet below the surface, would involve initial stripping of an estimated 165 million tons of alluvium and rock before mining can begin.

Other metals produced in the county included gold, lead, molybdenum, silver, and zinc. Most of the gold and silver was recovered as byproducts of copper mining. Phelps Dodge Corp. was the largest producer of gold in the county and the second largest producer of silver. The Mission mine ranked first in production of silver and second in the output of zinc. The Atlas mine, operated by B S & K Mining Co., was the largest producer of zinc. Molybdenum production came from the Esperanza mine operated by Duval Corp. and from the Silver Bell and Mission properties operated by Asarco.

Nonmetals accounted for 8 percent of the total value of mineral production. In addition to working open-pit clay deposits, Grabe Brick Co., Louis Devry & Son, Phoenix Brick Yard, and Tucson Pressed Brick Corp. operated brick plants in Tucson. A feldspar-silica mixture was mined by San Antonio Mine Co. from a deposit near Ajo. At its plant near Rillito, Arizona Portland Cement Co. manufactured portland and masonry cements from crushed limestone produced at the company quarry and from purchased slag, gypsum, and iron ore.

Sand and gravel for road construction produced by contractors for the Arizona State Highway Department and by crews of the Pima County Highway Department totaled 309,000 tons, valued at $250,000. Twenty commercial operators produced a total of 1.9 million tons of sand and gravel valued at $2.3 million for use by the construction and building industries as fill and railroad ballast for sand blasting, and other uses.

Pinal.—Copper accounted for 92 percent of the value of mineral production in the county and 24 percent of the State output value. Most of the copper came from three mines—San Manuel, Ray Pit, and Magma. Byproduct gold, molybdenum, and silver obtained from the treatment of the copper concentrates and the refining of copper from the three mines had a combined value of $6.4 million, 5 percent of the total value. The remaining 3 percent of the total value came from

the output of copper, gold, and silver produced at other metal mines and from the production of nonmetallic minerals.

Magma Copper Co., largest copper producer in the county and second in the State, operated the San Manuel and Magma underground mines. According to the company annual report of the parent company, the San Manuel mine yielded 12.4 million tons of ore containing 0.828 percent sulfide copper, compared with 12.6 million tons containing 0.795 percent in 1963. The tonnage of ore mined per operating day was 34,756, compared with 35,139 in 1963. Copper recovery per ton of ore mined was 14.88 pounds in 1964, compared with 14.11 pounds in 1963. The company milled 12.4 million tons of ore at an average rate of 34,582 tons per operating day, recovering 88.22 percent of the total copper and 92 percent of the contained sulfide copper. The San Manuel smelter processed 316,547 tons of concentrate at an average daily rate of 895 tons. Metal production was 92,588 tons of copper, 5 million pounds of molybdenum sulfide, 20,746 ounces of gold, and 282,334 ounces of silver. The increased production of copper was due to a higher copper content of the ore mined and to a better recovery at the concentrator of the copper contained in the ore. The San Manuel quarry delivered 59,635 tons of limestone and 25,098 tons of quartzite for metallurgical purposes. The Magma mine, operated by Superior Division, produced 377,575 tons of ore containing 4.78 percent copper, 0.03 ounce gold, and 0.85 ounce silver. Because of a fire in the crushing plant on January 12, milling and smelting operations were disrupted until the end of the month.

In its annual report, Kennecott Copper Corp. stated that its Ray Mines Division produced 6.9 million tons of ore containing 0.87 percent copper, compared with 7.1 million tons containing 0.91 percent copper in 1963. Installation of a new regrinding circuit for the sulfide concentrates resulted in a higher concentrate grade. Total copper production, including copper recovered from the leaching of dumps, was 58,235 tons, compared with 62,930 tons in 1963. The Ray mine was closed from July 1 to September 8 because of a strike called by the United Steelworkers of America. Because copper was less soluble in the older dumps and the lower copper content in newer dumps, copper-precipitate production declined. Pyrite recovered from mill tailings at Hayden and additional quantities purchased from Superior were used in manufacturing sulfuric acid and sponge iron.

Arizona Gypsum Corp. produced diatomite from its White Cliffs mine near Mammoth for use as a filtration media. The mine was acquired by the company from American Diatom, Inc., through merger of the two companies. Three companies—Arizona Gypsum Co., Garcia Gypsum Co., Inc., and National Gypsum Co.—produced gypsum from mines near Mammoth and Winkelman. The product was sold or used as portland cement retarder, as a soil supplement, and in manufacturing wallboard and lath. Crude perlite mined by Arizona Perlite Roofs, Inc., and Harborlite Corp. was expanded at Arizona and out-of-State plants and sold for use in construction materials and as a soil conditioner.

Santa Cruz.—Gold, silver, copper, lead, and zinc accounted for 68 percent of the total value of mineral production. The Hardshell mine, operated by E. W. McFarland, was the largest producer of lead and

silver. Six operators at five other mines also had mineral production. Sand and gravel for road construction produced by contractors for the Arizona State Highway Department accounted for all of the output in the county. A small quantity of miscellaneous stone was quarried by contractors for the Arizona State Highway Department for use as riprap.

Yavapai.—The value of mineral production was 6 percent higher, largely because of the increased prices for copper and zinc. Output of cement, clays, lime, and sand and gravel declined in value. Metals—gold, silver, copper, lead, zinc, iron ore, and molybdenum—furnished 77 percent of the total value of mineral output.

The largest producer of lead and the three largest producers of zinc in the State operated mines in the county. The Iron King mine, operated by Shattuck Denn Mining Corp., was the leading producer of lead and zinc in the State. According to the annual report, the company produced 28 million pounds of zinc, 9.2 million pounds of lead, 741,000 ounces of silver, and 18,749 ounces of gold from ores obtained at the Iron King mine.

Production of copper by Bagdad Copper Corp., according to the company annual report, increased 11 percent. Recovery of copper from sulfide ores was 23.8 million pounds, a decline of 5 percent, because of a drop in the average grade of ore milled from 0.86 percent copper to 0.77 percent. Recovery of copper by leaching oxide copper ores in place and in leach dumps was 15.5 million pounds, a 50-percent increase. Recovery of copper from a new leach dump was begun, and a second leach dump of approximately the same size was being prepared for leaching. Shipments of molybdenum concentrate, recovered as a byproduct in concentrating the sulfide ores, were 276,624 pounds, a 28-percent increase. Approximately the same amount of silver as in 1963 was recovered at the smelter.

Phoenix Cement Co. produced portland and masonry cements at its cement plant near Clarkdale. Limestone and clay used in manufacturing these cements were obtained from the company-owned limestone quarry and clay pit located in the county. Slag, gypsum, and resin for manufacturing the cements were purchased by the company. U.S. Lime produced crushed limestone from the Nelson quarry for the manufacture of quicklime and hydrated lime. The quicklime was sold by the company for use by the coke and gas and steel industries and for copper ore concentration. Hydrated lime was used in preparing food products, insecticides, treatment of sewage, and water purification. Crude gypsum ore continued to be mined by Arizona Gypsum Co., Verde Division, mainly for use as a portland-cement retarder; a small quantity was sold as a soil conditioner. Bentonitic clay mined by the company was used for pelletizing. Yavapai Block Co. produced a small quantity of scoria from the Cruice mine near Ashfork for use as a concrete aggregate.

Yuma.—Sand and gravel and stone—principal mineral commodities produced in the county—accounted for 98 percent of the total value of mineral output. Contractors for the Arizona State Highway Department and Federal Bureau of Reclamation and crews of the Yuma County Highway Department produced 708,000 tons of sand and gravel for highway construction. L. M. White Contracting Co., Tan-

ner Paving & Materials Co., Valley Sand & Gravel Co., and Yuma Builders Supply supplied 367,000 tons of building and road construction sand and gravel valued at $323,000. Marble was crushed for use in terrazzo and as roofing granules. Granite and miscellaneous stone were used for riprap. Gypsum produced by Harquahala Gypsum Co. from a deposit near Salome was sold uncalcined for use as a soil conditioner.

Small quantities of gold, silver, copper, and lead were reported; one placer and three lode mines were operated. Mineral Hill mine, operated by Mineral Hills, Inc., was the principal producer of copper; New Chance mine, operated by Lyman Wall, was the principal producer of lead and silver.

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]



ARKANSAS mineral output was valued at $174.8 million in 1964, an increase of about 4.5 percent over the 1963 figure. The value of mineral production set a new record and reflected the long-term upward trend in the Arkansas mineral industry. The mineral value revealed that Arkansas had retained its rank near the midpoint in terms of mineral-production value among all States. Substantial increases in value were scored in production of 11 mineral commodities; significantly lower values were incurred in production of 3; and value of 4 mineral commodities changed only slightly. Production of phosphate rock, gypsum, lime, bromine, clay, stone, natural gas liquids, cement, sand and gravel, novaculite for abrasives, and bauxite was responsible for the overall value gain; output of these minerals was adequate to offset generally slight decreases in value of six commodities.

TABLE 1.—Mineral production in Arkansas [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	236,077	$2,161	233,455	$2,202
Bauxite—long tons dried equivalent	1,478,047	16,701	1,561,984	17,431
Clays—thousand short tons	769	1,763	892	2,152
Coal—do	221	1,505	212	1,503
Gem stones	(2)	42	(2)	33
Lime—thousand short tons	167	2,237	189	2,814
Natural gas—million cubic feet	76,101	11,796	76,167	11,806
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	26,219	1,466	30,082	1,678
LP gases—do	66,377	2,497	61,616	2,460
Petroleum (crude)—thousand 42-gallon barrels	27,406	72,900	26,737	71,120
Sand and gravel—thousand short tons	12,099	13,589	11,794	14,836
Stone (includes slate)—do	18,913	22,727	20,241	26,172
Value of items that cannot be disclosed:				
Abrasive stone, bromine, cement, gypsum, iron ore, phosphate rock, and soapstone	XX	17,900	XX	20,582
Total	XX	r 167,284	XX	174,789

r Revised. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

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

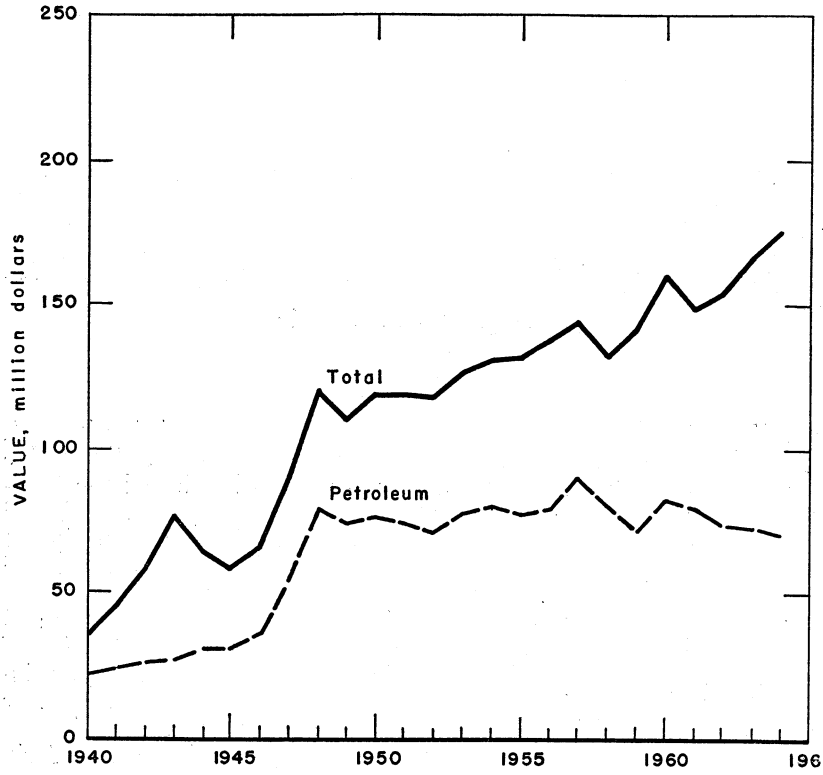


FIGURE 1.—Value of petroleum and total value of mineral production in Arkansas.

Record high values were established for bromine, cement, gypsum, natural gas, sand and gravel, and stone. Downward trends in mineral-fuel production and value continued; however, value remained greater than those of grouped nonmetallic or metallic mineral commodities.

Value of construction commodities—cement, clays, sand and gravel, and stone—was greater, owing to the continuing increase in construction and commercial and residential building in the State.

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

(Millions)

Year	Value	Year	Value
1952	$140	1959	$142
1953	143	1960	158
1954	144	1961	r 148
1955	144	1962	r 152
1956	143	1963	r 165
1957	141	1964	170
1958	133		

r Revised.

Substantial progress was made on U.S. Army Corps of Engineers' river-basin programs. These included bank-stabilization and channel-rectification projects and the following dam projects: Beaver (93 percent complete), Greers Ferry (complete), Dardanelle (82 percent complete), Millwood (99 percent complete), De Gray (under construction) and Gillham (under construction). Construction of access roads and work on preliminary structures was initiated at eight lock and dam projects downstream from Little Rock on the Arkansas River as an integral part of the overall program to provide navigation on the river by 1970. Construction programs of the U.S. Army Corps of Engineers throughout Arkansas provided markets for an estimated 4.7 million tons of stone valued at $2.9 million.

Highway construction programs in Arkansas consumed an estimated 4.2 million tons of stone valued at $11.8 million. Approximately 4.9 million tons of sand and gravel valued at $4.8 million was used in various phases of highway building.

Arkansas Electric Co-operative Corp. began construction of the Carl E. Bailey electric generation plant near Augusta in June. The $12.5-million plant, which will have a capacity of 125,000 kilowatts, was scheduled for completion in mid-1966.

Area Redevelopment Administration approved in May an advance of $40,000 to help finance a study on the establishment of a structural-clay-products plant at Malvern. Cost of the study was estimated at $60,000. Malvern Brick and Tile Co. and Arkansas Geological Commission were to provide the remaining $20,000.

Arkansas Cement Corp. announced plans in September for a $13-million expansion of its cement plant at Foreman. Plant capacity would be increased from 2.8 million barrels to 5 million barrels of cement annually. Completion of the expansion program was scheduled for late 1965.

Arkansas Power & Light Co. began constructing an $11-million, 500,000-volt electric transmission line that will extend 137 miles from West Memphis to Little Rock. The extra-high-voltage line will consist of a steel core wrapped in aluminum and will weigh about 20 million pounds. The line is part of an interconnected system of 1,150 miles of high-voltage lines being built by 11 companies. The system will connect with the Tennessee Valley Authority at Memphis.

Arkansas Power & Light Co. announced plans to more than double the capacity of its Helena steam-electric generating station with installation of a 500,000-kilowatt steam generator at a cost of $40 million. The Helena plant was completed in 1961 at a reported cost of $44 million. Its present generator has a capacity of 357,000 kilowatts. Mississippi River water will be used for cooling, and the river would provide barge transportation if coal were used for fuel. The present generator uses more than 3 million cubic feet of natural gas per hour in peak operation. The additional facilities, if coal fired, would consume an estimated 1.4 million tons of coal annually.

Arkla Chemical Corp. began constructing a $33-million, 600-ton-per-day chemical-fertilizer plant at Helena in September. The plant was tentatively scheduled for completion in about 18 months and will produce ammonia, a complexity of ammonia-based industrial chemicals, sulfuric acid, and phosphoric acid. Natural gas will be the prime raw material consumed at the plant.

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Arkla Chemical Corp. completed a $500,000 expansion of its Hamilton petrochemical plant near Magnolia. Plant capacity was increased from 350- to 365-million cubic feet of natural gas per day. The company converts hydrogen sulfide, extracted from sour gas, to elemental sulfur. Sulfur output increased from 11 to 20 long tons per day.

Continental Oil Co. announced plans in October to construct a $20-million plant near Blytheville to manufacture anhydrous ammonia. Initial output would consist of 1,000 tons of ammonia per day. An estimated 40-million cubic feet of natural gas would be consumed daily.

Planning moved into final stages on construction of a $25-million experimental nuclear-powered electric plant to be erected 20 miles south of Fayetteville, Washington County. Plant capacity is initially expected to be 20,000 kilowatts. Seventeen investor-owned electric companies, General Electric Co., six European Nations, and the U.S. Atomic Energy Commission are sponsoring the electric-power-research project. Principal objective of the project is to find more economical means of producing electric power using nuclear fuels.

Employment.—Mineral industry payroll totaled about $25.5 million, more than 2 percent above that of 1963. Weekly wages, compared with related data for 1963, averaged $127.62 in metal mining, an increase of 16 percent; $89.62 in coal mining, a 6-percent increase; $104.81 in production of crude oil and natural gas, a 4-percent increase; and $94.02 in nonmetallic mining and quarrying, an 8-percent increase.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	149	25	207	----	4	19
Metal	1,616	531	4,249	----	55	13
Nonmetal	691	161	1,289	----	66	51
Sand and gravel	1,215	294	2,447	----	43	18
Stone	1,531	417	3,511	1	95	27
Total	5,202	1,428	11,703	1	263	23
1964: p						
Coal	142	26	190	----	6	32
Metal	1,845	543	4,288	----	24	6
Nonmetal	630	146	1,167	----	75	64
Sand and gravel	1,110	287	2,533	----	46	18
Stone	1,805	482	4,027	----	102	25
Total	5,532	1,484	12,205	----	253	21

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REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Production of mineral fuels—petroleum, natural gas, natural-gas liquids, and coal, arranged in order of importance—contributed more than half (51 percent) of the value of the State's mineral output; however, the total value of fuel minerals ($88.6 million) was about 2 percent lower than comparable value in 1963.

Coal (Bituminous).—Production of coal decreased 4 percent in quantity, and less than 1 percent in value compared with that of 1963. Of 11 coal mines producing 1,000 or more short tons each during the year, 5 were underground and 6 were strip mines. The strip mines accounted for 65 percent of the total coal production. Coal production from strip mines decreased 5 percent and that from underground mines was 2 percent lower than in 1963. Only Johnson, Franklin, and Sebastian were coal-producing counties; output in Johnson County exceeded the combined coal output of the other two counties.

TABLE 4.—Coal production [1]

(Thousand short tons and thousand dollars)

Year	Short tons	Value	Year	Short tons	Value
1955–59 (average)	496	$3,824	1962	256	$1,809
1960	409	3,116	1963	221	1,505
1961	395	2,888	1964	212	1,503

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

TABLE 5.—Oil and gas drilling in 1964, by counties

County	Development			Exploratory			Total
	Oil	Gas	Dry	Oil	Gas	Dry	
Bradley	1						1
Calhoun	26		1			3	30
Cleveland						2	2
Columbia	8		3			7	18
Crawford		7	1			1	9
Cross						1	1
Drew						2	2
Faulkner						1	1
Franklin		15	4		1		20
Grant						2	2
Jefferson						1	1
Johnson		6	1				7
Lafayette	11	1	13	1		20	46
Little River						1	1
Logan		5	1			1	7
Miller	6		2			3	11
Nevada	15		12			6	33
Newton						1	1
Ouachita	38		18			6	62
Polk						1	1
Pope		1	1			2	4
Scott						2	2
Sebastian		10	3			1	14
Searcy						1	1
Union	60		57			19	136
Yell						1	1
Total:							
1964	165	45	117	1	1	85	414
1963	204	43	99	4		76	426

Source: Arkansas Oil and Gas Statistical Bulletin. V. 23, No. 12, December 1963, through v. 25, No. 4, April 1965.

Oil and Gas Exploration and Development.—Most drilling activity was in eight southern Arkansas oil and gas producing counties, where 337 wells were drilled. A success ratio of 50 percent was established statewide. The number of holes drilled in Calhoun, Columbia, Lafayette, and Ouachita Counties increased substantially; drilling activity dropped sharply in Miller, Nevada, and Union Counties, compared with the 1963 figure.

Oil and gas accumulations in southern Arkansas are attributable to folding and faulting and resultant traps in favorable host rocks in Cretaceous and Jurassic formations.

One new oilfield—Cornish Branch—was discovered in Lafayette County. Two fields—Shiloh in Lafayette County and Salem Church in Union County—were termed rediscoveries. A total of 11 new pools was found in Columbia, Lafayette, Ouachita, and Union Counties.

Natural gas in northern Arkansas is derived from pay zones in folded and faulted sediments of Pennsylvanian, Mississippian, and Silurian-Devonian ages. Drilling activity in this area, confined to a search for natural gas, resulted in completion of 45 natural-gas wells out of 61 holes drilled—a success ratio of nearly 74 percent. Franklin County led with 16 gas-producing wells out of 20 holes drilled. Five other counties in the same area had comparable ratios of successful wells to total wells drilled. Total number of holes drilled in a six-county area—Crawford, Franklin, Johnson, Logan, Pope, and Sebastian—was three more than total number drilled in 1963. One new field, Charleston, was discovered in Franklin County. Six new gas pools were discovered in previously known gasfields in Franklin, Johnson, Logan, Pope, and Sebastian Counties.

Pipeline Construction.—Arkansas-Louisiana Gas Co. laid about 90 miles of 24-inch-diameter pipeline extending eastward from Paris, Logan County. The line and smaller laterals will be extended east about 240 miles to Blytheville, Mississippi County. Estimated cost of the project was $20 million. Natural gas will be made available for major industrial markets in eastern Arkansas and will pass through a potential market area for natural gas.

Natural Gas.—Natural-gas production continued at a record rate in 1964, and its value was sufficient to rank the commodity sixth in terms of value of all commodities produced during the year. Nine northern Arkansas counties contributed 75 percent of the total value. Although natural gas was produced in six southern Arkansas counties, most was attributable to Lafayette County, which ranked third in the State in terms of value of production. Franklin, Sebastian, Lafayette, Columbia, Johnson, and Crawford were the six leading counties in value; range in value was from about $794,000 in Crawford County to about $4,566,000 in Franklin County, nearly a sixfold difference. Franklin County accounted for about 40 percent of the total value of natural gas produced in the State.

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

	Proved reserves Dec. 31, 1963	Changes in proved reserves, due to extensions and new discoveries in 1964	Proved reserves, Dec. 31, 1964 (production was deducted)	Change from 1963, percent
Crude oil ---- thousand barrels	225,291	5,806	205,160	−9
Natural gas liquids [1] ---- do	18,695	1,912	19,010	+2
Natural gas ---- million cubic feet	1,792,644	384,366	2,100,092	+17

[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. V. 19, Dec., 1964, pp. 11, 12, 22.

TABLE 7.—Gross withdrawals and disposition of natural gas

(Million cubic feet)

Year	Gross withdrawals [1]			Disposition			
	From gas wells	From oil wells	Total	Marketed production [2]		Repressuring	Vented and wasted [3]
				Quantity	Value (thousands)		
1955–59 (average)	21,600	38,960	60,560	33,435	$2,414	20,926	6,199
1960	45,700	41,100	86,800	55,451	6,599	27,640	3,709
1961	45,800	42,100	87,900	59,547	8,039	25,748	2,605
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	59,200	42,100	101,300	76,167	11,806	21,480	3,653

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

Natural Gas Liquids.—Total output and value reversed a 3-year downward trend. Natural gasoline, cycle products, and liquefied petroleum gases were recovered from wet gas in six processing plants in Columbia, Lafayette, and Union Counties. Total output of products was 1 percent less in quantity and 4 percent higher in value than in 1963. Columbia County accounted for nearly 65 percent of the total output of natural-gas liquids.

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
1955–59 (average)	41,362	$2,638	55,303	$2,470	96,665	$5,108
1960	34,558	2,148	73,252	3,735	107,810	5,883
1961	27,889	1,640	75,157	3,286	103,046	4,926
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

Petroleum.—Quantity and value of petroleum output decreased about 2 percent, compared to 1963 data; however, the commodity continued to be most significant in the overall mineral value in the State, contributing 41 percent of the total. Producing wells numbered 6,018 at yearend, 8 more than in 1963. Columbia, Union, and Lafayette, ranked in order of significance, accounted for 78 percent of the total output among eight southern Arkansas oil-producing counties.

A total of 31 oilfields in southern Arkansas were operating pressure-maintenance, secondary recovery, and unitized projects at yearend. Six such projects were initiated in 1964.

Magnolia field in Columbia County continued to lead in production with 6.5-million barrels.

Petroleum was processed in five refineries in southern Arkansas in Union and Columbia Counties. The combined crude oil capacity was rated at 84,900 barrels per day at yearend.

TABLE 9.—Crude petroleum production, by fields

(Thousand 42-gallon barrels and thousand dollars)

Field [1]	1963		1964	
	Quantity	Value	Quantity	Value
Champagnolle	713	$1,897	662	$1,754
El Dorado	431	1,146	457	1,211
Fouke	1,022	2,718	929	2,462
Lick Creek	368	979		
Magnolia	6,370	16,944	6,529	17,302
McKamie	569	1,514	1,579	4,184
Midway	2,400	6,384	2,403	6,368
Sandy Bend	608	1,617	550	1,458
Schuler	1,645	4,376	1,531	4,057
Smackover	3,102	8,251	3,168	8,395
Stephens	963	2,562	983	2,605
Village	472	1,255	420	1,113
Wesson	1,163	3,094	1,040	2,756
Other fields [2] [3]	7,580	20,163	6,486	17,455
Total	27,406	72,900	26,737	71,120

[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.
[3] Bureau of Mines figures.

TABLE 10.—Crude petroleum production, indicated demand, and stocks in 1964, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Arkansas
January	2,300	2,265	1,146
February	2,156	2,083	1,219
March	2,314	2,324	1,209
April	2,202	2,339	1,072
May	2,266	2,285	1,053
June	2,224	2,291	986
July	2,229	2,295	920
August	2,250	2,282	888
September	2,162	2,126	924
October	2,231	2,188	967
November	2,169	2,203	933
December	2,234	2,223	944
Total: 1964	26,737	26,904	XX
1963	27,406	27,511	XX

XX Not applicable.

NONMETALS

Nonmetallic-mineral production contributed 39 percent of the total value of the State's mineral output. Twelve commodities contributed to the total; values ranged from a low of $33,000 for gems and mineral specimens to a high of $26 million for stone output. Stone, cement, sand and gravel, bromine, lime, barite, clay, gypsum, soapstone, abrasive stone, phosphate rock, and gem and mineral specimens, ranked in order of contribution, were responsible for a value gain of 15 percent over that recorded in 1963. Major increase in value was attibuted to production of bromine, cement, gypsum, sand and gravel, and stone.

Abrasive Stone.—Novaculite from Garland County was used in making oilstones. Value of the crude rock, 5 to 15 cents per pound, was compounded to a few dollars per pound for finished oilstone products. Production decreased 5 percent, but value increased 7 percent, compared with data for 1963. Norton Pike (Division, Norton Co.) and Arkansas Oilstone Co., Inc., accounted for the output of crude novaculite.

Barite.—Output of primary barite decreased 1 percent, but value was 2 percent more than in 1963. The commodity, used in drilling fluids, was crushed and ground in Arkansas plants by three producing companies. Products were shipped to major oil-producing States. Arkansas again ranked second in the United States in barite output. Value of barite in 1964 was less than half of the 4.5-million total in 1957 when Arkansas ranked first in the Nation in barite output.

Bromine.—Production and value of bromine reached a record high. Arkansas, already third in the Nation in bromine output, imparted an even greater influence in bromine markets. Recovery plants in Union County, operated by Michigan Chemical Corp. and Arkansas Chemicals, Inc., extracted bromine from oil-well brines that contain 65 to 70 times the bromine content of sea water.

TABLE 11.—Primary barite sold or used by producers

Year	Short tons	Value (thousands)	Year	Short tons	Value (thousands)
1955–59 (average)	389,577	$3,463	1962	258,691	$2,232
1960	277,851	2,578	1963	236,077	2,161
1961	277,855	2,630	1964	233,455	2,202

Cement.—Arkansas cement producers, Ideal Cement Co. at Okay and Arkansas Cement Co. at Foreman, set a new cement-production record. Unprecedented-high rate of building and construction activities in Arkansas and adjacent States accounted for the increase in cement output. Cement shipments to Arkansas consumers gained 7 percent over the 1963 figure.

Clays.—Clay output increased for the second consecutive year; quantity and value were 16 and 22 percent greater than comparable 1963 data. Clay tonnage was greater than in any previous year. Value, however, was 16 percent lower than the record high in 1954, when Arkansas clay was valued at $2.6 million. Fifteen producers mined clay in 14 counties. Production of fire clay in 3 counties increased 25 and 27 percent, respectively, in quantity and value; production of miscellaneous clay in 13 counties gained 13 and 11 percent, respectively, in quantity and value. Hot Spring County led in production and together with Pulaski, Sebastian, Little River, Lonoke, and Howard Counties accounted for 76 percent of the total output. About 40 percent of total clay output was used in cement, lightweight aggregate, and refractories. Remaining clay production was used in making face brick, sewer pipe, building tile, and other heavy-clay products.

TABLE 12.—Shipments of portland cement to consumers

Year	Thousand barrels	Year	Thousand barrels
1955–59 (average)	2,162	1962	3,053
1960	2,590	1963	3,556
1961	2,968	1964	3,807

TABLE 13.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Miscellaneous clays [1]		Fire clay		Total clay	
	Quantity	Value	Quantity	Value	Quantity	Value
1955–59 (average)	306	$322	381	$1,594	687	$1,916
1960	388	387	427	2,069	815	2,456
1961	434	428	339	1,330	773	1,758
1962	368	365	286	1,328	654	1,693
1963	574	573	195	1,190	769	1,763
1964	649	636	243	1,516	892	2,152

[1] Includes clay used for cement.

Gypsum.—Production and value of gypsum were nearly double the 1963 figures. Dierks Forests, Inc., mined and prepared gypsum principally for use in wallboard and other products at its plant in Howard County. Dulin Bauxite Co., Gypsum Division, mined and crushed gypsum in Pike County for use as a retarder in cement manufacture.

Lime.—Quantity and value of lime production increased 13 and 26 percent, respectively, over comparable 1963 figures. Seven producers —four paper companies, two alumina producers, and one producer of lime for chemical and construction applications—manufactured lime in five counties. Total lime sold or used in Arkansas, including regenerated lime, was about 342,000 tons valued at about $6 million. Value was more than 1.5 times that in 1963. Saline County led in lime output, but value of lime in Jefferson County, including regenerated lime, was highest in the State.

Phosphate Rock.—Peyton Creek Phosphate Rock Mining Co. increased its production of ground-phosphate rock more than tenfold, compared with the 1963 figure. A drilling program, terminated during the year, outlined substantial resources of phosphate rock on company property in Van Buren County. The ground-phosphate rock was used as a fertilizer for direct-soil application. Results of the drilling program enhanced the potential for development of phosphate-rock resources elsewhere in northern Arkansas.

Sand and Gravel.—Sand and gravel output was recorded in 71 of the 75 counties and is thus indicative of the vast resources and widespread occurrence of high-quality sand and gravel available in the State. Total production was about 305,000 tons less than in 1963; however value was about $1.25 million higher. The higher value indicates that producers must meet more stringent specifications to satisfy market requirements.

Companies, individuals, and others supplying sand and gravel numbered 259, contrasted with 184 producers in 1963. Average unit value for commercial sand and gravel output was $1.27 per ton, 9 cents per ton more than in 1963. Average unit value of Government-and-contractor sand and gravel production was $1.22 per ton, a 20-cent-per-ton gain over that of 1963.

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
1955-59 (average)	6,533	$6,242	3,095	$2,206	9,628	$8,448
1960	5,935	6,732	2,257	3,530	8,192	10,262
1961	5,933	6,892	3,456	2,182	9,389	9,074
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

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,639	$1,745	1,676	$1,857
Paving	1,071	1,048	1,414	1,369
Other [1]	525	1,107	578	1,166
Total	3,235	3,900	3,668	4,392
Gravel:				
Building	1,747	2,645	1,745	2,728
Paving	2,678	2,528	3,186	3,833
Fill	26	12	16	14
Other [2]	13	11	22	23
Total	4,464	5,196	4,969	6,598
Total sand and gravel	7,699	9,096	8,637	10,990
Government-and-contractor operations:				
Sand:				
Building	6	8	----	----
Paving	1,385	900	1,442	1,226
Fill	269	121	----	----
Total	1,660	1,029	1,442	1,226
Gravel:				
Paving	2,712	3,453	1,709	2,616
Fill	28	11	6	4
Total	2,740	3,464	1,715	2,620
Total sand and gravel	4,400	4,493	3,157	3,846
Grand total	12,099	13,589	11,794	14,836

[1] Includes fill, glass, molding, and other construction, industrial, and ground sand.
[2] Includes other construction, railroad ballast (1963), and miscellaneous gravel.

Soapstone.—Production of soapstone by The Milwhite Co., Inc., in Saline County was 13 percent less than that of 1963, due to a drop in demand. The company controls considerable resources of soapstone that are suitable for insecticide, roofing, and rubber compounds.

Stone.—Stone output in Arkansas exceeded 20-million tons for the second time in history and was coincident with the record high rate of construction and building activities in the State. Value of stone products—crushed and dimension stone—set a new high record of more than $26 million. Stone output consisted of limestone, marble, novaculite, sandstone, slate, and syenite. Highway-construction projects and river-basin-development programs provided major markets for stone. Crushed sandstone was used for concrete aggregate, roadstone, riprap, and railroad ballast. Dimension sandstone was used in commercial and residential building. Crushed limestone was consumed in road construction, concrete aggregate, cement and lime manufacture, riprap, agricultural applications, flux, glass and paper manufacture, processing of bauxite for alumina, asphalt, and fertilizer fillers, and railroad ballast. Dimension marble was used in public and private building.

TABLE 16.—Stone sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1960	10,939	$13,555	1963	18,913	$22,727
1961	12,029	12,402	1964	20,241	26,172
1962	20,611	19,866			

Uses for syenite included riprap, concrete aggregate, roadstone, railroad ballast, fill, and roofing granules. Slate was mined and ground for roofing-granule applications and as filler in asphalt and rubber compounds.

Commercial-stone production accounted for 67 percent of total tonnage and 73 percent of total value. Stone output was recorded in 37 of the 75 counties, and about 140 companies, individuals, and others were engaged in stone production. Average-unit value for commercial stone was $1.40 per ton, an increase of 5 cents per ton over that of 1963; average-unit value of Government-and-contractor stone was $1.06 per ton, a 5-cent-per-ton increase.

Sulfur (Recovered Elemental).—Sulfur was recovered as a byproduct at three gas-processing plants in Columbia, Lafayette, and Union Counties. Monsanto Co. operated a sulfur-recovery plant in Union County and constructed a new sulfuric-acid plant; the company supplied more than 100 chemicals for the paper industry. The new plant will also provide sulfuric acid for fertilizer production and other industrial applications. Arkla Chemical Co. sulfur-recovery plant was expanded to handle an additional 15-million cubic feet of natural gas per day, thereby enlarging its sulfur-producing capacity from 11 to 20 tons daily. Olin Mathieson Chemical Corp. retained its lead in production of recovered sulfur at a company plant in Lafayette County.

METALS

Production of metallic minerals in Arkansas was dominantly bauxite; the commodity was primarily converted to alumina which was reduced to aluminum. A small quantity of iron ore was mined and used in cement manufacture.

Aluminum.—Two Reynolds Metals Co. aluminum-reduction plants reportedly operated at 80-percent capacity throughout the year. Reynolds rebuilt single potlines at its Jones Mills aluminum-reduction plant and increased its carbon-baking capacity as well.

Bauxite.—Bauxite output by four companies increased 6 percent in quantity and 4 percent in value, compared with the 1963 figures. A large part of the gain was attributed to increased demand for aluminum output, but alumina for other than aluminum reduction and bauxite for chemical, calcining, activating applications accounted for a significant part of the increase. Reynolds added new alumina products at its alumina plant at Hurricane Creek near Bauxite.

Alcoa began operating a reassembled dragline, equipped with a 210-foot boom and a 12-cubic-yard bucket, that was transferred from company operations at Rockdale, Tex. The machine was used to remove overburden from bauxite deposits and was more efficient and economical than motorized scrapers formerly used in this phase of mining. Reynolds Mining Corp. was assembling a new dragline at its large open pit mine at yearend. The unit was equipped with a 25-cubic-yard bucket and a 285-foot boom which will permit excavation to 170 feet below the dragline. Operation of the dragline was scheduled for early 1965 and will permit utilization of thin, high-grade zones of bauxite not amenable to mining methods used in the past.

Arkansas-bauxite output accounted for 98 percent of domestic production of bauxite. Alcoa accounted for the major share of bauxite mined in the State, followed closely by Reynolds Mining Corp.

TABLE 17.—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
1955–59 (average)	1,820	1,527	$14,029	1,835	1,571	$15,660
1960	2,327	1,932	20,469	1,876	1,603	18,982
1961	1,419	1,179	13,462	1,244	1,080	13,220
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	1,865	1,562	17,431	1,773	1,531	17,859

Iron Ore.—Production of iron ore by Southwest Enterprises, Inc., in Nevada County declined markedly. The drop was attributed to loss of markets for that ore formerly used in steel manufacture. The company also curtailed operations awaiting results of tests designed to determine the usefulness of its iron ore in pigment manufacture. Plans for a ferrous-scrap-reduction plant in Lafayette County were unsettled at yearend; reportedly Area Redevelopment Administration

(ARA) had withdrawn financial support from the project. According to report, ARA also withdrew financial support from a Lafayette County Industrial Corp. project to determine feasibility of using locally mined iron ores in pigment manufacture.

Zinc.—No zinc mining activity was reported in northern Arkansas for the second consecutive year. Athletic Mining & Smelting Co. zinc smelter at Fort Smith was sold by owners to Arkansas-Louisiana Gas Co., Fort Smith Gas Corp., and Stephens Production Co. The plant was idle throughout the year, and no plans were announced regarding future operations.

REVIEW BY COUNTIES

Mineral production was registered in 74 of the State's 75 counties; the exception was Lee County. Gains in mineral values were recorded in 53 counties and decreases were noted in 17 counties. Mineral output was reported in four counties—Arkansas, Monroe, Newton, and Prairie—for the first time in several years. Mineral value exceeded $1 million in 23 counties and $500,000 in 9 other counties.

Sand and gravel was produced in 71 counties, stone in 37, natural gas in 15, clay in 14, petroleum in 8, lime in 5, natural-gas liquids, gem stones, and mineral specimens in 3, barite, bauxite, cement, gypsum, and slate in 2, and abrasive stone, bromine, iron ore, phosphate rock, and soapstone in 1.

Columbia, Saline, Union, Lafayette, Pulaski, and Little River Counties, ranked in order of significance, contributed more than $10 million each and collectively accounted for 62 percent of the total mineral value in the State.

TABLE 18.—Value of mineral production in Arkansas, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Arkansas		$56,000	Sand and gravel.
Ashley	$352,493	448,772	Sand and gravel, lime.
Baxter	9,268	79,298	Stone, sand and gravel.
Benton	373,250	518,192	Do.
Boone	351,853	132,921	Stone.
Bradley	r 892,857	1,103,632	Petroleum, sand and gravel.
Calhoun	r 686,716	902,720	Sand and gravel, petroleum.
Carroll	1,610,693	W	Sand and gravel.
Chicot	130,312	203,000	Do.
Clark	91,212	348,904	Sand and gravel, clays.
Clay	74,291	170,000	Sand and gravel.
Cleburne	11,891	161,140	Stone, sand and gravel, natural gas.
Cleveland	13,446	43,000	Sand and gravel.
Columbia	r 35,859,294	31,564,228	Petroleum, natural gas liquids, natural gas, sand and gravel.
Conway	749,675	382,325	Natural gas, stone, sand and gravel.
Craighead	W	389,500	Sand and gravel, clays.
Crawford	2,043,247	2,762,320	Stone, natural gas, sand and gravel.
Crittenden	1,161	20,000	Sand and gravel.
Cross	W	265,000	Do.
Dallas	25,561	79,000	Do.
Desha	126,452	185,000	Do.
Drew	47,739	110,000	Do.
Faulkner	325,360	688,629	Stone, sand and gravel.
Franklin	5,832,140	5,505,074	Natural gas, coal, stone, sand and gravel.
Fulton	55,844	61,301	Stone, sand and gravel.
Garland	r 191,414	209,920	Sand and gravel, abrasive stone, gem stones.
Grant	103,556	345,000	Sand and gravel.
Greene	164,245	247,000	Do.
Hempstead	69,513	65,608	Sand and gravel, clays.
Hot Spring	3,029,825	3,019,989	Barite, clays, stone, sand and gravel.
Howard	5,876,748	7,457,554	Cement, stone, gypsum, sand and gravel, clays, barite.

See footnotes at end of table.

TABLE 18.—Value of mineral production in Arkansas, by counties [1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Independence	$1,934,217	$2,215,167	Stone, lime, sand and gravel.
Izard	1,954,482	1,679,296	Stone, sand and gravel.
Jackson	W	W	Sand and gravel, stone.
Jefferson	476,929	W	Lime, sand and gravel.
Johnson	r 1,824,643	2,347,985	Coal, natural gas, stone, clays.
Lafayette	r 16,157,365	16,961,345	Petroleum, natural gas, natural gas liquids, sand and gravel.
Lawrence	1,209,315	1,102,056	Stone, sand and gravel.
Lincoln	80,240	113,000	Sand and gravel.
Little River	W	10,640,615	Cement, stone, clays, sand and gravel.
Logan	1,143,184	1,322,792	Stone, natural gas, sand and gravel.
Lonoke	160,996	1,136,917	Stone, sand and gravel, clays.
Madison	55,935	132,275	Sand and gravel, stone.
Marion	44,725	88,623	Do.
Miller	r 6,068,798	6,977,404	Petroleum, sand and gravel, natural gas, clays.
Mississippi	187,083	137,000	Sand and gravel.
Monroe	----------	2,000	Do.
Montgomery	661,599	801,150	Slate, stone, sand and gravel, gem stones.
Nevada	r 1,870,011	2,404,464	Petroleum, iron ore, sand and gravel, natural gas.
Newton	----------	521,730	Stone, sand and gravel.
Ouachita	r 7,236,850	7,590,672	Petroleum, sand and gravel, natural gas, clays.
Perry	377,367	220,800	Stone.
Phillips	W	W	Sand and gravel.
Pike	403,187	695,531	Gypsum, stone, sand and gravel, gem stones.
Poinsett	W	287,000	Sand and gravel.
Polk	38,849	72,533	Clays, stone, sand and gravel.
Pope	1,686,120	1,581,208	Stone, natural gas, sand and gravel.
Prairie	----------	9,000	Sand and gravel.
Pulaski	8,378,581	11,579,789	Stone, clays, sand and gravel, bauxite.
Randolph	80,439	30,296	Sand and gravel, stone.
St. Francis	343,347	332,000	Sand and gravel.
Saline	18,037,633	19,208,141	Bauxite, lime, sand and gravel, soapstone, slate.
Scott	13,484	116,000	Sand and gravel.
Searcy	34,078	112,902	Stone, sand and gravel.
Sebastian	1,649,544	1,826,230	Natural gas, stone, clays, coal, sand and gravel.
Sevier	W	2,346,602	Sand and gravel, stone.
Sharp	84,121	177,851	Stone, sand and gravel.
Stone	390	20,000	Sand and gravel.
Union	r 17,214,676	18,679,695	Petroleum, bromine, natural gas, natural gas liquids, sand and gravel, clays.
Van Buren	W	484,900	Stone, sand and gravel, phosphate rock.
Washington	763,391	783,848	Stone, sand and gravel, natural gas.
White	581,301	326,638	Stone, sand and gravel.
Woodruff	8,681	4,000	Sand and gravel.
Yell	301,687	536,061	Stone, sand and gravel.
Undistributed	r 17,120,696	1,658,457	
Total	r 167,284,000	174,789,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".
[1] Lee County is not listed because no production was reported in 1963 or 1964.

Ashley.—Although sand and gravel production declined in value, lime output was more than three times that of 1963 and accounted for a total value increase of 27 percent over the 1963 figure. Crossett Paper Mills used lime in paper manufacture at its plant at Crossett. Two companies mined sand and gravel for road-construction and building purposes.

Benton.—Independent Gravel Co., McClinton Brothers Co., and Ozark Construction, Inc., quarried and processed dolomitic limestone for roadstone, concrete aggregate, and agricultural applications.

Bradley.—Value of petroleum and sand and gravel exceeded $1 million. Although petroleum value increased, output of sand and gravel was about seven times that of 1963 and accounted for most of the overall value increase. Moro Gravel Co., O'Neill Bros. Sand & Gravel Co., and others supplied sand and gravel for building and construction.

Calhoun.—Petroleum output and value decreased markedly; sand and gravel output was nearly three times that of 1963 and accounted for a total mineral value about 31 percent more than that of 1963. St. Francis Material Co. produced a substantial quantity of sand and gravel, and Arkansas State Highway Department contracted for 223,000 short tons of sand and gravel for road construction.

Columbia.—The county ranked first in value of mineral output for the eighth consecutive year. The county ranked first in output of petroleum and natural-gas liquids and fourth in natural gas. Berry Asphalt Co.—a subsidiary of Bird and Sons, Inc.—operated a petroleum refinery at Magnolia. Arkla Chemical Corp. produced LP gases, natural-gasoline and cycle products, and sulfur at its gas-processing plant in the county.

Conway.—Arkansas State Highway Department purchased crushed sandstone for road construction from Freshour Corp. and J. W. McCracken. Dardanelle lock and dam project, under construction by U.S. Army Corps of Engineers, was not a major market for crushed sandstone as in former years; this was a major factor in the drop in stone output from about 400,000 tons to 95,000 tons.

Craighead.—Production of sand and gravel combined with clay output reached a value nearly three times that recorded in 1963. Wheeler Brick Co., Inc., mined and processed clays principally for brickmaking. St. Francis Material Co., Davenport Sand & Gravel Co., and Arkansas State Highway Department were major producers of sand and gravel used in building and construction projects.

Crawford.—U.S. Army Corps of Engineers purchased crushed sandstone from Mississippi Valley Engineering & Construction Co. and Empire Construction Co. for revetments and dikes built as part of the bank-stabilization project on the Arkansas River. Arkhola Sand & Gravel Co. furnished crushed sandstone used in highway construction. Arkhola Sand & Gravel Co. recovered all sand and gravel output recorded in the county. Out of a total nine holes drilled, seven new gas wells established new sources of supply.

Franklin.—Although the county retained first place in natural-gas output, the value of natural-gas output decreased appreciably. Values of coal and stone increased, and the value increment added by sand and gravel offset part of the value loss for natural gas. Garland Coal & Mining Co., Inc., accounted for virtually all coal mined in the county. U.S. Army Corps of Engineers and Arkansas State Highway Department provided major markets for crushed sandstone. New gas sources were established at 15 of the 19 field-development wells. An exploratory well resulted in discovery of Charleston gasfield; initial production from an 8-foot-pay thickness in Morris sand of the Atoka formation was rated at over 1-million cubic feet per day.

Garland.—A slight increase in total mineral value was attributable to increased-production value of silica sand, sand and gravel, novaculite used for oilstone manufacture, and mineral specimens. Norton Pike, Division of Norton Co., and Arkansas Oilstone Co. reported output of crude novaculite. Smith Brothers Construction & Material Co. produced sand and gravel for concrete aggregate, concrete blocks, and other purposes. Tripoli was quarried and ground by Malvern Minerals Co. for use in finishing small cast-metal parts and other indus-

trial purposes. The county led in output of quartz crystals and iron minerals classified as mineral specimens.

Hot Spring.—Barite was mined and ground by Baroid Division of National Lead Co. and Magnet Cove Barium Corp.; production was sufficient to rank the State second in domestic-barite production in the Nation. Clay mined and processed by Acme Brick Co. (two plants) and Malvern Brick and Tile Co. was used for refractory brick, building brick, tile, and heavy clay products. The county again ranked first in total clay output but was second in value of crude-clay production. Clay products were shipped to several points both in and out of the State. Malvern Gravel Co. was the principal producer of sand and gravel; the company also quarried novaculite for several purposes including construction and special refractory applications. Arkansas State Highway Department purchased crushed novaculite for highway construction.

Howard.—The cement industry continued as a principal factor in the economy of the county. Ideal Cement Co., one of two cement producers in the State, produced both portland and masonry cements from chalk, marl, and clay mined in the county and from lesser quantities of sand and iron ore from other counties. Cement output followed the continued rise in construction in Arkansas and adjacent States that provided markets for cement. Dierks Forests, Inc., operated its wallboard-manufacturing plant for the first full year and thus accounted for a substantial gain in gypsum output. A small increment was added to the State's barite output by mining and processing operations conducted by The Minark Co. Stone output, consisting in part of that consumed in cement production, also included crushed sandstone for constructing access roads preparatory to building Gillham Dam (Howard County) and stone used for riprap at Millwood Dam in Little River and Hempstead Counties.

Independence.—A 15-percent increase in value over that recorded in 1963 was ascribed to increased output of stone. The county ranked third in the State in value of stone production. Batesville White Lime Co. mined and crushed a substantial quantity of limestone for use in concrete aggregate, roadstone, agriculture fertilizer, lime manufacture, glass and paper manufacture, asphalt compounds, and mineral foods. The company marketed a substantial quantity of quicklime and hydrated lime. Batesville Marble Co. and Wolford Marble Co., Inc., quarried marble that was used for interior and exterior building purposes. Galloway Sand & Gravel Co. recovered sand and gravel from White River by dredge operations. Freshour Corp., Southeast Construction Co., and Limestone Products, Inc., supplied crushed limestone for road construction to Arkansas State Highway Department. The Department produced a substantial quantity of sand and gravel.

Izard.—Value of mineral products consisting of crushed limestone, silica sand, and sand and gravel was 14 percent lower than comparable value in 1963. The value decrease was attributed to lower outputs of all three mineral commodities. The county dropped to ninth place among all Arkansas counties in value of stone output and ranked fourth in sand and gravel output. This marked a departure from past years when the county consistently ranked fifth or higher in

value of stone output and was among the top-three counties in value of sand and gravel output. Silica Products Co., Inc., and National Silica Co. produced silica sand for several industrial applications. Aluminum Company of America and Reynolds Mining Corp. were principal markets for crushed limestone which they used in converting bauxite to alumina in Saline County.

Jefferson.—Total value of lime production and sand and gravel output was substantially greater than the 1963 figure. Dierks Paper Co. and International Paper Co. consumed lime for paper manufacture. Pine Bluff Sand & Gravel Co. accounted for all sand and gravel output.

Johnson.—For the second consecutive year value of mineral production increased 29 percent. The county again led in coal output. Five coal-mining companies each produced over 10,000 tons of coal during the year. Six of seven field-development wells were successful producers of natural gas and established significant new sources of supply. Freshour Corp., Southeast Construction Co., Inc., and various producers furnished crushed sandstone for U.S. Army Corps of Engineers river stabilization projects and for the Arkansas State Highway Department. Eureka Brick & Tile Co. mined clay for brick manufacture at its plant in Clarksville.

Lafayette.—Total value of mineral production was sufficient to rank the county fourth in the State for the second consecutive year. The county ranked second in natural gas liquids output and third in production of natural gas and petroleum. Austral Oil Co., Inc., McKamie Gas Cleaning Co., and Sunray DX Oil Co. recovered LP gases and natural gasoline and cycle products from treatment of wet natural gas. The county led among three counties that recorded production of byproduct sulfur. Olin Mathieson Chemical Corp., with a plant at McKamie, recovered elemental sulfur from natural gas. The county ranked third in drilling activity. One well led to the discovery of Cornish Branch field, a new oil source of supply. Discovery was made in the Mitchell sand of Rodessa formation of Cretaceous age. Pay thickness was 4 feet, and daily rate of production was 18 barrels of 42° API (American Petroleum Institute) gravity crude oil. Gifford-Hill & Co., Inc., accounted for the major share of the sand and gravel output.

Lawrence.—Ben M. Hogan & Co., Valley Stone Co., Inc., and Black Rock Limestone Products Co. quarried and crushed limestone for concrete aggregate, roadstone, and agricultural fertilizer. Arkansas State Highway Department purchased nearly 300,000 tons of crushed limestone for road construction. The Department also provided a market for sand and gravel produced in the county. Black Rock Sand & Gravel, Inc., and L. F. Parker were principal suppliers of sand and gravel.

Little River.—Total value of mineral commodities increased substantially, owing in part to a record output of cement by Arkansas Cement Corp. The corporation announced plans to increase plant capacity to 5-million barrels of cement annually. Ark-La Limestone Corp. quarried and processed limestone.

Logan.—Total value of mineral output was about $180,000 more than the comparable value in 1963. Except for a few hundred tons of coal

mined and used to supply local markets, no coal output was registered during the year. Natural gas output declined. Five field wells established new sources of natural gas. Crushed and dimension sandstone contributed the major share of total mineral value. U.S. Army Corps of Engineers projects were principal markets of sandstone for riprap and construction of revetments and dikes. Reynolds & Williams furnished crushed sandstone to Arkansas State Highway Department for construction of highways. Most of the dimension sandstone production was credited to Logan County. Four companies quarried and prepared sandstone for commercial and residential building.

Lonoke.—A near tenfold increase in value of minerals occurred in 1964. Arkansas State Highway Department purchased major quantities of crushed sandstone and sand and gravel for road building. Arkansas Lightweight Aggregate Corp. mined and processed clay for lightweight aggregate used in concrete blocks.

Miller.—Combined value of petroleum, sand and gravel, natural gas, and clay was nearly $1 million more than the 1963 figure. Gifford-Hill & Co., Inc., and Lambert & Barr, Inc., produced a record quantity of sand and gravel. W. S. Dickey Clay Manufacturing Co. increased its output of brick and other clay products. Drilling activities dropped sharply as only 11 wells were drilled, contrasted to 48 wells drilled in 1963. Six wells were classified as oil productive.

Montgomery.—Bird & Son, Inc., mined and crushed slate for use as roofing granules and slate flour. Four Brothers, Inc., and Freshour Corp. quarried and crushed sandstone for highway construction projects. Arkansas State Highway Department and U.S. Forest Service used sand and gravel for road construction and maintenance.

Nevada.—There was a significant gain in petroleum output, but the number of wells drilled declined from 45 to 33; 15 wells were oil productive and added substantially to petroleum reserves. Southwest Enterprises, Inc., continued iron ore mining operations, but output was much lower than that of 1963. Arkansas State Highway Department accounted for a substantial gain in sand and gravel output.

Newton.—For the first time since 1955, this county reported mineral production—crushed sandstone and sand and gravel used for highway construction. Ben M. Hogan & Co. produced sandstone for road construction projects.

Ouachita.—Value of mineral output increased about 5 percent over that of 1963. Much of the gain was credited to larger output of petroleum and sand and gravel. Hope Brick Works mined clay for brick and tile. Pine Bluff Sand & Gravel Co. and Standard Gravel Co. produced sand and gravel for building and paving purposes. Sixty-two wells, twice the number reported in 1963, were drilled in search of oil and gas. Thirty-eight were successful producers of oil. Oil output was sufficient to rank the county fourth in the State.

Pike.—Dulin Bauxite Co., Gypsum Division, produced crushed gypsum for use in cement. Arkansas Rock & Gravel Co. (a division of McAlester Fuel Co.) extracted sand and gravel from Little Missouri River for paving and other uses. The same company quarried sandstone for use in dam construction and attendant facilities. Diamonds were gathered by tourists from deposits of weathered and altered peridotite near Murfreesboro.

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Pope.—Production of natural gas decreased more than 22 percent and sand and gravel value dropped to about 60 percent of that reported in 1963. Quantity and value of crushed sandstone showed substantial gains over comparable data for 1963. Mobley Construction Co., Inc., furnished sand and gravel for use in highway construction. U.S. Army Corps of Engineers and Arkansas State Highway Department were principal markets for crushed sandstone produced by seven companies. One well was a successful natural-gas producer.

Pulaski.—A gain of nearly $3.20 million in value of mineral products was distributed among gains ascribed to increased outputs of stone, clay, and sand and gravel. Output of bauxite used to upgrade the alumina content of refractory clay decreased. Total value was sufficient to rank the county fifth in the State.

Value of clay output exceeded that of 1963 by more than 30 percent and was more than three times the value recorded by the nearest competing county. A. P. Green Fire Brick Co. and Stauffer Chemical Co. processed clay for refractories and alumina chemicals. Porocel Corp. and Stauffer Chemical Co. processed bauxite for chemical- and oil-industry applications.

Syenite production accounted for about 75 percent of the total value of stone output; the remaining 25 percent was sandstone production. Total value ranked the county first in the State. U.S. Army Corps of Engineers purchased crushed syenite from 12 producers for use in construction of revetments and dikes in connection with improvements on the Arkansas River. The Corps also contracted for crushed sandstone which was used for similar purposes. Pine Bluff Sand & Gravel Co., Jeffrey Stone Co., Little Rock Quarry Co., West Lake Quarry & Material Co., and others quarried and crushed sandstone for railroad ballast, concrete aggregate, riprap, and roadstone. Big Rock Stone & Materials Co. was the principal producer of syenite which was used for roofing-granule manufacture, riprap, concrete aggregate, railroad ballast, and roadstone. Arkansas State Highway Department purchased crushed syenite for highway projects from Big Rock Stone & Materials Co., and the Department also contracted for a substantial quantity of sand and gravel. Big Rock Stone & Materials Co. and Jeffrey Sand Co. were dominant producers of sand and gravel.

Saline.—Total value of mineral products was sufficient to rank the county second in the State. Production of increased quantities of bauxite, lime, and sand and gravel accounted for a 6-percent gain in value. Aluminum Company of America (Alcoa), Reynolds Mining Corp. and American Cyanamid Co. mined bauxite that was processed for alumina and chemical applications. Reynolds Mining Corp. and Alcoa manufactured lime for use in recovery of alumina at their respective plants. The Milwhite Co., Inc., quarried and processed soapstone and slate at reduced rates. Holland Gravel Co., Inc., and Belvedere Sand & Gravel Co. produced most of the sand and gravel credited to the county. Arkansas State Highway Department purchased relatively small tonnages of sand and gravel for road-maintenance projects.

Sebastian.—A value gain of about 11 percent over 1963 was attributable to increased production of natural gas and clay and new pro-

duction of sand and gravel. Output of coal and stone dropped sharply, compared with the 1963 totals. The county ranked second in natural-gas output. Gas was produced at 10 of the 14 wells drilled during the year. The county ranked third in clay output. Acme Brick Co. and S. & S. Co. (formerly Rescolite Co.) mined and processed clay for brick products and lightweight aggregate, respectively. Three operators accounted for a total 10,550 tons of coal, which was about two-thirds of that mined in 1963. Souter Construction Co. quarried and crushed sandstone for use at U.S. Army Corps of Engineers river-improvement projects. Shoffner Sand & Gravel Co. and Arkansas State Highway Department accounted for sand and gravel production that was used as concrete aggregate, paving, and roadstone.

Union.—The county again ranked third in total value of mineral products; overall value was 8 percent more than that of 1963. The increase was ascribed to gains in petroleum, bromine, and sand and gravel production. Output of bromine, recovered from oilfield brines by Michigan Chemical Corp. and Arkansas Chemicals, Inc., was substantially higher than that of 1963. The county ranked second in petroleum output. Denton Corp. and Gay Oil Co. operated plants for treatment of wet natural gas. American Oil Co., Lion Oil Co., Macmillan Ring-Free Oil Co., Inc., and Cross Oil and Refining Co. operated oil refineries. El Dorado Brick Co. mined clay for brick and tile. Ouachita Towing & Gravel Inc., and Arkansas State Highway Department produced sand and gravel for concrete aggregate, road construction, and other purposes.

Van Buren.—Most of the gain was ascribed to output of crushed sandstone used for highway construction, although a significant gain in phosphate rock output added substantially to total value. Peyton Creek Mining Co. quarried and crushed phosphate rock for agricultural applications. G. P. Freshour, Freshour Corp., Ben M. Hogan & Co., and Rock Products, Inc., supplied crushed sandstone for highway construction. Arkansas State Highway Department also purchased sand and gravel for road construction.

Washington.—A minor increase in total value of mineral production was contributed by output of sand and gravel. Output of stone and natural gas declined, although stone production contributed the major part of total value. McClinton Bros. Co. quarried and crushed substantial quantities of limestone for use as concrete aggregate, roadstone, and soil conditioner. Arkansas State Highway Department purchased sand and gravel for road construction.

Yell.—Value of mineral production exceeded that of 1963 by nearly 78 percent. Increased outputs of both sandstone and sand and gravel accounted for the gain. U.S. Army Corps of Engineers and Arkansas State Highway Department purchased sandstone for various construction programs. Ben M. Hogan & Co., Mississippi Valley Engineering & Construction Co., and Earl F. Brosnahan Construction Co. furnished stone for riprap and fill. Ben M. Hogan & Co. produced crushed sandstone for highway construction. Forsgren Brothers supplied sand and gravel for highway-building programs.

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]

CALIFORNIA'S 1964 mineral production was highlighted by a continuing rise in nonmetallic mineral production and a marked gain in the output of metals and metal ores that offset by more than $34 million a $10-million decline in mineral fuels. Mineral fuels remained dominant, representing 64 percent of the total; nonmetallic minerals accounted for about 32 percent, and metals, nearly 4 percent.

Natural gas was the only mineral fuel that increased in both quantity and value. Of 28 nonmetallic mineral commodities produced, only 5—bromine, iodine, mica, pumice, and salt—showed declines; only 4 of 13 metals—gold, mercury, platinum, and uranium—had outputs below those in 1963. Optical grade calcite was mined and shipped for the first time since World War II. Major increases were reported for boron minerals and compounds, cement, sodium compounds, and stone among the nonmetals; and for iron ore and tungsten among the metals. Mercury output declined in quantity but rose in value because of the substantial unit price increase.

Consumption, Trade, and Markets.—California led all States in diversity of mineral production and in the value of raw materials consumed. Only in those instances where California was the sole or principal domestic source did production exceed consumption. Sources outside the State were essential for many mineral requirements, particularly mineral fuels. Refinery receipts of crude oil (all sources) rose 3 percent from 1963, and natural gas receipts (pipeline) were 16 percent higher. Plants within the State processed 3 percent less wet gas with an output of natural gas liquids that was nearly 3.5 percent lower. Two States produced more petroleum, but California consumed more petroleum products than any other, and although several States had a greater natural gas yield, only Texas consumed more.

Over 10.5 million motor vehicles were registered in California in 1964, and the number of operating retail service stations had increased to 21,755 at yearend. Again, the State derived about 16 percent of its total tax revenue from fuels used in motor vehicles and motor transportation.

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TABLE 1.—Mineral production in California [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos—short tons	19,591	$1,547	55,041	$4,419
Barite (crude)—do	5,082	r 31	5,604	45
Boron minerals—do	700,183	54,981	776,000	60,871
Calcite (optical grade)—pounds			4	2
Cement [2]—thousand 376-pound barrels	46,278	147,656	47,204	149,933
Clays—thousand short tons	3,395	8,031	[3] 3,651	[3] 8,196
Copper (recoverable content of ores, etc.)—short tons	916	564	1,035	675
Feldspar—long tons	75,516	W	102,264	W
Gem stones	(4)	200	(4)	200
Gold (recoverable content of ores, etc.)—troy ounces	86,867	3,040	71,028	2,486
Gypsum—thousand short tons	1,756	4,222	1,893	4,539
Lead (recoverable content of ores, etc.)—short tons	823	178	1,546	405
Lime—thousand short tons	487	8,932	577	10,312
Magnesium compounds from sea-water and bitterns (partly estimated)—short tons, MgO equivalent	82,397	6,135	94,739	7,143
Mercury—76-pound flasks	13,592	2,575	10,291	3,240
Mica, scrap—short tons	977	14	W	W
Natural gas—million cubic feet	646,486	189,420	664,051	198,551
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	715,303	54,188	720,373	54,088
LP gases—do	393,503	17,329	352,614	15,893
Peat—short tons	39,873	450	35,391	443
Petroleum (crude)—thousand 42-gallon barrels	300,908	746,252	300,009	729,022
Pumice, pumicite, and volcanic cinder—thousand short tons	460	2,017	443	1,937
Salt (common)—do	1,716	W	1,525	W
Sand and gravel—do	112,185	128,178	112,995	129,333
Silver (recoverable content of ores, etc.)—thousand troy ounces	157	200	172	222
Stone [5]—thousand short tons	37,977	58,253	45,805	63,566
Sulfur ore—long tons	785	4	520	3
Talc, pyrophyllite, and soapstone—short tons	120,452	1,427	132,601	1,631
Wollastonite—do	3,000	28	3,625	36
Zinc (recoverable content of ores, etc.)—do	101	23	143	39
Value of items that cannot be disclosed: Bromine, calcium chloride, carbon dioxide, masonry cement (1963), clays (ball clay and fuller's earth), coal (lignite), diatomite, iodine, iron ore, lithium minerals, molybdenum, perlite, platinum-group metals, potassium salts, rare-earth metals, sodium carbonate, sodium sulfate, tin, tungsten concentrate, uranium, and values indicated by symbol W	XX	r 90,366	XX	113,280
Total	XX	r 1,526,241	XX	1,560,510

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] Excludes masonry cement, included with "Value of items that cannot be disclosed."

[3] Excludes ball clay and fullers earth, included with "Value of items that cannot be disclosed."

[4] Weight not recorded.

[5] Includes slate.

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

(Millions)

Year	Value	Year	Value
1952	$1,473	1959	$1,456
1953	1,580	1960	1,417
1954	1,580	1961	r 1,418
1955	r 1,598	1962	r 1,434
1956	r 1,660	1963	r 1,489
1957	1,659	1964	1,509
1958	1,517		

r Revised.

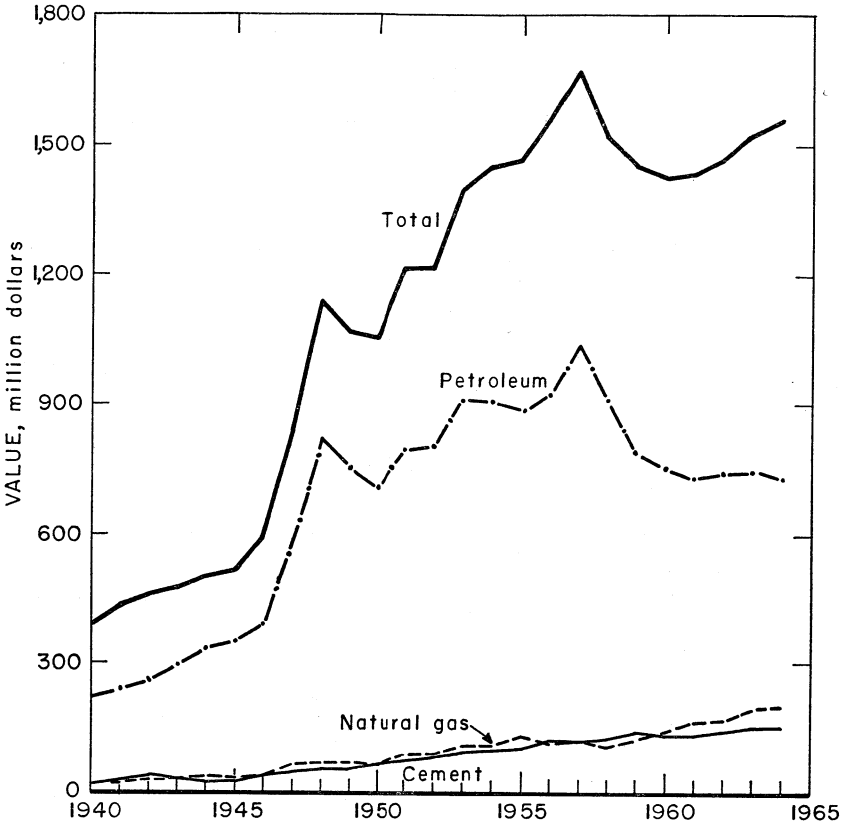


FIGURE 1.—Value of petroleum, natural gas, cement, and total value of mineral production in California.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	1,854	377	3,010	1	68	23
Nonmetal	4,359	1,169	9,379	----	165	18
Sand and gravel	5,462	1,282	10,342	9	248	25
Stone	5,031	1,419	11,368	6	187	17
Peat and coal	41	9	74	----	1	13
Total	16,747	4,256	34,173	16	669	20
1964: p						
Metal	2,045	458	3,660	----	95	26
Nonmetal	4,595	1,252	9,957	3	175	18
Sand and gravel	5,465	1,300	10,550	1	237	23
Stone	4,675	1,342	10,793	4	143	14
Peat and coal	38	7	51	----	4	78
Total	16,818	4,359	35,011	8	654	19

p Preliminary.

Forty-eight different mineral commodities were produced. The State was the sole domestic source for boron minerals and compounds, by far the leader in sand and gravel output, and the principal producer of asbestos (short fiber), diatomite, gypsum, mercury, rare-earth concentrate, sodium sulfate, sulfur ore, and tungsten concentrate. Plants in California also processed many nonmetal ores produced in other States, principally Arizona and Nevada.

In some instances metal ores and concentrates were processed in out-of-State plants and smelters. Exceptions were those shipped to the primary lead smelter and zinc fuming plant of American Smelting & Refining Co., Contra Costa County; the integrated steel plant of Kaiser Steel Corp., San Bernardino County; and the tungsten mill and chemical plant of Union Carbide Nuclear Co., Inyo County.

TABLE 4.—Principal custom mills, commercial grinding plants, and primary smelters in 1964

Company	County	Nearest city or town	Minerals processed	Remarks
C. K. Williams (Anchor Minerals Division).	Alameda	Emeryville	Nonmetals	Commercial grinding.
American Smelting & Refining Co.	Contra Costa	Selby	Lead, zinc, silver, gold.	Smelter, refinery, and fuming plant.
The Wilbur Ellis Co	Fresno	Fresno	Nonmetals	Commercial grinding.
Huntley Industrial Minerals Co.	Inyo	Bishop	do	Do.
Butte Lode Mining Co	Kern	Randsburg	Gold and silver	Custom mill.
American Minerals Co	Los Angeles	Los Angeles	Nonmetals	Commercial grinding.
Western Talc Co	do	do	do	Contract grinding.
Industrial Minerals & Chemical Co.	Sacramento	Florin	do	Do.
Kaiser Steel Corp	San Bernardino.	Fontana	Iron ore	Blast furnaces, steel plants, and fabricating plants.
C. K. Williams (Anchor Minerals Division).	do	Victorville	Nonmetals	Commercial grinding.
Yuba Minerals & Milling Co.	Sutter	Sutter	do	Do.

Trends and Developments.—A significant increase in crude petroleum was reported in the last half of 1964, attributed to thermal recovery operations in fields yielding heavy crude oils. Production rose from a low of 807,000 barrels daily in January to 811,000 barrels at midyear and to 830,000 barrels by yearend. The Conservation Committee of California reported that a net increase of 30,000 barrels daily resulted from operations at over 100 thermal recovery projects in 43 fields. Three significant crude oil discoveries were made during 1964—the Northeast Area of McKittrick field and the Railroad Gap field, Kern County, and the Los Angeles Downtown field, Los Angeles County. At yearend the two new Kern County fields were producing but the Los Angeles Downtown field had been shut-in. Development of the offshore East Wilmington field was imminent as bids were called for early in 1965.

Increased utilization of hydrocracking was the dominant trend at refineries. Two new units went on stream in 1964—Union Oil Co. of California completed a 16,000-barrel-a-day Unicracking unit at its Wilmington refinery and Wilshire Oil Co. of California completed an 11,000-barrel-a-day hydrocracker at its Santa Fe Springs refinery, both in Los Angeles County. Hydrocracking units were either under

construction or had been announced by Mobil Oil Co., Richfield Oil Co., Shell Oil Co., Standard Oil Co. of California, and Texaco, Inc. Two new refineries were proposed before yearend—a 50,000-barrel-a-day plant at Moss Landing, Monterey County, planned by Humble Oil & Refining Co., and a 20,000-barrel-a-day refinery at Hercules, Contra Costa County, announced by Sequoia Refining Corp.

Marketed natural gas output rose 3 percent as exploratory drilling resulted in four new field discoveries in addition to new pools and extensions in older fields. Natural gas liquids production continued the decline begun in 1960 and was 3 percent less than in 1963. In only one county, Santa Barbara, was the output of natural gas liquids higher in 1964. This increase was attributed largely to the development of offshore fields.

Early in the year Occidental Petroleum Corp. merged with Jefferson Lake Sulphur Co. As a result the corporate name of Jefferson Lake Asbestos Co. was changed to Pacific Asbestos Co. United States Asbestos Co. (formerly a Todd Industries operation) completed its 25,000-ton-a-year fiber mill at Coalinga and planned early 1965 operation. About midyear Stauffer Chemical Co. announced a $2 million expansion at its Westend plant on Searles Lake, Inyo County, principally to increase borax and sodium sulfate production. In August, Chas. Pfizer & Co. placed on stream its multimillion-dollar continuous lime calcination and hydration complex at Lucerne Valley, San Bernardino County, and announced plans to build a limestone processing plant at Lake Isabella in Kern County. Also in August, National Gypsum began operating its first West Coast wallboard plant at Richmond. At yearend the company had a second wallboard plant under construction at Long Beach. Other wallboard plants were being built by The Flintkote Co. at Fremont and by U.S. Gypsum Co. at Santa Fe Springs.

Homestake Mining Co. purchased the Port Costa Brick Works in Contra Costa County and announced plans to spend $3 to $4 million to modernize and add facilities that would include a lightweight aggregate plant to utilize local clays. The H. C. Muddox Co. of Sacramento was expanding its facilities and planned to use Amador County clays in the manufacture of flue linings. U.S. Borax & Chemical Corp. installed a truck-shovel system at its Boron open-pit mine, Kern County, replacing the tractor-scraper system in use since 1956. The company scheduled for completion in early 1965, a 30-percent expansion of facilities to increase production of fused borate products. The newly formed Southern California Cement Co. planned to construct a single-kiln cement plant at Gorman, south of Bakersfield. The kiln would be one of industry's largest. Southwestern Portland Cement Co., at Victorville, scheduled a new plant, adjacent to the old one, for completion late in 1965. During the year, Kaiser Aluminum & Chemical Corp. built and put into operation a facility at Moss Landing to produce basic refractory specialty products and began construction on a new tunnel kiln to produce basic brick fired at temperatures in excess of 3,100° F. Western Geothermal, Inc., a subsidiary of Natomas Co., drilled a second well on leased land in Imperial Valley. The property was held under joint venture agreement with another company. Although the well demonstrated sufficient potential for a power in-

stallation, disposal of the accompanying brines posed a major problem. Western Geothermal began a feasibility study of facilities for the recovery of potash and other marketable products from the brines, and the economic disposal of residual wastes.

In May, Natomas Co. auctioned all its mining equipment, cranes, and machinery at Natoma, Sacramento County, ending a 100-year dredging operation that yielded $90 million in gold. Union Carbide Nuclear Corp. announced that its ore processing mill near Bishop was being modified so that an up-graded molybdenum product could be produced rather than the present concentrate forms. Kaiser Steel Corp. began construction on an iron ore pelletizing plant at its Eagle Mountain mine, and launched a $119 million improvement program at Fontana, aimed primarily at expanding steel finishing facilities. New equipment was to include a rolling mill coupled to a hot galvanizing line and automated controls for the hot strip mill. Bethlehem Steel Co. announced plans for a modern steel fabricating plant on its 125-acre Pinole Point property in Contra Costa County. The new facility was to have an annual capacity of 30,000 tons of steel. Completion date was set for late 1965. Molycorp developed a new process for extracting europium oxide from rare-earth (bastnaesite) concentrates and demonstrated its success in a pilot plant at Mountain Pass. As a result the company scheduled a $1.1 million europium oxide plant for completion in June 1965.

TABLE 5.—Office of Minerals Exploration contracts in force during 1964

County and contractor	Commodity	Contract [1]	
		Date	Total amount
Plumas:			
California Alluvial Mining Corp.	Gold-platinum	October 1963 [2 3]	$46,920
Armin Speckert, Sr.	Gold	January 1963	61,078
Mariposa: Pyramid Mines, Inc.	do.	April 1964	42,200
San Bernardino: Resource Americas Corp.	Silver	February 1964	32,088
San Luis Obispo:			
Botts and Johnson	Mercury	June 1964	20,160
San Simeon Keystone, Inc.	do.	August 1963 [3]	45,389
Shasta: Austin H. Merrill	Gold-silver	January 1964	41,860
Sierra:			
Baker and Davis	Gold	February 1964 [4]	36,528
Best Mines Co., Inc.	do.	April 1963	80,090
S.E. & K.M. Brainerd	do.	October 1963 [2 3]	15,080
Consolidated Alleghany Mines, Inc.	do.	October 1963 [2]	101,220
Dickey Exploration Co.	do.	September 1963 [2]	65,520
Mugwump Mining Co., Inc.	do.	April 1964	70,440
Original Sixteen to One Mines, Inc.	do.	October 1963 [4]	46,600
Do.	do.	September 1964	43,300
Sonoma: Sonoma International, Inc.	Mercury	August 1964	105,400

[1] Government participation, 50 percent on all contracts except silver, 75 percent.
[2] Effective date of amendment.
[3] Terminated in 1964.
[4] Canceled in 1964.

Legislation and Government Programs.—Public land orders restored about 44,000 acres of land to mineral location and leasing under U.S. mining laws, more than half of which was restored by the Bureau of Reclamation, U.S. Department of the Interior. Other land orders withdrew nearly 61,000 acres for use by Federal agencies, principally the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the

Department of Defense (U.S. Navy). During 1964, California received U.S. Treasury checks totaling $3,094,149.89 in bonuses, royalties, and rentals from mineral leases and permits on Federal lands within the State borders, nearly $306,000 more than in 1963.

Of the three California producers who had been certified since the enactment of the Lead-Zinc Stabilization Program in October 1962, two were active as of December 31, 1964. During 1964, the two producers received payments totaling $7,423 for production of 290.2 tons of lead. No new applications were received or certifications made in 1964, and no payments were made for zinc although the metal was included in one of the three original certifications.

For the year ending December 31, 1964, the Office of Minerals Exploration (OME) received 491 requests for application forms by persons interested in exploring for minerals in California. Twelve applications were processed during the period—five for gold, three for silver, and two each for gold-silver and mercury. Contracts were awarded to seven applicants; one of these was cancelled later in the year. Two contracts terminated that had been in force prior to and during part of 1964. At yearend, 12 contracts were in force.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS [2]

Carbon Black.—Carbon black production reached 103.5 million pounds valued at nearly $6 million, increases of 26 percent in quantity and 21 percent in value over that of 1963. All output was furnace blacks and seven grades were produced—high abrasion furnace (HAF), fast extrusion furnace (FEF), general purpose furnace (GPF), semireinforcing furnace (SRF), intermediate abrasion furnace (ISAF), super abrasion furnace (SAF), and thermal. Continental Carbon Co., at Bakersfield, and United Carbon Co. at Mojave, both in Kern County, each produced the first five grades listed. United Carbon also made SAF grade. Shell Chemical Co. produced thermal black as a byproduct in the manufacture of ammonia fertilizers at Pittsburg, Contra Costa County. The carbon blacks were consumed by the rubber and metal industries.

Carbon Dioxide.—Tidewater Oil Co. extracted carbon dioxide from natural gas in its natural gasoline plant near Taft, Kern County. The output was greater than in 1963. The product was sold to aircraft companies for freezing rivets and to bottlers of carbonated beverages. Standard Oil Co. of California extracted carbon dioxide in a similar plant in the same area only to insure that the natural gas would meet pipeline specifications. The extracted carbon dioxide was not marketed.

Coal (Lignite).—American Lignite Products Co., Inc., the State's only commercial lignite producer, mined lignite at its open pit mine near Ione, Amador County. Production was virtually unchanged from that in 1963. The mineral was processed principally for its montan wax content. Several grades of wax were produced most of which was utilized by the carbon paper, polish, and rubber industries.

[2] Prepared by Curt D. Edgerton, Mineral specialist, Bureau of Mines, San Francisco, Calif.

During the year the company placed a new solvent extraction unit in operation.

Coke.—Kaiser Steel Corp. operated the State's only coking facilities at its integrated Fontana steel plant. Most of the coke was consumed in the producer's furnaces. Production and consumption were substantially above 1963 figures. A high percentage of the coking coal came from captive mines in New Mexico and Utah; however, purchases were made from producers in other States.

Natural Gas.—Marketed production of natural gas rose 3 percent from 1963 and again 57 percent of the output came from oil zones. The most active development drilling occurred in the Dutch Slough (22 wells) and the Grimes (15 wells) fields in the Sacramento Valley. According to the Conservation Committee of California Oil Producers there were 823 producing gas wells at yearend. Significant production increases were reported from the Brentwood, Concord, Dixon, Lindsay Slough, Llano Seco, Los Medanos, McMullen Ranch, Suisun Bay, Sutter Buttes, and Tisdale fields in the San Joaquin Valley. Large declines occurred in the Bunker, Butte West, Kirk, and Liberty Island fields in the Sacramento Valley. In southern California, production from the Cuarta offshore field dropped about 50 percent while that of the Molino offshore field increased nearly threefold.

Exploratory drilling resulted in the discovery of four new gas fields and three new pools. The quantity injected for repressuring and pressure-maintenance operations was down about 4 percent from 1963. Less than 1 percent of the total natural gas output was vented or otherwise wasted.

Natural Gas Liquids.—Production of natural gas liquids, continuing a decline begun in 1960, was down more than 3 percent from 1963 with a corresponding decrease in the volume of wet gas processed. Of the total output, 67 percent was natural gasoline and cycle products and 33 percent liquified petroleum (LP) gas.

One plant was shut down during 1965, leaving 65 natural gasoline and cycle products plants in operation at yearend. The plants were all in the eight contiguous counties of the Los Angeles Basin, the southern coastal area, and the San Joaquin Valley. The value of the natural gas liquids output was 2 percent less than in 1963, with a unit price of 7.5 cents for natural gasoline and cycle products (down 0.1 cent) and 4.5 cents a gallon for LP gas (up 0.1 cent).

Peat.—Peat production dropped 19 percent from 1963; sales were down 11 percent. More than 60 percent of the output was reed-sedge material by two producers in Contra Costa County and one in Riverside County. A Modoc County deposit yielded all the peat moss and an Orange County pit all the humus material. The humus was sold directly from the pit in an unprepared state, whereas most of the reed-sedge and moss peat was shredded and packaged for sale. About two-thirds of the peat was sold for general soil improvement; the remainder was sold to mushroom growers, fertilizer plants, and nurseries.

Petroleum.—Oilfields in the State's 16 producing counties yielded slightly less petroleum than in 1963. Kern County again had the largest production followed by Los Angeles, Orange, Ventura, and Santa Barbara Counties. Of the 10 counties that produced more than 1 million barrels each, 6 of these produced more than 20 million each.

TABLE 6.—Natural gas, natural gas liquids, and petroleum produced, by counties

County	1963					1964				
	Natural gas [1] (million cubic feet)		Natural gas liquids		Petroleum [1] (thousand barrels)	Natural gas [1] (million cubic feet)		Natural gas liquids		Petroleum [1] (thousand barrels)
	Oil zones [r]	Dry gas zones	Natural gasoline and cycle products (thousand gallons)	LP-gases (thousand gallons)		Oil zones	Dry gas zones	Natural gasoline and cycle products (thousand gallons)	LP-gases (thousand gallons)	
Butte		9,369					9,607			
Colusa		15,724					15,674			
Contra Costa	2,762	2,058			487	5,026	6,816			1,095
Fresno	27,167	119	W	W	25,254	29,379	108	W	W	23,451
Glenn		18,074					18,050			
Humboldt		2,057					1,979			
Kern	109,315	7,976	184,161	139,862	95,257	110,204	6,494	179,849	121,732	97,870
Kings	16,878	1,658	W	W	1,232	21,741	1,833	W	W	1,215
Los Angeles	82,979	2,742	193,487	66,987	78,264	78,660	2,679	194,985	55,160	77,422
Madera		1,936					1,958			
Monterey	4,608				10,175	3,941				10,234
Orange	32,299		88,911	17,345	31,762	31,892		86,644	18,251	32,439
Riverside					3					2
Sacramento		52,330					47,658			
San Benito	249	825			196	111	570			189
San Bernardino	112				76	60				62
San Joaquin		40,106					43,598			
San Luis Obispo	646		W	W	1,219	704		W	W	1,166
San Mateo	9				76	3				54
Santa Barbara	27,617	25,769	70,244	50,197	26,149	34,874	35,323	86,402	45,068	26,972
Solano		44,933			1		43,809			
Sonoma		68					45			
Sutter		39,924					44,689			
Tehama		1,155					1,102			
Tulare		5,220			56		5,019			52
Ventura	65,148	142	127,238	73,079	30,647	58,649	263	119,768	65,418	27,786
Yolo		2,059					1,533			
Undistributed	2,453		51,262	46,033				52,725	46,985	
Total	[r] 372,242	274,244	715,303	393,503	300,854	375,244	288,807	720,373	352,614	300,009

[r] Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Quantity figures for natural gas and petroleum by courtesy of California Department of Natural Resources, Division of Oil & Gas.

Petroleum production increased in 5 counties; production declined in 11.

Operators filed 2,916 notices of intention to drill (32 more than in 1963); 2,158 new wells were completed to production, and 622 were abandoned as dry holes. Also, 316 former producing wells were abandoned. The total footage drilled (including service wells) was 9,619,916 feet, down about 4 percent from that of 1963. According to the Conservation Committee of California Oil Producers, 683 exploratory wells were drilled, resulting in 18 new oil discoveries and 9 new gas discoveries. Three crude oil discoveries were of major importance—the Railroad Gap and Northeast McKittrick fields in Kern County and the Los Angeles Downtown field in Los Angeles County. At yearend, bid invitations for development of the East Wilmington (offshore) field, Los Angeles County, where reserves of about 1.5 billion barrels of crude oil are known to exist, were being prepared.

There were 145 waterflood and 43 gas-injection projects in operation during 1964. A few miscible-phase projects also were active. Secondary recovery emphasized thermal treatment, principally steam injection. Virtually all of the thermal projects were in fields containing low-gravity crude oil in sand of considerable thickness at shallow depth. There were approximately 150 thermal recovery projects in operation. Most of these were in Kern County. Production from thermal recovery projects had nearly offset the normal decline in the State's older fields by yearend.

Refinery construction centered principally on hydrocracking units. Units were completed or in progress by Union Oil Co. of California at Wilmington, Wilshire Oil Co. of California at Santa Fe Springs, Mobil Oil Co. at Torrance, Shell Oil Co. at Martinez, Standard Oil Co. of California at Richmond, and Richfield Oil Corp. at Long Beach. Other refinery improvement projects in progress were the delayed coking and vacuum units at Richfield's Long Beach refinery, and modernization and expansion of facilities (in addition to the new hydrocracking unit) at Shell's Martinez refinery. At yearend, California had 33 refineries in operation with a total crude oil throughput capacity of 1,656,361 barrels daily, over 300,000 barrels more than in 1963.

NONMETALS

Asbestos.—Most of the 1964 increase in U.S. asbestos production occurred in California. Nearly all of the California output was short-fiber material consumed in making asbestos cement and other asbestos building products. Five companies produced asbestos fiber—Pacific Asbestos Corp. (formerly Jefferson Lake Asbestos Corp.), Calaveras County; Atlas Minerals Corp. and Coalinga Asbestos Co., Fresno County; Asbestos Bonding Co., Napa County; and Union Carbide Corp., San Benito County. A sixth company, U.S. Asbestos Corp. near Coalinga, completed its new 25,000-ton-a-year fiber mill and scheduled production for early 1965. The corporate identity of Jefferson Lake Asbestos Corp. became Pacific Asbestos Corp. in May, when its parent company Jefferson Lake Sulphur Co., merged with Occidental Petroleum Corp.; Occidental was the surviving corporation.

A chrysotile asbestos prospect in Marin County was examined by several companies, one of which did some exploratory work. In Monterey County, Johns-Manville Corp. explored an asbestos property near Table Mountain, and American Exploration & Mining Co. did some exploration at a known deposit on the Hunter-Ligget Military Reservation.

Barite.—Crude barite production rose slightly from that of 1963, but still was only 80 percent of the 1962 figure. All of the output of Organic Mineral Sales, Ltd., at the White Swan property, Imperial County, was stockpiled. W. S. Hubbard shipped a small tonnage from the Paycheck mine, San Bernardino County, to the Macco Corp. mill at Rosamond. In Shasta County, Yuba Minerals & Milling Co. mined crude barite at the Loftus claims and shipped to its own grinding plant at Sutter. Warrington Bros. mined barite on the Baro claims, Tulare County, and shipped to mills at Rosamond and Terminal Island. Macco Corp. reported that its Tulare County deposit was depleted but shipped stockpiled barite from its Little Lake, Inyo County, jigging plant to its Rosamond mill. Wm. Reid mined a small tonnage of crude barite from a Gunther Canyon deposit, Inyo County, and shipped it to the Terminal Island plant.

Shipments of ground barite dropped 48 percent from those in 1963, reflecting a continued decline in demand for use in drilling muds. Of all crude barite ground in California plants, 82 percent came from Nevada mines. National Lead Co. closed its Merced mill and transferred all barite grinding to its Dunphy, Nev., facility.

Boron Minerals and Compounds.—All domestic production and most of the world supply of boron minerals and compounds came from bedded borate deposits in Kern and Inyo Counties and the brines of Searles Lake. U.S. Borax & Chemical Corp. operated refineries in Kern and Los Angeles Counties on crude borates from the company's open-pit mine at Boron, Kern County. U.S. Borax announced it would increase the anhydrous borax production facility at Boron by 30 percent early in 1965. In Inyo County, U.S. Borax mined colemanite near Furnace Creek and sodium-calcium borates near Shoshone, and Kern County Land Co. mined colemanite near Ryan. American Potash & Chemical Corp. and Stauffer Chemical Co. extracted boron compounds from brines in plants at Searles Lake. Stauffer announced it intended to increase borax production capacity 50 percent by early 1966. Stauffer also produced high-purity boron chemicals in its San Francisco plant using purchased Kern County borates. Production and sales of boron compounds rose 11 percent above those in 1963, mainly because of an increase in foreign sales.

Bromine and Bromine Compounds.—At Trona, San Bernardino County, American Potash & Chemical Corp. produced elemental bromine in the treatment of Searles Lake brines. The output, slightly less than in 1963, was sold to the chemical and pharmaceutical industries. FMC Corp. recovered liquid elemental bromine from salt-works bitterns in its Newark, Alameda County, plant and converted it to ethylene dibromide. Production, off about 20 percent from that of 1963, was sold principally for use as a fumigant in agriculture although some was consumed in preparing a gasoline antiknock compound.

Calcite (Optical Grade).—Several pounds of optical grade calcite was mined from claims on Mount Baldwin, Mono County, by United

States Calcite Co. of Fresno, and shipped to Bausch & Lomb, Inc., Rochester, N.Y. In addition to the optical-grade calcite about 140 pounds of suboptical material was sold for mineral specimens. Some preliminary work had been done in 1963 that included location and discovery work on the claims, but only sample material was removed and forwarded to prospective purchasers for quality inspection at that time. Late in 1964 Bausch & Lomb acquired the property from U.S. Calcite.

Calcium Chloride.—Bristol Lake brine, San Bernardino County, was the source for liquid calcium chloride recovered by Leslie Salt Co. and National Chloride Co. of America. Nearly 14 percent more chloride was produced and marketed than in 1963. Hill Bros. Chemical Co. purchased the liquid and prepared a flake product in a plant near Bristol Lake. Less of the flake chloride was produced and sold than in 1963. Customers in southern California, Nevada, and Arizona, used the products principally for a hygroscopic agent, and as a fireproofing material.

Cement.—Cement production increased 4 percent, and was over 1.8 million barrels above that in 1963. Shipments from California's 13 cement mills rose to more than 47 million barrels, of which more than 3 million barrels went to out-of-State customers. Distribution within the State was about 27 million barrels to southern California and 17 million barrels to northern California. Over 67,000 barrels of cement were consumed in reconstruction or expansion of facilities at mills in southern California. Annual productive capacity rose to 56,550,000 barrels, principally as a result of improved production methods at a northern California plant that raised capacity by 300,000 barrels. Completion of current expansion and improvement projects at southern California mills was scheduled for 1965.

Total apparent consumption of cement, including receipts from other States, rose to 44 million barrels, up 4 percent from that in 1963. Demand was at a new high in 1964, but purchases by manufacturers of concrete products, northern California building materials dealers, and southern California and Nevada ready-mixed concrete plants were lower.

TABLE 7.—Finished portland cement

(Thousand 376-pound barrels and thousand dollars)

District[1]	Active plants	Capacity Dec. 31	Production	Shipments from mills			Stocks at mills Dec. 31	Estimated consumption
				Quantity	Value			
					Total	Average per barrel		
1963:								
Northern California	6	20,850	17,973	18,028	$58,839	$3.26	1,164	15,883
Southern California	7	35,400	28,119	28,250	88,817	3.14	1,553	26,435
Total	13	56,250	46,092	46,278	147,656	3.19	2,717	42,318
1964:								
Northern California	6	21,150	18,999	18,418	59,834	3.25	1,745	17,141
Southern California	7	35,400	28,982	28,786	90,099	3.13	1,748	26,874
Total	13	56,550	47,981	47,204	149,933	3.18	3,493	44,015

[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 8.—Source and destination of shipments of portland cement

(Thousand 376-pound barrels)

Destination	Source				Total	
	Northern California mills		Southern California mills			
	1963	1964	1963	1964	1963	1964
Northern California	15,145	16,033	620	961	15,765	16,994
Southern California	657	418	25,731	26,430	26,388	26,848
Nevada	500	622	1,565	1,157	2,065	1,779
Oregon	W	W	W	W	(1)	(2)
Arizona			288	184	288	184
Utah			29		29	
Other	[3] 1,726	[3] 1,345	[4] 17	[5] 54	1,743	1,399
Total	18,028	18,418	28,250	28,786	46,278	47,204
Building material dealers	1,635	1,463	3,495	3,773	5,130	5,236
Concrete product manufactures	1,471	1,415	3,140	3,191	4,611	4,606
Ready-mixed concrete	11,904	11,912	19,646	19,167	31,550	31,079
Contractors and Government agencies	2,965	3,563	1,862	2,570	4,827	6,133
Miscellaneous and own use	53	65	107	85	160	150
Total	18,028	18,418	28,250	28,786	46,278	47,204

W Withheld to avoid disclosing individual company confidential data. Included with "Other."
[1] Included with "Other;" total 922,000 barrels shipped from northern and southern California to Oregon.
[2] Included with "Other;" total 538,000 barrels shipped from northern and southern California to Oregon.
[3] Includes Alaska, Idaho, Oregon, Washington, and foreign countries.
[4] Includes Colorado, Hawaii, Idaho, Michigan, New Mexico, Oregon, Texas, Washington, and foreign countries.
[5] Includes Colorado, Hawaii, Iowa, Michigan, New Mexico, Oregon, Texas, Utah, Washington, and foreign countries.

Clays.—Nearly 3.7 million tons of clay was mined at captive operations, an increase of 9 percent over 1963. Miscellaneous clay for making heavy clay products and portland cement accounted for 83 percent of the total; fire clay, 15 percent; and all other clays, 2 percent. Kaolin was mined from one Mono County deposit and two properties in Orange County; fuller's earth from two mines in Inyo County;

TABLE 9.—Clay production, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Alameda	W	W	13,585	$24,180
Amador	W	W	82,899	442,365
Contra Costa	58,560	$88,265	47,995	74,566
Inyo	W	W	7,558	39,874
Kern	79,935	125,935	89,397	152,846
Los Angeles	437,834	573,210	430,724	553,441
Madera	7,418	9,273	7,650	9,563
Orange	114,729	459,888	299,167	975,753
Riverside	497,780	1,391,655	446,910	1,229,506
Sacramento	24,460	35,591	W	34,203
San Bernardino	210,702	756,078	223,281	726,943
San Joaquin	20,826	44,430	44,675	67,185
San Luis Obispo	6,250	7,813	9,375	11,719
Stanislaus	W	W	3,338	21,157
Tulare	3,200	4,000	4,050	5,100
Undistributed [1]	1,933,587	4,534,692	1,940,358	3,827,449
Total	3,395,281	8,030,830	3,650,962	8,195,850

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Calaveras, Del Norte, Fresno, Imperial, Lake, Marin, Mono, Napa, Placer, Plumas, San Benito, San Diego, San Mateo, Santa Clara, Santa Cruz, Shasta, Siskiyou, Sonoma, Sutter, Trinity, Ventura, and Yuba, and counties indicated by symbol W; excludes ball clay and fuller's earth, withheld to avoid disclosing individual company confidential data.

and bentonite from three mines in San Bernardino, two in Inyo, and one each in Imperial and San Benito Counties. Clay from one of the San Bernardino deposits was classified as montmorillonite and was processed by the producer principally for use in making pharmaceuticals and cosmetics. Ball clay output came from four mines—two each in San Bernardino and Stanislaus Counties.

Experimental shipments of kaolin were made from a deposit near Winston, N. Mex., to three California ceramic plants where the mineral was ground to company specifications.

Diatomite.—Most of the diatomite production came from three open pit operations near Lompoc, Santa Barbara County. Another property in the same area (new in 1963) was also active. Interplant shipments were made from a diatomaceous silica stockpile in Napa County and ground for pozzolan. Sales of crude and prepared material were 3 percent above those of 1963. Sales, in order of greatest demand, were for filler, lightweight aggregate, pozzolan cement, insulation, and absorbent uses. Preparation plants were operated near all deposits. A small quantity of low-grade diatomaceous material was mined in Tuolumne County for experimental use, and exploration was conducted at a prospect in Fresno County.

Feldspar.—Del Monte Properties Co. and Owens-Illinois Glass Co. mined and processed sand from dunes on the Monterey peninsula. Both companies removed heavy minerals from the sand, Del Monte by froth flotation and Owens-Illinois using magnetic separators. Del Monte produced silica and feldspar concentrates by flotation and blended and ground the mill products to customer specifications, principally for use in making sanitary ware. Owen-Illinois shipped the upgraded feldspathic sand to company glass plants. Output of feldspathic sand declined slightly in 1964, but substantial gains were recorded in the production of flotation concentrates and of feldspar-silica mixtures. Shipments of ground products also increased notably.

Gypsum.—Producers of crude gypsum mined a record 1,893,000 tons in 1964. Kern County mines yielded more than 970,000 tons for agricultural use. The California Department of Agriculture reported that sales of agricultural gypsum reached 1,239,000 tons, 12 percent above the 1963 figure. Included in the total was crude from mines in Nevada and Mexico (San Marcos Island) and byproduct gypsum from chemical and fertilizer plants in Alameda, Fresno, and San Joaquin Counties.

Production of calcined gypsum also reached a new high of 1,019,000 tons although the output of gypsum building products was adversely affected by a lag in residential construction, particularly in southern California. Seven wallboard plants were in production during the year—four in southern California and three in northern California, including National Gypsum Co.'s new plant in Contra Costa County. At yearend three wallboard plants were under construction: at Long Beach by National Gypsum, at Fremont by the Flintkote Co. (Blue Diamond Division), and at Santa Fe Springs by U.S. Gypsum Co. These plants were scheduled for completion late in 1965. Initial sources of crude gypsum for the three plants will be Mexico for National Gypsum, Nevada for Flintkote, and Imperial County for U.S. Gypsum.

Iodine.—Crude iodine was extracted from waste oil brines of the Los Angeles basin (Los Angeles and Orange Counties) in the Seal Beach plant of Dow Chemical Co. Some of the iodine was consumed in making the iodides of potassium and titanium. Output of crude was down 16 percent from that of 1963, but production of iodine compounds rose 22 percent, reducing stocks appreciably.

At Compton, Los Angeles County, Deepwater Chemical Co. purchased foreign crude iodine and produced iodides of potassium and silver and iodates of potassium and calcium. The company also resublimed some crude iodine for resale.

Lime.—A record 576,868 tons of lime and dead-burned dolomite was sold or used in 1964. Producers sold more than 160,000 tons to California, out-of-State, and foreign customers, and used nearly 417,000 tons at their respective plants. Consumers in California also purchased over 210,000 tons from producers in Arizona, Missouri, Nevada, Ohio, and Utah. Of the California-produced lime, 491,000 tons (up 15 percent from 1963) was consumed for chemical and industrial uses. Included was more than 201,000 tons used in sugar refining (up 25 percent). Sales for construction uses, principally for soil stabilization, were more than double the 1963 volume.

Chas. Pfizer & Co., Inc. virtually completed its multimillion dollar expansion program at its Lucerne Valley lime plant, San Bernardino County. In September a fluidized-bed pilot kiln, in operation for several years, was replaced with a full-scale kiln of advanced design.

Lithium Compounds.—American Potash & Chemical Corp. recovered lithium in the form of dilithium sodium phosphate from the brines of Searles Lake in its Trona plant, San Bernardino County. The company converted the phosphate to a lithium carbonate which was sold as a source for lithium oxide. Production and sales were slightly above the 1963 figures.

Magnesium Compounds.—Production and producer consumption of all magnesia grades, except U.S.P. and technical, were higher than in 1963. Sales in all categories were higher. Plants in Alameda and San Diego Counties were operated by FMC Corp. to extract magnesium hydroxide and magnesium chloride, respectively, from salt-works bitterns. Magnesia was recovered by Kaiser Aluminum and Chemical Corp. in a Monterey County plant and by Merck & Co., Inc., in a San Mateo County facility. Kaiser used most of its output in the manufacture of refractories, used chiefly in the Fontana plant of Kaiser Steel Corp.

Mica.—Crude mica (sericite schist) was mined and ground by Western Non-Metallics near Ogilby, Imperial County, for use in the manufacture of roofing materials. Sunshine Mica Co. dry-ground scrap mica at Los Nietos, Los Angeles County, using crude mica shipped from South Dakota and imported from India. The plant product was consumed principally in the manufacture of paint and roofing materials.

A flotation plant was being built in Mariposa County during 1964 to produce a commercial grade mica from micaceous schist deposits in the county. The plant was expected to be operational in 1965.

Perlite.—Crude perlite production was essentially the same as in 1963, but the tonnage sold and used rose 17 percent. Most of the output was

mined by American Perlite Co. at its Fish Springs quarry near Zurich, Inyo County, and shipped to expanding plants in Fresno and Los Angeles Counties. Perlite Rock Co. expanded crude perlite from its Alvo mine, Napa County, in its St. Helena plant for company use in various construction products.

A total of 14 perlite expanding plants operated in 6 counties; 9 were in Los Angeles County. Sales of expanded products declined 26 percent from 1963. About 47 percent of the expanded output was used as plaster aggregate, 25 percent for filter aids, 4 percent as loose-fill insulation, 6 percent in soil conditioners, 4 percent for lightweight concrete aggregate, 3 percent in paint products, and 11 percent for all other uses.

Potassium Salts.—Potassium compounds were produced by American Potash & Chemical Corp. at Trona, San Bernardino County. The company extracted potassium chloride from Searles Lake brines and converted part of the output to potassium sulfate. Production and sales of both products were substantially above the 1963 figures. Both domestic and foreign consumers used most of the compounds either for direct application to soils or in the manufacture of fertilizers. Exports were higher than in 1963.

Pumice.—Combined output of pumice, pumicite, and volcanic cinder dipped 4 percent below that in 1963. Although advances were reported in the use of these materials as concrete admixture and in road construction, major declines occurred for such uses as cleansing compounds (off over 70 percent) and railroad ballast (down 90 percent). The combined tonnage of pumice and pumicite shipped to customers was 27 percent lower than in 1963 and totaled less than one-fifth the volcanic cinder tonnage.

About 88 percent of the total was used in road construction, as concrete aggregate, railroad ballast, and fill; 7 percent for soil conditioning, roofing granules, cleansing compounds, and filler; and 5 percent for decorative purposes (landscaping, etc.). Only 38 percent of the combined output was crushed, screened, and/or ground before shipment.

TABLE 10.—Pumice [1] sold or used by producers in 1964, by counties

County	Crude		Prepared		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Amador	389	$389			389	$389
Kern	W	W	2,284	$41,642	2,284	41,642
Lake	13,533	16,009	W	W	13,533	16,009
Lassen	21,746	43,492	W	W	21,746	43,492
Madera	1,000	2,890	W	W	1,000	2,890
Modoc	77,388	90,388	W	W	77,388	90,388
Mono	214	214	14,373	875,050	14,587	875,264
Napa	800	1,519			800	1,519
San Bernardino			39,179	103,463	39,179	103,463
Shasta	26,749	60,119			26,749	60,119
Siskiyou	122,862	167,308	19,871	59,953	142,733	227,261
Tehama	6,000	6,000			6,000	6,000
Other counties [2]	5,466	10,718	91,190	457,586	96,656	468,304
Total	276,147	399,046	166,897	1,537,694	443,044	1,936,740

W Withheld to avoid disclosing individual company confidential data.
[1] Includes pumicite and volcanic cinder.
[2] Includes Inyo County and counties indicated by symbol W.

Salt.—Seven companies produced crude salt by solar evaporation at 10 plants in 8 counties. A high percentage of the output was recovered from sea water at salt ponds in three San Francisco Bay area counties. In Alameda County, Leslie Salt Co. produced all grades of salt, including crude, kiln-dried, and vacuum refined. Morton Salt Co. refined crude salt in an adjacent plant. All other plants produced only crude salt, although the Kern County plant had equipment for producing kiln-dried salt. Some rock salt was quarried at Bristol Lake near Amboy, by the Leslie company.

Salt was shipped to all Western States (including Alaska and Hawaii) except New Mexico, to four Midwestern States, and exported to Canada, the Far East, Central America, and the South Pacific islands. The salt was marketed for a wide variety of uses, but the chemical, food processing, and water softening industries were the major consumers.

Sand and Gravel.—Production of sand and gravel reached a record high of nearly 113 million tons, 13 percent of the Nation's entire output, and a gain of 800,000 tons over that of 1963. The output for paving rose 3 percent accounting for the overall gain; output for structural use declined 3 percent. Production from deposits in northern California rose 1.5 million tons; output in southern California declined 500,000 tons. Los Angeles County deposits yielded 26 million tons, more than 23 percent of the State total. Production exceeded 5 million tons in five other counties—Alameda, Orange, Sacramento, San Bernardino, and San Diego.

Of the 365 sand and gravel operations classified as commercial, 22 produced over 1 million tons each, 35 were in the 500,000 to 1 million ton range, 110 produced between 100,000 and 500,000 tons, and 198 had output of less than 100,000 tons each.

Production of ground and unground industrial sands increased 32 percent over that in 1963, with glass sand showing the greatest rise. Oil Hydrafac, filler, and blast sand uses showed lesser gains.

TABLE 11.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Sand		Gravel		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1955–59 (average)	30,754	$34,555	49,724	$56,370	80,478	$90,925
1960	36,524	46,000	51,155	61,503	87,679	107,503
1961	42,379	51,080	67,802	73,031	110,181	124,111
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

TABLE 12.—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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	720	$3,494	833	$3,924
Molding	39	179	57	271
Building	22,825	25,615	21,994	24,542
Paving	11,864	12,200	11,896	12,799
Blast	r 210	r 681	260	954
Engine	47	140	56	163
Filter	22	92	29	101
Other	r 4,299	r 3,850	4,422	3,970
Total	40,026	46,251	39,547	46,724
Gravel:				
Building	25,574	30,639	26,371	31,395
Paving	24,789	29,702	26,927	31,258
Railroad Ballast	484	499	170	193
Other	2,960	2,965	3,856	3,767
Total	53,807	63,805	57,324	66,613
Total sand and gravel	93,833	110,056	96,871	113,337
Government-and-contractor operations: [1]				
Sand:				
Building	200	220	197	285
Paving	r 6,978	6,715	5,000	5,854
Fill	623	468	549	441
Other	4	4	4	5
Total	r 7,805	7,407	5,750	6,585
Gravel:				
Building	r 2,056	2,073	491	599
Paving	7,570	7,812	8,705	7,818
Fill	832	666	1,054	881
Other	89	164	124	113
Total	r 10,547	10,715	10,374	9,411
Total sand and gravel	18,352	18,122	16,124	15,996
All operations:				
Sand	47,831	53,658	45,297	53,309
Gravel	64,354	74,520	67,698	76,024
Total	112,185	128,178	112,995	129,333

r Revised.
[1] Includes figures for State, counties, municipalities, and other Government agencies

TABLE 13.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	10,094	$11,844	Plumas	99	$91
Alpine	29	34	Riverside	2,382	4,186
Butte	1,532	1,756	Sacramento	5,293	6,748
Colusa	188	202	San Benito	367	470
Contra Costa	281	290	San Bernardino	8,764	8,548
Del Norte	400	356	San Diego	5,032	8,868
El Dorado	142	299	San Joaquin	3,216	3,796
Fresno	4,095	4,888	San Luis Obispo	1,159	1,951
Glenn	349	374	San Mateo	193	175
Humboldt	1,557	1,664	Santa Barbara	1,001	1,080
Imperial	927	940	Santa Clara	2,961	2,595
Inyo	128	154	Santa Cruz	1,139	1,229
Kern	1,770	2,406	Shasta	1,785	1,229
Kings	195	195	Sierra	19	16
Lake	360	511	Siskiyou	481	529
Lassen	234	255	Solano	132	161
Los Angeles	26,245	25,498	Sonoma	2,947	3,648
Madera	1,252	1,535	Stanislaus	1,366	1,458
Mariposa	36	58	Sutter	130	88
Mendocino	777	1,188	Tehama	688	670
Merced	2,546	2,932	Trinity	13	24
Modoc	258	265	Tuolumne	9	9
Mono	50	41	Ventura	3,904	3,913
Monterey	1,006	2,042	Yolo	1,685	2,194
Napa	131	183	Yuba	1,001	1,228
Nevada	1,443	1,807	Other counties [1]	1,940	3,673
Orange	7,966	7,617			
Placer	1,298	1,422	Total	112,995	129,333

[1] Includes Amador, Calaveras, Marin, San Francisco, and Tulare Counties, combined to avoid disclosing individual company confidential data.

Sodium Compounds.—Production and sales of sodium compounds rose substantially above 1963 figures. Only one compound, sodium sesquicarbonate, was reported at a lower output. Salt cake (sodium sulfate) recorded the greatest rise, 38 percent higher than in 1963. Pittsburgh Plate Glass Co. produced the carbonate and sesquicarbonate from Owens Lake brines, Inyo County; American Potash & Chemical Corp. and Stauffer Chemical Co. both produced the carbonate and sulfate from Searles Lake brines, San Bernardino County; and U.S. Borax & Chemical Corp. produced anhydrous sodium sulfate in its Wilmington refinery, Los Angeles County, from borates mined by the company in Kern County. Stauffer also recovered byproduct sodium sulfate from purchased Kern County borates in its San Francisco plant. About midyear the company stated it intended to increase its salt cake producing facility at Searles Lake by early 1966.

Stone.—Public works facilities under construction helped boost stone production to a record 45.8 million tons. More than 26 percent of the total was riprap quarried for water resource projects in Merced, Nevada, and Placer Counties, and at Catalina Island for marinas, breakwater, and piers on the mainland. Operators of basalt, granite, and miscellaneous stone quarries produced appreciably larger tonnages for concrete and roadstone than in 1963. Limestone production was up because of increased demand at cement plants. Completion of road and flood control projects in Santa Barbara County accounted for a 300,000-ton decline in sandstone output. More marble was quarried for terrazzo. Slate production increased for flagging but declined for roofing granules because of the availability of other materials, including crushed ceramic rejects.

A lower output of dimension stone coincided with the lag in building construction. Producers of granitic monumental stone reported severe competition from out-of-State and foreign sources. Natural and artificially colored roofing granules production was down 7 percent from 1963.

Russell Benedict mined chlorite schist at the New Frontier property near Needles, San Bernardino County, for use as an ingredient in stucco.

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

Use	1963		1964	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble---short tons	139,461	$1,268,071	79,901	$826,193
Rough architectural---cubic feet	183,542	1,146,045	104,928	924,276
Approximate equivalent in---short tons	15,013		8,745	
Monuments and mausoleums---cubic feet	59,260	440,000	39,871	371,500
Approximate equivalent in---short tons	4,940		3,336	
Flagging---cubic feet	26,253	66,083	27,611	53,221
Approximate equivalent in---short tons	2,219		2,351	
Total dimension stone approximate, in short tons	161,633	2,920,199	94,333	2,175,190
Crushed and broken stone:				
Riprap---short tons	2,285,809	4,700,367	12,130,652	14,424,676
Metallurgical---do	W	W	W	W
Concrete and roadstone---do	14,191,863	18,348,016	15,510,319	19,321,432
Railroad ballast---do	W	W	W	W
Agricultural---do	W	W	19,342	132,375
Chemical---do	34,276	307,482	W	W
Miscellaneous [1]---do	[2] 21,303,459	[2] 31,976,980	[3] 18,049,958	[3] 27,512,207
Total crushed and broken stone---do	37,815,407	55,332,845	45,710,271	61,390,690
Grand total approximate, in short tons	37,977,040	58,253,044	45,804,604	63,565,880

W Withheld to avoid disclosing individual company confidential data.

[1] Includes whiting substitute, filler, mineral food, poultry grit, stucco, roofing granules, filter beds, terrazzo, miscellaneous, and uses indicated by symbol W.

[2] Includes 12,572,059 tons of limestone and oystershell used in cement valued at $11,553,145 and 679,187 tons of limestone used in lime valued at $2,027,035.

[3] Includes 12,989,143 tons of limestone and oystershell used in cement valued at $12,193,577 and 668,183 tons of limestone used in lime valued at $2,032,335.

TABLE 15.—Stone [1] production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	3,161	$2,416	Riverside	1,720	$3,626
Amador	69	86	Sacramento	18	95
Butte	3	2	San Benito	W	W
Calaveras	W	W	San Bernardino	6,242	8,635
Contra Costa	3,088	5,114	San Diego	1,276	2,086
Del Norte	55	61	San Joaquin	(2)	1
El Dorado	517	1,797	San Luis Obispo	303	1,553
Fresno	19	121	San Mateo	1,697	2,443
Humboldt	221	282	Santa Barbara	76	297
Imperial	25	24	Santa Clara	5,218	3,960
Inyo	136	727	Santa Cruz	1,193	1,616
Kern	2,426	2,888	Shasta	320	458
Lake	1	2	Sierra	71	80
Lassen	51	37	Siskiyou	95	87
Los Angeles	2,268	4,169	Solano	107	179
Madera	W	W	Sonoma	360	520
Marin	W	W	Tehama	32	127
Mariposa	2	23	Trinity	33	17
Mendocino	71	111	Tulare	15	83
Merced	6,871	6,873	Tuolumne	180	1,123
Monterey	W	W	Ventura	471	845
Napa	W	W	Yuba	77	115
Nevada	704	570	Other counties	4,863	8,832
Placer	1,750	1,485			
Plumas	(2)	(2)	Total	45,805	63,566

W Withheld to avoid disclosing individual company confidential data. Included with "Other counties."
[1] Includes stone used in cement and lime.
[2] Less than ½ unit.

TABLE 16.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Granite		Basalt and related rocks (traprock)		Limestone [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1960	4,208	$5,409	1,941	$2,748	15,054	$23,311
1961	4,867	7,233	1,880	2,225	16,669	23,989
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

Year	Sandstone		Other stone [2]		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1960	3,541	$5,626	8,331	$12,748	33,075	$49,842
1961	3,286	5,222	7,148	11,658	33,850	50,327
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

[1] Includes limestone and oystershell used in cement and lime as follows (in thousand short tons and thousand dollars): 1960, 12,605 tons, $16,645; 1961, 12,778 tons, $15,312; 1962, 12,799 tons, $15,393; 1963, 13,242 tons, $13,580; 1964, 13,657 tons, $14,226.
[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.

Sulfur.—Six plants, all using a modified Klaus process, recovered elemental sulfur from sour-natural and refinery gases as a byproduct of petroleum refining—two in Contra Costa County, three in Los Angeles County, and one in San Luis Obispo County. Production and shipments rose 5 and 18 percent, respectively, above 1963.

American Mineral Resources Development Co. mined sulfur ore at the S Bar S mine, Lake County, and shipped it for use as a soil aid. All other sulfur deposits were idle throughout the year.

Talc, Soapstone, and Pyrophyllite.—Combined production exceeded the 1963 figure by 10 percent, shipments to grinders rose nearly 2 percent, and consumer receipts from mines jumped 370 percent. Overall consumption was up nearly 6 percent with only the ceramic industry reporting a decline among the major consuming industries. Exports (all talc) increased 220 tons.

During the year Cyprus Mines Corp. purchased the controlling interest in Sierra Talc Co. which will be operated as a division within the Cyprus organization.

Diopside (calcium-magnesium silicate) produced in Arizona found a limited market in southern California. A Victorville, San Bernardino County, plant processed the mineral and marketed the minus 200-mesh material for ceramic uses. At least one tile company found that diopside imparts desirable properties to ceramic tile, replacing talc in the mix.

Water.—Thermal Power Co. drilled six steam wells in the Sulphur Bank area near The Big Geysers area, Sonoma County. As a result, steam flow increased to a total of 1.2 million pounds an hour equal to 60,000 kilowatt hours of energy. The Little Geysers area, to the east, was proven by two wells located 1,200 feet apart that were successfully completed in 1964. Pacific Gas & Electric Co. completed a feasibility study and announced plans for a third steam-electric unit in the Geysers-Sulphur Bank area with construction to start in March 1965. The proposed addition will double the capacity of the present facility.

In June, Western Geothermal, Inc., a Natomas Co. subsidiary, drilled a second geothermal well in the Salton Sea area, Imperial County, materially extending the proven productive area. Brines from the wells in the area were under study as sources for both geothermal power and minerals. Earth Energy, Inc., a subsidiary of Pure Oil Co., constructed a pilot plant for that purpose. The brines contain 25 to 35 percent dissolved solids, including a relatively high potassium content and large proportions of sodium and calcium chlorides.

Also in June, the Office of Saline Water awarded a contract to Fluor Corp. for design and specifications for a water conversion demonstration plant, using a multistage-multieffect (MSM) flash distillation process. The plant will be erected on Point Loma, near San Diego, to replace the plant that was dismantled and shipped to Guantanamo, Cuba, early in 1964. About mid-December, Secretary of the Interior Stewart L. Udall announced the signing of a feasibility study sponsored jointly by the Metropolitan Water District (MWD) of southern California, the Department of the Interior, and the Atomic Energy Commission (AEC) for a dual-purpose electric-power and desalting plant capable of producing up to 150 million gallons of pure water

daily. A $50,000 contract was awarded to Ralph M. Parsons Co. of Los Angeles for conceptual design studies for a 50 million gallon a day water and power plant.

Other Nonmetals.—Chas. Pfizer & Co., Inc. (C. K. Williams Division) produced manufactured and natural iron oxide pigments in a plant at Emeryville, Alameda County, the State's only facility. Output was slightly above that in 1963, with increases reported for most manufactured products and declines for most natural oxides.

Phosphate rock was shipped from mines in Idaho and Wyoming to California producers of chemicals and fertilizers. Best Fertilizer Co. began processing phosphate rock in a new plant near Lathrop, San Joaquin County, and received the first shipments of Florida pebble phosphate in April. The phosphate was back-hauled on a converted C–2 tanker that carried rice from Sacramento to Puerto Rico. Exploration of a low-grade phosphate rock deposit in the Paso Robles-San Luis Obispo-Cuyama Valley area indicated ore ranging on the order of 5 to 7 percent P_2O_5. Several companies had claims in the area.

Mountain Copper Co. made an intercompany shipment of a few tons of pyrite from the mine stockpile. The company mine had been idle since 1962.

Blast furnace slag from the furnaces of Kaiser Steel Corp. at Fontana was prepared for use as lightweight aggregate, roofing granules, railroad ballast, sewage filter medium, filler in fertilizers, paving material, fill, and mineral-wool insulation.

Crude vermiculite from Montana was exfoliated by the producer at plants in Sacramento and Los Angeles Counties. Some South African crude vermiculite was imported by another company and exfoliated in an Orange County plant. The plant products were used in acoustical and thermal insulation, as aggregate in plaster and concrete, and as a soil conditioner. Sales were higher in nearly all categories.

Wollastonite float was collected by two operators in Riverside County and sold to landscape architects and building contractors.

METALS

Copper.—The only active copper property was the Lucky John mine in the Whipple Mountain area, San Bernardino County, where a small tonnage of ore was mined and shipped to an Arizona copper smelter. Copper output was primarily a byproduct of tungsten at the Pine Creek mine, Inyo County, and from underground leaching operations at the Iron Mountain mine, Shasta County. Old tailings were shipped from the Consumnes Copper property near Fair Play, El Dorado County, to the smelter at Tacoma, Wash., for recovery of copper, silver, and gold. Recoverable copper was contained in shipments of lead-zinc ore from the Santa Rosa mine, Inyo County; silver ores from the Zaca mine, Alpine County, and the Silver Springs prospect, Riverside County; and lead ore from the September mine, San Bernardino County.

American Exploration & Mining Co. reported that its preliminary exploration at the Engels-Superior copper area, Plumas County, was

successful and that further work was planned. The Eagle-Picher Co. completed its exploration at the Copper Bluff mine, Humboldt County, and abandoned the project before yearend. Shasta Minerals & Chemical Co. reported encouraging results from a rotary drilling program in the Shasta copper area. About 4,000 feet was drilled with hole depths up to 320 feet. The Early Bird ore body was extended, demonstrating a width of more than 150 feet and a thickness of nearly 50 feet. Preliminary assays ran as high as 6.5 percent copper, 1.5 percent zinc, and 0.8 ounce of silver.

Gold.—Gold production declined 18 percent for the second consecutive year. Despite a 20-percent drop in placer output, gold from placers represented 93 percent of the total. One bucketline dredging operation (3 dredges, 1 less than in 1963), 1 dragline excavating and sluicing operation, 18 nonfloating washing plants, and 3 suction dredges recovered 97 percent of the placer gold. All but two of the nonfloat plants were sand and gravel preparation plants where placer gold was recovered as a byproduct. Placer gold recovery was also reported from 1 hydraulic operation, 1 drift mine, and 30 small hand-panning and sluicing operations.

Lode gold output rose 32 percent although there were six fewer operating mines than in 1963. The Original 16 to 1 mine, idle in 1963, was Sierra County's largest producer. Ores of only six mines yielded more than 100 ounces of gold, each—one silver (Zaca, Alpine County), one tungsten (Pine Creek, Inyo County), and four gold (Original 16 to 1 and Brush Creek, Sierra County; Kelly, Trinity County; and Red Banks, Mariposa County). However, these six mines accounted for 92 percent of all lode gold recovered.

Iron Ore.—Production of usable iron ore rose 32 percent above that in 1963. Shipments to domestic consumers were up 42 percent, and exports to Japan increased 7 percent. As in preceding years, the Kaiser Steel Corp. Eagle Mountain mine, Riverside County, yielded most of the State's output. In San Bernardino County, American Exploration & Mining Co. increased production considerably from its Iron Age mine, and Kaiser Steel worked its Silver Lake mine, shipped about half the output for its own use, and stockpiled the remainder. The Mountain Copper Co. Iron Mountain mine, Shasta County, was idle, but shipments were made from stockpile to a domestic steel plant. Kaiser and American Exploration produced and shipped concentrates; all other shipments were direct shipping grades.

Construction began on a new pelletizing plant at Eagle Mountain, and the first shipments of the plant products were scheduled for August 1965. National Metal & Steel Corp. announced it would operate a new bulk-loading facility to be built in the Los Angeles outer harbor to handle iron ore pellets. The proposed capacity will be a minimum of 800,000 long tons annually that will be shipped by Kaiser to Japanese steel plants.

Lead.—Except for a small quantity of recoverable lead contained in silver ore mined in Alpine County and a carlot of lead ore shipped from the Morengo mine in San Bernardino County, production of lead came from one lead-zinc mine (Santa Rosa) and two lead mines (Jubilee and Bunker Hill) in Inyo County. However, total lead recovered was nearly 88 percent above that in 1963.

TABLE 17.—Mine production of gold, silver, copper, lead and zinc in 1964, 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
Amador	1	2	172	$6,020	30	$38
Butte	1	(2)	59	2,065	14	18
Calaveras	1	(2)	9	315	1	1
El Dorado	----------	(2)	24	840	27	35
Fresno	----------	1	269	9,415	36	46
Imperial	1	----------	3	105	1	1
Inyo	3	----------	W	W	153,812	198,879
Kern	3	----------	23	805	12	16
Los Angeles	----------	(2)	155	5,425	21	27
Madera	----------	(2)	23	805	4	5
Merced	----------	(2)	68	2,380	6	8
Nevada	1	9	268	9,380	26	34
Placer	1	5	174	6,090	20	26
Plumas	----------	2	23	805	2	3
Riverside	3	----------	1	35	70	91
San Bernardino	7	(2)	87	3,045	490	633
Shasta	3	(2)	89	3,115	11	14
Sierra	5	9	4,369	152,915	731	945
Siskiyou	3	1	579	20,265	94	122
Trinity	3	5	604	21,140	114	147
Tuolumne	2	(2)	69	2,415	7	10
Yuba	----------	4	62,634	2,192,190	3,292	4,257
Undistributed[3]	6	1	1,326	46,410	12,800	16,550
Total	44	39	71,028	2,485,980	171,621	221,906

	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Amador	----------	----------	----------	----------	----------	----------	$6,058
Butte	----------	----------	----------	----------	----------	----------	2,083
Calaveras	----------	----------	----------	----------	----------	----------	316
El Dorado	W	W	----------	----------	----------	----------	875
Fresno	----------	----------	----------	----------	----------	----------	9,461
Imperial	----------	----------	----------	----------	----------	----------	106
Inyo	W	W	3,085,500	$404,200	W	W	603,079
Kern	----------	----------	----------	----------	----------	----------	821
Los Angeles	----------	----------	----------	----------	----------	----------	5,452
Madera	----------	----------	----------	----------	----------	----------	810
Merced	----------	----------	----------	----------	----------	----------	2,388
Nevada	----------	----------	----------	----------	----------	----------	9,414
Placer	----------	----------	----------	----------	----------	----------	6,116
Plumas	----------	----------	----------	----------	----------	----------	808
Riverside	W	W	----------	----------	----------	----------	126
San Bernardino	W	W	W	W	W	W	3,678
Shasta	W	W	----------	----------	----------	----------	3,129
Sierra	----------	----------	----------	----------	----------	----------	153,860
Siskiyou	----------	----------	----------	----------	----------	----------	20,387
Trinity	----------	----------	----------	----------	----------	----------	21,287
Tuolumne	----------	----------	----------	----------	----------	----------	2,425
Yuba	----------	----------	----------	----------	----------	----------	2,196,447
Undistributed[3]	2,070,000	$674,820	6,500	852	286,000	$38,896	777,528
Total	2,070,000	674,820	3,092,000	405,052	286,000	38,896	3,826,654

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 Alpine, Mariposa, Sacramento, and Stanislaus Counties and counties indicated by symbol W.

TABLE 18.—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:						
1955–59 (average)	3	9	32,050	125,915	$4,407,018	$0.138
1960	2	5	21,020	89,562	3,134,670	.149
1961	2	5	23,651	82,316	2,881,060	.122
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
Dragline dredges: [3]						
1955–59 (average)	6	6	185	818	28,637	.155
1960	13	14	111	1,081	37,835	.340
1961	3	3	493	309	10,815	.022
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
Suction dredges:						
1955–59 (average)	2	2	7	31	1,085	.155
1960	2	2	(4)	5	175	.583
1961	5	5	64	22	770	.012
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
Nonfloating washing plants: [3 5]						
1955–59 (average)	9	17	19	1,422	49,777	2.620
1960	2	6	8	365	12,775	.376
1961	6	9	340	557	19,495	.039
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
Gravel hydraulically handled:						
1955–59 (average)	6	----------	29	126	4,424	.153
1960	4	----------	1	11	385	.396
1961	2	----------	2	3	105	.050
1962	4	----------	21	85	2,975	.141
1963	4	----------	13	100	3,500	.279
1964	1	----------	2	73	2,555	1.278
Small-scale hand method: [6]						
1955–59 (average)	29	----------	58	1,163	40,719	.702
1960 [7]	26	----------	59	1,111	38,885	.617
1961	27	----------	119	1,105	38,675	.324
1962	14	----------	266	661	23,135	.087
1963	51	----------	54	2,612	91,420	1.701
1964	30	----------	54	1,420	49,700	.918
Underground placers: Drift:						
1955–59 (average)	8	----------	2	92	3,234	1.348
1960	1	----------	1	44	1,540	1.750
1961	3	----------	2	55	1,925	1.250
1962	1	----------	1	5	175	.170
1963	7	----------	4	202	7,070	1.656
1964	1	----------	16	163	5,705	.352
Grand total placers:						
1955–59 (average)	63	----------	32,350	129,567	4,534,894	.139
1960	50	----------	21,201	92,179	3,226,265	.152
1961	48	----------	r 24,671	84,367	2,952,845	.119
1962	37	----------	r 18,494	95,918	3,357,130	.182
1963	79	----------	r 13,157	82,998	2,904,930	.221
1964	39	----------	11,821	65,938	2,307,830	.195
1848–1964	----------	----------	NA	68,292,491	1,525,974,831	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 operations 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 19.—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)
1955–59 (average)	109	63	214	189,419	$6,630	555,136	$502
1960	83	50	157	123,713	4,330	179,780	163
1961	79	48	46	97,644	3,418	93,351	86
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
1848–1964	------	------	NA	106,066,458	2,414,429	119,478,385	97,499

Year	Copper		Lead		Zinc		Total value (thousand dollars)
	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	
1955–59 (average)	766	$511	4,277	$1,291	3,597	$921	$9,855
1960	1,087	698	440	103	465	120	5,414
1961	1,382	829	103	21	304	70	4,424
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
1848–1964	641,883	210,343	266,245	53,029	150,819	35,608	2,810,908

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 20.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	4,372	842	----------	----------	----------
Concentration and smelting of concentrates: Ore [2]	317	70,640	1,698,000	4,400	900
Direct smelting: Ore, tailings and copper precipitates [3]	401	96,503	372,000	3,087,600	285,100
Placer	65,938	3,636	----------	----------	----------
Grand total	71,028	171,621	2,070,000	3,092,000	286,000

[1] Includes gold recovered as "natural gold."
[2] Includes tungsten-ore concentrate.
[3] Combined to avoid disclosing individual company confidential data.

TABLE 21.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	9,753	4,532	908	100		
Silver	7	580	355	12,934	600	2,400	2,500
Copper and tungsten ore	1	[2] 93	140	68,144	2,058,900		
Lead	3	1,999	13	40,561		2,155,600	2,700
Lead-zinc	1	3,600	49	45,413	9,700	934,000	280,800
Total	43	16,025	5,089	167,960	2,069,300	3,092,000	286,000
Other lode material: Old tailings	[3]	19	1	25	700		
Total lode material	43	16,044	5,090	167,985	2,070,000	3,092,000	286,000
Placer	39	[4]	65,938	3,636			
Total all sources	82	16,044	71,028	171,621	2,070,000	3,092,000	286,000

[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] 11,790,088 cubic yards. Does not include material washed at commercial gravel plants to produce 1,148 ounces of byproduct gold and 117 ounces of byproduct silver included in placer totals.

Mercury.—Despite increased interest in exploration and development at mercury mines and prospects, production of the metal dropped more than 3,000 flasks from the 1963 figure. A much higher average unit price permitted lower grade ores to be processed and about 57 percent more material was treated than in 1963. Production was reported from 52 properties, 11 more than in 1963, but only 7 mines yielded more than 100 flasks each. These seven mines accounted for 97 percent of the total output. The major producing mines were New Idria, San Benito County; Buena Vista, San Luis Obispo County; and New Almaden, Santa Clara County. Production from the latter was the combined effort of 10 lessees with San Jose Mining Co. having by far the greatest output.

The Abbott mercury mine, Lake County, was purchased by Melvin H. Lord of Sacramento and will be operated as Mercury Mines.

TABLE 22.—Mercury production, by methods of recovery

Year	Operating mines	Recovery method					Total	
		Furnaced [1]		Retorted		Unclassified		
		Ore treated (short tons)	76-pound flasks	Ore treated (short tons)	76-pound flasks	76-pound flasks [2]	76-pound flasks	Value [3]
1955–59 (average)	52	110,501	13,075	9,721	1,628	270	14,973	$3,660,325
1960	41	120,714	17,862	4,334	785	117	18,764	3,954,701
1961	36	118,264	17,776	2,431	883	29	18,688	3,692,936
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	3,239,504

[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.

Molybdenum.—Molybdenite and powellite were recovered by Union Carbide Nuclear Co. as byproducts in the treatment of tungsten ores from the Pine Creek mine, Inyo County. Production of the two minerals (combined) rose nearly 19 percent and shipments were up 16 percent from 1963. All the powellite was consigned to domestic consumers, but most of the molybdenite was exported.

Pig Iron, Sinter, and Ferrous Scrap.—All the State's pig iron was produced in blast furnaces at the integrated steel plant of Kaiser Steel Corp., Fontana, San Bernardino County. The furnaces consumed 45 percent more agglomerated iron ore (sinter) in producing 24 percent more pig iron than in 1963. Production distribution of pig iron by class was 95 percent basic and 5 percent direct casting. No foundry pig was produced in 1964, although a minor tonnage was sold from stock. Total pig iron consumption rose 19 percent. Kaiser furnaces consumed 82 percent more sinter, 20 percent more pig iron (hot metal), and 21 percent more home and purchased ferrous scrap. Only one other steel producer, United States Steel Corp. at Torrance, Los Angeles County, used pig iron in addition to scrap. All other steel furnaces, in both the San Francisco Bay and Los Angeles areas, operated on ferrous scrap alone. Overall iron and steel scrap consumption was up nearly 7 percent. Use at steel furnaces increased 8 percent and that at iron furnaces 6 percent.

TABLE 23.—Ferrous scrap and pig iron consumption

(Thousand short tons)

Year	Ferrous scrap	Pig iron	Year	Ferrous scrap	Pig iron
1955–59 (average)	2,526	1,350	1962	2,248	1,818
1960	2,054	1,650	1963	2,415	1,891
1961	2,250	2,192	1964	2,575	2,250

TABLE 24.—Ferrous scrap and pig iron consumption by types of furnaces and miscellaneous uses

(Thousand short tons)

Ferrous scrap and pig iron charged to—	1963	1964	Ferrous scrap and pig iron charged to—	1963	1964
Steel furnaces: [1]			Miscellaneous uses: [3] Scrap	41	21
Scrap	2,019	2,178			
Pig iron	1,710	2,049	Total scrap	2,415	2,575
			Total pig iron	1,891	2,250
Total	3,729	4,227			
			Grand total	4,306	4,825
Iron furnaces: [2]					
Scrap	355	376			
Pig iron	181	201			
Total	536	577			

[1] Includes open hearth, electric furnace, and basic oxygen process.
[2] Includes cupola, and air; also direct castings.
[3] Includes rerolling, copper precipitation, nonferrous, and chemical uses.

Platinum.—Yuba Consolidated Gold Fields recovered byproduct platinum-group metals using a bucketline dredge to work stream gravels and ancient riverbeds for placer gold along the Yuba River at

Hammonton, Yuba County. Recovery declined to 82 ounces from a reported 124 ounces in 1963. This was the only reported recovery of platinum in California.

Rare-Earth Minerals.—Shipments of rare-earth mineral products from the Mountain Pass mine, San Bernardino County, were double those in 1963 and approximated 3 million pounds of rare earth oxides. Principal uses for which the products were sold were in glass, petroleum catalysts, ductile iron, steel, lighter flints, and color television tubes. The use of europium (one of the rare-earth elements) as an ingredient in phosphor coatings applied to color television tubes, a recent development, resulted in brighter, truer colors and improved picture quality. Molycorp developed a new process to extract europium oxide from the rare-earth mineral concentrates and operated a pilot plant at the mine to prove the process. Consumer acceptance of the high-purity europium oxide prompted construction of a new plant facility scheduled for completion in June 1965. The mine, which had been operated at one-fourth to one-third capacity since 1955, was to be operated at full capacity upon completion of the europium oxide plant.

Silver.—Ores from four lode mines—one silver (Zaca) in Alpine County; one tungsten (Pine Creek), one lead-zinc (Santa Rosa), and one lead (Jubilee) in Inyo County—yielded 99 percent of the recoverable lode silver and 97 percent of all silver recovered in 1964. Lode silver production rose nearly 11 percent despite closure of the Defense lead mine, Inyo County, whereas placer silver (coproduct recovery in placer gold mining) dropped 25 percent below that in 1963.

The Red Gap claims, Alpine County, were being explored for silver by Claude B. Lovestedt, operator of the Zaca mine. The Rainbow claims, San Bernardino County, were being explored for silver by Resources Americas Corp. & Associates.

Tin.—Tin concentrate produced and shipped from the Meeke-Hogan mine, Kern County, was five times greater than the 1963 figure. Installation of a gravity concentration plant improved the grade appreciably. As a result, the per ton value of the shipments rose $1,314. All shipments were consigned to a New York broker for export.

Tungsten.—The Pine Creek mine, Inyo County, of Union Carbide Nuclear Co. was the only active tungsten property in California. Union Carbide also purchased tungsten concentrates from producers and former producers in California, Idaho, and Nevada, and from stocks held by a Texas company. Some of the produced and purchased concentrates were converted to ammonium paratungstate in the Pine Creek plant. The company shipped concentrates and paratungstate to customers throughout the United States and Canada. Total shipments rose nearly 63 percent above those in 1963.

The Strawberry tungsten mine and mill of New Idria Mining & Chemical Co., Madera County, was idle throughout 1964, but shipments of stockpiled concentrate were made to the Union Carbide paratungstate plant.

Uranium.—Production and shipments of uranium ore declined 51 percent from 1963; however, because of shipment of higher grade material, the drop in contained U_3O_8 was only 39 percent. Humbug Development Co. shipped from its Northeast group of claims, Riverside County, and Garn L. Moody produced from the Juniper mine,

Tuolumne County. All shipments were consigned to a Salt Lake City, Utah, processing plant.

Zinc.—Zinc production rose 42 percent above that in 1963. Virtually all of the output was credited to the Santa Rosa lead-zinc mine, Inyo County. Over 99 percent of the recoverable zinc was shipped from three mines—the Zaca silver mine in Alpine County, and the Jubilee lead, and the Santa Rosa lead-zinc mines in Inyo County.

Other Metals.—The only activity reported at any beryllium prospects was the collecting of gem beryl in San Diego County. All chromite and manganese mines were idle throughout the year.

E. I. du Pont de Nemours & Co., Inc., received shipments of rutile concentrate from Australia for its titanium dioxide plant, Contra Costa County.

REVIEW BY COUNTIES

Mineral production was reported from each of California's 58 counties. However, output from eight counties—Fresno, Kern, Los Angeles, Orange, Riverside, San Bernardino, Santa Barbara, and Ventura—represented 78 percent of the total mineral value in 1964. In six of the eight leading counties mineral fuels were dominant, but in Riverside County iron ore and cement, and in San Bernardino County, cement and boron compounds were the major commodities.

TABLE 25.—Value of mineral production in California, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Alameda	$21,965,035	$21,983,423	Sand and gravel, salt, stone, magnesium compounds, lime, bromine, clays.
Alpine	130,181	63,469	Sand and gravel, silver, gold, zinc, lead, copper.
Amador	2,346,267	2,716,986	Sand and gravel, clays, coal (lignite), stone, gold, soapstone, pumicite, silver.
Butte	6,395,363	4,632,529	Natural gas, sand and gravel, gold, stone, silver.
Calaveras	20,576,319	18,439,155	Cement, asbestos, stone, clays, sand and gravel, gold, silver.
Colusa	4,802,471	4,888,677	Natural gas, sand and gravel, mercury.
Contra Costa	r 7,587,617	11,797,352	Stone, natural gas, petroleum, sand and gravel, peat, clays.
Del Norte	651,615	W	Sand and gravel, clays, stone.
El Dorado	3,112,911	2,900,370	Stone, lime, sand and gravel, soapstone, gold, copper, silver.
Fresno	r 80,661,384	78,308,961	Petroleum, natural gas, sand and gravel, asbestos, natural gas liquids, stone, clays, gold, mercury, silver.
Glenn	5,867,456	5,875,254	Natural gas, sand and gravel, lime.
Humboldt	2,845,548	2,539,122	Sand and gravel, natural gas, stone, mercury.
Imperial	3,296,101	3,261,101	Gypsum, sand and gravel, lime, clays, stone, mica (scrap), gold, silver.
Inyo	11,624,911	15,750,395	Tungsten, sodium carbonate, molybdenum, talc, stone, copper, lead, silver, pumice, and volcanic cinder, sand and gravel, perlite, boron minerals, clays, zinc, gold.
Kern	r 363,191,021	365,159,930	Petroleum, boron minerals, natural gas, cement, natural gas liquids, stone, sand and gravel, gypsum, sodium sulfate, clays, salt, tin, carbon dioxide, pumice and pumicite, gold, silver.
Kings	r 15,362,319	15,090,788	Natural gas, natural gas liquids, petroleum, sand and gravel.
Lake	443,690	724,793	Sand and gravel, volcanic cinder, clays, mercury, sulfur ore, stone.
Lassen	271,966	373,468	Sand and gravel, volcanic cinder, stone.
Los Angeles	r 271,583,842	264,718,753	Petroleum, sand and gravel, natural gas, natural gas liquids, stone, clays, iodine, gold, soapstone, silver.
Madera	1,875,591	3,395,678	Sand and gravel, stone, natural gas, tungsten, pumicite, clays, gold, silver.
Marin	2,701,934	3,433,785	Stone, sand and gravel, mercury, clays.
Mariposa	107,311	87,367	Sand and gravel, stone, gold, silver.
Mendocino	1,714,950	1,302,030	Sand and gravel, stone, mercury.
Merced	1,801,828	9,809,822	Stone, sand and gravel, gold, gypsum, silver.

See footnotes at end of table.

TABLE 25.—Value of mineral production in California, by counties—Con.

County	1963	1964	Minerals produced in 1964 in order of value
Modoc	646,418	614,277	Sand and gravel, peat, pumice and volcanic cinder.
Mono	1,065,660	970,518	Pumice and volcanic cinder, clays, sand and gravel, pyrophyllite, calcite (optical grade).
Monterey	r 28,333,706	29,120,767	Petroleum, lime, magnesium compounds, sand and gravel, stone, natural gas, feldspar, salt.
Napa	2,232,547	1,894,189	Clays, stone, salt, sand and gravel, diatomite, asbestos, mercury, perlite, pumice.
Nevada	1,901,044	2,386,654	Sand and gravel, stone, gold, silver.
Orange	r 105,605,341	105,346,940	Petroleum, natural gas, natural gas liquids, sand and gravel, clays, lime, salt, iodine, peat.
Placer	984,034	3,385,120	Stone, sand and gravel, clays, gold, silver.
Plumas	475,243	97,645	Sand and gravel, clays, gold, stone, silver.
Riverside	48,528,626	62,150,754	Iron ore, cement, sand and gravel, stone, clays, gypsum, peat, wollastonite, uranium, petroleum, copper, silver, gold.
Sacramento	22,690,931	21,143,735	Natural gas, sand and gravel, stone, clays, gold, silver.
San Benito	r 8,218,358	8,210,100	Cement, stone, mercury, petroleum, sand and gravel, asbestos, natural gas, clays.
San Bernardino	r 102,330,066	114,465,647	Cement, boron minerals, stone, sand and gravel, potassium salts, sodium carbonate, sodium sulfate, salt, iron ore, lithium minerals, rare-earths, clays, lime, talc, calcium chloride, bromine, petroleum, volcanic cinder, natural gas, copper, gold, barite, silver, lead, zinc.
San Diego	11,276,459	11,803,212	Sand and gravel, stone, magnesium compounds, salt, clays, pyrophyllite.
San Francisco	W	W	Sand and gravel.
San Joaquin	15,957,331	17,630,462	Natural gas, sand and gravel, lime, clays, stone.
San Luis Obispo	r 6,453,434	8,135,223	Petroleum, sand and gravel, stone, natural gas liquids, mercury, natural gas, gypsum, clays.
San Mateo	r 14,477,532	13,367,312	Cement, stone, magnesium compounds, salt, clays, sand and gravel, petroleum, natural gas.
Santa Barbara	r 113,580,801	120,378,076	Petroleum, diatomite, natural gas, natural gas liquids, sand and gravel, lime, stone, mercury.
Santa Clara	28,785,089	30,147,736	Cement, stone, sand and gravel, mercury, clays.
Santa Cruz	11,560,664	11,355,363	Cement, stone, sand and gravel, clays.
Shasta	6,017,746	6,729,158	Cement, sand and gravel, stone, copper, clays, volcanic cinder, barite, iron ore, gold, silver.
Sierra	305,282	249,860	Gold, stone, sand and gravel, silver.
Siskiyou	861,414	872,449	Sand and gravel, pumice and volcanic cinder, stone, gold, mercury, clays, silver.
Solano	13,655,929	13,438,850	Natural gas, stone, sand and gravel, petroleum.
Sonoma	3,455,634	4,357,159	Sand and gravel, stone, mercury, clays, natural gas.
Stanislaus	1,093,253	1,484,110	Sand and gravel, clays, gold, mercury, silver.
Sutter	11,853,047	W	Natural gas, sand and gravel, clays.
Tehama	899,718	1,132,859	Sand and gravel, natural gas, stone, volcanic cinder.
Trinity	246,800	62,022	Sand and gravel, gold, stone, silver, clays.
Tulare	r 3,864,779	2,675,976	Natural gas, sand and gravel, petroleum, stone, barite, clays.
Tuolumne	1,912,595	1,831,988	Stone, lime, uranium, sand and gravel, gold, diatomite, silver.
Ventura	r 117,893,933	106,014,408	Petroleum, natural gas, natural gas liquids, sand and gravel, clays, stone, gypsum.
Yolo	3,539,425	3,705,816	Sand and gravel, lime, natural gas.
Yuba	3,606,858	3,564,179	Gold, sand and gravel, stone, clays, platinum, silver.
Undistributed [1]	r 1,013,672	14,534,228	
Total	r 1,526,241,000	1,560,510,000	

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

[1] Includes gem stones, mercury, barite, and gold that cannot be assigned to specific counties and value indicated by symbol W.

Alameda.—Pits in the Pleasanton, Fremont, and Livermore areas, and dredging operations in San Francisco Bay, supplied more than 10 million tons of sand and gravel, an increase of about 200,000 tons over 1963. Much of the material was used in highway work in the Oakland, Berkeley, and Fremont areas although large tonnages also were used in preparing for future residential subdivisions. Stone production, also for use in highway work as base material and paving

aggregate, rose more than 1 million tons. Quarries in the Hayward, Oakland, and San Leandro areas supplied most of the stone.

Leslie Salt Co. harvested crude salt from several thousand acres of evaporating ponds and processed or refined the salt in three company plants. Oliver Bros. operated a salt plant at Mt. Eden. Leslie supplied the Morton Salt Co. refinery with crude salt and sold saltworks bitterns from its Newark plant to FMC Corp. for the extraction of magnesium hydroxide and bromine. FMC used dolomite from its San Benito quarry to make lime used in the process and byproduct gypsum, which was sold for use as a cement retarder. Fibreboard Paper Products Corp. calcined gypsum from its Nevada mine for use in the company's Newark wallboard plant under construction at Fremont with a scheduled completion date of mid-1965. At Alvarado, Holly Sugar Co. used purchased limestone to produce lime and carbon dioxide used in sugar refining. E. H. Metcalf mined miscellaneous clay near Livermore and sold it to brick manufacturers. Interlocking Roof & Tile Co., Mission Clay Products Co. and Kraftile Co. mined clays near Niles for use in roofing products, pottery, and ceramic tile. Fibreboard purchased magnesia for its Emeryville insulation plant, and Philadelphia Quartz Co. made hydrous magnesium sulfate from magnesite purchased in Nevada. Chas. Pfizer & Co., Inc. (C. K. Williams Division) produced natural and synthetic iron oxide pigments in its Emeryville plant. Raw materials for the natural pigments were obtained out-of-State.

Alpine.—Sand and gravel was produced for local building projects by Nevada Lumber Co. near Hope Valley and by Baun Construction Co., Inc., near Picketts. Sand and gravel used in highway projects near Picketts, Markleeville, and Woodfords was supplied mostly by State highway maintenance crews.

Claude B. Lovestedt mined and milled ore from the Zaca mine in the Monitor area and shipped the concentrate to the Selby smelter, Contra Costa County, for recovery of contained silver, gold, zinc, lead, and copper.

Amador.—Industrial sands were produced for glass making, foundry, and other uses by Owens-Illinois Glass Co. and International Pipe & Ceramics Corp. (Interpace) in the Ione area. Virtually all the glass sand was shipped by rail to distant consuming plants. Clays recovered at the Interpace clay-sand plant and clays mined by Harbison-Walker Refractories Co., H. C. Muddox Co., and Pacific Clay Products Co. in the same area were used in making heavy clay products and refractories. Calaveras Cement Co. mined fire clay near Buena Vista and sold it for refractory use. Also in the Buena Vista area, county road crews produced sand and gravel for highway maintenance and fill. Sierra Madre Stone Co. quarried rhyolite at Volcano for use as building stone. Elmer G. Wendt supplied stone for riprap from the Greenstone quarry near Ione to the U.S. Corps of Engineers and city of Stockton for use in levee projects. Industrial Minerals & Chemical Co. and R. J. Robideaux mined soapstone near Sutter Creek. The soapstone was ground in the Industrial Minerals Sacramento County mill for use in paint and insecticides.

Pacific States Steel Corp. in Union City and Judson Steel Corp. in Emeryville used iron and steel scrap as the only metal source in open-hearth steel furnace operations.

Butte.—Production of natural gas from the county's six dry gas fields rose 3 percent over that in 1963.

Sand and gravel was produced from stream bed deposits near Oroville, Chico, Gridley, and Live Oaks for local building and paving projects and in the construction of concrete foundations and structures at the Oroville dam. In addition, a large volume of cobbles was removed from old dredge tailings by an electrically operated bucket-wheel excavator and used in the earthen embankments at the dam. Stone was quarried by Government contractors at several locations for use in water and forestry projects.

Byproduct placer gold and silver was recovered at a sand and gravel nonfloating washing plant in the Oroville area, and prospectors panned stream gravels in the Forbestown and Palermo areas and recovered small quantities of placer gold.

Calaveras.—Calaveras Cement Co. produced portland cement in its wet process plant at San Andreas. The company quarried limestone nearby and mined clays near Burson and San Andreas for use in making cement. Truck and rail shipments of cement were made to California and out-of-State customers.

Pacific Asbestos Corp. (formerly Jefferson Lake Asbestos Co.) resumed full scale operations late in the year at its mine and processing plant near Copperopolis after a period of curtailed production due to adverse market conditions.

Roofing granules were prepared from stone quarried near Altaville and San Andreas, and stone from the Candy Rock quarry near Avery was quarried for building stone, exposed concrete aggregate, and decorative landscape rock. Neilson's Gravel Plant, Inc., at San Andreas supplied virtually all local requirements for aggregate. Additional tonnages of sand and gravel were produced by contractors for highway projects near Ganns Meadows and Mokelumne Hill. Pacific Clay Products Co. and Mission Clay Products Co. mined fire clays at pits in the Valley Springs area and used the material to make heavy clay products.

A few tons of gold ore mined at a Coyote Creek prospect yielded recoverable gold and silver. Prospectors panned stream gravels in the Mother Lode area and recovered small quantities of placer gold.

American Lignite Products Co. mined lignite near Ione and processed the material in its Buena Vista plant to obtain montan wax and other wax products. The company also mined pumicite south of the plant for its own use as concrete aggregate.

A small quantity of silver ore was mined and shipped from the I.X.L. mine near Pine Grove. The Mokelumne drift mine north of Volcano was worked to recover placer gold and silver. Several individuals panned stream gravels and recovered small quantities of placer gold.

Colusa.—Natural gas production was virtually the same as in 1963. Although significant increases were reported from the Sycamore, Grimes West, and Grimes fields, declines were registered at the Compton Landing and Kirk fields. Buttes Gas & Oil Co. extended the productive area from the Forbes formation in the Grimes field during 1964.

Sand and gravel was produced by Cortina Rock Products at Colusa for local building construction and by State and county crews and contractors for road maintenance and repair.

Ore from the New Elgin mercury mine near Wilbur Springs was retorted to recover a relatively small quantity of the metal.

Contra Costa.—Production of natural gas rose 146 percent above that in 1963. A nearly fivefold increase occurred at the Concord field, and a 129-percent increase was reported at the Brentwood field. The increases were the result of the first year of production at these fields, both having been discovered in 1963. Oil production in the Brentwood field also rose 125 percent for the same reason. Development drilling was in progress at both fields. Twenty-two wells were completed at the Dutch Slough field but at yearend the field was still shut in.

Four petroleum refineries—Shell Oil Co. at Martinez, Standard Oil Co. of California at Richmond, Tidewater Oil Co. at Avon, and Union Oil Co. of California at Oleum—operated throughout the year. Sulfur recovery plants were operated at refinery sites by Standard, Tidewater, and Union. At the Selby lead smelter, stack gases were treated to produce sulfuric acid and liquid sulfur dioxide. At Pittsburg, Shell Chemical Corp. produced a thermal carbon black as a byproduct in the manufacture of ammonia fertilizers. Mountain Copper Co. reclaimed copper from solution residues in its Martinez chemical plant and shipped the metal to the Tacoma, Wash., smelter for recovery of copper, gold, silver, and lead.

Large tonnages of sand and crushed stone were produced for highway and rapid transit projects and in the development of residential subdivisions. Sand produced in the Antioch area was shipped by rail to San Francisco for use in paving. Pits near Cowell yielded sand for foundry, building, and fill use. Over 3 million tons of basalt, sandstone, and miscellaneous stone was quarried in the Clayton, Orinda, Pacheco, and Richmond areas for riprap, aggregate, and road base.

At Antioch, Fibreboard Paper Products Corp. purchased makeup lime and regenerated lime needed in its sulfate paper-pulp operation. Kaiser Gypsum Co., Inc., calcined gypsum form Mexico and used it in making gypsum products. The company also expanded purchased perlite for use in the plant products. National Gypsum Co. new gypsum products plant at Richmond was placed on stream in August. This plant also utilized crude gypsum from Mexico. Miscellaneous clay was mined near Port Costa for the manufacture of building brick by Port Costa Clay Products Co. (formerly Port Costa Brick Works), division of Homestake Mining Co., and near Richmond by United Materials and Richmond Brick Co., Ltd.

Reed-sedge peat was dredged in the San Joaquin River delta. Most of the material was dried, shredded, and packaged for sale as a soil additive.

Del Norte.—Sand and gravel was produced from stream deposits and stone was mined from quarries in the Crescent City, Klamath, and Smith River areas for structural and paving use. A substantial tonnage of sand and gravel was used by State and county crews and contractors in road projects, particularly in the Klamath area. Much of the total stone output was by a contractor for the Corps of Engineers for use as riprap. About 180,000 tons of miscellaneous clay was mined on U.S. Forest Service land by several producers who sold or used the material for a variety of uses.

El Dorado.—Three producers quarried limestone but only Diamond Springs Lime Co. used the stone for making lime. El Dorado Limestone Co., at Shingle Springs, and California Rock & Gravel Co., at Cool, sold the limestone for flux, aggregate, and roadstone and for agricultural and various other industrial uses. Near Placerville, slate was quarried and crushed for roofing granules or ground for flour, and rhyolite was quarried by Sierra Placerville Corp. for dimension building stone. County maintenance crews quarried granite and miscellaneous stone for use as riprap and roadstone. Pits in the Placerville and Pollock Pines areas were sources for sand and gravel used in local building and paving, in State and county highway maintenance, and by the Sacramento Municipal Utility District. Commercial Minerals Co. mined soapstone at its Shrub deposit near Shingle Springs and ground it in the company's San Francisco plant, chiefly for use as a carrier in insecticides.

A shipment of old tailings was made to an out-of-State smelter from the Consumnes Copper property near Fair Play for recovery of relatively small quantities of copper, silver, and gold. Various individuals panned stream gravels along the American River and elsewhere and recovered a few ounces of placer gold.

Fresno.—Crude oil production was down 7 percent and natural gas (wet) output was up 8 percent, compared with 1963. As a result, Fresno County ranked sixth in production of both petroleum and natural gas from oil zones. Some natural (dry) gas also was produced. The decline in petroleum was attributed to the normal decline experienced by older fields and to the fact that no new oil discoveries were made. Two wet gas processing plants in the county extracted natural gasoline and cycle products and liquid petroleum gas.

Sand and gravel production was more than 4 million tons. Paving requirements in the Sanger and Coalinga areas were greater but building needs, particularly in the Fresno area, were appreciably less. Large tonnages of sand and gravel were produced by contractors for highway projects near Selma. The Academy granite quarry, source of monumental granite, was sold by Superior Academy Granite Co. to Raymond Granite Co. in August. Decomposed granite was quarried near Friant and Sanger as a base material for streets and driveways. A small but significant tonnage of fusing grade quartz was shipped from stockpile at the Pincushion quarry near Huntington Lake. Stone used for rubble was obtained from U.S. Forest Service land by several producers. Valley Nitrogen Producers, Inc., at Helm, produced byproduct gypsum in the manufacture of phosphoric acid and sold the product for agricultural use.

Atlas Minerals Corp. and Coalinga Asbestos, Inc., produced asbestos fiber (grade 7 shorts) at mines and milling plants northwest of Coalinga. U.S. Asbestos Corp. made test runs at its new milling plant in Coalinga. Craycroft Brick Co. mined and used clay from a pit near Fresno in making heavy clay products. Fresno Perlite Corp. expanded perlite purchased from California and Nevada producers and sold the product principally for plaster aggregate and insulation. Wilbur-Ellis Co. custom ground barite in its Fresno plant.

Five sand and gravel preparation plants on the San Joaquin River, near Friant, used sluice boxes to recover byproduct placer gold and silver. A small suction dredge was used on stream gravels at Auberry to recover a small quantity of placer gold. E. R. Fetzer furnaced ore at the Panoche mercury mine and recovered a few flasks of the metal. A relatively small quantity of mercury was retorted from ore mined at the Ero Cuchea property by Lucio Quinonez.

Glenn.—Dry natural gas production was virtually unchanged from the 1963 level, and Glenn County again ranked sixth among the State's dry gas producing counties.

Sand and gravel was produced by commercial operators, crews of the State Water Resources department, and county maintenance crews from stream-bed deposits in the Orland, Willows, and Hamilton City areas. Much of the total output was used in the construction and repair of county roads. Holly Sugar Corp. purchased limestone to produce lime and carbon dioxide for use in its Hamilton City beet-sugar refinery.

Humboldt.—Dry natural gas production from the Table Bluff field, the county's only producing field, declined about 4 percent from 1963. The only other field, the Grizzly Bluff which was discovered by Zephyr Oil Co. in 1964, had not been placed in production by yearend.

Sand and gravel production was virtually unchanged from 1963. The output came chiefly from deposits along the Eel, Klamath, Mad, and Van Dusen Rivers. Large quantities were produced by Government crews and contractors, particularly for highway projects in the Arcata, Blue Lake, Garberville, and Phillipsville areas. Over 220,000 tons of stone was quarried by Government crews and contractors for riprap in levees and base course in roads.

Hand-sorted ore from the Running Silver property in the Mill Creek area was retorted to recover about four flasks of mercury.

Imperial.—U.S. Gypsum Co. mined gypsum at its Fish Creek Mountains deposit and calcined it in the company's Plaster City plant for use in making lath, plaster, and wallboard. Some crude gypsum was sold for cement retarder and agricultural use.. Sand and gravel production was virtually the same as in 1963. Most of the output was produced and prepared by commercial operators in the Brawley, El Centro, Holtville, and Salton City areas. Large tonnages also were produced and used by county maintenance crews. Granite was quarried for riprap and decomposed granite for road base from several deposits by Government crews and contractors.

Holly Sugar Corp. produced lime and carbon dioxide, from purchased limestone, for use in its beet-sugar refinery at Carlton. California Mining Co. mined bentonite near Brawley for use as a filler in livestock feeds. Near Ogilby, Western Non-Metallics mined and dry-ground mica (sericite schist) to 35 mesh, and sold the product to manufacturers of roofing materials. Organic Mineral Sales, Ltd., mined and stockpiled barite from the White Swan property near Blythe.

A few tons of ore mined on the Rainbow group of claims yielded small quantities of gold and silver.

Inyo.—Union Carbide Nuclear Co. operated its Pine Creek tungsten mine, mill, and chemical plant throughout the year. The mine was

the source of all California's 1964 tungsten and molybdenum concentrate production, a high percentage of the recoverable copper, and much of the recoverable lode silver. Union Carbide used company-produced and purchased concentrates to make ammonium paratungstate in its chemical plant. Lead-zinc ore from the Santa Rosa mine southeast of Keeler and lead ore from the Jubilee mine west of Shoshone yielded a high percentage of the State's recoverable lead and zinc, some gold, and most of the recoverable lode silver. Some stockpiled lead ore was shipped to a smelter from the Bunker Hill property in the Kearsarge area. The ore also contained recoverable silver, gold, and zinc. The Iron Cap iron mine southwest of Ballarat was idle throughout 1964.

Pittsburgh Plate Glass Co. recovered soda ash and sodium sesquicarbonate from Owens Lake brines in its Bartlett plant. U.S. Borax & Chemical Corp. mined colemanite in Corkscrew Canyon and ulexite near Shoshone. The minerals were shipped to the company's Kern County refinery. Kern County Land Co. mined and shipped colemannite from its Kern Borate mine west of Death Valley Junction.

Production was reported from 10 talc mines in 1964. Shipments from stockpile were made from another mine that did not produce during the year. Output from the Warm Springs mine of Grantham Mines was greater than from all others combined. Mineral from this mine was shipped to grinders in southern California, Nebraska, and Mexico. Talc also was ground in plants at Laws and Keeler by the producers.

Limestone was quarried by Stauffer Chemical Co. near Searles Lake as a source for lime and carbon dioxide used in the company plant at Westend, San Bernardino County. Premier Marble Products produced marble from its underground quarry near Lone Pine for construction and ceramic use. At the Lakeview quarry, International Pipe & Ceramics Corp. made withdrawals from its quartzite stockpile for use in making silica brick. Travertine was quarried at the Stutterite stone quarry, north of Searles Lake, and used as rubble in building construction. A comparatively small tonnage of miscellaneous stone was quarried by contractors for public works projects. Sand and gravel was produced from pits in the Bishop area for local use, by State contractors and county crews for use in road construction and repair, by crews for the city of Los Angeles for use in the maintenance of its water system in Owens Valley, and by crews and contractors for the Death Valley National Monument for use in local projects.

Near Little Lake, pumice was mined from the Crownite deposit and volcanic cinder from the Redlite property. Except for a small tonnage of pumice sold for insulation, the materials were used for lightweight aggregate. Some volcanic cinder was mined on U.S. Forest Service land and used in maintaining the agency's roads. American Perlite Co. mined perlite at its Fish Springs quarry, south of Big Pine, and shipped the material to expanding plants outside the county. Near Olancha, fuller's earth was mined from the Calearth deposit by Sierra Talc & Chemical Co. and from the Jones property by Mason & Co. The mineral was prepared for use as a filler in insecticides and as a clarifying agent for mineral and vegetable oils. Chas. Pfizer & Co., Inc., mined bentonite from the Ibex deposit at Tecopa, and L. R.

Moretti produced the mineral at the Side Hill property near Death Valley. The bentonite was prepared for filler use in animal feeds and insecticides or used in lining reservoirs. The Crater sulfur deposit was idle throughout 1964.

Kern.—Kern County was by far the leading producer of petroleum and natural gas among the State's producing counties. Crude oil output was up nearly 3 percent from 1963; natural gas production rose less than 1 percent. The increase in crude oil was directly related to thermal recovery projects, most of which were the steam-injection type located principally in the Midway-Sunset, Kern River, and South Belridge fields. Also, there were 15 new oil discoveries during 1964. Among the more significant was the Northwest Area, McKittrick field, where Standard Oil Co. of California brought in several high-potential wells.

Natural gas liquids production, from the county's wet gas processing plants, continued a decline (4 percent in 1964) begun in 1958. Eight oil refineries, all in the Bakersfield area, were in operation throughout the year. Carbon dioxide was extracted from natural (oil zone) gas in plants near Taft operated by Tidewater Oil Co. and Standard Oil Co. of California. The carbon dioxide from Standard's plant was not marketed. Continental Carbon Co. and United Carbon Co. produced carbon blacks in plants at Bakersfield and Mojave, respectively.

U.S. Borax & Chemical Corp., the Nation's leading producer of boron minerals and compounds, mined crude borates from its open pit mine at Boron and refined or partially refined the minerals in an adjacent plant. Boron minerals mined by the company in Inyo County also were shipped to this plant. Sodium sulfate was produced as a byproduct of borate refining. Some partially refined borates were shipped to the company refinery in Los Angeles County for further processing. Crude and refined borates and boron compounds were shipped to chemical plants and customers outside the county and exported.

Portland cement was produced in the California Portland Cement Co. dry-process plant at Mojave and in the Monolith Cement Co. wet-process plant at Monolith. Although some of the cement was bagged, most shipments were made in bulk, chiefly to ready-mixed concrete plants in California and Nevada. Stone production was principally limestone quarried for use in nearby plants; however, rhyolite was quarried at the Desert Rock quarry near Rosamond for roofing granules, landscape rock, and exposed aggregate. Miscellaneous stone was quarried by contractors for use as riprap by the State highway department and at Edwards Air Force Base. Commercial operators and State and county crews and contractors produced nearly 1.8 million tons of sand and gravel from pits in the Bakersfield, Maricopa, Ridgecrest, and Taft areas. Much of the output was used locally for building purposes and in the construction of Interstate Route 5 and other highways in the Bakersfield, Keene, Lebec, and Ridgecrest areas. More than 1 million tons of gypsum was mined from deposits near Lost Hills, Taft, and Wasco, principally for agricultural use. Gypsum from the Bitterwater deposit near Bakersfield was sold for cement retarder.

Clays were mined near Tehachapi for use in making cement at Monolith. Clays used as a component in drilling muds were dug from pits near Boron, McKittrick, and Rosamond; for use in making stoneware, at Cantil; and for absorbent use, near Mojave. Western Salt Co. harvested solar-evaporated salt from Koehn dry lake and processed it in its Saltdale plant. The plant product was shipped to customers in Los Angeles County. Pumicite was mined from the Calsilco claims north of Saltdale and prepared for use as an absorbent.

Tin concentrate was produced from ore mined at the Meeke-Hogan property and shipped to an out-of-State customer. Bullion produced from gold ore of the Butte mine near Randsburg was shipped to the Selby smelter for recovery of gold and silver. Cleanup operations at the Butte Lode Property in the same area yielded a few ounces of gold and silver. Ore from an unnamed prospect near Kernville was treated to recover a small quantity of silver.

Kings.—Production of natural gas from oil zones rose 29 percent above the 1963 figure. The quantity of wet gas processed in the county's three processing plants also was higher, yielding 10 percent more natural gas liquids. Much of the wet gas increase was credited to the Kettleman North Dome field where net withdrawals were up 22 percent. Although dry gas production was comparatively small, the yield was 11 percent above that in 1963, all of which came from that part of the Trico gas field extending into Kings County. Crude oil production was down 1 percent, reflecting the normal decline in older fields. The county's only refinery, at Hanford, was operated by Caminol Co.

All of the sand and gravel produced was used by county crews in the construction and maintenance of roads and highway structures. Sand and gravel and crushed stone used as concrete aggregate were supplied by producers in adjacent counties.

The Dawson and Little King mercury mines were idle.

Lake.—Demand for sand and gravel in building construction at Clear Lake offset the decline for sand and gravel for road construction. Pits and plants near Clearlake Highlands, Lower Lake, and Lakeport were principal sources for the materials. Crews and contractors for the Corps of Engineers, State forest department, and State and county road departments, produced sand and gravel for the agency use. The principal highway projects were in the Middleton and Kelseyville areas. A small tonnage of stone was quarried for rubble on U.S. Forest Service land. Volcanic cinder was mined near Clearlake Oaks by Cinder Products Co. and sold for aggregate, landscaping rock, and roofing granules. Near Clearlake Highlands, Roger Hellgren mined volcanic ash for use as fill, and Lake County Aggregates mined cinder for concrete aggregate. Some volcanic cinder was produced on U.S. Forest Service land by agency crews for road maintenance. Shale was quarried at the Konocti deposit near Kelseyville for use in surfacing roads.

Ed Downey retorted ores from various mercury mines and prospects and recovered several flasks of the metal. About midyear the Abbott mercury mine was purchased by Melvin H. Lord of Sacramento and reactivated before yearend under the name Mercury Mines, Inc. American Mineral Resources Development Co. mined sulfur ore on the S Bar S Ranch east of Kelseyville and sold the material for soil conditioning.

Lassen.—Sand and gravel was produced and prepared at a pit and new stationary washing plant operated by Lassen Sand & Gravel Co. about 1 mile west of Standish. The plant products were used in building and paving. State highway contractors produced sand and gravel for use in highway projects in the Adin and Standish areas, and crews for the county and the U.S. Forest Service produced and used the materials in the maintenance of roads. Stone production was all by public works crews—basalt for the U.S. Forest Service, granite for the Sierrra Army Depot, and miscellaneous stone for the State Division of Forestry.

Crews and contractors for the California Division of Highways produced volcanic cinder for use in the repair and maintenance of roads. Mt. Lassen Cinder Co. mined volcanic cinder near Susanville and prepared the material for lightweight concrete aggregate.

Los Angeles.—Crude oil production declined about 1 percent from that in 1963, and natural gas from oil zones was down 5 percent. A relatively small quantity of dry natural gas also was produced, virtually unchanged in volume from 1963. The petroleum and wet gas decreases were attributed to normal decline from old fields. A new oil discovery, the Los Angeles Downtown field, was made by Standard Oil Co. of California but at yearend the field was still shut-in. Bids were expected to be called early in 1965 on the East Wilmington offshore field, which had reserves estimated at approximately 1.5 billion barrels of oil. Sixteen petroleum refineries were in operation, unchanged from 1963. The county's natural gas liquids plants treated 6 percent less wet gas than in 1963 and yielded 5 percent less plant product.

Sulfur recovery plants (removing elemental surfur from effluent gases at petroleum refineries) were operated by Wilshire Oil Co. near Santa Fe Springs, by Stauffer Chemical Co. near Long Beach, and by Collier Carbon & Chemical Corp. near Wilmington.

Over 26 million tons of sand and gravel was produced, principally at 26 commercial stationary plants. Ten of the plants had outputs of more than 1 million tons each. Large tonnages also were produced by public works maintenance crews and on-site contractors. The output of industrial sands rose above that in 1963, particularly for blast and engine uses. Stone production increased to more than 2 million tons. Large tonnages were quarried in Los Angeles County (including Catalina Island) for dikes, breakwater, and fill projects for the Long Beach and Los Angeles harbor departments. Appreciable tonnages of building stone and decomposed granite for base material in construction projects were produced.

Fibreboard Paper Products Corp. operated its South Gate lath, plaster, and wallboard plant on gypsum received from a company mine in Nevada. Kaiser Gypsum Co. imported gypsum from Mexico for its Long Beach gypsum products plant. U.S. Gypsum Co. wallboard plant at Santa Fe Springs was under construction with completion scheduled by the end of 1965. Gypsum for the new plant will come from the company's Imperial County mine. Clays used in making heavy clay products were mined from pits near Castaic, Compton, Los Angeles, Reseda, Torrance, and Van Nuys. A relatively small tonnage of shale was mined in the San Fernando area and sold for use as a carrier in insecticides and fungicides. A few tons of soapstone was mined in the Sierra Pelona Valley and shipped to a Los Angeles

grinding plant. Five plants in the county ground talc and soapstone from mines in California and Nevada. Nine plants in the Los Angeles area expanded perlite received from producers in California, Arizona, Nevada, and New Mexico. Barite mined in Nevada was ground in a Harbor City plant and prepared for use in well drilling muds. California Zonolite Co. exfoliated vermiculite from its Montana mine and sold the product for lightweight aggregate, insulation, and soil conditioner. Sunshine Mica Co. dry-ground scrap mica in its Los Nietos plant. Part of the mica was purchased from a South Dakota producer; the remainder was imported from India. The plant product was sold to manufacturers of roofing materials.

U.S. Borax & Chemical Corp. operated its Wilmington refinery on crude and partly refined borates received from its operations in Kern County. Some sodium sulfate was produced as a byproduct of borate refining. Waste oil-well brines from the Los Angeles Basin were pumped to The Dow Chemical Co. iodine recovery plant in Orange County.

Two sand and gravel preparation plants on the San Gabriel River channel used sluice boxes to recover byproduct placer gold and silver.

Madera.—Dry natural gas production was about 1 percent higher than in 1963. Nearly 99 percent of the total came from the Gill Ranch field; the remainder came from the Moffat Ranch field. There was no production from the Chowchilla field in 1964. Development drilling was limited to two wells, both in the Gill Ranch field.

Sand and gravel production rose to 1.2 million tons. Most of the output was by operators of stationary plants in the Madera, Pinedale, Chowchilla, and Oakhurst areas. Contractors on State highway projects also produced structural and paving sand and gravel. Granite was quarried at Raymond for building and monumental use. Miscellaneous stone was quarried near Madera by Sierra Lava Stone Co. for building construction. Government crews quarried stone for use in embankments in the maintenance of roads. California Industrial Minerals obtained pumicite from the Taylor deposit near Belleview and prepared the material for use as a carrier in insecticides. U.S. Pozzolan Corp. mined pumicite from its Erickson property in the same area and used the material for lightweight aggregate. Hans Sumpf Co. mined clay near Madera for use in making adobe brick.

The Strawberry tungsten mine and mill, near Bass Lake, was idle throughout the year; however, shipments of stockpiled concentrate were made to an Inyo County chemical plant. Byproduct placer gold and silver were recovered at two sand and gravel preparation plants on the San Joaquin River near Friant.

Marin.—Basalt Rock Co., Inc., quarried basalt at the Novato quarry, and Hutchinson Co. quarried sandstone at the Greenbrae quarry. The materials were used as base material, paving aggregate, and riprap. Joslin Brothers operated a stationary sand and gravel plant at Point Reyes to supply local projects needs. United Sand & Gravel Co. of Sausalito dredged sand from San Francisco Bay for fill use. Most of the sand and gravel required for concrete aggregate came from pits near Healdsburg, Sonoma County. L. P. McNear Brick Co. and The McNear Co. quarried shale at San Pedro Hill, near San Rafael, and used the material in making brick and lightweight aggregate. At

Sausalito, Scottlite Products expanded perlite that was purchased from a Colorado producer.

Buena Suerte Mines, Inc., retorted ore from its mine and recovered over 350 flasks of mercury. Jack Reid worked the Chileno Valley deposit and recovered nearly 50 flasks of mercury by retorting the ore. Ore from the Corda prospect was hand sorted before retorting, and a few flasks of mercury were recovered.

Mariposa.—Sand and gravel was produced for building, paving, and fill use at preparation plants in the Groveland, Mariposa, and El Portal areas and by State, county, and National Park Service maintenance crews. At the Mt. Bullion quarry, near Mariposa, slate was quarried for flagging and produced in blocks and slabs for milling. Quarry waste was used for road fill. A small tonnage of waste slate was taken from the idle Aqua Fria quarry for road fill. Some dimension building stone was quarried at Haigh's Quarry near Coulterville.

Two lode gold mines were active during 1964. The Red Banks mine near Kittridge yielded most of the recoverable gold and silver. In addition, two gold prospects—one near Kittridge and the other near Bullion Mountain—were worked for small quantities of gold. H. L. Souter used a small suction dredge to work stream gravels on the Merced River near Kittridge and recovered a few ounces of placer gold.

In the Mariposa area, a flotation pilot plant designed to yield a commercial grade mica from micaceous schist was under construction. The plant was expected to be operational in 1965. Metallurgical work was conducted on samples from the deposit under a cooperative agreement between the Bureau of Mines, the University of Alabama, and Kelly-Moore Paint Co., Inc.

Mendocino.—About 780,000 tons of sand and gravel was produced at commercial plants in the Ukiah, Fort Bragg, Point Arena, and Covello areas, and by maintenance crews of public works agencies. Large tonnages were used in highway projects near Ukiah, Laytonville, and Willits. Several established sand and gravel pits, and stationary and portable preparation plants, were damaged during the December floods. State and county maintenance crews and contractors quarried stone for riprap and road base in highway repair.

Janusz Yuen Mining Co. retorted ore from its Janusz-Yuen (Janusz "B") mine near Hopland and recovered several flasks of mercury.

Merced.—Nearly 7 million tons of miscellaneous stone (basaltic) was quarried by contractors for use as riprap, bedding and blanket material, fill, and concrete aggregate for use in various zones of the massive San Luis Dam, and its reservoir and canal project near Los Banos. Merced Patio quarried sandstone on the Schwinn ranch near Le Grand for decorative building stone and landscaping rock. Over 2.5 million tons of sand and gravel was produced by commercial operators, county maintenance crews, and Federal and State contractors. The material was used as aggregate in structures and paving for extensive public works projects. Substantial tonnages were used in the construction maintenance, and relocation of roads in the Merced and Los Banos areas, and in the San Luis unit of the Central Valley project. Gypsite was mined near Los Banos by Agricultural Minerals & Fertilizer Co. for soil improvement use.

River Rock, Inc., recovered byproduct placer gold and silver in its washing plant on the Merced River near Snelling.

Modoc.—Although sand and gravel production was limited to the outputs by State, county, and city (Alturas) crews and contractors, substantial tonnages were produced and used in highway projects near Adin, Alturas, and Lookout. The Moyer Gravel Co. preparation plant at Alturas was idle all year. Crews for the State, county, and U.S. Forest Service mined volcanic cinder for use in road maintenance and repair. Herman P. Free mined pumice near Glass Mountain and prepared the material for lightweight concrete aggregate.

John G. Harris obtained peat moss from a bog in Jess Valley, near Likely, and dried, shredded, and packaged the output for sale as a soil improvement agent.

Mono.—Featherock, Inc., mined pumice near Lee Vining and sold it for landscaping and decorative use. U.S. Pumice Supply Co., Inc., obtained pumice in the same area and prepared the material for abrasive uses. Near Benton, Bishop Building Materials Co. mined pumice at the Cowan property for use as lightweight concrete aggregate.

Huntley Industrial Minerals Co. mined kaolin from its Little Antelope deposit in the Casa Diablo area and pyrophyllite at the Pacific property near White Mountain. The kaolin was sold for use in cement, and the pyrophyllite was ground in the producer's Inyo County plant for use in pesticides and paint.

Optical calcite crystals were mined on Mount Baldwin at an altitude of about 11,000 feet. The output was sold to an eastern optical company.

Sand and gravel was produced by county road crews and State highway contractors, principally for use in highway construction in the Lee Vining and Bridgeport areas.

Monterey.—Crude oil production was virtually the same as in 1963, and the natural gas yield from oil zones dropped 15 percent. According to the Conservation Committee of California Oil Producers, two thermal recovery projects were active in the San Ardo field at year-end. Thirty-nine new wells were completed in this field during 1964. A new 50,000-barrel-a-day refinery at Moss Landing was planned by Humble Oil & Refining Co.

Kaiser Aluminum & Chemical Corp. quarried dolomite at Natividad and upgraded it by heavy-medium separation. Some dolomite was sold for roofing granules and landscaping rock, or prepared for use in making glass and as a filler in fertilizers. The remainder was either calcined and hydrated to produce lime used principally as a precipitant at Kaiser's Moss Landing magnesia plant or was dead-burned for making refractories. Some lime was sold to the building materials industry. Some magnesium hydroxide recovered in the company's sea-water-processing plant was sold, but most of the product was consumed by Kaiser in making refractories. Near Salinas, Spreckles Sugar Co. calcined purchased limestone to obtain carbon dioxide and lime used in refining beet-sugar.

Over 1 million tons of sand and gravel, including industrial sands, were produced in 1964. Pits in the Watsonville, Salinas, and Bradley areas supplied aggregate needs in road maintenance and repair. Industrial sands were prepared principally at plants working the dune deposits near Pacific Grove. Both Owens-Illinois Glass Co. and Del Monte Properties Co. produced glass sands. Del Monte also proc-

essed silica and feldspar products. Some of the products were blended and/or ground to customer specifications. Decomposed granite was quarried near Salinas and Monterey by Department of Defense maintenance crews and county contractors for use as road base and fill.

Monterey Bay Salt Co., Inc. harvested crude salt from solar evaporating ponds near Moss Landing and sold the product locally to ice companies, water softening companies, food processors, and others.

Napa.—Shale was mined near Oakville and expanded at Napa by Basalt Rock Co. for lightweight aggregate. The company also prepared a pozzolan for cement from stockpiled diatomaceous silica, previously mined near Napa, and quarred basalt at the nearby Pedrotti quarry for riprap, roadbase, and concrete aggregate. Sand and gravel was produced and prepared for local building and paving use by commercial operators in the Napa and St. Helena-Angwin areas. State and county road crews also produced sand and gravel for highway structures and for maintaining and repairing highways.

Leslie Salt Co. harvested crude salt from solar evaporating ponds along San Pablo Bay. Asbestos Bonding Co. produced several grades of asbestos filler material at its Phoenix mine and plant near Napa. Perlite from the Alvo mine near St. Helena was expanded in a nearby plant by Perlite Rock Co. for use as plaster aggregate and soil conditioner. The Pearl Quarry in the Mt. George area was the source for pumice used as concrete aggregate and in surfacing horse corrals.

Mercury was recovered from ore and dump material of the Oat Hill (retorted) and Corona (furnaced) mines, and by two operators who worked James Creek to recover the metal washed down into the creek bottom from the old Oat Hill operation. An unnamed prospect in the same area also yielded some mercury by retorting.

Nevada.—Sand and gravel was produced and prepared in stationary plants at Grass Valley and Truckee, and in portable plants by State and county crews and contractors. Much of the total output was consumed in highway projects near Soda Springs and Cisco. Stone was quarried for riprap on U.S. Forest Service land for use in road and river embankments.

Lode gold production was limited to that recovered in cleanup operations at the Empire Star Group in Grass Valley and the treatment of a few tons of gold ore at the Indiana mine near Osborne Hill. Nine placer properties were active in 1964. Only three—the Crystal Hill, Washington area; Deer Creek, Grass Valley area; and Rocky Road, French Corral area—yielded appreciable quantities of gold and silver. A number of individuals panned stream gravels particularly in the French Corral area. A few ounces of placer gold was recovered.

Orange.—Crude oil production rose 2 percent above that in 1963 while the output of natural gas from oil zones was 1 percent lower. The Huntington Beach field continued its upward production trend with completion of 87 new wells in 1964. Sixty new wells were completed in the Yorba Linda field with a significant increase in production. About 3 percent less wet gas was processed at a plant in the county, with a corresponding drop in output of natural gasoline and cycle products. However, production of liquified petroleum gas was 5 percent higher. The Huntington Beach refinery of Socal Oil & Refining Co. was sold to Signal Oil & Gas Co. during 1964 and was subsequently shut down.

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Nearly 8 million tons of sand and gravel was produced, all by established stationary and portable plant operations. Lesser tonnages were required for structural and paving uses primarily because residential and freeway construction needs were lower than in 1963. Industrial sands were mined in the Trabucco and El Toro areas and prepared for use in cement, ceramics, and refractories. Clay-sand mixtures mined in these areas were marketed by California Nonmetallics and W. A. Schoeppe Clay Co. for foundry ganister; however, both companies also prepared washed kaolin and sand for sale. Clays were dug near Huntington Beach by La Bolsa Tile Co. and near Corona by Pacific Clay Products Co. and were used in making heavy clay products. Riverside Cement Co. mined clays near San Juan Capistrano for consumption in its cement plant. Shale was mined and expanded for lightweight aggregate near San Clemente by Crestlite Aggregates Co.

At Dyer, Holly Sugar Co. purchased and calcined limestone for carbon dioxide and lime used in refining beet sugar. Western Salt Co. harvested crude salt from the solar evaporating ponds of Newport Bay Salt Works at Corona Del Mar. The product was sold locally and some salt works bittern was marketed as an herbicide. The Dow Chemical Co. extracted iodine from waste oil-well brines of the Los Angeles Basin in its Seal Beach plant. R. W. McClellan & Sons operated a peat humus pit near Huntington Beach. The peat was sold in bulk or mixed with earth for sale as top soil.

Placer.—Over 1 million tons of sand and gravel and nearly 2 million tons of stone were produced, chiefly by contractors for State and county highway and water resource projects. Pits along the Bear River were sources for most of the sand and gravel used for base material and aggregate. Stone was quarried for riprap on U.S. Forest Service land. Interstate Route 80 projects near Emigrant Gap and Baxter consumed substantial tonnages of these materials. Pits near Auburn, Colfax, and Tahoe City provided sand and gravel for local needs. The Auburn pits were the source of industrial sands sold for blast, engine, and filter uses, and of gravel for exposed aggregate and landscaping. Union Granite Co. quarried granite near Rocklin for building and monument stone, and for roofing granules, retail nursery use, and poultry grit. Scott's decomposed granite pit supplied a large tonnage of fill material. International Pipe & Ceramics Corp. and Lincoln Clay Products Co., Inc., mined fire clays in the Lincoln area for manufacturing brick, structural tile, and sewer pipe.

Roy Duncan treated a small tonnage of gold ore from the Bowman prospect on the Butcher Ranch and recovered a few ounces of gold. Except for some old tailings that were washed in Miners Ravine, all placer gold was recovered by individuals who panned or sluiced stream gravels in the Colfax, Iowa Hill, Forest Hill, Folsom, Auburn, and Dutch Flat areas.

Plumas.—Sand and gravel was produced by State and county crews and contractors for use in roads and road structures in the Blairsden, Quincy, and Canyon Dam areas. Local needs were supplied by commercial operations at Quincy and Portola. U.S. Forest Service land was the source for stone quarried and used for riprap and fill, and for clays sold to brick plants.

Metal mining was limited to the search for placer gold. Except for two sluicing operations in the La Porte area, all recoveries were by individuals who panned stream gravels in the Butte Valley, Edmonton, Genesee, Granite Basin, Johnsville, and Quincy areas.

Riverside.—Production of iron ore and shipments of concentrate from the Eagle Mountain mine of Kaiser Steel Corp. rose 25 percent above 1963 figures. About 34 perceent more iron concentrate was consumed in the Kaiser furnaces at Fontana, and nearly 7 percent more was exported to Japan. Although relatively small, the shipments to other domestic furnaces jumped 84 percent. There was some activity at the Storm-Jade underground iron mine in the Joshua National Monument, but no shipments were made.

Riverside Cement Co. produced regular and white portland cements at its Crestmore facility for shipment to California, out-of-State, and foreign destinations. Nearly 2.4 million tons of sand and gravel (including specialty sands) was produced for building, paving, fill, and other industrial uses. Much of the output came from pits in the Corona, Indio, Mira Loma, and Banning areas and was used locally or for State highway construction. The Corona deposits were the principal sources for industrial sands produced for glass and cement manufacture. Granite and decomposed granite were quarried for riprap, base material, railroad ballast, and fill in the Riverside and Corona areas. During the year, Haven Granite Corp. shut down its Ormand quarry, the company's principal source for poultry grit for many years. Limestone was quarried at Crestmore for cement making, and at Riverside and Nightingale for roofing granules and decorative use. Minnesota Mining & Manufacturing Co. quarried stone in Temescal Canyon for roofing granules and exposed aggregate. Others in the area quarried building stone, riprap, and roadbase.

Six producers mined clays in the Alberhill, Corona, and Elsinore areas for the manufacture of heavy clay products. Clays from deposits in the Riverside and Corona areas were used in making cement. U.S. Gypsum Co. mined and calcined gypsum at Midland for use in wall board and plaster. Some crude gypsum was sold for agriculture use. The Midland area also was a source of wollastonite float, collected and sold for decorative use.

Morongo Corp. dug reed-sedge peat from a depost near Banning. The material was air-dried and shredded for bulk shipment to customers who sold the product as a soil improvement agent or used it as an ingredieent in mixed fertilizers. Crude oil production was from two wells in the Prado Dam field. The yield was 22 percent below that in 1963. Humbug Development Co. mined uranium ore at its Northeast group of claims near Blythe and shipped to a Utah processing plant. Ores from the Silver Springs prospect in the Temescal Canyon area and the Copper Queen near Ironwood contained recoverable copper and silver. A small quantity of gold was recovered in treating ore from the Snowcloud claim near Eagle Mountain.

Sacramento.—Sacramento continued to lead all other counties in the production of dry natural gas, although the volume produced was 9 percent below that of 1963. Production declines were reported at the Freeport, Thornton, and River Island fields; other fields had slight increases or were unchanged. Standard Oil Co. of California

found new production from the Domengine sand in the West Thornton-Walnut Grove field. The discovery well flowed more than 2 million cubic feet a day.

Over 5 million tons of sand and gravel was produced for building and paving use in the Sacramento area, principally for structures and roadways on Interstate Route 80 through the city. Large tonnages of sand and gravel also were used on McClellan Air Force Base. Government contractors quarried a comparatively small tonnage of stone for use as riprap. Miscellaneous clay was mined by Cannon Co. at Michigan Bar and by Sacramento Brick Co. near Sacramento for use in making heavy clay products. In the Ione area, Industrial Minerals & Chemical Co. and R. J. Robideaux mined fire clays for use in making stoneware products, firebrick and block, and fire-clay mortar; for use in the manufacture of rubber; and for use as a carrier in fungicides and insecticides. At Florin, Industrial Minerals ground barite from Nevada mines and custom-ground other nonmetallic minerals to customer specifications. California Zonolite Co. exfoliated vermiculite from its Montana mine in a Sacramento plant and sold the product for insulation, plaster aggregate, and soil additive.

Metal production was essentially limited to byproduct placer gold and silver recovered at two sand and gravel washing plants on the American River near Folsom. Only 8 ounces of placer gold was recovered by individuals who panned stream gravels in the same area.

San Benito.—Ideal Cement Co. produced portland cement in a wet-process plant at San Juan Bautista. The company obtained its raw materials from a nearby limestone quarry and a shale deposit in Santa Cruz County. Bulk and bag shipments of cement went chiefly to California customers although some out-of-State shipments were made. Limestone was quarried near Hollister by FMC Corp. for its Alameda County magnesia plant. Granite Rock Co. quarried granite at the Logan quarry for riprap, concrete aggregate, and railroad ballast.

Six mercury mines were active but only one, the New Idria, yielded more than 30 flasks of the metal. The New Idria mine was the Nation's largest mercury producer. Relatively small quantities of crude oil and natural gas (wet and dry) were produced. Crude oil output declined 4 percent and natural gas output declined 37 percent from 1963 figures.

Sand and gravel was produced by commercial operators in Hollister, crews of Federal and county agencies, and contractors on State highway projects in the Gilroy and Bitterwater areas. Union Carbide Nuclear Corp. recovered asbestos fiber from ore mined on company land in the southeast corner of the county and processed it in UCN's King City plant in Monterey County. Wilbur-Ellis Co. mined bentonite from the Lewis pit near Idria and prepared it for use as a water seal in reservoirs, carrier in insecticides, ingredient in foundry facings, component in drilling muds, and various other applications.

San Bernardino.—California Portland Cement Co. at Colton, Kaiser Cement & Gypsum Corp. at Cushenbury, Riverside Cement Co. at Oro Grande, and Southwestern Portland Cement Co. at Victorville, produced cement and made shipments to customers in and out of the State. Dry-process plants were operated at Colton and Oro Grande while the Cushenbury and Victorville plants used the wet process. Limestone

was quarried by the cement companies for their own use and by others for lime production. The Chas. Pfizer & Co., Inc. lime producing operation, in Cushenbury Canyon, was expanded to provide lime to meet increased industrial and chemical demands. Large tonnages of dimension and crushed marble, sandstone, and miscellaneous stone were quarried for building construction, roadbase, paving, and fill. Nearly 8.8 million tons of sand and gravel was produced by commercial operators and Government crews and contractors. Much of the output was consumed in interstate highway projects in the Buellton, Field, San Bernardino, Baker, Barstow, and Redlands areas. Local building requirements were below those in 1963.

American Potash & Chemical Corp. extracted sodium borates, boric acid, potassium chloride, potassium sulfate, dilithium-sodium phosphate, and bromine from Searles Lake brines in a plant at Trona. Stauffer Chemical Co. also extracted sodium borate, sodium carbonate, and sodium sulfate (including glauber salt) from the lake brines in its plant at Westend, using a different process. Stauffer also calcined limestone from its Inyo County quarry to produce carbon dioxide used in plant processes and lime for chemical and industrial uses. Most of the bromine and potassium salts were sold to Los Angeles fertilizer plants. All of the State's calcium chloride output was recovered from Bristol Lake brines by Leslie Salt Co. and National Chloride Co. The compound was recovered as a liquid, some of which was purchased by Hill Bros. Chemical Co. and converted to a flake product in a nearby plant. Products from the plants were marketed in California, Nevada, and Arizona for fireproofing and hygroscopic uses. Solar evaporated salt was harvested at Bristol Lake by Leslie Salt and at Searles Lake by Pacific Salt & Chemical Co. Leslie also mined rock salt near Amboy, chiefly for sale to producers of chlorine gas. The Metropolitan Water District of Southern California used solar evaporated salt, harvested on its U.S. Sodium Lease near Rice, as a water-softening agent.

The Iron Age Mine, east of Twentynine Palms, was operated throughout 1964. As a result, production and shipments more than trebled those in 1963. The mine yielded high-grade lump ore shipped to the Fontana steel plant and fines that were marketed to cement plants. The Kaiser Steel Corp Silver Lake iron property was operated intermittently, and shipments of iron ore were lower than in 1963. Molybdenum Corporation of America mined and milled bastnaesite ore at its Mountain Pass property. Production of rare earth concentrate was about half that in 1963, but shipments quadrupled and stocks were reduced appreciably. During the latter part of the year Molycorp successfully operated a pilot plant at the mine for extraction of europium oxide and planned a full-scale plant in 1965. Copper ore was shipped from the Lucky John mine in the Whipple Mountains to an Arizona smelter, as was a very small tonnage of silver ore from the B & B Group near Barstow. Shipments of ore were made to the Selby smelter from the September gold mine, Morengo area, and a silver prospect near Trona. The smelter also received lead concentrate produced at the Morengo mine. Amalgamation was used to extract gold from ore mined at the Fremont Peak property, Randsburg area, and stockpiled ore at the T.K.T. prospect, Ord Mountain area. A few

ounces of placer gold and silver were recovered by individuals who panned stream gravels in the vicinity of Twentynine Palms.

Ball clay was mined at the Hart deposit near Ivanpah by Southern California Minerals Co. and International Pipe & Ceramics Corp. The clay was used in making floor and wall tile. The Honey Brown bentonite property near Vidal was mined by Brown Minerals Co. and sold to producers of animal feeds. Hectorite was mined from deposits near Newberry and Dagget by National Lead Co. and processed for use in clarifying beverages. Miscellaneous clay was mined near Lucerne and Oro Grande for use in making cement and near Chino and Highgrove for the manufacture of heavy clay products. Four companies worked 12 talc deposits in the county, producing more than one-third the State output. Virtually all production was consigned to producer grinding plants in the Los Angeles area. The Victorite pyrophyllite deposit near Victorville was idle, but shipments from stock were made to Chas. Pfizer & Co., Inc. (C. K. Williams & Co. Division) mill at Victorville. W. S. Hubbard shipped a small tonnage of barite from the Paycheck mine near Calico to a Kern County grinding plant.

Small quantities of petroleum and natural gas were produced from small oil-fields in the extreme southwest section of the county. Outputs of oil and gas declined 18 and 47 percent, respectively, from 1963.

Aiken Builders Products and Cima Cinders, Inc., obtained volcanic cinder in the Cima area for use as lightweight concrete aggregate. Cima also sold some material for soil conditioning, roofing granules, and decorative use. John J. Ravese mined volcanic ash from the Williams Bros. deposit in the Opal Mountain area and sold it for a soil additive. The perlite deposit of Polaris Perlite Co., near Barstow, was idle throughout 1964.

San Diego.—Sand and gravel production totaled 5 million tons, unchanged from 1963. Large tonnages continued to be consumed in State highway projects near San Diego, National City, Escondido, and Coyote Wells. Virtually all aggregate supplied for highway work came from established pits. Federal and county agency crews produced the materials for road maintenance and repair. Industrial sands were mined in the Oceanside area and prepared for glassmaking, foundry, and other industrial uses. Nearly 1.3 million tons of stone, chiefly decomposed granite, sandstone, and basalt, was quarried. Much of the output was used for riprap, base material, landscape rock, and roofing granules. Dimension granite was quarried in the Escondido area for architectural and monument use.

Western Salt Co. harvested solar evaporated salt from ponds on South Bay. Western processed the salt in its Chula Vista plant for local customers and pumped saltworks bittern to the nearby FMC Corp. plant for extraction of magnesium chloride. The city of San Diego regenerated lime in its Alvarado water treatment plant from carbonate sludges precipitated from the Colorado River water. The regenerated lime was recycled in the water treatment system. Hazard Block Co. and Union Brick Co. mined clays from pits in the San Diego area and used the materials in making heavy clay product. Harborlite Corp. mined pyrophyllite from its Harris mine in the San Diequito area and ground it in San Diego for use as a carrier in in-

secticides. H. G. Golem mined pyrophyllite at his Four-Gee mine in the same area and shipped it to a Los Angeles chemical plant. Organic Mineral Sales, Ltd., mined and stockpiled pyrophyllite from its Pioneer mine, near the Harris property. Harborlite also expanded perlite from its Arizona mine and from a Nevada producer.

San Francisco.—Sand was obtained from dune deposits along the Great Highway and dredged from the bay near the Presidio. The entire output was used for fill and nonspecification paving mix. Concrete aggregate requirements were supplied by stone and sand and gravel producers in other counties.

Commercial Minerals Co. custom-ground talc, soapstone, and limestone received from deposits outside the county.

San Joaquin.—Dry natural gas production rose 9 percent above that in 1963. Much of the rise was credited to greater withdrawals from the McMullin Ranch field as production from the Lathrop and other fields registered little or no change. During the year, McCrate Oil Co. extended the productive area of the Lodi field.

Structural and paving sand and gravel needs, particularly State highway projects in the Stockton, Tracy, and Vernalis areas, were supplied by established plants and pits near Tracy, Lodi, Escalon, and Clements, and by county road crews. A small tonnage of stone was quarried by a Government contractor for riprap used in river embankments. Holly Sugar Corp. at Tracy and Spreckles Sugar Co. at Manteca calcined purchased limestone for carbon dioxide and lime used in processing sugar beets. Miscellaneous clay mined near Stockton by California Clay Products Co. and Stockton Building Materials Co. and fire clays obtained near Tracy by Pacific Clay Products Co., were used in making heavy clay products. At Lathrop, Best Fertilizer Co. recovered byproduct gypsum, produced in the manufacture of phosphoric acid. The gypsum was sold for agriculture use.

San Luis Obispo.—Crude oil production declined 4 percent while that of natural gas from oil zones rose 9 percent. Although the county's petroleum production was down, the yield from the San Ardo field rose slightly, due principally to active steam-injection projects. Relatively small quantities of natural gas liquids were recovered in processing the wet natural gas. Union Oil Co. of California operated a refinery and sulfur recovery plant near Arroyo Grande.

Large tonnages of sand and gravel were produced at commercial operations in the San Luis Obispo, Cambria, San Miguel, and Atascadero areas, principally for structural and paving use. Much of the output was consumed in State highway projects near Pismo, San Luis Obispo, and Camp Roberts, and for county road maintenance and repair. The Oceano area was the source of special industrial sands. Limestone was quarried near Arroyo Grande for rough building stone and near Adelaide for riprap and agricultural use and for sale to beet sugar refineries. Dimension stone was quarried in the Morro Bay and Cambria areas for building construction, road base, and concrete aggregate. Various quarries supplied stone for riprap in embankment and fill projects. Superior Gypsum Co. mined gypsite from its Cariso deposit near Simmler and sold it for agricultural use. San Luis Obispo Brick Co. mined clay from a pit near the city limits for its own use.

Ore from the underground Buena Vista mercury mine near Klau was furnaced to recover a substantial quantity of the metal. However, output was 18 percent below that in 1963. Mercury ores from the Cambria mine near Red Mountain and the Polar Star mine in the Carpojaro area were retorted to recover several flasks of the metal.

San Mateo.—Ideal Cement Co. produced portland cement in its Redwood City wet process plant using oystershell and clay dredged from the bay. Shipments of cement were made by truck, rail, and waterway to California and out-of-State customers. Other companies dredged oystershell from the bay and sold the washed shell to producers of poultry grit and animal feeds. Sandstone was quarried near Brisbane, limestone was quarried at Rockaway Beach, and miscellaneous stone was produced at several locations. Commercial operators and public works contractors produced the stone for road base and concrete aggregate, chiefly for highway projects in the Daly City, Pacifica, and Redwood City areas. Sand and gravel output was limited to commercial operations along Pilarcitos Creek and that by public works crews and contractors.

Merck & Co. extracted magnesia from seawater in its South San Francisco plant, using purchased limestone-dolomite mixture as a precipitant. Leslie Salt Co. harvested solar evaporated salt from company ponds that extended into Alameda and Santa Clara Counties. The crude salt was prepared for out-of-State shipment, principally export. Kaiser Gypsum Co., Inc., stockpiled Mexican gypsum at Redwood City for agricultural use and for making cement.

Crude oil output was 29 percent below that in 1963. Only slightly more than 50,000 barrels was produced. A very small volume of wet natural gas was obtained with the oil.

Santa Barbara.—County fields yielded 3 percent more crude oil, 26 percent more wet natural gas, and 37 percent more dry natural gas. Petroleum and wet gas increases were due largely to development drilling in the Casmalia and Gato Ridge fields with the completion of 23 new oil wells and 10 new gas wells and increased withdrawal from the Orcutt field. Thermal recovery projects were in operation in the Casmalia and Cat Canyon fields. Higher yields of dry natural gas were obtained, chiefly from the Caliente Offshore, Molino Offshore, Naples Offshore, and Gaviota fields. More wet gas was processed, resulting in the recovery of larger quantities of natural gas liquids, thus continuing an upward trend begun in 1960. Refineries were operated near Santa Maria by Douglas Oil Co. of California and Union Oil Co. of California.

Johns-Manville Products Corp. and Great Lakes Carbon Corp. mined and processed diatomite near Lompoc for filtration and insulation uses. Near Santa Maria, The Airox Co. mined and processed diatomite for lightweight aggregate and pozzolan. Diatomic Chemical Co. mined and processed diatomite from a deposit north of Lompoc and ground, calcined, and screened the material for sale as an absorbent.

Over 1 million tons of sand and gravel was produced, principally for road projects, building, and paving in and around Vandenburg Air Force Base. Limestone quarried near Lompoc and sandstone from near Rincon was used for riprap and base material. A large

tonnage of dimension stone was obtained from several quarries for building construction. At Betteravia, Union Sugar Division, Consolidated Foods, calcined purchased limestone for carbon dioxide and lime used in beet sugar refining.

Ore from the Gilbralter mine, north of Santa Barbara, was retorted to recover several flasks of mercury. A small quantity of mercury also was retorted from ore produced at the Apex mine.

Santa Clara.—At Permanente, Kaiser Cement & Gypsum Corp. operated the State's largest producing cement plant. Annual capacity of the plant was 8.5 million barrels. The company shipped portland cement in bulk and bags to California, out-of-State, and foreign customers. Raw materials for use in making cement came from a limestone quarry in the Los Altos hills and a clay pit in the Cupertino area. Sandstone and miscellaneous stone were obtained from quarries in the Palo Alto, San Jose, and Los Altos areas for use as base material and concrete aggregate. Nearly 3 million tons of sand and gravel was produced, mainly for highway projects in the San Jose, Cupertino, and Mountain View areas. Remillard-Dandini mined clay near San Jose and sold it to manufacturers of heavy clay products.

The combined mercury output at the New Almaden mine by 10 lessees totaled more than 1,500 flasks. Of these, San Jose Mining Co. was by far the major producer. Mercury production rose sharply at the Guadalupe mine where ore was retorted to recover 809 flasks of the metal.

Santa Cruz.—Pacific Cement & Aggregates, Inc., produced portland cement in its dry-process plant at Davenport, using shale and limestone from its own nearby quarries. The company shipped cement in bulk and bags. Most of the output went to ready-mixed concrete operations in northern California. Ideal Cement Co. quarried shale near San Juan Bautista for use in its San Benito County cement plant. Pacific Limestone Products, Inc., quarried limestone near Santa Cruz for building stone and poultry grit. Granite was quarried near Felton and Soquel and used as base material and concrete aggregate. Over 1 million tons of sand and gravel, mostly sand, was produced from deposits in the Felton, Santa Cruz, and Scotts Valley areas. Much of the material was shipped to projects in the peninsula counties, including San Francisco.

Shasta.—Calaveras Cement Co. produced portland cement in its dry-process plant at Redding. The company shipped cement to customers in northern California and out-of-State. Calaveras obtained its raw materials from clay pits near Redding and its nearby Gray Rock limestone quarry. Some limestone was sold to sugar refineries.

Nearly 1.8 million tons of sand and gravel was produced by commercial operators in the Redding, Cottonwood, and Hot Creek areas and by contractors for Federal, State, and county agencies, principally for base material and concrete aggregate. Stone was quarried at several locations by Government crews and contractors for rubble, riprap, and base material. A fluidized-bed lime regenerator was installed at the Anderson papermill of Kimberly-Clark Corp. to reclaim lime sludge. During the break-in period the company purchased makeup lime. Volcanic cinder was mined by State highway crews for road maintenance and repair, and on the H&H Ranch near Glenburn and

near Fall River Mills for the same use. Stewart Masonry Supply mined volcanic cinder from the Black Butte near Manton for lightweight concrete aggregate. A contractor mined barite from the Loftus claims and trucked the mineral to a Sacramento County grinding plant.

Mountain Copper Co. recovered cement copper from the mine water of its idle Hornet pyrite mine at Iron Mountain and shipped it to the producer's chemical plant in Contra Costa County. Mountain Copper also shipped iron ore from stockpile at its Iron Mountain mine to a domestic steel plant. Gold ore and cleanup operations at two properties in the French Gulch area and ore from the Leonard gold mine in the Shasta area yielded recoverable gold and silver. Byproduct placer gold and silver were recovered in the Shea Sand and Gravel washing plant near Redding. Individuals panned stream gravels in the Cottonwood Creek, Igo, and Shasta areas and recovered small quantities of placer gold.

Sierra.—Five lode gold mines were active, but only the Original 16 to 1 mine at Alleghany and the Brush Creek mine near Goodyears Bar yielded significant quantities of gold and silver. Except for Condor Exploration Co., Inc., operation in ancient riverbed gravels in the Downieville area, all placer gold and silver was recovered by individuals who worked stream gravels by small-scale hand methods in the Alleghany, Downieville, Poker Flat, and Poverty Hill areas.

State highway contractors produced sand and gravel and quarried granite for use in highway projects in the Sierra City, Downieville, and Loyalton areas. The Crystal Peak quartz mine was idle throughout 1964.

Siskiyou.—Some sand and gravel and stone was produced for State and county highway maintenance and repair. Most of the output of these materials and nearly half the volcanic cinder production was by and for the U.S. Forest Service for use in road construction within the National Forest. Over 30,000 tons of volcanic cinder was mined by building supply and block companies for concrete aggregate and admixture, about 8,000 tons was used for railroad ballast, and more than 4,000 tons was used for roofing granules and landscape rock. About 13,500 tons of pumice was mined in the Tulelake area and used for lightweight aggregate. Over 200 tons of clay was mined on Forest Service land and sold to producers of heavy clay products.

Ores from three small gold properties—near Poker Flat, north of Orofino, and in the Mule Creek area—were treated to recover several ounces of gold and silver. A dragline operation at the Humbug claims on the Klamath River yielded all but a few ounces of the total placer gold and silver recovered in the county. Small quantities of placer gold were panned from stream gravels on the Scott River by several individuals. Several flasks of mercury were recovered by a combination flotation-leaching operation in treating ore at an open pit mercury prospect near Cinnabar Springs.

Solano.—Production of natural gas was virtually the same as in 1963 and was third highest among the State's dry gas producing counties. During the year Standard Oil Co. of California made a new formation discovery in the Lower Zone of the Martinez formation in the Suisun Bay field. Initial production from the new zone was about 2.5 million cubic feet a day.

Basalt was quarried at the Griffin and Goodyear properties near Benecia and from the Cordelia quarry for use as riprap, base material, and concrete aggregate. At the Tolenas quarry near Fairfield, building stone and terrazzo chips were produced. Roadstone and screenings for fill were obtained from the Solano Red Rock quarry near Benecia. Sand and gravel was produced for paving and fill from pits near Vallejo, Vacaville, and Benecia.

Sonoma.—Nearly 3 million tons of sand and gravel was produced, much of which came from deposits near Healdsburg and Windsor. Most of the output was used in structures and paving projects as far south as Marin County. Basalt and miscellaneous stone was quarried in the Petaluma, Forestville, and Sonoma areas for riprap, base material, and concrete aggregate. Dimension building stone and flagging was produced at the Trinity quarry near Glen Ellen. A small tonnage of stone was quarried by on-site contractors for use in State highway projects. Near Santa Rosa, the Mark West shale pit was the source for fill uses in road construction.

Dump material from the Culver-Baer property in The Geysers area and ore from the Eagle Rock lease and the reactivated Mt. Jackson mine was furnaced to recover mercury. Ores from the Socrates mine in the same area and from the Contac prospect near Castle Peak were retorted to recover the metal.

A very small quantity of dry natural gas was produced from the Petaluma field. The total volume withdrawn was about 33 percent below that in 1963.

Stanislaus.—Sand and gravel production rose nearly 1.4 million tons. Stationary and portable plants near Modesto, Escalon, Waterford, Newman, and Patterson supplied the materials for building and paving aggregate. Large tonnages also were used in highway projects in the Ceres, Modesto, and Waterford areas, and for the Central Valley Project. Ball clay and miscellaneous clay were mined in the Oakdale and Knights Ferry areas by E. H. Metcalf and Western States Materials. The ball clay was sold for use in making whiteware and the other clays were used in making heavy clay products. Fire clay was mined near La Grange by Kraftile Co. and used in heavy clay products.

Two sand and gravel washing plants, one on the Stanislaus River near Oakdale and another on the Tuolumne River near La Grange, recovered byproduct placer gold and silver. A few tons of ore from the Adobe Valley mine at Red Mountain was retorted to recover a couple flasks of mercury.

Sutter.—Dry natural gas output rose 12 percent above that in 1963. Fields in the county yielded more dry gas than any county except Sacramento. Much of the rise was due to increased withdrawals from the Sutter Buttes and Grimes fields where 3 and 15 new wells, respectively, were completed during 1964.

Sand and gravel deposits in the Live Oaks and Nicolaus areas were worked for road base material and cobbles used in river embankments. Additional tonnages of sand and gravel for local needs were supplied by producers in other counties, particularly Yuba County. International Pipe & Ceramics Corp. mined clay near Nicolaus and used the material in making heavy clay products. At Sutter, Yuba Minerals

& Milling Co. operated a grinding plant for processing nonmetallic minerals for its own use. The company also did custom grinding.

Tehama.—Nearly 700,000 tons of sand and gravel was produced from deposits near Red Bluff, Richfield, and Elder Creek, by commercial operators and by Government crews and contractors. Much of the output was used in structures and paving on U.S. Highway 99. Crews and contractors for the Bureau of Reclamation and the U.S. Forest Service quarried basalt for use by the agencies. County crews also quarried stone for rubble and riprap. State highway crews mined volcanic cinder for use in the maintenance and repair of roads.

A relatively small volume of natural gas was withdrawn from the county's four fields. Overall production was down about 5 percent from 1963. The Kirkwood field yielded nearly 80 percent of the total. A new field discovery, the Red Bank Creek field, was made by Kenyon Sills when he found production in the Forbes formation.

Trinity.—Sand and gravel was produced for local construction projects at preparation plants in the Weaverville area. Government crews and contractors also produced the materials for use in road maintenance and repair. Stone was obtained from the Island Mountain quarry for riprap and fill. Clays were dug from deposits on National Forest land and sold or used for making heavy clay products.

Ore from two lode mines in the Hayfork area and one in the Trinity River area was treated by amalgamation and the resulting bullion shipped to the U.S. Mint. One hydraulic operation and a small suction dredge recovered placer gold and silver from stream and bench gravels along the Trinity River. Individuals panned and sluiced stream gravels in the same area and recovered small quantities of placer gold and silver.

Tulare.—Deer Creek oilfield and a portion of the Trico gasfield yielded all the county's petroleum and dry natural gas. Crude oil production was 7 percent less than in 1963, and dry natural gas output was 4 percent lower.

Sand and gravel was produced at stationary plants in the Porterville, Lemon Cove, and Woodlake areas by county and U.S. Forest Service maintenance crews and by State highway on-site contractors. Limestone was quarried near Orosi for rough and dressed building stone and near Porterville for use as a filler in animal food and for poultry grit. Stone also was quarried by crews and contractors for the State Division of Forestry, National Park Service, and U.S. Forest Service and used for rubble, riprap, and road base.

Macco Corp. relinquished its lease on the Barite King property and sold its Little Lake, Inyo County, jigging plant to Warrington Bros. Warrington began mining at the Baro barite claims in the Bald Mountain area above Nine Mile Canyon. The operator shipped the mineral to grinding plants in Kern and Los Angeles County. S. P. Brick Co. mined clay near Exeter and used it in making heavy clay products.

Tuolumne.—The Flintkote Co. quarried limestone at Columbia and Sonora. The company used the stone to make lime for the construction, chemical, and other industries and sold the materials for agricultural use and to the glass industry. Sonora Marble Aggregates Co. quarried marble in the Sonora area for terrazzo. Stone from the Tunes

quarry near Twain Hart was used for drain rock and fill. County and U.S. Forest Service crews quarried stone for road maintenance and repair. These crews also produced about 9,000 tons of sand and gravel for the same use. Pacific Clay Products Co. produced low-grade diatomite from a deposit near Knights Ferry for experimental use.

Garn L. Moody mined uranium ore at his Juniper mine near Pinecrest and shipped it to a Utah processing plant. Gold ore from the Lazar prospect near Bald Mountain was treated by amalgamation to recover gold and silver. Some free gold was recovered at the Fenton claims in the Big Oak Flat area in addition to bullion recovered in treating the ore. Individuals panned stream gravels along the Tuolumne River for small quantities of placer gold.

Ventura.—Crude oil production was 9 percent below the 1963 output, and the natural gas yield from oil zones dropped 10 percent. A normal decline occurred in most older oilfields. However, large crude oil production declines were reported in other fields: West Montalvo production was down 29 percent; Fillmore and Barsdall, 25 percent; Oxnard, 22 percent; South Mountain, 18 percent; and Saticoy and Rincon, 7 percent each. Output at the Shiells Canyon field was up 61 percent with three new well completions, that at the Ojai field, where four new wells were completed, was up 21 percent, and that at the Sespe Canyon group, which had six new wells completed, was up 19 percent. Production of natural gas liquids at the county's 10 processing plants was lower, continuing a decline begun in 1960. Seven percent less wet gas was processed than in 1963. Dry natural gas output, though relatively small, was up 85 percent.

Nearly 4 million tons of sand and gravel was produced at stationary and portable plants, principally for building and paving, although large tonnages were consumed in public works structures and for road base and concrete aggregate in State highway projects near Santa Paula and El Rio. Western Lime Products Co. quarried shell limestone from the ancient Tapo Alto oystershell deposit and sold the material to producers of animal feeds and poultry grit. Sandstone was quarried at Rincon, La Jolla, Serrano, and Oxnard for riprap in shoreline and beach protection, both public and private, and in construction of facilities for various Government agencies. Shale was quarried near Ventura by Rocklite Products, Inc., and near Frazier Park by Ridgelite Products, Inc. Both producers expanded the shale for use as light weight aggregate. Monolith Portland Cement Co. quarried gypsum near Maricopa for use in its Kern County cement plant.

Yolo.—About 1.7 million tons of sand and gravel was produced by commercial operators and public works crews and contractors. The output came mainly from deposits in the Madison, Woodland, and Yolo areas. Although most of the sand and gravel was used in the State highway project in West Sacramento, building and paving projects in the county required larger tonnages than in 1963. American Crystal Sugar Co. at Woodland, used purchased limestone to produce carbon dioxide and lime needed in beet sugar refining.

A relatively small volume of dry natural gas was produced from four fields, a drop of 25 percent from 1963 which is attributed to normal decline. Franco Western Oil Co. discovered a new producing for-

mation in the Fairfield Knolls field when production was found in the Winters formation. However, at yearend the field was still shut-in.

Yuba.—Yuba Consolidated Gold Fields operated three bucketline dredges on the Yuba River in the Marysville area and recovered a high percentage of the State's placer gold and silver output. The company not only was California's leading gold producer but also the sole producer of platinum-group metals, recovered as a byproduct of gold dredging. Except for the Good Luck "7" Mining Co. operation near Challenge, the county's placer gold and silver was recovered by individuals who sluiced and panned stream gravels in the Camptonville, Dobbins, Smartville, and Strawberry areas. All lode mines in the county were idle.

Over 1 million tons of sand and gravel was produced, principally from old dredge tailings along the Yuba River near Marysville. The output was used in State, county, and local road projects in both Yuba and Sutter Counties, and by the U.S. Corps of Engineers for structures. Stone was quarried for riprap by Government contractors for flood control and embankments. International Pipe & Ceramics Corp. dug clay near Wheatland and used it in making drain tile and sewer pipe.

The Mineral Industry of Colorado

By Carl L. Bieniewski [1] and Joseph N. Harstead [2]

MINERAL PRODUCTION in Colorado was valued at $316 million—a decrease of $1.1 million (less than 1 percent). The State continued to lead the Nation in output of molybdenum and vanadium and was one of three States that produced beryllium, tin, and vermiculite. Record outputs were established for lime, peat, stone, and tin. Petroleum had the largest output value, $100.1 million, one-third of the State total value of mineral production.

Mineral fuels accounted for 45 percent ($144 million) of the value of mineral production, metals 39 percent ($121.9 million), and nonmetals 16 percent ($50.1 million). Of the 32 mineral commodities produced, 19 increased in output value and 13 decreased. Eighteen mineral commodities each had a production value over $1 million.

Nine mines produced 99 percent of the copper, 98 percent of the zinc, 95 percent of the lead, 95 percent of the silver, and 89 percent of the gold. They were Brenneman, Silver Wing, and Sunnyside in San Juan County, Cascade in Clear Creek County, Eagle in Eagle County, Emperius in Mineral County, Idarado in Ouray and San Miguel Counties, Keystone in Gunnison County, and Rico Argentine in Dolores County.

Of the 63 counties in the State, only Phillips County had no mineral production. Thirty-four counties had increases in value of mineral production; 28 had decreases. Of 29 counties that had production exceeding $1 million, 11 had production exceeding $10 million. Lake County had the highest value of mineral production, $70.7 million, followed by Rio Blanco with $56.5 million; these two counties accounted for 40 percent of the State value.

Employment and Injuries.—Table 3 shows 1963 final and 1964 preliminary employment and injury data in the mineral industries, excluding the mineral fuels except coal. The data were collected and compiled by the Federal Bureau of Mines.

Government Programs.—The Office of Minerals Exploration (OME) executed a contract in May with W. S. Moore Co. to explore for gold and silver by trenching and drilling in Rio Grande County; total cost of the work was estimated at $81,680, with Federal Government participation of 50 percent ($40,840).

Repayment to the Federal Government was completed in May of a $33,458.28 exploration assistance contract by New Idria Mining &

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TABLE 1.—Mineral production in Colorado [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate—short tons, gross weight	751	W	W	W
Carbon dioxide (natural)—thousand cubic feet	224,856	$38	211,830	$36
Clays—thousand short tons	686	1,334	558	1,275
Coal (bituminous)—do	3,691	21,888	4,355	23,427
Copper (recoverable content of ores, etc.)—short tons	4,169	2,568	4,653	3,034
Gem stones	[2]	63	[2]	80
Gold (recoverable content of ores, etc.)—troy ounces	33,605	1,176	42,122	1,474
Gypsum—thousand short tons	99	346	100	398
Iron ore (usable)—thousand long tons, gross weight	W	W	35	231
Lead (recoverable content of ores, etc.)—short tons	19,918	4,302	20,563	5,388
Lime—thousand short tons	128	2,104	138	2,193
Mica (scrap)—short tons	440	7	----	----
Molybdenum (content of concentrate)—thousand pounds	47,977	67,168	46,378	69,207
Natural gas (marketed)—million cubic feet	105,705	12,367	114,312	13,489
Natural gas liquids:				
LP gases—thousand gallons	91,309	4,171	88,916	3,894
Natural gasoline and cycle products—do	56,869	3,191	52,400	2,845
Peat—short tons	13,774	98	27,931	188
Petroleum (crude)—thousand 42-gallon barrels	38,283	110,255	34,755	100,094
Pumice—thousand short tons	60	87	61	114
Sand and gravel—do	20,385	20,929	20,746	22,227
Silver (recoverable content of ores, etc.)—thousand troy ounces	2,307	2,951	2,626	3,396
Stone—thousand short tons	2,510	5,693	3,217	6,805
Uranium ore—short tons	1,014,206	15,864	833,282	13,389
Vanadium—do	3,047	W	3,312	9,916
Vermiculite—thousand short tons	[3]	1	[3]	1
Zinc (recoverable content of ores, etc.)—short tons	48,109	11,065	53,682	14,602
Value of items that cannot be disclosed: Cement, feldspar, fluorspar, perlite, pyrites, salt, tin, tungsten concentrate, and values indicated by symbol W	XX	[4] 29,478	XX	[5] 18,308
Total	XX	r 317,144	XX	316,011

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] Weight not recorded.

[3] Less than ½ unit.

[4] Value of metals, $11,653,000; value of nonmetals, $17,825,000.

[5] Value of metals, $1,291,000; value of nonmetals, $17,017,000.

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

(Millions)

Year	Value	Year	Value
1953	$236	1959	$319
1954	281	1960	344
1955	308	1961	r 344
1956	336	1962	r 304
1957	335	1963	r 308
1958	309	1964	301

r Revised.

Chemical Co. and a subsequent leasing company; the contract had been established to explore for uranium on the New Idria-Johnnie Mae group of claims in Mesa County.

Negotiations continued throughout the year between the U.S. Atomic Energy Commission (AEC) and Mining and Metals Division, Union Carbide Corp., on a stretchout agreement for production of

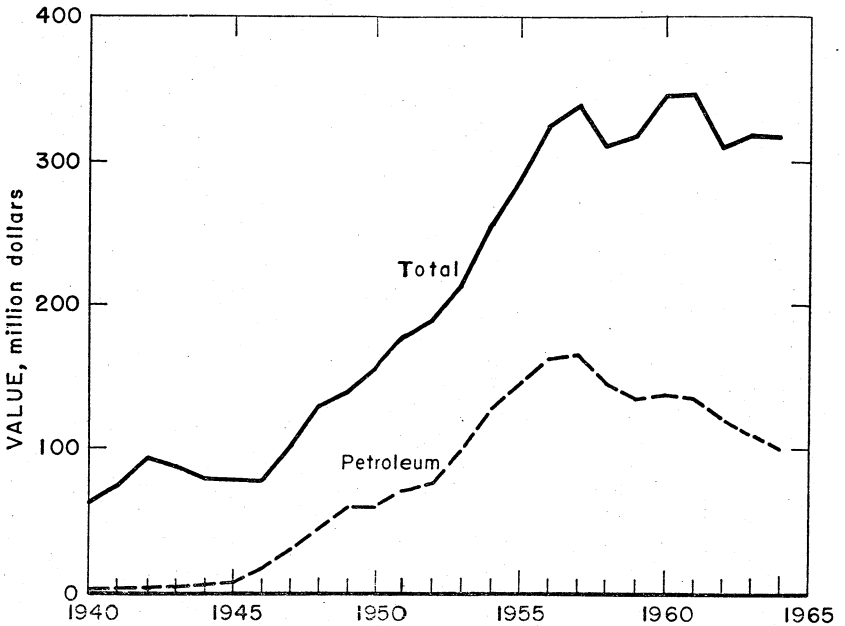


FIGURE 1.—Value of petroleum and total value of mineral production in Colorado.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	1,433	291	2,281	1	105	46
Metal	4,526	1,078	8,616	3	306	36
Nonmetal	437	82	655		12	18
Sand and gravel	1,047	226	1,836		50	27
Stone	899	174	1,388	1	46	34
Peat	10	2	12			
Total	8,352	1,853	14,788	5	519	35
1964: p						
Coal	1,487	297	2,310	3	99	44
Metal	4,645	1,155	9,292	9	422	46
Nonmetal	360	60	475		13	27
Sand and gravel	1,170	252	2,048		46	22
Stone	940	186	1,482		70	47
Peat	25	3	22		1	46
Total	8,627	1,953	15,629	12	651	42

p Preliminary.

uranium concentrates from the company uranium mills at Rifle and Uravan. Under such an agreement the company was to defer delivery into 1967 and 1968 of a part of uranium concentrates originally scheduled for delivery by December 31, 1966; AEC was to purchase from the company an additional quantity during 1969 and 1970 equal to the amount deferred and delivered in 1967 and 1968.

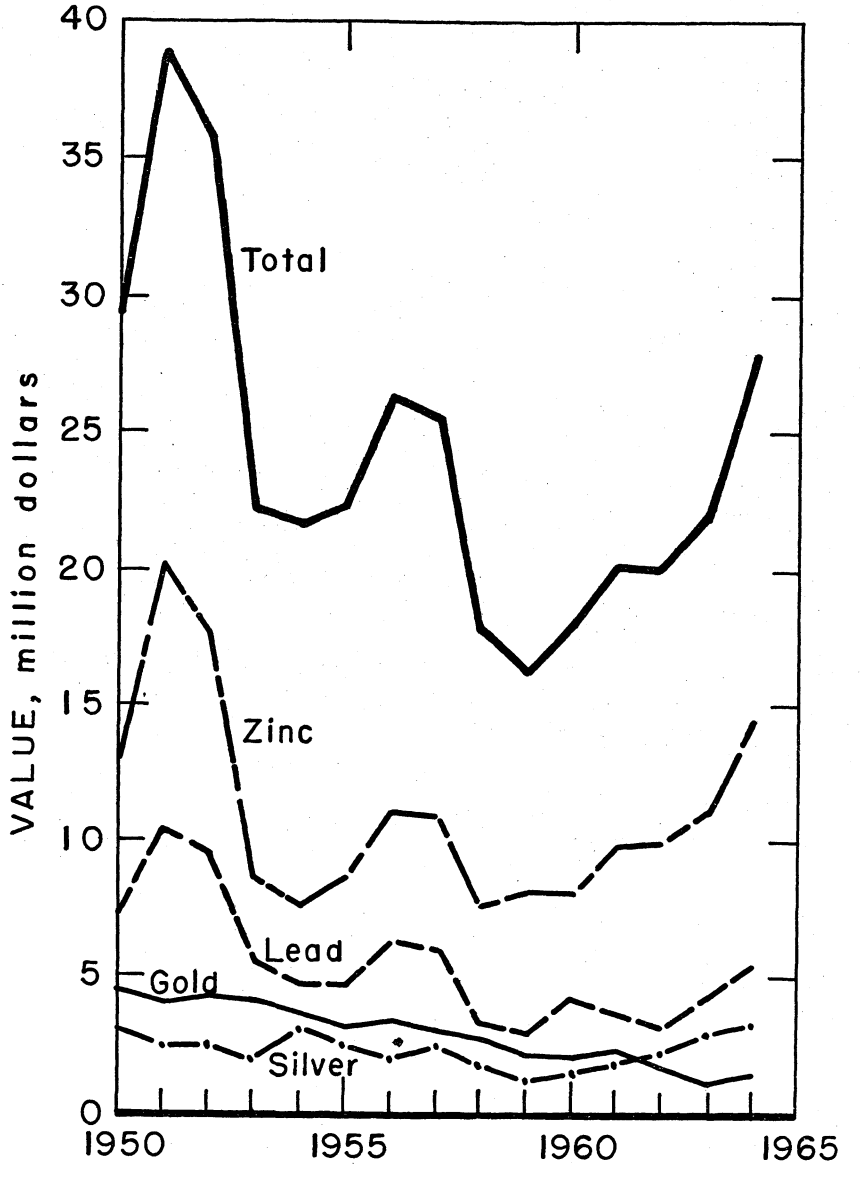


FIGURE 2.—Value of mine production of gold, silver, lead, and zinc, and total value of these minerals (including copper) in Colorado.

Federal, State, and industry special advisory boards and committees studied the oil shale situation during the year. Secretary of the Interior Stewart L. Udall appointed an Oil Shale Advisory Board of seven private citizens in June to assist the U.S. Department of the Interior in forming long-term policies and solving problems associated with the development of oil shale in Colorado, Utah, and Wyoming. One of the appointed board members was Dr. Orlo E. Childs, president of the

Colorado School of Mines. H. A. (Dave) True, Jr., president of the Independent Petroleum Association of America, formed a 23-man special committee in March to study all matters related to oil shale; named to the committee were five Denver men: Bruce Anderson, W. T. Blackburn, Collis P. Chandler, Jr., James S. Holmberg, and Ted P. Stockmar. In December 1963, Governor John Love established a 16-member advisory committee for developing an oil-shale industry in the State.

A Congressional report [3] described the geology, mineral industry, and water resources of Colorado.

At yearend, the Area Redevelopment Administration announced the completion of a study [4] on the feasibility of building a smelter utilizing the Imperial process developed in England; the smelter—for treating base-metal ores and concentrates from Arizona, Colorado, New Mexico, and Utah—was to be located in Colorado.

Construction projects financed by Federal, State, county, and municipal funds accounted for a large part of the production of cement, sand and gravel, and stone. State highway construction contracts awarded during the year totaled $60.5 million.[5] Two-thirds of the funds were for constructing roads in the National System of Interstate and Defense Highways. Of the 945.9 miles in this system designated for Colorado, 406.6 miles was open to traffic at yearend; 288.1 miles was either in the construction, engineering, or right-of-way phase; and 251.2 miles had not been started.[6] In December the Straight Creek pioneer bore tunnel for Interstate Highway 70 was completed; total length of the tunnel was 8,383 feet. Construction of the first of two roadway tunnels was to begin in 1965. Road construction on 223.8 miles of roads was completed under the Federal-Aid Program for Primary and Secondary Highway Systems (ABC program).

Other major heavy construction in progress during the year was the building of the Morrow Point and Blue Mesa dams of the Curecanti project (Federal Bureau of Reclamation), the Ruedi dam of the Fryingpan-Arkansas project (Federal Bureau of Reclamation), and the Homestake dam of the Homestake Transmountain Water Diversion project (municipalities of Aurora and Colorado Springs).

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt and Related Bitumens (Gilsonite).—Gilsonite, a brittle variety of asphalt mined at Bonanza, Utah, was processed at the American Gilsonite Co. refinery near Fruita. Metallurgical coke, diesel fuel, gasoline, kerosene, and a tar byproduct used for highway surfacing were produced at the refinery. In the fall, the company announced

[3] U.S. Geological Survey. Mineral and Water Resources of Colorado. Committee Print. Committee on Interior and Insular Affairs, U.S. Senate, 88th Congress, 2d Session, 1964, 302 pp.

[4] F. B. Turck & Co., Inc. A Study of Non-Ferrous Metal Refining Opportunities in the Four Corners States. U.S. Dept. of Commerce, Area Redevelopment Administration, January 1965, 246 pp.

[5] Engineering News-Record. State Highway Contract Awards Jump to a Record High. V. 174, No. 12, Mar. 25, 1965, pp. 30–32.

[6] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65–10, Feb. 11, 1965.

plans to build an $800,000 de-ashing unit at the refinery. The unit, scheduled for completion in mid-1965, was to process gilsonite from the Independence vein, a new vein developed at the company mines in Utah. The ore in the vein contained fine silt which could not be removed by existing processing facilities at the refinery. Anticipated as a byproduct of processing this ore was a premium grade of metallurgical coke.

Carbon Dioxide.—Marketed carbon-dioxide production, decreasing 6 percent, came from three fields: McElmo in Montezuma County, Nina View in Las Animas County, and McCallum in Jackson County. The output from the McCallum field was oil-contaminated and thus of limited use. Gas from the Nina View field was processed at a plant in Bent County; gas from the other fields was processed at plants in the same county as the field. Almost 99 percent of the carbon dioxide produced in the State was vented.

Coal (Bituminous).—Coal production of 4.4 million tons was the largest since 1949 when production had been 4.6 million tons. Output was from 82 mines; 73 underground mines and 9 strip mines, compared with 74 and 8, respectively, in 1963. Production from underground mines was 3.4 million tons, and that from strip mines, 946,000 tons. The average price per ton of coal sold from underground and strip operations was $5.92 and $3.43, respectively. Coal output came from the same 15 counties that reported production in 1963; all, except El Paso, Fremont, and Garfield Counties, recorded increases. Routt, Las Animas, and Weld Counties (listed in order of output) had a total production of 2.4 million tons, slightly more than one-half of the total State output.

The electric utility industry was the major consumer of coal; most of the coal used for generating electricity came from strip mines in Montrose and Routt Counties. The steel industry in Colorado and Utah was the next largest consumer; coal used for making steel came from underground mines in Gunnison, Las Animas, and Pitkin Counties.

The largest generating unit in the State began operating at the Valmont powerplant of Public Service Co. of Colorado (PSC) near Boulder. Capable of generating 196 megawatts, this fifth unit raised the capacity to 320 megawatts. With the five units in operation, the annual consumption of coal at the plant was expected to exceed 500,000 tons.

In the latter part of the year, Seneca Coals, Ltd., owned by Peabody Coal Co., began mining operations at the Seneca strip mine near Hayden. The coal was stockpiled for use at the 150-megawatt Hayden powerplant of Colorado-Ute Electric Association which was nearing completion and scheduled to begin operations early in 1965. Annual coal consumption of the plant was expected to be about 500,000 tons.

Ten western and southwestern utility companies, including PSC, formed Western Energy Supply & Transmission Associates (WEST) for developing power-generation and transmission facilities in a 9-State area consisting of Arizona, Colorado, New Mexico, and Utah and parts of California, Idaho, Nevada, Texas, and Wyoming. Officials of WEST stated that the development would call for power generation from coal and other fossil fuels requiring the equivalent of

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

(Excludes mines producing less than 1,000 short tons)

County	1963		1964	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Delta	34,407	$5.79	62,576	$5.08
El Paso	[2] 737,049	[2] 7.54	[3] 930,898	[3] 7.52
Fremont	321,966	3.78	292,704	3.78
Garfield	8,266	7.48	8,234	7.47
Gunnison	156,314	5.95	462,985	5.94
Huerfano	42,627	6.52	49,921	6.10
La Plata	25,006	4.30	26,780	4.25
Las Animas	772,396	9.54	801,484	6.40
Mesa	78,462	5.45	92,843	5.43
Moffat	[2]	[2]	[3]	[3]
Montrose	[2]	[2]	[3]	[3]
Pitkin	[2]	[2]	[3]	[3]
Rio Blanco	6,587	6.33	[3]	[3]
Routt	786,401	3.49	861,373	3.46
Weld	721,031	4.11	765,447	4.12
Total	3,690,512	5.93	4,355,245	5.38

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes a 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] Production of Moffat, Montrose, and Pitkin Counties combined with that of El Paso County to avoid disclosing individual company confidential data.

[3] Production of Moffat, Montrose, Pitkin, and Rio Blanco Counties combined with that of El Paso County to avoid disclosing individual company confidential data.

10.5 million tons of coal per year by 1971, 50 million tons by 1978, and 105 million tons by 1986. One of the first projects considered was the development of a giant coal-fueled powerplant in the Four Corners area of Arizona, Colorado, New Mexico, and Utah.

Mr. Donald Haske, a former State Coal Mine Inspector, was appointed Chief Coal Mine Inspector by the Colorado State Civil Service Commission on February 17, 1964. He replaced Mr. Thomas Allen who retired at the end of 1963.

Natural Gas.—Marketed natural gas increased 8 percent. Dry-gas production [7] increased from 66 to 67.5 billion cubic feet; wet (oil well) gas production decreased from 68.3 to 63.9 billion cubic feet. Natural-gas sales totaled 83.8 billion cubic feet, 81 percent dry gas and 19 percent wet gas.

Rio Blanco was ranked first among the counties in gas production, mostly wet gas from the Rangely field. The wet gas was processed for the recovery of liquids; the residual (dry gas) was returned to the reservoir to increase oil recovery. La Plata County was ranked second in gas production; nearly all was dry gas from the Ignacio-Blanco field. La Plata County was ranked first in gas sales.

To meet fuel requirements during the cold winter months, natural gas was taken from storage in the abandoned Leyden coal mine, about 14 miles northwest of Denver. The storage facility, believed to be the only one of its kind, had a capacity of 3 billion cubic feet.

Garfield Gas Gathering Co., Denver, received approval from the Federal Power Commission to construct a $6.1 million, 113-mile pipe-

[7] The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil & Gas Statistics, 1964, part II. All petroleum and natural gas figures cited in the county section also are from this work.

line to provide outlets for natural gas from shut-in gasfields of the Piceance basin in western Colorado.

Natural Gas Liquids.—Natural gas liquids were recovered at 14 plants, one more than in 1963. The new plant, built by Continental Oil Co. near Fruita, had a daily capacity of 20 million cubic feet. The Associated Oil & Gas Co. plant at the Lewis Creek field in Logan County was abandoned in June. According to the Colorado Oil and Gas Conservation Commission [8] total intake (14 plants) was 85.5 billion cubic feet, and total recovery was 3.4 million barrels (144 million gallons); the intake was 4 percent more and the recovery 5 percent less than in 1963. The intake included dry gas which was compressed but not processed for liquid recovery.

Oil Shale.—On May 1, the Federal Government's experimental oil-shale facilities at Anvil Points near Rifle were leased for 5 years to the Colorado School of Mines Research Foundation, Inc. The Foundation, in turn, contracted with Socony-Mobil Oil Co., Inc., to perform oil-shale research for Socony, Humble Oil & Refining Co., and other parties that wished to enter a cooperative research agreement concluded by Socony and Humble. By yearend Continental Oil Co.; Pan American Petroleum Corp.; Phillips Petroleum Co.; and Sinclair Research, Inc., a division of Sinclair Oil and Gas Co., had joined Socony and Humble in the venture. Scheduled at the outset was an investigation to be conducted in two 18-month stages. Stage 1, estimated to cost $2 million, was to comprise relatively small-scale studies with 6-ton and 25-ton retorts used by the Federal Bureau of Mines in its earlier research. This work was to establish process variables and to define as precisely as possible several potential operating problems. Stage 2, at an estimated cost of $3 million, was to be undertaken only if an evaluation of Stage 1 indicated that it was warranted. The second stage was to encompass large-scale experiments in retorting and possibly some mining research.

The first symposium devoted exclusively to oil shale was held at the Colorado School of Mines April 30 and May 1. The interest in oil shale was reflected in that registrants to the symposium came from 146 companies, 24 States, and 4 countries.

Colony Development Co., formed by Standard Oil Co. (Ohio), Cleveland Cliffs Iron Co., and Oil Shale Corp., awarded a contract to Bechtel Corp. of San Francisco, Calif., to build a prototype plant near Grand Valley to produce oil from oil shale; completion of the plant was scheduled for mid-1965.

The Federal Bureau of Mines published a report describing the mining of oil shale at Rifle.[9]

Peat.—Peat production of 27,931 tons was twice that of the previous high set in 1963. The greater output resulted from the increased demand for peat as a general soil conditioner; all the peat was used directly for soil improvement, except for about 6,000 tons which was used in mixed fertilizers. Of the total production, 54 percent was moss peat, 36 percent humus peat, and 10 percent reed-sedge peat. About two-thirds of the output was sold as excavated; the remainder

[8] The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil & Gas Statistics, 1964, part IV.

[9] East, J. H., Jr., and E. D. Gardner. Oil-Shale Mining, Rifle, Colo., 1944–56. BuMines Bull. 611, 1964, 163 pp.

was processed with shredders, hammermills, grinders, and screens. The average price per ton for unprepared peat was $5.95, and for processed peat, $8.11. In addition to Boulder, Gilpin, Park, and Teller Counties which had outputs last year, peat also was produced in Lake and La Plata Counties. Production came from 14 operations, 9 more than in 1963.

Petroleum.—Petroleum production decreased 3.5 million barrels or 9 percent below that of 1963. Fifty-two percent of the production was from Rio Blanco County; Rangely and Wilson Creek, both in Rio Blanco County, were the largest producing fields in the State. Rangely produced 44 percent of the State total. The Adena field in Morgan County was ranked third in output. The average value of crude oil at the wellhead was $2.88 a barrel.

Fluid-injection projects were underway in 37 reservoirs in 36 different fields of which the Rangely field project was the most important. According to the Colorado Oil and Gas Conservation Commission, 69 percent of production was from reservoirs into which fluid was being injected.

Wildcat and development drilling decreased 3 and 8 percent, respectively. The wildcat success ratio improved from 1 in 11 to 1 in 8. Perhaps the most significant discovery was the Pan American Petroleum Corp. No. 1 Veach (Cache field) in Montezuma County. Completed for an initial daily production of 1,434 barrels of oil, the well renewed exploratory interest in southwestern Colorado. By yearend the Cache field was ranked third in the State in daily production. Also significant was the discovery of the Comanche field in Prowers County. The discovery well, completed in the Mississippian for 40 barrels of oil daily, was the first production from pre-Pennsylvanian in eastern Colorado.

TABLE 5.—Crude petroleum production, by counties
(Thousand 42-gallon barrels)

County	1963	1964	Principal fields in 1964, in order of production
Adams	478	492	Badger Creek, Deer Trail, Middlemist, Beacon, Windy Hill.
Archuleta	79	70	Price Gramps.
Baca	262	197	Flank.
Bent	2	6	McClave, Bent's Fort.
Boulder	2	2	Boulder.
Fremont	26	24	Florence-Canon City.
Jackson	463	355	McCallum, Battleship.
Kiowa	11	16	Brandon.
La Plata	58	43	Red Mesa.
Larimer	274	393	Loveland, Fort Collins, Wellington.
Logan	4,197	3,495	Northwest Graylin, Divide, Lewis Creek, Minto, West Padroni, Yenter, Mount Hope.
Moffat	1,296	856	Iles, Danforth Hills, Williams Fork, Buck Peak.
Montezuma	367	513	Flodine Park, Cache.
Morgan	3,394	2,283	Adena, Sand River, Zorichak, Bijou, West Bijou.
Prowers	----	4	Commanche.
Rio Blanco	18,320	18,109	Rangely, Wilson Creek.
Routt	93	81	North Sage Creek, Tow Creek, Grassy Creek.
San Miguel	2	----	
Washington	7,169	6,224	Plum Bush Creek, Big Beaver, Bison, Little Beaver, Rush Willadel, Blade.
Weld	1,790	1,592	Black Hollow, Pierce, Southwest Roggen, New Raymer, Indian Cave, Mustang.
Total	38,283	34,755	

Source: Colorado Oil and Gas Conservation Commission.

TABLE 6.—Oil and gas discoveries in 1964

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		
Adams County:												
Moccasin	No. 1 R.M. Hough	Cardinal Petroleum Co.	2	2 S.	57 W.	"J" Sandstone	5,440–5,451	5,532	274		Nov. 23	Flowed. New field.
Apollo	No. 1 State-Huckabay.	Midwest Oil Corp.	36	2 S.	57 W.	do	5,293–5,295	5,374	27		Apr. 5	Pumped. New field.
Kiowa County: Indio	No. 1 Weisenberger.	Amarillo Oil Co.	27	19 S.	49 W.	Morrow	5,120–5,126	5,607	40		Nov. 18	Do.
Larimer County: Unnamed	No. 1 Jacob & Anna M. Hirsch.	William J. Geary	31	6 N.	68 W.	Niobrara	4,970–5,208	5,208	5–10		Oct. 9	Do.
Logan County: Tomahawk	No. 1 R.G. Mathewson.	DeKalb Agricultural Association, Inc.	11	9 N.	55 W.	"J" Sandstone	5,556–5,560	5,605	240		Oct. 1	Flowed. New field.
Bonanza	No. 1 Propst	C.F. Raymond	15	10 N.	53 W.	do	4,963–4,967	5,250	242		Sept. 10	Pumped. New field.
Mesa County: Unnamed	No. 1 Hells Gulch	Fred W. Pool-Wacker Oil Co.	22	8 S.	92 W.	Mesaverde	6,155–6,545	7,939		5,000	Jan. 8	Flowed. Old well work-over.
Wallace Creek	No. 1 Kennon	Don M. Rounds-Winona Oil Co. of Delaware.	15	8 S.	96 W.	Wasatch	1,908–1,918	5,500		5,750	Feb. 10	Flowed. New field.
Shire Gulch Unit	No. 31–2 Shire Gulch.	Pacific Natural Gas Exploration Co.	2	10 S.	97 W.	Dakota	7,456–7,617	8,200		1,051	Nov. 2	Do.
Moffat County: Waddle Creek	No. 1 Durham	Alpine Oil Co., Inc.-Ken Luff & Associates.	8	4 N.	90 W.	Niobrara	2,076–3,026	3,026	144		Jan. 6	Pumped. New field.
Montezuma County: Ismay Discovery	No. 7 Ute Tribal-Government.	Champlin Oil & Refining Co., California Oil Co.	9	33½ N.	20 W.	Ismay	5,770–5,798	5,812	271	273	Mar. 1	Flowed. New field.
Cache Field	No. 1 Veach	Pan American Petroleum Corp.	2	34 N.	20 W.	do	5,428–5,578	5,744	1,434		Oct. 26	Do.

Morgan County:											
Travois	No. 1 Huddart	Sentinel Petroleum Corp.	3	4 N.	59 W.	"D" Sandstone	5,903–5,906	6,000	30	Jan. 8	Pumped. Old well work-over.
Travois	No. 1 Bisher	D & M Oilfield Specialty Co.	3	4 N.	59 W.	Hygiene	2,656–2,755	5,977	2	Mar. 22	Flowed. Old well work-over.
Prowers County:											
Comanche	No. 1 Schmidt	Cleary Petroleum Co.	25	21 S.	46 W.	Mississippian	4,825–4,839	5,118	40	Aug. 9	Pumped. New field.
Rio Blanco County:											
Texas Mountain	No. 1 Government.	Walter S. Fees	17	3 S.	102 W.	Morapos	2,662–2,684	2,823		1,100	May 5	Flowed. New field.
Douglas Creek, South	No. 6 South Douglas Creek Unit.	Cities Service Oil Co.	1	4 S.	102 W.	Morrison Buckhorn	5,340–5,352 5,158–5,163	6,065		2,500 4,500	Aug. 22	Flowed. New pays.
Sedgwick County:											
Red Lion	No. 1 Sprague Brothers.	Continental Oil Co. et al.	18	10 N.	47 W.	"D" Sandstone	3,912–3,920	6,647		1,450	Mar. 9	Flowed. New field.
Washington County:											
Dorado	No. 1 Friend	Apex Oil Co.-Tipps Drilling Co., Inc.	20	3 S.	50 W.	"J" Sandstone	3,901–3,906	4,031	120	Aug. 9	Pumped. New field.
Unnamed	No. 1 Marick	Allison Drilling Co., Inc., et al.	10	3 S.	52 W.	----do----	4,329½–4,331½	4,480	20	Feb. 10	Pumped.
Buckaroo	No. 2 Nothdurft	Allison Drilling Co., Inc., et al.	27	3 S.	52 W.	----do----	4,251–4,265	4,340	98	Apr. 7	Pumped. New field.
Stem	No. 1 Lewton	Edward Mike Davis-Champlin Oil & Refining Co.	5	1 N.	52 W.	"D" Sandstone	4,574–4,580	4,750		2,045	Aug. 20	Flowed. New field.
Patrol	No. 1 Stolte	Winslow & Hayes	2	1 N.	54 W.	"J" Sandstone	4,864–4,870	4,970	120	Jan. 10	Pumped. Old well work-over.
Calhoun	No. 1 Walters	Stuarco Oil Co.-Webb Resources, Inc.	21	2 N.	49 W.	----do----	3,945–3,948	4,005	130	Nov. 26	Pumped. New field.
Pinto Field	No. 1 Theurer	Union-Texas Petroleum.	28	3 N.	52 W.	"D" Sandstone	4,672–4,688	4,850		1,000	Jan. 9	Flowed. Old well work-over.
Weld County:											
Baxter Lake	No. 1 Buehler-Carroll.	Texaco Inc	30	4 N.	68 W.	Niobrara	5,249–5,316	6,340	4		Oct. 24	Pumped. New field.
Indian Cave	No. 2 Moyer-Nore	Juniper Oil & Gas Co.-Brinkerhoff Drilling Co.	5	11 N.	56 W.	"J" Sandstone	6,400–6,405	6,475	582		Jan. 5	Flowed. New field.

Source: Petroleum Information Corp. 1964 Resume, Oil and Gas Operations in the Rocky Mountain Region.

TABLE 7.—Wildcat- and development-well completions in 1964, by counties

County	Oil	Gas	Dry	Total	Footage	County	Oil	Gas	Dry	Total	Footage
Wildcat:						Weld	2	----	20	22	135,400
Adams	2	----	8	10	61,800	Yuma	----	----	11	11	49,500
Arapahoe	----	----	1	1	5,600	Total	22	11	244	277	1,366,300
Baca	----	----	4	4	19,700						
Bent	----	----	1	1	5,800						
Boulder	----	----	1	1	3,200	Development:					
Costilla	----	----	1	1	4,700	Adams	3	----	4	[1] 8	44,800
Dolores	----	----	1	1	7,300	Baca	1	5	10	16	80,300
El Paso	----	----	1	1	6,700	Jackson	1	----	----	1	6,300
Garfield	----	----	1	1	9,000	La Plata	----	28	----	28	201,300
Gunnison	----	1	1	2	5,400	Larimer	9	----	5	14	70,900
Huerfano	----	----	1	1	2,200	Logan	12	1	14	27	157,900
Jackson	----	----	3	3	7,100	Mesa	----	12	4	16	90,900
Kiowa	1	----	1	2	10,500	Moffat	4	1	7	12	53,300
Kit Carson	----	----	3	3	18,700	Montezuma	1	1	2	4	24,900
Larimer	1	----	6	7	22,200	Morgan	----	----	11	11	60,800
Logan	2	----	33	35	184,900	Pitkin	1	----	----	1	4,900
Mesa	----	4	1	5	35,700	Rio Blanco	20	6	28	54	186,600
Moffat	3	----	16	19	109,300	Routt	1	----	----	1	4,500
Montezuma	3	----	15	18	57,300	Sedgwick	----	----	1	1	3,800
Morgan	1	----	17	18	105,900	Washington	19	----	50	69	319,000
Pitkin	----	----	2	2	7,000	Weld	5	5	15	25	163,400
Prowers	1	----	1	2	10,400						
Rio Blanco	----	3	4	7	27,600	Total	77	59	151	[1] 288	1,473,600
Routt	----	----	4	4	18,100						
San Miguel	----	----	1	1	10,200	Total all drilling	99	70	395	[1] 565	2,839,900
Sedgwick	----	1	----	1	6,600						
Washington	6	2	85	93	418,500						

[1] Includes 1 service well.

Source: Oil and Gas Journal.

Five refineries, four in the Denver metropolitan area and one at Alamosa, were operating at the end of the year. The Uinta Oil & Refining Co. plant at Rangely was shut down. Refinery throughput was 11.2 million barrels, a 15-percent drop. About 90 percent of the oil refined in Colorado was from out of State, 84 percent from Wyoming, and the remainder from Montana and New Mexico. About 96 percent of the oil produced in Colorado was shipped to refineries in Illinois, Indiana, Kansas, Ohio, Oklahoma, Pennsylvania, Utah, and Wyoming. Utah received 50 percent of the interstate shipments.

METALS

Beryllium.—Beryllium production was limited to a few short tons of hand-cobbed beryl produced by small operators. The beryl, sold to Beryl Ores Co., was used to make beryllium compounds. Lack of markets resulted in no shipments of beryllium ore from the Boomer mine of U.S. Beryllium Corp. in Park County, a major producer of beryllium ore in 1963. Beryllium concentrates, produced last year by Mineral Concentrates and Chemical Co., Inc. (Mincon) at its mill near Lake George, were processed by the company at its Loveland plant; high-purity beryllium oxide compounds were marketed.

Cadmium and Thallium.—American Smelting and Refining Co. (Asarco) obtained cadmium and thallium metal and thallium sulfate at its Globe plant in Denver from processing flue dust, dross, and other byproduct material from smelters and processing plants outside the State. The value of these products was not included in the State value of mineral production because of their out-of-State origin.

Copper.—Copper production increased 12 percent in quantity and 18 percent in value; the greater percentage in value reflected the increase in the average price which rose from 30.8 cents per pound to 32.6 cents. Output of copper came from 45 mines in 19 counties, 15 more mines than in 1963. The Idarado mine of Idarado Mining Co. in Ouray and San Miguel Counties was the largest single source of copper. Other mines that had substantial production, ranked according to output, were the Eagle mine of The New Jersey Zinc Co. in Eagle County, Keystone mine of Asarco operated by McFarland & Hullinger in Gunnison County, Silver Wing mine of Silver Wing Mining Co. in San Juan County, Emperius mine of Emperius Mining Co. in Mineral County, and Sunnyside mine of Standard Metals Corp. in San Juan County.

Gold.—Production of gold, up 8,517 ounces or 25 percent, came from 46 lode mines (11 more than in 1963), 19 placer mines, and mill and smelter cleanups. The lode mines accounted for 97.4 percent of the production, placer mines, 2.5 percent, and cleanups, 0.1 percent. Eleven of the 19 placer mines were sand and gravel operations from which gold was recoverd as a byproduct. Idarado Mining Co. was the largest single gold producer; byproduct gold was obtained from the copper-lead-zinc ore mined at its Idarado mine. San Miguel County with production from four lode mines had nearly two-thirds of the State total output of gold. Four other counties—Boulder, Eagle, Ouray, and San Juan—each had production greater than 1,000 ounces.

Iron Ore.—Output of iron ore increased substantially; six mines, compared with two in 1963, had production; two of the mines were in San Miguel County and one each in Clear Creek, Larimer, Pitkin, and San Juan Counties. Magnetite mined in Pitkin County was used for making pig iron and steel. Brown ore (limonite), produced at mines in Clear Creek, San Juan, and San Miguel Counties, was used as a soil amendment or as a paint pigment. Iron ore, not identified as to type, produced in Larimer County, was used as a soil amendment.

Lead.—Lead production increased 3 percent (645 tons) in quantity and 25 percent ($1.1 million) in value. The increase in value resulted from the average price of lead rising 2.3 cents per pound to 13.1 cents. The production came from 50 mines, 17 more than last year; the 5 largest producing, in descending order, were the Idarado mine of Idarado Mining Co., Sunnyside mine of Standard Metals Corp., Eagle mine of The New Jersey Zinc Co., Keystone mine of Asarco operated by McFarland & Hullinger, and Emperius mine of Emperius Mining Co. These mines, the only ones with lead production of 1,000 tons or more, accounted for 18,624 tons, or 91 percent, of the total output of lead. Eighteen counties had lead production, compared with 14 in 1963. San Miguel and San Juan Counties accounted for slightly more than 50 percent of the lead produced in the State.

Molybdenum.—The second largest source of mineral wealth in the State was molybdenum, accounting for 22 percent of the total value of mineral production. Shipments of molybdenum decreased about 1.6 million pounds, but because the average price increased 9.2 cents per pound, the value increased about $2 million. The Climax mine of Climax Molybdenum Co., Climax Division, American Metal Climax,

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)
1955–59 (average)	103	16	963	82,962	$2,904	2,248	$2,035
1960	70	15	809	61,269	2,144	1,659	1,502
1961	57	19	938	67,515	2,363	1,965	1,817
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
1858–1964	NA	NA	NA	40,738,695	919,731	775,487	610,648

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	4,160	$2,782	16,737	$4,645	39,023	$9,268	$21,634
1960	3,247	2,085	18,080	4,231	31,278	8,070	18,032
1961	4,141	2,485	17,755	3,658	42,647	9,809	20,132
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
1858–1964	316,528	104,969	2,836,970	343,841	2,112,645	403,571	2,382,760

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.

Inc., was again rated as the largest underground mine (based on quantity of ore mined) in the Nation; a record tonnage, 13.7 million tons of ore, was produced at the mine. However, because the mined ore was of lower grade than in 1963, the molybdenum recovered was less. Molybdenum shipped from the Climax operation represented 71 percent of the molybdenum produced in the Nation. Work progressed on the $40 million program of American Metal Climax, Inc., to expand molybdenum production. Major features of the program were the development of a new mining level at the Climax mine, construction of a plant at the Climax operation to treat mixed oxide-sulfide molybdenum ores, and mine development and construction of milling facilities at the Urad molybdenum mine, acquired in 1963, near Empire in Clear Creek County.

Nye Metals, Inc., a new producer, mined high-grade molybdenum ore of 1.24-percent MoS_2 at its Wilma mine near Black Hawk in Gilpin County.

Silver.—The emphasis on silver was reflected in increased production, 14 percent or 319,000 ounces, from 57 lode and 15 placer mines, compared with 46 lode and 13 placer mines in 1963. The value of silver production was 15 percent greater because of increased production and the change in the average price of silver from $1.279 per ounce to $1.293. Of 72 mines, the Eagle mine of The New Jersey Zinc Co. in Eagle County was the largest single source of silver, a byproduct of zinc and copper ores. Other operations with production of more than 100,000 ounces were the Idarado mine of Idarado Mining Co., Keystone mine of Asarco operated by McFarland & Hullinger, Emperius

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc, in 1964, 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		7		615	$21,525	83	$107
Boulder	2		[3] 12,678	[3] 2,318	[3] 81,130	[3] 41,761	[3] 53,997
Chaffee	1		[3]	[3]	[3]	[3]	[3]
Clear Creek	7	2	8,539	265	9,275	163,681	211,640
Custer	2		[3]	[3]	[3]	[3]	[3]
Dolores	1		[3]	[3]	[3]	[3]	[3]
Eagle	1		315,416	3,473	121,555	705,149	911,758
Gilpin	4	3	4,658	125	4,375	393	508
Gunnison	2		83,586	157	5,495	507,318	655,962
Hinsdale	4		190	62	2,170	897	1,160
Jefferson	1	4	150	343	12,005	58	75
Lake	1	1	2,031	179	6,265	1,168	1,510
La Plata	1		257	170	5,950	233	301
Larimer	1		[3]	[3]	[3]	[3]	[3]
Las Animas	1		[3]	[3]	[3]	[3]	[3]
Mineral	1		41,993	495	17,325	284,716	368,138
Montezuma			1	29	1,015	6	8
Montrose	1		19			132	171
Ouray	3		77,710	6,279	219,765	134,757	174,241
Park	2	2	832	181	6,335	15,340	19,834
Saguache	4		2,059	21	735	14,320	18,516
San Juan	7		174,333	1,239	43,365	194,724	251,778
San Miguel	4		321,120	26,104	913,640	538,677	696,509
Summit	7		5,931	67	2,345	23,018	29,762
Total:							
1964	58	19	1,051,503	42,122	1,474,270	2,626,431	3,395,975
1963	46	19	975,038	33,605	1,176,175	2,307,305	2,951,320

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Adams							$21,632
Boulder	[3] 4	[3] $2,738	[3] 511	[3] $133,869	[3] 537	[3] $145,887	[3] 417,621
Chaffee	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Clear Creek	9	5,901	120	31,374	128	34,816	293,006
Custer	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Dolores	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Eagle	1,003	653,760	3,318	869,368	27,506	7,481,714	10,038,155
Gilpin	[4]	293	1	341	2	435	5,952
Gunnison	488	317,916	2,044	535,607	3,910	1,063,520	2,578,500
Hinsdale	[4]	33	3	799	3	966	5,128
Jefferson	[4]	196	[4]	13			12,289
Lake	1	652	11	3,000	10	2,774	14,201
La Plata							6,251
Larimer	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Las Animas	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Mineral	265	172,910	1,542	403,873	2,438	663,163	1,625,409
Montezuma							1,023
Montrose	2	1,402					1,573
Ouray	453	295,160	1,713	448,714	2,325	632,318	1,770,198
Park	6	3,716	84	21,969	58	15,858	67,712
Saguache	12	7,759	110	28,755	80	21,923	77,688
San Juan	532	346,897	4,107	1,076,086	6,726	1,829,459	3,547,585
San Miguel	1,874	1,221,652	6,686	1,751,706	9,684	2,633,953	7,217,460
Summit	4	2,771	313	82,032	275	74,718	191,628
Total:							
1964	4,653	3,033,756	20,563	5,387,506	53,682	14,601,504	27,893,011
1963	4,169	2,568,104	19,918	4,302,288	48,109	11,065,070	22,062,957

[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 Boulder, Chaffee, Custer, Dolores, Larimer, and Las Animas Counties combined to avoid disclosing individual company confidential data.
[4] Less than ½ unit.

TABLE 10.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	10	7,152	1,980	11,669	1,400	2,800	3,200
Dry gold-silver	2	262	841	7,782	400	1,200	400
Dry silver	7	9,755	61	140,484	20,800	207,300	225,700
Total	17	17,169	2,882	159,935	22,600	211,300	229,300
Copper	6	34,661	2,835	472,746	2,239,600	215,200	800
Copper-lead-zinc	4	477,678	32,417	1,164,173	5,608,300	20,552,200	31,475,400
Lead	7	1,320	54	11,874	4,900	207,800	22,000
Lead-zinc	23	224,375	1,799	532,613	1,032,200	13,427,400	20,492,500
Zinc	4	294,264	878	283,660	396,400	6,489,000	55,123,300
Total	41	1,032,298	37,983	2,465,066	9,281,400	40,891,600	107,114,000
Other "lode" material:							
Gold mill cleanup	(2)	2	30	14			
Gold tailings	(2)	2,000	172	778	1,100	20,700	19,400
Silver smelter cleanup	(2)	31	4	389	900	2,200	1,000
Zinc cleanup	(2)	3	1	97		200	300
Total		2,036	207	1,278	2,000	23,100	20,700
Total "lode" material	58	1,051,503	41,072	2,626,279	9,306,000	41,126,000	107,364,000
Gravel (placer operations)	19		1,050	152			
Total all sources	77	1,051,503	42,122	2,626,431	9,306,000	41,126,000	107,364,000

[1] Detail will not necessarily add to totals because some mines produce more then one class of material.
[2] From properties not classed as mines.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	9,427	3,093			
Tailing	6	2			
Total	9,433	3,095			
Concentration, and smelting of concentrates: Ore	27,650	2,100,027	7,665,500	40,573,700	107,191,900
Direct-smelting:					
Ore	3,954	522,657	1,639,600	549,900	170,800
Cleanup	35	500	900	2,400	1,300
Total	3,989	523,157	1,640,500	552,300	172,100
Placer	1,050	152			
Grand total	42,122	2,626,431	9,306,000	41,126,000	107,364,000

mine of Emperius Mining Co., Sunnyside mine of Standard Metals Corp., and Cascade mine (Clear Creek County) of Humphreys Engineering Co. All silver from these mines was a byproduct of copper, lead, and zinc ores, except for some silver recovered from silver ore mined at the Cascade mine. Silver production was reported from 24 counties. Eagle County had the largest output, followed in

order by San Miguel and Gunnison Counties, cumulatively accounting for 67 percent of the total.

Tin.—Output of tin reached an alltime high. Tin concentrate obtained by treating tailings at the Climax molybdenum operation was sold by Climax Molybdenum Co. to Lenway Mining and Development Corp., which upgraded the concentrate at its mill near Boulder.

Tungsten.—Climax Molybdenum Co. shipped 1,200 tons of tungsten concentrate produced as a byproduct of milling molybdenum ore at Climax; the concentrate contained 70 percent WO_3. Lenway Mining and Development Corp. shipped a small quantity of tungsten concentrate obtained from processing rejected material from the tungsten circuit of the milling operation of Climax Molybdenum Co. at Climax.

Uranium Ore.—Uranium ore production declined for the third straight year as the quantity decreased 18 percent or 180,924 tons and the value 16 percent or $2.5 million. The contained U_3O_8 decreased 16 percent or 684,196 pounds; however, the average grade of the ore, 0.210 percent U_3O_8, was 0.004 percent greater than in 1963. This was the first time since 1958 that the output of uranium ore was less than 1 million tons. The number of mining operations with production was 276, 60 less than in 1963. Except for San Miguel, all counties with uranium ore production showed declines; San Miguel reported an increase of about 19,000 tons.

TABLE 12.—Mine production of uranium ore, by counties [1]

County	1963				1964			
	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]
Boulder	2	W	W	W	2	W	W	W
Fremont	4	1,740	9,946	$41,556	2	W	W	W
Grand	1	W	W	W	1	34	72	$160
Huerfano	1	321	817	2,170				
Jefferson	5	15,300	215,566	1,001,299	4	12,528	223,513	1,046,039
Larimer					2	W	W	W
Mesa	46	92,631	530,786	2,242,562	40	90,559	541,730	2,293,256
Moffat	31	W	W	W	11	W	W	W
Montezuma	1	W	W	W	1	11	42	159
Montrose	174	376,042	1,773,821	7,125,658	134	311,150	1,346,398	5,267,333
Park	2	W	W	W				
Rio Blanco	2	W	W	W	2	W	W	W
Saguache	1	17,686	265,096	1,221,554	2	W	W	W
San Miguel	66	125,513	604,374	2,489,854	75	144,046	640,703	2,597,392
Undistributed		384,973	784,570	1,739,784		274,954	748,322	2,184,382
Total	336	1,014,206	4,184,976	15,864,437	276	833,282	3,500,780	13,388,721

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.

Uranium concentrates were produced at five mills—Climax Uranium Co., a unit of Climax Division, American Metal Climax, Inc., mill at Grand Junction; Cotter Corp. mill at Canon City; and Union Carbide Corp., mills at Maybell, Rifle, and Uravan. The uranium concentrate shipped from these mills contained 3.6 million pounds of uranium oxide valued at $28.8 million; 3.2 million pounds of uranium

oxide valued at $26 million was recovered from ores mined in the State.

Partly because of the lack of high-grade ores, Union Carbide Corp. ceased mining at its uranium property near Maybell in August and closed down the uranium mill in the same area in November. Low-grade ores in the area could not be mined and processed economically.

Vanadium.—Output of vanadium increased 9 percent or 265 tons. The vanadium was contained in vanadium oxide concentrate obtained from processing uranium ores at three uranium mills in the State and one in New Mexico. The concentrate was recovered by Climax Uranium Co. at Grand Junction, and by Union Carbide Corp. at Rifle and Uravan in Colorado, and by Vanadium Corporation of America (VCA) at Shiprock in New Mexico. The average grade of vanadium oxide in the uranium ores processed was 1.31 percent. Mesa, Montrose, and San Miguel Counties accounted for 99.8 percent of the output.

In the fall Union Carbide Corp. began reopening the Rifle Creek mine near Rifle. Vanadium from the mine was to be used for making Carvan, a material developed by Union Carbide for use in place of ferrovanadium.

Zinc.—One of the few metal commodities having a production value greater than $10 million was zinc. Output increased 12 percent in quantity and 32 percent in value, reflecting the jump in the average price of zinc from 11.5 cents per pound to 13.6 cents. Forty-three mines, 17 more than in 1963, had zinc production; the Eagle mine of The New Jersey Zinc Co. led the State in zinc output. The second leading mine in output was the Idarado mine of Idarado Mining Co. The Eagle and Idarado mines were the only ones with zinc production greater than 10,000 tons. Seventeen counties, one more than last year, had production. Eagle County accounted for 51 percent of the State total output, and combined with production from San Juan and San Miguel Counties accounted for 82 percent.

NONMETALS

Cement.—Shipments of portland and masonry cements decreased 7 percent; output came from two plants owned and operated by Ideal Cement Co. Portland and masonry cements were produced at the Portland plant; however, only portland cement was produced at the Boettcher plant. Cement shipments were made within the State and to Idaho, Kansas, Michigan, Nebraska, Nevada, New Mexico, Oklahoma, Utah, and Wyoming. Ready-mixed concrete companies were the major purchasers, followed in order by building-material dealers, concrete-product manufacturers, highway contractors, other contractors, and miscellaneous customers.

Martin Marietta Corp. announced plans to build a $20 million cement plant near Lyons in Boulder County; Rocky Mountain Cement Co., a subsidiary, was to be the plant operator.

Clays.—Clay production decreased 19 percent in quantity. The big drop in output was in miscellaneous clay and shale, from 491,000 tons in 1963 to 380,000 tons. Fire clay production decreased from 194,000 tons to 177,000 tons. The output of bentonite stayed the same (1,000 tons). Clay production consisted of 68.1 percent miscellaneous clay, 31.7 percent fire clay, and 0.2 percent bentonite. The output came

from 53 operations in 11 counties, compared with 44 operations in 9 counties in 1963. In addition to the counties with output last year, Bent and Custer Counties also had production. Jefferson County was still the leading county in production, accounting for 62 percent of the State total; however, the output from the county was 120,000 tons below that of the previous year. Bentonite was used for lining reservoir ponds and as a bonding agent for pelletizing animal feed. Fire clay was used for making heavy clay products—building brick and sewer pipe—and refractories—fire brick, high-alumina brick, clay crucibles, mortars, zinc retorts, and as a bonding agent for making foundry molds. Miscellaneous clay and shale were used for making heavy clay products—building brick and sewer pipes—and lightweight aggregates.

TABLE 13.—Clay production, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Bent			250	$3,125
Boulder	W	W	13,611	W
Custer			1,531	6,890
Douglas	85,097	$226,612	75,530	193,516
Elbert	W	W	W	W
El Paso	16,262	61,194	W	W
Fremont	32,189	132,565	25,945	104,138
Huerfano	W	W	W	W
Jefferson	468,759	664,776	348,306	520,172
Las Animas	16,082	29,121	13,195	32,663
Pueblo	44,905	166,281	37,134	211,714
Undistributed	22,842	53,347	42,407	202,798
Total	686,136	1,333,896	557,909	1,275,016

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

Clay mines near Ft. Carson were placed in jeopardy when Congressional authorization was given to the U.S. Army to acquire about 80,000 acres of land adjacent to the Army base. At yearend protests were being made by several operators of these mines. If the mines were not allowed to operate, it was contended, brickmakers in Colorado Springs, Denver, and Pueblo would lose some of their valuable sources of high-grade refractory clay.

Feldspar.—Output of feldspar decreased drastically, as the main producer of 1963 closed down its operation with no future plans for reopening. Lockhart & Sons, the only producer, mined and sold potash feldspar from an operation in Fremont County.

Fluorspar.—Fluorspar production increased 50 percent in quantity and value, principally because General Chemical Division, Allied Chemical Corp., boosted the output from its mine in Boulder County; the fluorspar, after being processed at its Valmont mill, was used to make hydrofluoric acid. A few hundred tons of fluorspar was mined by a new producer, Crisler & Corder, from a deposit in Jefferson County; the output was sold for use as a flux at an iron foundry.

Gypsum.—Four mines in Fremont and Larimer Counties accounted for the total production which increased 1 percent or 1,000 tons. Calcined gypsum was produced by two companies for making building

materials. Uncalcined gypsum was used as a portland cement retarder and for agricultural purposes.

Lime.—Output of lime, at a record high, was 8 percent or 10,000 tons greater than in 1963. The increase in lime consumption for making steel more than offset the decrease in lime used for sugar refining. The biggest use for lime continued to be for sugar refining; 58 percent of the State output was used for this purpose. Other uses were for ore concentration, petroleum refining, sewage treatment, steel and magnesium production, tanning, and water treatment. Twelve of the 15 lime plants were operated by sugar companies, 9 by The Great Western Sugar Co., and 1 each by American Crystal Sugar Co., Holly Sugar Corp., and The National Sugar Manufacturing Co. The other three lime producers were Basic Chemical Corp., Colorado Lime Co., and The Colorado Fuel and Iron Corp. (CF&I). Some shipments were made to New Mexico, Utah, and Wyoming.

Perlite.—Persolite Products, Inc., was the only producer of crude perlite. The output came from the company mine near Rosita in Custer County. Except for a few tons sold, the crude perlite was expanded at the company mill at Florence. Crude perlite, mined in New Mexico, was expanded at the Antonito plant of Great Lakes Carbon Co. and at the Denver plant of Western Mineral Products Co. The principal uses of the expanded products were as an aggregate for making building plaster and concrete, as a filter aid, and in oil-well cementing.

Pumice and Pumicite.—Output of pumice, including scoria and volcanic cinders, increased 2 percent or 1,000 tons. The output was produced by four companies: Colorado Aggregates Co., Inc., in Costilla County; Lava Products, Inc., and Roaring Fork Pumice Co. in Eagle; and McCoy Aggregate Co. in Routt. Pumice, scoria, and volcanic cinders were used as concrete aggregate for making cinder blocks. Scoria also was used for railroad ballast, as a roofing granule, and in rock gardens.

Pyrites.—Production of pyrites dropped 4,000 tons below that of 1963. At its mine in Dolores County, Rico Argentine Mining Co. produced pyrites for making sulfuric acid at a plant near the mine. The only other producer, Climax Molybdenum Co., recovered pyrites from molybdenum ore at its Climax operation; the output was sold mainly for manufacturing sulfuric acid.

Salt.—Brines were obtained from wells in Montrose County by Union Carbide Corp. for use at its uranium-vanadium milling operation at Uravan and by Jensen & Jensen, a new producer, for use in drilling oil wells.

Sand and Gravel.—Sand and gravel output was the second highest in the history of the State, only 200,000 tons below the alltime high of 20.9 million tons set in 1959. Production increased about 400,000 tons in quantity and $1.3 million in value. Sand and gravel used for road construction and maintenance was 15.4 million tons, an increase of 1.8 million tons, whereas that used for building construction was 4.3 million tons, a decrease of 1.4 million tons. The balance of 1 million tons was used for blast sand, fill, filtration, railroad ballast, and other purposes.

All counties, except 2, had some Government-and-contractor production and 35 of the 63 counties had commercial production. Six counties—Weld, Jefferson, Adams, El Paso, Arapahoe, and Boulder, ranked in that order according to output—had production exceeding 1 million tons and, combined, had 10.2 million tons or 49 percent of the State output. Thirty-five counties had production between 100,000 and 1 million tons, and 21 counties had production below 100,000 tons. Only one county, Phillips, had no recorded output.

TABLE 14.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	1,849	$2,018	La Plata	447	$460
Alamosa	20	13	Larimer	730	801
Arapahoe	1,383	1,568	Las Animas	191	211
Archuleta	127	127	Lincoln	432	419
Baca	193	193	Logan	324	334
Bent	108	129	Mesa	653	691
Boulder	1,025	1,173	Mineral	4	4
Chaffee	282	241	Moffat	404	379
Cheyenne	32	32	Montezuma	334	479
Clear Creek	142	151	Montrose	169	178
Conejos	40	40	Morgan	224	226
Costilla	40	40	Otero	158	175
Crowley	127	127	Ouray	35	35
Custer	42	42	Park	108	108
Delta	234	262	Pitkin	114	101
Denver	W	W	Prowers	W	W
Dolores	12	13	Pueblo	912	1,094
Douglas	507	596	Rio Blanco	56	54
Eagle	91	101	Rio Grande	102	105
Elbert	90	45	Routt	23	25
El Paso	1,547	1,687	Saguache	110	110
Fremont	133	128	San Juan	29	29
Garfield	81	83	San Miguel	W	W
Gilpin	2	1	Sedgwick	86	86
Grand	75	80	Summit	210	217
Gunnison	304	325	Teller	3	3
Hinsdale	3	2	Washington	277	193
Huerfano	422	422	Weld	2,400	2,400
Jackson	54	54	Yuma	199	197
Jefferson	1,995	2,387	Undistributed	532	552
Kiowa	257	216			
Kit Carson	122	117	Total	20,746	22,227
Lake	141	148			

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

Sand and gravel production consisted of 4.2 million tons of sand and 16.5 million tons of gravel, representing 20 and 80 percent, respectively, of the State output. About 1 million tons of sand and gravel was used as pit-run material; the other material received some processing such as washing, crushing, or screening. The average price for pit-run material was $0.51 per ton, and that for prepared material, $1.10; the overall average price was $1.07, an increase of 4 cents over the 1963 price. Of the 308 operations with production, the 195 classified as Government-and-contractor accounted for 57 percent of the State output and the 113 classified as commercial, 43 percent. The five leading commercial producers, ranked according to output, were The Brannan Sand & Gravel Co., Cooley Gravel Co., Asphalt Paving Co., Boise Cascade Sand & Gravel Co., and Tower Construction Co.

Stone.—Stone production, exceeding the 3-million-ton mark for the first time, established a record output of 3.2 million tons. The produc-

tion increased appreciably over that of 1963; namely, 28 percent (707,000 tons) in quantity and 20 percent ($1.1 million) in value. Road construction in El Paso and Gunnison Counties and construction of the Homestake dam accounted for most of the increased production. The total output came from 140 operations in 43 counties, compared with 124 operations in 36 counties in 1963. The leading counties in order of output were Larimer, Fremont, El Paso, Pitkin, Chaffee, and Gunnison; each of these counties had production exceeding 100,000 tons. Larimer and Fremont Counties accounted for 1.6 million tons or 50 percent of the State production.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	2,247	$2,625	1,960	$2,260
Paving	584	599	618	764
Fill	116	77	118	61
Railroad ballast	3	3		
Other	(1)	(1)	2	2
Industrial:				
Blast	(2)	(2)	2	7
Engine	(2)	(2)		
Filtration	(2)	(2)	1	4
Other	46	103	1	3
Total	2,996	3,407	2,702	3,101
Gravel:				
Construction:				
Building	3,282	4,103	2,338	3,044
Paving	4,459	4,404	3,505	4,112
Railroad ballast	7	11	1	1
Fill	192	143	341	405
Miscellaneous	282	298	119	146
Total	8,222	8,959	6,304	7,708
Total sand and gravel	11,218	12,366	9,006	10,809
Government-and-contractor operations:				
Sand:				
Building	(3)	(3)	3	3
Paving	657	621	1,503	1,500
Fill	24	28	3	3
Total	681	649	1,509	1,506
Gravel:				
Building	203	239	10	10
Paving	7,974	7,433	9,821	9,553
Fill	309	242	400	349
Total	8,486	7,914	10,231	9,912
Total sand and gravel	9,167	8,563	11,740	11,418
All operations:				
Sand	3,677	4,056	4,211	4,607
Gravel	16,708	16,873	16,535	17,620
Total	20,385	20,929	20,746	22,227

[1] Withheld to avoid disclosing individual company confidential data; included with "Fill."
[2] Withheld to avoid disclosing individual company confidential data; included with "Other."
[3] Less than one-half unit.

TABLE 16.—Stone production in 1964, by counties

County	Short tons	Value	County	Short tons	Value
Adams	2,766	$6,264	Kit Carson	3,534	$7,293
Alamosa	1,300	2,600	La Plata	5,382	10,855
Arapahoe	40,873	90,428	Larimer	804,172	1,681,052
Archuleta	5,150	10,300	Las Animas	2,689	5,378
Baca	3,515	7,030	Lincoln	530	1,192
Boulder	31,202	194,308	Logan	6,298	13,670
Chaffee	W	W	Mesa	W	15,650
Clear Creek	1,170	2,632	Mineral	2,158	3,237
Conejos	458	920	Moffat	1,780	3,661
Crowley	510	1,148	Park	W	W
Custer	3,610	17,120	Pitkin	345,000	517,500
Dolores	33,702	33,702	Prowers	5,743	11,486
Douglas	6,901	35,131	Pueblo	717	1,468
Eagle	100	2,400	Rio Blanco	W	W
El Paso	508,370	1,001,537	Routt	11,737	23,474
Fremont	801,521	1,666,325	Saguache	395	790
Garfield	W	W	Summit	402	472
Grand	5,936	6,006	Teller	W	W
Gunnison	151,812	340,374	Weld	7,848	16,458
Huerfano	6,683	14,456	Yuma	6,008	12,016
Jackson	42,387	88,174	Undistributed	336,415	791,874
Jefferson	27,139	164,170			
Kiowa	1,379	2,758	Total	3,217,292	6,805,309

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

TABLE 17.—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
1960	16,400	$25,700	145,944	$532,041	2,123,194	$3,484,757	4,075	$124,026
1961	----------	----------	10,528	145,988	2,221,902	4,255,761	9,350	75,171
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

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1960	61,371	$298,447	90,952	$185,809	2,441,936	$4,650,780
1961	52,281	427,356	157,229	396,288	2,451,290	5,300,564
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	6,805,309

Limestone constituted 70.6 percent of the production, granite 15 percent, miscellaneous stone (unclassified as to type) 10.9 percent, sandstone 3 percent, marble 0.3 percent, and basalt 0.2 percent. Except for 1 percent of the total output, the stone was broken and crushed. Principal uses of the broken and crushed stone, according to the quantity, were for making cement (limestone and sandstone), concrete and roadstone (all types, except basalt), dam embankment (granite), flux (limestone), lime (limestone), and riprap (all types, except marble). Other uses were as an abrasive, aggregate for making precast slabs, asphalt filler, coal dust, filler (other than asphalt), ground cover, mineral wool, poultry grit, roofing granules, stone sand, stucco, and terrazzo and for agricultural, erosion control, foundry, and land-

TABLE 18.—Stone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble short tons	11,950	$131,577	11,471	$129,463
Rough architectural cubic feet	67,852	63,868	78,139	63,566
Dressed architectural do	177,072	124,197	102,005	212,353
Rough monumental do	11,505	48,600	7,500	28,150
Dressed monumental do			300	12,000
Flagging do	18,190	19,759	50,163	42,393
Total (approximate, in short tons)	28,700	388,001	30,400	487,925
Crushed and broken stone:				
Riprap short tons	47,576	112,336	202,099	443,576
Metallurgical do	292,185	644,198	275,122	624,334
Concrete and roadstone do	470,038	1,119,467	693,746	1,267,705
Other do	[1] 1,671,149	[1] 3,429,163	[2] 2,015,896	[2] 3,981,769
Total do	2,480,948	5,305,164	3,186,863	6,317,384
Total stone (approximate, in short tons)	2,509,677	5,693,165	3,217,292	6,805,309

[1] Includes stone used in cement, coal dust, colored concrete, exposed aggregate, foundry, ground cover, landscaping, lime, mineral food, ornamental aggregate, precasting, roofing granules, terrazzo, and tumbling.
[2] Includes stone used in abrasives, agriculture, asphalt filler, cement, coal dust, decorative aggregates, dam embankment, erosion control, filler, foundry, ground cover, landscaping, lime, mineral wool, precasting, poultry grit, roofing granules, stone sand, stucco, and terrazzo.

scaping purposes. Dimension stone was used in building construction (all types except granite). Dimension granite was used for monuments.

Stone producers with outputs exceeding 100,000 tons, ranked according to quantity, were Ideal Cement Co., CF&I, Castle Concrete Co., Morrison-Knudsen, Inc., and Schmidt Construction Co. These five companies produced 2.6 million tons or 81 percent of the State production.

Vermiculite.—A small quantity of vermiculite was mined and sold by Rimledge Uranium & Mining Corp. from a deposit in Custer County. Crude vermiculite from Montana was exfoliated by Western Mineral Products Co. at its plant in Denver and then sold for use as insulating material against heat and sound, and as an aggregate for making lightweight plaster.

REVIEW BY COUNTIES

Mineral production was reported in 62 of the 63 counties; Phillips County had no production. Only those counties with significant production or mineral industry activity are discussed; see table 19 for additional details.

Adams.—Mineral production decreased $1 million, principally because of reduction in sand and gravel output of 1.3 million tons; irrespective, the county was ranked fourth in output in the State. Sand and gravel output, representing 53 percent of the value of mineral production, was produced at 16 commercial and 6 Government-and-contractor operations; 81 percent of the output came from commercial operations. Commercial producers were Adams Aggregates, Inc., Boise Cascade Sand & Gravel Co., The Brannan Sand & Gravel Co. (eight operations), Cooley Gravel Co. (two operations), Empire Sand & Gravel Co., Jones Fine Sand Co., Superior Sand & Gravel Co., and

Tower Construction Co. Crews of the State and county highway departments and three contractors for the Colorado Department of Highways produced the Government-and-contractor sand and gravel output.

Gold and silver, valued at $21,632, were recovered as byproducts at seven commercial sand and gravel operations. Miscellaneous stone was produced by contractors for the Colorado Department of Highways. The Great Western Sugar Co. produced quicklime at its Brighton plant for refining beet sugar.

Petroleum production from 66 wells in 19 fields increased 3 percent (14,000 barrels) over that of 1963. Two small fields—Apollo and Moccasin—were discovered. Natural gas production, largely from the Deer Trail field, increased from 1 to 2 billion cubic feet.

Alamosa.—The crude oil throughput of the Oriental Refining Co. plant at Alamosa was 47.5 percent below that of 1963.

TABLE 19.—Value of mineral production in Colorado, by counties

County	1963	1964	Minerals produced in 1964, in order of value
Adams	r $4,909,591	$3,913,896	Sand and gravel, petroleum, natural gas, lime, gold, stone, silver.
Alamosa	234,000	15,600	Sand and gravel, stone.
Arapahoe	r 1,384,493	1,782,428	Do.
Archuleta	370,149	339,300	Petroleum, sand and gravel, stone.
Baca	900,677	885,030	Petroleum, sand and gravel, natural gas, stone.
Bent	74,000	197,125	Sand and gravel, natural gas, petroleum, clays.
Boulder	1,536,180	2,078,687	Sand and gravel, fluorspar, lime, stone, gold, clays, peat, silver, petroleum, uranium ore, vanadium, copper, lead, zinc.
Chaffee	W	857,541	Stone, sand and gravel, zinc, lead, gold, silver, copper.
Cheyenne	6,000	32,000	Sand and gravel.
Clear Creek	388,346	W	Silver, sand and gravel, zinc, lead, gold, copper,
		W	stone, iron ore.
Conejos	114,090	40,920	Sand and gravel, stone.
Costilla	W	W	Pumice, sand and gravel.
Crowley	W	W	Sand and gravel, lime, stone.
Custer	W	92,649	Sand and gravel, perlite, stone, clays, zinc, lead, silver, vermiculite.
Delta	586,388	W	Coal, sand and gravel, lime.
Denver	W	W	Sand and gravel.
Dolores	W	W	Zinc, pyrites, lead, stone, silver, sand and gravel, copper, gold.
Douglas	924,509	824,647	Sand and gravel, clays, stone.
Eagle	8,157,885	W	Zinc, silver, lead, copper, gold, sand and gravel, pumice, stone.
Elbert	W	W	Clays, sand and gravel.
El Paso	1,784,425	2,899,133	Sand and gravel, stone, lime, clays, coal.
Fremont	11,333,755	11,136,242	Cement, stone, coal, gypsum, sand and gravel, clays, petroleum, uranium ore, vanadium, feldspar.
Garfield	669,312	678,633	Natural gas, lime, stone, sand and gravel, coal.
Gilpin	10,671	89,464	Molybdenum, peat, gold, sand and gravel, silver, zinc, lead, copper.
Grand	W	W	Sand and gravel, stone, vanadium, uranium ore.
Gunnison	2,459,372	5,995,738	Coal, zinc, silver, lead, stone, sand and gravel, copper, gold.
Hinsdale	3,668	7,128	Gold, sand and gravel, silver, zinc, lead, copper.
Huerfano	464,010	753,212	Sand and gravel, coal, stone, clays.
Jackson	1,423,304	1,198,174	Petroleum, stone, sand and gravel, natural gas.
Jefferson	r 3,920,197	4,137,745	Sand and gravel, uranium ore, clays, stone, gold, fluorspar, copper, silver, lead.
Kiowa	223,447	519,758	Natural gas, sand and gravel, petroleum, stone, natural gas liquids.
Kit Carson	73,000	124,293	Sand and gravel, stone.
Lake	68,144,480	70,705,037	Molybdenum, tungsten concentrate, sand and gravel, tin, pyrites, peat, gold, lead, zinc, silver, copper.

See footnotes at end of table.

TABLE 19.—Value of mineral production in Colorado, by counties—Continued

County	1963	1964	Minerals produced in 1964, in order of value
La Plata	$6,222,918	$6,757,687	Natural gas, natural gas liquids, sand and gravel, petroleum, coal, stone, gold, peat, silver.
Larimer	14,008,932	12,565,663	Cement, stone, petroleum, sand and gravel, lime, gypsum, iron ore, uranium ore, gold, vanadium, silver.
Las Animas	7,628,389	5,393,007	Coal, sand and gravel, clays, carbon dioxide, stone, copper, silver.
Lincoln	278,535	420,192	Sand and gravel, stone.
Logan	14,240,106	12,095,670	Petroleum, natural gas, natural gas liquids, sand and gravel, lime, stone.
Mesa	5,288,821	5,623,730	Uranium ore, vanadium, sand and gravel, coal, natural gas, natural gas liquids, stone.
Mineral	1,067,909	1,632,646	Zinc, lead, silver, copper, gold, sand and gravel, stone.
Moffat	7,906,230	7,135,018	Petroleum, natural gas, uranium ore, coal, sand and gravel, stone.
Montezuma	1,305,808	2,125,730	Petroleum, sand and gravel, natural gas, carbon dioxide, gold, vanadium, uranium ore, silver.
Montrose	13,809,337	11,469,665	Vanadium, uranium ore, coal, sand and gravel, salt, copper, silver.
Morgan	14,223,509	10,156,000	Petroleum, natural gas liquids, natural gas, sand and gravel, lime,
Otero	W	W	Lime, sand and gravel.
Ouray	3,606,850	1,805,198	Zinc, lead, copper, gold, silver, sand and gravel.
Park	325,260	287,422	Sand and gravel, peat, stone, lead, silver, zinc, gold, copper.
Phillips	7,050	----------	
Pitkin	W	W	Coal, stone, iron ore, sand and gravel, natural gas.
Prowers	124,000	152,486	Sand and gravel, petroleum, stone.
Pueblo	1,925,045	W	Sand and gravel, lime, clays, stone.
Rio Blanco	r 57,088,135	56,463,928	Petroleum, natural gas liquids, natural gas, sand and gravel, coal, uranium ore, vanadium, stone.
Rio Grande	29,613	105,000	Sand and gravel.
Routt	3,315,135	3,322,279	Coal, petroleum, pumice, sand and gravel, stone.
Saguache	1,337,506	W	Uranium ore, sand and gravel, lead, zinc, silver, copper, stone, gold.
San Juan	1,947,028	W	Zinc, lead, copper, silver, gold, sand and gravel, iron ore.
San Miguel	11,073,258	12,689,553	Zinc, vanadium, uranium ore, lead, copper, gold, silver, sand and gravel, iron ore.
Sedgwick	225,000	203,000	Sand and gravel, lime, natural gas.
Summit	643,296	409,100	Sand and gravel, lead, zinc, silver, copper, gold, stone.
Teller	202,442	48,180	Peat, stone, sand and gravel.
Washington	21,929,054	19,161,000	Petroleum, natural gas liquids, natural gas, sand and gravel.
Weld	9,573,308	10,721,932	Petroleum, coal, sand and gravel, natural gas, lime, natural gas liquids, stone.
Yuma	216,000	209,016	Sand and gravel, stone.
Undistributed [1]	r 7,499,276	25,753,216	
Total	r 317,144,000	316,011,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes some stone (1963), gem stones, and beryllium concentrate (1964) that cannot be assigned to specific counties and values indicated by symbol W.

Sand and gravel was produced by crews of the State and county highway departments.

Arapahoe.—The county had the fifth largest output of sand and gravel in the State. Production from 9 commercial and 10 Government-and-contractor operations increased 28 percent. The commercial producers were The Brannan Sand & Gravel Co. (two operations), Central Construction Co., Cooley Gravel Co. (two operations), Hebertson Sand and Gravel Co., Lester E. Jones Sand & Gravel Co., Russell Sand Co., and Tower Construction Co. Crews of the State and county highway departments produced sand and gravel; contractors for the Colorado Department of Highways produced sand and gravel and stone.

Baca.—Petroleum production from the Flank field was 25 percent less than in 1963. The Walsh and Greenwood gasfields produced 5 and 30 percent less, respectively.

Because of three road-construction projects in the county, sand and gravel production increased from 7,000 tons in 1963 to 193,000 tons. Except for 18,000 tons produced by a Colorado Department of Highways crew, the output was by two contractors for the State highway department. Miscellaneous stone was produced by one contractor for the Colorado Department of Highways.

Bent.—Petroleum production, largely from the McClave field, increased 4,000 barrels. The carbon dioxide plant at Ninaview processed 22 percent less carbon dioxide gas. Natural gas production increased from 173 to 296 million cubic feet. The increase was largely from the Bent's Fort field.

Sand and gravel was produced by Graham Construction Co., and by crews for the State and county highway departments. Bentco, Inc., mined a few hundred tons of bentonite for lining stock-reservoir ponds.

Boulder.—Mineral production value increased slightly more than $500,000. Of the 14 mineral commodities produced, sand and gravel output was 56 percent of the county value of mineral production; fluorspar, gold, lime, and stone accounted for 39 percent; clays, copper, lead, peat, petroleum, silver, uranium ore, vanadium, and zinc comprised the remaining 5 percent. Sand and gravel output, increasing by 300,000 tons, was produced from 15 operations, 4 more than in 1963; 8 of the 15 operations were commercial, and 7, Government-and-contractor. Commercial operators were Boulder Gravel Products, Inc., Feldstrom Brothers, Golden Transfer Co., Kugel Sand & Gravel, Martenson Sand & Gravel, Pastore Gravel Co., Pendleton Construction Co., and Turnpike Gravel Co.; total output of these operators was 728,000 tons, or 71 percent of the county output. Crews of the State and county highway departments, two contractors for the U.S. Forest Service, two for the Colorado Department of Highways, and one for the Boulder County Highway Department cumulatively produced 297,000 tons, 29 percent of the county output.

Three operations yielded 13,611 tons of clay. Fire clay produced by El Dorado Clay Co. and Stroud Whisenhunt and miscellaneous clay by Colorado Brick Co. and El Dorado Clay Co. were used for making building bricks. General Chemical, operator of the Burlington mine and Valmont mill, produced acid-grade fluorspar. Dimension sandstone for building stone and flagging was produced at 10 quarries, including 1 operated by the University of Colorado. Principal producers of dimension sandstone were Jacobson Lyon Stone Co., Inc., Clyde Landau, Loukonen Brothers Stone Co., Sterling Stone Co., and the University of Colorado. Crushed and broken sandstone was produced at three operations for use as filler and riprap and for making precast panels. Miscellaneous stone was quarried by King Mountain Rock Co. and by a contractor for the Colorado Department of Highways. Quicklime was produced by The Great Western Sugar Co. at its Longmont plant for making sugar from sugar beets.

Gold, silver, copper, lead, and zinc came from the Cash and Rex mines, operated by Steen Mining Co., in the Gold Hill mining district. Uranium ore was mined at the Fair Day mine near Jamestown

by Roy Busby and Climax Uranium Co.; vanadium oxide was recovered from the ore at the Climax uranium mill in Grand Junction. Tin concentrate and low-grade tungsten rejects purchased from Climax Molybdenum Co. by Lenway Mining and Development Corp. were upgraded at the Marion mill for resale.

Petroleum production from the Boulder field was less than 2,000 barrels. Moss peat mined in the Nederland-Ward area by Omar Beagle, Beaver Lake Peat Co., and Western Peat Co. was sold for use in improving soils; McCoy & Jensen mined humus peat in the Nederland area for use in mixed fertilizer.

A $20-million cement plant was planned near Lyons by Rocky Mountain Cement Co., a subsidiary of Martin Marietta Corp. A unique feature of the new plant was to be the lack of a smokestack; electrolytic precipitators and glass-bag filters were to be used to insure that no waste material or gases would escape into the atmosphere. The only noise in the plant was to be in the crushing and grinding section; however, the noise was not expected to be audible outside the building. Limestone and shale, the major ingredients for making the cement, were to be quarried from deposits near the plant site.

Chaffee.—Because of increased road construction, sand and gravel output was 282,000 tons, three times that of 1963. Nearly all of the output was produced by crews of the State and county highway departments and by a contractor for the U.S. Forest Service; the remainder was produced by Hart Rok Redi Mixt Concrete, the only commercial producer in the county. CF&I mined and shipped a substantial quantity of limestone from the Monarch quarry to its steel mill at Pueblo; the crushed stone was used as a flux and for making lime needed in the new basic-oxygen steel process at the plant. Granite, quarried by Colorado Granite Co., was used for dressed monumental stone. Alpine Industrial, Inc., produced and sold crushed granite as poultry grit. Quartz for making precast panels was produced by Ralph Pierce. Cotter Corp. mined lead-zinc ore from the Stonewall mine; copper and silver also were recovered from the ore. James H. Roberts, using a sluice box, recovered gold and silver from the Cache Creek placer deposit.

Reynolds Mining Corp. dismantled its fluorspar mill near Poncha Springs in the fall; equipment and materials were shipped to a company fluorspar operation near Eagle Pass, Texas. The mill had been kept intact since operations ceased in 1954.

Clear Creek.—Seven underground and two placer operations accounted for the production of gold, silver, copper, lead, and zinc. The underground operators, ranked according to output value, were Humphreys Engineering Co. (Cascade mine), Silver Lake, Inc. (Johnny Bull), Silver Wreath Mines Co. (Fairmount), Atlas Milling & Mining Co. (Stevens), Lee Downey & Associates (Dixie), B & E Mining Co. (Bald Eagle), and Denver Mining & Milling Corp. (Lamartine). The placer operators were Western Placer Co., Inc., and John M. Peck.

Construction began at the newly acquired (1963) Urad molybdenum mine of American Metals Climax, Inc., in the Jones Pass area near Empire. According to the 1964 annual report of the company, the

mine was to be in production by mid-1967; up to 7 million pounds of molybdenum was to be produced annually.

Stoney Point Development, Inc., produced and sold brown iron ore from the Geneva Creek mine for use as a paint pigment. Production of sand and gravel increased from 10,000 tons to 142,000 tons, mostly because of construction of Interstate Highway I–70. The output was produced by Whitewater Sand & Gravel Co., crews for the State and county highway departments, and by a contractor for the Colorado Department of Highways. Stone, also produced by the contractor for the Colorado Department of Highways, was used as riprap.

Custer.—The only perlite and vermiculite produced in the State came from the county. Crude perlite, mined by Persolite Products, Inc., from its open pit near Rosita, was sent to the company expanding plant at Florence in Fremont County. Rimledge Uranium & Mining Corp. produced crude vermiculite from a mine in the Silver Cliff-Westcliffe area. Fire clay, for making building brick, was mined by George O. Stroup near Wetmore. The county highway department crew and one contractor each for the U.S. Forest Service and Colorado Department of Highways, produced sand and gravel. Miscellaneous stone was produced by O. L. Braly for use as terrazzo and by a contractor for the Colorado Department of Highways.

Silver, lead, and zinc were recovered from ore mined by Cotter Corp. from the Lady Franklin mine. H. D. Rusler & Son produced lead ore from the Keystone mine; silver also was recoverd from the ore.

Delta.—Coal production, increasing 82 percent or 28,169 tons, came from five underground mines; the King mine of The Juanita Coal & Coke Co., was the major coal producer in the county. Other producers were Emmons Bros. Coal Co. (Emmons mine), Lyndon H. Fogg (Red Canon), Green Valley Coal Co. (Green Valley No. 2), and States Coal Co. (Top). Sand and gravel was produced by Delta Sand and Gravel Co., crews of the State and county highway departments, and a contractor for the U.S. Forest Service. Holly Sugar Corp. produced quicklime at its Delta plant for making sugar from sugar beets.

Denver.—The only mineral production was sand and gravel produced by The Brannan Sand & Gravel Co. from its operation near Ft. Logan. Cadmium and thallium metal and thallium sulfate were produced at the Asarco Globe plant from smelters and processing-plant material shipped into the State.

Four oil refineries in the Denver metropolitan area processed 9.7 million barrels, 2.6 million less than in 1963. The refineries were operated by Continental Oil Co., Empire Petroleum Co., Oriental Refining Co., and Tenneco Oil Co.

Dolores.—Gold, silver, copper, lead, zinc, and pyrites were recovered from ore produced at the Rico Argentine mine of Rico Argentine Mining Co. at Rico. According to the company annual report, lead-zinc production was up to mill capacity by mid-December. Work got underway in the mill to improve milling results and increase capacity. On October 20 the sulfuric acid plant was placed on standby until the market would warrant production. The market for acid within reach of the plant had been cut because of the stretch-

out program of the uranium mills, major consumers of the acid. Miscellaneous stone was produced for road work by the Dolores County Highway Department crew. Two contractors for the U.S. Forest Service produced sand and gravel.

Douglas.—Clay production, down 9,567 tons, came from nine operations, two more than in 1963. Nearly one-half of the output was sold as raw material to consumers; the remainder was used by the producers to make company products. Robinson Brick & Tile Co. produced fire clay from the Hogback mine and miscellaneous clay from the Pioneer and Ute mines; all the clay was used for making building brick. Fire clay—mined and sold by Stroud E. Whisenhunt from the Madis, Stevens, and Stroh mines—was used in building brick and vitrified sewer pipe. Fire clay produced by Denver Brick & Pipe Co. from the Ringenberg mine was used in building brick. Fire clay mined and sold by Helmer Brothers from the Helmer mine and by Waterton Sand & Clay from the Hogback mine was used at foundries for refractory purposes.

Stone output decreased greatly because of no noncommercial production. M & S, Inc., mined quartz for making precast panels. Waterton Sand & Clay produced sandstone for foundry use. Rough-construction dimension stone was produced from rhyolite (classed as miscellaneous stone) by Johnson Stone Co. Miscellaneous stone, also mined by Walker's Concrete & Rock Products, Inc., was used as riprap and concrete aggregate, and for roofing granules. Sand and gravel, slightly below the 1963 output, was produced by crews of the State and county highway departments, a contractor for the Colorado Department of Highways, and four commercial operators—Hall Sand & Gravel, Inc., Helmer Brothers, Pre-Mix Concrete, Inc., and Tower Construction Co.

Eagle.—The county was one of 11 with the value of mineral production exceeding $10 million. The New Jersey Zinc Co. operated its Eagle mine throughout the year. The mine was ranked first in the State in production of silver and zinc and second in gold and copper.

Volcanic cinders mined by Lava Products, Inc., from a deposit near Gypsum, and pumice by Roaring Fork Pumice Co. were used as an aggregate, mostly for making cinder blocks. R. E. Gordon produced sandstone for dressed building stone and flagging. Production of sand and gravel, about one-half that of 1963, came from two commercial producers (Whitewater Sand & Gravel Co. and Zemlock & Son), crews of the State and county highway departments, a contractor for the Colorado Department of Highways, and a contractor for the cities of Aurora and Colorado Springs working on the Homestake Transmountain Water Diversion project.

El Paso.—The value of mineral production increased $1.1 million because of greater outputs of sand and gravel and stone which accounted for 93 percent of the county value. The sand and gravel output, fourth largest of all counties, was produced from seven commercial and four Government-and-contractor operations. The commercial producers were Broderick & Gibbons, Inc., Castle Concrete Co., Daniels Sand Co. (two operations), Harding Bros. Sand & Gravel, R. J. Quinn, and Rocky Mountain Oil Paving, Inc. The other producers were crews of the State and county highway departments and of the Colorado

Springs Street Department, and a contractor for the Colorado Department of Highways. Castle Concrete Co., the third largest stone producer in the State, produced limestone, mostly used as an aggregate in construction; a small quantity was used for riprap and ground cover. Colorado Lime Co. mined limestone principally for making lime at its plant near the quarry; some stone was used as an asphalt filler, aggregate, and for dusting coal mines. Springs Silica Sand Co. produced sandstone for making abrasives, silica brick, stone sand, and for use in foundries. Sandstone mined by Carl Quinn was used for road construction. Contractors for the U.S. Army Corps of Engineers and the U.S. Forest Service produced granite for construction work. A contractor for the Colorado Department of Highways produced miscellaneous stone for road construction. Clay output increased 1,200 tons. The National Clay Products Co. mined fire clay and miscellaneous clay for building brick. Standard Fire Brick Co. produced fire clay for firebrick and sewer pipe. Robinson Brick & Tile Co. produced fire clay for building brick. Output of coal, by Franceville Coal Co. from its strip mine, was virtually the same as in 1963.

Fremont.—Although the value of mineral production decreased $200,000, it was still over the $10 million mark. Shipments of cement from the Portland plant by Ideal Cement Co., the only cement producer in the State, were about the same as in 1963. The company produced portland and masonry cements at the plant. Placing of concrete for constructing nine cement storage silos at the plant was completed in November; the silos were to be in operation in mid-1965, providing an additional storage of 150,000 barrels of cement to meet peak shipping demands. Stone output, the second largest in the State, decreased 19,000 tons; production came from 20 operations, 1 more than in 1963. Most of the stone output was limestone quarried by Ideal Cement Co. for making cement. CF&I produced a substantial quantity of limestone (dolomite) for use as a flux and for making lime at its Pueblo steel mill. Limestone produced by Colorado Limestone Co. also was used as a flux for making steel. Granite produced by Lockhart & Sons was used as concrete aggregate and that by Ralph Atencio for making precast panels. A crew of the city of Florence Highway Department produced granite for road construction. Marble, produced by Colonna & Company of Colorado, Inc., Colorama Rock Products Co., Cowan Brothers, and Lockhart & Sons, was used for rough exterior building stone, terrazzo, concrete aggregates, and for agricultural purposes. Sandstone was produced by Ideal Cement Co. for making cement, by Lockhart & Sons for making precast panels, by Ralph J. Pierce for landscaping, by Standard Fire Brick Co. and Ray B. Sturbaum for refractory stone, and by Kenneth P. Hodgson for terrazzo. Miscellaneous stone produced by Johnson Stone Co. was used as rubble and that by O. L. Braly as roofing granules. A contractor for the Colorado Department of Highways produced miscellaneous stone for riprap and road construction.

Coal output, down 29,000 tons, was produced from 22 mining operations—17 underground mines with production of 257,694 tons and 5 strip mines with production of 35,010 tons. Major underground producers, ranked in order of output, were The Corley Co. (two mines), Canon Black Diamond Coal Co., Vento Coal Co., Canon Monarch

Coal Co., Twin Pines Coal Co., Golden Quality Coal Co., Rex Carbon Fuel Co., Cedar Canon Coal Co., and Last Chance Coal Co. Other producers from underground mines were Double Dick Coal Co., Alvidrez & Sons, Canon National Coal Co., Canon Liberty Coal Co., Coal Creek Canon Mining Co., Nick J. Moschetti, and Annex Coal Co. The strip-mine operators were Beer Coal & Construction Co. (two mines), Annex Coal Co., The Corley Co., and Ralph Carestia.

Petroleum production from the Florence-Canon City field, the second oldest in the Nation, decreased 8 percent.

Production of clay decreased 6,000 tons; total output came from seven operations, compared with five in 1963. Bentonite was produced from the Triangle-Lamberg mine by Silver Rocker Bentonite Co. for pelletizing animal feed and lining reservoir ponds. Fire clay was produced by George O. Stroup from the Phantom Canyon, 8 Mile and 12 Mile mines for building brick; by Irvin Clay Co. from the I & E mine for building brick and firebrick and from the Irvin mine for firebrick; and by Harbinson-Walker Refractories Co. from the Blunt mine for firebrick.

Gypsum was produced by Pabco Building Material Division, Fibreboard Paper Products Corp.; part of the output was calcined for making gypsum board products at the company plant at Florence, and part was sold uncalcined for use as a portland-cement retarder. U.S. Soil Conditioning Co. produced and sold uncalcined gypsum for agricultural purposes. The only feldspar output in the State was produced by Lockhart & Sons from the Mica Lode mine. Uranium and vanadium were recovered from uranium ore mined by Climax Uranium Co. from the Knob Hill property; the ore was processed at the company uranium mill at Grand Junction. C. H. Heisen mined uranium ore from the Last Chance claim and shipped it to the Cotter Corp. uranium mill at Canon City. In addition to processing uranium ore, the Cotter mill treated base-metal ores for recovery of gold, silver, copper, lead, and zinc. Sand and gravel output more than doubled, although there were only six operations, three less than in 1963. The output was produced by crews of the State and county highway departments, Canon City Highway Department, Colorado State Penitentiary, and contractors for the U.S. Forest Service and the Colorado Department of Highways.

Garfield.—Natural gas production from 20 wells in 6 fields was 1.4 billion cubic feet, very nearly the same as that in 1963. The leading producing fields were Garmesa, South Canyon, and Rulison.

The Federal Bureau of Mines Anvil Points oil-shale mine and plant were leased to the Colorado School of Mines Research Foundation, Inc., for carrying out oil-shale research sponsored by several petroleum companies. Colony Development Co. awarded a contract to Bechtel Corp. for building a prototype oil-shale plant near Grand Valley.

Coal production, virtually the same as in 1963, came from three underground mines operated by Bendetti Bros., Bradley Brothers Enterprise, and Four Mile Coal Co., Inc. Basic Chemical Corp. produced limestone for asphalt filler, aggregate for concrete and road construction, flux, dusting coal mines, and mineral wool and for mak-

ing lime at its plant in Glenwood Springs. The limestone output by Frank H. Norberg Co. was used mostly for making lime at a sugar beet plant. Miscellaneous stone was produced by a contractor for the Colorado Department of Highways. The sand and gravel output was produced by two commercial producers (Zemlock & Son and A. S. Horner Construction Co., Inc.), crews of the U.S. Forest Service and the Colorado Department of Highways, and a contractor for the State highway department.

Union Carbide Corp. operated its 1,000-ton-per-day uranium mill at Rifle for recovering uranium and vanadium; the company negotiated with the AEC for a stretchout contract which would affect the operation of this mill. The company started reopening the Rifle Creek mine near Rifle, a source of vanadium ore to be treated at the Rifle mill. The mine, dating back to 1916, was once the largest single source of vanadium in the Nation.

Gilpin.—Mineral production increased $78,793 in value principally as a result of Nye Metals, Inc., attaining production of molybdenum from the Wilma mine. The company mined a few thousand tons of high-grade ore averaging 1.24 percent MoS_2. Peat output by Eiven Jacobson and Gus Rudolph was 6,000 tons; except for a few hundred tons of humus, the output was moss peat. Three placer operations, four underground mines, and material from mill cleanup accounted for the production of gold, silver, copper, lead, and zinc worth about $6,000. The sand and gravel output was produced by a crew of the Colorado Department of Highways.

Gunnison.—The county had the largest increase in value of mineral production of all counties with $3.5 million. The big increase was due primarily to additional coal output of 307,000 tons. Greater outputs of silver, lead, and zinc—accompanied by their higher prices—also contributed substantially to the increase. The coal output, fifth largest in the State, came from eight underground mines. Contributing significantly to the large coal output was the Somerset mine of United States Steel Corp.; the mine was operated throughout the year. Other principal coal producers were Bear Coal Co., Champion Coal Mining Co., Ellis Coal Co., and Nu-Mine Coal Co. Other coal producers were North Fork Coal Co., Ohio Creek Coal Co., and J. M. Smith. The Asarco Keystone mine, reopened by McFarland & Hullinger in May 1963, was operated throughout 1964; the mine had the third largest silver output in the State and was the principal source of gold, silver, copper, lead, and zinc in the county. The other mining operation contributing to the metal production was the Micawber mine of Elk Mountain Mining & Milling Corp. Small quantities of gold, silver, lead and zinc were recovered from cleanup material obtained by Lawson B. Gaines & J. C. Warde from the Copper Girl property. The Colo-Tex Stone Co. produced marble from the Yule Marble quarry for making stucco. Granite and miscellaneous stone were produced by contractors for the Colorado Department of Highways, and miscellaneous stone was produced by a contractor for the U.S. Forest Service. The sand and gravel was produced by two commercial operators (Gunnison Ready Mix Co., Inc., and Whitewater Sand & Gravel Co.), crews of the State and county highway departments, a contractor for the Colorado Department of Highways, and two contractors for the

U.S. Forest Service. Most of the output was used for the relocation of U.S. Highway 50 caused by the Blue Mesa dam project.

Huerfano.—Sand and gravel output nearly doubled. Except for 1,000 tons produced by the crew of the Huerfano County Highway Department, the output was produced by two contractors for the Colorado Department of Highways; most of the production was used for constructing Interstate Highway I–25 north and south of Walsenburg. Clay production increased 1,007 tons. Standard Fire Brick Co., the only 1963 producer in the county, produced fire clay from the Chamblin mine for firebrick and sewer pipe. Miscellaneous clay mined by Empire Clay Products, Inc., a new producer in the county, was used for building brick. Coal output, up 7,000 tons, came from four underground mines—Calumet No. 2 operated by Delcarbon Coal Co., Gordon by Skinner Coal Co., Maitland No. 2 by Red Ash Coal Co., and Morning Glory by Morning Glory Coal Co.

Jackson.—Petroleum production decreased 23 percent below that of 1963. Oil-contaminated carbon dioxide gas from the Morrison formation in the McCallum field was processed for limited industrial use. Carbon dioxide from other producing formations in the McCallum field and all producing formations in the McCallum South field was vented.

Stone production increased 42,000 tons. The output, all granite, was produced by two contractors for the U.S. Forest Service for road construction and by a contractor for the Colorado Game and Fish Department for riprap. Sand and gravel output, 16,000 tons less than in 1963, was produced by crews of the Colorado Department of Highways and the Jackson County Highway Department.

Jefferson.—Sand and gravel output, the second largest in the State, accounted for 58 percent of the value of mineral production. The output, the same as in 1963, came from 11 commercial operations, with 86 percent of the production and 4 Government-and-contractor operations with 14 percent. The commercial producers, ranked in order of output, were Asphalt Paving Co., Rio Grande Gravel Co., Kilgroe-Atchinson Construction & Paving Co., Tower Construction Co., Lee Sand & Gravel Co., Bear Valley Gravel Co., Table Mountain, Inc., The Brannan Sand & Gravel Co. (two operations), Suburban Sand & Gravel Co., and Adolph Coors Co. The output by Adolph Coors Co., was used by the company for construction work at its brewery and porcelain plant in Golden. Sand and gravel was produced by crews for the State and county highway departments and two contractors for the Colorado Department of Highways. Byproduct gold and silver were recovered at four of the commercial sand and gravel operations. Silver, copper, and lead were recovered from ore obtained from the Augusta mine by C & S Mining Co.

Production of uranium ore valued at $1 million, from four underground mines, accounted for 25 percent of the value of mineral production. The output was produced by Denver-Golden Corp. from the Schwartzwalder mine, Cotter Corp. from the Wright Lease and U P Fork mines, and Leigh D. Ohman from the Nare Lease mine; all the ore was shipped for processing to the Cotter uranium mill at Canon City.

Although clay output decreased 120,000 tons, the county accounted for 62 percent of the quantity produced in the State. Fire-clay output from seven operations was 21,995 tons, or 6 percent of the county production of clay. Fire-clay producers were Denver Fire Clay Co. (two operations), Leland Doughty, Denver Brick & Pipe Co., Garnett C. Bennetts & Sons, and Robinson Brick & Tile Co. (two operations). Except for the outputs by Garnett C. Bennetts & Sons and Leland Doughty, which were sold for making building brick, the fire clay was used by the producers for making clay products at their plants. Miscellaneous clay and shale output, produced at ten operations, was 326,311 tons, or 94 percent of the county output of clay. The Idealite Co., a subsidiary of Ideal Cement Co., the major clay producer in the State, mined shale at its Rocky Flats operation for making lightweight aggregates; a crushing system was installed in April at the plant for producing finely crushed aggregate. Clalite Concrete Products, Inc., produced miscellaneous clay from one operation and shale from another for making lightweight aggregates at its Denver plant. Colorado Brick Co., Lakewood Brick & Tile Co. from two operations, Denver Brick & Pipe Co., and Robinson Brick & Tile Co. produced and used miscellaneous clay for making building brick at their respective Denver plants. The outputs of miscellaneous clay by George W. Parfet Estate, Inc., and H. M. Rubey Clay Co. were sold for making building brick.

Crisler & Corder mined a few hundred tons of fluorspar ore, containing 90 percent CaF_2, from the Daisy Bell mine; the output was sold for use in foundries as a flux.

Production of stone increased 6,000 tons. Eight commercial producers had outputs totaling 24,408 tons. Garnett C. Bennetts & Sons produced granite for making precast panels. Robinson Mining Co. and Carl Quist quarried sandstone for use as rough construction building stone. E. M. Cooper, Garnett C. Bennetts & Sons, and Forest Hamilton produced quartz for use as concrete aggregate, ground cover, roofing granules, and for making precast panels; Herbert Crisler produced quartz for concrete aggregates, and Paul E. Linstrom, for precast panels. A contractor for the Colorado Department of Highways produced miscellaneous stone for riprap and road construction.

Kiowa.—The value of mineral production was more than twice the 1963 value principally because of sand and gravel output worth $216,000; no sand and gravel was produced in 1963. The output was produced by crews of the State and county highway departments and two contractors for the Colorado Department of Highways. Miscellaneous stone was produced by one of the contractors for his road construction project.

Petroleum production increased 45 percent, due largely to the increased production from the McClave field. The Indio field, completed in November, yielded 364 barrels of oil by yearend. Natural gas production from the McClave field increased from 1.2 to 1.6 billion cubic feet.

Lake.—Mineral-production value, the highest for any county in the State, increased $2.6 million, mainly because of the higher price of molybdenum. The value of molybdenum output increased $2 million even though production was 1.6 million pounds below the 1963 output. Of the 11 mineral commodities in the county, molybdenum—produced

by Climax Molybdenum Co. at its Climax operation—accounted for 98 percent of the county value. Daily mine production averaged 38,600 tons. Except for a 6-day shutdown in July caused by a fire in the main service shaft, the mine was operated every day of the year. Production of ore from the Ceresco Level was begun during September, following 3 years of development; daily production averaged 1,000 tons and was expected to rise to 3,000 tons per day in 1965. A gigantic blast, reportedly the largest in U.S. mining history, was set off at the mine on May 23. Several months of work went into preparing the blast, detonated by 417,216 pounds of explosives that were hand loaded into 4-foot-square drifts more than 600 feet long. Molybdenum ore, about 1.5 million tons, broken by the blast was under production within hours after the shot was fired. A significant byproduct of the blast was its contribution to the scientific study of the structure of the earth. Seismographs throughout the Nation recorded the energy released by the blast. About 100 miles away, the Colorado School of Mines seismograph recorded the magnitude of the blast as 2.9 on the Richter Scale, equivalent to a medium small tremor. At Yellow Knife in the Northwest Territory of Canada, the blast was recorded 6 minutes, 37 seconds after detonation.

Also on May 23, construction was begun on the new plant for extracting molybdenum from mixed oxide-sulfide ores by a hydrometallurgical process. Production of approximately 3 million pounds of molybdenum per year was expected after completion of the plant in 1966.

Pyrites, tin, and tungsten were recovered as byproducts from processing molybdenum ore at the Climax operations. Gold and silver were obtained with a washing plant and sluice boxes by H. W. Mining Co. from the H-W placer mine. Gold, silver, copper, lead, and zinc were obtained from about 2,000 tons of ore produced by Kostelic Mining & Milling Co. from the Yak Tunnel tailings dump and from cleanup material collected by Aoh Jacobson from the Arkansas Valley smelter. Mt. Elbert Peat Moss Co. produced peat moss for soil improvement. Sand and gravel output, increasing 60,000 tons, was produced by two commercial operators (C. Ryan & Son, Inc., and Ellis B. Webster), crews of the State and county highway departments, and a contractor for the Colorado Department of Highways. Much of the output by C. Ryan & Son, Inc., was used for building construction at the Climax operations.

La Plata.—Natural gas and crude oil production dropped 3 and 26 percent, respectively. Natural gas accounted for 80 percent of the county value of mineral production. The county continued to lead the State in natural gas sales with 33.6 billion cubic feet; all but about 2 billion cubic feet came from the Ignacio-Blanco field. The intake of the El Paso Natural Gas Co. plant at Ignacio was 23.2 billion cubic feet, largely dry gas compressed but not processed for liquid recovery. Red Mesa was the only producing oilfield in the county.

Sand and gravel output, 2½ times that of 1963, came from nine operations, compared with two in 1963. Road-construction projects on U.S. Highway 550 and Colorado Highway 140 stimulated the increased production. Crews and contractors for the State and county highway departments produced 84 percent of the sand and gravel.

The commercial production was produced by three operators—Animas Valley Sand & Gravel, Burnett Construction Co., and McJunkin Construction Co. Miscellaneous stone was produced by one of the contractors for the Colorado Department of Highways for riprap and road construction. Gold and silver were recovered from ore mined by Silgo, Inc., from the Bessie G. mine. Four peat operations had production totaling 1,026 tons; all of the output was sold for soil improvement. Arizona Columbine Ranch, Inc., and Arthur Campbell produced moss peat; Adrian B. Locke, humus peat; and Mountain Valley Moss, Inc., reed-sedge peat.

Coal output increased 1,800 tons, although the output came from six underground mines, one less than in 1963. The coal producers were Morning Star Coal Co. (Morning Star mine), Peacock Coal Co. (Peacock), Oren A. Pilcher (Burnwell No. 1 and No. 2), Irvin A. Smith (King Coal), and Victory Coal Co. (Victory No. 3).

Larimer.—Although mineral production decreased $1.4 million, the county was ranked fifth in the State in value of mineral production. Of the 11 mineral commodities produced, cement output had the highest value, followed by stone and petroleum, the only other commodities with production values exceeding $1 million. The county led the State in the production of stone. The cement output, consisting of portland cement, was produced by Ideal Cement Co. from its Boettcher plant. The new truck-loading station near the plant was completed in September; seven 1,200-barrel bins provided bulk loading of trucks near, but outside, the plant area, thereby speeding delivery and lessening heavy truck traffic in the plant area.

Mincon operated its Loveland plant part of the year, producing high-purity beryllium oxide compounds from beryllium concentrates.

Production of stone, decreasing 61,000 tons, came from 22 operations. The major stone producer was Ideal Cement Co., which quarried limestone for making cement. Frank H. Norberg Co. produced limestone from two operations for making cement and lime; limestone from one operation also was used for road construction. Limestone also was produced by Pinon Grove Lime Co. for making lime. Granite for rough monumental stone was mined by Rocky Mountain Quarry Co. Crews of the Federal Bureau of Reclamation produced granite for riprap, road construction, and erosion control and crews of the U.S. Forest Service produced granite for riprap. Ten producers at 12 operations quarried dimension sandstone; the output was used for rough construction, rubble, rough architectural use, sawed and dressed building stone, and flagging. Colorado Stone Co. with three operations was the major producer. Other significant producers were Arkins-Olin Stone Quarry, Berthoud Pink Stone Co., Colorado Quarries, Jacobson-Lyon Stone Co., Inc., and Weaver Stone Co. Operators with lesser production were Johnson Stone Co., B. H. Spear, Sterling Stone Co., and Wild's Stone Quarries. Jacobson-Lyon Stone Co., Inc., also produced sandstone for riprap. F. R. & King Koenig produced quartz for precast panels. A crew of the Federal Bureau of Reclamation produced sandstone for riprap.

United States Gypsum Co. mined crude gypsum and calcined the output for gypsum building products. The gypsum output by Ernest W. Monroe was sold uncalcined for use as a portland-cement retarder.

The Great Western Sugar Co. made quicklime at its Loveland plant for making sugar from sugar beets. Production of sand and gravel was slightly more than one-half that of 1963 because of a decrease in road construction. Two-thirds of the sand and gravel output came from four commercial operations and one-third from six Government-and-contractor operations. The commercial producers were Flatiron Materials Co., Haags Sand and Gravel, Loveland Ready Mix Concrete, Inc., and Sterling Sand & Gravel Co. Crews of the State and county highway departments and the Federal Bureau of Reclamation and three contractors for the U.S. Forest Service produced the Government-and-contractor production.

Petroleum production, largely from the Loveland field, increased 43 percent (119,000 barrels) over that of 1963.

Small quantities of gold, silver, and iron ore were produced from one mine; the iron ore was used as a soil amendment. Uranium ore was mined at the Red Hill and Robinson Ranch properties by Robinson Ranch Mines; vanadium also was recovered from the uranium ore produced from the Red Hill mine.

Las Animas.—Coal output, second largest in the State, accounted for 95 percent of the county value of mineral production. The output, about 4 percent more than in 1963, came from nine underground operations. The Allen mine of CF&I had the most coal output of all the underground and strip mines in the State; the output was sent to the company plant at Pueblo for making coke used in the steel process. Albert Iuppa & Sons Coal Co., Berwind Coal Co., Broadhead Coal Co., Grey Creek Coal Co., Guadagnoli Bros. Coal Co., Eugene Lopez, Maschio Coal Co., and Sonchar Coal Co. were the other coal producers.

Carbon dioxide production from the Nina View field fell 22 percent below that of 1963. The carbon dioxide was processed in Bent County.

Small quantities of silver and copper were recovered from copper ore. Production of clay, from three operations, decreased 2,887 tons. Scott Mining Co. mined and sold fire clay for making firebrick. Fire clay mined by Harbison-Walker Refractories Co. was used by the company for making firebrick. Empire Clay Products, Inc., mined miscellaneous clay for making building brick at its plant. Production of sand and gravel, decreasing 6,000 tons, was produced by one commercial operator (Frank Leone Sand & Gravel), crews of the State and county highway departments, and a contractor for the Colorado Department of Highways. The contractor also produced miscellaneous stone for road construction.

Logan.—The county was ranked third in the State in petroleum production with an output of 3.5 million barrels, a 17-percent decrease. The production, accounting for 83 percent of the county value of mineral output, placed the county among the 11 with a value exceeding $10 million. Natural gas sales declined from 6.2 to 5.6 billion cubic feet. All 70 fields produced from one or more Cretaceous sands ("D," "J," and "O"). Four natural gas plants, three operated by Associated Oil & Gas Co. in the Lewis Creek, Padroni, and Yenter fields, and one by Sunray-DX Oil Co., in the Minto field, processed 4.9 billion cubic feet of gas and recovered 366,000 barrels of natural gas liquids. The plant at the Lewis Creek field was shut down and abandoned in June.

Quicklime was produced by The Great Western Sugar Co. at its

Sterling plan for making sugar from sugar beets. With road construction under way for Interstate Highway I–80, sand and gravel output increased 17 percent or 47,000 tons. Three operators—Sterling Ready Mix Concrete Co. Pre Ten Concrete Co., and Northeastern Sand & Gravel Co.—produced the commercial output of 97,000 tons, 30 percent of the total output. Crews of the State and county highway departments and a contractor for the Colorado Department of Highways produced 227,000 tons. The contractor also produced miscellaneous stone for riprap and road construction.

Mesa.—The value of mineral production increased 6 percent or $335,000. Output of coal, natural gas, stone, and vanadium slightly increased; these increases, with the addition of production of natural gas liquids, offset the losses in production of sand and gravel, and uranium ore. Although uranium ore production decreased 2,072 tons, 10,945 more pounds of U_3O_8 were contained in the output because the average grade of U_3O_8 was 0.012 percent higher. The uranium-ore output came from 40 operations, 6 fewer than in 1963. Ten operations each had production of less than 100 tons, 15 between 100 and 1,000 tons, 13 between 1,000 and 10,000 tons, and 2 over 10,000 tons. The principal producers, ranked according to output, were Beaver Mesa Uranium, Inc., Climax Uranium Co., Union Carbide Corp., and Shipman Mining & Exploration Co. In addition to the 40 mining operations, a small quantity of high-grade uranium material was obtained from cleanup of drums that had contained uranium concentrate. Vanadium was recovered from the uranium ores of all 40 operations. The average grade of vanadium oxide (V_2O_5) in the ore was 1.10 percent. Uranium and vanadium concentrates were produced from uranium ores processed at the Grand Junction uranium mill of Climax Uranium Co. According to the 1964 annual report of American Metal Climax, Inc., the company decided not to extend delivery of uranium concentrate from the Grand Junction uranium mill to AEC beyond the expiration of the present contract at the end of 1966.

Dry natural gas was produced from 37 wells in 12 fields, 2 discovered in 1964. Output was 2 billion cubic feet, slightly less than that of 1963, accounting for 6 percent of the county value of mineral production. Throughput of the Continental Oil Co. gas plant at Fruita was 4.3 billion cubic feet; the recovery was 73,000 barrels of natural gas liquids. American Gilsonite Co. operated its refining plant near Fruita; gilsonite, mined in Utah, was transported through a 72-mile pipeline to the plant where metallurgical coke, diesel fuel, gasoline, kerosene, and a tar byproduct used for highway surfacing were produced.

Coal output, increasing 14,000 tons, was from five underground mines operated by Eagle Head Coal Co.; Rudolph Fontanari; Gearhart Coal Mine; Juanita Coal & Coke Co., the major producer; and Willis Barstow and Partners. Although there were two more operations than in 1963, the production of sand and gravel decreased 180,000 tons or 22 percent. Most of the sand and gravel was used on construction of sections of Interstate Highway I–70. The total output came from four commercial and eight Government-and-contractor operations. The commercial producers were Fruita Ready Mix Sand & Gravel and United Sand & Gravel Co. (two operations). Crews of

the State and county highway departments and contractors for the U.S. Forest Service, Colorado Department of Highways, and Grand Junction Highway Department produced the Government-and-contractor output.

Joe C. Coffman produced dimension sandstone for sawed building stone and flagging. Kelley Stone Co. and C. E. Mendenhall produced dimension sandstone for dressed building stone. Miscellaneous stone was produced by contractors for the Colorado Department of Highways for riprap and road construction.

Mineral.—The value of mineral production increased $565,000. Except for $7,327 worth of sand and gravel and stone, the value was derived from the production of gold, silver, copper, lead, and zinc recovered from lead-zinc ore mined at the Emperius property of Emperius Mining Co. at Creede. Development work at the mine continued; the mine-ventilation system was improved. A contractor for the U.S. Forest Service produced granite for riprap. The sand and gravel output was produced by another contractor for the U.S. Forest Service for road construction.

Moffat.—Natural gas and petroleum accounted for 62 percent of the county value of mineral production. Petroleum production was 34 percent (440,000 barrels) below that of 1963. The decrease was largely (374,000 barrels) from the Williams Fork field. Natural gas production—largely from the Hiawatha-West, Powder Wash, Hiawatha and Sugar Loaf fields—increased 20 percent (2.1 billion cubic feet). Uranium ore output decreased 119,000 tons, because only 11 operations had production, compared with 31 in 1963. The uranium ore producers were Union Carbide Corp. (nine operations), Bill Levkulich, and Buffalo Head Mining Co. Union Carbide Corp.'s uranium operations (mining and milling in the Maybell area) were terminated in the last half of the year, because they no longer were economical. Production of coal, from two underground mines operated by Colowyo Coal Co. and by Silengo Coal Co., increased 11 percent. Sand and gravel, increasing 64,000 tons, was produced by one commercial operator (Craig Sand & Gravel Co.), crews of the State and county highway department, and two contractors for the Colorado Department of Highways. One of the contractors produced miscellaneous stone for riprap and road construction and one for road construction.

Montezuma.—Mineral production value increased $820,000, mainly because of greater output of petroleum and sand and gravel. Petroleum production increased 40 percent; the increase was mainly from the Cache field, discovered in October by Pan American Petroleum Corp. Carbon dioxide gas production from the McElmo field increased 5 percent. Sand and gravel was produced by Neilsons, Inc., a commercial operator, and a crew of the Montezuma County Highway Department. Gold and silver were recovered from some mill-cleanup material. A small quantity of uranium ore was mine by Elree Young from the Blue Eagle No. 1 mine; uranium and vanadium were recovered from the ore.

Montrose.—The value of mineral production decreased $2.3 million but was still high enough for the county to be among the 11 with a value exceeding $10 million. The big drop was caused mainly by a decrease in production of uranium ore; however, the county continued

to lead in output with 37 percent of the State production. Production of uranium ore was 17 percent below that of 1963; the number of operations decreased by 40. The average grade of the ore was 0.216 percentU_3O_8. Of the 134 operations, 21 each had production of less than 100 tons, 59 between 100 and 1,000 tons, 47 between 1,000 and 10,000 tons, and 7 greater than 10,000 tons. Principal producers, ranked in order of output, were Union Carbide Corp., VCA, and Climax Uranium Co.; these three companies accounted for 93 percent of the production and 77 percent of the operations. Union Carbide Corp. operated its Uravan uranium mill for recovery of uranium and vanadium concentrates from uranium ores. The county also was the principal source of vanadium in the State; output was more than twice that of any other county. Vanadium was recovered from uranium ores containing 1.12 percent vanadium oxide (V_2O_5).

Production of coal from the only operation, the Nucla strip mine of Peabody Coal Co., increased 15 percent. The coal was used for electric-power generation at the nearby powerplant of the Colorado Ute Electric Association. Union Carbide Corp. obtained salt brine from a well for use at the Uravan uranium mill. Salt brine obtained by Jensen & Jensen, a new producer, was used in drilling oil wells. Sand and gravel, increasing 45,000 tons, was produced by a commercial operator (Montrose Concrete Products Co.), crews of the State and county highway departments, and a contractor for the U.S. Forest Service.

Morgan.—The county had the largest decrease ($4.1 million) of all counties in value of mineral production mainly because of a decline in petroleum production, which was 33 percent or 1.1 million barrels below that of 1963; however, the total value was over $10 million.

The Adena field, third largest in the State, yielded 1 million barrels less than in 1963. All but 1 of the 47 fields in the county produced from either or both the "D" and "J" sands of Cretaceous age. Oil-well gas was processed at four plants, two operated by Associated Oil & Gas Co. and one each by Natural Gas Producers, Inc., and Pure Oil Co. Gas sales decreased by 1.9 billion cubic feet, 19 percent less than was sold in 1963.

The Great Western Sugar Co. produced quicklime at its Fort Morgan plant for making sugar from sugar beets. Sand and gravel output was only one-third that of 1963. The three commercial operators—Builders Aggregate Co., Jacob Dorn & Son, Inc., and Morgan Sand and Gravel, Inc.—produced one-third of the output. Crews of the Colorado Department of Highways and Morgan County Highway Department produced two-thirds of the output.

Ouray.—Except for $35,000 worth of sand and gravel, the value of mineral production was derived from gold, silver, copper, lead, and zinc from three underground operations. Most of the metal output came from ores produced from that part of the mine in the county. This mine also extends into San Miguel County. The other mines were the Bachelor operated by Bachelor Mines Co. and the Wewissa by Kuykendall Mines, Inc. The old Bay City mill north of Ouray was rebuilt by Carl Dismant to treat lead, zinc, and silver ores from the Bachelor mine. Federal Resources Corp. continued rehabilitating and exploring the Camp Bird mining properties acquired late in 1963.

Sand and gravel was produced by crews of the State and county highway departments and a contractor for the U.S. Forest Service.

Park.—Humus peat, more than twice that of 1963, was produced by Harvey F. Kemp and Universal Peat Co. Two placer and two underground operations accounted for gold, silver, copper, lead, and zinc outputs, except for a few ounces of gold and silver produced previously but not sold until this year. A notable increase in the outputs of these metals was that of silver—10,000 ounces. Sand and gravel was produced by a crew and a contractor for the Colorado Department of Highways. The contractor also produced miscellaneous stone for road construction.

Pitkin.—The value of mineral production increased $1.8 million, mainly because of a one-third increase in coal production. The output of coal came from four underground mines: Dutch Creek operated by Mid-Continent Coal & Coke Co. and Thompson Creek Nos. 1, 2, and 3 operated by Thompson Creek Coal & Coke Corp. Pitkin Iron Corp. shipped magnetite ore from the Cooper's Fork deposit to CF&I at Pueblo. Natural gas production from the two-well Wolf Creek field (one well in 1963) increased from 65 to 419 million cubic feet. Sand and gravel, decreasing 192,000 tons, was produced by two commercial operators (Hemann Sand & Gravel and Charles M. Evans), a crew of the Colorado Department of Highways, and a contractor for the U.S. Forest Service. Construction was begun at Homestake Transmountain Water Diversion project for the cities of Aurora and Colorado Springs. The project contractor produced a substantial quantity of granite for dam embankment.

Prowers.—Petroleum production from the one well in the Comanche field was 4,115 barrels. The well, completed in August for an initial daily production of 40 barrels, was the first in eastern Colorado to produce from a Mississippian formation.

Sand and gravel output was produced by one commercial operator (Lamar Valley Concrete Co.) and a crew and a contractor for the Colorado Department of Highways. A contractor also produced miscellaneous stone for road construction for the State highway department.

Pueblo.—Clay production, from six operations, decreased 17 percent. Fire clay was the only type of clay produced. Output by Standard Fire Brick Co. was used for making firebrick and mortar. Colorado Fire Clay Co. produced and sold fire clay for making firebrick. General Refractories Co. sold a part of its output and used the remainder for making firebrick. Red Mountain Clay Co. produced fire clay for making firebrick and lining zinc retorts. Production by Harbison-Walker Refractories Co. was used for making firebrick. Denver Fire Clay Co. produced fire clay for making clay crucibles, high-alumina brick, firebrick, and mortar.

Sand and gravel output decreased 345,000 tons. Road construction was less than in 1963, however, the sand and gravel output for building and road construction was near the 1-million-ton mark. Three-fourths of the production was by five commercial operators: Broderick & Gibbons, Inc., Certified Concrete Co., Fountain Sand & Gravel Co., Lluts Construction Co., and Yaron Sand & Gravel. Crews of the State and county highway departments and two contractors for the

Colorado Department of Highways produced one-quarter of the total. One of the contractors produced miscellaneous stone for road construction. Lime was produced by CF&I at its steel plant at Pueblo for making steel.

Rio Blanco.—The county was ranked second in value of mineral production in the State and continued to lead in petroleum and natural gas production. Petroleum production, approximately the same as in 1963, accounted for 92 percent of the county value. Rangely field, the largest in the State, yielded 84 percent of the petroleum production in the county. Natural gas production, mostly wet gas from the Rangely field, dropped 6 percent. The bulk of the gas produced was returned to the Weber reservoir to increase oil recovery. Of 52 billion cubic feet of gas produced in the county, only 10 billion cubic feet was sold. Wet gas was processed for natural gas liquids at the Western Division, California Oil Co. plant at Rangely. About 68 million barrels of water was injected into the Weber reservoir in the Rangely field. During December, daily injection (104 wells) averaged 176,000 barrels; cumulative injection at yearend was about 202 million barrels. The Uinta Refining Co. crude oil refinery at Rangely was shut down.

Coal output was from two underground operations—Rienau mine operated by Jenkins & Mathis Coal Co. and White River mine by Staley-Gordon Coal Co., Inc. Uranium ore, about one-half that of 1963, was produced by Harry H. Harp, Jr. Vanadium was recovered from the uranium ore processed by Union Carbide Corp. at its Rifle mill. Production of sand and gravel decreased 44 percent or 44,000 tons; the output was produced by one commercial operator, Albert Kirkpatrick, and by the Rio Blanco Highway Department. Kelley Stone Co. produced dressed dimension sandstone for building construction.

Routt.—The county continued to lead the State in coal production. Coal output increased 10 percent (75,000 tons) and represented 90 percent of the county value of mineral production. Output was from two strip mines and two underground mines, one less than in 1963. Energy Coal Co. operated the Energy strip mine, and The Pittsburg & Midway Coal Mining Co., the Edna strip mine. Virtually all the coal output from these two operations was shipped by rail to thermal powerplants in the Denver area.

Frederick H. Cromwell, employed at the Edna strip mine, received the Joseph A. Holmes Safety Association award of the Gold Medal of Honor and the Certificate of Honor for outstanding heroism in aiding a burned victim of an accident on February 5.

The underground production was from the Cardinal mine operated by Dry Creek Coal Co. and the Keystone mine by Routt Mining Corp. The Seneca strip mine of Seneca Coals, Ltd., near Hayden, went into operation at yearend to provide coal for the nearby newly constructed powerplant of Colorado-Ute Electric Association scheduled for operation early in 1965.

Petroleum production from 13 wells in five fields was 13 percent below that of 1963.

Scoria mined by McCoy Aggregate Co. was used for railroad ballast and as concrete aggregate. Sand and gravel, decreasing 86 percent or 138,000 tons, was produced by one commercial operator (D. R.

Moon Trucking Co.) and a crew and a contractor for the Colorado Department of Highways. The contractor also produced miscellaneous stone for road construction. Granite was produced by a contractor for the U.S. Forest Service for road construction.

Saguache.—Four operations, compared with one in 1963, yielded an increase in silver, copper, lead, and zinc. The most significant increase was for silver, from 182 ounces in 1963 to 14,320 ounces. Producers were Johnson Leasing & Land Co. at the Brighton mine, Monon Leasing Co. at the Monon, Rawley Metals, Inc., at the Rawley, and John F. Lewis at the Warwick. A small quantity of gold also was recovered from ore mined at one operation. Pinnacle Exploration, Inc., continued to ship uranium ore from a stockpile of ore mined in 1962 from its Pitch mine (Erie) in the Marshall Pass area. Gibralter Minerals Co. shipped uranium ore from its operation. Uranium ores were processed at the Cotter Corp. uranium mill at Canon City. Production of sand and gravel increased 24 percent; output was by crews of the State and county highway departments, two contractors for the U.S. Forest Service, and a contractor for the Colorado Department of Highways. A contractor for the Colorado Department of Highways produced miscellaneous stone for road construction.

San Juan.—Seven underground operations, two more than in 1963, accounted for the production of gold, silver, copper, lead, and zinc. Output of all the metals increased, except gold, which declined 10 ounces. Standard Metals Corp. operated the Belle Creole, Brenneman, Mogul, Silver Lake, and Sunnyside mines. The Sunnyside mine was the second major source of lead in the State. Ore from the five operations was processed by the company at its Shenandoah mill near Silverton. Other operations were the Osceola operated by Two-Bits Mining Co. and the Silver Wing by Silver Wing Mining Corp. A. A. McCluskey produced brown iron ore (limonite) from the Fifty-Fifty mine; the output was sold for paint pigment. Sand and gravel was produced in the county after a lapse of a year; the output was by a crew and a contractor for the Colorado Department of Highways.

San Miguel.—The county had the fourth largest value of mineral production in the State. The value increased substantially, $1.6 million or 15 percent, because of greater outputs of all mineral commodities, except vanadium which decreased slightly. The county was ranked first in production of gold, copper, and lead and second in silver, vanadium, and zinc. Most of the production of gold, silver copper, lead, and zinc came from the section of the Idarado mine in the county. This mine also extends into Ouray County. Ore production from the entire mine was processed at the Pandora mill at Telluride. Silver Hat Mining Co., Inc., produced 1,900 tons of silver ore from the San Bernardo mine near Trout Lake; gold, copper, lead, and zinc, beside silver, were recovered from the ore. Other operations with production of either precious or base metals were the Andrus mine of Eagle Ridge Co. and the Courthouse-Dynamo of Dick & George Koskinen.

Uranium ore production increased 19,000 tons, or 15 percent. The output, averaging 0.222 percent U_3O_8, came from 75 operations, 9 more than in 1963. Thirty-one of the operations each had production of less than 100 tons, 22 between 100 and 1,000 tons, 19 between 1,000 and 10,000 tons, and 3 more than 10,000 tons. Principal producers were

Union Carbide Corp. and Dulaney Mining Co. Uranium ores contained vanadium which was recovered at uranium ore processing plants; the average grade of V_2O_5 in the ore processed was 1.86 percent. Brown iron ore (limonite) was produced by Chas. Pfizer & Co., Inc., from the Iron Springs Placer for use as paint pigment, and by Theresa B. Robinson from the Iron Lode No. 3 for soil amendment. Sand and gravel output was by one commercial operator (Brasiers Bros. Construction) and a crew and a contractor for the Colorado Department of Highways.

Summit.—Mineral-production value decreased $234,000. Of the seven mineral commodities produced, only sand and gravel increased. The value of all metal production decreased $254,000 and that of stone $41,000. Seven underground mines accounted for gold, silver, copper, lead, and zinc output. Most of the gold, lead, and zinc came from the Wellington mine operated by the Wellington Mine Association; however, the mine and mill at the property were shut down after being operated only in the early part of the year. Other producers were Big Four Mines, Inc.; Burke-Martin Mine; Chautauqua, Inc.; Patterson-Lindsey Mining Co.; Summit Mining & Reduction Co; and Tom Martin & George Warren. Three commercial operators—C. Ryan & Son, Inc., Giberson Sand & Gravel Co., and J. S. Fulton Concrete—produced 69 percent (144,000 tons) of the sand and gravel, which was used mostly for construction at the Climax molybdenum operation. Crews of the State and county highway departments and a contractor for the Colorado Department of Highways produced 31 percent (66,000 tons) of the output. A contractor for the Federal Bureau of Reclamation produced granite for riprap and road construction.

Teller.—Mineral production decreased $154,000 in value, with declines in the three mineral commodities produced. The most notable decrease was a drop of 94,000 tons in sand and gravel production; 3,000 tons was produced by a crew of the Colorado Department of Highways. Dimension granite for monuments was produced by Pikes Peak Granite Co. Herb E. Smith produced quartz for terrazzo and landscaping. Alpine Meadows, Inc., produced both moss peat and reed-sedge peat for soil improvement.

Washington.—Although the value of mineral production decreased $2.8 million, the county was ranked third in output value. Although the large decrease was due to petroleum, the county was second to Rio Blanco in petroleum production. Output from 66 fields dropped 13 percent below that of 1963. All of the fields produced from the "D" or "J" sands, or both, of Cretaceous age. The county led the State in wildcat and development drilling. Oil well gas was processed at the Little Beaver plant operated by Continental Oil Co. Plant throughput was 1.7 billion cubic feet; plant recovery was 360,000 barrels of natural gas liquids. The only nonmineral-fuel commodity produced was sand and gravel; the output increased 261,000 tons over the 1963 output of 16,000 tons because of increased road construction. The output was produced by crews of the State and county highway departments and a contractor for the Colorado Department of Highways.

Weld.—With an increase of $1.1 million in mineral-production value, the county was among the 11 with a value exceeding $10 mil-

lion. The county led in output of sand and gravel with 2.4 million tons. The principal mineral commodities, ranked according to output value, were petroleum, coal, and sand and gravel; their combined values accounted for 95 percent of the county value. Coal production, third largest in the State, increased 44,000 tons or 6 percent. The output was from the same six underground operations as in 1963—Eagle and Imperial mines by The Imperial Coal Co., Lincoln and Washington mines by Clayton Coal Co., Boulder Valley mine by Boulder Valley Coal Co., and Sterling mine by McNeil Coal Corp. Petroleum production from 39 fields dropped 11 percent. The large majority of the fields produced from the "D" or "J" sands, or both, of Cretaceous age. Natural gas production, mainly oil well gas, dropped 29 percent. Only 2 discoveries, both oil, were made out of 22 wildcats drilled. Oil well gas was processed at the Roggen plant operated by McWood Corp. Plant throughput was 428 million cubic feet; plant recovery was 48,000 barrels of natural gas liquids. The Great Western Sugar Co. produced quicklime at its Eaton, Greeley, and Windsor plants for making sugar from sugar beets.

Sand and gravel production increased 1.6 million tons. Except for 49,000 tons produced by 3 commercial operators, the output, at 10 Government-and-contractor operations, reflected the great amount of road construction in the county. The commercial operators were Max Torrez Sand & Gravel, Moffat & Son, and Western Rock Products Co. Crews of the State and county highway departments and eight contractors for the Colorado Department of Highways produced virtually all of the 2.4 million tons. Miscellaneous stone was produced by contractors for the State highway department; output was used for riprap and road construction.

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 Joseph Krickich [1]

THE STATE's mineral industry continued to expand with a record high value of $21.9 million, an increase of 6 percent above that of the previous record year 1963. The increase was attributed primarily to price increases for most sand and gravel products and a record high output of stone. Increased production and value of feldspar and lime also contributed to the high level of mining activity.

The Geological and Natural History Survey of Connecticut continued its program of geologic mapping in cooperation with the Federal Geological Survey. The State maintained its own program and published three geological reports: The Surficial Geology of the Branford Quadrangle, the Bedrock Geology of the Essex Quadrangle, and the Bedrock Geology of the Collinsville Quadrangle. The Federal Geological Survey published two Water Supply Papers: No. 1661, Geology and Ground Water in the Farmington-Granby Area, Connecticut, and No. 1752, Ground-Water Resources of North-Central Connecticut.

TABLE 1.—Mineral production in Connecticut [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---- short tons	189,344	$339	211,621	$262
Gem stones	(2)	8	(2)	8
Lime ---- short tons	35,262	666	38,574	689
Sand and gravel ---- thousand short tons	10,503	9,343	10,088	9,437
Stone ---- do	5,318	9,612	5,864	10,764
Value of items that cannot be disclosed: Feldspar, mica (scrap), and peat	xx	646	xx	690
Total	xx	20,614	xx	21,850

xx Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.

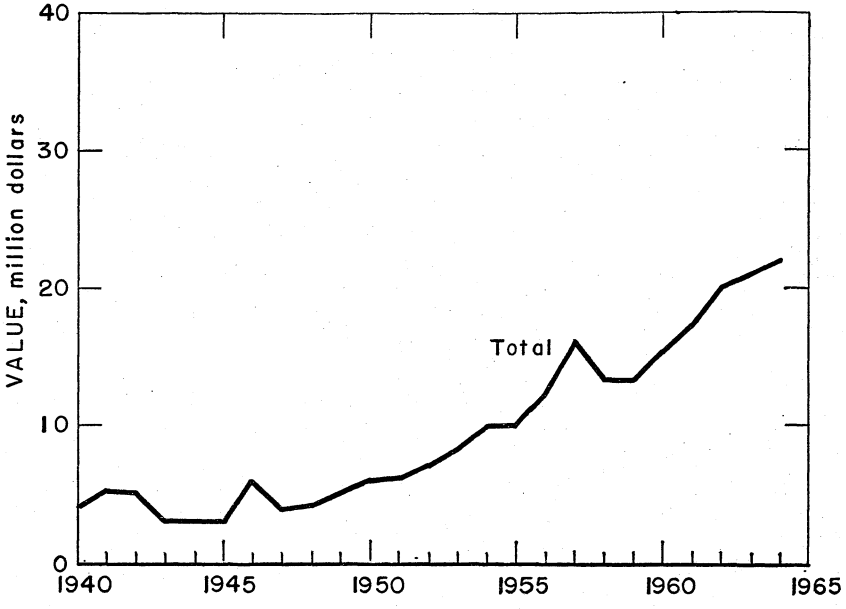


FIGURE 1.—Value of mineral production in Connecticut.

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

(Thousands)

Year	Value	Year	Year	Value	Year
1940	$7,375	1949	$5,617	1958	$13,245
1941	9,716	1950	6,526	1959	12,738
1942	8,334	1951	6,802	1960	15,243
1943	7,774	1952	7,891	1961	16,601
1944	7,436	1953	8,266	1962	r 19,835
1945	5,450	1954	9,973	1963	r 20,937
1946	7,833	1955	10,718	1964	22,013
1947	4,972	1956	11,495		
1948	5,304	1957	16,316		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Nonmetal and peat	109	25	208	----	4	19.23
Sand and gravel	619	140	1,173	1	26	23.02
Stone	348	92	787	----	17	21.60
Total	1,076	257	2,168	1	47	22.14
1964 p:						
Nonmetal and peat	92	26	208	----	3	14.42
Sand and gravel	555	130	1,070	2	16	16.82
Stone	360	91	791	1	17	22.76
Total	1,007	247	2,069	3	36	18.85

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Nine cement companies operated distribution terminals at Bridgeport, Hartford, Middletown, New Haven, North Haven, Plainville, and Rocky Hill. Cement for the terminals was produced at plants in New York and Pennsylvania.

Clays.—Output of clays increased principally because of greater demands for clay raw material used in manufacturing lightweight aggregate. Production of clays used for manufacturing building brick was below that of 1963. A limited quantity of miscellaneous clay was used for manufacturing flowerpots. Hartford County continued as the leading clay-producing area.

Feldspar.—Output of crude feldspar from two mines in Middlesex County was greater than that of 1963. The crude material was processed at nearby company-owned plants; one was a flotation concentrate plant and the other processed feldspar by dry grinding. In addition, another dry-grinding feldspar plant operated in the county but used purchased crude material. The ground feldspar was sold mainly to the glass and ceramic industries; some was used in sweeping compounds. Shipments of ground feldspar were principally to consumers in New Jersey and Pennsylvania.

Gem Stones.—Mineral collecting continued at the same level as in 1963. Pegmatites, quarries, and abandoned mine dumps, primarily in central and western counties, continued to interest mineral collectors and amateur lapidarists. Excavations for construction exposed some new mineral localities. In Fairfield County, specimens of thorite, parathorite, and dumortierite were collected near Danbury. Sheelite, topaz, and fluorite were found in an excavation for a housing development 1 mile west of the old Trumbull mine dumps. Near Haddam, Middlesex County, specimens of morganite, green beryl, black tourmaline, bismuthinite, and other bismuth minerals were recovered. Contact metamorphic minerals were collected at the Gillette quarry near Haddam Neck.

Gypsum.—National Gypsum Co. calcined gypsum at New Haven from crude material shipped from out of the State for manufacturing finished building products.

Lime.—Production of lime increased 9 percent compared with that of 1963. Quicklime and hydrated lime were produced by one company in Litchfield County. Most of the output was hydrated lime used in masonry work. The quicklime was used chiefly to manufacture calcium and magnesium at a nearby plant. Sales of lime were to consumers in Connecticut, Massachusetts, Rhode Island, and New York.

Mica.—Scrap mica (flake mica) was recovered as a byproduct of feldspar flotation at a plant in Middlesex County and processed for use in roofing materials.

Sand and Gravel.—Although sand and gravel production decreased 4 percent below the record high output of 1963, total value increased slightly because of higher unit values for most use categories. Production by both commercial and Government-and-contractor opera-

tions declined. The average price of commercial sand and gravel increased from $1.06 in 1963 to $1.14 in 1964. Building and paving use of sand and gravel accounted for 80 percent of the commercial output. Commercial producers washed or screened 78 percent of their output. Hartford County continued to lead in sand and gravel production, followed by New Haven, Fairfield, and Windham Counties.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	2,145	$2,284	2,106	$2,484
Paving	1,836	1,726	1,255	1,268
Fill	174	78	243	100
Other [1]	225	163	208	190
Total	4,380	4,251	3,812	4,042
Gravel:				
Structural	1,389	2,193	1,566	2,674
Paving	1,162	1,175	977	968
Fill	541	273	742	388
Other	160	172	280	303
Total	3,252	3,813	3,565	4,333
Total sand and gravel	7,632	8,064	7,377	8,375
Government-and-contractor operations:				
Sand:				
Paving	111	41	112	43
Fill			(2)	(2)
Other	31	16	17	7
Total	142	57	129	50
Gravel:				
Building	(2)	(2)		
Paving	2,705	1,211	2,575	1,008
Other [4]	24	10	7	4
Total	2,729	1,221	2,582	1,012
Total sand and gravel	2,871	1,278	2,711	1,062
All operations:				
Sand	4,522	4,308	3,941	4,092
Gravel	5,981	5,034	6,147	5,345
Total	10,503	9,342	10,088	9,437

[1] Includes molding, filter, grinding and polishing (1964), and other sand.
[2] Included with other sand. [3] Less than ½ unit. [4] Includes fill gravel.

Stone.—Production of stone increased 10 percent as demand for all types of stone (basalt, granite, limestone, sandstone, quartz, and miscellaneous stone) was greater than in 1963. Basalt (traprock) continued as the primary stone quarried and accounted for 90 percent of the total production and 80 percent of the value. Ninety-eight percent of the basalt was sold for concrete aggregate and roadstone; the remainder was marketed as railroad ballast, riprap, and for other uses. Production was centered chiefly in New Haven and Hartford Counties. Limestone, the second ranking stone, was quarried only in Litchfield County. Output was used chiefly for agstone (agricultural

stone) and lime manufacture. Granite was quarried and crushed in New London County for concrete aggregate and riprap. Dimension granite was produced in four counties, mainly for achitectural and monumental purposes. Quartz was quarried in New London County and recovered as a byproduct of feldspar flotation in Middlesex County; output from both operations was used primarily in glass manufacture. Dimension sandstone for construction was produced in Windham County. Miscellaneous stone was quarried in New London, Tolland, and Windham Counties.

TABLE 5.—Stone sold or used by producers, by uses

Use	1963		1964	
	Short tons	Value	Short tons	Value
Dimension stone	13,846	$171,074	17,538	$156,928
Crushed and broken stone:				
Agstone	80,985	378,821	W	W
Concrete, roadstone	4,937,179	7,861,882	5,413,486	8,762,155
Undistributed [1]	286,327	1,200,413	432,541	1,844,699
Total	5,318,337	9,612,190	5,863,565	10,763,782

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes flux, ground quartz, railroad ballast, riprap, other stone, and data indicated by symbol W.

MINERAL FUELS

Coke.—Connecticut Coke Co. operated a merchant coke plant at New Haven. In addition to coke, coal chemical materials produced included ammonium sulfate, coal tar, crude light oil, and intermediate light oil. Most of the coke and chemical products produced in the 70 slot-type ovens were marketed in the northeast.

Peat.—Production of reed-sedge peat was below that of 1963. Peat from a bog in Middlesex County was shredded and sold in bulk for soil conditioning uses.

METALS

The State continued as an important center for smelting and processing a wide variety of primary and secondary nonferrous metals. Castings from these metals as well as ferrous metals were produced in foundries throughout the State. Companies conducted active research programs with rarer metals, such as rhenium, zirconium, and osmium. The metallurgical research was aimed at developing new production techniques and products. Carpenter Steel of New England, Inc., produced steel in two electric furnaces at Bridgeport. Iron and steel scrap dealers were active in collecting and processing metal for domestic consumption and for the export market.

The only domestic production of calcium metal in the United States was at the magnesium and calcium reduction and calcium redistillation plant of Nelco Metals, Inc., a subsidiary of Chas. Pfizer & Co., Inc., at Canaan. The company purchased the Government-owned plant in May for $892,000. The company had been operating the plant under contract with the Atomic Energy Commission to supply

them with calcium and magnesium and was allowed to produce calcium for its own commercial sales. The plant had a rated annual capacity of 5,000 tons of primary magnesium. Annual capacity of calcium metal at the redistillation plant was 600,000 pounds.

REVIEW BY COUNTIES

Sand and gravel produced under contract for the Connecticut State Highway Department was not attributed to specific counties. Other Government-and-contractor sand and gravel was produced by municipalities in Hartford, Litchfield, New Haven, and New London Counties. Most of this material was used for road construction and maintenance and some was used for controlling icy highways. Value of mineral specimens (gem stones) was not attributed to specific counties.

Fairfield.—Sand and gravel production totaled 779,000 tons, 11 percent below that of 1963. Ten principal producers were active. About 90 percent of the output was processed material used mainly for building and highway construction. Some was used for fill and sanding icy highways. Principal producers were John Lamazzo & Sons Corp., Weston; Daddario Sand & Gravel, Newtown; and Grasso Construction Co., Shelton.

TABLE 6.—Value of mineral production in Connecticut, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Fairfield	$1,257,899	$1,169,000	Sand and gravel.
Hartford	5,977,865	6,276,579	Stone, sand and gravel, clays.
Litchfield	2,436,376	2,769,911	Stone, lime, sand and gravel.
Middlesex	1,225,523	1,183,689	Feldspar, sand and gravel, stone, mica, peat.
New Haven	5,990,049	7,379,980	Stone, sand and gravel, clays.
New London	980,371	923,031	Stone, sand and gravel.
Tolland	187,237	W	Sand and gravel, stone.
Windham	W	W	Do.
Undistributed [1]	2,558,687	2,147,950	
Total	20,614,000	21,850,000	

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.

Hartford.—The county continued as the second ranking mineral-producing area. Output of crushed and broken basalt (traprock) totaled 2.1 million tons and was slightly below that of 1963. Most of the output was used for concrete aggregate and roadstone, but some was sold for railroad ballast and as riprap. The Edward Balf Co., Newington, was the leading producer. Other producers were Roncari Industries, Inc., East Granby; The New Haven Trap Rock Co., Plainville; Sherman-Tomasso Concrete, Inc., with two quarries near Plainville; and Arborio-Tomasso, Inc. (formerly Arborio & Sons, Inc.), Farmington. Dimension granite was produced near Glastonbury by Tower Hill Granite Co.

Compared with 1963, commercial sand and gravel production increased slightly. Production totaled 2.6 million tons, most of which was used in construction. Leading commercial producers were Dunning Sand & Gravel Co., The Edward Balf Co., Costello Construction

Corp., and Connecticut Sand & Stone Corp. Sixty-five percent of the output was washed, sized, screened, or otherwise prepared. All commercial producers utilized truck transportation for marketing their materials.

Kelsey Ferguson Brick Co., Suffield, and Carpenter Brick & Clay Products Corp., South Windsor, produced miscellaneous clay for manufacturing building brick. The latter company sold part of its output to Plasticrete Corp., South Windsor, for manufacturing expanded clay lightweight aggregate. Miscellaneous clay for making flowerpots was produced by Keller Pottery Co. at Kensington. Edward W. Mack & Son, Windsor, resumed operations of its clay mine after being idle in 1963. Output was used for manufacturing building brick.

Litchfield.—Minerals, Pigments, and Metals Division, Chas. Pfizer & Co., Inc. (formerly New England Lime Co. Division), quarried limestone for manufacture of lime and agstone and for use as a filler. Most of the lime was used in the manufacture of high-purity calcium and magnesium at the nearby Nelco Metals, Inc., plant; the remainder was sold as agricultural lime and for use in construction. Conklin Limestone Co., Canaan, and Allyndale Corp., East Canaan, produced limestone used exclusively as agstone. Output of limestone from the Falls Village quarry of United States Gypsum Co., was used as agstone, flux, filler, and in stucco. Basalt for concrete aggregate was produced by Building Materials, Inc., at Woodbury. The company also produced sand and gravel from two operations near Torrington. Other sand and gravel operations were active near Canaan, Lime Rock, North Woodbury, New Milford, and Litchfield. Commercial production totaled 562,000 tons, 18 percent greater than that of 1963. Most of the output was used in construction and paving.

Middlesex.—The Feldspar Corp. mined and processed crude feldspar at Middletown. The material was beneficiated by flotation for use principally in manufacturing glass and ceramic products. The company also recovered scrap mica and quartz as coproducts in the feldspar flotation process. The flake mica was further processed by dry grinding for use as roofing material. The company has taken over the grinding operation of Deneen Mica Co. of Connecticut. The coproduct, quartz, was sold for use in manufacturing glass. Feldspar also was mined and processed by Eureka Feldspar Mining & Milling Co., Inc., Portland, exclusively for ceramic applications. R. & S. Enterprises, Inc., took over the grinding operations of Worth Spar Co., Inc., and purchased its crude material requirements. Ground feldspar from this plant was sold for use in sweeping compounds.

Sand and gravel production increased slightly and totaled 339,000 tons. Principal producers were Shore Line Washed Sand & Stone Co., Inc., Killingworth, Rollar Sand & Gravel, and Shoreline Concrete Co., Inc., both near Clinton. Cedar Swamp Peat Co. produced reed-sedge peat from a bog near Saybrook.

New Haven.—The county continued to rank first in total value of mineral production, leading in stone production and ranking second in sand and gravel output. Basalt, the principal stone, was quarried at five operations. Producers were The New Haven Trap Rock Co., North Branford and Wallingford; York Hill Traprock Quarry Co.,

Meriden; Charles W. Blakeslee & Sons, Inc., Hamden; and A. N. Farnham, Inc., New Haven. Most of the stone was sold for use as concrete aggregate, but some was used as riprap, railroad ballast, and roofing granules. Castelluccia & Sons, Inc., quarried granite for architectural work at Stoney Creek.

Output of commercial sand and gravel increased 34 percent, totaling nearly 2 million tons. Fourteen commercial operations were active producing mostly processed material for paving, construction, and as fill material. Some sand was produced for use in manufacturing concrete masonry units. Principal producers were Beard Sand & Gravel Co., Inc., Milford; The D. J. Carten Sand & Gravel Co., Devon; Cinque Bros. Co., North Branford; Meriden-Wallingford Sand & Stone Co., Inc., Wallingford; estate of Stillman H. Rice, New Haven; and Waterbury Sand & Gravel Co., Waterbury. Eighty-five percent of the commercial output was processed material; all producers used truck transportation for marketing their material. Miscellaneous clay for manufacturing building brick was produced by Stiles Brick Corp., North Haven.

New London.—Quartzite was produced at North Stonington by Connecticut Silica Co. The material was crushed, ground, and sized to specifications for use in manufacturing glass and as foundry, abrasive, and plaster sand. Some of the output was used for roofing granules, exposed aggregates, and filler. Granite was quarried at Montville for concrete aggregate and riprap by Barrett Division, Allied Chemical Corp. Dimension granite was produced at East Lyme. A small tonnage of miscellaneous stone was quarried near Old Lyme. Production of commercial sand and gravel increased but total value was below that of 1963. Seventy-eight percent of the output was processed material. Principal producers were Seymour Adelman, Fitchville; John J. Doyle Sand & Gravel Co., Inc., Montville; Lavoie Brothers, Inc., Waterford; Machnik Bros., Inc., Montville; and The Westerly Ready-Mixed Concrete Co., Inc., Pawcatuck.

Tolland.—Production of sand and gravel dropped sharply because Chapman Sand & Gravel discountinued operations in the county. The company, a large producer in 1963, moved its portable operations to Hartford County. Active producers were E. Foster Hyde, Ellington, and Myron M. Lee, Andover. Miscellaneous stone was quarried near Crystal Lake and sold for building stone and as rubble.

Windham.—Sand and gravel production was larger than in 1963. Most of the output was processed material used for building and paving. The principal producers were Dunning Sand & Stone Co., Inc., Wauregan, and R. A. Rawson Sand & Gravel, Inc., Putnam. Dunning Sand & Stone Co., Inc., recovered and crushed basalt boulders at its sand and gravel pit. Output was used for aggregate and railroad ballast. Helene Stone Corp., Sterling, and Arthur L. Hughes, Killingly, produced dimension sandstone. R. B. Marriott & Sons produced dimension granite near Oneco for curbing and rubble. Robert Olson produced dimension wallstone at Killingly.

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]

DELAWARE produced miscellaneous clay, sand and gravel, stone, and a small quantity of mineral specimens in 1964. The total value of these crude minerals was about $1.7 million, an increase of 30 percent over 1963.

TABLE 1.—Mineral production in Delaware [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	13	$13	11	$11
Gem stones	(2)	1	(2)	1
Sand and gravel—thousand short tons	1,094	1,136	1,282	1,280
Stone—do	66	191	W	W
Value of items that cannot be disclosed: Other nonmetals and value indicated by symbol W	XX		XX	450
Total	XX	1,341	XX	1,742

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

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

(Thousands)

Year	Value	Year	Value
1955	$1,701	1960	$982
1956	1,205	1961	1,055
1957	1,059	1962	r 1,543
1958	1,152	1963	r 1,368
1959	1,255	1964	1,765

r Revised.

[1] Physical science administrator, Bureau of Mines, Pittsburgh, Pa.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Non-fatal	
1963:						
Nonmetal, sand and gravel, and stone	89	18	157	----	2	13
1964: p						
Nonmetal, sand and gravel, and stone	101	21	177	----	2	11

p Preliminary.

REVIEW BY MINERAL COMMODITIES

Clays.—Miscellaneous clay was produced by the Delaware Brick Co. from an open pit mine near New Castle. All production was used by the company in the manufacture of common red building brick. Output was down slightly from that of 1963.

Gem Stones.—A variety of mineral specimens were collected by individuals and members of mineral clubs. Sources were the seashore and rock outcrops. The value of $1,000 credited to gem stone production in both 1963 and 1964 is an estimate based on a consensus of opinion of several local dealers and the author of this chapter.

Sand and Gravel.—Sand and gravel continued to be the principal mineral of value produced in the State. Sand was used chiefly for building and paving purposes. Reports in 1964 indicated that about 290,000 tons of sand was sold for building purposes, 200,000 tons for highway use, and the remainder for other uses—principally for fill and as engine traction sand. A total of 557,000 tons of sand was sold in 1964, compared with 499,000 tons in 1963. Production of sand was up about 12 percent over that of 1963, and the average overall value f.o.b. plant was 99 cents per ton, compared with 95 cents in the previous year. Values ranged from $1.00 to $1.50 per ton for building and paving uses to a low of 35 cents a ton for fill.

Most of the sand was processed; that sold as "pit run" was used chiefly as fill. Virtually all the sand except that sold for engine traction was transported to destination by truck. Gravel production in the State was about 22 percent greater in 1964 than in the previous year, as use for building material and as fill recorded increased sales. Sales for paving and highway use declined. Gravel sold for building use totaled 133,000 tons; paving use, 485,000 tons; and fill and other uses, 107,000 tons in 1964, compared with 75,000, 514,000, and 6,000 tons, respectively, in the previous year. The average overall value of gravel in 1964 was $1.01 per ton, 10 cents per ton less than in 1963. The decline reflected greater sales of low valued pit run fill material.

Washed gravel ranged in price from about $2.00 to $3.85 per ton, while pit run material ranged from $0.33 to $1.00 per ton f.o.b. plant. Thirteen plants reported production in 1964, compared with 15 in the previous year. Most of the gravel was shipped to consumers by truck. Of the total sand and gravel produced, 761,000 tons was processed and 521,000 tons was unprocessed.

Stone—Good demand for highway use resulted in a substantial increase in production of crushed stone. Stone was produced from gabbro deposits in New Castle County which have been classified as granite for statistical purposes. Most of the production was crushed and sized for use as a concrete aggregate on highways or as stone sand. About 5 percent of the tonnage produced was sold for riprap.

In addition to State sources, a considerable tonnage of crushed stone, chiefly for highway construction, was purchased from quarry operators in Maryland and Pennsylvania.

REVIEW BY COUNTIES

Kent.—Production of sand and gravel, the only mineral commodity produced, was about 40 percent up from the previous year, chiefly the result of a sale of a large tonnage of pit run material for fill use. Producers included St. Jones River Gravel Co. at Dover, Clough & Caulk Sand & Gravel at Wyoming, M. A. Hartnett, Inc., at Dover, and Barber Sand & Gravel at Harrington. Virtually all the material was used in building or highway construction. All four producing companies had stationary plants.

New Castle.—Sand production was 255,000 tons and gravel production was 533,000 tons in 1964, compared with 213,000 and 513,000 tons, respectively, in the previous year, showing an increase for both commodities even though there was one less producer. In 1964, five companies operated a total of four stationary plants and two portable plants. Producers of sand and gravel in the county included Delaware Sand & Gravel Co., and Parkway Sand & Gravel, Inc., near New Castle; Whittington Sand & Gravel Co. at Bear; John C. Green, Jr., at Middletown; and Petrillo Bros., Inc., at Wilmington. Riprap and crushed granite (gabbro) was quarried near Wilmington. Building brick was produced by Delaware Brick Co. from miscellaneous clay mined at an open pit near New Castle.

Sussex.—Production of sand increased slightly over that of the previous year, while gravel output was about the same. Lewes Sand Co. with a stationary plant near Lewes produced bank run sand for engine traction use. Atkins Brothers with a stationary plant at Millsboro produced sand and gravel for building and highway construction. Henry G. Graves & Sons, Inc., with a stationary plant at Georgetown produced sand for building 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 production of mineral commodities increased 11 percent over that of 1963, establishing a record year, due primarily to an 18-percent gain in the value of phosphate rock output over that of 1963.

For the 71st consecutive year, Florida was the leading phosphate rock producing State, and for the 25th consecutive year, was the leading zircon producer.

Commodities showing increases in output, in addition to those already mentioned, were portland cement, miscellaneous clay, crushed limestone, rare-earth mineral concentrates, ilmenite, and zirconium concentrate. Commodities showing decreases in output compared with

TABLE 1.—Mineral production in Florida [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	538	$7,777	627	$8,405
Gem stones	(2)	(3)		
Lime—thousand short tons	126	1,996	117	1,814
Natural gas—million cubic feet	35	7	40	5
Peat	21,049	129	19,813	102
Petroleum (crude)—thousand 42-gallon barrels	464	W	620	W
Phosphate rock—thousand long tons	14,592	101,050	17,108	119,667
Sand and gravel—thousand short tons	7,542	5,823	7,420	6,427
Stone—do	31,900	38,173	33,157	38,362
Value of items that cannot be disclosed: Cement, magnesium compounds, natural gas liquids, rare-earth metal concentrates, staurolite, titanium concentrates, zircon concentrates, and values indicated by symbol W	XX	46,665	XX	48,627
Total	XX	201,620	XX	223,409

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] Weight not recorded. [3] Less than ½ unit.

[1] Mining engineer, Area II Mineral Resource Office, Bureau of Mines, Knoxville, Tenn.
[2] Director, Division of Geology, Florida Board of Conservation, Tallahassee, Fla.

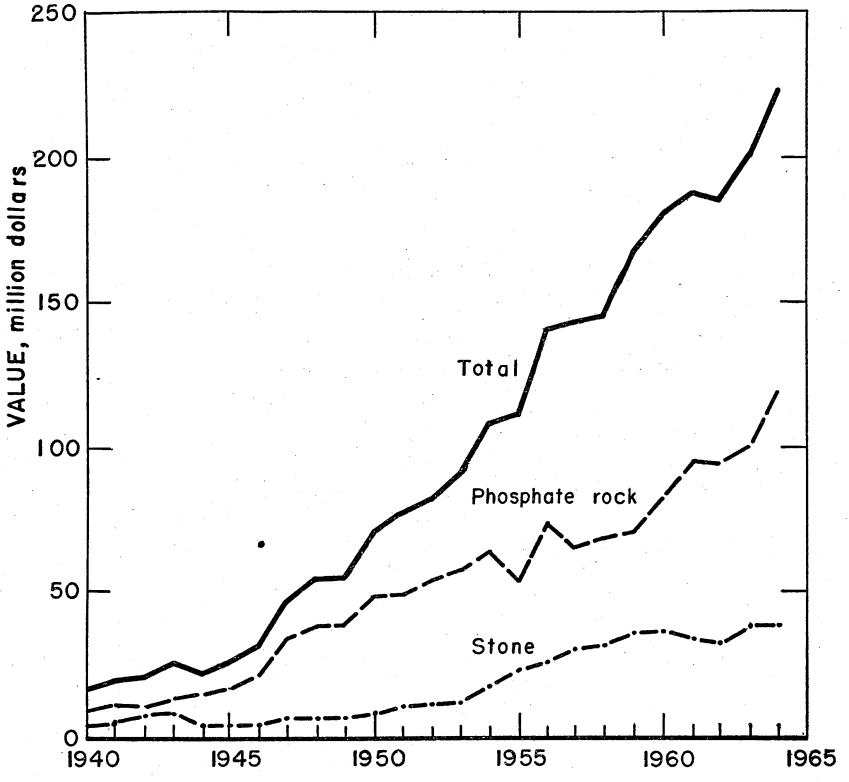


FIGURE 1.—Value of phosphate rock, stone, and total value of mineral production in Florida.

1963 were masonry cement, primary lime, hard-rock and soft-rock phosphate, sand and gravel, crushed oystershell, and rutile.

The three leading companies in value of mineral production were International Minerals & Chemical Corp., General Portland Cement Co., and V–C Chemical Co. Division of Socony-Mobil Oil Co.

Consumption, Trade, and Markets.—Consumption of mineral commodities continued at a high level with emphasis on increased consumption of phosphate rock, which accounted for 54 percent of the total mineral production value of the State. Enlargement of facilities

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

(Thousands)

Year	Value	Year	Value
1955	$115,324	1960	$180,228
1956	141,692	1961	191,887
1957	139,193	1962	185,282
1958	145,989	1963	r 199,829
1959	166,311	1964	219,628

r Revised.

for production and handling of phosphate rock coupled with expanding markets, both domestic and foreign, indicated even higher consumption of the commodity in 1965. Crushed limestone, portland cement, and miscellaneous clay increases reflected the continued high level of construction activity within the State and the upward consumption of these materials for use in all types of construction.

Export and import trade through Florida ports continued to gain. Export trade from the State rose at a rate of 25 percent compared with the remainder of the Southeast, but twice that for the Nation as a whole. According to U.S. Department of Commerce reports, the rate of gain of the value of imports for the first 10 months of 1964 was 18 percent, compared with the same period in 1963. Phosphate rock exports totaled 1 million tons more than in 1963, and new port loading and handling facilities were under construction. The Florida Phosphate Terminal Co. was constructing new facilities estimated to cost $5 million at Port Sutton, including elevators, drying plant, storage silos, and other automated equipment, to be completed in 1965. Tampa Terminals, Inc., at the head of Ybor Channel near downtown Tampa, was undergoing a $500,000 expansion that would double its storage capacity of phosphate rock, all of which is received at the terminal by truck. Loading facilities at Port of Tampa, Seddon Island, and Boca Grande were undergoing appraisal for expediting the handling of phosphate rock, and channel deepening was under consideration for handling deeper draft ships. New port expansion was in progress at the major seaports of Jacksonville, Miami, Everglades, Canaveral, and others; there were 14 deepwater ports in the State. The new Port of Miami was scheduled to be completed in 1965, and Port Canaveral was to be linked to the Atlantic Intracoastal Waterway by barge canal in late 1965.

Trends and Developments.—The continued high output of mineral commodities in the State and the establishment of a record year in 1964 by some of the commodities carried forward the upward trend which began several years ago. Phosphate rock, fuller's earth, miscellaneous clay, stone, monazite, ilmenite and rutile, zircon and others have shown production gains within the past 10 years. Population growth, the establishment of new industries, and the increased use of fertilizer have had an impact on the mineral industry of the State, and as a result the value of mineral output has increased from $109 million in 1955 to $221 million in 1964.

The Division of Geology, Florida Board of Conservation Tallahassee, continued its program of area minerals resource studies and at yearend had 63 major studies underway, including 19 map and 10 county-geologic and hydrologic projects; the studies were to provide data on mineral, water, and other natural resources required by an expanding economy. In 1963–64 the Division recorded its work in 34 papers on the geology and hydrology of the State. The first part of a comprehensive study of the "Geology of Florida" was completed; the study will terminate with the publication of a new, detailed geologic map. Test holes were being drilled at the corners of each township where geologic information was not available.

Electric energy requirements continued to increase and programs were underway for construction of additional facilities. Florida

Power & Light Co. planned an oil fired electric generating plant to be built near Turkey Point in Dade County; the plant will have two generating units. Florida Power also announced that a 20-year contract had been made with Peabody Coal Co. to deliver coal to its new Crystal River plant on the Gulf Coast. The first unit will be a 421,000-kw generator requiring 850,000 tons of coal annually. Additional generating units were planned to raise capacity to 2 million kw. This will be the company's first coal-burning plant. The coal will be moved by barge down the Green, Ohio and Mississippi Rivers to a point below New Orleans, through a 3,500-ton-per-hour transfer facility under construction, and then by seagoing barges across the Gulf of Mexico to the Crystal River plant. Tampa Electric Co. also announced that it had signed a 20-year agreement with Peabody Coal Co. to supply coal for its coal-burning generator plants; Peabody was to supply coal in amounts increasing each year from 1.08 million tons in 1964 to 3.02 million tons in 1975.

Florida experienced one of the largest road construction years in its history. At mid-year the State Road Department had more than $290 million in road and bridge projects underway on its State-maintained highway network. Progress also was made on the Interstate Highway System in the State; 370 miles had been completed, 130 miles were under construction, and right-of-way acquisition was underway on an additional 100 miles; the State's allotment is 1,161 miles of the U.S. System. Use of crushed stone and portland cement in road construction increased during the year.

Legislation and Government Programs.—Construction on the Cross Florida Barge Canal, authorized by the U.S. Congress in 1942, began in February. A navigation channel 12 feet deep by 150 feet wide was being built from the St. Johns River near Palatka, to the Gulf of Mexico near the Withlacooche River. The canal will pass through or along Putnam, Marion, Levy, and Citrus Counties, and become a vital link in both the State and Nation waterway systems. Construction completed to date includes a 2-mile length of the canal from Stokes Landing in the St. Johns River to the site of the first lock in Putnam County, designated the St. Johns Lock. Lock construction began late in the year, and a contract was awarded for excavating an additional 5 miles of canal at the western end of the project. The project was administered by the U.S. Corps of Engineers. Studies by that agency and others have indicated that transportation savings, over a project life of 50 years, will result in a savings of over $7 million, as well as providing other benefits, such as flood control and land value enhancement. Mineral commodities that would benefit from this new transportation route would include the low-cost bulk commodities such as phosphate, crushed limestone, sand and gravel, cement, and others. The total estimated cost of the canal was $158 million; quantities of material that must be excavated during construction of the 170-mile waterway has been estimated at 88 million cubic yards, of which about 20 percent would be rock excavation.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	281	99	792	----	2	3
Nonmetal	3,056	940	7,567	----	43	6
Sand and gravel	354	94	827	----	5	6
Stone	2,681	729	6,107	1	92	15
Peat	23	5	40	----	----	----
Total	6,395	1,867	15,333	1	142	9
1964:p						
Metal	320	78	618	----	5	8
Nonmetal	3,310	1,023	8,035	1	102	12
Sand and gravel	350	92	814	1	22	28
Stone	2,610	726	6,308	8	74	13
Peat	21	4	34	----	----	----
Total	6,611	1,923	15,809	10	203	13

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Total cement production, including masonry and portland, increased slightly compared with that of 1963; both output and value were about 1 percent higher. Masonry cement continued a decline begun in 1960; output decreased 2 percent and value 3 percent. Portland cement increased 1 percent in output and value. Shipments of cement were made principally to points within the State. Portland cement shipments to consumers were as follows: 14 percent to building material dealers, 25 percent to concrete products manufacturers, 46 percent to ready-mixed concrete companies, 9 percent to highway contractors, and 2 percent each to other contractors, government agencies, and miscellaneous customers.

Four production plants operated during the year. General Portland Cement Co. operated two plants, one at Miami and the other at Tampa. General Portland acquired Atlantic Cement Co.'s distribution plant at Tampa about mid-year; Atlantic will continue to operate two additional distribution plants in Florida, at Jacksonville and Port Everglades. Lehigh Cement Co. operated two production plants, one at Miami and the other at Bunnell, Flagler County.

Ideal Cement Co., West Palm Beach, awarded a contract for construction of 12 cement storage silos at its Port of Palm Beach terminal. The silos were slated to be 115 feet high, 28 feet in diameter, and to have storage capacity for 180,000 barrels of cement. The project, begun in April, was scheduled for completion in August 1965.

Clays.—For the 7th consecutive year, Florida was the leading fuller's earth producer. Clay production included fuller's earth, kaolin, and miscellaneous clay.

Fuller's earth increased 6 percent in tonnage and 9 percent in value, establishing another record year in both output and value. Three companies operated four mines in Gadsden County; producers listed in order of output were Minerals & Chemicals Philipp Corp., Floridin

Co. Inc., and Magnet Cove Barium Corp. Most of the material was used for absorbent purposes; other major uses included insecticides and fungicides, filtering, decolorizing, and clarifying agents for oils and fats, and in oil-well drilling muds.

Magnet Cove Barium Corp. reported expansion of its fuller's earth plant at Havana; new equipment installed included a drier, impact mill, screens, and granulating mills.

Minerals & Chemicals Philipp Corp. reported increased sales and new uses for fuller's earth products. Largest sales increases came as a result of expanded demand for granular products used as carriers for agricultural products; granular fuller's earth was used in the filtration of jet fuels to remove traces of unwanted contaminants at the refinery as well as at the point of delivery. The company continued its research to develop new uses for the products of its minerals and chemicals division.

The Division of Geology, Florida Board of Conservation, Tallahassee, published Information Circular 48, Ceramic Clay Investigations in Alachua, Clay, and Putnam Counties, by Robert C. Hickman and Howard P. Hamlin. The work, performed by the Federal Bureau of Mines, entailed sampling and testing of clays in three areas in the northeast portion of the State; the report includes description of the deposits, method of evaluation, drill hole logs, sample test results, and A.S.T.M. specifications for clay products.

Gypsum.—Gypsum from Nova Scotia was calcined by two companies, U.S. Gypsum Co., near Jacksonville, Duval County; and National Gypsum Co., near Tampa, Hillsborough County. Construction of the Kaiser Gypsum Co. plant on Dames Point, near Jacksonville, continued; production from the new operation was expected in 1965.

Lime.—Chemical Lime, Inc., Hernando County, and Dixie Lime & Stone Co., Marion County, produced lime for construction, agricultural, and chemical uses. Michigan Chemical Corp., Port St. Joe, Gulf County, produced quicklime for use at its magnesium compounds plant to extract magnesia from sea water.

Regenerated quicklime was produced by five companies and two municipalities; the companies used the lime principally in manufacturing paper, and the municipalities used the material for water purification. Total production was 420,000 tons valued at $6.2 million, compared with 402,000 tons valued at $5.5 million in 1963.

Magnesia.—For the third consecutive year, Florida ranked third in the Nation in magnesium compounds sold or used. Michigan Chemical Corp., Port St. Joe, Gulf County, produced magnesium compounds from sea water; products shipped, listed in order of tonnage, were caustic calcined magnesia, refractory magnesia, and magnesium hydroxide. The material was used for insulation, chemical, and pulp and paper purposes.

Perlite.—Expanded perlite was processed by three companies from ore shipped into the State from Colorado. Total output and value decreased. Producers were Perlite, Inc., Dade County, Chemrock Corp., Duval County, and Airlite Processing Corp., Indian River County. The expanded material was used for building plaster, concrete aggregate, soil conditioning, insulation and filler.

Phosphate Rock.—For the 71st consecutive year, Florida led the Na-

tion in total marketable production of phosphate rock. Land-pebble, hard-rock, and soft-rock phosphate were produced; land-pebble production comprised over 99 percent of total output. Land-pebble production again established a record in output and value, with the largest annual increase in the industry's history.

Mine production of crude dry ore was 58.1 million long tons with a P_2O_5 content of 9.4 million tons, an increase of 7 percent in tonnage and 17 percent in P_2O_5 content. Land-pebble for agricultural uses totaled 10.5 million long tons or 65 percent; for industrial uses 0.6 million long tons or 4 percent, and for export 5.1 million long tons or 31 percent. Agricultural uses were divided as follows: 46 percent in the manufacture of ordinary superphosphate, 50 percent in wet process phosphoric acid and triple superphosphate, and the remaining 4 percent in nitraphosphate, direct application to the soil, and stock and poultry feed. In the interchange of sales and purchases by mining companies common to the Florida field, a total of 1.4 million tons of processed material with a P_2O_5 content of 439,000 tons was interchanged.

Because of the heavy cost of transportation of phosphate rock, there was evidence of a trend toward refining and processing fertilizer materials close to the mines in order to reduce this expense; this trend has led to the development of highly concentrated dry and even more highly concentrated liquid fertilizers. Expanded production of liquid phosphoric acid near the producing mines appears probable. Consumers Cooperative Association of Kansas, announced it would build a $20 million fertilizer complex in Polk County near producers, and ship phosphoric acid instead of phosphate rock to its plant in the Midwest. Consumers Cooperative planned to buy rock for the acid plant from local mining companies.

The trend toward shipping liquid sulfur to Florida terminals near the large phosphate consuming industry continued, and it seemed likely that in a short time all sulfur for use by the phosphate industry would be transported in liquid form. Freeport Sulphur Co. announced that it would increase storage capacity at its Tampa terminal by one-third; two new liquid storage tanks would increase total storage capacity to 60,000 tons. Construction began on a new 635-foot liquid tanker for Freeport, to supply Tampa and east coast terminals with sulfur from the company storage facilities at Port Sulphur, La.

Land-pebble phosphate was produced at 17 mines by 11 companies in Polk and Hillsborough counties.

Soft-rock phosphate was produced at five mines, operated by four companies in Citrus, Marion, and Gilchrist counties. All of the soft rock was used for stock and poultry feed and for direct application to the soil.

Hard-rock phosphate was again produced by only one company, Kibler-Camp Phosphate Enterprise, in Marion County (Section 26 mine).

The leading producer of land-pebble phosphate continued to be International Minerals & Chemical Corp., with mines and plants in the Bartow area. The corporation announced near yearend that a new $2 million dragline had been ordered for use at its Achan mine; the new dragline, scheduled to be operating by September 1965, will

have a bucket capacity of 37 cubic yards, or about 60 tons of phosphate ore, and would be the largest dragline ever operated by the corporation in the Florida field. The planning of mining operations by International for 1 year ahead by the use of computers and associated equipment was described.[3] In addition to computations for the "year-ahead" mine plan, the computer aids corporation engineers in reserve calculations for land acquisition or exchange programs, long-range planning, storage planning, map information, monthly production reports, planning waste disposal, and planning changes for the plants' ore-handling equipment. The Bonnie Chemical Division operations of the corporation set a new safety record during the year by working 1 million man-hours without a lost time accident; the previous record was 521,197 man-hours. International began shipping phosphate rock to California during the year, under an agreement with Bulk Food Carriers, owner of a self-unloading ship which recently received approval of a freight rate, making Florida phosphate competitive with western phosphates in the west coast marketing area. The ship will carry rice from California to Puerto Rico, and on its return trip will pick up phosphate rock at Port of Boca Grande for shipment to the west coast. The corporation's new 250,000-ton-per-year phosphate granulation plant, whose cost was estimated at $2.5 million, was placed in operation at Bonnie; the new facility replaces a plant built in 1954 and provides twice as much capacity. International also installed two 60-ft. scrubbing towers at its Noralyn plant to handle gases from a drying kiln which has a capacity of 500,000 tons per year of calcined phosphate; the new scrubbers will help alleviate air pollution from the kiln. The capacity of the Noralyn plant was doubled by the installation of a new dryer, additional wet-rock conveying, storage, and reclaiming facilities, and other equipment; the plant expansion was described, along with a flowsheet of the operation.[4]

American Agricultural Chemical Co., wholly owned subsidiary of Continental Oil Co., announced that new processing techniques would be incorporated into its sulfuric acid-using plant at Pierce. Work began on a $13-million fertilizer complex, to be known as the South Pierce plant, to process rock into various phosphate fertilizers; the new facility was expected to be in operation by early 1965 and will produce regular and granular triple superphosphate, diammonium phosphate, sulfuric acid, and phosphoric acid. More than $1 million of the total project cost will be spent for effluent control equipment. The company's Palmetto washer and recovery plant and equipment was described.[5] The plant is designed around a hydrosizer, developed by the company, which replaces conventional screening procedures; the washer uses excavated storage or surge pits instead of the usual tanks or bins between the washer and recovery departments, effecting important economies in the original plant cost and in handling. The installation was designed by company metallurgical staff, and was built by the company.

[3] Barnes, Billy. A "Year-Ahead" Mine Plan in Minutes. Eng. and Min. J., v. 165, No. 5, May 1964, pp. 107–111.
[4] Mitchell, Ronald J. IMC Doubles Noralyn Plant Capacity. Metal Mining and Processing, July 1964 pp. 20–23.
[5] Trauffer, Walter E. New AAC Phosphate Washer Features Two Major Operating Improvements. Pit and Quarry, February 1964, pp. 108–116.

V–C Chemical Co., Division of Socony-Mobil Oil Co., late in the year opened a new phosphate mining area near Bartow comprising 1,200 acres; the new mine, to be known as Cedar Branch, will increase company production in 1965. New additions were to be completed early in 1965 at the Clear Springs processing plant to handle the increased output. V–C installed a fourth dust collector at its Harding super-phosphate plant in Polk County; previous installations had cleaned up the major sources of dust pollution.

American Cyanamid Co. continued its mining and processing operations in Polk and Hillsborough Counties. A statistical analysis study resulting from data supplied to the Federal Bureau of Mines was published; [6] the report describes a method for evaluating the mean and variance of assay data from samples of different lengths. The company's Orange Park and Sydney mines were awarded certificates of safety achievement for records of 302,743 and 295,977 accident-free man-hours, respectively, in 1963, without a disabling injury.

W. R. Grace & Co., Davison Chemical Division, late in the year started on a major expansion of facilities for the production of concentrated phosphates and fertilizers; the expansion will increase the wet phosphoric acid capacity by 100,000 tons, and diammonium phosphate, by 200,000 tons per year.

Armour Agricultural Chemical Co. installed a new 200-ton-per-day Prayon process plant and new sulfuric acid facilities at its Bartow operations.

Enlarged flotation facilities for phosphate rock recovery at the Swift & Co. Watson mine went into production in June, increasing output considerably. Minerals Recovery Corp. contracted with Swift to recover phosphate from previously processed tailings at Sand Mountain, south of Fort Meade. Minerals Recovery was reworking the sand and obtaining additional phosphate.

Smith-Douglass Co. Inc. was acquired by Borden Chemical Co. late in the year to be operated as a division of Borden Co.; Borden issued 976,935 shares of stock in exchange for the assets and business of Smith-Douglass. The company awarded a contract for the expansion of its phosphate defluorination plant at Plant City; construction of the new facilities was underway and completion scheduled for early 1965.

Occidental Petroleum Corp. announced late in the year that its subsidiary, Occidental Corp. of Florida, would build a $10-million phosphate complex in Hamilton County near White Springs. Initially, the company planned to process 1 million tons of phosphate rock per year from its Suwannee River mine. Occidental controls International Ore & Fertilizer Corp., phosphate export company at Tampa. Large reserves of phosphate have been proved in northeastern Florida, centered in Hamilton, Alachua, Union, Columbia, Baker, Gilchrist, Marion and Bradford Counties, Florida, and Echols County, Georgia. At least 24 companies have expressed an interest in the area, or have exploration programs underway.

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[6] Berkekotter, R. D. Application of Statistical Analysis in Evaluating Bedded Deposits of Variable Thickness. Florida Phosphate Data. BuMines Rept. of Inv. 6526, 1964, 38 pp.

Kerr-McGee Oil Industries, Inc., purchaser of Baugh Chemical Co. phosphate reserves in Polk County in 1963, reportedly optioned phosphate acreage in north Florida and was actively conducting exploration in that area, along with several other companies.

Consumers Cooperative Association of Kansas City, Mo., announced about midyear that it would build a $20-million plant in Polk County, in close proximity to producing mines, for the manufacture of high-analysis fertilizers; the new plant will manufacture sulfuric acid, phosphoric acid, granular triple superphosphate, and diammonium phosphate. Consumers has a large interest in Farmers Chemical Co. near Joplin, Mo., which used phosphate rock shipped by rail from Florida; completion of the new Florida plant will eliminate the processing of rock at Joplin, since the Association planned to ship phosphoric acid from Florida at a considerable reduction in cost.

TABLE 4.—Marketable production of phosphate rock

Type	1963		1964	
	Long tons	Value	Long tons	Value
Soft	32,476	$264,734	29,734	$239,554
Hard	73,651	698,000	70,120	681,000
Land pebble	14,486,245	100,087,186	17,008,398	118,746,365
Total	14,592,372	101,049,920	17,108,252	119,666,919

TABLE 5.—Phosphate rock sold or used by producers, by uses

Use	1963			1964		
	Long tons	Value		Long tons	Value	
		Total	Average per ton		Total	Average per ton
Ordinary superphosphate	4,336,226	$30,403,218	$7.01	4,853,171	$32,838,382	$6.77
Phosphoric acid (wet process)	2,685,878	18,814,481	7.00	3,131,163	25,084,095	8.01
Triple superphosphate	2,344,765	17,600,334	7.51	2,154,644	17,804,346	8.26
Elemental phosphorus, ferrophosphorus, and phosphoric acid	471,275	3,165,273	6.72	685,055	2,731,590	3.99
Direct application to the soil [1]	675,881	4,747,783	7.02	446,645	3,492,351	7.82
Exports	3,972,000	27,009,600	6.80	5,086,000	34,533,940	6.79
Total	14,486,025	101,740,689	7.02	16,356,678	116,484,704	7.12

[1] Includes nitraphosphate and stock and poultry feed.

Stauffer Chemical Co. reportedly had an option to purchase approximately 8,000 acres of phosphate lands in western Hardee County.

Tennessee Valley Authority (TVA) announced awards of contracts with a possible total of almost $1.4 million for the purchase of phosphate rock from two Florida producers; TVA used the high-grade phosphate rock in making certain concentrated fertilizers at its National Fertilizer Center at Muscle Shoals, Ala.

Sand and Gravel.—A record high sand and gravel production was established in value, but output declined 2 percent. Total commercial sand production was 6.6 million tons, and gravel, 340,000 tons,

which was 94 percent of total output; government-and-contractor sand and gravel production was 509,000 tons valued at $388,000. Ninety-seven percent of the total sand and gravel, including government-and-contractor production, was classified for construction uses, and the remaining 3 percent, for industrial uses. Construction sand and gravel was used for building, paving, fill, railroad ballast, and other uses; industrial sand was used for glass, blasting, filtration, and other uses.

Sand and gravel was produced in 26 counties at 59 mines; 52 of the mines were commercial sand and/or gravel operations and the remaining 7 were government-and-contractor mines, operated by county highway departments or the U.S. Forest Service.

Leading commercial sand and gravel producing counties were Polk, Lake and Putnam. Leading individual producing mines, listed in order of output, were Standard mine (Standard Sand & Silica Co.), Polk County; Eustis mine (Eustis Sand Co.), and Clermont mine (E. R. Jahna Industries, Inc.), both in Lake County. Commercial sand and gravel, produced at 52 mines, was processed at 43 stationary and 9 portable plants; 19 plants produced less than 25,000 to 50,000 tons, 30 plants produced from 50,000 to 400,000 tons, and 3 plants produced from 400,000 to 700,000 tons. Processed material totaled 6.5 million tons and unprocessed 381,000 tons. Commercial sand and gravel was transported as follows: By truck, 4.3 million tons; by railroad, 2.5 million tons; and by waterway, 51,000 tons.

Government-and-contractor sand was produced in 6 counties, and gravel was produced in one county; total output was 509,000 tons valued at $388,000. All of the plants were portable, and 359,000 tons of the total were processed. The material was used as follows: Paving sand, 437,000 tons; building sand, 60,000 tons, and paving gravel, 12,000 tons. All of the sand and gravel was transported by truck.

Staurolite.—Florida was the only State producing staurolite, for the seventh consecutive year. E. I. du Pont de Nemours & Co., Inc., Clay County, recovered staurolite as a byproduct of ilmenite at its Highland and Trail Ridge plants. Most of the material was used as an abrasive material.

Stone.—Crushed limestone and crushed oystershell continued to be the most important stone commodities for use in construction of roads, building, cement and lime manufacture, and other uses in the State. Crushed limestone increased, offsetting a decline in crushed oystershell. Government-and-contractor crushed limestone was produced by four county highway departments and one city; total production was 374,000 tons valued at $333,000. The material was used for roadstone and concrete, and was transported by truck.

Eighty-one quarries in 23 counties crushed limestone. Dade, Hernando, and Broward Counties accounted for 67 percent of the total quantity produced and 62 percent of the total value. Leading quarries were Florida Rock Products Co. (Diamond Hill quarry), Seminole Rock Products Co., Inc. (Medley quarry), and Pennsuco Aggregates, Inc. (Pennsuco quarry), formerly Ponce Products Corp. Crushed limestone was transported 70 percent by truck, 29 percent by railroad, and less than 1 percent by waterway.

TABLE 6.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Bay	W	W	81	$69
Brevard	47	$58	44	53
Broward	407	274	305	232
Dade	1,200	609	240	178
Duval	36	26		
Escambia	405	392	562	573
Indian River			25	25
Lake	1,181	626	1,548	1,143
Leon	97	123	W	W
Liberty			5	4
Orange	150	136	150	129
Palm Beach	1	1	170	87
Pinellas			7	5
Polk	2,224	1,802	2,411	1,996
Putnam	624	525	487	380
St. Lucie	155	151	128	103
Wakulla			42	36
Washington	21	16	14	11
Undistributed [1]	994	1,083	1,201	1,403
Total	7,542	5,822	7,420	6,427

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Clay, Franklin (1964), Gadsden, Glades, Hendry, Hillsborough, Marion (1964), Volusia, and Walton 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	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	5,059	$3,670	$0.73	5,647	$4,413	$0.78
Paving	364	325	.89	747	588	.79
Fill	1,538	782	.51	335	170	.51
Glass	109	218	2.01	W	W	W
Other sands [1]	172	315	1.82	339	660	1.95
Total	7,242	5,310	.73	7,068	5,831	.82
Gravel [2]	300	512	1.71	352	596	1.69
Total sand and gravel	7,542	5,822	.77	7,420	6,427	.87

W Withheld to avoid disclosing individual company confidential data.
[1] Includes filtration, blast, molding (1963), other uses, and uses indicated by footnote W.
[2] Includes structural and paving gravel.

Oystershell was dredged on seven State leases by six companies in five counties. Total production was 1.7 million tons valued at $2.4 million, a reduction in output and value from those of the previous year. Most of the material was used for roadstone and concrete; one company indicated use of the material in poultry grit and for other uses. Leading producers, listed in order of output, were Benton & Co., Pinellas County, Radcliff Materials Co., Walton County, and Bay Dredging & Construction Co., Hillsborough County. Sixty-seven percent of the oystershell was transported by truck, 32 percent by waterway, and the remaining 1 percent by railroad.

The Suwannee quarry of Florida Rock Products Corp., Live Oak, won top honors in the first annual National Limestone Institute Safety Competition conducted by the Bureau of Mines, U.S. Department of the Interior. The operation received a plaque, provided by Pit and Quarry magazine, for having achieved the best safety record in each of four classes of limestone producers in the competition. Each official and employee of the plant was awarded a Certificate of Accomplishment in Safety by the Bureau of Mines in recognition of his part in the attainment of the outstanding record of the plant. The Newberry quarry of Houdaille-Duval, Inc., Newberry, was awarded a Certificate of Achievement in Safety by the Bureau of Mines for an injury-free record during the 1963 competitive year; the quarry worked 45,910 man-hours without a disabling work injury during the year.

Houdaille-Duval, Inc., a division of Houdaille Industries, Inc., announced the purchase of Deerfield Rock Co., Lakeview; included in the purchase was the company name, mining and processing facilities, inventory and equipment, and approximately 1,100 acres of real estate and aggregate reserves.

Several short articles were published describing typical crushed limestone operations in Dade and Broward Counties; operations of the following companies were described: Pennsuco Aggregates Co. (Pennsuco quarry),[7] Miami Crushed Rock, Inc. (Coral Gables quarry),[8] and R. H. Wright Co. (Pompano quarry).[9]

Vermiculite.—Exfoliated vermiculite was produced by Zonolite Division of W. R. Grace & Co. at plants in Duval, Hillsborough, and Palm Beach Counties, and by Verlite Co. at a plant in Hillsborough County. Production increased 7 percent over that of 1963. Crude vermiculite was obtained from South Carolina, Montana, and the Republic of South Africa.

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Alachua	1,345,784	$1,181,678	1,408,583	$1,071,464
Broward	4,789,785	5,284,362	4,250,747	4,549,278
Collier	701,848	653,253	564,931	737,756
Dade	7,508,475	7,329,825	10,161,681	9,742,079
Hendry	100,364	65,961	9,350	10,846
Hernando	5,826,419	8,235,430	6,658,103	9,352,879
Levy	287,519	554,096	299,731	426,735
Marion	1,333,791	1,506,001	1,423,327	1,509,273
Monroe	242,000	485,000	325,000	297,500
Palm Beach	W	W	669,719	491,993
Pasco	8,217	8,217	39,171	33,295
Volusia	10,000	10,000	6,250	6,000
Undistributed [1]	7,931,667	10,245,554	5,659,128	7,714,419
Total	30,085,869	35,559,377	31,475,721	35,943,517

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Citrus, Columbia, Flagler, Jackson (1963), Lafayette, Lee, Manatee, Pinellas, Sarasota, Sumter, Suwanee, and Taylor Counties, and counties indicated by symbol W.

[7] McDonough, E. W. Maule's Pennsuco Plant Working Double Shift. The Dixie Contractor, v. 34, No. 25, October, 1964, pp. 102–103.
[8] Mitchell, Ronald J. Portability Equals Profits at Miami Crushed Rock. Rock Products, v. 67 No. 11, November 1964, pp. 65–66.
[9] ———. Compact Plant Processes Coral Rock. Rock Products, v. 67, No. 6, June 1964.

TABLE 9.—Crushed limestone sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	25,461,245	$29,576,062	$1.16	27,269,652	$30,590,247	$1.12
Agstone	481,926	1,642,849	3.41	679,368	1,795,706	2.64
Railroad ballast	W	W	W	427,133	670,986	1.57
Riprap	W	W	W	1,000	2,500	2.50
Other uses [1]	4,142,698	4,340,466	1.05	3,098,568	2,884,078	.93
Total	30,085,869	35,559,377	1.18	31,475,721	35,943,517	1.14

W Withheld to avoid disclosing individual company confidential data.
[1] Includes asphalt filler, cement, lime, other uses, and uses indicated by symbol W.

METALS

Ferroalloys.—V–C Chemical Co., Division of Socony-Mobil Oil Co.; Nichols; and American Agricultural Chemical Co., subsidiary of Continental Oil Co., produced ferrophosphorus as a byproduct in the electric furnace process for making elemental phosphorus.

Rare-Earth Minerals.—For the third consecutive year, Florida ranked second in the Nation in production of rare-earth minerals. Monazite was recovered from sands as a byproduct of concentrating titanium minerals by Titanium Alloy Manufacturing Division of National Lead Co. at its Skinner mine near Jacksonville. Output and value of monazite sold or used increased 41 percent in tonnage and value over those of the previous year.

Titanium Concentrates.—For the ninth consecutive year, Florida ranked second in the Nation in production of titanium concentrates. Combined output of ilmenite and rutile increased 1 percent in quantity and 14 percent in value.

Ilmenite production increased 2 percent in tonnage and 22 percent in value; rutile output decreased 15 percent and value 40 percent. Ilmenite was produced by E. I. du Pont de Nemours & Co., Inc., at its Highland and Trail Ridge mines; ilmenite and rutile were produced by Titanium Alloy Manufacturing Division of National Lead Co. (Skinner mine), Duval County, and by Florida Minerals Co. (Vero mine), Indian River County.

Zircon.—Florida ranked first in the Nation in zircon production for the 25th consecutive year. Total zircon sold or used increased 9 percent in tonnage and 14 percent in value. Producers, listed in order of output, were E. I. du Pont de Nemours & Co. Inc. (Trail Ridge plant), Titanium Alloy Manufacturing Division of National Lead Co. (Skinner plant), and Florida Minerals Co. (Vero plant). The zircon was recovered as a byproduct in the concentration of titanium minerals from sands.

MINERAL FUELS

Natural Gas.—All natural gas production came from the Humble Oil Co. Sunniland Field, Collier County, and was used in company operations.

Florida Gas Transmission Co. late in the year asked the Federal Power Commission to approve a contract purchase of 600 billion cubic feet of gas from reserves held by Pan American Petroleum and Austral Oil in southern Louisiana. Over the 20-year life of the contract, Florida Gas would pay the producers about $120 million. The company planned a $42.7-million construction program to loop a portion of its mainline, add compressor horsepower, and build gathering lines; new compressor stations were proposed for Juniper Springs and St. Pierce.

Peat.—Peat was produced by seven companies. Producing counties, listed in order of output, were Hillsborough, Orange, Putnam, Clay, and Volusia. Two types of peat were produced; namely, humus and reed-sedge. Most of the material was shredded, and used for general soil improvement and as an earthworm culture medium. Smaller quantities were unprepared or cultivated for sale or use. Leading producers were F. E. Stearns, Seffner, Daetwyler Peat mine, Orlando, and Traxler Peat Co., Florahoma.

Petroleum.—Crude petroleum production came from the Humble Oil Co. Sunniland field in Collier County, from 15 wells, 3 more than in 1963. Cumulative production from the Sunniland field exceeds 8 million barrels.

Sun Oil Co. discovered the Sunoco-Felda field in Collier County. In official tests of the No. 2 Red Cattle Co. discovery well in October, the well flowed from an open hole at 11,472 to 11,485 feet through a $^{20}/_{64}$-inch choke at a rate of 111 barrels of oil per day, with 3 percent bottom sediment. In November the well was washed with acid, and the first 24-hour pumping test performed. As of December 31, two additional wells had been drilled or located to determine the limits of the field, but no wells had been opened to commercial production. The entire yield of oil from the new field from October through December was 19,222 barrels, all of which came from the discovery well.

Four permits were granted for the drilling of exploratory wells in two counties; three wells, ranging in depth from 6,524 to 6,576 feet, were drilled in Santa Rosa County, and one hole was drilled in Hendry County to a total depth of 12,686 feet.

Six permits were granted for offshore geophysical surveys in the Gulf Coast area. The types of surveys performed were reflection, reflection and refraction, and gravity. The work was performed principally by geophysical contracting companies for major petroleum producers including Gulf, Pan Am, California, and others; Shell conducted its own work. The six surveys required a total of 34 weeks time for completion, and the use of 14 boats.

REVIEW BY COUNTIES

Mineral production was recorded in 46 of the 67 counties, 3 counties more than in 1963. Counties producing for the first year were Franklin, Liberty, and Wakulla, all reporting sand and gravel output. Polk, Hillsborough, and Dade Counties, in order of value, as in 1963, were the leading mineral producing counties and furnished 71 percent of the total mineral production value. The leading 10 counties all had values over $2 million and furnished 91 percent of the total value;

the other 7 counties, listed in order of value, were Hernando, Clay, Gadsden, Flagler, Broward, Gulf, and Suwannee.

Alachua.—Six companies crushed limestone at 6 quarries for use in roadstone and concrete; total output was 1.3 million tons valued at $1.0 million. Producers, listed in order of output, were Houdaille-Duval-Wright Co. (Haile quarry); Limestone Products, Inc. (Haile quarry); Alachua Corp. (High Springs quarry), reporting for the first year; Ocala Lime Rock Corp. (Haile quarry); Williston Shell Rock Co. (Buda quarry); and Peacock Lime Rock Corp. (Peacock quarry). Fifty-one percent of the material was transported by railroad, and the remainder by truck. The City of Gainesville produced regenerated quicklime for use in its municipal water plant.

TABLE 10.—Value of mineral production in Florida, by counties[1]

County	1963	1964	Minerals produced in 1964, in order of value
Alachua	$1,181,678	$1,071,464	Limestone.
Bay	W	69,000	Sand and gravel.
Brevard	57,693	53,000	Do.
Broward	5,558,848	4,781,278	Limestone, sand and gravel.
Citrus	W	W	Limestone, phosphate rock, miscellaneous clay.
Clay	W	W	Ilmenite, zircon, staurolite, sand and gravel, 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	Zircon, ilmenite, oyster shell, rutile, monazite.
Escambia	W	586,130	Sand and gravel, miscellaneous clay.
Flagler	W	W	Cement, limestone.
Franklin	----	W	Sand and gravel.
Gadsden	W	W	Fuller's earth, sand and gravel, miscellaneous clay.
Gilchrist	W	W	Phosphate rock.
Glades	W	W	Sand and gravel.
Gulf	W	W	Magnesium compounds, lime.
Hendry	W	W	Sand and gravel, limestone.
Hernando	W	W	Limestone, lime.
Hillsborough	20,895,544	25,508,388	Cement, phosphate rock, oyster shell, sand and gravel, peat.
Indian River	W	W	Rutile, sand and gravel, ilmenite, zircon.
Jackson	W	----	
Lafayette	W	W	Limestone.
Lake	625,987	1,143,000	Sand and gravel.
Lee	W	W	Limestone, oyster shell.
Leon	123,135	W	Sand and gravel.
Levy	554,096	426,735	Limestone.
Liberty	----	4,000	Sand and gravel.
Manatee	W	W	Limestone.
Marion	W	W	Limestone, phosphate rock, lime, sand and gravel.
Monroe	485,070	297,500	Limestone.
Orange	W	W	Sand and gravel, peat.
Palm Beach	W	578,993	Limestone, sand and gravel.
Pasco	8,217	33,295	Limestone.
Pinellas	W	W	Oyster shell, limestone, sand and gravel.
Polk	94,315,891	108,851,765	Phosphate rock, sand and gravel.
Putnam	W	W	Kaolin, sand and gravel, peat.
St. Lucie	150,688	103,000	Sand and gravel.
Sarasota	W	W	Limestone.
Sumter	W	W	Do.
Suwannee	W	W	Do.
Taylor	W	W	Do.
Volusia	W	W	Peat, sand and gravel, limestone.
Wakulla	----	36,000	Sand and gravel.
Walton	W	W	Oyster shell, sand and gravel.
Washington	16,000	11,000	Sand and gravel.
Undistributed[2]	77,647,153	79,854,452	
Total	201,620,000	223,409,000	

W Withheld to avoid disclosing individual company confidential data.

[1] The following counties are not listed because no production was reported: Baker, Bradford, Calhoun, Charlotte, De Soto, Dixie, Hamilton, Hardee, Highlands, Holmes, Jefferson, Madison, Martin, Nassau, Okaloosa, Okeechobee, Osceola, St. Johns, Santa Rosa, Seminole, and Union.

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

Broward.—Limestone was crushed at 12 quarries; total output was 4.0 million tons valued at $4.4 million. The limestone was used for roadstone, concrete, and other uses. Producers, listed in order of output, were Maule Industries, Inc. (Prospect quarry); Hollywood Quarries, Inc. (Broward County quarry); R. H. Wright, Inc. (Deerfield quarry), formerly Deerfield Rock Co.; Meekins, Inc. (Oakland Park No. 5 and Hollywood quarries); Houdaille-Duval-Wright, Inc. (Green quarry); Sample Rock Co. Inc. (Pompano Beach quarry); R. H. Wright Inc. (Wright quarries); Hallandale Rock & Sand Co. (Hallandale quarry); Rozzo Mining, Inc. (No. 7 and No. 8 quarries); and Broward Rock Co. (Fort Lauderdale quarry). Sand was produced from four mines for use as building, fill, and lawn sand. Producers, listed in order of output, were Bennie F. Matthews (Pompano Beach mine), Florida Silica Sand Co. (Pegram mine), Dania Fill & Silica Sand Corp. (Fort Lauderdale mine), and Des Rocher-Davie Sand Corp. (Fort Lauderdale mine).

Citrus.—General Portland Cement Co. crushed limestone at its Citrus County quarry and mined miscellaneous clay, both for use in manufacturing cement at its Tampa plant. Other crushed limestone producers, listed in order of output, were Middleton Mining Co. (Dunnellon mine), Indian Waters Development Corp. (Blue Water quarry), and Crystal River Quarries, Inc. (Crystal River quarry). Middleton and Crystal River produced limestone exclusively for agricultural purposes, and Indian Waters for roadstone and concrete. Ninety percent of the limestone was transported by railroad, and the remainder by truck. Soft-rock phosphate was produced by 3 mines; total output was 7,013 tons valued at $65,000. Producers, listed in order of output, were Soil Builders, Inc. (Mincoll mine), Sun Phosphate Co. (Dunnellon mine), and Kellogg Co. (Kellogg mine).

Clay.—E. I. du Pont de Nemours & Co., Inc. (Trail Ridge and Highland mines) mined ilmenite, zircon, and staurolite; output and value showed increases compared with those of 1963. All-Florida Sand Co. (Keystone Heights mine) produced building sand. Florida Solite (Russell mine) mined miscellaneous clay for use in manufacturing lightweight aggregate for building products. Tomes Peat Humus Co. at Keystone Heights produced shredded humus peat in bulk for general soil improvement.

Collier.—Collier County was again the only crude petroleum and natural gas producing county in the State; Humble Oil Co. completed drilling 3 wells during the year and operated 15 producing wells. Total output and value of oil and gas increased. The Sunoco-Felda field was discovered in the county by Sun Oil Co. Four mines crushed limestone for roadstone, concrete, and agricultural purposes; total output was 549,000 tons valued at $700,000. Producers, listed in order of output, were Fuller Industries, Inc. (Sunniland quarry), Leon McCormick (Naples quarry), Naples Limerock Co. (Belle Meade quarry), and West Coast Rock Co. (Sunniland quarry). Eighty-nine percent of the stone was transported by truck, and the remainder by railroad.

Dade.—The county ranked first in crushed limestone output and had the third largest limestone quarry in the State. Both masonry and portland cement were produced by General Portland Cement Co.

(Everglades mill) and Lehigh Portland Cement Co. (Miami mill); in addition, both companies crushed limestone for use in manufacturing cement. Limestone was crushed by 16 quarries; total output was 10.2 million tons valued at $9.7 million; 88 percent of the stone was used for roadstone and concrete, and the remaining 12 percent was used for other purposes. Seventy-eight percent of the stone was transported by truck, and the remainder by railroad. The three leading quarries, listed in order of output, were Seminole Rock Products (Medley quarry), Pennsuco Aggregates, Inc. (Pennsuco quarry), and Ideal Crushed Stone Co. (Dade County quarry). Sand produced from four mines in the Miami and Opa Locka areas was used for paving, fill, lawn, and building purposes. Producers, listed in order of output, were Des Rochers Sand Co. Inc. (Cape Florida mine), Sample Sand Co. Inc. (Opa Locka mine), T. J. James Construction Co. Inc. (Miami mine), and Sample Rock Co. Inc. (Opa Locka mine). A small tonnage of sand was produced by the Dade County Highway Department. The City of Miami (Hialeah limekiln) produced regenerated quicklime for use as water softening and purification agents in its municipal water plant. Perlite, Inc. (Hialeah plant), processed crude perlite mined and shipped from Western States for use in concrete, building plaster, and soil conditioning.

Duval.—Titanium Alloy Manufacturing Division of National Lead Co. produced ilmenite, rutile, zircon, and monazite. Humphreys Mining Co., mining contractor for the Skinner mine, announced that mining would close down at the Skinner tract in the spring of 1965, and would be relocated on an 1,800-acre tract near Folkston, Ga., on property owned by E. I. du Pont de Nemours & Co., Inc.; Humphreys has been mining the Skinner tract since 1944. Houdaille-Duval-Wright Co. dredged and crushed oystershell; the material was used in roadstone, concrete, and poultry grit. Chemrock Corp. processed crude perlite, mined in Western States, for use in building plaster, concrete aggregate, soil conditioning, and for other purposes. Zonolite Co. Division of W. R. Grace & Co. (Jacksonville plant) exfoliated crude vermiculite, mined in Southeastern and Western States, for use in building products and other uses. Owen-Illinois Glass Co. (Jacksonville limekiln) produced regenerated quicklime for use in pulp and paper manufacture. U.S. Gypsum Co. processed crude gypsum from Nova Scotia for use in building products and other uses. Kaiser Gypsum Co. was constructing a plant near Jacksonville for processing Nova Scotia rock; production was expected in 1965.

Escambia.—Sand and gravel produced from four mines was all processed; 51 percent was transported by railroad, and the remainder, by truck. Ward Gravel Co. (Century mine) and Campbell Sand & Gravel Co. (Flomaton mine) produced sand and gravel; Edward M. Chadbourne, Inc. (Pensacola mine), a new producer, and Clark Sand Co. (Pensacola mine) produced sand only. Most of the gravel was used for building purposes, and the sand was used for building and fill. Escambia County Highway Department mined Government-and-contractor sand for building and paving uses, and transported the sand by truck. Miscellaneous clay was mined by Taylor Brick & Tile Co. (Barth mine) at Pensacola, for use in building brick and other heavy clay products.

Gadsden.—Fuller's earth was produced by the following three companies, listed in order of output: Minerals & Chemicals Philipp Corp. (Willacoochee, La Camelia, and Midway mines); Floridin Co. Inc. (Quincy mine), and Magnet Cove Barium Corp. (Havana mine); total output and value established a record. Sand and gravel was produced by Florida Gravel Co. (Chattahoochee mine) for building and paving uses. Appalachee Correctional Institute (Chattahoochee mine) produced a small quantity of miscellaneous clay for use in building brick.

Gulf.—Michigan Chemical Corp. (Port Saint Joe plant) recovered magnesium compounds from seawater, and produced primary lime for use in its recovery plant. Port Saint Joe Paper Co. (Port Saint Joe limekiln) produced regenerated quicklime for use in pulp and paper manufacture.

Hernando.—The county ranked second in crushed limestone output, and had the leading limestone quarry in the State. The limestone was used for roadstone and concrete, railroad ballast, and other uses; 52 percent of the stone was transported by railroad, 47 percent by truck, and the remaining 1 percent by waterway. The three leading producers, listed in order of output, were Florida Rock Products Corp. (Diamond Hill quarry), Camp Concrete Rock Co. (Gay quarry), and Brooksville Rock Co. (Broco quarry). Chemical Lime, Inc. (Brooksville limekiln), produced primary lime from crushed limestone supplied by Camp Concrete Rock Co.'s Gay quarry.

Hillsborough.—Masonry and portland cement were produced by General Portland Cement Co. at its Tampa mill. American Cyanamid Co. (Sydney mine) and American Agricultural Chemical Co. (Boyette mine) mined land-pebble phosphate; American Cyanamid also washed and concentrated the material at its Sydney plant. Bay Dredging & Construction Co. dredged and crushed oystershell from State Lease No. 1703; most of the shell was used for roadstone and concrete. Edgar Plastic Kaolin Co. (Plant City mine) produced building and industrial sand, all of which was processed; 67 percent of the sand was transported by railroad, and the remainder, by truck. Humus peat was produced by two companies; both shredded and cultivated peat were processed for soil improvement purposes; the county led the State in peat output. Zonolite Division of W. R. Grace & Co. (Tampa plant) and Verlite Co., Tampa, exfoliated vermiculite for use in building products, soil conditioning, and other purposes. National Gypsum Co. at Tampa processed crude gypsum from Nova Scotia for use in building products and other uses; this was the first year of recorded production from this new plant.

Indian River.—Florida Minerals Co. (Vero mine) produced ilmenite, rutile, and zircon from beach sands. Indian River County Highway Department produced Government-and-contractor paving sand for use in its highway maintenance program. Airlite Processing Corp. (Vero Beach plant) expanded crude perlite mined and shipped from Western States for use in building plaster, concrete aggregate, and other uses.

Lafayette.—Williston Shell Rock Co. (Chauncey quarry) crushed limestone for use in roadstone and concrete. Lafayette County Highway Department crushed 39,000 tons of Government-and-contractor limestone valued at $42,000, for use in roadstone and concrete.

Lake.—Sand produced from five mines was processed; 93 percent was transported by truck, and the remainder, by railroad. Producers, listed in order of output, were Eustis Sand Co. (Eustis mine); E. R. Jahna Industries, Inc. (Clermont mine); Orange Sand Co. (Jacksonville mine), reporting for the first year; Silver Lake Estates (Leesburg mine); and Coddings White Sand Co. (Eustis mine). Most of the sand was used for building and paving purposes.

Lee.—West Coast Rock Co. (Fort Myers quarry) and Harper Bros. Inc. (Estero quarry) crushed limestone for use in roadstone and concrete; all of the material was transported by truck; Harper Bros. reported for the first year. Oystershell was dredged and crushed by two companies. Edison Shell Co. produced from State leases 1504 and 1684, and dredged during only a part of the year; the company reported that its business closed in June. Fort Myers Shell Co. dredged oystershell from new State Lease No. 1917. Most of the oystershell was used for roadstone and concrete, and was transported by waterway to stockpiles and then handled by truck.

Levy.—Limestone was crushed at four quarries. Sixty-four percent of the stone was transported by truck, and the remainder, by railroad. Producers, listed in order of output, were Dixie Lime & Stone Co. (Lebanon No. 4 quarry), W & M Construction Co. Inc. (Raleigh quarry), Connell & Shultz (Williston quarry), and Ralph Swiney (Miller quarry). Dixie Lime & Stone and Ralph Swiney produced and processed the stone for agricultural purposes; the other two companies produced the stone for use in roadstone and concrete.

Marion.—Limestone was crushed for roadstone, concrete, agricultural purposes, and other uses; 77 percent of the material was transported by truck, 15 percent by railroad, and the remainder by waterway. Producers, listed in order of output, were Ocala Lime Rock Corp. (No. 7 Kendrick quarry), Cummer Lime & Manufacturing Co. (Kendrick quarry), Southern Materials Corp. (Lowell quarry), and Dixie Lime & Stone Co. (Kendrick No. 3 quarry). The City of Ocala and Marion County Highway Department crushed Government-and-contractor limestone for use in roadstone and concrete; combined output was 126,000 tons valued at $110,000. Dixie Lime & Stone Co. produced primary lime at its No. 1 limekiln; the company reported that the lime operation was closed late in the year. National Silica Corp. (Lynn mine) mined blasting sand and reported for the first year. Kibler-Camp Phosphate Enterprise (Sec. 26 mine) mined 70,000 tons of hard-rock phosphate valued at $681,000; the company continued to be the only hard-rock phosphate producer in the state. Loncala Phosphate Co. (Minehead mine and plant) produced soft-rock phosphate for stock and poultry feed and for soil improvement purposes; output and value was about the same as in 1963.

Monroe.—Charley Toppino & Sons, Inc. (Stock Island quarry), crushed limestone for use in roadstone and concrete.

Orange.—The county ranked second in peat output. Daetwyler Peat mine at Orlando produced reed-sedge peat for general soil improvement and as an earthworm culture medium; the material was shredded. Raymond Johnson at Plymouth produced humus peat for soil improvement purposes; the material was unprepared and shredded. Orange County Highway Department (County mine) produced

150,000 tons of Government-and-contractor paving sand valued at $129,000 for use in its highway maintenance program.

Palm Beach.—Limestone was crushed at three commercial quarries and one Government-and-contractor quarry; total commercial output was 470,000 tons valued at $332,000, and all of the stone was transported by truck. Producers, listed in order of output, were P. C. Smith Co. Inc. (Palm Beach quarry), Palm Beach Mining Co. Inc. (West Palm Beach mine), and Belle Glade Rock Co. (Belle Glade quarry); the material was used in roadstone and concrete. Palm Beach County Highway Department crushed Government-and-contractor limestone from its County quarry for roadstone and concrete; 200,000 tons valued at $160,000 was produced; the highway department also mined 170,000 tons of sand valued at $87,000 from its County mine for use in paving. Zonolite Co., Division of W. R. Grace & Co. (Boca Raton plant), exfoliated crude vermiculite shipped from other States for use in insulation, building plaster, concrete aggregate, and other uses.

Pinellas.—Pinellas County was the leading oystershell producing county. Struthers & Hollash (Pinellas Park quarry) crushed limestone for use in roadstone and concrete, and transported all of the stone by truck. Benton & Co. (Lease No. 1788) dredged oystershell and crushed it for use in roadstone and concrete. Florida Washed Sand Co. (St. Petersburg mine) produced a small tonnage of building sand and reported for the first year.

Polk.—Polk County again ranked as the leading county in value of mineral production and led the State in land-pebble phosphate rock and sand and gravel output. The county furnished 49 percent of the State's total mineral production value, 2 percent more than in 1963. Land-pebble phosphate rock was produced by 12 companies; marketable production was 15.2 million long tons, valued at $106.9 million. The leading producers, listed in order of output, were International Minerals & Chemical Co. (Achan and Noralyn mine), V–C Chemical Co. Division of Socony-Mobil Oil Co. (Clear Springs and Homeland mines), and American Agricultural Chemical Co. (Palmetto mine), W. R. Grace & Co. (Bonny Lake mine), American Cyanamid Co. (Orange Park mine), Swift & Co. (Silver City and Watson mines), Armour Agricultural Chemical Co. (Armour mine), Smith-Douglass Division of Borden Chemical Co. (Tenoroc mine), New Concept Co. (Green Bay mine), Hydromines, Inc. (Eaton Park mine), and Minerals Recovery Corp. (Sand Mountain mine).

Polk County also had the largest producing sand company. Eleven mines produced sand. The leading company, Standard Sand & Silica Co., produced sand for industrial uses, and the remaining 10 companies produced building, paving, and fill sand. All of the sand was processed; 65 percent was transported by railroad, and 35 percent, by truck. Producers, listed in order of output, were Standard Sand & Silica Co. (Standard mine); Oak Ridge Sand Co. (Achan mine); Mammoth Sand Co. (Lake Wales mine); Gall Silica Mining Co. Inc. (Lake Wales mine); Polk City Sand Co. (Polk City mine); United Sand & Materials Corp. (Fort Lauderdale mine), a new producer reporting for the first year; Lake Wales Concrete Sand Co. (Lake Wales mine); Lake Wales Independent Sand Co. Inc. (Independent

mine); Davenport Sand Co. Inc. (Mammoth mine); Superior Sand Co. Inc. (Winter Haven mine); and Waverly Road Sand Co. (Winter Haven mine). The U.S. Forest Service (Florida mine) produced Government-and-contractor paving gravel for use in road construction; 12,000 tons valued at $24,000 were mined.

Putnam.—Sand was produced by five mines. Two companies produced industrial sand, and the other three, building sand; all of the sand was processed; 72 percent was transported by railroad, and 28 percent by truck. Producers, listed in order of output, were Diamond Interlachen Sand Co. (Keuka mine), Southern Materials Co. of Florida (Putnam Hall mine), Diamond Interlachen Sand Co. (Interlachen mine), United Clay Mines Corp. (Crossley mine), and Edgar Plastic Kaolin Co. (Edgar mine). Kaolin was produced by two companies, Edgar Plastic Kaolin Co. and United Clay Mines Corp.; combined output was about the same as in 1963. Traxler's Peat Co. at Florahoma mined humus peat for general soil improvement use; the material was shredded preparatory to sale. Hudson Pulp & Paper Co. (Palatka limekiln) produced 30,000 tons of regenerated quicklime valued at $1 million for pulp and paper manufacture.

St. Lucie.—Three mines produced 128,000 tons of building and fill sand valued at $103,000; 93 percent of the sand was unprocessed, and all of the sand was transported by truck. Producers, listed in order of output, were Ft. Pierce Sand & Materials, Inc. (White City and Ft. Pierce mines), and Dixie Sand Co. (Edward A. Ulrich mine).

Sumter.—Dixie Lime & Stone Co., the only mineral producer in the county, operated the Sumterville, Mabel and Coleman stone quarries. All of the stone was used for roadstone and concrete; 89 percent was transported by truck, and the remainder, by railroad.

Suwannee.—Four quarries crushed limestone for roadstone, concrete, railroad ballast, agricultural purposes and other uses. Sixty-two percent of the stone was transported by railroad, and the remainder by truck. Producers, listed in order of output, were Florida Rock Products Corp. (Suwannee quarry), Suwannee Dolomite and Lime Co. (Live Oak quarry), Ocala Lime Rock Co. (Lanier quarry), and Dixie Lime & Stone Co. (Mulkey quarry).

Taylor.—Williston Shell Rock Co. (Perry quarry) crushed limestone for roadstone and concrete; all of the stone was transported by truck. Buckeye Cellulose Corp. (Foley limekiln) produced regenerated quicklime for use in pulp and paper manufacture; output was 120,000 tons valued at $2.1 million.

Wakulla.—U.S. Forest Service (Wakulla County mine) produced 42,000 tons of paving sand valued at $36,000 for use in its road program. This was the first year that mineral production has been reported in the county.

Walton.—Walton County was again the second leading county in oystershell output. Radcliff Materials, Inc., a Division of Southern Materials Corp., Mobile, Ala., dredged and crushed oystershell from State Lease No. 1718 for use in roadstone and concrete; all of the shell was transported by waterway. Adams Sand Co. Inc. (Mossy Head mine) mined building sand at a reduced rate; all of the sand was 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 production value increased 7 percent and attained $128 million in 1964, the 11th successive year of record value. In only 2 years, 1949 and 1953, has value of mineral production in Georgia failed to increase since 1944. Increases were noted in most minerals; exceptions were bauxite, coal, mica, and some stone, dimension granite and dimension marble. Nonmetallics made up more than 98 percent of the value of the State's mineral production. Georgia ranked first among the States in output of kaolin, second in scrap mica and fuller's earth, third in bauxite, and fourth in barite and feldspar. Georgia also was first in output of granite and marble, both crushed and dimension.

TABLE 1.—Mineral production in Georgia [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—thousand short tons	117	$2,013	109	$2,022
Clays—do	4,208	54,024	4,365	58,899
Coal (bituminous)—do	5	16	4	15
Gem stones	(2)	1		
Iron ore (usable)—thousand long tons, gross weight	260	1,304	354	1,752
Sand and gravel—thousand short tons	3,817	3,922	4,159	4,311
Stone—do	19,582	46,044	22,730	46,532
Talc and soapstone—short tons	42,000	93	40,400	135
Value of items that cannot be disclosed: Bauxite, cement, feldspar, kyanite, mica (scrap), and peat	XX	12,059	XX	14,292
Total	XX	119,476	XX	127,958

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

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] Director, Department of Mines and Geology, Atlanta, Ga.

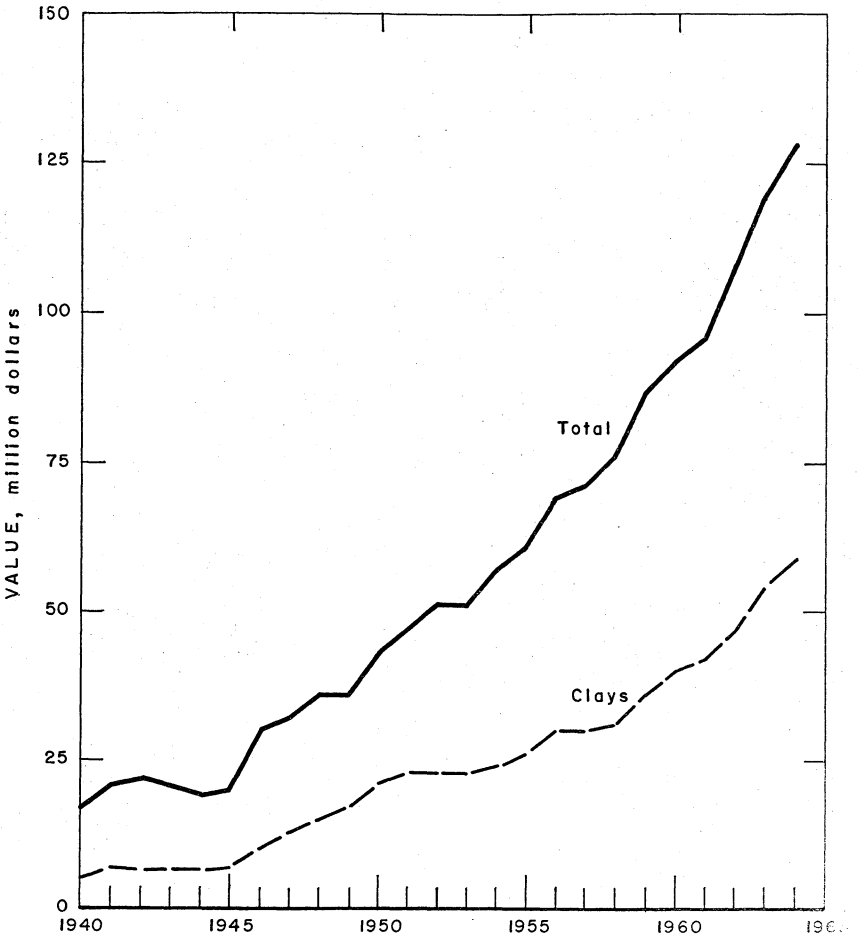


FIGURE 1.—Value of clays and total value of mineral production in Georgia.

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

(Thousands)

Year	Value	Year	Value
1955	$67,721	1960	$90,817
1956	70,275	1961	93,686
1957	71,648	1962	101,528
1958	76,575	1963	r 118,410
1959	86,007	1964	118,363

r Revised.

Trends and Developments.—The high level of construction activity in highways, both State and Federal interstate, and industrial, commercial, and home building was reflected in increased production of cement, clays, sand and gravel, and stone. Three new crushed granite

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal and peat	16	4	33			
Metal	116	16	132		1	8
Nonmetal	2,863	826	6,654		183	27
Sand and gravel	326	79	697		12	17
Stone	2,629	653	5,415	3	133	25
Total	5,950	1,578	12,931	3	329	26
1964: p						
Coal and peat	17	4	30			
Metal	90	10	80			
Nonmetal	3,425	1,063	8,543	3	197	23
Sand and gravel	355	86	759		21	28
Stone	2,625	655	5,621	1	185	33
Total	6,512	1,818	15,033	4	403	27

p Preliminary.

quarries and two new dimension granite quarries reported initial production. Expansion and improvements in the brick and heavy clay industry continued. Chattahoochee Brick Co., Atlanta, began construction of a new fire brick plant with a capacity of 700,000 brick per week. Merry Bros. Brick & Tile Co., Augusta, started construction of a new drier, kiln, and other improvements at its No. 3 plant to manufacture 40 million brick equivalents annually, which will bring its total capacity to 240 million brick per year. Oconee Clay Products Division of Griffin Pipe Products, Milledgeville, announced plans to construct a new 60,000 square foot addition, including a new tunnel kiln and pipe forming and drying equipment. American Cyanamid Co. planned to install a multimillion dollar 20,000 ton per year unit to manufacture titanium dioxide by the chloride process at its Savannah plant.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Primary barite producers were B. R. Cain, Lake Mining Co., New Riverside Ochre Co., and Paga Mining Co. Shipments of ground barite were considerably higher in both tonnage and value. Primary barite was used for well drilling and barium chemicals; crushed and ground barite were shipped for well drilling, paint and rubber fillers.

Cement.—Cement ranked third in value in the State's mineral production. Shipments of portland cement increased 24 percent in quantity and 21 percent in value. Masonry cement shipments were 10 percent higher but decreased 26 percent in value. Portland cement producers were Marquette Cement Manufacturing Co., Penn-Dixie Cement Corp., and Southern Cement Co. The new Southern Cement Co. plant was described.[3] Marquette Cement

[3] Trauffer, Walter. Southern Cement's New Atlanta Plant Features. Pit and Quarry, v. 57, No. 1, July 1964, pp. 120-124, 129-133, 174-179.

Manufacturing Co. was the only producer of masonry cement. Out-of-State shipments were principally to Florida with smaller tonnages to Alabama, North Carolina, South Carolina, and Tennessee.

Clays.—Clay comprised 46 percent of the total value of mineral production; kaolin alone accounted for more than 42 percent. Kaolin production increased 3 percent and 8 percent, respectively, in tonnage and value; fuller's earth, increased 17 percent and 15 percent, respectively, in tonnage and value; and miscellaneous clay increased 3 percent in tonnage and 26 percent in value.

Georgia continued to lead the nation in kaolin production and ranked second in fuller's earth. Sixteen companies mined kaolin from 23 mines in 7 counties; 4 companies produced fuller's earth from 6 mines in Decatur, Jefferson, Thomas, and Twiggs Counties, and 11 companies mined miscellaneous clay in 7 counties. In all, 31 companies operated 40 mines in 15 counties. Leading producers of kaolin were Minerals & Chemicals Philipp Corp., J. M. Huber Corp., Freeport Kaolin Co., Georgia Kaolin Co., and American Industrial Clay Co. Georgia Coating Clay Co. was acquired by

TABLE 4.—Kaolin sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Twiggs	1,232,389	$26,682,124	1,201,922	$27,562,292
Washington	832,774	17,807,996	1,004,184	22,451,656
Other counties [1]	424,834	5,803,763	378,049	4,505,931
Total	2,489,997	50,293,883	2,584,155	54,519,879

[1] Includes Baldwin, Floyd, Macon (1963), Richmond, Sumter, and Wilkinson Counties.

TABLE 5.—Kaolin sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Pottery and stoneware: Whiteware	64,474	$1,469,960	$22.80	92,488	$1,992,174	$21.54
Refractories: Firebrick and block	200,316	1,532,519	7.65	173,548	1,468,777	8.46
Fillers:						
Paper filling	590,601	12,093,169	20.48	685,654	14,788,464	21.56
Paper coating	1,046,091	23,920,578	22.87	1,027,597	24,455,922	23.80
Rubber	113,121	1,687,715	14.92	105,833	1,506,807	14.24
Paint	60,542	1,362,574	22.51	61,761	1,442,945	23.36
Fertilizers	W	W	W	6,203	122,848	19.80
Insecticides and fungicides	7,181	94,298	13.13	6,825	85,280	12.49
Chemicals	W	W	W	15,332	331,740	21.64
Exports	126,266	3,073,383	24.34	136,102	3,255,295	23.92
Other uses [1]	281,405	5,059,687	17.98	272,812	5,069,627	18.58
Total	2,489,997	50,293,883	20.20	2,584,155	54,519,879	21.10

W Withheld to avoid disclosing individual company confidential data.

[1] Includes stoneware; art pottery, flowerpots, and glaze slip; enameling; floor and wall tile; mortar; glass refractories; foundries, steelworks; saggers, pins, stilts, and wads; other refractories; linoleum and oilcloth; plaster and plaster products; plastics, organic; other fillers; portland and other hydraulic cements; catalysts; other uses; and uses indicated by symbol W.

TABLE 6.—Miscellaneous clay sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Crawford	400	$180		
Fulton	296,076	154,750	323,730	$168,700
Gordon	28,456	12,800	29,598	14,500
Richmond	604,923	277,300	W	W
Other counties[1]	651,482	326,199	1,267,935	790,621
Total	1,581,337	771,229	1,621,263	973,821

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Bibb, Columbia (1963), Floyd, Houston, Polk, and Walker (1963) Counties, and counties indicated by symbol W.

United Clay Mines Corp. during the year. Producers of fuller's earth were Cairo Production Co., Diversey Corp., Georgia-Tennessee Mining & Chemical Co., Milwhite Co., Minerals & Chemicals Philipp Corp., and Waverly Petroleum Products Corp.; principal producers of miscellaneous clay were Merry Bros. Brick & Tile Co., Cherokee Brick & Tile Co., Oconee Clay Products Co., and Chattahoochee Brick Co.

Feldspar.—The Feldspar Corp. produced feldspar flotation concentrate at its Monticello mill from feldspathic rock mined in Jasper County. Consolidated Quarries Division of Georgia Marble Co. produced a feldspar-quartz flotation concentrate (60 percent feldspar), a byproduct obtained from fines of the granite quarrying operation. Total State production of feldspar was little changed from 1963, but value was 18 percent higher. Feldspar concentrate was used in the manufacture of pottery and glass; the feldspar-silica mixture was used for glass and brick.

Gypsum.—Bestwall Gypsum Co. (Brunswick) and National Gypsum Co. (Savannah) calcined imported gypsum and manufactured wallboard and other gypsum products.

Kyanite.—Aluminum Silicates, Inc., more than doubled production and value of kyanite over 1963, its first year of operation at Graves Mountain near Lincolnton.

Lime.—Production of regenerated lime was 335,000 tons valued at $6.5 million, an increase of 6 percent and 10 percent respectively, in tonnage and value. This lime was produced and reused principally by pulp and paper companies by burning calcium carbonate sludge in rotary kilns. Data on regenerated lime are not included in table 1 of this chapter.

Mica.—No sheet mica was produced in 1964. Scrap mica was mined in Cherokee and Hart Counties. Glen-Ray Corp. reported initial production from the Waleska mine in Cherokee County. Grinding plants were operated by the Ruberoid Co. at Hartwell and Thompson-Weinman Co. at Cartersville. Ground mica production increased 4 percent and 1 percent, respectively, in tonnage and value.

Sand and Gravel.—Output of sand and gravel, ranking fourth in the State's mineral production, increased 10 percent in value.

Twenty-two companies produced sand only from 26 pits in 20 counties; 2 companies produced gravel only in 2 pits in Franklin and Forsyth Counties and 4 companies produced both sand and gravel in

TABLE 7.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Brooks	67	$67	35	$21
Chatham	15	19	W	W
Cherokee			1	2
Cook	73	104	111	127
De Kalb	24	34	19	27
Dougherty	138	128	168	158
Evans	10	8	W	W
Franklin	W	W	101	129
Fulton	70	81	W	W
Montgomery	37	37	30	22
Richmond	30	25	40	35
Taylor	447	305	W	W
Telfair	W	W	15	15
Ware	W	W	19	15
Undistributed [1]	2,906	3,114	3,620	3,760
Total	3,817	3,922	4,159	4,311

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Bibb, Camden (1963), Chattooga (1963), Crawford, Effingham, Glynn, Greene, Gwinnett (1964), Houston (1963), Long, Lumpkin (1963), Muscogee, Talbot, Thomas, and White (1963) 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	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,366	$1,867	$0.79	2,634	$1,998	$0.76
Paving	497	378	.76	273	233	.85
Fill	54	38	.71	55	32	.58
Other sands [1]	347	795	2.29	370	929	2.51
Total sand	3,264	3,078	.94	3,332	3,192	.96
Gravel [2]	553	844	1.53	827	1,119	1.35
Total sand and gravel	3,817	3,922	1.03	4,159	4,311	1.04

[1] Includes railroad ballast, glass, molding, blast, filtration and other sands.
[2] Includes structural, paving, fill (1963), and other gravel.

Bibb, Muscogee (2 pits), and Richmond Counties. Talbot, Crawford, Gwinnett, Taylor, and Muscogee were the principal producing counties. Dawes Silica Mining Co. Inc. (Dougherty, Effingham, Long, and Thomas Counties), Atlanta Sand & Supply Co. (Crawford County), Clement Bros. (Gwinnett County), Taylor County Sand Co. (Talbot County), Howard Sand Co. (Taylor County), and Brown Bros. (Talbot County) were the principal producers; of the 32 sand and gravel plants, 15 produced less than 50,000 tons in 1964, 4 between 50,000 and 100,000 tons, 8 between 100,000 and 300,000 tons, and 5 between 300,000 and 600,000 tons.

Stone.—Stone ranked second in value in the State's mineral production. Total output of all stone increased 16 percent in quantity

TABLE 9.—Crushed granite sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average Per ton		Total	Average Per ton
Concrete and roadstone	12,481,834	$17,409,782	$1.39	14,752,836	$20,403,543	$1.38
Riprap	372,661	541,448	1.45	278,241	512,955	1.84
Other [1]	1,559,243	2,629,537	1.69	1,699,709	2,378,944	1.40
Total	14,413,738	20,580,767	1.43	16,730,786	23,295,442	1.39

[1] Includes railroad ballast, stone sand, poultry grit, and other uses.

TABLE 10.—Dimension granite sold or used by producers, by counties

County	1963			1964		
	Cubic feet	Short tons (equivalent)	Value	Cubic feet	Short tons (equivalent)	Value
DeKalb	1,099,076	91,223	$1,268,031	890,504	73,911	$1,157,951
Elbert	610,571	50,676	1,398,879	639,829	53,107	1,625,514
Hancock	50,752	4,212	49,557	36,160	3,001	56,160
Madison	179,718	14,917	549,938	W	W	W
Oglethorpe	284,091	23,584	631,433	W	W	W
Other counties [1]				455,087	37,772	843,760
Total	2,224,208	184,612	3,897,838	2,021,580	167,791	3,683,385

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Madison and Oglethorpe Counties.

and 1 percent in value. All crushed stone, except sandstone (including quartz and quartzite) increased in tonnage and value; granite, limestone, and marble were 16, 26 and 13 percent higher in tonnage and 13, 18 and 14 percent higher in value, respectively. Crushed quartzite decreased 4 percent and 7 percent respectively in tonnage and value. All dimension stone, including granite, limestone, marble, and sandstone, was lower, 15 percent in tonnage and 31 percent in value.

Stone was produced from 74 quarries in 35 counties by 54 companies and one Government-and-contractor operation. Dimension granite was produced in 5 counties and 30 quarries by 27 companies; crushed granite in 18 counties from 22 quarries by 11 companies and crushed limestone in 9 counties by 11 companies and 1 Government-and-contractor operation. Crushed and dimension marble were produced in Pickens County and crushed marble only in Chattooga and Gilmer Counties. Crushed slate was mined in Bartow and Polk Counties, quartzite in Richmond County, byproduct quartz in Jasper County, and sandstone in Polk County.

Leading producers of crushed granite were Stockbridge Stone Division of Vulcan Materials Co., Dixie Lime & Stone Co., and Weston & Brooker Co. Leading producer of dimension granite for building stone and curbing and flagging was Davidson Granite Co.; for monumental stone, Coggins Granite Industries, Inc., Comolli Granite Co., and Continental Granite Co. Georgia Marble Co. produced crushed

TABLE 11.—Dimension granite sold or used by producers, by uses

Use	1963			1964		
	Cubic feet	Value		Cubic feet	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Rough monumental	977,350	$2,004,273	$2.05	944,547	$1,669,308	$1.77
Rubble	647,916	138,376	.21	512,662	109,377	.21
Curbing and flagging	354,533	542,023	1.53	293,309	551,030	1.88
Dressed monumental	W	W	W	100,139	712,200	7.11
Rough construction	45,470	41,634	.92	29,482	45,044	1.53
Other uses [1]	198,939	1,171,532	5.89	141,441	596,426	4.22
Total	2,224,208	3,897,838	1.75	2,021,580	3,683,385	1.82

W Withheld to avoid disclosing individual company confidential data.
[1] Includes architectural stone and uses indicated by symbol W.

TABLE 12.—Crushed limestone sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	1,756,738	$2,330,217	$1.33	2,396,150	$2,958,201	$1.23
Agstone	210,336	435,399	2.07	W	W	W
Other uses [1]	776,875	1,191,153	1.53	1,048,147	1,699,632	1.62
Total	2,743,949	3,956,769	1.44	3,444,297	4,657,833	1.35

W Withheld to avoid disclosing individual company confidential data.
[1] Includes cement, railroad ballast, other uses, and uses indicated by symbol W.

and dimension marble and Marble Products Co. produced crushed marble only. Excluding the cement companies, the principal producers of crushed limestone were Dalton Rock Products, Rossville Crushed Stone Co., and Ready-Mix Concrete Co. Inc. Superior Stone Co. Division of Martin Marietta Corp. was the only producer of quartzite. Funkhouser Mills Division of the Ruberoid Co. mined and crushed slate for roofing granules. Georgia Lightweight Aggregate Co. quarried slate for use in manufacturing lightweight aggregates.

Operations at three granite quarries were described in trade journals.[4]

Talc and Soapstone.—Georgia Talc Co., Murray County, the only producer, mined and ground crude talc for asphalt filler, insecticides, roofing, rubber, and paint. Output of ground talc was 7 percent higher in tonnage and value.

Vermiculite.—Zonolite Division of W. R. Grace & Co. exfoliated crude vermiculite shipped into the State at its Atlanta plant.

[4] Mitchell, Ronald J. Tyrone Rock Captures An Expanding Market. Rock Products, v. 67, No. 7, July 1964, pp. 76–79.
Davis, Dick. Quarrying Operation of General Aggregate Co. Dixie Contractor, v. 39, No. 15, Sept. 25, 1964, pp. 44–47.
Excavating Engineer. Emery Stone Quarry, v. 58, No. 4, April 1964, pp. 16–19.

METALS

Bauxite.—Production of bauxite from Floyd and Sumter Counties was considerably lower than in 1963; shipments, however, were 2 percent higher. American Cyanamid Co., the only producer, shipped to the company's Halls Station drying plant in Bartow County and direct to consumers in other States.

Iron Ore.—More than 90 percent of the iron ore was mined in the Stewart-Webster-Dooly district, south of the Fall Line and the remainder in the Bartow-Polk County area in the northwestern part of the State. Production in the Bartow-Polk area decreased more than 35 percent; in the Webster-Dooly area, production rose more than 50 percent. Only two companies were active in the northwestern part of the State, one in Bartow County and one in Polk County. Two companies were active in Dooly County, one in Marion, five in Stewart and one in Webster County. Leading producers were Davis Bros., in Webster County, and Dunbar & Layton, in Stewart County.

Crude iron oxide pigments increased 2 percent and 5 percent, respectively, in tonnage and value; finished pigments were slightly lower in both quantity and value.

MINERAL FUELS

Coal (Bituminous).—W. T. Blevins Coal Co. of Walker County produced 4,000 tons of coal valued at $15,000. This was the only mine producing more than 1,000 tons.

Peat.—Humus peat was produced by two companies in Lowndes County for agricultural and horticultural purposes.

REVIEW BY COUNTIES

Mineral production was reported from 70 counties; 23 counties had production valued above $1 million and constituted 90 percent of the State total. The 9 leading counties, each having production exceeding $3 million, in descending order, were Twiggs, Washington, Pickens, Fulton, Houston, Polk, De Kalb, Wilkinson, and Bartow.

Baldwin.—General Refractories Co. mined kaolin at the Wood mine for the manufacture of fire brick and block.

Bartow.—Increased production of crushed limestone and slate offset losses in barite and iron ore. 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. Marquette Cement Manufacturing Co. quarried limestone for use in its cement plant at Rockmart, Polk County, and Funkhouser Mills Division of the Ruberoid Co. mined and crushed slate at its Fairmount underground mine for roofing granules and slate flour. American Cyanamid Co. dried bauxite mined in other counties of the State at its Halls Station drying plant. Joe Mosteller was the only active producer of brown iron ore.

TABLE 13.—Value of mineral production in Georgia, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value
Baldwin	W	W	Kaolin.
Barrow	$25		
Bartow	3,197,519	$3,187,986	Barite, slate, limestone, iron ore, iron oxide pigments.
Bibb	332,439	W	Miscellaneous clay, sand and gravel.
Brooks	66,621	21,000	Sand and gravel.
Camden	W		
Chatham	18,979	W	Do.
Chattooga	W	W	Marble.
Cherokee	W	W	Mica, sand and gravel.
Clarke	W	W	Granite.
Clayton	W	W	Do.
Cobb	W	W	Do.
Columbia	W		
Cook	103,433	127,000	Sand and gravel.
Crawford	W	W	Do.
Dade	W	W	Limestone.
Decatur	W	W	Fuller's earth.
DeKalb	W	W	Granite, feldspar, sand and gravel.
Dooly	140,350	W	Iron ore.
Dougherty	127,863	158,000	Sand and gravel.
Douglas	W	W	Granite.
Early		W	Limestone.
Effingham	W	W	Sand and gravel.
Elbert	1,598,879	W	Granite.
Evans	8,000	W	Sand and gravel.
Fannin	W	W	Limestone.
Fayette	W	W	Granite.
Floyd	W	W	Limestone, miscellaneous clay, bauxite, kaolin.
Forsyth		625,000	Granite.
Franklin	W	129,000	Sand and gravel.
Fulton	3,473,642	6,111,048	Cement, granite, miscellaneous clay, sand and gravel.
Gilmer	W	W	Marble.
Glynn	W	W	Sand and gravel.
Gordon	12,800	14,500	Miscellaneous clay.
Greene	W	W	Sand and gravel.
Gwinnett	W	W	Granite, sand and gravel.
Hall	W	W	Granite.
Hancock	W	W	Do.
Haralson	15		
Hart	W	W	Mica.
Henry	W	W	Granite.
Houston	W	W	Cement, limestone, miscellaneous clay.
Jasper	458,068	576,111	Feldspar, sandstone.
Jefferson	W	637,520	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.
Lumpkin	W		
Macon	W		
Madison	549,938	W	Granite.
Marion		W	Iron ore.
Mitchell	W	W	Limestone.
Montgomery	37,000	22,000	Sand and gravel.
Murray	93,300	134,800	Talc, soapstone.
Muscogee	W	W	Granite, sand and gravel.
Oglethorpe	631,433	W	Granite.
Paulding	10		
Pickens	W	W	Marble, sandstone.
Polk	W	W	Cement, slate, miscellaneous clay, iron ore, sandstone.
Rabun	135,000	W	Granite.
Richmond	W	W	Sandstone, kaolin, miscellaneous clay, sand and gravel.
Stewart	564,550	684,270	Iron ore.
Sumter	W	W	Bauxite, kaolin.
Talbot	W	W	Sand and gravel.
Taylor	305,117	W	Do.
Telfair	W	15,000	Do.
Thomas	W	W	Fuller's earth, sand and gravel.
Towns	200		
Troup	290		
Twiggs	27,139,078	W	Kaolin, fuller's earth.
Walker	W	W	Limestone, coal.
Ware	W	15,000	Sand and gravel.
Warren	W	W	Granite.
Washington	17,807,996	22,451,656	Kaolin.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Georgia, by counties [1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Webster	W	W	Iron ore.
White	W		
Whitfield	W	W	Limestone.
Wilkinson	W	W	Kaolin.
Undistributed	$62,673,455	$92,451,747	
Total	119,476,000	127,958,000	

W Withheld to avoid disclosing individual company confidential data.
[1] The following counties are not listed because no production was reported: Appling, Atkinson, Bacon, Baker, Banks, Ben Hill, Berrien, Bleckley, Brantley, Bryan, Bulloch, Burke, Butts, Calhoun, Candler, Carroll, Catoosa, Charlton, Chattahoochee, Clay, Clinch, Coffee, Colquitt, Coweta, Crisp, Dawson, Dodge, Echols, Emanuel, Glascock, Grady, Habersham, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lanier, Laurens, Lee, Liberty, McDuffie, McIntosh, Meriwether, Miller, Monroe, Morgan, Newton, Oconee, Peach, Pierce, Pike, Pulaski, Putnam, Quitman, Randolph, Rockdale, Schley, Screven, Seminole, Spalding, Stephens, Taliaferro, Tattnall, Terrell, Tift, Toombs, Treutlen, Turner, Union, Upson, Walton, Wayne, Wheeler, Wilcox, Wilkes, and Worth.

Bibb.—Burns Brick Co. and Cherokee Brick & Tile Co. mined miscellaneous clay for brick and other clay products. Cornell-Young Co. and Sand Suppliers, Inc., mined sand for building, paving, and fill purposes.

Brooks.—Bannockburn Sand Co. mined building and fill sand near Valdosta.

Camden.—St. Marys Kraft Corp. calcined paper mill sludge to lime for recirculation in the mill process.

Chatham.—Sayler Marine Construction, Inc., mined building and fill sand. Continental Can Co. calcined paper mill sludge to lime for reuse in the pulp mill. National Gypsum Co. calcined imported crude gypsum for use in its building products mill at Savannah.

Chattooga.—Marble Products Co. of Georgia increased its production of crushed marble for terrazzo chips.

Cherokee.—Glenn-Ray Corp. and Thompson-Weinman & Co. mined scrap mica. Wolf Creek Sand Co. produced a small tonnage of molding sand.

Clarke.—Gainesville Stone Co. quarried granite for concrete and roadstone.

Clayton.—Tyrone Rock Division of Dixie Lime & Stone Co. quarried and crushed granite for concrete and roadstone.

Cobb.—Stockbridge Stone Division of Vulcan Materials Co. produced crushed granite for concrete and roadstone at its Kennesaw quarry.

Cook.—Bannockburn Sand Co. produced building and fill sand at the Burneyhill mine.

Crawford.—Atlanta Sand & Supply Co. produced building, paving, blast, and railroad sands at the Rollo mine.

Dade.—Dave L. Brown quarried limestone for concrete and roadstone at Morganville.

Decatur.—The Milwhite Co. and Minerals & Chemicals Philipp Corp. mined and processed fuller's earth for absorbent uses, fillers for insecticides and fungicides, filters for oils and greases, and other uses.

De Kalb.—Tonnage and value of crushed granite was slightly lower than in 1963; dimension granite although lower in quantity was higher in average value. Producers of crushed granite were Consolidated

Quarries Division of Georgia Marble Co., Davidson Granite Co. Inc., and Stone Mountain Grit Co.; dimension granite producers were Davidson Granite Co. Inc., J. T. Reagan Granite Co., and Stone Mountain Granite Corp. Stamps Sand Co. mined building and paving sand. Consolidated Quarries Division also marketed a 60–40 percent feldspar-quartz mixture for glass manufacture.

Dooly.—American Mines, Inc., and Armco Mining Co. produced brown iron ore.

Dougherty.—Production of sand for building and other uses increased more than 20 percent in both tonnage and value. Producers were Albany Lime & Cement Co., Dawes Silica Mining Co. Inc., and Musgrove Sand Co.

Douglas.—Consolidated Quarries Division of Georgia Marble Co. quarried and crushed granite for concrete and roadstone, riprap, railroad ballast and other uses.

Early.—Georgia Rock Products Co. quarried and crushed limestone for concrete and roadstone.

Effingham.—Dawes Silica Mining Co. produced building, blast, filter, and molding sands and fertilizer filler.

Elbert.—Production of dimension granite, principally for monumental stone, increased 16 percent in value. Fourteen companies operated 17 granite quarries, 13 of which produced rough monumental stone only, 2 produced rough and dressed monumental stone, 1 produced rough architectural stone only, and another produced rough architectural and monumental stone. Coggins Granite Industries, Inc., Comolli Granite Co., Continental Granite Co., and Elberton Granite Industries, Inc., were the largest producers in terms of tonnage. McLanahan Crushed Stone Co. quarried and crushed granite for concrete, roadstone, riprap, and other uses.

Fannin.—Willingham-Little Stone Co. Division of Georgia Marble Co. quarried and crushed limestone at Mineral Bluff for concrete, roadstone, and agricultural use.

Fayette.—Tyrone Rock Division of Dixie Lime & Stone Co. produced crushed granite for concrete and roadstone.

Floyd.—American Cyanamid Co. mined bauxite from the New Holland and Watters mines; kaolin was also produced at the New Holland mine. Ready-Mix Concrete Co. quarried and crushed limestone for concrete and roadstone, agstone, railroad ballast, and riprap; Floyd County Highway Department quarried limestone for roadstone. Oconee Clay Products Co. mined shale for use in its clay products plant at Milledgeville.

Forsyth.—General Aggregates Co. quarried and crushed granite for concrete and roadstone.

Fulton.—Southern Cement Co. mined miscellaneous clay from a pit adjacent to the cement plant and shipped waste marble from Pickens County and limestone from a company quarry in Alabama for use in the mill. Atlanta Brick & Tile Co. and Chattahoochee Brick Co. mined miscellaneous clay for manufacture of brick. Hitchcock Corp. and Stockbridge Stone Division of Vulcan Materials Co. quarried and crushed granite for concrete and roadstone. W. J. Griffins, C. J. Ross, and Thompson Bros. Sand Co. mined building sand for local use. Zonolite Division of W. R. Grace & Co. operated

plants at Atlanta for exfoliation of crude vermiculite and expansion of crude perlite, both shipped from other States.

Gilmer.—Willingham-Little Division of Georgia Marble Co. mined and crushed marble at the Gobel and Whitestone mines for terrazzo and roadstone.

Glynn.—Gray Towing Co. produced building sand at Brunswick. Bestwall Gypsum Co. calcined imported crude gypsum for wallboard and other building materials. Brunswick Pulp & Paper Co. calcined mill sludge to lime for recirculation in the paper making process.

Gordon.—Plainville Brick Co. mined shale for making brick at Plainville.

Greene.—L. C. Curtis & Sons, Inc., mined sand for building purposes.

Gwinnett.—Clement Bros. Co. and Stockbridge Stone Division of Vulcan Materials Co. quarried and crushed granite for concrete and road material.

Hall.—Gainesville Stone Co. quarried and crushed granite for concrete and roadstone.

Hancock.—Middle Georgia Quarrying Co. quarried dimension granite for rough monumental and construction stone; Weston & Brooker Co. produced crushed granite for concrete and roadstone.

Hart.—Funkhouser Mills Division of the Ruberoid Co. mined and ground mica at Hartwell for roofing, wallboard and joint cement.

Henry.—Stockbridge Stone Division of Vulcan Materials Co. quarried and crushed granite for concrete, roadstone, and railroad ballast.

Houston.—Penn-Dixie Cement Corp. mined miscellaneous clay and limestone and manufactured portland cement at Clinchfield. Georgia Limerock Division of Dixie Lime & Stone Co. produced crushed limestone for agricultural use.

Jasper.—The Feldspar Corp. mined feldspathic rock at several locations and produced flotation grade feldspar and byproduct quartz sand 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 (Ruby quarry) mined crushed granite for concrete and roadstone.

Lamar.—Tyrone Rock Division of Dixie Lime & Stone Co. quarried granite at Yatesville for concrete and roadstone.

Lincoln.—Aluminum Silicates, Inc., produced kyanite at its mine and mill at Graves Mountain near Lincolnton.

Long.—Dawes Silica Mining Co. produced building sand at Ludowici.

Lowndes.—Lake Park Peat Moss Co. and Georgia Peat Moss Co. produced humus peat and moss, respectively, for horticultural and agricultural use. Owens-Illinois Glass Co. produced and recirculated lime by calcining pulp mill sludge at its papermill at Valdosta.

Madison.—Coggins Granite Industries, Inc., quarried rough monumental granite at the Piedmont quarry.

Marion.—Pope Mining Co. began mining brown iron ore near Buena Vista.

Mitchell.—Bridgeboro Lime & Stone Co. crushed limestone for concrete and roads and for agstone.

Montgomery.—R. W. Geiger mined paving sand at Mt. Vernon.

Murray.—Georgia Talc Co., the only talc producer in the State, mined crude talc near Chatsworth and marketed ground talc for asphalt filler, insecticides, paint, roofing, rubber, and other uses.

Muscogee.—Brown Sand & Gravel Co. and Calhoun Sand & Gravel Co. mined construction sand and gravel. Stockbridge Stone crushed granite at the Barin quarry north of Columbus for concrete and roads and for railroad ballast.

Oglethorpe.—Liberty Premier Granite Co. quarried dressed monumental and rough architectural granite. Delta Blue Quarries, a new producer in 1964, quarried rough architectural stone only; six companies quarried rough monumental stone only. Leading producers of rough monumental stone were American Granite Quarries, Inc., Dixie Granite Quarries, and Hoover Granite Industries, Inc.

Pickens.—The county continued to rank third in mineral production in the State. Georgia Marble Co. quarried dimension marble (Tate and Nelson Divisions) for dressed building and monumental stone and crushed marble (Calcium Products Division, New York mine, and Willingham-Little Division, Cove Mountain mine) for terrazzo, whiting, and other uses. Marble Products Co. of Georgia also mined and crushed marble at the Whitestone mine for terrazzo, whiting, and other uses. 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. Price & Albea Mining Co. mined brown iron ore.

Rabun.—At Dillard, Rabun Quarries, Inc., quarried and crushed granite for concrete and roadstone.

Richmond.—Babcock & Wilcox, Albion Kaolin Department (formerly a division of Interchemical Corp.) mined kaolin for refractories, whiteware, chemicals, and other uses. Georgia-Carolina Brick & Tile Co. and Merry Bros. Brick & Tile Co. mined miscellaneous clay for brick and other clay products. Superior Stone Co. Division of Martin Marietta Corp. quarried and crushed quartzite for concrete and roadstone at the Dan quarry north of Augusta. Speer Sand & Gravel Co. mined building sand and gravel for miscellaneous uses. Continental Can Co. calcined paper mill sludge to lime for recirculation through its mill at Augusta.

Stewart.—Five companies mined brown iron ore, Dunbar & Layton, Lumpkin Mining Co., Brown-Nuggett Mining Co., Howell & Chandler, and Pope & Ragsdale.

Sumter.—American Cyanamid Co. mined bauxite and kaolin from the Easterlin mine and kaolin only from the Cavender and Holloway mines.

Telfair.—Flanders Bros. mined building sand near Scotland.

Thomas.—Cairo Production Co. Inc. and Waverly Petroleum Products Co. mined and processed fuller's earth for absorbent uses. Dawes Silica Mining Co. Inc. mined building and industrial sand.

Twiggs.—The county continued to rank first in value of mineral production. Freeport Kaolin Co., Georgia Kaolin Co., J. M. Huber Corp., and United Clay Mines (Twiggs County mine, acquired by purchase of Georgia Coating Clay Co.) mined and processed kaolin for many uses. The Diversey Corp. mined and processed fuller's earth for filtering and clarifying, absorbents, insecticides, fungicides, and other uses.

Walker.—Patton Rock Products Corp. and Rossville Crushed Stone Co. crushed limestone for concrete, roadstone, and other uses. H. R. Perry Stone Co. quarried dimension limestone for rough architectural uses. W. T. Blevins Coal Co.'s Walden mine was the only active coal operation in the State.

Ware.—E. W. Pafford mined building sand near Waycross.

Warren.—Weston & Brooker Co. quarried and crushed granite at Camak for concrete, roadstone, riprap, railroad ballast, and other uses.

Washington.—The county ranked second in value of mineral production. Kaolin, the only mineral produced, was mined and processed by American Industrial Clay Co., Anglo-American Clays Corp., Champion Paper & Fibre Co., Minerals & Chemicals Philipp Corp., Thiele Kaolin Co., and United Clay Mines Corp. The kaolin was sold principally for paper coating and filling; other uses were whiteware, tile, refractories, plastics, paint, rubber, fertilizer, and catalysts.

Wayne.—Rayonier, Inc., calcined sludge and recirculated the resulting lime in its cellulose plant at Jesup.

Whitfield.—Dalton Rock Products Co. quarried and crushed limestone for concrete, roadstone, and agricultural purposes.

Wilkinson.—Kaolin was mined by Evans Clay Co., D. C. Hardie Clay Co., M & M Clays Co., and Oconee Clay Products Co., principally for rubber, paint, 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]



STIRRED largely by efforts of the construction industry to make up for setbacks suffered during rainstorms and labor disputes in 1963, Hawaii's mineral producers recorded an alltime high output in 1964.

Mill shipments of portland cement rose nearly 16 percent and consumption of cement reached a new peak. Producers of pumice, pumicite, and volcanic cinders reported increased use of the lightweight materials as concrete aggregate, as roofing granules, and for road surfacing. Clay mined for the manufacture of building products and flower pots increased.

Solar-evaporated salt and the rare black coral gem material gathered by scuba divers for the tourist trade recorded appreciable output gains.

TABLE 1.—Mineral production in Hawaii [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement---376-pound barrels	1,482,845	$7,125	1,717,040	$8,877
Clays---short tons	W	W	2,555	W
Gem stones	(2)	36	(2)	W
Lime---short tons	12,056	428	8,737	321
Pumice, pumicite, volcanic cinder---do	273,851	469	365,475	603
Sand and gravel---do	304,367	764	407,000	979
Stone---do	3,844,000	6,480	5,281,714	8,765
Value of items that cannot be disclosed: Salt and values indicated by symbol W	XX	5	XX	60
Total	XX	15,307	XX	19,605

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] Weight not recorded.

[1] Mineral specialist, Bureau of Mines, San Francisco, Calif.

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

(Thousands)

Year	Value[1]	Year	Value[1]
1952	$2,152	1959	$7,472
1953	3,471	1960	9,302
1954	3,764	1961	15,019
1955	3,706	1962	14,963
1956	6,848	1963	15,614
1957	6,049	1964	19,853
1958	6,369		

[1] 1960–64 figures include the value of portland cement shipments (in thousand dollars), as follows: 1960, $567; 1961, $5,585; 1962, $6,104; 1963, $7,270; 1964, $8,994.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Nonmetal	72	11	83	----	3	36
Sand and gravel	48	4	35	----	2	57
Stone	460	114	917	2	28	33
Total	580	129	1,035	2	33	34
1964: *p*						
Nonmetal	130	11	90	----	1	11
Sand and gravel	65	6	46	----	2	43
Stone	475	126	1,045	----	28	27
Total	670	143	1,181	----	31	26

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—The two cement plants in Hawaii produced nearly 1,798,000 barrels and shipped 1,717,000 barrels (376 pounds per barrel) to the following customers: 52 percent to ready-mixed concrete companies, 20 percent to government agencies, 14 percent to building material dealers, 7 percent to concrete product manufacturers, and 7 percent to contractors, miscellaneous customers, and for their own use. Nearly 424,000 barrels were exported. Total consumption of domestic cement, including white and other premium types received from the U.S. mainland, was 1,296,000 barrels in 1964, compared with 995,000 in 1963 and 1,242,000 during the previous peak in 1961. Cement imports during 1964 amounted to only 574 barrels, from Japan and Denmark.

Cement shipments in paper bags totaled 596,000 barrels, almost half the volume of the 1,121,000 barrels shipped in bulk. Over 399,000 tons of coral limestone and 68,000 tons of basalt and trachyte from quarries on Oahu, and 47,000 tons of silica sand, gypsum, iron ore, and grinding aids, imported or shipped in from the mainland, were used as raw materials for making cement. Hawaiian Electric Co., Ltd., supplied the plants with nearly 44.9 million kilowatt-hours of electrical energy. The two plants had a combined annual productive capacity of 2.7

million barrels. The cement fines, collected in electrostatic precipitators, were pelletized and recirculated into the plant system or utilized as an ingredient of special plastic cement which was gaining acceptance in Hawaii for masonry and plaster work.

Clays.—Decreased precipitation during most of 1964, as compared with the heavy rains in 1963, permitted mining of an increased tonnage of clay near Waimanalo on Oahu. The material was hauled to the Barbers Point plant of Hawaii Clay Products, Inc., the sole producer of clay tile, pipe, solid and hollow brick, and flowerpots. During the year, the company added tracks and concrete flooring in its main building, began construction of a new dryer, and installed a shuttle kiln and other equipment as part of its broad expansion program. In the interim, the company continued to utilize a scove kiln and a periodic downdraft kiln for firing clay products. Sales of the company products increased appreciably.

Gem Stones.—Increased numbers of tourists continued to visit Hawaii and make heavy demands for souvenirs, including jewelry items, to take back home. The most popular mineral gem item has been Hawaii's rare black coral, collected by scuba divers and cut, polished, and mounted by lapidaries and jewelers. The quantity gathered in 1964 was nearly 13 times that collected in 1959. Forests of the treelike black coral were discovered in 1958 while divers were laying fish traps in the deep, hazardous channel waters off Maui Island.

In recent years small cellophane packets, containing Hawaii's red and black cinders and black basalt and green olivine beach sands, have been sold in souvenir shops.

Lime.—Crushed limestone was calcined on Oahu, and coral beach sand was calcined on Maui. Shipments of lime to sugar mills for use in clarifying cane juice remained steady, but shipments to canneries for adjusting the acidity in pineapple juice were lower than in 1963. Markets for agricultural and construction lime continued to decline, apparently because of the availability of surplus dredged coral for liming fields and the entry of plastic portland cements for masonry and mortar. Demand for lime for other food-processing uses increased appreciably in 1964.

Pumice and Volcanic Cinders.—More than 365,000 tons of volcanic cinders, pumice, and pumicite (volcanic ash) was produced. Of the total, 68 percent was used for road construction and maintenance and 32 percent for lightweight concrete aggregate, roofing granules, and decorative purposes. A substantially increased portion of the total output was produced on the island of Hawaii. Output gains also were reported by producers on the islands of Kauai, Maui, Molokai, and Oahu. Commercial interisland shipments of lightweight aggregate to Oahu consisted of pumice from the Puuwaawaa quarry on Hawaii and volcanic cinder from the Waieli deposit on Molokai.

Salt.—Hawaii consumed 4,349 tons of commercial domestic salt, supplied principally by producers on the mainland. Included in the shipments from California and Louisiana were salt used in food and chemical processing, block salt for livestock feed, common table salt, and an undried medium-grade salt packaged in the islands and marketed as Hawaiian salt. Genuine Hawaiian salt was produced com-

mercially at a small facility on Oahu and noncommercially at backyard family operations throughout the islands. The yield of solar-evaporated salt from the Oahu facility increased appreciably in 1964 owing to favorable weather conditions.

Sand and Gravel.—Sand and gravel was produced at 16 principal beach, dune, and stream deposits. The largest operation was the Molokai sand facility of HC&D, Ltd., Hawaii's major producer, consumer, and supplier of sand, cinder, and crushed stone.

Streambed and alluvial gravels were produced on several of the outer islands for road and building construction. Some of the islands contain excellent deposits of uniformly graded gravels suitable for such premium uses as landscape pebbles and round exposed aggregate in building facings and walkways. However, the select deposits of continuously replenished gravels are in streams situated near the remains of ancient heiaus (sacrificial temples). Since these are tourist attractions, the producers are reluctant to move in diesel shovels, trucks, loaders, or other equipment to haul out the gravels. Local homeowners and itinerant contractors, using methods similar to those of small-scale placer gold miners in California, removed some material. The smooth oblong waterworn stones are used as "clackers" by Hawaiian hula dancers.

Stone.—Commercial producers and government crews and contractors mined a record 5.3 million tons of stone, mainly for use as asphaltic and portland cement concrete aggregate and base material. The quantity was 852,000 tons more than in the previous record year of 1961. Oahu Island yielded 63 percent of the total stone output, compared with 73 percent in 1963. Production on the island of Hawaii was nearly 1.8 million tons, a gain of 873,000 tons from that in 1963. Stone output was more on Kauai (commercial), less on Maui (commercial up and noncommercial substantially down), and substantially less on Molokai (commercial).

The entire group of islands yielded 2,755,000 tons of basalt, nearly 1,073,000 tons of coral limestone, and 1,454,000 tons of miscellaneous stone, including pahoehoe and aa. A total of 4.7 million tons, or 89 percent of the total, was processed for use as concrete aggregate and roadstone. The remainder consisted of dimension decorative slabs, riprap, railroad ballast, roofing granules, stone sand, one-man stone for rubble, and coral limestone for agricultural liming, cement, and lime.

Vermiculite.—A vertical brick-lined exfoliating furnace was operated on Oahu to expand crude Montana vermiculite into a lightweight product that was sold or used for aggregate, insulation, agriculture, and accoustical plaster and fireproofing.

MINERAL FUELS

Standard Oil Co. of California operated its Barbers Point refinery on Oahu at close to the rated capacity of 35,000 barrels per day (42 gallons per barrel), using crude oil imported mainly from Sumatra and Kuwait.

The new Isomax hydrocracking facilities were operated to more efficiently improve the octane rating of gasoline produced and to in-

crease production of liquefied petroleum gas (LPG). The Isomax facilities produced 125 barrels of high-quality gasoline and LPG products for every 100 barrels of feed. The LPG products were distributed throughout the islands by Isle Gas Division, Honolulu Gas Co., Ltd., for use in cooking, heating, and refrigeration. Large quantities of aviation and automotive fuels and other petroleum products also were manufactured at the refinery.

Total consumption of petroleum-asphalt paving and roofing products in Hawaii reached an alltime high of 42,204 tons (5.5 barrels per ton), compared with 32,613 tons in 1963 and the previous record of 40,368 tons in 1961.

REVIEW BY ISLANDS

Hawaii (Hawaii County).—The redevelopment of Hilo, including a new sewage outfall, construction and maintenance of highways and plantation roads, and the building of subdivisions and Rockefeller's $13 million Mauna Kea resort, made heavy demands on the mineral resources of Hawaii Island.

James W. Glover, Ltd., quarried basalt at its Hilo facility for structural and paving concrete aggregate, produced more than 400,000 tons of aa at the 299th pit for use in extending runway 8–26 at the Hilo Airport, and hauled cinder from Kapoho and purchased crushed coral limestone from Al Lirou (Island Trucking Service and Kawaihae Products, Inc.), of Kawaihea for use in the manufacture of lightweight concrete building block.

TABLE 4.—Value of mineral production in Hawaii, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Hawaii	$1,510,663	$2,644,000	Stone, pumice and volcanic cinder, sand and gravel.
Honolulu	12,411,243	15,450,000	Cement, stone, sand and gravel, lime, volcanic cinder, salt, clays.
Kauai	383,577	409,000	Stone, volcanic cinder, sand and gravel.
Maui	1,001,386	1,102,000	Sand and gravel, stone, lime, volcanic cinder, gem stones.
Total	15,307,000	19,605,000	

Kuwaye Bros., Inc., quarried over 600,000 tons of aa and related miscellaneous stone at the 299th and various other pits. Most of the output was used for raising the level of a section of Hilo to more than 20 feet above sea level, the approximate crest of the disastrous 1960 tidal wave. Kuwaye Bros. also processed nearly 144,000 tons of surplus dredged coral from the huge stockpile at Kawaihae, primarily for the nearby Rockefeller resort project, and worked several cinder deposits for road base and for surfacing the Saddle (Defense) Road and the Mauna Kea Summit (National Aeronautics and Space Administration) jeep trail. The Kawaihae stockpile of surplus dredged coral was reduced by over 174,000 tons during 1964. In addition to that processed by Kuwaye, the coral was sold or used by Corps Construction, Ltd., by Yamada Sons, Inc., by Al Lirou (Island Trucking Service and Kawaihae Products, Inc.), and by maintenance crews of the county and State agencies. The material was crushed or

screened for base course, concrete aggregate, and agricultural liming. J. M. Tanaka Contractors, Inc., quarried basalt and aa rock near Keauhou, southeast of Kailua-Kona, mainly for asphalt concrete aggregate.

An appreciable quantity of volcanic rock and cinder was produced from sources throughout the island, for use in base course and surfacing of roads and subdivisions, by Yamada Sons, Inc., James Kuwana, other contractors, and public works construction and maintenance crews. Kuwana and Walter Yamaguchi were principal suppliers of decorative lava slabs obtained from the 1890 flow near Pahoa. Miscellaneous rock and cinder from deposits on plantation lands were used for construction and maintenance of haul roads by Hawaiian Agricultural Co., Pahala; Hutchinson Sugar Co., Naalehu; Kohala Sugar Co., Hawi; the Paauhau, Pepeekeo, and Puna sugar companies; and others.

A substantially increased quantity of unconsolidated pumice from the Puuwaawaa quarry was processed by Volcanite, Ltd., for use as lightweight concrete aggregate at its Kona concrete products plant, at the Mauna Kea resort project, and for barge shipment through Kawaihae Harbor to Oahu Island.

Kauai (Kauai County).—Demand for concrete aggregate increased in 1964 owing to construction of a large modern multimillion dollar shopping center at Lihue, new tourist facilities, road projects near Lihue and Moloaa, and subdivisions between Kekaha and Hanalei. A substantial tonnage of aggregate was supplied by Grove Farm Co., Ltd., from its Bluestone quarry and crusher operation near Puhi. The company installed a large crusher at the Kahili basalt quarry, about 2 miles northeast of Kilauea. Rock from the quarry was processed for use as road base. Streambed gravel from the Kalihiwai River was crushed at a nearby plant by Grove Farm for use in a highway project. Activities at the company's Koloa quarry were confined to improvement of the crushing facility atop a high cliff and the stockpile withdrawal of processed limestone from the bottom of the cliff for use as concrete aggregate. A substantial volume of road material was mined at the Koloa cinder pit for use in maintaining Grove Farm's sugar-cane haulage system.

Hale Kauai, Ltd., at Nawiliwili, purchased crushed stone and obtained its own increased requirements of coral sand from the 10–C beach, for use in ready-mixed concrete and for the manufacture of concrete products. Significant tonnages of concrete sand were produced from other deposits, including those near Bonham Beach and Wahiawa Bay.

Demand for material from the McBryde Sugar Co., Ltd., Kapeku cinder hill, for use in roads and structures, was more than twice that in 1963. The Lihue Plantation Co., Ltd., requirements of crushed rock, produced under contract at the Kapaia Valley quarry near Hanamaulu, also doubled. Olokele Sugar Co. crews began quarrying at the company's newly opened Field 370 cinder pit near Hanapepe.

Lanai (Maui County).—Crews from the Dole Corp. Lanai plantation obtained concrete sand from Manele Bay for construction of culverts, ditches, and other structures. The company purchased crushed stone and stone fines from producers on Oahu Island and transported the

material in the empty pineapple bins on the return voyages of the barges. Fieldstone from the pineapple plantation was used by a U.S. Army Corps of Engineers contractor for construction of a small boat harbor at Manele Bay.

Maui (Maui County).—After completion of the main complex of the Kaanapali resort facilities, where the 1964 International Golf Championship and Canada Cup Matches were held, output of concrete aggregate was limited mainly to that needed in the Wailuku and Kahului areas for construction of residential subdivisions and public and plantation roads and structures, and for use in concrete precast forms fabricated by Healy Tibbits Construction Co. for the Kahului breakwater. The quantity used for commercial projects exceeded that for public works.

Basalt was quarried and processed by Kahului Railroad Co. at its Camp 10 quarry near Puunene. Maui Concrete & Aggregates, Inc., produced concrete aggregate for its Naska ready-mixed concrete and block plants from an alluvial gravel deposit near Waikapu. The Puuhele cinder pit near Maalaea was mined by A & B Commercial Co., for its ready-mixed-concrete, tile, and block plants.

Other cinder and ash deposits worked intermittently during the year included the Puu Pane pit of the Haleakala Ranch Co., the Honokohau ash pit by Maui Pineapple Co. crews and county crews, the Kanaio cinder deposit near Ulupalakua by county crews, and the Haleakala pit by maintenance crews of the Haleakala National Park.

Coral sand for building construction, railroad engine sand, and plantation requirements was obtained mainly from the Kaa and Kaanapali beaches and the Wailuku dunes. Hawaiian Commercial & Sugar Co. removed coral beach sand near Lower Paia for concrete and for use as raw material at its nearby lime plant. The calcined beach sand was processed into hydrated lime for sugar mills, pineapple canneries, masonry, and other uses.

Molokai (Maui County).—Molokai Aggregates, Inc., blasted and processed basalt rock at Manawainui for use in asphaltic and portland cement concrete. Small requirements of sand for local construction, the Molokai irrigation-water distribution project, and the U.S. Coast Guard station were obtained from the Moomomi dunes by Molokai Aggregates and HC&D, Ltd., and from Papohaku by HC&D. The latter company operated the State's largest commercial sand and cinder production and loading facilities at Papohaku beach, the Waieli cinder pit and the Lono barge harbor, respectively. A renewed contract for shipping the sand and cinder to Oahu Island provided for payment of $977 per trip for a minimum of 150 trips. A new harbor tug *Lorna M* was delivered to Lono Harbor from Seattle in 1964.

A. P. Lum and his State highway maintenance crew supplemented purchased basalt aggregate with streambed gravel produced from a dry gulch east of Kaunakakai. Local requirements of volcanic cinder were mined at the Molokai Ranch cinder pit on the west half of Puu Maninikolo.

Oahu (Honolulu County).—Oahu's mineral producers supplied base material, concrete aggregate, and cement and asphalt products for the continuing buildup of the Waikiki tourist area with high-rise

structures like the 1,000-unit Ilikai apartment and hotel facility, other urban and suburban condominium and single dwellings on newly opened fee-simple and leasehold lands, freeway extensions, and other commercial, industrial, and public works projects. The lull during 1963, resulting from inclement weather and labor disputes, permitted producers to install or recondition crushers and other equipment, resize surplus material inventories, and improve blasting and quarrying methods to meet the near-capacity demands of 1964.

The value of portland cement shipped from the Hawaiian Cement Corp. plant at Barbers Point and the Kaiser Cement & Gypsum Corp. (formerly Permanente Cement Co.) plant at Waianae was nearly $8.9 million, or 57 percent of the value of the mineral output in Honolulu County.

Stone quarries yielded over 2.4 million tons of basalt, 891,000 tons of coral limestone, and 12,000 tons of miscellaneous stone, a record total of 3.3 million tons. Stone was produced from the Ewa Plantation Co. coral pits near Ewa; HC&D, Ltd., Kapaa basalt quarry near Kailua; Hawaiian Bitumuls & Paving Co., Ltd., Kaena basalt near Camp Erdman; Hawaiian Cement Corp. field 28 limestone at Barbers Point; Kahuku Plantation Co. Malaekahana limestone; Kaiser Cement & Gypsum Corp. Waianae limestone; Nanakuli Paving & Rock Co., Ltd., Testa limestone near Nanakuli; Pacific Cement & Aggregates, Inc., Halawa basalt near Aiea and Lualualei limestone; and Pacific Concrete & Rock Co., Ltd., Palailai basalt near Ewa and Kailua limestone near Kailua.

Changes in the zoning ordinance will force Nanakuli Paving to discontinue operation of its Valley basalt quarry, crushing plant, and asphalt concrete plant near Nanakuli before the end of 1965. The U.S. Army abandoned its Kolekole Pass basalt quarry near Schofield Barracks and planned to sell the crushing plant, which was formerly used by an engineer battalion.

Commercial stone producers supplied virtually all of the aggregate requirements of county, State, and Federal public works agencies. State highway projects on Oahu consumed 232,000 tons of basalt and coral base, select borrow, portland cement and asphalt concrete aggregate, and filter material. About 18,000 tons of coral was produced at a Barbers Point quarry by maintenance crews of the U.S. Naval Air Station. Large quantities of moss rock were hand-gathered in the Waianae area by Joe's Moss Rock Co. and Stanley Contracting, Inc., for use as decorative stone.

The volume of concrete sand obtained from beach and dune deposits in northern Oahu was nearly twice that of 1963. Volcanic cinder, removed in the course of a subdivision development at Makiki Heights, was utilized mainly as cushion material under drain pipes and concrete slabs.

Clay was mined near Waimanalo and hauled to the Hawaii Clay Products, Inc., Barbers Point plant by Pacific Truckers Association at a cost of $2.30 per cubic yard. GasprO, Ltd., produced hydrated lime near Waianae for use by sugar mills and pineapple canneries and for masonry. Salt was solar-evaporated from sea water by Tamotsu Tanaka at Keehi Lagoon. Vermiculite of Hawaii, Inc., Honolulu, expanded crude vermiculite from Montana to produce special lightweight aggregates.

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 Richard W. Knostman [1] and Norman S. Petersen [1]

IDAHO mining operations yielded products valued at a record $86.3 million in 1964. Silver, lead, and zinc, which accounted for 65 percent ($56.1 million) of the total mineral output value, were recovered largely from the Coeur d'Alene mining region, Shoshone County. Vanadium output increased due to production from the Kermac Nuclear Fuels Corp. plant built at Soda Springs in 1963.

Nonmetal output value ($25.8 million) declined 6 percent and represented 30 percent of the total value of State mineral production.

TABLE 1.—Mineral production in Idaho [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate, short tons, antimony content	645	W	585	W
Clays [2] thousand short tons	31	$15	29	$25
Copper (recoverable content of ores, etc.) short tons	4,172	2,570	4,666	3,042
Gold (recoverable content of ores, etc.) troy ounces	5,477	192	5,677	199
Iron ore (usable) thousand long tons	6	40	4	33
Lead (recoverable content of ores, etc.) short tons	75,759	16,364	71,312	18,684
Lime thousand short tons	60	874	W	W
Mercury 76-pound flasks	W	W	83	26
Peat short tons	W	W	900	8
Phosphate rock thousand long tons	1,700	10,589	W	W
Pumice thousand short tons	161	275	59	100
Sand and gravel do	12,433	10,615	9,582	8,691
Silver (recoverable content of ores, etc.) thousand troy ounces	16,711	21,375	16,483	21,313
Stone thousand short tons	1,168	2,217	1,144	2,773
Tungsten ore and concentrate (60 percent WO_3 basis) short tons			11	8
Vanadium (content in recovered V_2O_5) do	23	W	W	W
Zinc (recoverable content of ores, etc.) do	63,267	14,551	59,298	16,129
Value of items that cannot be disclosed: Barite, cement, garnet (abrasive), gem stones, mica, perlite, titanium, and values indicated by symbol W	xx	3,110	xx	15,231
Total	xx	r82,787	xx	86,262

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] Incomplete figure; bentonite, fire clay, and kaolin included with "Value of items that cannot be disclosed."

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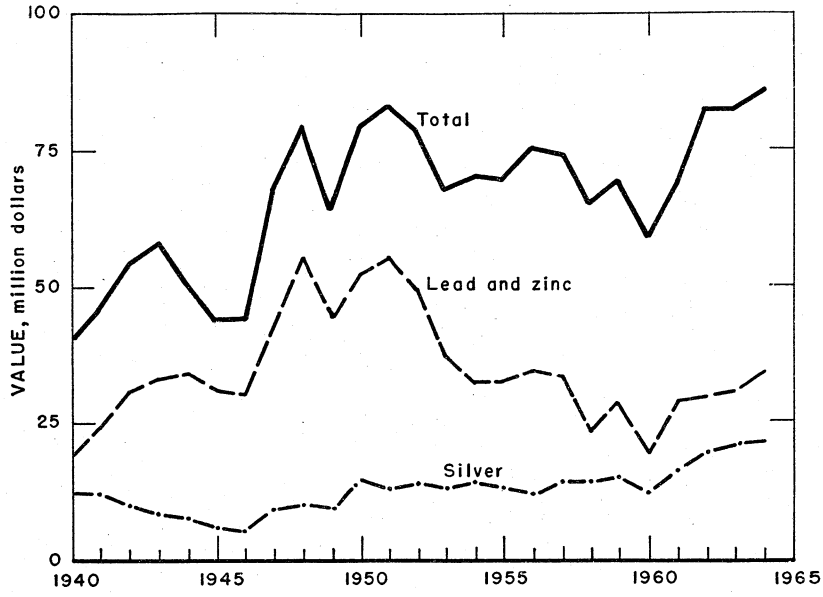


FIGURE 1.—Value of silver, lead and zinc, and total value of mineral production in Idaho.

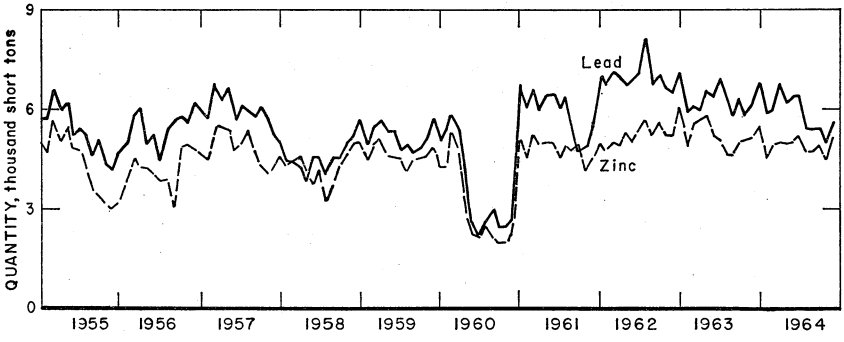


FIGURE 2.—Mine production of lead and zinc in Idaho, by months in terms of recoverable metals.

The decline in sand and gravel output reflected reduced requirements by the State highway department.

Increased demand for phosphate rock and related products resulted in a number of major industry developments. As part of a $10-million expansion program begun in 1963, J. R. Simplot Co. completed and placed on stream a second fluosolids reactor and a second ammonium phosphate plant at the company fertilizer complex west of Pocatello in Power County. Monsanto Chemical Co. prepared to triple capacity for manufacturing elemental phosphorus at its Soda Springs plant. Monsanto also obtained leases on 1,680 acres of

phosphate-bearing land in the Soda Springs area. The Bunker Hill Co. announced plans for a joint venture with Stauffer Chemical Co. to build a $1.5-million plant at Kellogg for producing superphosphoric acid and ammonium phosphate fertilizers. El Paso Natural Gas Products Co., a subsidiary of El Paso Natural Gas Co., purchased the Central Farmers Fertilizer Co. property and plant at Georgetown, Bear Lake County.

Exploration and development of silver and lead-zinc properties continued to be accelerated because of a strong demand for these metals. Of possible major importance were plans of American Smelting and Refining Co. to pursue a $3-million, deep-level exploration program at properties controlled by Coeur d'Alene Mines Corp. and Rainbow Mining Co. in the Coeur d'Alene mining region, Shoshone County.

Hecla Mining Co. became the leading domestic silver-producing company by merging with Lucky Friday Silver-Lead Mines Co. However, the Sunshine mine (Sunshine Mining Co.) continued to be the greatest single domestic source of silver.

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

(Thousands)

Year	Value	Year	Value
1955	$62,734	1960	$55,299
1956	64,176	1961	r 67,724
1957	71,849	1962	r 79,351
1958	67,666	1963	r 78,252
1959	69,119	1964	78,641

r Revised.

The U.S. Geological Survey, in collaboration with the Idaho Bureau of Mines and Geology, prepared a survey of the mineral and water resources of Idaho.[2]

Consumption, Trade, and Markets.—Most indicators of Idaho business activity rose during 1964. Notable exceptions were cash receipts for farm marketings and employment in manufacturing. Increased construction activity during the year was evidenced by a 6-percent increase in building-permits value and 3.4-percent rise in construction employment. A high level of future construction activity was indicated by $35.9 million in contracts awarded by the State highway department and by a 34.0-percent increase in heavy engineering awards. The largest single heavy engineering contract ($7.5 million) was awarded by Idaho Power Co. to Westinghouse Electric Corp., Pittsburgh, Pa., and Newport News Shipbuilding and Drydock Co., Newport News, Va., for turbines and associated equipment for three generating units at the Hells Canyon Dam on the Snake River. Cement shipments to and within Idaho remained about the same as in 1963. Employment by all industries except manufacturing increased, and unemployment declined 6.8 percent.

[2] U.S. Geological Survey. Mineral and Water Resources of Idaho. Prepared for the Committee of Interior and Insular Affairs, U.S. Senate. Idaho Bureau of Mines and Geology, Spec. Rept. No. 1, 1964, 335 pp.

TABLE 3.—Indicators of Idaho business activity

	1963	1964 p	Change (percent)
Personal income:			
Total millions	$1,366.0	$1,392.0	+ 1.9
Per capita	$1,988.0	$2,012.0	+ 1.2
Construction activity:			
Building permits millions	$38.3	$40.6	+6.0
Heavy engineering awards do	$47.3	$63.4	+34.0
State highway commission:			
Value of contracts awarded do	$24.0	$35.9	+49.6
Value of contract work performed do	$26.2	$26.9	+2.7
Cement shipments to and within Idaho thousand 376-pound barrels	1,141.5	1,140.6	0.0
Cash receipts from farm marketings millions	$457.4	$454.8	−0.6
Mineral production do	$82.8	$86.3	+4.2
Factory payrolls do	$169.4	$164.7	−2.8
Annual average labor force and employment:			
Total labor force thousands	266.2	266.2	0.0
Unemployment do	14.6	13.6	−6.8
Employment:			
Construction do	8.7	9.0	+3.4
Food processing do	11.1	11.5	+3.6
Lumber do	11.5	11.9	+3.5
All manufacturing do	32.4	31.6	−2.5
All industries do	251.5	252.5	+0.4

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.

Employment.—Idaho Employment Security Agency employment figures indicated that the number of workers employed by the mining industry rose 2.1 percent, and the annual payroll increased 5.4 percent over 1963 totals. Metal mining employment increased slightly despite a labor dispute between 400 employees represented by the United Steelworkers of America and Sunshine Mining Co. which idled the Sunshine operation throughout most of the first quarter of the year. The employment increase was due largely to increased exploration and development. Metal-mining in Shoshone County experi-

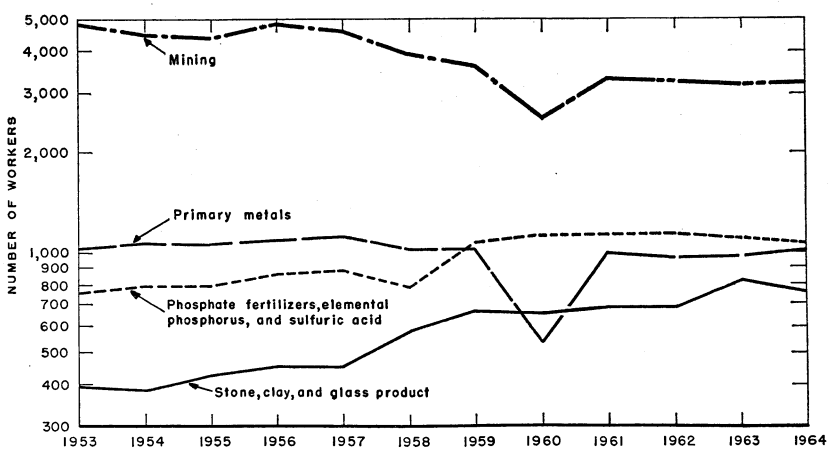


FIGURE 3.—Employment trends.
(Source: Idaho Employment Security Agency)

enced a shortage of hardrock miners capable of meeting physical qualifications for the work. Companies received little response from advertisements for miners in other parts of the Nation.

TABLE 4.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	2,571	611	4,889	6	338	70
Nonmetal and peat	664	190	1,526	2	14	10
Sand and gravel	865	190	1,523	----	14	9
Stone	215	36	291	----	3	10
Total	4,315	1,027	8,229	8	369	46
1964: p						
Metal	2,610	612	4,947	7	262	54
Nonmetal and peat	455	118	951	----	22	23
Sand and gravel	665	147	1,174	----	15	13
Stone	190	28	219	----	3	14
Total	3,920	905	7,291	7	302	42

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)
1960	2,282	$13,550	235	$1,187	20	$132	2,537	$14,869
1961	3,032	17,607	288	1,785	2	5	3,322	19,397
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
1964p	2,951	18,310	327	1,901	14	82	3,292	20,293

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)
1960	654	$3,376	534	$3,023	1,244	$7,991	2,432	$14,390
1961	677	3,457	1,008	5,750	1,250	8,263	2,935	17,470
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
1964p	757	4,138	1,032	6,425	1,106	8,086	2,895	18,649

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

	1960	1961	1962	1963	1964 p
Annual average:					
Weekly earnings	$103.21	$105.32	$107.32	$110.21	$114.86
Hourly earnings	$2.66	$2.62	$2.72	$2.79	$2.88
Weekly hours	38.8	40.2	39.4	39.5	39.9

p Preliminary.

Source: Idaho Employment Security Agency.

TABLE 7.—Office of Minerals Exploration contracts active during 1964

County and contractor	Commodity	Contract		
		Date	Total amount	Government participation (percent)
Custer:				
Clayton Silver Mines	Silver	Dec. 2, 1963	$90,370	50
Ivers Mining Co., Inc	Gold	Nov. 20, 1963	46,623	50
Idaho: Clyde D. Painter	Gold and silver	Sept. 2, 1964	41,830	50
Lemhi:				
Clemens and Arthur Lombardi	Silver and gold	Dec. 24, 1963	86,670	50
J. Howard Sims	Silver and gold	May 7, 1963	59,230	50

Legislation and Government Programs.—Under the program of the Office of Minerals Exploration (OME), U.S. Department of the Interior, five contracts were active; only one was signed during the year. Clyde D. Painter was awarded a $41,830 contract for gold and silver exploration in Idaho County; Government participation was 50 percent.

REVIEW BY MINERAL COMMODITIES

METALS

Aluminum.—The Anaconda Co. announced cancellation of a purchase option on 500 acres of clay-bearing land in Latah County. The land, part of 3,000 acres originally optioned by the company in 1956, contained clay from which alumina had been produced in pilot-plant operations at Anaconda, Mont.

Antimony.—Production of antimony was 9 percent below the 1963 output because of the labor strike at the Sunshine mine during the first quarter, but value rose 15 percent because of an increased market price. The production, entirely from the Sunshine mine, was recovered as cathode metal containing 96.3 percent antimony at the Sunshine Mining Co. electrolytic plant. Silver Summit mine concentrate was not processed at the Sunshine plant as had been the practice since 1961. Antimony Gold Ores Co. mined and stockpiled ore from properties near Yellow Pine, but the material was not included in State mineral production totals because it was not milled or sold.

Responding to the increased demand, Sunshine Mining Co. shipped 734 tons of cathode metal, 257 tons (54 percent) more than was mar-

keted in 1963. The metal was sold mostly to secondary lead smelters for use in producing battery grid metal.

Cadmium.—A record 1,187,861 pounds of cadmium was recovered as a byproduct of slab zinc production at the Bunker Hill Co. electrolytic zinc plant. The increased production was largely due to the installation of a new 4,000-ampere rectifier which made it possible to use additional cathodes in the cadmium electrolytic cells.

Columbium-Tantalum.—Porter Bros. Corp. continued investigating technologic and economic factors that could result in resuming dredging operation in Bear Valley, Valley County. Although there had been no dredging since October 1959, the two dredges and related camp facilities were maintained in operating condition.

Copper.—Approximately 57 percent of copper production was a byproduct of silver. Much of the output was from the Galena, Sunshine, and other silver mines in the Coeur d'Alene mining region; however, the Blackbird mine (Machinery Center, Inc.) in Lemhi County shipped concentrate to copper smelters at Anaconda, Mont., and Tacoma, Wash. Shoshone County mines supplied 71 percent of the State output.

Gold.—Approximately 60 percent of the gold produced was byproduct of base-metals, and 18 percent was from silver ores. Seven placer mines yielded 104 ounces, the lowest output on record. Shoshone County mines yielded 52 percent of the combined lode and placer total.

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)	
	Lodes	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1955-59 (average)	88	26	1,929	11,692	$409	14,992	$13,569
1960	79	20	1,105	6,135	215	13,647	12,351
1961	60	22	1,497	5,718	200	17,576	16,249
1962	60	13	1,586	5,845	205	17,772	19,283
1963	57	16	1,535	5,477	192	16,711	21,375
1964	55	7	1,649	5,677	199	16,483	21,313
1863-1964 [3]			146,088	8,317,912	194,266	785,757	615,301

Year	Copper		Lead		Zinc		Total Value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955-59 (average)	7,749	$5,028	63,224	$17,340	53,226	$12,613	$48,959
1960	4,208	2,702	42,907	10,040	36,801	9,495	34,802
1961	4,328	2,597	71,476	14,724	58,295	13,408	47,178
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
1863-1964 [3]	187,913	81,472	7,243,171	1,013,173	2,460,228	512,328	2,416,541

[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.

The Lucky Friday mine supplied the largest quantity (1,672 ounces) for the fourth consecutive year. Gem State Consolidated Mines, Inc. (Dewey group), Gem County, was the second largest producer, followed by Machinery Center, Inc., Lemhi County.

Placer production was from seven operations in four counties of which Idaho County was the most significant. The largest amount sold was mined in previous years from the Baker Gulch placer in Idaho County.

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)
1955–59 (average)	15	266	2,727	11	5	71	26	271	2,798
1960	9	64	793	11	6	50	20	70	843
1961	8	60	488	14	9	53	22	69	541
1962	7	38	318	6	8	58	13	46	376
1963	5	8	90	11	4	54	16	12	144
1964	[3] 3	9	80	4	2	24	7	11	104

[1] Combined to avoid disclosing individual company confidential data.
[2] Data may not add to totals shown because of rounding.
[3] Includes 3 hydraulic operations.

TABLE 10.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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)
Boise	3	----	13	(1)	513	$1
Bonner	6	----	177	$6	42,187	55
Boundary	2	----	----	----	211	(1)
Custer	7	2	301	11	164,325	212
Idaho	3	2	94	3	24	(1)
Shoshone	18	----	2,952	103	16,121,580	20,845
Undistributed [2]	16	3	2,140	75	154,655	200
Total [3]	55	7	5,677	199	16,483.495	21,313

	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Boise	----	----	(1)	(1)	(1)	(1)	$2
Bonner	2	$1	42	$11	3	$1	74
Boundary	----	----	8	2	(1)	(1)	2
Custer	136	89	751	197	107	29	537
Idaho	----	----	----	----	----	----	3
Shoshone	3,336	2,175	69,586	18,232	58,054	15,791	57,146
Undistributed [2]	1,192	777	925	242	1,134	308	1,603
Total [3]	4,666	3,042	71,312	18,684	59,298	16,129	59,367

[1] Less than ½ unit.
[2] Includes values and quantities that cannot be shown separately for Blaine, Camas, Elmore, Gem, Lemhi, and Owyhee Counties.
[3] Individual items may not add to total shown

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	9	1,328	1,143	2,513	400	8,100	6,200
Dry gold-silver	2	3	4	216			
Dry silver	19	369,386	1,024	10,137,071	5,325,900	3,686,300	1,756,500
Total	30	370,717	2,171	10,139,800	5,326,300	3,694,400	1,762,700
Copper	3	71,547	1,220	6,075	2,586,000		
Lead	16	211,036	1,688	3,531,894	691,300	42,440,900	3,794,900
Lead-zinc and zinc	8	923,111	490	2,722,061	645,600	94,181,200	105,888,400
Total	27	1,205,694	3,398	6,260,030	3,922,900	136,622,100	109,683,300
Other lode material:							
Gold mill cleanings, silver old tailings, and lead-zinc mill cleanings [2]	4	26,039	4	69,287		573,700	1,130,600
Zinc slag smelted	1	46,883		14,357	82,800	1,733,800	6,019,400
Total lode material	55	1,649,333	5,573	16,483,474	9,332,000	142,624,000	118,596,000
Placer	7	[3]	104	21			
Total all sources	62	1,649,333	5,677	16,483,495	9,332,000	142,624,000	118,596,000

[1] Because some mines produce more than one class of material, detail will not necessarily add to total shown.
[2] Combined to avoid disclosing individual company confidential data.
[3] 10,513 cubic yards.

TABLE 12.—Mine production of gold, silver, copper, lead, and zinc in 1964 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	561	365			
Concentration and smelting of concentrates	4,742	16,423,657	9,127,000	140,396,200	112,487,900
Total	5,303	16,424,022	9,127,000	140,396,200	112,487,900
Direct smelting:					
Gold	14	68		700	200
Silver	155	36,223	200	36,300	200
Gold-silver	4	216			
Copper	79	277	120,700		
Lead	16	7,299	1,300	414,300	49,400
Lead-zinc and lead-zinc mill cleanings [1]	2	1,012		42,700	38,900
Old slag		14,357	82,800	1,733,800	6,019,400
Total	270	59,452	205,000	2,227,800	6,108,100
Placer	104	21			
Grand total	5,677	16,483,495	9,332,000	142,624,000	118,596,000

[1] Combined to avoid disclosing individual company confidential data.

Iron Ore.—Shipments of iron ore declined 2,337 long tons (39 percent) below the 1963 total. The decrease was due largely to the cessation of operations at the Cudahy Mountain, Campbell, and Mortimer mines in Washington County. The largest output was from an open pit operation at the McCleary Butte property near

Tensed, Benewah County. Porter Bros. Corp. shipped magnetite sand, mined previously at the company's Bear Valley property in Valley County, to the Atomic Energy Commission for use as heavy aggregate.

Lead.—An increased metal price resulted in a 14-percent rise in the value of lead production despite a 6 percent drop in output from that of 1963. Nearly all of the production was from Shoshone County. The largest output was from the Bunker Hill mine, followed by production from the Lucky Friday, Star (Star Unit area), and Page mines. Most of the approximately 1,700 tons of lead mined outside of Shoshone County came from operations in Blaine and Custer Counties.

Exploration and development programs received added emphasis because of the increased metal price that reached 16 cents per pound in December. The Bunker Hill Co. continued efforts to discover and develop ore in the Yreka and Stewart blocks of ground adjoining the Bunker Hill block from which approximately 27 million tons had been removed since the mine was discovered in 1885. The crosscut to connect the 23 level of the Bunker Hill mine and the 3100 level of the Crescent mine was extended and exploration drilling conducted from drill stations cut above the tunnel level. Hecla Mining Co. deepened the main shaft of the Lucky Friday mine 110 feet, began developing the 3250 level, and drilled a series of holes from a 3050-level heading into the adjoining Jutila property. Day Mines, Inc., announced plans for a diamond-drilling program preparatory to reopening the Dayrock mine in 1965.

Production from The Bunker Hill Co. lead smelter was 86,282 tons, the lowest since the strike-reduced output of 1960. The curtailed production resulted from a delay in shipments of lead concentrates during the fourth quarter of the year.

Mercury.—Mercury was produced at the Hermes property in Valley County for the estate of J. J. Oberbillig. The ore, mined by both open pit and underground methods, was upgraded by flotation to a 65-percent concentrate (dry basis) prior to retorting. The output was marketed through W. R. Grace & Co.

As a result of the sharp mercury price rise, El Paso Natural Gas Co. began rehabilitating the Idaho-Almaden mine near Weiser and announced plans to begin production early in 1965. The property had been idle since December 1961 when the market price dropped to $184 per flask (76 pounds). The El Paso company had evaluated resources at the property in 1962 by exploratory drilling.

Silver.—Production of silver declined approximately 228,000 ounces below the 1963 total, but was the tenth largest output in the history of the State. Shoshone County mines continued to supply nearly all of the State total. The Sunshine mine, with an output of 4,632,348 ounces, remained the largest silver-producing mine in the State and the Nation despite a labor dispute that idled the operation from November 4, 1963, until a contract was signed on March 10. Other major output came from the Galena, Lucky Friday, and Bunker Hill mines. These four mines accounted for approximately 85 percent of the State total, and much of the remainder came from Shoshone County operations at the Crescent, Silver Summit, Page, and Star Unit mines. The largest production outside Shoshone County was from the Clayton mine (Clayton Silver Mines) in Custer County.

The elevated price, coupled with the long-term upward trend in industrial consumption, spurred exploration and development projects already in progress and provided impetus for new programs. In the Coeur d'Alene region, winze sinking and development of new working levels were continued by Hecla Mining Co. at the Silver Summit mine. The Bunker Hill Co. began deepening the Alhambra winze in the Crescent mine despite the severe rockburst conditions encountered. Exploration and development of the Princeton property were continued by Magna Mining Co. Allied Silver, Inc., a Kellogg firm organized in 1963, completed a relatively small footage of drilling. American Smelting and Refining Co. signed an agreement with Coeur d'Alene Mines Corp. and Rainbow Mining Co. to spend at least $3 million during a 6-year period for deep exploration of claims adjoining a portion of the Galena property. Phillips Petroleum Co. obtained an option on the Rock Creek Silver-Lead Co. property, east of Wallace, and began surface and underground exploration. Daybreak Mines, Inc., acquired 13 mining claims in the silver belt of the Coeur d'Alene region.

Interest also was shown in silver-bearing properties outside the Coeur d'Alene region. Federal Resources Corp. completed constructing a 250-ton-per-day mill at Bellevue and began concentrating ore from the adjacent Silver Star-Queens mine and other operations in the vicinity in addition to processing tailings remaining from past operations at the nearby Minnie Moore mine. Clayton Silver mines completed considerable drifting and diamond drilling to check the continuation of ore zones below the bottom 800 level of the Clayton mine in Custer County. The drilling, conducted under an OME loan granted in 1963, intersected ore containing a higher silver content than that found in the upper levels. An $86,670 OME grant was used to finance silver and gold exploration in the Texas district, Lemhi County. Sidney Mining Co. optioned 48 mining claims in the Silver City area of Owyhee County and completed a limited amount of trenching and soil sampling.

Thorium.—No production was reported, but interest continued in Lemhi Pass area deposits. The Dow Chemical Co. obtained a 5-year option on 26 claims belonging to Rare Metals Exploration, Inc., and Carroll W. Wells of Salmon. Dow's interest in the property was reported to stem from the fact that its United Kingdom (Rio Tinto-Dow, Ltd.) and Canadian (Thorium, Ltd.) subsidiaries were large consumers of thorium. In the same area, Nuclear Fuels & Rare Metals Corp. mined and stockpiled thorium-bearing material, but no shipments were made.

Titanium.—Shipments of ilmenite concentrate, used in manufacturing a roofing product and as a component of oil-well cement, were considerably below the comparative 1963 figure. The concentrate resulted from reprocessing stockpiled garnet- and magnetite-bearing ilmenite concentrate at the Porter Bros. Corp. Lowman mill, which was operated during part of the year.

A study of the relation of the titanium industry to the Pacific Northwest was prepared by the Bureau of Mines under a cooperative agreement with the Bonneville Power Administration.[3]

[3] Fulkerson, Frank B., and Jerry J. Gray. The Titanium Industries and Their Relation to the Pacific Northwest. Bonneville Power Administration Pacific Northwest Economic Base Study for Power Markets, v. 2, pt. 7G, 1964, 46 pp.

Tungsten.—Tungsten concentrate was shipped from stockpiles to a California market. The concentrate, containing 697 units of tungsten trioxide, represented ore mined and milled in 1956 and 1957 by McRae Tungsten Corp. at the Snowbird property near Big Creek in Valley County.

Vanadium.—Output of vanadium increased sharply over the quantity produced in 1963. Vanadium pentoxide was recovered from ferrophosphorus at the Kermac Nuclear Fuels Corp. plant at Soda Springs and at the Vitro Chemical Co. facility, Salt Lake City, Utah. The Kermac plant, completed in 1963, was brought into full production after overcoming startup difficulties. Most of the ferrophosphorus processed was from the Monsanto Chemical Co. elemental phosphorus plant at Soda Springs, but a small quantity was obtained from El Paso Natural Gas Products Co. (formerly operated by Central Farmers Fertilizer Co.) at Georgetown. Vanadium compounds produced at the Kermac plant were shipped to chemical and metallurgical industries. The Vitro plant was operated on an experimental basis to develop a satisfactory process for vanadium pentoxide recovery. Source of the ferrophosphorus processed was the FMC phosphorus operation in Power County.

Zinc.—Production of zinc was 3,969 tons lower than in 1963, but the value of the metal increased 11 percent because of higher prices. Shoshone County operations supplied most of the total, but a significant quantity came from Blaine County producers. The Star Unit area continued to be the largest zinc-producing mine in the State. Sizeable production also came from the Bunker Hill and Page mines. The combined production from these three Shoshone County mines represented approximately 85 percent of the State's total.

As a result of the increased metal price and the purchase of custom ores for milling at the Bunker Hill mine concentrator, interest was renewed in reopening mines in the Pine Creek area of the Coeur d'Alene region. Nabob Mining Co. leased the Nabob mine, and several shipments of ore were made to the Bunker Hill concentrator. Signal Mining Co. announced plans to lease the New Hilarity mine, which had not been operated for 10 years, and the reopening of additional mines in the Pine Creek area was contemplated.

The Bunker Hill Co. electrolytic zinc plant at Kellogg established a new plant record for the fourth consecutive year by producing 91,761 tons of special high grade slab zinc from domestic and foreign concentrates.

NONMETALS

Barite.—Shipments of barite declined 25 percent compared with those of 1963. Crude material obtained from stockpiles at the J. R. Simplot Co. Sun Valley mine, Blaine County, was ground at the firm's Pocatello plant and sold for use as a weighting agent in oil-well-drilling muds. The operation of Bannock Apex Mines in Power County, which yielded a small tonnage in 1963, was idle.

Cement.—As in previous years, portland and masonry cements were produced at the Inkom plant of Idaho Portland Cement Co. Production and shipments of portland cement were 18 percent lower than

in 1963; masonry cement shipments also declined. Cement shipped from the Inkom plant went mainly to destinations in the State; quantities also were moved to markets in other Rocky Mountain States.

Idaho Portland Cement Co. constructed and placed into operation three cement distribution terminals—one each at Pocatello, Idaho Falls, and Twin Falls. Kaiser Cement & Gypsum Corp. (formerly Permanente Cement Co.) constructed distribution terminals at Pocatello and Meridian during the year; these distribution points were to be supplied from the firm's Montana City, Mont., plant. Oregon Portland Cement Co. (plants at Oswego and Lime, Oreg.) erected a distribution and storage facility at Boise to serve markets in southwestern Idaho.

Clays.—The quantity of clays sold or used by producers in Idaho increased moderately over the total for 1963. The gain was attributable to greater production of paper-filler clay by J. R. Simplot Co. from the Miclasil operation near Bovill, Latah County. Miscellaneous and fire clay production totals were down moderately from those of the previous year. Miscellaneous clay, for making heavy-clay products, was dug at pits in Ada, Bonneville, Cassia, Elmore, and Minidoka Counties. Fire clay for refractories manufacture was mined in Latah County. Bentonite was produced from an operation in Owyhee County. Output, used in oil-well-drilling muds and for lining irrigation canals and ponds, increased sharply. Bulldog Mining & Milling Co. (Carl Paynter) reported stripping overburden in preparation for mining a bentonitic clay deposit near Montour, Gem County.

J. R. Simplot Co. increased production of paper-filler clay (kaolin) from the Miclasil operation. A raw material feed consisting essentially of a mixture of clay, sand, and mica was separated, and the clay fraction was beneficiated to a product suitable for use as a filler by the paper industry. The Anaconda Co., early in the year, dropped options on a segment of the high-alumina clay-bearing lands that the firm had under lease-purchase option near Moscow in Latah County. The Anaconda firm for several years previous had been investigating the feasibility of producing alumina from high-alumina clay resources.

Garnet.—Shipments of garnet by Idaho producers were 2 percent greater than for the previous year; production of refined material increased 21 percent.

Idaho Garnet Abrasive Co., a division of Sunshine Mining Co., and Emerald Creek Garnet Milling Co. produced garnet at operations near Fernwood, Benewah County. Porter Bros. Corp. shipped a quantity of abrasive garnet from stockpiles near Lowman in Boise County.

In January, the assets of Idaho Garnet Abrasive Co. were acquired by Sunshine Mining Co. The Idaho Garnet firm continued operating as a division of the Sunshine company.

Gem Stones.—Total production value was difficult to estimate because the gem materials were collected in small amounts by a large number of amateur collectors. The industry was served by 17 gem and mineral clubs and a number of commercial dealers.

The value of garnet probably was the highest for any material collected for gem or mineralogical reasons, although the State is rich in other sought-after mineral specimens, such as those of the metallic ores and the many varieties of quartz.

According to a local producer of industrial garnet, over 25,000 persons visited the Emerald Creek area near Fernwood, Benewah County, to collect specimens of star garnet. Most of the digging was on gravel tailings which had been mined for industrial garnet. Garnets larger than one-half inch were not recovered for processing into industrial garnet, and these specimens were eagerly sought by the collector. While many of the stones were fully faced crystals, most of the specimens were rounded crystal fragments. The value of rough, gem-quality star garnet ranged up to $3.50 per pound.

Gypsum.—Gypsum for agricultural (land plaster) use from the Rock Creek mine was shipped from stocks by Rock Island Gypsum Co., Weiser, Washington County. The quantity shipped was substantially less than in 1963.

Lime.—Production of lime at sugar refineries increased moderately compared with the 1963 total of 60,000 tons. Production was from kilns at sugar refineries in Bannock, Bonneville, Canyon, Minidoka, and Twin Falls Counties. Lime also was recovered from calcium-carbonate sludge precipitated in the chemicals recovery system of a Kraft-paper plant in Nez Perce County. As in previous years, all production was captive for interplant use by the respective firms.

Mica.—Non-Metallics, Inc., shipped a quantity of scrap mica recovered from old mine workings and dumps at the Muscovite mine north of Deary, Latah County. Shipments were substantially less than in 1963. The scrap mica was sent to California where the material was ground and sold for use in paints and roofing materials. Work continued on constructing a grinding plant at the mine site.

Peat.—Peat production registered more than a fourfold increase compared with the 1963 output; however, sales advanced only slightly compared to the total for the prevoius year. A large variance between production and sales was caused by stockpiling of certain production for future sales. Reed-sedge peat was produced and shipped from an operation in Bannock County, and humus peat was dug in Teton County. Sales were primarily in bulk for horticultural and general soil-improvement uses.

Perlite.—The quantity of perlite mined by Oneida Perlite Corp. at its open pit operation north of Malad, Oneida County, was less than in the previous year. The crude material, after crushing and sizing, was shipped by rail to the firm's storage and expanding facilities at Malad. Sized and dried perlite was marketed in bulk to commercial expanding plants in the Northwest. Expanded perlite, produced at the Malad plant, was shipped to markets in the Western United States for use as loose-fill insulation, as a soil conditioner, and as a lightweight aggregate for concrete.

Phosphate Rock.—Production of both crude and marketable phosphate rock increased significantly over the 1963 totals.

J. R. Simplot Co. continued mining phosphate rock at operations in Bingham (Gay mine) and Caribou (Conda mine) Counties, and Monsanto Chemical Co. continued production from the Ballard mine in Caribou County. The Georgetown Canyon mine of El Paso Natural Gas Products Co. (formerly operated by Central Farmers Fertilizer Co.) remained idle throughout the year.

Phosphate rock sold or used by producers also was greater than in 1963, but the advance was not as large as that shown for mine pro-

duction. Elemental phosphorus manufacture continued as the principal end use for phosphatic materials mined in the State. The quantity reported used for this purpose was 5 percent greater than that for the previous year. Other uses included manufacturing wet-process phosphoric acid and phosphate fertilizers, both of which increased significantly compared with totals for 1963.

Phosphate rock was reduced to elemental phosphorus at plants of Monsanto Chemical Co., Soda Springs, and FMC Corp. at Pocatello. The El Paso Natural Gas Products Co. elemental phosphorus furnace and related works at Georgetown, Bear Lake County, remained idle throughout the year.

J. R. Simplot Co. continued producing triple superphosphate and ammonium phosphate fertilizers and wet-process phosphoric acid at the firm's fertilizer complex near Pocatello. As part of a $10-million expansion program begun by the company in 1963, a second fluosolids reactor and a second ammonium phosphate plant were completed and placed into production during the year. Construction also proceeded on an anhydrous ammonia facility and an ammonium sulfate fertilizer plant as well as on additions to the plant bagging and bulk fertilizer handling systems. The program, when completed, was to double the fertilizer productive capacity at the Pocatello works.

Monsanto Chemical Co. in April announced long-range plans for tripling capacity for manufacturing elemental phosphorus at its Soda Springs installation. Construction of the first of two additional phosphorus furnaces was begun, and a second unit was scheduled for construction within 3 years. In anticipation of increased raw material requirements, the company early in the year obtained leases on 1,680 acres of phosphate-bearing lands in the Soda Springs area of Caribou County.

FMC Corp. in July announced plans for a $3-million expansion and modernization program for the Pocatello phosphorus plant. A major portion of the expenditure would be for rebuilding one of the older, small-capacity furnaces into a larger, more efficient unit. Foreseeing increased raw material needs, the firm obtained leases on 1,000 acres of phosphate-bearing lands east of Soda Springs.

The Bunker Hill Co., Kellogg, Shoshone County, continued producing fertilizer-grade phosphoric acid. In May, the firm announced plans for a joint venture with Stauffer Chemical Co. to produce superphosphoric acid and ammonium phosphate fertilizers at the Kellogg site. The plant, which was to be constructed adjacent to the present Bunker Hill phosphoric acid plant and smelter complex at Kellogg, was to be operated by Bunker Hill, with marketing of the fertilizer products to be assigned to the Stauffer firm. Estimated cost of the proposed construction was $1.5 million. The joint venture would operate as North Idaho Phosphate Co.

El Paso Natural Gas Products Co., a subsidiary of El Paso Natural Gas Co., at midyear announced purchase of the Central Farmers Fertilizer Co. operations at Georgetown. The Georgetown elemental phosphorus plant and related facilities and the Georgetown mine were closed in 1963.

In November, the El Paso firm began constructing a fertilizer manufacturing complex at a site 5 miles north of Soda Springs. Under construction were phosphate and ammonium phosphate fer-

tilizer plants, related acid facilities, and a fertilizer granulating unit. The project was scheduled to be completed by late 1965. The El Paso company planned to produce phosphate fertilizers for markets in the Western States.

The first of a series of five reports being prepared by the Bureau of Mines evaluating the Western States phosphate industry and its resources was published.[4]

Pumice and Volcanic Cinder.—Curtailed use of pumice and cinder by the State highway department was the principal reason for a sharp decline in output of pumice and pumiceous material. The quantity sold or used by commercial firms also was less. Production was from six operations in five counties. Largest production was from Bonneville County; output also was reported from Canyon, Caribou, Oneida, and Twin Falls Counties. Pumice output was used mainly as lightweight aggregate in precast concrete building products. The State highway department used a quantity of volcanic cinder for sanding icy roads.

Sand and Gravel.—Curtailed demand at projects of the State highway department accounted for most of the decline in sand and gravel production; 2.3 million tons was produced for this agency compared with 7.1 million tons in 1963. Smaller quantities also were used by the Bureau of Public Roads and U.S. Forest Service for road building and maintenance projects. The quantity of sand and gravel used by various county and municipal agencies, however, more than doubled.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	397	$616	609	$978
Road material	1,167	1,228	2,120	1,985
Fill	24	25	48	52
Other [1]	135	320	94	96
Total	1,724	2,189	2,871	3,111
Government-and-contractor operations:				
Building			505	288
Road material	9,784	7,902	4,146	4,025
Fill	925	524	2,059	1,266
Other [1]			1	1
Total	10,709	8,426	6,711	5,580
All operations:				
Building	397	616	1,114	1,266
Road material	10,951	9,130	6,266	6,010
Fill	950	549	2,107	1,318
Other [1]	135	320	95	97
Grand total [2]	12,433	10,615	9,582	8,691

[1] Includes special sands, railroad ballast, and sand and gravel used for miscellaneous purposes.
[2] Owing to rounding, individual items may not add to totals shown.

[4] Service, A. L., and C. C. Popoff. An Evaluation of the Western Phosphate Industry and Its Resources Part I—Introductory Review. BuMines Rept. of Inv. 6485, 1964, 86 pp.

Plants producing over 100,000 tons accounted for over 62 percent of the commercial sand and gravel total. These operations were mainly contractors producing aggregate for State highway department projects. Output exceeded 500,000 tons in Ada, Bannock, Bonneville, Canyon, Franklin, and Madison Counties. Franklin County with output exceeding 1 million tons was the principal producing area; Madison and Canyon Counties ranked second and third, respectively. Sand and gravel was produced from operations in 39 of the 44 counties in the State.

Stone.—Production of stone for all purposes totaled 1.14 million tons, a decline of 2 percent from the 1.17-million-ton total for 1963. Reduced output by commercial operations was the principal reason for the drop. Commercial firms produced 738,000 tons compared with 895,000 tons in 1963. Government-and-contractor tonnages (largely contractor production for Federal, State, county, and municipal agencies) totaled 406,000 tons compared with 273,000 tons in the previous year.

Basalt, used mainly as a road base and surfacing material, continued to be the principal stone quarried. Substantial quantities of limestone and quartzite also were produced. Limestone output, quarried in Bannock and Lewis Counties, was 11 percent lower than in 1963, owing primarily to reduced demand by the cement industry. Other major markets for limestone were sugar refining and metallurgical smelting. Minor quantities were reported used for agricultural purposes. Sandstone and quartzite were produced at quarries in Caribou and Shoshone Counties. Stone was produced from operations in 11 of the 44 counties in the State.

REVIEW BY COUNTIES

Mineral production was recorded from 42 of the 44 counties. Shoshone County accounted for 67 percent of the total mineral-output value. Sand and gravel and stone were the principal or only products from 31 counties. Selected counties with significant metal and nonmetal developments are discussed in the following review.

Adams.—Hecla Mining Co., Wallace, and Copper Ridge Mines, Ltd., Vancouver, British Columbia, conducted exploration at properties in the remote Snake River area of Adams County. Hecla drilled a number of holes and completed other exploration at the Red Ledge property. Men and equipment were transported to and from the area by helicopter. Copper Ridge secured options on various claim groups and began diamond drilling the Peacock and other properties. The Snake River area exploration prompted Idaho Mining and Smelting Co. to investigate the feasibility of constructing a small copper smelter at Oxbow Dam.

Bannock.—Limestone was quarried by Idaho Portland Cement Co. for use in manufacturing portland and masonry cements at the company's Inkom plant. Output was lower than in 1963 owing to curtailed cement production. Idaho Peat, Inc., produced and shipped reed-sedge peat from an operation near Downey. Sand and gravel was produced for construction and road uses at about the 1963 rate.

TABLE 14.—Value of mineral production in Idaho, by counties [1]

(Thousand dollars)

County	1963	1964	Minerals produced in 1964 in order of value
Ada	$1,718	W	Sand and gravel, clays.
Adams	W	$43	Sand and gravel.
Bannock	W	W	Cement, sand and gravel, stone, peat.
Bear Lake	W	223	Sand and gravel, stone.
Benewah	176	248	Abrasive garnet, sand and gravel, iron ore.
Bingham	W	W	Phosphate rock, vanadium, sand and gravel.
Blaine	W	738	Zinc, lead, silver, barite, copper, gold.
Boise	29	14	Sand and gravel, silver, gold, lead, zinc.
Bonner	432	132	Sand and gravel, silver, lead, gold, copper, zinc.
Bonneville	1,948	880	Sand and gravel, lime, pumice, clays.
Boundary	50	59	Sand and gravel, stone, lead, silver, zinc.
Butte	----------	81	Sand and gravel.
Camas	W	W	Lead, silver, zinc, gold.
Canyon	943	868	Sand and gravel, lime, pumice.
Caribou	W	W	Phosphate rock, stone, vanadium, sand and gravel, pumice.
Cassia	548	W	Sand and gravel, clays.
Clark	19	112	Sand and gravel.
Clearwater	95	198	Stone, sand and gravel.
Custer	496	538	Silver, lead, copper, zinc, gold, sand and gravel.
Elmore	96	139	Sand and gravel, clays, gold, silver.
Franklin	21	842	Sand and gravel.
Fremont	6	117	Sand and gravel, stone.
Gem	335	W	Sand and gravel, gold, silver, lead, zinc, copper.
Gooding	71	47	Sand and gravel.
Idaho	552	501	Stone, sand and gravel, gold, silver.
Jefferson	160	76	Sand and gravel.
Kootenai	207	345	Do.
Latah	399	W	Clays, sand and gravel, mica.
Lemhi	660	W	Copper, sand and gravel, gold, lead, silver, zinc.
Lewis	W	408	Stone, sand and gravel.
Lincoln	66	298	Sand and gravel.
Madison	367	615	Sand and gravel, stone.
Minidoka	191	545	Sand and gravel, lime, clays.
Nez Perce	354	563	Sand and gravel, stone.
Oneida	336	29	Pumice, sand and gravel, perlite.
Owyhee	11	6	Sand and gravel, clays, gold, lead, silver, zinc.
Payette	12	49	Sand and gravel.
Power	417	26	Do.
Shoshone	54,466	57,565	Silver, lead, zinc, copper, antimony, gold, stone.
Teton	17	----------	
Twin Falls	656	686	Sand and gravel, lime, pumice.
Valley	126	83	Mercury, ilmenite, sand and gravel, iron ore, tungsten abrasive garnet.
Washington	W	32	Sand and gravel.
Undistributed [2]	16,807	19,156	
Total	r 82,787	86,262	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] No production reported in Jerome County.
[2] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

Bear Lake.—The Georgetown Canyon mine of El Paso Natural Gas Products Co. (formerly operated by Central Farmers Fertilizer Co.) remained idle. El Paso Natural Gas Products Co. at midyear purchased the assets of Central Farmers Fertilizer Co. at Georgetown. The firm conducted exploration to compile resource estimates and to assess the economics of mining phosphate from leased deposits acquired from the Central Farmers firm.

Benewah.—Abrasive garnet was dredged and processed by two firms—Idaho Garnet Abrasive Co. (a division of Sunshine Mining Co.) and Emerald Creek Garnet Milling Co.—at operations near Fernwood. Installation of additional grinding equipment and construction of a new maintenance shop were reported by Idaho Garnet. The Emerald Creek firm reported constructing additional warehouse space during the year.

Sand and gravel output for general road use was slightly below that of 1963.

Bingham.—Phosphate rock and phosphatic shale were mined and shipped by J. R. Simplot Co. from the Gay mine near Fort Hall. Production of both phosphate rock and phosphatic shale was increased significantly compared with that of the previous year when a labor dispute interrupted production for 3 months.

Sand and gravel output increased 40 percent owing primarily to greater demand for these commodities at State highway department projects.

Blaine.—Federal Resources Corp. completed constructing a 250-ton-per-day concentrator and related facilities near Bellevue and began lead-zinc milling operations in April. Tailings from previous operations at the Minnie Moore mine and ore from the adjacent Silver Star-Queens mine were processed in addition to custom ore from smaller operations in the area. Lead and zinc concentrates were shipped to metallurgical facilities of The Bunker Hill Co. at Kellogg.

Federal Resources secured an option on the Triumph mine dump from Idaho-Pacific Mining Co. Idaho-Pacific terminated all operations in the area at midyear. A portable sink-float plant at the Triumph property was operated part of the year to upgrade dump material before further concentration by flotation methods.

Eleven men were employed by Federal Resources in exploring the Phi Kappa mine. Test shipments were made to the company mill at Hailey, but no production was reported.

A small flotation mill was constructed at the Silver King property in the Sawtooth district to process dump material for its silver and antimony content. A small amount of ore was extracted at the Liberty Gem mine in the Mineral Hill district and shipped to the Tooele, Utah, smelter.

J. R. Simplot Co. shipped a quantity of crude barite from stockpiles at the Sun Valley mine near Hailey to the company grinding plant at Pocatello. The mine remained idle throughout the year.

Boise.—Production from the Come Back mine in the Boise Basin district was by far the largest of the three metal mines operated.

Bonner.—Austin Meyer Corp. (Weber mine) was the largest of the six base- and precious-metal producers. Silver ore was extracted at the Telache and Brown Bear mines in the Pend Oreille district. In the Clark Fork district, lead ore was mined at the Lawrence and Whitedelf mines. Federal Resources Corp. terminated exploration at the Conjecture mine in the Lakeview district after spending $2.75 million on the project.

Bonneville.—The county continued as the principal pumice-producing area in the State; however, output was substantially lower than in 1963. Pumice was produced near Idaho Falls by Idaho Concrete Products, Inc., and Idaho Falls Pumice Co. Limestone was processed to quicklime by the Utah-Idaho Sugar Co. for use at its Idaho Falls sugar refinery. Clay for manufacturing heavy-clay products was mined near Idaho Falls. Reduced requirements for sand and gravel at State highway department projects resulted in a sharp drop in the production of these commodities compared with totals in 1963.

Boundary.—A & P Mining Co. shipped jig concentrate and crude ore containing 190 ounces of silver and 7 tons of lead from the Old Dam claims in the Porthill district to the lead smelter at Kellogg. A small quantity of silver ore was produced at the Idaho Continental mine.

Camas.—Russco Silver, Inc., shipped silver ore from the Buttercup mine, Willow Creek district, to the Federal Resources Corp. mill at Bellevue.

Caribou.—The Kermac Nuclear Fuels Corp. vanadium recovery plant, completed during 1963, began full-scale operations in April. Located 2 miles north of Soda Springs, the plant processed ferrophosphorus from the Monsanto Chemical Co. elemental phosphorus operation to recover vanadium compounds including ammonium metavanadate used in catalysts for synthetic-fiber manufacture and vanadium pentoxide used in steel alloying.

Mining and processing of phosphate rock continued as the principal mineral industry activity in the county. Phosphate rock was mined at the Ballard (Monsanto Chemical Co.) and the Conda (J. R. Simplot Co.) mines. Production from both mines was increased significantly compared with output for the previous year. Auger mining was used in recovering a portion of the Ballard output. The auger mining technique was employed in certain areas where overburden-to-ore ratios were excessive for economic recovery by conventional open-pit mining methods. Phosphate rock from the Ballard property was reduced to elemental phosphorus at the Monsanto phosphorus plant at Soda Springs. The Conda mine production was beneficiated, and the concentrate was shipped by rail to the Simplot fertilizer works at Pocatello. Quartzite was quarried near Soda Springs for use as a furnace flux at the Monsanto phosphorus plant. Sand and gravel for road and construction uses also was produced.

Custer.—Clayton Silver Mines (Clayton mine) continued to be the major operator in the county by producing 23,531 tons of ore, 27 ounces of gold, 144,275 ounces of silver, 18 tons of copper, 689 tons of lead, and 103 tons of zinc. The company annual report to shareholders stated that mining and milling costs were $140,625 and $73,617, respectively. The report further stated that a diamond-drilling project to check mineral zones at depth was begun in April and continued throughout the year. Results indicated that between 2 and 3 million ounces of silver was contained between the 800 working level and the projected 1500 level.

Other significant production came from the Empire group (R. V. Lloyd & Co.), Alder Creek district, and 295 tons of jig concentrate was produced from 10,000 tons of Ramshorn dump ore. Four other lode mines and two placer operations supplied small quantities of gold and silver.

Work was begun by Ivers Mining Co., Salt Lake City, Utah, in the Loon Creek mining district under a $46,773 OME contract awarded late in 1963.

Gem.—Gem State Consolidated Mines, Inc. (Dewey group), mined 1,068 tons of ore assaying 1.2 ounces of gold and 3.1 ounces of silver per ton. Flotation concentrate was shipped to the East Helena, Mont., smelter, and gold-silver bullion went to the Federal Mint in San Francisco, Calif.

Idaho.—Small quantities of gold and silver ore were shipped from three properties—Yakima, Wonder, and Brown Mountain. C. D. Painter was awarded a $41,830 OME loan for a gold exploration project in the Dixie mining district.

Latah.—J. R. Simplot Co. continued producing paper-filler clay at the Miclasil plant near Bovill. The principal source of raw material for the Miclasil operation was the Stanford pit 8 miles northwest of Deary. The clay was dug with power shovels and trucked to a rail siding for shipment to the processing plant at Bovill, a distance of 18 miles. The Bovill pit, which in previous years had supplied the raw material requirements of the Miclasil operation, was idle; a small tonnage of material stockpiled from previous mining was used. Several plant modifications were made during the year to accommodate the new source of raw material as well as to satisfy changing market demands. Fire clay for refractories was mined during the summer months at an open pit operation near Helmer by A. P. Green Firebrick Co. The fire clay was used in manufacturing refractory brick and shapes at the firm's Troy (Idaho) plant. Non-Metallics, Inc., recovered a small portion of scrap mica from the Muscovite mine near Deary.

Lemhi.—Value of base- and precious-metal production from county mines ranked a distant second behind Shoshone County. The sharp rise in output value over that of 1963 resulted from increased production at the Blackbird mine by Machinery Center, Inc. The mine and mill, formerly operated by Calera Mining Co., a subsidiary of Howe Sound Co., were operated throughout the year. Ore, mined at the rate of about 200 tons per day, was milled in a portion of the 1,000-ton-per-day copper-cobalt concentrator, and the concentrate was shipped to smelters at Anaconda, Mont., and Tacoma, Wash. No effort was made to recover the cobalt content (0.7 percent or more) of the ore because of the lack of a profitable market for the material. The 25 employees operating the mine and mill resided at the company-owned town of Cobalt. The town, mill, and other surface equipment and buildings were purchased by Machinery Center, Inc., in 1959, but the mine was leased from Howe Sound Co.

United Idaho Mining Co. shipped development ore from the United Idaho mine in the Texas district. A silver and gold exploration project was begun in the Texas district as the result of an $86,670 OME contract awarded to Clemens and Arthur Lombardi.

Oneida.—Oneida Perlite Co. continued mining perlite at deposits north of Malad. Bulk screened and sized perlite and packaged expanded perlite were shipped from the Malad plant to markets in the Western States. Pumice was mined at an operation near Malad by the South Idaho Construction Co., Inc. Production, which was used principally as a lightweight aggregate for concrete, was lower than in the previous year owing to a decline in residential building in the principal market area.

Owyhee.—Sidney Mining Co. acquired claims covering nearly 1½ square miles between the idle Dewey and Delmar mines in the Silver City mining district.

Power.—The county continued as the principal phosphate processing center in the State. Phosphate rock was processed to manufacture phosphate fertilizers and elemental phosphorus at plants west

of Pocatello by J. R. Simplot Co. and FMC Corp., respectively. The quantity of phosphate rock utilized at both operations increased significantly.

Continued growth for the phosphate industry in the area was evidenced by construction programs underway and announced during the year. A construction program begun in 1963 to expand production capacity at the Simplot fertilizer works was continued, and plans were revealed by FMC Corp. for expending $3 million for plant and equipment modifications which would increase capacity of the firm's elemental phosphorus facility near Pocatello.

Barite shipped from stocks at the Sun Valley mine in Blaine County was ground at the Simplot Pocatello works. Sulfur obtained from recovery plants in the Western United States and Canada was converted to sulfuric acid by the Simplot company for use in manufacturing fertilizer products.

Shoshone.—Eighteen mines in the county supplied 98 percent of the silver, lead, and zinc produced in the State, 71 percent of the copper, and 52 percent of the gold. County mines accounted for 98 percent of the value of base- and precious-metal output.

The Bunker Hill Co. lead smelter was closed for 2 weeks in August for repairs. The plant underwent a general overhaul including installation of a new slag-tapping system and cleaning and repairing of the fuming furnace, most of the flue system, electrical equipment, and the electric furnace. In October, fire nearly destroyed the Cottrell precipitating plant and bag-house and idled the operation for approximately 2 weeks.

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] (thousands 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							
1955–59 (average)	30	1	1,556	2,141	14,424	3,312	60,162	51,415	$43,912
1960	22	1	980	2,591	13,459	2,606	41,692	36,639	33,153
1961	15	1	1,434	3,279	17,369	3,673	70,651	58,184	46,313
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
1884–1964	------	-------	[2] 110,996	441,610	685,422	112,476	6,770,031	2,328,866	2,027,576

[1] Does not include gravel washed.
[2] Complete data not available: 1904–64.

The Independent Northwest Metal Workers Union won the right to continue representing nearly 1,600 employees of The Bunker Hill Co. at Kellogg by winning an election from two nationally affiliated unions—International Union of Mine, Mill and Smelter Workers and United Steelworkers of America. New labor contracts were negotiated at all major Shoshone County mining operations during the year.

The ore deposits of the Coeur d'Alene mining region were described.[5]

[5] Fryklund, V. C., Jr. Ore deposits of the Coeur d'Alene District, Shoshone County, Idaho (with a section on the bleached rock in the Coeur d'Alene district, by P. L. Weis). U.S. Geol. Survey Prof. Paper 445, 1964, 103 pp.

Beaver District.—Kennedy and Zanetti, lessees, operated the Mountain Goat portion of the Monitor mine at an accelerated rate compared with that of 1963. The Day Mines, Inc., annual report to shareholders stated that 62,841 tons of lease ore averaged 0.8 ounce of silver, 1.7 percent lead, and 3.4 percent zinc. Day Mines resumed operations elsewhere in the mine on ore blocks last worked in 1953. Company ore mined, which amounted to 9,482 tons averaging 0.7 ounce of silver per ton, 1.6 percent lead, and 5.9 percent zinc, was concentrated at the Dayrock mill. The Mountain Goat lease was reported to have ore reserves for several years' production, but company ore was equivalent to less than 1 year's output.

Evolution District.—The Sunshine Unit area remained the largest silver producer in the Nation, although the operation was idled throughout most of the first quarter of the year by a labor strike. The 131,799 tons of ore mined and milled yielded 137 ounces of gold, 4,632,348 ounces of silver, 872 tons of copper, 408 tons of lead, and 116 tons of zinc. Silver production was slightly less than in 1963, mostly because the average content declined from 38.25 to 36.02 ounces per ton of ore. According to the Sunshine Mining Co. annual report to stockholders, yearend ore reserves were 32,800 tons less than the 457,750 tons reported at the end of 1963. Exploration and development consisted of 2,094 feet of raising, 6,973 feet of drifting and crosscutting, and 12,330 feet of diamond drilling. Three 60-inch fans were installed to improve working conditions on the lower levels of the mine. A 3-year labor agreement providing for automatic wage increases in March 1965 and 1966 was signed with the United Steelworkers of America. Strikes of varying duration had affected production from the property in each year since 1961.

Hecla Mining Co. produced 16,321 tons of ore averaging 22.4 ounces of silver per ton and 0.88 percent copper at the Silver Summit mine. Concentrate from the Polaris mill was shipped to the International Smelting and Refining Co. smelter at Tooele, Utah. A major development project begun in 1963 was continued throughout the year. The Silver Summit winze was deepened 600 feet, and drifting was started on the 3600, 3800, and 4000 levels. Yearend ore reserves were 31,000 tons, 7,000 tons larger than at the beginning of the year.

Hunter District.—According to The Bunker Hill Co. annual report to shareholders, production from the Star Unit area was 245,388 tons, from which 549,726 ounces of silver, 10,426 tons of lead, and 24,955 tons of zinc were recovered. The Star winze was deepened 127 feet to the 7100 level, and the Noonday shaft and hoisting facilities were completed to serve the 2500 to 4000 levels of the Noonday vein. A 7100-level station was cut in preparation for development of that level. Ore reserves were increased nearly 130,000 tons to over 905,000 tons as considerable ore was developed on the 6300 and 6500 levels of the Morning East vein.

Hecla Mining Co. extracted 182,704 tons of ore averaging 0.01 ounce of gold, 19.38 ounces of silver, 11.28 percent lead, and 1.11 percent zinc from the Lucky Friday mine. The 3,464,837 ounces of silver recovered ranked the mine third among silver producers in the State and the Nation. A portion of the Lucky Friday vein developed on the 3250 level was comparable to sections mined on the 3050 level above. Ore reserves declined to 671,000 tons, 96,000 tons less than at

the start of the year. Lucky Friday Silver-Lead Mines Co. was merged into Hecla Mining Co. on April 1 through an exchange of stock.

Lelande District.—Lead ore was extracted at the Sherman mine by W. Fannan and L. Bailey under a lease agreement with Day Mines, Inc. The company shipped cleanup material from the Hercules mine.

Placer Center District.—Day Mines, Inc., reported in its annual report to shareholders that American Smelting and Refining Co. produced 136,214 tons of ore from the Galena mine averaging 32.4 ounces of silver per ton and 1.2 percent copper, from which 4,340,514 ounces of silver and 1,592 tons of copper were recovered. The mine was the second largest domestic silver producer for the fourth consecutive year. A new 4300 level was opened 300 feet below the former bottom level. Development totaled 10,328 feet, and diamond drilling amounted to over 8,580 feet. The silver-copper ore reserve was maintained at a level equivalent to 6 years' production at current extraction rates. In addition, there was a large lead-silver ore reserve.

American Smelting and Refining Co. agreed to a long-term, deep exploration project on ground adjoining the Galena property belonging to Coeur d'Alene Mines Co. and Rainbow Mining and Milling Co., Ltd. American Smelting was to spend at least $3 million in a 6-year period to explore the property. The initial part of the project was to include the sinking of a 3,000-foot vertical shaft.

Two diamond-drill holes totaling 293 feet were drilled below the 1100 level of the Dayrock mine by Day mines, Inc., and plans were made to begin production from the 1250 level of the mine during the last 6 months of 1965.

Smelter District.—The Bunker Hill Co. smelted 46,883 tons of dump slag accumulated prior to the installation of the slag-fuming plant at the lead smelter. The slag yielded 14,357 ounces of silver, 867 tons of lead, and 3,010 tons of zinc.

Summit District.—Ray Simmons continued to operate the Bear Top mine under a lease from Merger Mines Corp. Approximately 21 tons of ore shipped to the Bunker Hill lead smelter yielded 66 ounces of silver, 9 tons of lead, and 2 tons of zinc. A small quantity of gold ore was shipped from the Mountain Lion group.

Yreka District.—Ore production by The Bunker Hill Co. and four lessees (Bailey, Marr, McLin, and Thompson) at the Bunker Hill mine was about the same as in 1963, but the metal content was lower. According to the Bunker Hill annual report to stockholders, 1,741,181 ounces of silver, 30,199 tons of lead, and 16,817 tons of zinc were recovered from 454,326 tons of ore milled. Yearend ore reserves increased 42,000 tons to 1,848,728 tons. The zinc content decreased slightly. Emphasis continued to be placed on exploration and development, but no new major ore bodies were discovered. At yearend, the headings between the Bunker Hill and Crescent mines were 1,200 feet apart, and a connection was expected by mid-1965. As a result of the increased price of lead and zinc, milling of old tailings was resumed at the Bunker Hill concentrator.

In an effort to increase the supply of lead and zinc concentrates to its smelting facilites, Bunker Hill announced plans to process custom ore in the company concentrator at Kellogg. The company previously had smelted purchased ore and concentrate at the lead smelter but had not processed custom ore at the concentrator. A large asphalt

pad and weighing station were installed to facilitate handling of custom material.

The Bunker Hill Co. reported that silver production at the Crescent mine increased to 525,740 ounces from 494,828 ounces in 1963 despite a 5,000-ton drop in ore mined. The increase resulted from a rise in the grade of ore extracted to 32 ounces per ton from 25 ounces per ton in 1963. The Alhambra winze was sunk 400 feet to the 3500 level, and development was begun on the 3100 and 3300 levels. Yearend ore reserves totaled 44,655 tons.

According to the American Smelting and Refining Co. annual report, 130,937 tons of ore mined and milled at the Page mine contained 442,089 ounces of silver, 7,241 tons of lead, and 11,166 tons of zinc in concentrates.

The Nabob mine was reopened on a lease basis, and 437 tons of custom zinc ore was shipped to the Bunker Hill concentrator. Ore also was shipped to the concentrator from the Royal mine.

Valley.—Antimony ore was mined by Antimony Gold Ores Co. from the Garnet Creek, Sugar Creek, and Profile Ridge properties. The ore was stockpiled for later concentrating in the company mill near Yellow Pine. Mercury ore mined at the Hermes mine was concentrated in a 2-ton-per-hour-capacity flotation mill prior to processing in a D-type retort.

Washington.—Iron ore was not mined in the county, although two mines had been operated in 1963. Late in 1964, El Paso Natural Gas Co. began rehabilitating the Idaho-Almaden mercury mine near Weiser to prepare for production scheduled to begin early in 1965.

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]



ILLINOIS mineral production in 1964 was valued at $591 million, slightly higher than in 1963. Increases in total value of production of portland and masonry cements, clays, coal, lime, peat, sand and gravel, stone, and tripoli offset decreases in fluorspar, lead, natural gas, natural-gas liquids, petroleum, and zinc. Mineral fuels was the major commodity group, supplying nearly 73 percent of the State total value. Nonmetals comprised over 26 percent and metals less than 1 percent.

A variety of minerals was produced in Illinois. In 1964, 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.

TABLE 1.—Mineral production in Illinois [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	9,281	$30,577	9,790	$32,191
Masonry—thousand 280-pound barrels	472	1,440	596	2,038
Clays—thousand short tons	1,949	4,368	[2] 2,007	[2] 4,358
Coal (bituminous)—do	51,736	196,518	55,023	208,448
Fluorspar—short tons	132,060	6,547	127,454	6,452
Lead (recoverable content of ores, etc.)—do	2,901	627	2,180	571
Natural gas—million cubic feet	9,459	1,220	7,867	905
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	14,939	1,077	14,109	1,030
LP gases—do	337,278	14,714	312,173	13,758
Petroleum (crude)—thousand 42-gallon barrels	74,796	222,892	70,168	205,592
Sand and gravel—thousand short tons	31,746	36,431	34,880	39,966
Stone—do	40,293	52,217	42,987	56,553
Zinc (recoverable content of ores, etc.)—short tons	20,337	4,678	13,800	3,754
Value of items that cannot be disclosed: Fuller's earth (1964), gem stones, lime, peat, and tripoli	XX	13,656	XX	15,520
Total	XX	r 586,962	XX	591,136

r Revised. 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."

[1] Mining engineer, Bureau of Mines, Minneapolis, Minn.

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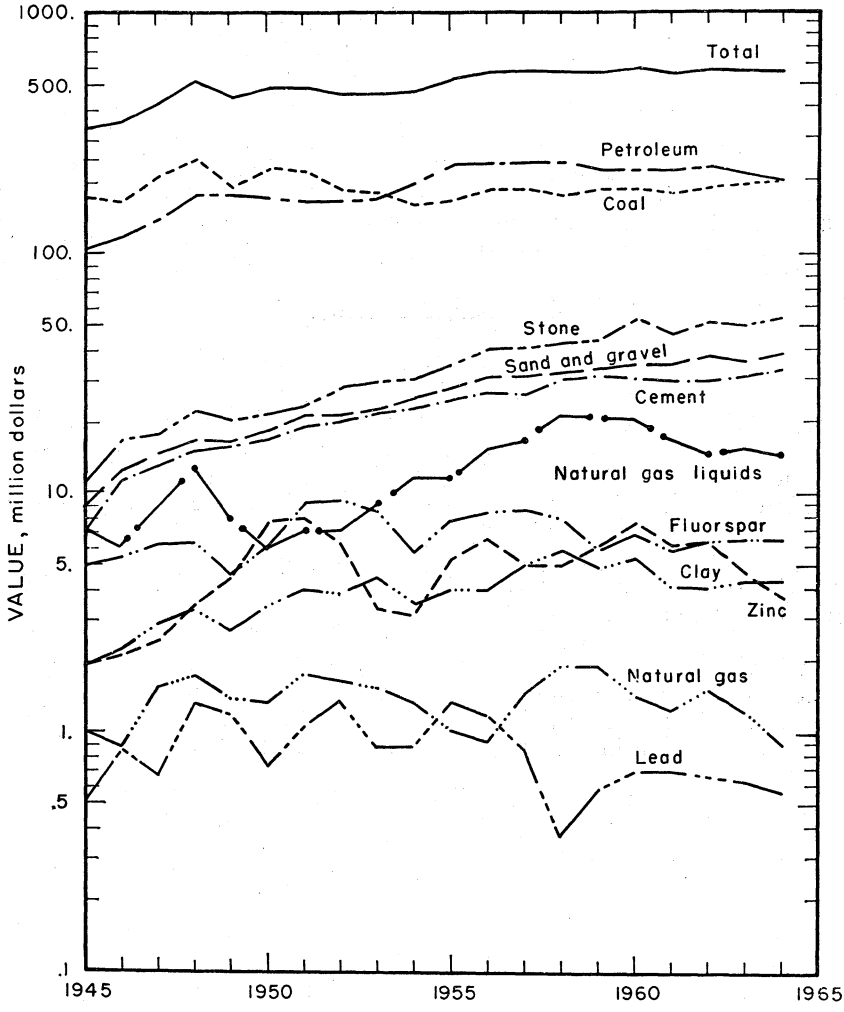


FIGURE 1.—Value of selected mineral commodities and total value of mineral production in Illinois.

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

(Millions)

Year	Value	Year	Value
1953	$491	1959	$581
1954	512	1960	598
1955	562	1961	577
1956	597	1962	r 605
1957	572	1963	605
1958	582	1964	611

r Revised.

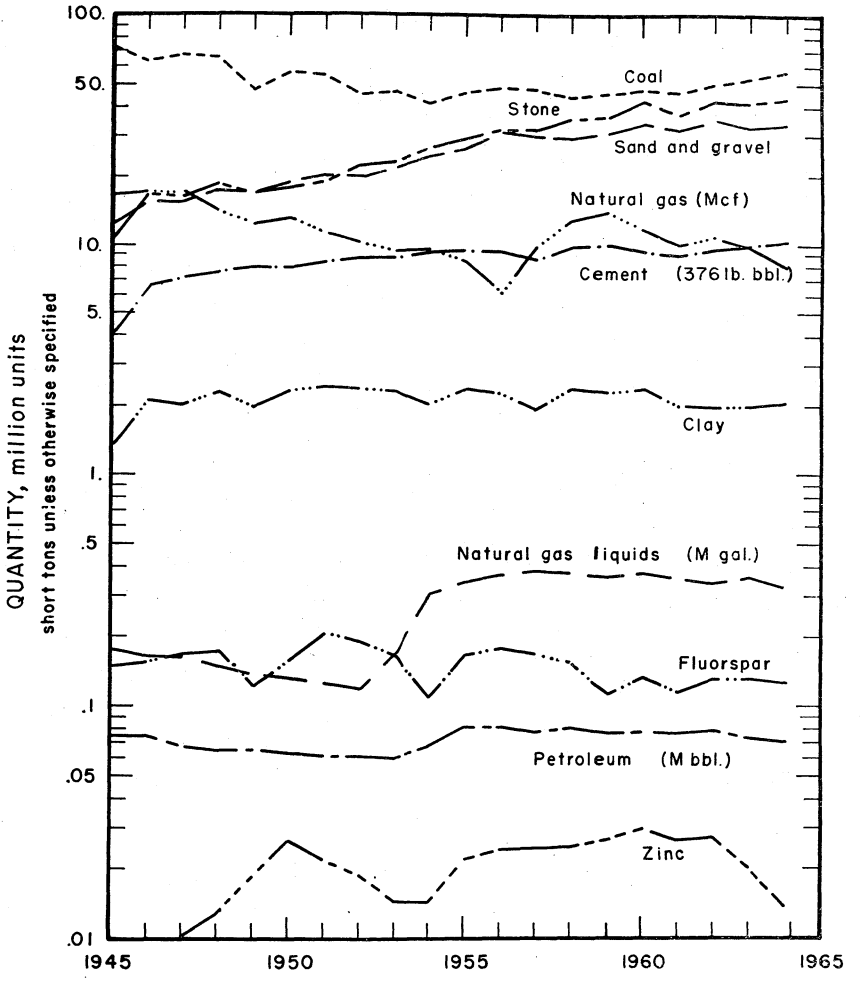


FIGURE 2.—Quantity of production for selected mineral commodities produced in Illinois.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	8,297	2,005	15,564	16	619	41
Metal	104	19	149		11	74
Nonmetal	1,832	421	3,417		88	26
Sand and gravel	1,670	345	2,879	1	44	16
Stone	3,863	964	7,968	3	112	14
Peat	7	1	9			
Total	15,773	3,755	29,986	20	874	30
1964: p						
Coal	8,500	2,110	16,770	10	700	42
Metal	75	13	103		6	58
Nonmetal	1,710	388	3,125	1	106	34
Sand and gravel	1,750	363	3,194	1	62	20
Stone	3,990	1,033	8,460		167	20
Peat	17	2	18			
Total	16,042	3,909	31,670	12	1,041	33

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Illinois ranked as the fourth largest coal-producing State in the Nation with an output of 55 million tons. Over a 6-percent increase in both tonnage and value from that of 1963 was attributed to a 3-million-ton increase in coal consumption by electric utilities.

Nearly two-thirds of the coal mined in the State was used in producing electrical energy. Total shipments to general manufacturing and processing industries increased about 1 million tons and to coke and gas plants increased about 60,000 tons. Sales to retail dealers decreased over 300,000 tons. Railroad fuel consumption declined slightly to under 280,000 tons.

The total value of bituminous-coal production was the greatest of any single commodity group produced within the State in 1964. This is the first year since 1953 that coal has outranked petroleum production value for the State. Total coal consumption in Illinois increased by 6 percent, and over 75 percent of the 41.5 million tons of bituminous coal consumed in Illinois was produced within the State. Average mine value was $3.79 per ton, compared with $3.80 per ton in 1963.

Coal was produced at 102 mines in 32 counties. Data exclude mines producing less than 1,000 tons annually.

Ten companies each produced over 1 million tons in 1964 and together furnished nearly 94 percent of the State total output. These companies were Bell & Zoller Coal Co.; Freeman Coal Mining Corp.; Old Ben Coal Corp.; Peabody Coal Co.; Sahara Coal Co., Inc.; Southwestern Illinois Coal Corp.; Stonefort Coal Mining Co., Inc.; Thunderbird Collieries Corp.; Truax-Traer Coal Division, Consolidation Coal Co., Inc.; and The United Electric Coal Cos. Peabody Coal Co. No. 10 underground mine in Christian County ranked as the

largest-producing bituminous coal mine in the Nation. Two other Illinois mines were among the eight largest-producing mines in the Nation.

Strip mines supplied over 54 percent of the total production and underground mines provided the remainder. Output from strip mines increased nearly 10 percent and from underground mines increased over 2 percent from 1963 production tonnages.

TABLE 4.—Coal (bituminous) production in 1964, 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		28,109	28,109	$195,013
Bureau		1		255,452	255,452	W
Christian	1		5,451,697		5,451,697	W
Douglas	1		581,516		581,516	W
Franklin	3		5,908,612		5,908,612	W
Fulton		8		7,433,793	7,433,793	29,103,022
Gallatin	2	1	53,117	5,115	58,232	189,223
Greene		1		3,102	3,102	17,599
Grundy		1		339,759	339,759	W
Henry	1		70,504		70,504	W
Jackson	2	2	138,032	1,253,754	1,391,786	W
Jefferson	1	1	2,517,491	1,159	2,518,650	W
Knox		2		1,838,983	1,838,983	W
Logan	1		21,899		21,899	109,000
Macoupin	1		373,937		373,937	1,414,635
Madison	2		126,822		126,822	532,755
Menard	1		7,350		7,350	W
Mercer	1	1	50,189	1,462	51,651	W
Montgomery	2		2,070,058		2,070,058	W
Peoria	2	4	13,969	1,103,718	1,117,687	5,429,347
Perry		3		4,051,589	4,051,589	W
Randolph	1	2	831,889	1,541,186	2,373,075	W
St. Clair	4	3	1,461,190	4,309,274	5,770,464	20,512,597
Saline	3	10	1,491,774	2,535,837	4,027,611	15,039,450
Sangamon	2		79,286		79,286	350,043
Schuyler		1		577,668	577,668	W
Stark		1		443,913	443,913	W
Vermilion	3	2	50,408	1,066,101	1,116,509	W
Wabash		1		1,103	1,103	4,517
Washington	1		28,295		28,295	W
Will		1		484,832	484,832	W
Williamson	10	10	3,706,441	2,712,217	6,418,658	24,554,770
Total	45	57	25,034,476	29,988,126	55,022,602	208,447,765

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

Fifty-six plants cleaned 87 percent of the State coal ouput. All but a minor fraction of the underground production was cut by machines and mechanically loaded. Loading equipment included 104 mobile loaders, 43 continuous miners, and 5 duckbills or self-loading conveyors. Stripping and loading equipment at strip mines included 173 power shovels, draglines, and wheel excavators. Among the new equipment was a 140-cubic-yard stripping shovel added at the Peabody Coal Co. River King mine near Marissa. Over 83 percent of the total State output was shipped to consumers by rail, less than 10 percent by truck, and nearly 7 percent by waterways. A small quantity was consumed at the mines.

Truax-Traer Coal Division, Consolidation Coal Co., Inc., resumed production in mid-year at the Burning Star No. 1 slope mine near Elkville after being shut down for nearly 3 years. Southwestern

Illinois Coal Corp. started shipping in the fourth quarter by unit train from the new Captain mine to the Commonwealth Edison Co. electric generating plant at Joliet. Truax-Traer's new Hillsboro mine at Coffeen, part of the State's first "mine-mouth" coal-by-wire complex, reported initial production in the fourth quarter.

The Illinois State Geological Survey reported progress in the mapping of strippable coal reserves in Illinois.[2] Plans call for mapping all coals over 18 inches thick with overburdens up to 150 feet thick.

Coke.—Approximately 2.3 million tons of coke, valued at $43.4 million, was produced at six plants; these figures represent an increase of nearly 23 percent from 1963 quantities and values. Consumption of coke breeze by producing companies increased nearly 26 percent to over 2.2 million tons. During the year, 568 ovens were operated, the same number as in 1963.

Recovery from coke plants of over 175,000 tons of coke breeze valued at $1,421,137 represents a 3-percent increase in quantity and more than a 19-percent increase in value over the 1963 totals. Less than 102,000 tons of coke breeze was used by producers in agglomerating iron ore, compared with 108,000 tons in 1963. Other products of coke-oven plants included coke-oven gas, tar, ammonia, crude light oil, and light-oil derivatives.

Peat.—Peat production was reported by five companies in Cook, Kane, Lake, and Whiteside Counties. Moss, humus, and reed-sedge types were sold in bulk form as general soil conditioners. Some reed-sedge was packaged.

Petroleum, Natural Gas, and Natural-Gas Liquids.—Crude-petroleum production decreased over 6 percent in quantity and nearly 8 percent in value to comprise about 35 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. Over one-third of the crude-petroleum production came from the Loudon and Old Illinois fields.

The Illinois State Geological Survey reported the completion in 1964 of 1,577 wells, of which 728 were producing oil wells, 19 were gas wells, 428 were dry holes in pools, and 402 were unsuccessful wildcats. Total footage drilled was 3,096,732, of which 50 percent was in producing wells. Data do not include service wells, natural-gas storage wells, and old wells reworked.

Estimated proved crude-oil reserves on December 31 totaled nearly 392 million barrels, according to the American Petroleum Institute.[3] This represents a decrease from the previous year of approximately 25 million barrels.

Marketed production of natural gas decreased nearly 17 percent in quantity and 26 percent in value. Estimated proved natural-gas reserves on December 31 totaled approximately 180,000 million cubic feet, according to the American Gas Association.[4] This is an increase from 1963 estimates of about 11 million cubic feet.

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[2] Reinertsen, David L. Strippable Coal Reserves of Illinois—Part 4, Adams, Brown, Calhoun, Hancock, McDonough, Pike, Schuyler, and the southern parts of Henderson and Warren Counties. Illinois State Geol. Survey, Circ. 374, 1964, 32 pp.

[3] Oil and Gas Journal. Crude Reserves Eke Out A Plus. V. 63, No. 13, Mar. 29, 1965, pp. 59–61.

[4] Work cited in footnote 3.

TABLE 5.—Crude petroleum production, by fields [1]

(Thousand 42-gallon barrels)

Field	1960	1961	1962	1963	1964
Albion	888	863	772	775	900
Benton	467	442	565	553	438
Centralia	1,420	995	1,238	875	714
Clay City	7,470	6,683	6,495	5,725	5,168
Dale	2,506	3,136	2,852	2,525	2,059
East Inman	746	495	593	560	444
Johnsonville	1,438	1,433	1,720	1,350	1,469
Loudon	12,628	13,356	14,925	14,125	12,612
New Harmony	5,252	5,246	5,333	5,100	4,310
Old Illinois (Bridgeport, Casey, and Robinson-Stoy)	12,225	12,483	11,275	11,150	11,030
Phillipstown	653	622	665	525	622
Roland	1,545	1,304	1,175	1,100	976
Sailor Springs	1,382	1,281	1,216	1,400	1,628
Salem	8,482	9,659	10,590	10,100	8,832
Other fields [2]	20,239	18,820	19,382	18,933	18,966
Total	77,341	76,818	78,796	74,796	70,168

[1] Based on "Oil and Gas Journal" data adjusted to Bureau of Mines total.
[2] Bureau of Mines figures.

Liquefied petroleum-gas output decreased approximately 7 percent in quantity and value. Production of natural gasoline decreased less than 6 percent in quantity and more than 4 percent in value. Estimated proved-recoverable reserves of natural-gas liquids totaled 3.2 million barrels on December 31, according to the American Gas Association.[5]

The Illinois State Geological Survey conducted a study to evaluate the petroleum possibilities in the Lower Ordovician and Cambrian rocks in the deeper part of the Illinois Basin.[6]

NONMETALS

Cement.—Four companies with plants in LaSalle, Lee, and Massac Counties produced portland and masonry cements. Shipments of portland cement increased over 5 percent in both quantity and value. Average value per barrel remained at $3.29. Total production of portland cement was over four-fifths of the annual finished portland cement capacity. More than 97 percent of production was of types I and II (general-use and moderate-heat); the remainder was high-early-strength and special-use types.

Sales to ready-mixed concrete companies accounted for approximately two-thirds of the total shipments. This was an increase of over 5 percent in quantity. Concrete-product manufacturers and highway contractors accounted for approximately 16 percent and 12 percent, respectively, of the shipments. Shipments to concrete-product manufacturers increased nearly 30 percent, but shipments to highway contractors decreased nearly 14 percent.

Sales of masonry cement increased by over 26 percent in quantity and about 42 percent in value. Average value per barrel increased to $3.42.

[5] Work cited in footnote 3.
[6] Bell, Alfred H., Elwood Atherton, T. C. Buschbach, and David H. Swann. Deep Oil Possibilities of the Illinois Basin. Illinois State Geol. Survey, Circ. 368, 1964, 38 pp.

Nearly 95 percent of shipments was in bulk; the remainder was in paper bags. About 59 percent of shipments was by truck, over 39 percent by rail and, except for minor quantities used at plant, the remainder by waterways.

Sixty-two percent of the portland cement and over 30 percent of the mansory-cement shipments were distributed within the State. Portland-cement shipments to Wisconsin accounted for over 14 percent of the State production. Nearly 32 percent of the masonry-cement shipments went to Wisconsin. Tennessee received nearly 8 percent of the shipments of portland cement and almost 29 percent of the masonry-cement shipments. Other shipments went to Alabama, Arkansas, Indiana, Iowa, Kentucky, Michigan, Minnesota, Mississippi, Missouri, and South Dakota.

Nearly 2.9 million tons of limestone was used for the manufacture of cement. Approximately 422,000 tons of other raw materials such as anhydrite, clay, gypsum, sand, shale, and slag was also consumed.

Over 274 million kilowatt hours of electrical energy was used. About three-eighths of this electrical energy was home-generated, and the remainder was purchased. All four plants used the dry process of production.

The Medusa Portland Cement Co. completed modernization of the raw-grinding department of its Dixon plant.

TABLE 6.—Finished portland cement produced and shipped

(Thousand 376-pound barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills	
			Quantity	Value
1955–59 (average)	4	9,084	8,814	$26,356
1960	4	9,270	8,770	29,321
1961	4	8,757	8,595	28,301
1962	4	9,081	9,145	30,205
1963	5	9,465	9,281	30,577
1964	4	9,978	9,790	32,191

Clays.—Total production of fire clay, fuller's earth, miscellaneous clay, and shale increased both in quantity and value. There was over a 20-percent decrease in fire-clay consumption and about a 5-percent decrease in miscellaneous clay and shale used in manufacturing heavy-clay products. Miscellaneous clay and shale consumption for lightweight aggregate decreased nearly 11 percent. Fire-clay consumption for refractories decreased less than 2 percent. The basis for the total clay-production increase was the nearly double output of miscellaneous clay and shale for cement.

Production was reported from 23 counties. Fire-clay production was reported by 10 companies in Grundy, LaSalle, McDonough, Marshall, Rock Island, and Scott Counties.

Fluorspar.—Illinois supplied 58 percent of the total domestic output of fluorspar to rank first among the seven fluorspar-producing States. Shipments decreased over 3 percent in quantity and 1 percent in value. Sales of acid-grade fluorspar decreased 9 percent but accounted for two-thirds of total sales. Sales of ceramic-grade fluorspar increased over 11 percent to represent 32 percent of total sales. Metallurgical-

grade fluorspar sales decreased to account for less than 2 percent of total sales.

Production of crude ore came from Hardin and Pope Counties. All finished fluorspar was produced in Hardin County. Over 423,000 tons of crude ore, a small quantity of which was mined in Kentucky, was processed to produce about 124,000 tons of finished fluorspar. Some byproduct lead and zinc concentrates also were produced.

Principal producers were Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co. The latter company lost about a half year of production because of a temporary shutdown in midyear followed by a strike at the company operations.

Gem Stones.—Specimens of glacial agates, fluorspar, and other minerals were obtained principally for private collections.

Lime.—Quicklime and hydrated-lime production increased by over 10 percent in quantity and 11 percent in value. About 57 percent of the output was for refractory use, 37 percent for chemical and industrial use, and over 5 percent for construction use. More than half of the State's shipments went to Indiana destinations. About one-third of the lime shipments were distributed within the State.

Perlite.—Eight companies with plants in Champaign, Cook, DeKalb, Kankakee, Lake, and Will Counties processed crude perlite from mines in the Western United States. Processed material sold or used increased slightly in quantity but decreased in value.

Use of processed perlite for roof insulation consumed nearly 70 percent of the total output. Filter-aid use consumed over 10 percent and concrete aggregate use nearly 9 percent of the total production.

Sand and Gravel.—Total production of sand and gravel increased nearly 10 percent in both quantity and value. Illinois ranked sixth in the Nation in quantity and fourth in value of sand and gravel produced. Production was reported in 79 counties from 248 commercial and 139 Government-and-contractor operations. Commercial operations accounted for over 95 percent of the total sales. Sand and gravel for paving use increased over 17 percent and for building use over 4 percent. These two uses represented 83 percent of the total sales. Sales of unground industrial sands for glass and molding use increased nearly 19 percent to represent over 7 percent of total sand and gravel sales. Nearly 90 percent of total shipments were by truck, almost 10 percent by rail, and less than 1 percent by water.

Production of over 1 million tons each in Grundy, Kane, Lake, LaSalle, McHenry, Peoria, Tazewell, Will, and Winnebago Counties represented over 62 percent of the total output from the State. Major producers were Chicago Gravel Co.; Consumers Co., Division of Vulcan Materials Co.; Crystal Lake Trucking & Excavating Co.; Elmhurst-Chicago Stone Co.; McGrath Sand & Gravel Co., Inc.; Material Service Division, General Dynamics Corp.; Moline Consumers Co.; Ottawa Silica Co.; Road Materials Corp.; and Wedron Silica Co.

Stone.—Total production consisted essentially of limestone, with only a small quantity of sandstone from Alexander County reported as used for refractory purposes. Stone production increased nearly 7 percent in quantity and over 8 percent in value. Approximately three-fourths of the production was used for concrete and roadstone; this represented an increase of nearly 9 percent over 1963 usage. Use

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	6,330	$5,732	6,527	$5,850
Paving	4,598	4,147	5,550	5,084
Glass (unground sand only)	1,431	3,400	1,609	3,295
Molding (unground sand only)	749	2,386	975	3,115
Ground [1]	181	1,901	202	2,224
Other [2]	2,210	3,699	2,039	2,811
Total	[3] 15,500	[3] 21,266	16,902	22,379
Gravel:				
Building	5,126	4,881	5,437	5,457
Paving	8,234	8,398	10,099	10,512
Railroad ballast	148	154	175	158
Fill	806	474	735	486
Other	244	193	121	102
Total	14,558	14,100	16,567	16,715
Total sand and gravel	30,058	35,366	33,469	39,094
Government-and-contractor operations:				
Sand:				
Building	[4]	[4]	2	1
Paving	299	163	325	177
Fill	10	5		
Total	309	168	327	178
Gravel:				
Paving	1,379	896	1,064	683
Fill			20	11
Total	1,379	896	1,084	694
Total sand and gravel	[3] 1,689	1,064	1,411	872
All operations:				
Sand	15,809	[3] 21,435	17,229	22,557
Gravel	15,937	14,996	17,651	17,409
Total	31,746	36,431	34,880	39,966

[1] Includes abrasive, chemical, enamel, filler, foundry, glass, pottery, porcelain, tile, and other ground sand.
[2] Includes blast, engine, fill, filtration, grinding and polishing, oil (hydrafrac), railroad ballast, and other construction and industrial sand.
[3] Data do not add to total shown because of rounding.
[4] Less than ½ unit.

for agricultural purposes decreased nearly 4 percent but still represented about 11 percent of the total production. Nearly 7 percent of the production was used in the manufacture of cement, an increase of almost 9 percent in quantity. Production of dimension stone increased nearly 11 percent.

Over 92 percent of the crushed and broken stone was shipped by truck, 6 percent by rail, and the remainder by water.

Illinois ranked second in the Nation in limestone and total stone production. Limestone production was reported from 59 counties. Sixty-three percent of the State total crushed and broken limestone production came from 10 counties—Cook, Hardin, Kankakee, La Salle, Lee, Livingston, Randolph, Rock Island, St. Clair, and Will. Each of these counties had more than 1 million tons of production. Production from Cook County represented nearly a third of the total State

TABLE 8.—Limestone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rubble—thousand short tons	2	$12	2	$18
Sawed—thousand cubic feet	W	W	W	W
House stone veneer—do	W	W	W	W
Flagging—do	9	8	W	W
Total—approximate thousand short tons [1]	5	117	5	141
Crushed and broken:				
Riprap—thousand short tons	283	404	586	860
Concrete aggregate and roadstone—do	29,105	37,356	31,615	41,524
Railroad ballast—do	344	353	370	390
Agriculture—do	4,841	7,053	4,661	6,904
Asphalt—do	119	471	[2]	[2]
Cement—do	2,665	2,044	2,895	2,235
Other [3]—do	2,930	4,413	2,854	4,492
Total—do	[4] 40,288	52,094	42,981	56,405
Grand total—do	[4] 40,292	52,211	42,986	[4] 56,547

W Withheld to avoid disclosing individual company confidential data; included in "Total."
[1] Average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.
[2] Included with "Other" to avoid disclosing individual company confidential data.
[3] Includes limestone for asphalt filler (1964), chemical uses, dust for coal mines, fertilizer, lime, metallurgical uses, mineral food, poultry grit, stone sand, whiting or whiting substitute, and other uses.
[4] Data do not add to total shown because of rounding.

production. Leading producers in the State were Columbia Quarry Co.; Consumers Co., Division of Vulcan Materials Co.; Dolese & Shepard Co.; Elmhurst-Chicago Stone Co.; Lehigh Stone Co.; Marquette Cement Manufacturing Co.; Material Service Division, General Dynamics Corp.; Medusa Portland Cement Co.; Rein, Schultz & Dahl, Inc.; and Solvay Process Div., Allied Chemical Corp.

Sulfur.—Shipments of elemental sulfur decreased nearly 4 percent in quantity and almost 7 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. used the Modified-Claus process to recover sulfur at its Lemont refinery in Will County.

Tripoli (Amorphous Silica).—Production of crude material decreased nearly 4 percent in quantity but increased slightly in value. Prepared material decreased in both quantity and value by less than 1 percent. Material was used for abrasives, filler, and other purposes. Production was reported from Alexander County by Ozark Minerals Co. and Tamms Industries Co.

Vermiculite.—Production of exfoliated vermiculite decreased over 4 percent in quantity and 7 percent in value. Plants of Zonolite Division, W. R. Grace & Co. in Cook County; Mica Pellets, Inc., in De Kalb County; and International Vermiculite Co. in Macoupin County processed crude material. Processed material was used primarily for insulation, concrete and plaster aggregate, and agricultural purposes.

METALS

Lead and Zinc.—Lead and zinc production, in terms of recoverable metals, decreased 25 and 32 percent, respectively, from 1963 quantities. Total value of lead decreased nearly 9 percent and of zinc almost 20 percent. Major producers of lead and zinc were The Eagle-Picher Co. 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 fluorspar operations. Lower fluorspar production was partly responsible for the decreased lead and zinc production.

Average weighted yearly prices used to calculate total values of lead and zinc production were 13.1 cents per pound for lead and 13.6 cents per pound for zinc. Prices in 1963 were 10.8 cents for lead and 11.5 cents for zinc.

The Eagle-Picher Co. completed repayment of an exploration-assistance contract for lead and zinc exploration in Jo Daviess County, Ill., and Lafayette County, Wis.

Pig Iron and Steel.—Almost 5.6 million short tons of pig iron, nearly a 23-percent increase from the 1963 total, was shipped from Illinois blast furnaces or consumed by producing companies. Total value was $322.1 million. Five companies operated blast furnaces in Chicago and Granite City. Of the 22 blast furnaces in the State, 6 were inactive the entire year, 11 were out of operation part of the year, and 5 operated throughout the year.

TABLE 9.—Mine production of silver, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Materials sold or treated [1] (short tons)	Silver		Lead		Zinc		Total value
			Troy ounces	Value	Short tons	Value	Short tons	Value	
1955–59 (average)	20	895,557	931	$843	3,105	$874,924	23,936	$5,665,403	$6,541,170
1960	22	1,015,581			3,000	702,000	29,550	7,623,900	8,325,900
1961	20	965,541			3,430	706,580	26,795	6,162,850	6,869,430
1962	17	970,900			3,610	664,240	27,413	6,304,990	6,969,230
1963	13	750,930			2,901	626,616	20,337	4,677,510	5,304,126
1964	14	537,141			2,180	571,160	13,800	3,753,600	4,324,760

[1] Data include fluorspar ore from which lead and/or zinc were recovered as follows: 1955—309,311 tons; 1956—336,635 tons; 1957—360,406 tons; 1958—401,526 tons; 1959—297,252 tons; 1960—380,395 tons; 1961—368,283 tons; 1962—399,742 tons; 1963—400,283 tons; and 1964—359,247 tons.

TABLE 10.—Mine production of lead and zinc in 1964, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	180	1,085	August	95	905
February	180	1,215	September	115	1,095
March	210	1,340	October	165	975
April	275	1,275	November	170	980
May	235	1,325	December	220	1,175
June	235	1,320			
July	100	1,110	Total	2,180	13,800

About 3.1 million short tons of iron ore was consumed in Illinois agglomerating plants. Approximately 82 percent of the iron ore was from domestic sources. Nearly 9.5 million tons of iron and manganiferous ores, sinter, and pellets was consumed in Illinois blast furnaces. The blast-furnace consumption included over 4.2 million tons of iron and manganiferous ores, about 3.8 million tons of sinter, and over 1.4 million tons of pellets. All but a fractional percent of the material was from domestic sources.

In addition, approximately 1.7 million tons of limestone and dolomite was consumed in Illinois agglomerating plants and blast furnaces. Nearly 4.0 million tons of coke was consumed in Illinois blast furnaces. Data for nonintegrated steel plants are not included.

According to the American Iron & Steel Institute, steel production in Illinois increased nearly 14 percent to 10,503,592 short tons.

Other Metals.—The American Potash & Chemical Corp. at West Chicago manufactured refined thorium compounds, yttrium, and other rare earths from monazite. American Zinc Co. recovered cadmium and germanium as a byproduct of zinc refining at its Fairmont plant.

REVIEW BY COUNTIES

Mineral production in 1964, excluding liquid fuels and natural gas, was reported in 94 of the 102 counties. Of this group, Cook County led in value of mineral output with $32.3 million. Franklin, Fulton, La Salle, St. Clair, and Williamson each reported mineral production values of over $20 million. Other leading counties with mineral-output values exceeding $10 million were Christian, Hardin, Jefferson, Lee, Perry, and Saline. Total reported value of mineral production increased in 66 counties and decreased in 31 counties, compared with 1963 values.

TABLE 11.—Value of mineral production in Illinois, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Adams	$2,057,686	$1,911,499	Stone, lime, coal, sand and gravel.
Alexander	221,444	246,325	Tripoli, sand and gravel, stone.
Bond	217,795	352,000	Sand and gravel, clays.
Boone	150,997	339,328	Stone, sand and gravel.
Brown	78,274	W	Clays, sand and gravel.
Bureau	2,293,975	1,543,332	Coal, sand and gravel.
Calhoun	41,400	W	Stone, sand and gravel.
Carroll	249,590	307,049	Do.
Cass	3,327	2,000	Sand and gravel.
Champaign	360,329	450,000	Do.
Christian	W	W	Coal, stone.
Clark	647,492	726,917	Stone, sand and gravel.
Clay	149,250	W	Stone.
Clinton	W	W	Stone, sand and gravel.
Coles	684,773	W	Do.
Cook	30,373,014	32,342,102	Stone, lime, sand and gravel, clays, peat.
Crawford	W	W	Sand and gravel.
Cumberland	W	W	Do.
De Kalb	485,337	506,782	Sand and gravel, stone.
De Witt	W	W	Sand and gravel.
Douglas	W	W	Coal, stone.
Du Page	W	W	Stone, sand and gravel.
Edgar	2,195	----------	
Fayette	333,011	212,845	Stone, sand and gravel, clays.
Ford	156,940	244,000	Sand and gravel.
Franklin	W	W	Coal, sand and gravel.
Fulton	25,443,282	29,702,022	Do.
Gallatin	W	404,223	Sand and gravel, coal.
Greene	501,635	436,659	Stone, clays, coal.
Grundy	4,425,571	5,378,853	Sand and gravel, coal, clays.

See footnotes at end of table.

TABLE 11.—Value of mineral production in Illinois, by counties—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Hancock	$413,592	$407,539	Stone.
Hardin	10,218,920	10,648,425	Fluorspar, zinc, stone, lead, sand and gravel.
Henderson	349,508	460,040	Stone, sand and gravel.
Henry	580,478	573,448	Coal, stone, sand and gravel.
Iroquois	W	W	Sand and gravel.
Jackson	4,660,976	W	Coal, stone, sand and gravel.
Jefferson	W	W	Coal, stone.
Jersey	221,903	269,331	Stone, sand and gravel.
Jo Daviess	3,107,295	1,773,215	Zinc, stone, sand and gravel, lead.
Johnson	1,279,250	1,140,645	Stone.
Kane	2,782,137	2,542,457	Sand and gravel, stone, peat.
Kankakee	2,072,334	W	Stone, clays, sand and gravel.
Kendall	289,100	358,428	Stone, sand and gravel.
Knox	W	W	Coal, stone, clays, sand and gravel.
Lake	838,141	925,679	Sand and gravel, clays, peat.
La Salle	33,263,700	29,670,332	Cement, sand and gravel, stone, clays.
Lawrence	243,563	383,000	Sand and gravel.
Lee	W	W	Cement, stone, sand and gravel, clays.
Livingston	2,283,858	2,494,052	Stone, clays, sand and gravel.
Logan	691,954	776,115	Sand and gravel, stone, coal.
McDonough	W	W	Stone, clays.
McHenry	3,022,075	3,503,360	Sand and gravel, stone.
McLean	W	578,000	Sand and gravel.
Macon	W	W	Do.
Macoupin	1,098,403	1,414,635	Coal.
Madison	3,994,487	2,112,849	Stone, coal, sand and gravel.
Marion	W	W	Stone, sand and gravel.
Marshall	275,592	304,302	Sand and gravel, clays.
Mason	W	19,000	Sand and gravel.
Massac	W	W	Cement, sand and gravel, stone.
Menard	W	W	Stone, coal, clays.
Mercer	522,368	527,947	Coal, stone, clays.
Monroe	W	W	Stone.
Montgomery	W	W	Coal, stone, sand and gravel.
Moultrie		12,000	Sand and gravel.
Ogle	1,822,627	2,146,106	Sand and gravel, stone.
Peoria	7,194,309	8,567,567	Coal, sand and gravel, stone.
Perry	W	W	Coal.
Piatt	W		
Pike	635,028	761,011	Stone, sand and gravel.
Pope	4,982	3,000	Sand and gravel, fluorspar.
Pulaski	W	W	Stone, clays, sand and gravel.
Putnam	79,048	9,000	Sand and gravel.
Randolph	7,736,701	9,227,599	Coal, stone, sand and gravel.
Richland	537		
Rock Island	2,181,000	2,177,850	Stone, sand and gravel, clays.
St. Clair	23,425,360	24,692,686	Coal, stone, sand and gravel, clays.
Saline	14,264,976	15,043,450	Coal sand and gravel.
Sangamon	1,146,579	1,253,170	Sand and gravel, coal, clays.
Schuyler	W	W	Coal, stone, sand and gravel.
Scott	233,803	231,848	Stone, clays, sand and gravel.
Shelby	W	W	Stone, sand and gravel.
Stark	W	W	Coal, sand and gravel.
Stephenson	338,684	489,776	Stone, sand and gravel.
Tazewell	1,241,035	1,173,000	Sand and gravel, clays.
Union	1,196,885	1,264,140	Stone, sand and gravel.
Vermilion	6,307,652	6,323,395	Coal, stone, clays, sand and gravel.
Wabash	191,267	169,517	Sand and gravel, coal.
Warren	146,273	W	Stone.
Washington	W	525,744	Stone, coal.
Wayne	W	W	Sand and gravel.
White	185,783	234,000	Do.
Whiteside	338,055	552,092	Stone, peat, sand and gravel.
Will	6,629,559	8,162,042	Sand and gravel, coal, stone.
Williamson	24,270,859	24,554,770	Coal.
Winnebago	2,154,263	2,460,543	Sand and gravel, stone.
Woodford	W	W	Sand and gravel.
Undistributed [2]	r 344,149,784	345,112,959	
Total	r 586,962,000	591,136,000	

r Revised. W—Withheld to avoid disclosing individual-company confidential data.

[1] Data for petroleum, natural gas, and natural-gas liquids are not available on a county basis; however, values for these commodities are included with "Undistributed." Edwards, Effingham, Hamilton, Jasper, and Morgan Counties are not listed because no production was reported.

[2] Includes value for petroleum, natural gas, natural-gas liquids, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

Adams.—Limestone from three underground mines and six quarries was produced for various uses. Black White Limestone Co.; Marblehead Lime Co., Division of General Dynamics Corp.; and Menke Stone & Lime Co. operated stationary plants in connection with their underground mines. Missouri Gravel Co. operated portable plants at the Reinebach, Richfield, and Shoomaker quarries. Western Illinois Stone Co. operated portable plants at its No. 7 No. 8, and No. 9 quarries. Marblehead Lime Co. and Menke Stone & Lime Co. also produced quicklime and hydrated lime near Quincy.

Blick's Sand Co. and Quincy Sand Co. produced sand and gravel near Quincy. Output was for building, paving, and fill uses. Blick's Sand Co. operated a portable plant and Quincy Sand Co. operated a stationary plant.

The Triple S Mines, Inc., produced coal from a strip mine near Augusta for local consumption. Approximately half of the 28,100 tons of production was cleaned by jigging.

Alexander.—Tripoli (amorphous silica) was produced by Ozark Minerals Co. and Tamms Industries Co. from underground mines near Elco and Tamms. Prepared material was used for abrasives, filler, and other uses. Sand and gravel was produced for building, paving, fill, and railroad ballast by the dredge operation of H. H. Halliday Sand Co. near Cairo. Paving gravel was produced by the county highway department.

Sandstone was mined by the Western Fire Brick Co., Division of A. P. Green Fire Brick Co., from an underground mine near Elco. The material was shipped by rail to the company plant at Granite City for processing into refractory material.

Bond.—Sand and gravel was produced by Greenville Gravel Co., Inc., Munie Gravel Pit, and Pruitt Sand Pit. Munie Gravel Pit operated both stationary and portable plants near Keyesport. Greenville Gravel Co., Inc., and Pruitt Sand Pit operated stationary plants near Greenville. Material was used for building, paving, fill, and other uses. Clay was produced near New Douglas by the Richards Brick Co. for building brick manufactured at its plant near Edwardsville, Madison County. The Bond Stone Co. near Sorento was reported idle throughout the year.

Brown.—Frederic Brick & Tile Co. produced shale near Mt. Sterling for use in the manufacture of draintile. The Brown County Stone Co. and Missouri Gravel Co. limestone quarries were idle throughout the year.

Bureau.—The Midland Electric Coal Corp. produced coal from a strip mine near Mineral and treated it at the company plant in Henry County. About a fourth of the production was thermally dried. Shipments were primarily by rail. The mine was closed down for the last half of the year.

Nine commercial operators, the county highway department, and contract operators for the State and county highway departments produced sand and gravel for building, paving, and fill purposes. Production was from both stationary and portable plants. The Sheffield sand and gravel operation of the Material Service Division of General Dynamics Corp. was idle in 1964. Wyanet Sand & Gravel

Co. went out of business during the year. New Jersey Zinc Co. operated its zinc smelter at Depue.

Champaign.—Ryolex Corp. expanded crude perlite at its Champaign plant from ore mined in New Mexico. Approximately 492,000 tons of sand and gravel was produced by four companies and Government contractors for building, paving, fill, and other uses.

Christian.—Peabody Coal Co. mined coal at its No. 10 underground mine near Pawnee. The mine was the largest producer of bituminous coal in the United States. The county was second in underground production and fifth in total output in the State. Over 96 percent of the total output was shipped by rail. Forty-seven percent of the coal was cleaned by jigging.

Tri-County Stone Co. produced limestone for concrete aggregate, roadstone, and agricultural uses.

Clark.—Crushed limestone was produced by Casey Stone Co. from two quarries near Casey and by Quality Lime Co., Inc., from a quarry near Marshall for concrete aggregate, roadstone, and agricultural uses. All plants were stationary.

Sand and gravel was produced at the portable operation of C. & E. Materials, Inc., near Westfield, and at stationary plants of Lawrence Sand & Gravel near West Union and Marshall Gravel Co. near Marshall. Output was for building, paving, and other uses.

Coles.—Crushed limestone was produced by Olen Humphres Stone Quarry and Charleston Stone Co. near Ashmore and Charleston, respectively. The Charleston Stone Co. purchased the Olen Humphres Stone Quarry in midyear. Material was used for concrete aggregate, roadstone, and agricultural purposes.

Sand and gravel was produced by the Olen Humphres Stone Quarry from a portable plant near Charleston for use as paving and fill material. The Mattoon Sand & Gravel Co. produced sand and gravel from a stationary plant near Mattoon for building, paving, and fill uses.

Cook.—Mineral production value increased to over $32.3 million. This was the highest county value of mineral output (excluding liquid fuels and natural gas) in the State. Limestone led in quantity and value with over 13.3 millions tons and $16.8 million. Producers were Consumers Company, Division of Vulcan Materials Co., with quarries near Hillside, Lemont, and McCook; Dolese & Shepard Co. with a quarry near Hodgkins; R. P. Donohoe Co., Inc., with a quarry near Lemont; and Material Service Division of General Dynamics Corp. operating quarries near Chicago, Lyons, McCook, and Thornton. Processed material was used as concrete aggregate, roadstone, metallurgical flux, railroad ballast, agricultural limestone, lime, and refractory material.

Lime was produced by two companies operating three plants. Marblehead Lime Co. produced quicklime and hydrated lime at plants in South Chicago and Thornton for construction, refractory, chemical, and industrial uses. Standard Lime & Cement Co., Division of Martin Marietta Corp., produced quicklime at its operation near McCook for refractory use.

Approximately 882,000 tons of sand and gravel was produced for building, paving, and fill purposes by five companies: Chicago Gravel Co. operating the Hammonds plant near Elgin; Doetsch Bros. near

Glenview; Material Service Division of General Dynamics Corp. near Wheeling; Road Materials Corp. near Arlington Heights; and Worth Sand & Gravel Co., Inc., near Worth.

Brisch Brick Co. near Stickney; Carey Brick Co. near Chicago; Chicago Brick Co. near Riverdale; and Illinois Brick Co. near Blue Island produced over 300,000 tons of miscellaneous clay for use in manufacturing building brick.

Humus peat was mined near Barrington by Henry Frenzer, Inc. Material was sold in bulk for soil conditioning.

Blast and steel furnaces and coke-oven plants were operated in the South Chicago area. The following were pig-iron producers: Interlake Iron Corp.; Republic Steel Corp.; United States Steel Corp.; and Wisconsin Steel Division, International Harvester Co. Steel-producing companies included Acme Steel Co.; Borg-Warner Corp.; Ceco Steel Products Corp.; Finkl & Sons Co.; H. M. Harper Co.; International Harvester Co.; Republic Steel Corp.; and United States Steel Corp.

The American Potash & Chemical Corp. manufactured refined-thorium compounds from monazite concentrate at West Chicago. The company also produced rare-earth compounds.

Research Sales Division of ITT Bell & Gossett, Inc., at its Dolton plant, and Silbrico Corp. at its Chicago plant produced expanded perlite mined in California and New Mexico, respectively. Finished material was used as building plaster, concrete aggregate, filter aid, loose-fill insulation, paint texture and soil conditioner.

Zonolite Division, W. R. Grace & Co., produced exfoliated vermiculite at its Franklin Park plant for agricultural purposes, concrete and plaster aggregate, and loose-fill insulation. U.S. Mica Co., Inc., produced ground mica at its Forest Park plant from crude mica mined in South Dakota.

De Kalb.—About 357,000 tons of sand and gravel was produced for building, road construction, and fill. Six companies reported production near Cortland, Kingston, Millington, Sycamore, and Waterman. The county and State highway departments contracted for road-construction gravel. Crushed limestone for roadstone and agricultural purposes was produced by two companies near Cortland and Fairdale. Mica Pellets, Inc., produced exfoliated vermiculite and expanded perlite at its De Kalb plant.

Douglas.—Moffat Coal Co. produced coal from its underground mine near Murdock. Nearly 70 percent of the output was shipped by rail. The entire production was cleaned by jigs, and approximately 35 percent was thermally dried.

Material Service Division of General Dynamics Corp. produced limestone from an underground mine near Tuscola. The mine will be used as an off-season storage cavern for gas.

Du Page.—Elmhurst-Chicago Stone Co. produced crushed limestone from its stationary plant near Elmhurst for concrete aggregate, roadstone, and agricultural uses. The company also produced sand and gravel from its stationary plants near Bartlett and Warrenville for building and road purposes.

Fayette.—Crushed limestone was produced chiefly for roadstone and agricultural uses by Winter Stone Quarry at its stationary plant near Ramsey. Sand and gravel was produced by three companies operating

stationary plants near Hagarstown, Mulberry Grove, and Vandalia. The material was used for building, road construction, fill, and molding sand. Diller Shale Products Co. produced miscellaneous clay for use in manufacturing heavy-clay products at its St. Elmo plant. The company installed new grinding equipment.

Franklin.—Coal was produced by Freeman Coal Mining Corp. from its Orient No. 5 underground mine near Benton and by Old Ben Coal Corp. from its No. 9 and No. 21 underground mines near West Franklin and Sesser, respectively. The Old Ben Coal Corp. No. 21 ranked as the eighth bituminous-coal producer in the Nation. Production increased approximately 13 percent to over 5.9 million tons. The output was treated at three plants by heavy media, jigging, and pneumatic methods. Thermal drying was also utilized. Ninety-eight percent of the production was shipped by rail. The State highway department contracted for paving sand.

Fulton.—Coal production increased over 18 percent to 7.4 million tons. The county ranked first in coal production and second in value of minerals produced in the State. Eight strip mines accounted for the production. Coal was cleaned at seven plants. Of the total production, 65 percent was shipped by rail, 28 percent by water, and the remainder by truck. Peabody Coal Co. took over operation at the Flamingo mine of Fairview Collieries Corp. near Fairview.

Sand and gravel production was reported by three companies: Duck Island Sand & Gravel Co. near Canton; Holle Building Service Co. near Enion; and Otter Creek Sand & Gravel Co. near Havana. Material was used for building, road construction, fill, and other purposes. The State and county highway departments contracted for paving gravel.

Gallatin.—Total coal production increased 15 percent from two underground mines near Junction and Sparks Hill and one strip mine near Carrier Mills. The Leamington Coal Co. opened a new strip mine but closed down later in the year. About 83 percent of the county production was shipped by water and most of the remainder by truck.

Sand and gravel was produced by Delta Materials Co. near Shawneetown from a dredging operation. Output was used as road-construction material. The county highway department produced some sand and gravel for their own use. The State highway department contracted for paving sand and gravel.

Greene.—Crushed limestone was produced by two companies from three operations near Hillview and Kane. Output was for roadstone, riprap, and agricultural purposes. American Vitrified Products Co. produced miscellaneous clays for use in manufacturing vitrified sewer pipe.

Birch Creek Coal Co. produced coal near Roodhouse for local consumption.

Grundy.—Coal was produced by Peabody Coal Co. from a strip mine near Wilmington. Output increased about 6 percent. The mine extends into Kankakee and Will Counties, but additional production was reported only from Will County. About 60 percent of the production was shipped by truck and the remainder by railroad. The coal was processed in the company plant in Kankakee County.

Sand and gravel was produced by Material Service Division of General Dynamics Corp. near Morris. Output increased substantially and was used for building and road construction. The State highway department contracted for paving gravel.

Illinois Clay Products Co. produced 99,000 tons of plastic fire clay near Coal City for use in manufacturing refractories.

Hardin.—Shipments of finished fluorspar decreased over 3 percent in quantity and 1 percent in value. Major producing companies were Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co. Each of these companies produced lead and zinc concentrates in addition to fluorspar. Aluminum Company of America operated its Fairview-Blue Diggings mine. Minerva Oil Co. operated the Crystal Group and No. 1 mines and mills. Minerva Oil Co. installed a heavy medium separation plant and finished its pellet plant. Part of the Crystal Group was idle during the year. Ozark-Mahoning Co. operated the Mahoning, Hill-Ledford, Deardorff, and North Green mines. The company was on strike for approximately half the year. Rosiclare Lead & Fluorspar Mining Co. and Tamora Mining Co. sold stockpiled fluorspar. Several other companies sold crude material from stockpiles for processing in Illinois and Kentucky. A small amount of crude ore mined in Kentucky was processed in Illinois.

Crushed limestone for riprap, road construction, agricultural purposes, and cement manufacture was produced. Operators were Bob Barnett near Rosiclare; Denny & Simpson Stone Co. near Elizabethtown; Missouri Portland Cement Co. and Rigsby & Bernard Quarry near Cave-in-Rock; and Williams Quarry near Rosiclare. The county highway department produced paving gravel.

Henry.—The Shuler Coal Co. produced coal from an underground mine near Alpha. Production was 31 percent less than in 1963. Shipments were mainly by railroad.

Limestone was produced near Cleveland by Cleveland Quarry, Inc., for roadstone. Sand and gravel was produced by Collinson Bros., Oberlaender Sand Co., and Schadt Service Co. near Kewanee, Colona, and Cleveland, respectively. Output was for building, paving, fill, and foundry use.

Jackson.—Coal production increased over 10 percent from the 1963 figure to approximately 1.4 million tons. Three companies contributed to the output. Truax-Traer Coal Division, Consolidation Coal Co., Inc., accounted for most of the production from the Burning Star No. 1 strip and slope mines near Elkville. The slope mine was reopened in midyear after nearly a 3-year shutdown. The entire output from these mines was cleaned at the company plant in Perry County. Fabco, Inc., formerly Farley Bros. Coal Co., produced coal from a strip mine near De Soto. Elk Coal Co. operated an underground coal mine near Elkville but went out of business in midyear. Most of the shipments from county producers of coal were by railroad.

Illinois Quarry Co. near Ava produced crushed limestone for roadstone, railroad ballast, and agricultural purposes.

Sand was produced by Lawder Sand Co. from their dredging operation near Grand Tower for building, road construction, and fill.

Jefferson.—Coal was produced by Freeman Coal Mining Corp. from the Orient No. 3 underground mine near Waltonville and by Belle

Rive Mining Co., Inc., from a strip mine near Belle Rive. The Orient No. 3 mine was ranked as the 12th largest bituminous-coal producer in the Nation. The Belle Rive operation ceased activity early in the year. Output from the county decreased nearly 7 percent from the 1963 total. Most of the shipments were by railroad.

Randall Stone Co. produced limestone near Mt. Vernon for roadstone and agricultural purposes.

Jo Daviess.—Production of lead and zinc decreased substantially. The Eagle-Picher Co. operated the Graham Group and the O'Rourke mine. The O'Rourke mine operated only in January. Ore was concentrated at the Graham mill. An important factor in the decrease of production was the closing of Tri-State Zinc, Inc., operations in 1963.

About 472,000 tons of crushed limestone was produced for roadstone, railroad ballast, and agricultural purposes by six companies. Producers included Broege Limestone Co.; Rees Construction Co.; Rein, Schultz & Dahl, Inc.; Eugene Schamberger; Elmer Wienen & Sons Co.; and Willowa Engineering Co.

Dubuque Sand & Gravel Co. produced sand and gravel near East Dubuque for building and fill.

Johnson.—About 877,000 tons of crushed limestone was produced at stationary plants operated by Charles Stone Co. near Cypress; Ramona Stone Co. near Goreville; and Southern Illinois Stone Co. near Buncombe.

Kane.—Nearly 2.7 million tons of sand and gravel was produced by 10 companies operating portable and stationary plants near Algonquin, Big Rock, Dundee, Elgin, Hampshire, Montgomery, North Aurora, and St. Charles. The material was used for building, paving, fill, and other purposes.

Conco-Western Stone Co., Fox River Stone Co., and Elmer Larson, Inc., produced limestone near North Aurora, Elgin, and Big Rock for concrete aggregate, roadstone, agricultural use, rubble, architectural stone, and flagging.

Batavia Soil Builders produced reed-sedge peat near Batavia for soil conditioning. Material was sold in bulk form.

Natural red-iron-oxide pigments were produced by George B. Smith Chemical Works, Inc., at its plant at Maple Park.

Kankakee.—Crushed limestone was produced by Lehigh Stone Co. near Kankakee and Manteno Limestone Co. near Manteno for concrete aggregate, roadstone, railroad ballast, and agricultural purposes.

Clay was produced for heavy-clay products by Eastern Illinois Clay Co. near St. Anne, Kankakee Clay Products Co. near Kankakee, and St. Anne Brick & Tile Co. near St. Anne.

Peabody Coal Co. did not produce from the portion of its Northern Illinois coal mine in the county. Coal from portions of the mine in Grundy and Will Counties was cleaned at the company preparation plant near South Wilmington.

Perlite was expanded for use in acoustical tile by U.S. Perlite Corp. at its Momence plant from crude material mined in New Mexico.

Sand for paving and railroad ballast was produced by the Kankakee Bank Sand Co. near Kankakee.

Knox.—Coal was produced by Midland Electric Coal Corp. from the Middle Grove strip mine near Farmington and the Mecco strip

mine near Victoria. Coal from the Middle Grove mine was processed at the company plant in Fulton County. Output from the Mecco mine was processed at the plant at the mine site. Over 99 percent of the shipments was by railroad and the remainder was by truck.

Abingdon Rock Co. produced limestone near Abingdon for roadstone and agricultural purposes.

Alton Brick Co. produced shale near East Galesburg for manufacturing building brick.

Lawrence Downin produced gravel near London Mills for paving use. Knox County Gravel Co. did not operate during the year. The county highway department contracted for paving gravel.

Briggs Manufacturing Co. produced ground feldspar at its Abingdon plant from crude material mined by the company in South Dakota. The ground material was used in manufacturing pottery.

Lake.—Nearly 1.3 million tons of sand and gravel was produced by eight companies operating stationary and portable plants near Antioch, Barrington, Gurnee, Half Day, Libertyville, Prairie View, Wadsworth, and Wauconda. Production increased about 10 percent from that of 1963. Output was used for building, paving, fill, and other purposes. The State and county highway departments contracted for paving sand and gravel.

Clay was produced by the National Brick Co. near Deerfield. Total output of over 33,000 tons was used in manufacturing building brick.

National Gypsum Co. manufactured gypsum products at its Waukegan plant from crude material mined by the company in Michigan. The company also expanded perlite for use as building plaster. Filter Materials Corp. produced expanded perlite at its Lake Zurich plant. Finished material was used as a filter aid. Crude material was mined in Arizona.

Joseph W. Grenus Excavating & Trucking and Marvin J. Walker reported production of moss peat near Millburn and Lake Villa, respectively, for use in general soil improvement.

La Salle.—Total value of mineral production in the county decreased 11 percent to less than $30 million. Alpha Portland Cement Co. and Marquette Cement Manufacturing Co. produced portland and masonry cements near La Salle. Each company produced limestone and miscellaneous clay or shale for use in manufacturing cement. Shipments of cement went to consumers in Illinois, Indiana, Iowa, Missouri, and Wisconsin.

Crushed limestone was produced for concrete aggregate, roadstone, and agricultural purposes by H. & F. Stone Co. (formerly Beardsley Stone Co.) near Sheridan; Marquette Cement Manufacturing Co. near Oglesby; Troy Grove Stone Co. near Troy Grove; and Utica Stone Co. near Utica. The Utica Stone Co. operated its quarry only part of the year.

Over 3.8 million tons of sand and gravel was produced by 13 companies at 16 operations. Total production increased over 7 percent. Output was used for building, paving, railroad ballast, fill, and industrial purposes. Producers of industrial sands included American Silica Sand Co., Inc., near Utica; Arrowhead Silica Corp. near Troy Grove; Bellrose Silica Co. and Ottawa Silica Co. near Ottawa; and Wedron Silica Co., Wedron. Pure Silica Co. continued construction

on its silica-sand plant near Troy Grove. First production was expected early in 1965.

Illinois Valley Minerals Co. and La Salle Canyon Quarry produced plastic fire clay for use in manufacturing refractories. Hydraulic-Press Brick Co. and Ristokrat Clay Products Co. mined plastic fire clay for use in manufacturing building brick. Material Service Division of General Dynamics Corp. produced shale for use in manufacturing lightweight aggregate.

Lee.—Medusa Portland Cement Co. produced portland and masonry cements at its Dixon plant. Limestone and clays were mined by the company for use in manufacturing cement.

Crushed limestone was also produced by Frank N. Butler Co.; Oregon Stone Quarries; Laurde Renner Limestone Co.; Stoneridge Limestone Co.; and Wastone, Inc. Plants were operated near Ashton, Dixon, Lee Center, and Steward. Material was used for road construction and agricultural purposes.

Sand and gravel production increased nearly 9 percent to 251,000 tons. Output was used for building, road construction, engine sand, and fill. Producing companies included: C. C. Macklin near Steward; Nelson Sand & Gravel Co. near Nelson; and Rock River Ready Mix, Inc., near Dixon.

Livingston.—Crushed limestone was produced near Chenoa and Pontiac by Chenoa Stone Co., Livingston Stone Co., Ocoya Stone Co., Pontiac Stone Co., and Wagner Stone Co. Output of about 1.4 million tons was for road construction, agricultural use, riprap, and asphalt filler.

Miscellaneous clay or shale was produced by Diller Tile Co., Inc., Hydraulic-Press Brick Co., and Streator Clay Pipe Co. for use in manufacturing building brick, vitrified sewer pipe, and other heavy clay products.

Howard Arnold Construction Co., Rowe Construction Co., and Valley View Dirt & Gravel Co. produced sand and gravel for building, road construction, and fill. The State highway department contracted for paving sand.

Logan.—Coal was mined by Logan County Coal Mine, Inc., from an underground mine near Lincoln. Output was sold for local consumption.

Crushed limestone for road construction and agricultural use was produced by Rocky Ford Limestone Co. near Lincoln.

Allsopp's Sand & Gravel; Chestnut Sand & Gravel; R. A. Cullinan & Son, Inc.; and The Lincoln Sand & Gravel Co. produced sand and gravel for building, road construction, engine sand, and fill.

McDonough.—Plastic fire clay, stoneware clay, and miscellaneous clay was produced near Colchester by Booz & Co., Colchester Brick & Tile Co., and Martin's Clay Pits. Material was used in manufacturing building brick, draintile, refractory products, and artware. Ceramics, Inc., did not operate its clay pits in 1964.

Crushed limestone was produced near Colchester by Colchester Stone Co. and McClure Quarries, Inc., for riprap, roadstone, and agricultural use.

McHenry.—Approximately 4.3 million tons of sand and gravel was produced by 14 companies and the county highway department. This

represented an increase of about 9 percent from 1963 production. Output was used for building and road construction, railroad ballast, and fill. Plants were operated near Alden, Algonquin, Cary, Crystal Lake, Huntley, Island Lake, Marengo, McHenry, and Woodstock. The State highway department contracted for paving material. Garden Prairie Stone Co., Inc., operated a portable plant near Marengo to produce limestone for flagging, roadstone, and agricultural use.

Macoupin.—Approximately 374,000 tons of coal was produced by Little Dog Coal Co. from an underground mine near Gillespie. The entire output was mechanically cleaned. About 79 percent of the total production was shipped by rail and nearly all the remainder by truck. International Vermiculite Co. produced exfoliated vermiculite at its Girard plant. Material produced was used chiefly for insulation.

Madison.—Coal was produced from underground mines by Livingston-Mt. Olive Coal Co. and Lumaghi Coal Co. Most of the output was shipped by truck for local consumption. Operations of both companies were abandoned early in the year.

C. M. Lohr, Inc., Mississippi Lime Co., and Reliance Whiting Co. produced limestone near Alton and Godfrey for riprap, roadstone, and agricultural use. Mississippi Lime Co. operated an underground mine; the others operated quarries. Paving sand was produced by C. E. Barker Trucking Service at a stationary plant near Granite City. Mississippi Lime Co. operated a portable plant near Alton and produced sand and gravel for building, road construction, engine sand, and other uses. The State highway department contracted for paving sand.

Sulfur was recovered by the Anlin Company of Illinois using the 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. Laclede Steel Co. produced steel in open-hearth furnaces at Alton.

Marion.—Marion County Coal Mining Corp. abandoned its underground mine near Centralia at the start of the year.

Shoots Stone Quarry operated a stationary plant near Iuka to produce limestone for roadstone, agricultural use, and riprap. The county highway department contracted for paving sand and gravel.

Marshall.—About 275,000 tons of sand and gravel was produced by Vernon Henry near La Rose and Wilson's Gravel Co. near Lacon for use as paving material and fill. Portable plants were operated by both companies. In addition, the county highway department contracted for 1,000 tons of paving gravel. Elmer Larson, Inc., and Princeville Stone Co. ceased operations. Hydraulic-Press Brick Co. produced plastic fire clay near Sparland for use in manufacturing building brick.

Massac.—Missouri Portland Cement Co. produced portland and masonry cements near Joppa. Limestone for the plant was quarried and crushed near Cave-in-Rock, Hardin County, and then barged on the Ohio River to the plant.

Crushed limestone for roadstone and agricultural uses was produced near Karnak by Columbia Quarry Co. Sand and gravel for building construction and fill was produced by Delta Materials Co.

near Joppa and by Federal Materials Co. and Metropolis Ready Mix Concrete Co. near Metropolis. Massac and Pope County highway departments produced gravel for road construction. The State highway department contracted for road-construction gravel.

Menard.—An underground coal mine near Petersburg was operated by New Salem Mining Corp. Shipments were all by truck.

Limestone for roadstone, agricultural purposes, and riprap was produced near Athens by Athens Stone Quarry and D–P Indian Point Limestone Products, Inc. Petersburg Clay Products Co., Inc., produced clay near Petersburg for use in manufacturing building brick.

Mercer.—About an 18-percent decrease in coal production to approximately 52,000 tons of coal was reported from the county. Hazel Dell Coal Corp. operated an underground mine near New Windsor, and Viola Materials, Inc., operated a strip mine near Viola. About 80 percent of the production was shipped by rail and the remainder by truck.

Crushed limestone was produced near Viola by Mercer County Stone & Coal Co. and Viola Materials, Inc., for use in road construction. Both companies operated stationary plants. Hydraulic-Press Brick Co. produced shale near Aledo for use in manufacturing building brick. The State highway department contracted for gravel for use in road construction.

Monroe.—Columbia Quarry Co. produced limestone from its underground mine near Valmeyer. Material was used for metallurgical work, roadstone, agricultural purposes, asphalt filler, dust for mines, and mineral food.

Montgomery.—About 2.1 million tons of coal was produced from two underground mines. Freeman Coal Mining Corp. operated its Crown mine near Farmersville, and Truax-Traer Coal Division Consolidation Coal Co., Inc., reported initial production from its Hillsboro mine near Coffeen. This operation is part of the State's first "mine-mouth" coal-by-wire complex. Production was shipped by conveyor from the mine to the electric-generating powerplant. Most of Freeman Coal Mining Corp. production was shipped by rail.

Four companies produced a total of 747,000 tons of crushed limestone from quarries near Litchfield and Nokomis. Output was used for riprap, roadstone, and agricultural purposes. The State highway department contracted for paving sand.

Ogle.—Approximately 841,000 tons of sand and gravel was produced by four companies near Forreston, Kings, and Oregon. Production was 22 percent greater than in 1963. Material was used for building, road construction, railroad ballast, fill, and industrial sands. Operators were McGrath Sand & Gravel Co., Inc.; C. C. Macklin; Manley Sand Division of Martin Marietta Corp.; and Floyd Weigle. Byron Material Service reported no sand-and-gravel production during the year.

Eight companies produced 538,000 tons of crushed limestone for use as roadstone, agricultural purposes, and other uses. Quarries were located near Byron, Leaf River, Monroe Center, Mount Morris, Oregon, Polo, Rochelle, and Stillman Valley.

Peoria.—Over 1.1 million tons of coal was produced, nearly 19 percent more than in 1963. Two underground mines and four strip mines

reported production. Producers were Big Bear Coal Co.; Layne's Coal Co.; Peabody Coal Co.; Sherwood-Templeton Coal Co., Inc.; The United Electric Coal Cos.; and Zaborac Coal Co.

Sand and gravel was produced by five companies for building, road construction, railroad ballast, fill, and other uses. Over 1.6 million tons were produced at plants located near Chillicothe, Kickapoo, Peoria, and Pottstown. The sand-and-gravel operation of Peoria Concrete Construction Co. was idle during the year. About 665,000 tons of crushed limestone was produced by three companies near Princeville for road construction and agricultural purposes.

Perry.—Over 4 million tons of coal was produced by three companies operating strip mines near Cutler and DuQuoin. Producers were Southwestern Illinois Coal Corp.; Truax-Traer Coal Division, Consolidation Coal Co., Inc.; and The United Electric Coal Cos. Southwestern Illinois Coal Corp. started production at its new Captain mine in September. This mine is to furnish a 10-year coal supply for the electric generating plant of Commonwealth Edison Company at Joliet. Capacity of the preparation plant at the new mine is 3,000 tons per hour. Coal mined from the Streamline mine of Southwestern Illinois Coal Corp. all came from the portion in Randolph County; none was mined in Perry County.

About 96 percent of all shipments were by rail. Cleaning plants were operated by each of the companies. The Truax-Traer plant also cleaned coal mined by the company in Jackson County.

Pike.—Approximately 482,000 tons of crushed limestone was produced by six companies operating plants near Milton, Pearl, Pittsfield, and Pleasant Hill. Material was used for roadstone, agricultural purposes, and riprap. Producers were V. H. Callender Construction Co.; Lacey & Bauer Quarry; Lumley Quarry Co.; Missouri Gravel Co.; Montezuma Quarry Co.; and Webster Limestone Co. Missouri Gravel Co. also operated a stationary sand-and-gravel plant near Barry. Material was used for road construction and railroad ballast. The State and county highway departments each contracted for road construction gravel.

Pope.—Ozark-Mahoning Co. produced crude fluorspar-lead-zinc ore from its Barger, Parkinson, and Loyd-Gibson properties. The ore was processed at the company plant in Hardin County. Stockpile shipments of fluorspar ore were made by other producers for processing in Kentucky. The county highway department produced road construction gravel.

Pulaski.—Crushed limestone was produced by Columbia Quarry Co. from a stationary plant near Ullin. Material was used for roadstone, railroad ballast, agricultural limestone, and riprap. Star Enterprises, Inc., produced clay near Olmsted and sold the material for absorbent uses. Delta Materials Co. and Mize Gravel Pit produced sand and gravel for road construction from portable plants near Olmsted.

Randolph.—Nearly 2.4 million tons of coal was produced from two strip mines and one underground mine. This is a 25-percent increase from 1963 figures. Producers were Eden Mining Corp. and Zeigler Coal & Coke Co. near Sparta, and Southwestern Illinois Coal Corp. near Percy. The latter two companies operated cleaning plants utiliz-

ing jigs. Southwestern Illinois Coal Corp's. Streamline mine extended into Perry County, but no production was reported from that portion of the mine. About 94 percent of the total county production was shipped by rail.

Solvay Process Division, Allied Chemical Corp.; Chester Quarry Co.; and Stotz Quarry Co. operated underground limestone mines near Chester and Prairie du Rocher. Output was used for roadstone, agricultural limestone, and chemical uses. Sand for building, road construction, and engine use was produced by Southern Illinois Sand Co. near Chester. The State highway department contracted for paving sand.

Rock Island.—Over 1 million tons of crushed limestone was produced near Cordova, Hillsdale, and Milan for roadstone, agricultural limestone, and riprap. Allied Stone Co., Collinson Stone Co., and Midway Stone Co., Inc. each operated stationary plants. Cordova Quarry, Inc., shipped from stockpiles only.

Approximately 756,000 tons of sand and gravel was produced, a 27-percent increase from the 1963 total. Output was for building, road construction, and molding use. Producers were Builders Sand & Gravel Co.; General Sand & Gravel Co.; Kouski & Stout; Moline Consumers Co.; and Oberlaender Sand Co. The State highway department contracted for paving sand.

The Flintkote Co. produced plastic fire clay near Carbon Cliff and used it in the manufacture of chimney liners.

St. Clair.—St. Clair County dropped to fourth in State coal production with an output approximately the same as in 1963. About 75 percent of the production was from three strip mines. Four underground mines accounted for the rest of the production. Strip-mine producers were Morgan Coal Co. near Millstadt, and Peabody Coal Co. near Millstadt and Freeburg. The Morgan Coal Co. mine closed in May. Peabody Coal Co. River King mine near Freeburg ranked as fifth-largest bituminous-coal mine in the Nation. Operating underground mines were Belle Valley Coal Co., Inc., and Shiloh Valley Coal Co. near Belleville; Midland Electric Coal Corp. near Marissa; and Peabody Coal Co's. near Millstadt. Almost the entire county coal production was cleaned at six preparation plants.

Limestone production increased about 37 percent to over 2.4 million tons. Output was for roadstone, railroad ballast, agricultural limestone, and riprap. Producers were Columbia Quarry Co. near Dupo and Columbia; East St. Louis Stone Co. near East St. Louis; Quality Stone Co., Inc., near Hecker; and The Casper Stolle Quarry & Contracting Co. near Dupo. Missouri-Illinois Material Co. produced sand near East St. Louis for building, road construction, engine use, and fill. The State highway department contracted for paving sand. Hill Brick Co. produced clay near Belleville for use in manufacturing building brick. Hydraulic-Press Brick Co. produced clay near East St. Louis for use in manufacturing lightweight aggregate.

Chas. Pfizer & Co., Inc., Minerals, Pigments, & Metals Division, produced ground barite at East St. Louis for paint filler, rubber filler, and pharmaceutical use. This plant was formerly owned and operated by C. K. Williams Co. The company also produced a variety of finished iron-oxide pigments.

Saline.—Over 4.0 million tons of coal were produced from 10 strip mines near Carrier Mills, Harrisburg, and Herod and 3 underground mines near Harrisburg. Three cleaning plants were operated. Producers were Herod Mining Corp.; Houston Coal Co.; J. W. Coal Co., Inc.; Marshall Equipment Co.; New Gallatin Coal Co. (formerly New Oak Hill Coal Co.) (three mines); Sahara Coal Co., Inc. (three mines); Shawnee Coal Co.; Storme Mining Co. (formerly Liberty Coal Co.); and Youngs Coal Corp. Shawnee Coal Co. and New Gallatin Coal Co. each opened up new mines during the year. Walse Coal Co. was idle most of the year. Approximately 84 percent of the county production was shipped to consumers by rail and about 10 percent by water. The remainder was for local consumption.

The county highway department produced and the State highway department contracted for gravel for road construction.

Sangamon.—Two underground coal mines near Cantrall produced over 79,000 tons of coal, 19 percent less than in 1963. Most of the production was shipped by truck for local consumption.

Sand and gravel production decreased nearly 8 percent to 629,000 tons. Output was for building, road construction, and fill. Producers were Buckhart Sand & Gravel Co., Inc., near Buckhart and Clear Lake Sand & Gravel Co. and Springfield Sand & Gravel Co., both near Springfield. The city of Springfield contracted for road construction sand and gravel.

Clay Products Co. produced clay near Springfield for use in manufacturing heavy-clay products. Poston Brick & Concrete Products Co. manufactured building brick and lightweight aggregate from clay it produced near Springfield.

Tamms Industries Co. produced natural red-iron-oxide pigments at its plant near Springfield.

Schuyler.—Peabody Coal Co. produced coal from its Key strip mine near Rushville. The entire output was cleaned by jigging. Over 91 percent of the production was shipped on the Illinois River by barge and the remainder was shipped by rail or truck.

Crushed limestone was produced by Elas Quarries near Rushville and Missouri Gravel Co. near Damon. Output was used for roadstone, agricultural limestone, and riprap. Elas Quarries sand-and-gravel operation was discontinued. The State highway department contracted for road construction sand and gravel.

Scott.—Krueger Quarry and Thomas Quarry, Inc., produced limestone near Winchester for use as roadstone and agricultural limestone. Sterling Shafer produced clay near Alsey for use in manufacturing building brick. The State highway department contracted for road construction sand.

Stark.—Stonefort Coal Mining Co., Inc., produced coal from its strip mine near Wyoming. Production decreased 17 percent from the 1963 figure. The entire output was cleaned by jigging and shipped by rail.

R. A. Cullinan & Son, Inc., operated a portable plant near Castleton and produced gravel for road construction.

Tazewell.—Nearly 1.2 million tons of sand and gravel was produced for use in building, road construction, railroad ballast, and fill. Producers were R. A. Cullinan & Son, Inc.; Hoffer Construction Co., Inc.; McGrath Sand & Gravel Co., Inc.; and C. A. Powley Co. Plants were

operated near East Peoria, Green Valley, Hopedale, Mackinaw, Manito, Pekin, South Pekin, and Tremont. The State highway department contracted for paving sand. Peoria Brick & Tile Co. produced clay near East Peoria and used it to manufacture building brick.

Union.—American Limestone Co. (Division American Zinc, Lead & Smelting Co.) and Midwest Stone Co. produced crushed limestone from quarries near Anna and Jonesboro. Output was for roadstone, agricultural limestone, and metallurgical uses. Lutz Marble Co., Inc., produced dimension limestone near Anna for house stone veneer. American Limestone Co. reported production from properties formerly owned and operated by Jonesboro Stone Co. as well as from a new quarry. Bittle Construction Co. produced paving gravel from portable plants near Anna and Jackson.

Vermilion.—Over 1.1 million tons of coal was produced from two strip mines and three underground mines in the vicinity of Danville. Output was slightly less than in 1963. Strip mines furnished 95 percent of the total. Strip-mine operators were Fairview Collieries Corp. and The United Electric Coal Cos. Two Rivers Coal Co. strip mine did not operate during the year. Underground mines were operated by Blue Lake Coal Co., Inc., Deep Valley Coal Co., and V-Day Coal Co. Cleaning plants were operated by Fairview Collieries Corp. and V-Day Coal Co. Almost 84 percent of the total shipments went to consumers by rail.

Material Service Division of General Dynamics Corp. produced limestone from its Fairmount quarry for concrete aggregate, roadstone, agricultural limestone, and refractory material. Eight companies produced a total of 200,000 tons of sand and gravel. Output was for building, road construction, and fill. Plants were operated near Danville, Fithian, Oakwood, Potomac, Wellington, and Westville. Western Brick Co. produced shale near Danville for use in manufacturing building brick and lightweight aggregate.

Wabash.—Sand and gravel production decreased nearly 12 percent to 169,000 tons. Output was for building, road construction, fill, and other uses. Plants were operated near Allendale, Bellmont, Cowling, and Mount Carmel. The State highway department contracted for paving sand.

Allendale Coal Co. produced over 1,000 tons of coal from a strip mine near Allendale. The entire output was for local consumption.

Washington.—Crushed limestone was produced by Covington Stone Co. near New Minden and Pitts Quarry, Inc., near Radom. Output was for roadstone and agricultural limestone.

Venedy Coal Co. produced coal from its underground mine near Venedy. Output increased 23 percent and was primarily for local consumption.

Whiteside.—About 294,000 tons of crushed limestone was sold in the county. Four companies operated seven quarries near Coleta, Emerson, Erie, Fulton, Morrison, and Rock Falls. Output was for concrete aggregate, roadstone, and agricultural limestone. Operators were Alldritt Brothers; Cordova Quarry, Inc.; Johnson Coal Co.; and Rein, Schultz & Dahl, Inc. Cordova Quarry, Inc., shipped from stockpiles only. The county highway department contracted for crushed limestone. Collinson Brothers and McCue Brothers, Inc.,

operated portable sand and gravel plants near Prophetstown and Sterling, respectively. Production was used for road construction. Jordan Township produced road construction gravel.

Markman Peat Co. produced reed-sedge peat near Morrison for use as general soil improvement. Over 86 percent of the output was shredded and sold in package form. The remainder was unprepared and sold in bulk form.

Will.—Approximately 3.3 million tons of sand and gravel was produced for building, road construction, railroad ballast, and fill. Output increased nearly 28 percent. Producers were Avery Gravel Co.; Chicago Gravel Co.; Elmhurst-Chicago Stone Co.; Material Service Division of General Dynamics Corp.; C. H. Monk; Peabody Coal Co.; and Turner Stone, Inc. Plants were operated near Joliet, Lemont, Lisle, Lockport, Plainfield, and South Wilmington. The Channahon pit of Material Service Division of General Dynamics Corp. was idle in 1964. The State highway department contracted for paving sand. Limestone production remained nearly the same as in 1963. Output was for concrete aggregate, roadstone, agricultural limestone, railroad ballast, and metallurgical uses. Producers were Elmer Larson, Inc.; Lincoln Stone Co.; Material Service Division of General Dynamics Corp.; National Stone Co., Division of Dolese & Shepard Co.; Navajo Stone Co.; and Illinois State Penitentiary.

Nearly 485,000 tons of coal was produced from the Will County portion of the Northern Illinois strip mine operated by Peabody Coal Co. near South Wilmington. Production was also recorded for the Grundy County portion of the mine. All production was cleaned by jigs at the company plant in Kankakee County.

The Pure Oil Co. recovered sulfur by the Modified-Clause process at its Lemont refinery. Celite Division of Johns-Manville Perlite Corp. produced perlite at its Joliet and Rockdale plants from crude material mined in New Mexico. The expanded product was used for roof insulation and filter aid.

Williamson.—Williamson County dropped to second in coal production in the State with an output of 6.4 million tons, approximately the same as in 1963. Ten underground mines furnished almost 58 percent of the total production, with 10 strip mines producing the remainder. Underground-mine production increased slightly over 1 percent while strip-mine production decreased slightly under 1 percent from 1963 outputs. Major underground producers were Bell & Zoller Coal Co. and Freeman Coal Mining Corp. Major strip-mine producers were Forsyth-Energy Co.; Peabody Coal Co.; Stonefort Coal Mining Co., Inc.; and Thunderbird Collieries Corp. Almost 6.0 million tons was cleaned at 12 plants. Nearly 93 percent of the county shipments to consumers was by rail. New producers in 1964 were Big Muddy Coal Corp., Liberty Coal Co., Polinski Mines, and Wenzel Brothers Coal Co. These operations were strip mines opened near Cambria, Carterville, and Marion. Basin Cream Coal Co., Inc., took over Blue Blaze Coal Co. underground mine near Herrin. Morse Coal Co. strip mine and the Thunderbird Collieries Corp. Carmac underground mine closed in the third quarter of the year.

Winnebago.—Sand and gravel production increased more than 226,000 tons to about 1.6 million tons. The material was used for building, road construction, and fill. Producers were Illinois-Wisconsin Sand & Gravel Co.; John L. Kelley & Sons; Larson Bros. Sand & Gravel; Rockford Blacktop Construction Co.; and Sahlstrom Building Products, Inc. Plants were operated in the Rockford-South Beloit area. The State highway department and the city of Rockford contracted for road-construction sand and gravel. Crushed limestone production increased over 10 percent. Output was used for concrete aggregate, roadstone, and agricultural limestone. Producers included Beard & Carlson; E. B. Davis Co.; Gregory-Anderson Co.; Chas. Ind Co.; Porter Bros.; F. M. Porter & Sons; Rockford Blacktop Construction Co.; Fred Smith; Wilson & Shipler, Inc.; Arthur Zimmerman & Son; and the county highway department. Quarries were operated near Durand, Pecatonica, Rockford, Rockton, Roscoe, and South Beloit. Beard & Carlson purchased equipment from Rockford Crushed Rock Co., which did not operate in 1964. F. M. Porter & Sons opened a new quarry near Roscoe.

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 Conservation, for collecting information on all minerals except fuels.

By Donald F. Klyce [1] and Mary B. Fox [2]

MINERAL production in Indiana was valued at nearly $212 million in 1964, about 4 percent greater than in 1963. Production of cement, peat, sand and gravel, and stone increased, while output of coal, natural gas, petroleum, and gypsum declined.

Nonmetals accounted for nearly 58 percent of the value of the State mineral production, compared with 55 percent in 1963. The remaining 42 percent represented the value of mineral fuels. No metallic minerals were produced.

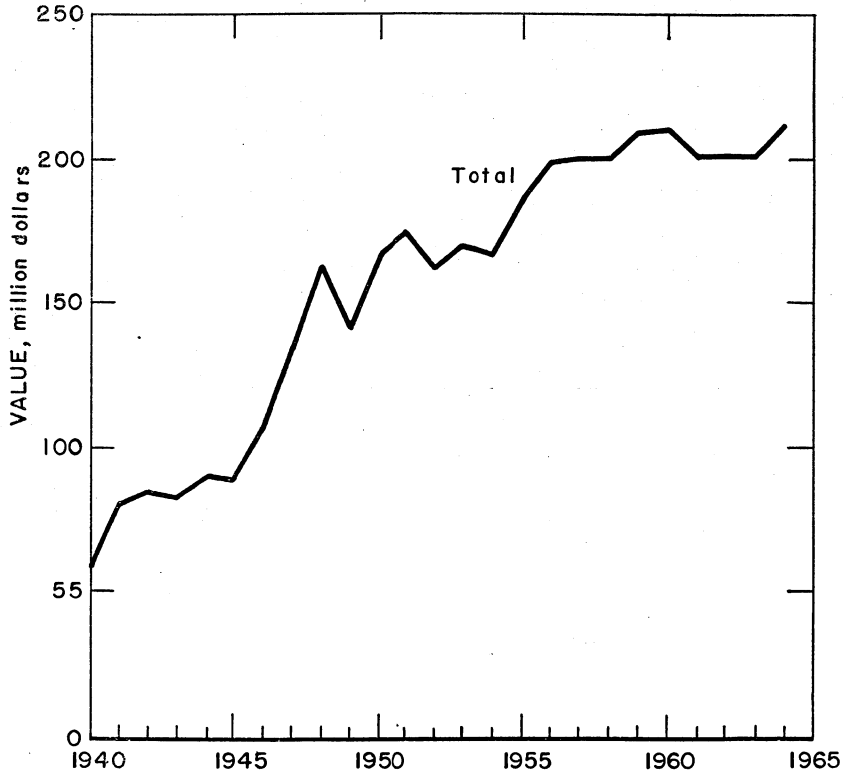


FIGURE 1.—Total value of mineral production in Indiana.

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.
[2] Mineral statistician, Geological Survey, Indiana Department of Conservation, Bloomington, Ind.

TABLE 1.—Mineral production in Indiana [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives (whetstones)—short tons	5	$16	5	$16
Cement, portland—thousand 376-pound barrels	13,165	43,216	15,038	48,695
Clays—thousand short tons	1,546	2,347	1,545	2,264
Coal (bituminous)—do	15,100	57,120	15,075	57,246
Natural gas—million cubic feet	286	67	200	47
Peat—short tons	47,695	412	66,568	543
Petroleum (crude)—thousand 42-gallon barrels	11,902	35,230	11,283	32,157
Sand and gravel—thousand short tons	22,840	20,683	24,416	21,811
Stone—do	19,667	35,616	22,318	39,978
Value of items that cannot be disclosed: Masonry cement and gypsum	XX	9,259	XX	9,026
Total	XX	r 203,966	XX	211,783

r Revised. 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	Year	Value
1953	$177	1959	$209
1954	177	1960	213
1955	192	1961	206
1956	201	1962	r 209
1957	199	1963	r 212
1958	202	1964	219

r Revised.

TABLE 3.—Employment and industry experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	2,953	656	5,039	2	219	44
Nonmetal	889	236	1,880		33	18
Sand and gravel	1,052	251	2,238		46	21
Stone	3,514	873	7,185	1	181	25
Peat	37	7	54		2	37
Total	8,445	2,023	16,396	3	481	30
1964: p						
Coal	2,916	649	4,910	1	220	45
Nonmetal	780	194	1,597	1	18	12
Sand and gravel	1,085	259	2,244		28	12
Stone	3,665	951	7,826	3	155	20
Peat	36	7	58			
Total	8,482	2,060	16,635	5	421	26

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Sandstone was quarried and fabricated into whetstones at a mill near Orleans in Orange County. The Hindostan Whetstone Co. of Bedford and its predecessors have been producing abrasives in this area for more than 150 years. Output in 1964 was about the same as in 1963.

Cement.—Portland and masonry cements were manufactured at plants 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 in Clark and Cass Counties by Louisville Cement Co.

The average mill values of both portland and masonry cements decreased. Portland cement, valued at $3.28 per barrel in 1963, was $3.24, and masonry, $2.64 per barrel in 1963, was valued at $2.63. Cement shipments in 1964 were more than 2 million barrels greater than in 1963. Yearend stocks of portland cement were about 1.8 million barrels, compared with 1.7 million in 1963. Nearly two-thirds of the portland cement shipments went to ready-mixed concrete companies. The remainder was sold to contractors, concrete product manufacturers, and building material dealers.

About 39 percent of the cement shipped was used in Indiana. Principal out-of-state consumers were in Illinois, Kentucky, and Wisconsin. Shipments also went to 13 other States. More than 3.6 million tons of limestone and nearly 1 million tons of clay, shale, slag, sand, gypsum, grinding aids, and air-entraining compounds were used in manufacturing cement. Approximately 384 million kilowatt-hours of electrical energy was used at the plants. Three plants used the dry process of manufacture, and two used the wet process. Annual finished-cement capacity of Indiana plants was 18.8 million barrels.

Dundee Cement Co., Dundee, Mich., announced plans for construction of a distribution center in Indianapolis. The project, to cost $600,000, will include four silos, rail- and truck-loading facilities, an office, and a workshop.

Clays.—Fire clay was mined in seven counties. Output declined 16 percent because of decreased demand for material for refractories and for floor and wall tile. The clay was also used in the manufacture of pottery, stoneware, terra cotta, and heavy clay products.

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
1955–59 (average)	451	$811	1,213	$2,060	1,664	$2,871
1960	348	635	1,474	2,761	1,822	3,396
1961	334	588	1,028	1,858	1,362	2,446
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

Miscellaneous clay was mined in 20 counties. The slight increase in output was approximately equal to the loss reported for fire clay. Gains were reported by manufacturers of lightweight aggregate, tile, and brick. Principal consumers were manufacturers of cement, lightweight aggregates, and heavy clay products (building brick, draintile, pipe, etc.).

Figures compiled by the Indiana Geological Survey indicated that the value of products manufactured from clay and shale was $34 million.

Gypsum.—Crude gypsum output decreased about 25 percent, reflecting a lessened demand for building materials. Underground mines and adjacent board plants were operated by National Gypsum Co. and United States Gypsum Co. near Shoals in Martin County. Building materials, including lath, plaster, and wallboard, were manufactured.

By drilling a test hole about 2 miles southeast of La Porte, geologists of the Indiana Geological Survey found a bed of gypsum about 12 feet thick and of 80-percent purity. The gypsum layer is found in a deposit of anhydrite and gypsum from 350 to 500 feet below the surface and in an area of 10 to 25 square miles. The area, underlain by thick gypsum beds, has not yet been determined.

Mineral Wool.—Mineral wool was manufactured from Lake County blast furnace slags and small amounts of clay, gravel, and limestone. Plants were in Huntington, Madison, Wabash, and Wayne Counties.

Perlite.—Crude perlite, mined in Nevada and New Mexico, was expanded at plants in Lake, Martin, and Scott Counties. It was used in building plaster, concrete aggregate, and insulation.

Sand and Gravel.—Output of sand and gravel increased nearly 7 percent, continuing an upward trend that began in 1961.

Demand for sand and gravel for building and paving increased by nearly 900,000 tons. Industrial sand output was 6 percent greater, and fill material totaled 662,000 tons more than in 1963. Commercial production was reported from 69 counties at 252 operations. County highway departments in 20 counties produced sand and gravel.

The largest production of sand and gravel came from Marion County. Large production was also reported from Allen, Cass, DeKalb, Kosciusko, La Porte, Madison, St. Joseph, Tippecanoe, and Warren Counties.

The 10 leading commercial producers, in alphabetical order, were American Aggregates Corp.; Burtzner Bros. & Wilhelm; Interstate Sand & Gravel Co., Inc.; Irving Bros. Gravel Co., Inc.; Irving Materials, Inc., No. 2; Manley Sand Division (Martin Marietta Corp.); Neal Gravel Co., Inc.; Standard Materials Corp.; Stone-Street Gravel, Inc.; and Western Indiana Aggregates Corp.

Indiana Glass Sand Co., Inc., started production in the Elizabeth area in Harrison County close to the Ohio River and downstream from Louisville, Ky. The silica sand deposit was processed for use mainly as silica flour and abrasives.

Slag (Iron-Blast Furnace).—Slag, a byproduct of pig iron production in Lake County blast furnaces, had a variety of industrial applications. It was used in the manufacturing for roofing granules, mineral wool, and cement; crushed for use as an aggregate; and expanded for lightweight aggregate.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,963	$3,346	4,553	$3,847
Paving	4,089	3,432	4,932	3,642
Fill	1,190	538	1,568	711
Other [1]	903	1,306	864	1,463
Total	[2] 10,146	[2] 8,621	11,917	9,663
Gravel:				
Building	3,487	4,070	3,625	4,153
Paving	6,967	6,729	6,274	6,494
Railroad ballast	122	96	93	77
Fill	1,343	703	1,574	838
Other	82	78	200	175
Total	12,001	[2] 11,677	11,766	11,737
Total sand and gravel	22,147	[2] 20,299	23,683	21,400
Government-and-contractor operations:				
Sand:				
Building	1	[3]		
Paving	1	[3]	22	10
Other	15	5		
Total	[2] 16	[2] 6	22	10
Gravel:				
Paving	659	373	642	363
Fill	16	6	69	38
Other	1	[3]		
Total	[2] 677	379	711	401
Total sand and gravel	693	385	733	411
All operations:				
Sand	10,162	8,627	11,939	9,673
Gravel	12,678	12,056	12,477	12,138
Total	22,840	20,683	24,416	21,811

[1] Includes engine, fire or furnace, foundry, glass, molding, railroad ballast, and other construction and industrial sands (1963–64) and filler sands (1964).
[2] Data do not add to total shown because of rounding.
[3] Less than ½ unit.

Stone.—Stone was quarried in 58 counties. Nearly all of the output (99 percent) was limestone (crushed and dimension). Small quantities of calcareous marl and sandstone were also produced. Nearly 98 percent of the stone was crushed for use in cement, concrete aggregate, roadstone, filler, flux, mineral food, railroad ballast, and agricultural limestone. Stone production was 13 percent greater than in 1963. About 90 percent of the increase was due to increased demand for crushed stone for concrete aggregate and roadstone.

Crushed and broken limestone was produced in 45 counties. The largest output was reported from Allen, Clark, Lawrence, and Putnam Counties. The leading crushed stone producers were Bloomington Crushed Stone Co., Inc.; J & K Stone Corp.; Louisville Cement Co.; May Stone & Sand, Inc.; Mitchell Crushed Stone Co., Inc. (Ralph Rogers & Co., Inc.); Mulzer Bros.; Ohio & Indiana Stone Corp.;

Standard Materials Corp.; Utica Limestone Quarry (Louisville Sand & Gravel Co.); and Yeoman Stone Co.

All classes of dimension limestone, except rubble which declined, increased in volume or value. Overall value was 14 percent greater than in 1963. Leading dimension stone producers included Bloomington Limestone Corp.; Empire Stone Co.; B. G. Hoadley Quarries, Inc.; Indiana Limestone Co., Inc.; and Victor Oolitic Stone Co.

TABLE 6.—Limestone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rubble—thousand short tons	198	$680	72	$261
Rough architectural—thousand cubic feet	2,183	2,533	3,035	3,535
Sawed—do	1,438	3,453	1,701	3,989
House stone veneer—do	1,080	1,763	1,051	1,781
Cut—do	530	2,258	400	2,624
Flagging—do	100	36	189	43
Total (approximate thousand short tons) [1]	584	[2] 10,724	534	12,233
Crushed and broken:				
Riprap—thousand short tons	183	278	115	157
Concrete aggregate and roadstone—do	13,408	17,657	15,789	20,305
Railroad ballast—do	283	352	386	481
Agriculture—do	2,520	3,636	2,467	3,569
Cement—do	2,371	1,748	2,586	1,975
Other [3]—do	229	659	321	749
Total—do	[2] 18,993	[2] 24,329	21,664	27,236
Grand total—do	19,577	35,053	22,198	39,469

[1] Average weight of 145 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, dust for coal mines, fertilizer, filter beds, mineral food, metallurgical, poultry grit, stone sand, and other uses.

TABLE 7.—Calcareous marl production

Year	Number of producers	Short tons	Value	Year	Number of producers	Short tons	Value
1955–59 (average)	7	68,576	$44,185	1962	16	50,952	$34,657
1960	9	56,406	38,389	1963	17	59,265	36,635
1961	9	31,707	19,137	1964	29	86,493	52,335

Calcareous marl was produced in 11 counties. The principal production came from Elkhart, Kosciusko, Lagrange, and Marshall Counties.

Sandstone was quarried in Brown, Lawrence, Martin, Monroe, and Spencer Counties. The principal use of the material was for building purposes, although a quartz conglomerate, quarried in Martin County, was crushed for use in manufacturing refractories.

Sulfur.—Byproduct sulfur was recovered from crude petroleum by American Oil Co. at the Whiting Refinery. The Mathieson-Fluor process was used.

MINERAL FUELS

Coal (Bituminous).—Volume and value of coal production did not vary much from 1963 totals. Sixty mines were operated, four fewer than in 1963. Of these, 23 were underground mines, and 37 were strip mines. The latter produced 77 percent of the coal. Nearly 11.6 million tons of coal was mechanically cleaned at 15 plants. More than 9.3 million tons of coal was moved by rail, about 1.8 million tons by water, 2.5 million tons by truck, and most of the remainder by conveyors or tram.

More than 99 percent of the coal mined underground was mechanically loaded. Mining-equipment sales to Indiana coal producers included two mobile loading machines. Fifty-three mobile loaders and six continuous mining machines were in use.

Coal was mined in 15 counties. More than 92 percent of the production came from mines in Clay, Greene, Pike, Sullivan, Vigo, and Warrick Counties.

About 62 percent of the coal mined in Indiana was used by electric utilities.

TABLE 8.—Coal (bituminous) production in 1964, 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		7		960,267	960,267	$3,716,461
Daviess		1		11,100	11,100	55,495
Dubois	1		10,500		10,500	36,750
Fountain		1	W	W	W	W
Gibson	2		551,704		551,704	W
Greene	1	5	1,201	1,551,511	1,552,712	6,033,026
Knox	1		64,899		64,899	210,922
Owen		2		W	W	W
Parke		1		7,416	7,416	43,965
Pike	4	4	73,049	2,195,416	2,268,465	8,523,625
Spencer	1	5	2,758	67,687	70,445	327,732
Sullivan	5	1	1,937,972	6,740	1,944,712	7,974,513
Vermillion	2		10,210		10,210	61,260
Vigo	2	1	378,193	463,802	841,995	3,452,686
Warrick	4	9	422,491	5,934,640	6,357,131	22,643,031
Total	23	37	3,452,977	11,621,654	15,074,631	57,246,164

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

In July, Peabody Coal Co. announced plans for opening the Hawthorn mine 4 miles northwest of Sanborn. About 1 million tons of coal will be produced annually and approximately 100 persons will be employed. A preparation plant and a 70-cubic yard stripping shovel will be installed. Operation was expected to start by March 1965.

On May 28, the Viking mine (acquired late in 1963 by Midland Electric Coal Corp., subsidiary of Peabody Coal Co.) northwest of Terre Haute, was closed after 16 years of operation. Peabody Coal Co. plans to increase production at its new Airline underground mine near Dugger.

At the Friar Tuck mine near Dugger, Ayrshire Collieries Corp. installed a 4,000-ton dragline. The dragline will carry a 70-cubic yard bucket suspended from a 275-foot boom.

Coke.—Coke was produced at 5 plants with 2,218 ovens, the same number as in 1963. Output was 8.2 million tons, compared with 7.5 million in 1963. About 11.7 million tons of coal was delivered to the coke plants and carbonized. Most of the coking coal came from Kentucky and West Virginia. None was mined in Indiana. Most of the coke produced in Indiana was used in Lake County blast furnaces.

Peat.—Reed-sedge and moss peat were mined from bogs in Grant, Hamilton, Kosciusko, Marion, Marshall, Porter, Warren, and Wells Counties. The output reported was nearly 40 percent larger than in 1963. In 1964, eight producers reported output, compared with 6 in 1963. The peat was primarily for soil-conditioning and horticultural use. None was sold for use as fuel.

TABLE 9.—Peat production

Year	Number of producers	Short tons	Value	Year	Number of producers	Short tons	Value
1955–59 (average)	6	12,348	$121,067	1962	5	47,430	$272,238
1960	7	27,486	290,338	1963	6	47,695	411,848
1961	7	57,146	501,850	1964	8	66,568	543,046

Petroleum and Natural Gas.—Oil production in 1964 amounted to 11.3 million barrels, about 5 percent less than in 1963. The number of wells drilled also declined from 1,104 in 1963 to 971 in 1964. Included in the 971 wells were 585 drilled in search for oil and gas, 240 for secondary recovery purposes, and 146 in connection with gas storage projects.

Of the 585 wells drilled for oil and gas, 288 were development wells which resulted in 160 oil wells, 6 gas wells, and 122 dry holes. Exploratory drilling produced 8 new fields, 19 new pools, and 17 pool extensions—38 in Mississippian rocks and 2 each in Pennsylvanian, Devonian, and Ordovician rocks.

The greater part of the exploration and development drilling was done in four counties in southwestern Indiana—Spencer (136), Gibson (88), Posey (80), and Pike (71). The remainder was carried on in 30 additional counties.

Secondary oil accounted for almost 54 percent of the total production in 1964, and the number of wells drilled for this purpose increased to 240 from 231 in 1963.

Discoveries of oil in Cambrian and Ordovician rocks in central Ohio have caused increased interest in exploration of these rocks in eastern Indiana. Large blocks of land have been leased, and extensive exploration programs are being developed.

The proved oil reserve at the end of 1964 was 60,629,000 barrels, and the total liquid hydrocarbon reserve was 60,720,000 barrels.[3]

[3] American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas. V. 19, 1964, 33 pp.

TABLE 10.—Crude petroleum production in 1964, by major fields

Name of field	Year discovered	Area, acres	County	Number of wells		Production (barrels)
				Producing	Completed	
Caborn Consolidated	1940	1,710	Posey	127	3	184,262
Coe South	1961	420	Pike	17	7	237,499
Evansville	1947	390	Vanderburgh	(1)	0	142,028
Glezen	1952	330	Pike	(1)	0	215,157
Griffin Consolidated	1938	7,160	Gibson and Posey	653	11	2,453,731
Heusler Consolidated	1938	2,030	Posey and Vanderburgh	110	7	449,761
Mount Vernon Consolidated	1941	2,160	Posey	173	4	602,468
Newtonville Consolidated	1943	510	Spencer	(1)	0	133,586
Owensville Consolidated	1940	1,800	Gibson	(1)	2	320,467
Owensville North Consolidated	1943	1,920	do	85	3	203,979
Patoka East Consolidated	1947	1,000	do	(1)	0	104,550
Plainville	1950	350	Daviess	55	0	108,498
Princeton North Consolidated	1943	880	Gibson	56	5	188,288
St. Wendells	1934	520	Posey	(1)	16	106,398
Springfield Consolidated	1946	2,400	do	200	7	958,321
Union-Bowman (New) Consolidated.	1941	14,880	Gibson, Knox, and Pike.	574	19	733,699
Welborn Consolidated	1941	1,650	Posey	131	5	132,575
West Hovey	1944	450	do	22	0	158,272
Undistributed				2,791	148	3,849,573
Total				4,994	237	11,283,112

[1] Figure for field not available; included with "Undistributed."

Source: Petroleum Section, Indiana Geological Survey.

METALS

Aluminum.—Aluminum Company of America operated a smelter in Warrick County. In September, the first of two cold-rolling mills was placed in operation at the Warrick location. Construction was also started on the second cold mill and a hot mill. Work also progressed on a second 35,000-ton potline at the Warrick smelter. The company also operated fabricating plants at Fort Wayne, Lafayette, and Richmond.

Pig Iron and Steel.—Pig iron and steel were produced at East Chicago by Inland Steel Co. and Youngstown Sheet & Tube Co. and at Gary by United States Steel Corp. In December, Burns Harbor plant of Bethlehem Steel Co. in Porter County began operations. The plant had been under development for several years.

Jones & Laughlin Steel Corp. announced plans to triple the size of its cold-finished bar mill in Hammond. A 1965 completion date was scheduled.

The new hot strip rolling mill of Inland Steel Co. at Indiana Harbor was scheduled for production late in the year. United States Steel Corp. announced plans for construction of an 84-inch hot strip mill at the Gary Sheet and Tin Works and a large-scale continuous casting unit at the Gary Steel Works. The two new facilities will be able to produce the largest weld-free coils of hot strip steel available anywhere and are expected to be in operation within 2 years. Output of pig iron was 11.5 million tons, compared with 10.0 million in 1963.

The American Iron & Steel Institute reported that steel production in Indiana exceeded 17.5 million tons, compared with 15.5 million in 1963. About 7.9 million tons of coke and coke breeze and 4.0 million tons of limestone and dolomite were used at integrated steel plants.

REVIEW BY COUNTIES

Mineral production was reported from 90 of the 92 counties; Ohio and Union Counties were the exceptions. In each of 27 counties, the value of mineral production was $1 million or more. Petroleum and natural gas are not included as such data are not available on a county breakdown. About two-thirds of the petroleum was estimated to have come from fields in Gibson and Posey Counties. As some fields extend over parts of more than one county, actual county production cannot be determined.

About 60 percent of the State total value of mineral production came from 10 counties: Cass, Clark, Greene, Lake, Lawrence, Monroe, Pike, Putnam, Sullivan, and Warrick.

Only those counties with significant production or activity are discussed below. See table 11 for additional detail.

Adams.—Heavy clay products were manufactured from clay mined near Decatur by The Krick-Tyndall Co. Limestone was quarried and crushed near Linn Grove and Pleasant Mills by Meshberger Bros. Stone Corp. for use as concrete aggregate and roadstone and for agricultural purposes. John W. Karch Stone Co., Geneva, quarried limestone for road material, agricultural purposes, and flagging. Lybarger Gravel Co. and Yost Gravel Ready Mix, Inc., operated stationary sand and gravel plants near Geneva and Decatur, respectively. S. & L. Gravel Co., Inc., operated a portable plant.

TABLE 11.—Value of mineral production in Indiana, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Adams	$586,713	$575,570	Stone, sand and gravel, clays.
Allen	1,893,952	2,233,423	Stone, sand and gravel.
Bartholomew	W	468,800	Stone.
Benton	W	----	
Blackford	W	W	Stone, sand and gravel, clays.
Boone	100,450	176,000	Sand and gravel.
Brown	----	11,830	Stone.
Carroll	W	W	Stone, sand and gravel.
Cass	W	W	Cement, stone, sand and gravel.
Clark	W	W	Cement, stone, sand and gravel, clays.
Clay	4,070,814	3,923,935	Coal, clays, sand and gravel.
Clinton	56,551	W	Sand and gravel.
Crawford	W	W	Stone.
Daviess	206,002	124,495	Sand and gravel, coal.
Dearborn	W	376,000	Sand and gravel.
Decatur	W	W	Stone.
De Kalb	281,323	812,000	Sand and gravel.
Delaware	1,400,088	1,293,003	Stone, sand and gravel.
Dubois	33,401	44,626	Coal, clays.
Elkhart	403,276	436,602	Sand and gravel, stone.
Fayette	W	W	Sand and gravel.
Floyd	W	W	Stone.
Fountain	W	W	Sand and gravel, clays, coal.
Franklin	W	W	Sand and gravel, clays.
Fulton	39,362	50,375	Sand and gravel, stone.
Gibson	2,436,728	W	Coal, sand and gravel.
Grant	W	W	Stone, sand and gravel, peat.
Greene	6,032,518	6,223,900	Coal, clays, sand and gravel.
Hamilton	954,031	1,033,668	Sand and gravel, stone, peat.
Hancock	49,526	50,000	Sand and gravel.
Harrison	231,025	354,385	Stone, sand and gravel.
Hendricks	W	W	Sand and gravel.
Henry	W	W	Do.
Howard	W	W	Stone, sand and gravel.
Huntington	748,189	1,079,418	Stone, sand and gravel, clays.

See footnotes at end of table.

TABLE 11.—Value of mineral production in Indiana, by counties[1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Jackson	$147,878	$182,998	Clays, sand and gravel.
Jasper	W	552,123	Stone, sand and gravel.
Jay	W	W	Do.
Jefferson	W	W	Stone.
Jennings	143,263	280,197	Do.
Johnson	310,510	W	Sand and gravel.
Knox	655,801	631,922	Sand and gravel, coal.
Kosciusko	563,576	691,658	Sand and gravel, stone, peat.
Lagrange	W	W	Sand and gravel, stone.
Lake	W	W	Cement, clays, sand and gravel.
La Porte	W	W	Sand and gravel, stone.
Lawrence	11,309,010	14,882,855	Cement, stone.
Madison	1,445,738	1,531,540	Stone, sand and gravel.
Marion	W	W	Sand and gravel, peat.
Marshall	W	253,111	Sand and gravel, stone, peat.
Martin	3,523,105	W	Gypsum, clays, stone.
Miami	352,422	W	Sand and gravel.
Monroe	7,662,089	8,204,412	Stone.
Montgomery	W	52,422	Clays, sand and gravel.
Morgan	742,191	780,327	Clays, sand and gravel, stone.
Newton	W	W	Stone, sand and gravel.
Noble	351,199	346,492	Sand and gravel, stone.
Orange	528,641	648,486	Stone, abrasives.
Owen	W	2,663,486	Coal, stone, clays, sand and gravel.
Parke	W	W	Clays, sand and gravel, coal.
Perry	W	W	Stone, sand and gravel.
Pike	7,183,043	8,528,808	Coal, stone.
Porter	W	W	Sand and gravel, peat, clays, stone.
Posey	W	W	Sand and gravel.
Pulaski	W	W	Stone, clays, sand and gravel.
Putnam	W	W	Cement, stone, clays, sand and gravel.
Randolph	370,865	376,518	Stone, sand and gravel.
Ripley	325,861	392,227	Stone.
Rush	W	W	Stone, sand and gravel.
St. Joseph	753,811	679,730	Sand and gravel, stone.
Scott	201,714	196,502	Stone.
Shelby	885,147	1,249,449	Stone, sand and gravel.
Spencer	413,815	380,907	Coal, sand and gravel, stone.
Starke	37,251	W	Sand and gravel.
Steuben	192,558	W	Sand and gravel, stone.
Sullivan	7,155,410	8,219,320	Coal, sand and gravel, stone.
Switzerland	121,754	121,450	Stone, sand and gravel.
Tippecanoe	W	W	Sand and gravel.
Tipton	W	W	Do.
Vanderburgh	W	W	Stone, clays.
Vermillion	746,298	703,644	Sand and gravel, clays, coal.
Vigo	8,569,883	4,000,086	Coal, sand and gravel, clays.
Wabash	179,954	287,500	Stone, sand and gravel.
Warren	514,541	W	Sand and gravel, peat.
Warrick	20,611,473	22,878,688	Coal, sand and gravel, stone.
Washington	W	W	Stone.
Wayne	909,400	727,444	Sand and gravel, stone.
Wells	W	W	Stone, sand and gravel, peat.
White	267,200	349,650	Stone.
Whitley	96,787	204,000	Sand and gravel.
Undistributed[2]	r 107,169,863	111,517,018	
Total	r 203,966,000	211,783,000	

r Revised. 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." Ohio and Union 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.

Allen.—May Stone & Sand, Inc., operated sand and gravel plants and stone crushing plants at several sites in the county. At the Woodburn quarry the company installed a secondary crusher and storing conveyor. Midwest Aggregates Corp., Division of Old Fort Supply Co., Inc., operated a limestone quarry and crushing plant at Edgerton.

Sand and gravel was mined and processed at Fort Wayne by Paul C. Brudi Stone & Gravel Co., Inc. The W. W. Gravel Co., Inc.,

produced from a pit at Roanoke, and S. & L. Gravel Co., Inc., operated a portable plant.

Much of the stone and sand and gravel produced was used for building and road purposes. Some crushed stone was used for flux and asphalt filler.

Bartholomew.—Meshberger Stone Corp. quarried limestone and operated a crushing plant near Columbus. Fluxstone, asphalt filler, stone sand, filter sand, roadstone, and agricultural limestone were produced.

Blackford.—Clay mined near Hartford City was used for manufacturing draintile by Inman Tile Co. J. & K. Stone Corp. operated the Montpelier quarry and produced material for building and road construction and agricultural use.

S. & L. Gravel Co., Inc., produced road gravel with a portable plant.

Brown.—The Brown County Stone Co., Inc., produced sandstone at Nashville. The material was used for rubble and rough construction, and some was dressed and sawed for use as building stone.

Carroll.—Delphi Limestone Co. quarried and crushed limestone at Delphi for road construction and agricultural use.

Gravel for road use and fill was produced in the Flora and Delphi areas. The county highway department operated a portable gravel plant to obtain road materials.

Cass.—Louisville Cement Co. operated a plant at Logansport and produced portland and masonry cements. The company also operated the Logansport quarry and produced limestone for its own use. Cass County Stone Corp. and The France Stone Co. also operated limestone quarries and crushing plants in the Logansport area. The material was sold for a variety of uses including riprap, flux, railroad ballast, building, road, and farm use.

Sand and gravel was produced at several sites and sold for fill and building and road use.

Clark.—Louisville Cement Co. produced portland and masonry cements at its Speed plant. Clay and limestone for use at the plant were mined in the area. Limestone quarries and crushing plants were also operated at Sellersburg and Utica by the Sellersburg Stone Co., Inc., and Utica Limestone Quarry (Louisville Sand & Gravel Co.), respectively. Riprap, road materials, and agricultural limestone were produced. Sand and gravel was produced in the Jeffersonville and Utica areas and sold for building and road use.

At the Speed plant of Louisville Cement Co. a nuclear scale is used for precision weighing of bulk materials on moving conveyors. This scale is contained in a steel C-frame that extends above and below the conveyor. Beneath the belt, encased in an explosion-proof tube, is a strip source of radioactivity (cesium 137); above the belt is a series of cells that convert radiation passing through the belt into an electrical current. The current is then amplified and fed into a power supply indicator and readout meter. A direct weight signal in pounds per linear foot is produced; this, coupled with belt speed, gives pounds per minute. Permanently recorded readout is in tons per hour; a visual indicator in the readout meter gives second by second reports.

Clay.—Coal was produced from seven strip mines. The Buckalew

and Peanut strip mines did not operate. The Chinook mine of Ayrshire Collieries Corp. was the largest producer in the county. Fire clay and miscellaneous clay were obtained from several coal mines. The clays were used in the manufacture of brick, pottery, tile, refractories, and cement and for other purposes. The county highway department contracted for a small quantity of road gravel.

Crawford.—Hy-Rock Products Co. operated an underground limestone quarry at Marengo. Mulzer Bros. operated the Eckerty quarry and its new Leavenworth quarry started production on May 1. Most of the limestone produced in the county was used as road material. Some was sold for riprap, railroad ballast, and farm use.

Daviess.—Coal was produced from a strip mine by P. & R. Coal Co. Mize Gravel Co. operated a portable sand and gravel plant in the Elnora area to produce building and paving materials.

Decatur.—Limestone quarries and crushing plants were operated at Greensburg by Harris City Stone Co., Inc., and at New Point by New Point Stone Co. The latter company added more crushing equipment to its plant in 1964. Most of the county output of limestone was for concrete aggregate and road use, although some riprap and agricultural limestone was produced.

De Kalb.—More than 1.3 million tons of sand and gravel was produced. Leading producers included Burtzner Bros. & Wilhelm at Waterloo, Hixon Sand & Gravel Co., Garrett, and Irving Gravel Co., Inc., Spencerville. Several other stationary and portable plants were operated in the county. The material was used mostly for building and paving purposes and fill.

Delaware.—Most of the mineral producing activity was centered in the Muncie area. Sand and gravel was mined and processed by The Muncie Excavating Co., Park Sand & Gravel, Inc., and Irving Bros. Stone & Gravel Co., who also operated a limestone quarry. S. & L. Gravel Co., Inc., operated a portable plant.

Muncie Stone & Lime Co. quarried limestone and J. & K. Stone Corp. operated the Muncie quarry as well as a quarry at Eaton.

Dubois.—Coal was produced from the Frick Bros. Coal Co. underground mine. At Huntingburg, clay mined by Hugo H. Bartelt was sold for manufacturing stoneware, and clay from the Stenftenagel pit was used for brick.

Elkhart.—Marl was produced near Elkhart and Middlebury for agricultural use. In the area around Elkhart and Goshen nearly half a million tons of sand and gravel was produced. It was used for building and road construction and maintenance.

Floyd.—The New Albany limestone quarry near Greenville was operated by Standard Materials Corp. The output was sold as riprap and for concrete aggregate, roadstone, and agricultural use.

Fountain.—Coal was produced from the Maple Grove strip mine. Clay was mined from pits near Veedersburg and West Point and was used in the manufacture of building brick and inorganic plastic. A large sand and gravel pit and plant at Attica produced building and paving material.

Franklin.—Heavy clay products were manufactured from clay mined near Batesville by Batesville Brick & Tile Corp. Standard Materials Corp. operated sand and gravel pits and processing plants at Meta-

mora and New Trenton. The material was sold for building and paving use. The county highway department operated a portable gravel plant for its own use.

Fulton.—Four marl pits were active during the year and produced small quantities of marl for agricultural use. Sand and gravel was produced in the Rochester area for building and paving use.

Gibson.—Coal from underground mines was produced by Princeton Mining Co. (Kings Station mine) and Somerville Coal Co. (Somerville No. 1 mine).

Sand and gravel was produced from pits near Owensville, Princeton, and Patoka. KMK Materials, Inc., of Paoli began operation of their stationary plant at Patoka in 1964. The Crawleyville Gravel Co. of Crawleyville ceased operations and did not produce in 1964.

Grant.—Pipe Creek Stone Co. (Irving Bros. Gravel Co., Inc.) operated a limestone quarry near Sweetser. Flagstone and crushed stone for concrete aggregate, roadstone, and agricultural limestone was produced. Glacier Peat Moss Corp. dug peat from a bog near Jonesboro. Sand and gravel for building, paving, and fill was mined and processed at a plant in the Marion area.

Greene.—Coal was produced from five strip mines and one underground mine. The Y & V strip mine did not operate in 1964.

Clays were mined near Bloomfield and Switz City. The material (both miscellaneous and plastic fire clay) was used in brick manufacture. On April 30, the Bloomfield Brick Co., Inc., was acquired by Bloomfield Shale, Inc. Sand and gravel was produced in the Bloomfield area and was used for building, road material, and fill.

Hamilton.—Limestone was quarried near Noblesville by Stony Creek Stone Co., Inc., and crushed for use as roadstone and concrete aggregate and for agricultural purposes. East Side Peat Moss Co. produced peat near Noblesville and sold it both in bulk and packages for soil improvement. Sand and gravel was produced in the Carmel, Fortville, Noblesville, and Sheridan areas and sold for building, paving, railroad ballast, and fill.

Harrison.—Limestone was quarried and crushed at Corydon by Corydon Crushed Stone & Lime Co. and Mathes Stone Quarry and at Depauw by Davis Crushed Stone & Lime Co. The crushed stone was used mostly for concrete aggregate, roadstone, and agricultural purposes. Some was sold for poultry grit. The Indiana Glass Sand Corp. began operation during the year and mined silica sand from a pit near Elizabeth.

Howard.—Riprap, roadstone, and agricultural limestone were quarried by Yeoman Stone Co. near Kokomo. In the same area, Fred Goodier Gravel Co. and Kyle Pickering Gravel Co. operated portable plants and produced sand and gravel for road construction and fill.

Huntington.—Majenica Tile Co., Inc., mined the Majenica clay pit and used the material in the manufacture of draintile. The company did not operate the Simpson Clay Works in 1964.

At Markle, Heller Stone Co., Inc., produced crushed limestone for road use. Erie Stone Co., Inc. (Irving Bros. Gravel Co., Inc.) operated a quarry and crushing plant at Huntington and sold the output for flux, concrete aggregate, roadstone, and agricultural limestone.

Sand and gravel for building and paving use was produced in the county.

Jackson.—Clay was mined from pits in the area of Brownstown, Mitchell, and Medora and was used in the manufacture of building brick, cement, and heavy clay products. Sand and gravel was produced near Brownstown and Seymour.

Jasper.—Limestone was quarried at Rensselaer by W. C. Babcock Construction Co., Inc., and at Pleasant Ridge by Northern Indiana Stone, Inc. The latter company is a new operator in the county. During the year the Babcock plant increased its crushing and screening capacity. The limestone was crushed for road and agricultural use.

At Rensselaer, sand and gravel was mined and used for building, paving, and fill. The Jasper County Sand & Gravel Co. of Rensselaer is no longer in business.

Jay.—Limestone was quarried and crushed near Portland by Rockledge Products, Inc. It was used for concrete aggregate, roadstone, and agricultural purposes. Road gravel was produced with a portable plant by S. & L. Gravel Co., Inc.

Jefferson.—Standard Materials Corp. operated the Hanover quarry and produced riprap, road materials, and agricultural limestone.

Jennings.—Berry Materials Corp. operated the North Vernon quarry and crushed limestone for agricultural use, roadstone, and concrete aggregate.

Knox.—Coal was produced from the White Ash underground mine. More than 600,000 tons of sand and gravel was produced, much of it in the Vincennes area, for building and paving purposes, and fill.

Kosciusko.—Kosco Peat Co. produced moss peat for soil improvement from a bog near Silver Lake. Marl was obtained from pits at several sites in the county. Nearly 900,000 tons of sand and gravel was produced, most of it in the Leesburg, Syracuse, and Warsaw areas. The county highway department produced gravel for its own use with a portable plant.

Lagrange.—Marl was obtained from pits near Howe, Lagrange, and Middlebury. It was sold for soil improvement. Sand and gravel was mined at several sites in the county and used principally for building and paving purposes.

Lake.—Portland and masonry cements were produced by Universal Atlas Cement Division of United States Steel Corp. at Buffington. Limestone, transported by water from Michigan quarries, and slag from Lake County blast furnaces were the principal raw materials used. Building brick was manufactured from clay mined near Munster by National Brick Co. John N. Bos Sand Co. produced industrial sands at Dune Park. Pits near Griffith and Lowell yielded sand and gravel for fill and building and paving use.

At Hammond, Federal Cement Products, Inc., expanded perlite from crude material mined in New Mexico for use in concrete aggregate. Roofing granules were manufactured from slag at Hammond by H. B. Reed & Co., Inc. Byproduct sulfur was recovered from crude petroleum at Whiting by American Oil Co. Pig iron and steel were produced by United States Steel Corp. at Gary and at East Chicago by Inland Steel Co. and Youngstown Sheet & Tube Co.

La Porte.—Marl was obtained from pits near La Porte and Walkerton and sold for agricultural use. At Michigan City, Manley Sand Division of Martin Marietta Corp. produced industrial sand from dune sands along Lake Michigan. The material was used for glass manufacture, molding and engine sand. Building and paving sand and gravel were obtained from pits near Hanna and La Porte.

Lawrence.—Dimension limestone was produced in and near Bedford by companies that operated both quarries and mills. Several independent mills fabricated stone purchased from local quarries. Bedford Ground Limestone Co. produced finely ground limestone from purchased material and sold it for use in glass manufacture, agricultural use, and mineral food. Crushed limestone for use in cement, concrete aggregate, roadstone, and agricultural limestone was produced by Bloomington Crushed Stone Co., Inc. (Springville), Lehigh Portland Cement Co. (Mitchell), Mitchell Crushed Stone Co., Inc. (Mitchell), and Oolitic Ground Limestone Co. (Bedford). Portland and masonry cements were manufactured at Mitchell by Lehigh Portland Cement Co.

Sandstone was quarried and milled by Indiana Sandstone Co., Inc., Spice Valley Sandstone Co., Inc., and Springs Valley Sandstone Co. It was used for flagging, and rough construction and sawed and dressed for building stone.

Madison.—Standard Materials Corp. operated a quarry and crushing plant at Lapel and produced material for concrete aggregate, roadstone, and agricultural limestone. Nearly 800,000 tons of sand and gravel was produced, most of it from operations in the Anderson area. It was used for building and paving, railroad ballast, and fill.

Marion.—The county continued to hold first place in State sand and gravel output. American Aggregates Corp. and Standard Materials Corp. had several large plants in the area. Fisher Oil & Gravel Co., Inc., Shannon Gravel Co., and Spickelmier Industries, Inc., also operated in the Indianapolis area. Standard Materials Corp. acquired National Aggregates Corp. in March 1964. Peat Moss, Inc., produced reed-sedge peat and sold it in bulk and packaged form for soil improvement.

Marshall.—Marl was obtained from pits in the Argos, Bremen, and Culver areas and sold for agricultural use. At Bremen, Miller's Marl & Peat Moss produced moss peat from a bog and sold it in bulk form for soil improvement. Sand and gravel for building, paving, and fill was mined from pits near Argos, Bremen, and Culver.

Martin.—National Gypsum Co. and United States Gypsum Co. mined gypsum from underground operations near Shoals. At large surface installations near the mines the crude ore was manufactured into plaster, wallboard, and other building materials. At the same installation crude perlite, mined in Western States, was expanded and used in building plaster. During the year, United States Gypsum Co. began a major expansion of its Shoals operation. Building brick and farm draintile were manufactured from clay mined near Loogootee by Loogootee Clay Products Corp. General Refractories Co. mined a quartz conglomerate near Shoals for use in manufacturing refractories. The Trinity Springs sandstone quarry was not operated because the French Lick Sandstone Co., Inc., went out of business.

Monroe.—Dimension limestone was quarried in the Bloomington area by Bloomington Limestone Corp., Empire Stone Co., B. G. Hoadley Quarries, Inc., Independent Limestone Co., Indiana Limestone Co., Inc., Midwest Quarries Co., Inc., Victor Oolitic Stone Co., Texas Quarries, Inc., and Woolery Stone Co., Inc. Some of these companies and several independent mills in the Bedford-Bloomington area fabricated most of the stone quarried. B. G. Hoadley Quarries, Inc., installed diamond gangsaws at their mill. Woolery Stone Co., Inc., added two wire saw units. Indiana Calcium Corp. operated a fine-grinding plant at Bloomington using spalls purchased from local stone mills. Bloomington Crushed Stone Co., Inc., operated a quarry and crushing plant west of Bloomington. Hinkle Sandstone Co. quarried and milled sandstone in the Bloomington area. It was used for rough construction as well as for dressed building stone.

Montgomery.—Clay mined near Crawfordsville was used in the manufacture of building brick and vitrified sewer pipe. In the same area sand and gravel was mined for building use and fill.

Morgan.—Near Brooklyn and Martinsville clay was mined for use in producing building brick, lightweight aggregate, draintile, and other heavy clay products. At Gosport, Clayton Winders & Sons quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Sand and gravel for building and paving was produced at stationary plants near Martinsville.

Newton.—Newton County Stone Co., Inc., operated a limestone quarry at Kentland and produced material for road use, railroad ballast, and agricultural purposes. Morocco Sand & Gravel Co., Morocco, produced building and road materials.

Noble.—Pits near Albion and Topeka yielded marl for agricultural use. More than 400,000 tons of sand and gravel was produced at stationary plants, portable plants, and by dredge at sites throughout the county. The material was used mainly for building and road construction.

Orange.—Limestone was quarried near Orleans and Paoli and used for riprap, concrete aggregate and roadstone and for agricultural purposes. Cave Quarries, Inc., Paoli, added a 2-yard shovel to their equipment, while Calcar Quarries, Inc., purchased a 1½-yard shovel, a 3¼-yard loader, and a pug mill. Whetstones were quarried and fabricated near Orleans by Hindostan Whetstone Co.

Owen.—American Aggregates Corp. operated a limestone quarry at Spencer. During the year the company installed a 400-ton-per-hour crushing plant. Coal was produced from the Burcham and Old Glory strip mines. Peabody Coal Co. produced fire clay at Coal City and sold it to manufacturers of pottery, brick, tile, etc. Sand and gravel was mined at Gosport and Spencer for building and road use.

Parke.—Coal was mined from the Turner strip mine. The same operation yielded fire clay (underclays of Pennsylvanian coals) that was sold for building brick. At Bloomingdale, Cayuga Brick & Tile Co. mined miscellaneous clay for its own use. Sand and gravel was mined near Bellmore and Montezuma and used for building and road construction.

Perry.—Mulzer Bros. operated the Derby quarry and produced road materials and agricultural limestone. At Tell City the Ohio Valley Co. produced a small amount of building and fill sand.

Pike.—Coal was produced from four strip and four underground mines. The Glezon strip mine and the Meyer Coal Co. underground mine were abandoned and did not operate in 1964. The county highway department quarried limestone for its own use.

Porter.—Fire clay was mined near Portage by Charles Lorenz & Son and sold to pottery and refractories manufacturers. The Good Earth Co. dug peat near Portage and sold it in bulk for soil improvement. A pit near Chesterton yielded marl for agricultural use. In the Portage area both industrial (furnace) and building sand were produced. In the northern part of Porter County at Burns Harbor the Bethlehem Steel Co. steel plant began operations late in the year.

Pulaski.—Francesville Drain Tile Corp. mined miscellaneous clay at Francesville for its own use. A dragline was replaced by a self-loading motor scraper. Western Indiana Aggregates Corp. quarried limestone in the same area and crushed it for agricultural use, railroad ballast, and road materials. A pit near Star City yielded sand and gravel.

Putnam.—Portland and masonry cements were manufactured at Limedale by Lone Star Cement Corp. The company quarried limestone for its own use. The Indiana State Farm produced clay and limestone on its property near Greencastle. Several large limestone quarries and crushing plants were operated near Greencastle, Manhattan, Russellville, and Stilesville. The material was used as riprap, flux, roadstone, agstone, filler, mineral food, and for other purposes. A stationary sand and gravel plant at Reelsville produced building, paving, and fill materials.

Randolph.—Limestone quarries were operated at Albany by Portland Stone Corp. and at Ridgeville by H & R Stone Co. The material was crushed for agricultural and road use. Sand and gravel was produced at Farmland and Lynn at fixed plants and with portable plants throughout the county. It was used mainly for building and road construction.

Ripley.—Limestone quarries were operated at Napoleon, Osgood, and Versailles. Riprap, roadstone, and agricultural limestone were produced.

Rush.—At Milroy stone veneer was produced by Indiana Rubble Veneer Co. In the same area McCorkle Stone Co. and Rush County Stone Co. produced roadstone, agricultural limestone, and riprap. Road gravel was produced with portable plants at several sites in the county.

St. Joseph.—Pits near North Liberty and South Bend yielded marl for agricultural use. More than 800,000 tons of sand and gravel was produced in the Mishawaka-South Bend area. It was used for building, paving, and fill.

Scott.—Scott County Stone Co., Inc., Scottsburg, quarried and crushed limestone for road and agricultural use. Airlite Processing Corp. expanded crude perlite, mined in Nevada and New Mexico, for use in building plaster, insulation, and concrete aggregate.

Shelby.—Rubble and flagstone were quarried at Waldron by Blue Ridge Quarries. Limestone quarries near Norristown, St. Paul, and Waldron yielded stone that was used for riprap, flux, road materials,

railroad ballast, and agricultural purposes. Sand and gravel was produced in the Fairland, Morristown, and Shelbyville areas.

Spencer.—Coal was produced from one underground and five strip mines. Sandstone was quarried and milled by St. Meinrad Quarry Industries at St. Meinrad's Arch Abbey. This Benedictine Foundation has been producing minerals at this site for nearly 100 years. Molding sand was produced near Richland by Hardy Sand Co.

Steuben.—Taylor & Son produced marl from four pits in the county. It was sold for agricultural use. Sand and gravel was produced from fixed plants at Angola and Fremont and with portable plants throughout the county.

Sullivan.—Coal was produced from one strip and five underground mines. Kixmiller Bros., Inc., at Freelandville quarried limestone for riprap, road, and agricultural use. Sand and gravel production was reported from the Carlisle, Graysville, and Sullivan areas. It was used mostly for building and paving.

Switzerland.—Tri-County Stone Co. at Cross Plains quarried and crushed limestone for asphalt filler, road material, and agricultural use. The county highway department produced road gravel for its own use.

Vanderburgh.—Standard Brick & Tile Corp., Evansville, mined clay for its own use. In the same area Mulzer Bros. quarried limestone from the West Franklin quarry and crushed it for concrete aggregate, roadstone, and agricultural use.

Vermillion.—Coal was produced from two underground mines. Fire clay, for structural tile and other heavy clay products, was mined from the Dana pit by Arketex Ceramic Corp. Cayuga Brick Corp. mined clay for its own use at Cayuga. Sand and gravel was mined and processed near Cayuga and Clinton.

Vigo.—Coal was produced from one strip and two underground mines. The Viking mine of Midland Electric Coal Corp. was abandoned on May 28. Terre Haute Vitrified Brick Works, Inc., mined clay for its own use at West Terre Haute. Sand and gravel was produced at fixed plants at Prairie Creek and Terre Haute. Output exceeded 600,000 tons.

Wabash.—Mill Creek Stone & Gravel Corp. quarried and crushed limestone near Wabash. It was used for road material, agricultural purposes, and riprap. Sand and gravel, mainly for road use, was produced at several sites in the county.

Warren.—Peat was obtained from a bog near Otterbein by Millburn Peat Co., Inc. It was sold in bulk and packaged form for soil improvement. Sand and gravel was produced at a fixed plant at Covington and by the county highway department with a portable plant.

Warrick.—Coal was produced at nine strip mines and four underground mines. The Scales strip mine and the Phillips underground mine were not operated in 1964. Tecumseh Coal Corp. (Peabody Coal Co.) operated a limestone quarry and crushing plant near Booneville. In the same area the Mid West Sand & Gravel Co., Inc., operated a fixed sand and gravel plant. The company reported that construction of the Newburg dam on the Ohio River will put them out of business in 1965.

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Washington.—Hoosier Lime & Stone Co., Inc., operated a quarry and crushing plant at Salem. The material was used for road construction and agricultural purposes.

Wayne.—De Bolt Concrete Co., Inc., produced riprap, road materials, and agricultural limestone from a quarry near Richmond. Sand and gravel, mainly for road use, was produced near Cambridge City, Hagerstown, and Richmond.

Wells.—Moss peat was produced near Warren by Ballards Peat Moss. It was sold in bulk for soil improvement. At Bluffton, Erie Stone Co., Inc. (Irving Bros. Gravel Co., Inc.) quarried and crushed limestone for flux, roadstone, agricultural limestone, and riprap. Gravel for road use and fill was mined in the county.

White.—The Monon Crushed Stone Co., Inc., operated a limestone quarry and crushing plant at Monon. Agricultural limestone, railroad ballast, and road materials were produced.

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]



MINERAL production in Iowa reached a record high of $106.6 million in 1964. Nonmetals accounted for 97 percent, and fuels 3 percent, of the total value.

Exploration for metallic minerals was conducted in northwestern Iowa by various companies. Areas in Clay County, reportedly containing positive magnetic anomalies, were investigated and drilled by Badgett Exploration Co.

A wildcat hole drilled in Butler County was the only reported activity in oil exploration in the State.

TABLE 1.—Mineral production in Iowa [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland thousand 376-pound barrels	12,495	$42,891	13,607	$46,398
Masonry thousand 280-pound barrels	551	1,754	585	1,847
Clays thousand short tons	1,064	1,405	1,008	1,254
Coal (bituminous) do.	1,213	4,244	973	3,447
Gypsum do.	1,282	5,667	1,287	5,821
Petroleum (crude) thousand 42-gallon barrels	(2)	W		
Sand and gravel thousand short tons	14,168	12,845	13,890	13,546
Stone do.	20,904	27,788	23,935	33,038
Value of items that cannot be disclosed:				
Other nonmetals, peat, and value indicated by symbol W	xx	1,076	xx	1,279
Total	xx	97,670	xx	106,630

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.

[1] Minerals specialist, Bureau of Mines, Minneapolis, Minn.

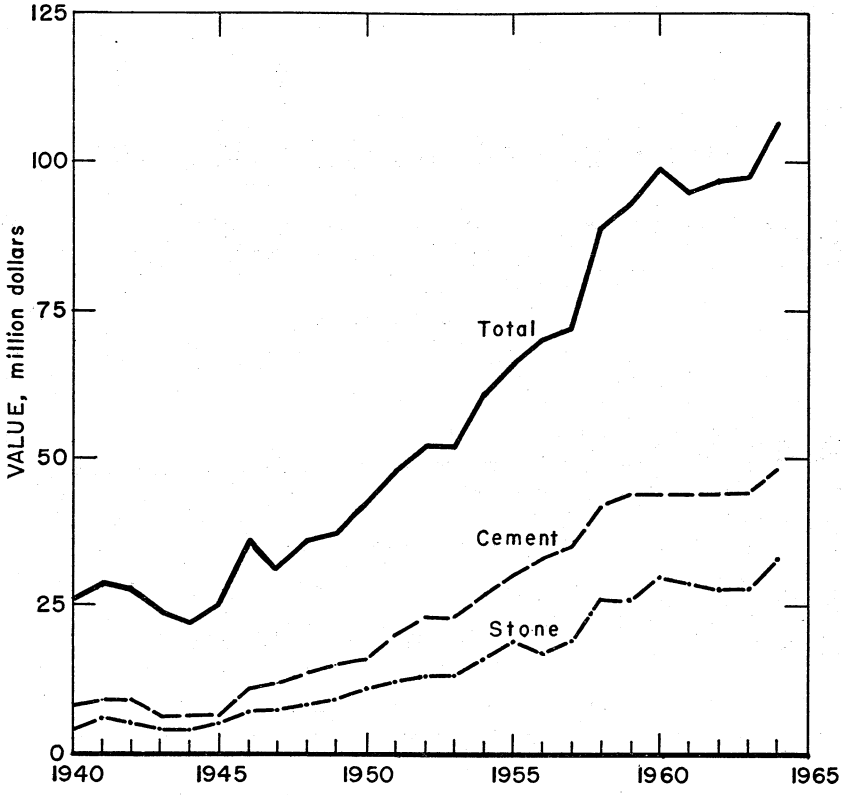


FIGURE 1.—Value of cement and stone, and total value of mineral production in Iowa.

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

(Thousands)

Year	Value	Year	Value
1953	$53,867	1959	$91,098
1954	63,987	1960	98,861
1955	67,924	1961	95,424
1956	68,534	1962	r 97,688
1957	73,410	1963	r 100,031
1958	89,973	1964	108,361

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal and peat	403	81	687	----------	20	29
Nonmetal	855	221	1,788	----------	32	18
Sand and gravel	1,204	199	1,799	2	25	15
Stone	2,460	653	5,612	2	82	15
Total	4,922	1,154	9,886	4	159	16
1964: p						
Coal and peat	397	80	659	1	20	32
Nonmetal	820	201	1,615	----------	54	33
Sand and gravel	1,100	191	1,658	2	25	16
Stone	2,480	656	5,631	2	98	18
Total	4,797	1,128	9,563	5	197	21

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Total capacity of the five plants located in the State was 15.6 million barrels per year. These plants, operated 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. in Scott County, utilized about 87 percent of their total combined production capacity. Producers operated 28 kilns.

Announcement was made that a new 590-foot-long dry process cement kiln will be installed in the Northwestern States Portland Cement Co. Mason City plant. Dewey Portland Cement Co. expected to add a new kiln to its plant near Davenport which would reportedly increase the plant's annual capacity to about 4.5 million barrels.

Types I, II, and III cement were produced at all five plants. Two companies using the dry process and three companies using the wet process consumed a total of 308 million kilowatt-hours of electricity. Markets for the cement were chiefly in Iowa and Minnesota which together received approximately 84 percent of the shipments, followed by Illinois, Wisconsin, North Dakota, Nebraska, South Dakota, Missouri, and Indiana. Railroads handled approximately 53 percent and trucks 47 percent of the portland cement shipped from Iowa plants during the year. Shipments of 6.9 million barrels went to ready-mixed concrete companies, 2.9 million barrels to highway contractors, 2.3 million barrels to concrete product manufacturers, 1.3 million barrels to building material dealers, and the remainder to other users.

Four of the five cement plants in the State produced mixed hydraulic and masonry cements. Shipments totaled 585,000 barrels, a 6-percent increase over 1963. The average unit value per barrel, f.o.b. mill, was $3.15, compared with $3.18 in 1963. The marketing area was similar to that for portland cement with Minnesota and Iowa receiving 77 percent of the shipments.

Clays.—Deposits of clay and shale were mined by 27 firms in 18 counties. Of the total clay and shale production, approximately 40 percent was used in the manufacture of heavy clay products, 53 percent in cement manufacture, and the remainder chiefly for use in lightweight aggregate, mortar mix, pozzolans, and floor and wall tile.

Sales of crude clay were reported by three of the producing companies. The other companies used their entire output in their own plants.

Production of fire clay was reported by Nelson Clay Products Co. in Keokuk County and Ver Steeg Coal Co. in Marion County.

Expandable shale was mined from a deposit near Centerville, Appanoose County, by the Carter-Waters Corp. of Kansas City, Mo., for use in lightweight aggregate manufacture. An announcement was made that the Carter-Waters Corp. will increase the production capacity of their lightweight aggregate plant at Centerville with the addition of a new 8- by 125-foot gas-fired rotary kiln.

Gypsum.—Iowa continued to be one of the Nation's major producers of gypsum and gypsum products, ranking third in quantity of crude gypsum produced in 1964.

Deposits of gypsum were mined at the United States Gypsum Co. underground mine in Des Moines County, and at four open pit mines in Webster County operated by Bestwall Gypsum Co., The Celotex Corp., National Gypsum Co., and United States Gypsum Co. All companies made a wide variety of gypsum products including base coat plaster, ready-mixed and other special-use plasters, gypsum lath, wall board, sheathing, tile, other preformed items, and pulverized gypsum.

Lime.—American Crystal Sugar Co. produced quicklime for use at its Mason City, Cerro Gordo County, plant. Purchased limestone was burned in a shaft kiln using coke as fuel.

Linwood Stone Products Co., Inc., produced both quicklime and hydrated lime for sale in a plant near Buffalo in Scott County. Two rotary kilns using coal, producer gas, and natural gas as fuel were used for burning high calcium limestone mined at the company pit near Buffalo.

Sales of quicklime and hydrated lime increased in quantity over that of 1963. The principal marketing areas outside the State were Illinois, Indiana, and South Dakota, with lesser quantities being sold in other adjacent states.

Major uses were for steel (basic oxygen converter and open-hearth furnaces), water purification, construction lime, sugar refining, and sewage treatment.

Perlite.—Crude perlite, mined outside the State, was expanded in plants operated by the four gypsum producers in Webster County. The bulk of the output was used in manufacture of lightweight building plaster.

Sand and Gravel.—Sand and gravel production was reported in 79 counties from 223 commercial operations and 38 Government-and-contractor operations. Ninety-seven percent of the sand and gravel produced was transported by truck.

Producers of the largest quantities of sand and gravel during the year were:

Acme Fuel & Material Co.
Adel Sand & Gravel Co.
Concrete Materials Division (Martin Marietta Corp.)
Hallett Construction Co.
Keefner-White Materials Corp.
Maudlin Construction Co.
Carl M. Mauer Construction Co., Inc.
Peters Construction Co.
Vanden Brink Bros.
L. H. Wagener, Inc., Martin Mauer Construction Co., Inc.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,231	$2,061	2,094	$2,005
Paving	2,089	2,019	2,394	2,308
Fill	680	391	743	412
Other [1]	207	594	187	551
Total	5,207	5,065	5,418	5,276
Gravel:				
Building	1,247	1,940	1,204	1,844
Paving	4,616	3,932	5,194	5,234
Fill	115	78	235	163
Other [2]	87	79	61	34
Total	[3] 6,066	[3] 6,030	6,694	7,275
Total sand and gravel	[3] 11,272	11,095	12,112	12,551
Government-and-contractor operations:				
Sand:				
Paving	221	121	116	66
Fill	10	7	25	18
Other			1	1
Total	[3] 230	[3] 129	142	85
Gravel:				
Building	16	9	18	10
Paving	2,635	1,609	1,593	894
Other	14	4	25	6
Total	2,665	[3] 1,621	1,636	910
Total sand and gravel	2,895	1,750	1,778	995
All operations:				
Sand	5,437	[3] 5,193	5,560	5,361
Gravel	[3] 8,730	[3] 7,652	8,330	8,185
Grand total	[3] 14,168	12,845	13,890	13,546

[1] Includes engine, filtration, and unspecified industrial sands (1963), and blast, molding, railroad ballast, and other construction sands.
[2] Includes gravel for railroad ballast and other uses.
[3] Data do not add to total shown because of rounding.

Stone.—Stone produced in 64 of 99 counties consisted entirely of limestone. Ninety-eight percent of the output was supplied by commercial operations, and government agencies supplied the rest. All but 2 percent of the limestone produced was transported by truck.

Principal quantity producers of crushed and broken limestone during the year were:

B. L. Anderson, Inc.
Concrete Materials Division (Martin Marietta Corp.)
Dewey Portland Cement Co.
Kaser Construction Co.
Lehigh Portland Cement Co.
Malcom Stone Co.
Northwestern States Portland Cement Co.
Schildberg Construction Co., Inc.
The River Products Co.
Weaver Construction Co.

Dimension limestone was produced from quarries operated in Dubuque and Jones Counties.

TABLE 5.—Limestone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rubble—thousand short tons	2	$15	3	$26
Rough architectural—thousand cubic feet	5	20		
Sawed—do	5	20	5	20
House stone veneer—do	14	22	12	36
Cut—do	53	71	48	84
Flagging—do	2	3	2	3
Total	[1] 8	151	[1] 9	169
Crushed and broken:				
Riprap—thousand short tons	330	414	342	471
Concrete aggregate and roadstone—do	15,529	20,425	17,714	24,126
Agriculture—do	1,449	2,042	2,093	2,995
Railroad ballast—do	17	23	10	16
Cement—do	3,319	3,850	3,534	4,190
Other [2]—do	251	883	233	1,072
Total—do	[3] 20,896	27,637	23,926	[3] 32,869
Grand total—do	20,904	27,788	23,935	33,038

[1] Approximate thousand short tons; average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.
[2] Includes limestone for chemical uses (1963), flux, lime, asphalt filler, fertilizer, mineral food, and other purposes.
[3] Data do not add to total shown because of rounding.

MINERAL FUELS

Coal (Bituminous).—Closing of the Wilkinson Coal Co. strip mine in Marion County late in 1963 contributed to the 10-percent decline in 1964 coal production. The Lovilia Coal Co. closed its No. 3 underground mine in Marion County early in 1964, but increased the production rate at its new No. 4 underground mine in Monroe County.

All coal produced was consumed within the State. Electric utilities were the largest users, consuming 74 percent of the State production. Sixty-seven percent of the total production was handled by rail and the remainder by truck. The average unit value of strip mine coal was $3.43 per ton, and that for underground coal was $4.09 per ton.

Thickness of the coal seams mined in the strip mines ranged from

22 to 66 inches, and overburden thickness ranged from 18 to 60 feet. Underground coal seams mined during the year ranged from 29 to 68 inches in thickness. No mechanical cleaning plants were operated in the State.

TABLE 6.—Coal (bituminous) production in 1964, by counties

(Excludes mines producing less than 1,000 tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Appanoose	7	2	30,058	9,524	39,582	$213,773
Lucas	1		49,723		49,723	204,000
Mahaska		5		318,486	318,486	1,084,045
Marion	3	7	22,117	375,570	397,687	1,367,678
Monroe	2	4	67,695	26,820	94,515	303,412
Van Buren		1		16,931	16,931	81,031
Wapello		2		56,290	56,290	193,058
Total	13	21	169,593	803,621	973,214	3,446,997

Peat.—Modest increases in peat production were reported during the year. Two companies, Colby Pioneer Peat Co. and Eli Colby Co., produced peat in Worth and Winnebago Counties, respectively. Processing plants were operated by both firms in Hanlontown. Moss, reed-sedge, and humus were produced.

REVIEW BY COUNTIES

Adair.—Limestone was produced by Schildberg Construction Co., Inc., at three portable plants near Greenfield. Production was mainly for highway construction, agricultural use, and riprap.

Appanoose.—The Carter-Waters Corp. produced lightweight aggregate (expanded shale) at a plant near Centerville. Announcement was made that the plant capacity was to be increased by adding a new 8- by 125-foot gas-fired rotary kiln. Adel Clay Products Co. mined clay near Centerville and used the material for manufacturing building brick and other heavy clay products.

Limestone for road construction and agricultural use was produced by Beryl Farnsworth, L. & W. Construction Co., Inc., and Porter & Magnall Construction Co. Quarries were operated near Centerville, Cincinnati, and Custerville.

Bituminous coal was produced at seven underground mines and two strip mines, all in the vicinity of Centerville. Underground mines were operated by Appanoose Coal Co., Clarke Coal Co., D. C. Coal Co., New Block Coal Co., New Gladstone Coal Co., Number 4 Coal Co., and Shamrock Coal Co. The latter company went out of business in April. Strip mines were operated by Charbon Stripping Co., Inc., and L. & M. Coal Co. Both of these operations were new, although Charbon Stripping Co., Inc., abandoned its operation later in the year.

Ewing Gravel Pit produced gravel for building and paving use from a pit near Cincinnati.

TABLE 7.—Value of mineral production in Iowa, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value
Adair	W	W	Stone.
Adams	W	W	Stone, sand and gravel.
Allamakee	W	$257,244	Do.
Appanoose	$1,026,673	968,881	Stone, coal, clays, sand and gravel.
Audubon	W	W	Sand and gravel.
Benton	W	W	Sand and gravel, stone, clays.
Black Hawk	1,277,605	1,198,898	Stone, sand and gravel.
Boone	393,515	W	Sand and gravel, clays.
Bremer	W	W	Stone, sand and gravel.
Buchanan	221,186	270,650	Do.
Buena Vista	165,406	144,000	Sand and gravel.
Butler	375,145	299,061	Stone, sand and gravel.
Calhoun	43,642	W	Sand and gravel.
Carroll	52,704	143,000	Do.
Cass	W	W	Stone, sand and gravel.
Cedar	W	W	Stone.
Cerro Gordo	24,837,004	26,680,822	Cement, stone, clays, sand and gravel, lime.
Cherokee	328,180	336,000	Sand and gravel.
Chickasaw	W	W	Stone, sand and gravel.
Clarke	W	W	Stone.
Clay	93,465	121,000	Sand and gravel.
Clayton	579,674	638,054	Sand and gravel, stone.
Clinton	W	W	Stone, sand and gravel.
Crawford	W	160,000	Sand and gravel.
Dallas	398,828	563,423	Sand and gravel, clays, stone.
Decatur	W	506,792	Stone.
Delaware	276,593	286,583	Stone, sand and gravel.
Des Moines	1,390,222	1,626,268	Gypsum, stone, sand and gravel.
Dickinson	W	W	Sand and gravel.
Dubuque	524,974	604,697	Stone, sand and gravel.
Emmet	198,164	160,000	Sand and gravel.
Fayette	523,039	532,692	Stone, sand and gravel.
Floyd	337,978	252,706	Stone, clays, sand and gravel.
Franklin	244,057	178,252	Sand and gravel, stone, clays.
Fremont	90,326	39,000	Stone, sand and gravel.
Greene	W	W	Sand and gravel.
Grundy	18,500	53,140	Stone, sand and gravel.
Guthrie	117,289	W	Sand and gravel.
Hamilton	W	178,292	Stone, sand and gravel.
Hancock	284,972	291,463	Do.
Hardin	1,213,864	1,172,927	Do.
Harrison	W	W	Do.
Henry	W	260,000	Do.
Howard	109,679	152,999	Do.
Humboldt	W	W	Do.
Ida	W	W	Sand and gravel.
Iowa	W	W	Do.
Jackson	241,356	254,462	Stone, sand and gravel.
Jasper	W	W	Sand and gravel, stone.
Jefferson	W	W	Stone, sand and gravel.
Johnson	1,653,758	W	Do.
Jones	350,255	378,465	Do.
Keokuk	W	W	Stone and clays.
Kossuth	192,500	204,000	Sand and gravel.
Lee	W	W	Stone.
Linn	1,991,045	2,105,621	Stone, sand and gravel.
Louisa	W	W	Stone.
Lucas	194,602	204,000	Coal.
Lyon	174,291	W	Sand and gravel.
Madison	2,563,844	3,043,435	Stone and clays.
Mahaska	1,530,439	1,478,472	Coal, stone, sand and gravel, clays.
Marion	3,002,708	2,203,613	Do.
Marshall	W	W	Stone, sand and gravel.
Mills	W	W	Stone.
Mitchell	W	427,038	Stone, sand and gravel.
Monona	192,040	W	Sand and gravel.
Monroe	174,705	303,412	Coal.
Montgomery	W	W	Stone.
Muscatine	984,972	817,141	Sand and gravel, stone.
O'Brien	226,546	114,000	Sand and gravel.
Osceola	W	W	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	88,825	80,000	Sand and gravel.
Plymouth	W	369,000	Do.
Pocahontas	W	W	Stone.
Polk	14,189,362	15,479,771	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone, sand and gravel.
Poweshiek	W	W	Stone.
Sac	506,188	293,000	Sand and gravel.
Scott	12,618,889	14,196,628	Cement, stone, lime, clays, sand and gravel.
Shelby	W	W	Sand and gravel.

TABLE 7.—Value of mineral production in Iowa, by counties [1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Sioux	$630,792	$581,000	Sand and gravel.
Story	W	1,172,270	Sand and gravel, stone, clays.
Tama	W	W	Sand and gravel, stone.
Taylor	W	W	Stone.
Union	W	W	Do.
Van Buren	824,398	862,387	Stone, coal, sand and gravel.
Wapello	497,587	456,640	Coal, stone, sand and gravel, clays.
Warren	W	W	Sand and gravel, clays.
Washington	W	W	Stone.
Webster	5,489,353	5,271,573	Gypsum, stone, sand and gravel, clays.
Winnebago	274,512	W	Peat, sand and gravel.
Winneshiek	301,977	232,715	Stone, sand and gravel.
Woodbury	W	177,000	Sand and gravel, clays.
Worth	405,014	W	Stone, peat, sand and gravel.
Wright	145,939	69,000	Sand and gravel.
Undistributed [2]	13,096,419	17,778,513	
Total	97,670,000	106,630,000	

W Withheld to avoid disclosing individual company confidential data.
[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.

Black Hawk.—Concrete Materials Division (Martin Marietta Corp.) and DeWees & Pottoff Stone Co. produced limestone from quarries near Waterloo, La Porte City, Janesville, and Raymond for road construction, agricultural use, and riprap.

Sand and gravel was produced commercially by six companies. Plants were operated near Cedar Falls, Dunkerton, La Porte City, and Waterloo. The Waterloo Street Department produced some sand for fill. The county highway department contracted for paving sand.

Boone.—Hallett Construction Co., Pound Construction Co., and Vanden Brink Bros. produced sand and gravel from pits near Boone. Output was for building, paving, and fill. Grarok, Inc., produced clay from a pit near Boone, for use as a pozzolanic material in mortar, concrete, and sewer pipe.

Cerro Gordo.—Ranking first, the county produced more than one-fourth of the State's total mineral value. Lehigh Portland Cement Co. and Northwestern States Portland Cement Co. produced portland and masonry cement at their plants near Mason City. Both companies operated quarries and clay pits. Northwestern States Portland Cement Co. planned to install a new 590-foot long, dry process cement kiln at its plant.

Mason City Brick & Tile Co. produced clay and shale for use in building brick, building tile, and draintile near Mason City.

Grupp Construction Co., Ideal Sand & Gravel Co., Weaver Construction Co., Lillibridge Quarries, and Welp & McCarten, Inc., produced limestone for use principally in concrete, roadstone, and agricultural purposes. Quarries were operated near Mason City, Nora Springs, and Rockwell.

About 156,000 tons of sand and gravel was produced by three companies, operating plants near Clear Lake, Swaledale, and Mason City. The material was used for building and road construction and fill.

American Crystal Sugar Co. produced lime for use at a sugar plant in Mason City.

Clayton.—A friable sandstone deposit near the town of Clayton was mined by Concrete Materials Division (Martin Marietta Corp.).

Material processed was used as molding sand. Sand was produced by H. Leslie Leas near Monona and by the county highway department.

Approximately 142,000 tons of limestone was produced commercially by five companies and used for road construction and agricultural purposes.

Clinton.—Limestone was produced at 12 quarries operated by Lowe & Eschman Construction Co. at various locations throughout the county; and a quarry near Grand Mound by the Techau Limestone Co. Limestone produced was used principally for roadbuilding and for agricultral purposes, and some riprap.

Sand and gravel was produced by four companies operating plants near Camanche, DeWitt, and Wheatland.

Dallas.—Limestone was produced by Gendler Stone Products Co. at a portable plant near Dexter. Material was used in roadbuilding and for agricultural purposes.

A total of 418,000 tons of sand and gravel was produced by 4 companies, operating plants near Adel, Booneville, Minburn, Perry, and Redfield.

Adel Clay Products Co. and Redfield Brick & Tile Co. of Redfield, and United Brick & Tile Co. of Iowa at Adel produced clays for manufacture of building tile, building brick, and draintile.

Decatur.—Limestone was produced by Grand River Quarries, Inc., Jackson Quarries, Inc., and E. I. Sargent Quarries, Inc., for use principally in roadbuilding and agricultural purposes.

Des Moines.—United States Gypsum Co. produced gypsum from an underground mine near Sperry.

Two companies produced limestone at plants near Mediapolis and Burlington for use in riprap, concrete, and agricultural purposes.

Dubuque.—Sand and gravel was produced by Molo Sand & Gravel Co. near Dubuque for building, road construction, and other uses. The city of Dubuque contracted for paving gravel.

Limestone used for architectural and rough construction was produced by Becker Stone Co. Dubuque Stone Products Co., L. A. Light Construction Co., and the Dubuque County Highway Department produced crushed stone chiefly for road construction and agricultural purposes.

Fayette.—About 48,000 tons of sand and gravel was produced by four companies for building and road construction. Plants were operated near Alpha, Clermont, Randalia, and West Union. Four companies and the county highway department produced a total of 465,000 tons of crushed limestone for use principally in roadbuilding and agricultural purposes.

Hardin.—Nearly 197,000 tons of sand and gravel was produced by four companies at stationary and portable plants near Eldora, Iowa Falls, Buckeye, and New Providence. The material was used principally for building, paving, and fill.

The Iowa Limestone Co. and Weaver Construction Co., produced limestone from quarries near Alden. Production was principally for use as roadbuilding, agricultural purposes, and miscellaneous fillers.

Harrison.—Sand and gravel for road construction, fill, and other uses was produced by Schemmer Concrete Materials at a stationary plant near Logan.

Limestone was produced at a portable and stationary plant near Logan by Clark Construction Co. and W. A. Schemmer Limestone Q., Inc., respectively. Output was for road construction, agricultural use, riprap, and other purposes.

Johnson.—Concrete Materials Division (Martin Marietta Corp.) and The River Products Co. produced crushed limestone at portable plants for use chiefly in roadbuilding, agricultural purposes, riprap, and railroad ballast.

Stevens Sand & Gravel Co., Inc., produced 192,000 tons of sand and gravel from a portable plant near Iowa City. The material was used chiefly in construction, roadbuilding, and fill.

Linn.—About 373,000 tons of sand and gravel was produced from stationary plants near Cedar Rapids, Marion, and Mount Vernon by Concrete Materials Division (Martin Marietta Corp.), DeWees & Pottoff Stone Co., King's Concrete Co., and Frank J. Meyer Sand & Gravel Co. Material produced was used principally for building, paving, and fill. Approximately 1.3 million tons of crushed limestone was produced from portable and stationary plants operated near Cedar Rapids, Marion, and Mount Vernon by five companies.

Madison.—Over 1.9 million tons of limestone was quarried by six companies and the county highway department. Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. were the principal producers, using their output in their Polk County cement plants. Substantial tonnages of crushed limestone were also produced for roadbuilding and agricultural purposes.

Marquette Cement Manufacturing Co. mined shale near Earlham for use in its cement plant.

Mahaska.—About 318,000 tons of bituminous coal valued in excess of $1 million was produced by four companies, operating five strip mines near Oskaloosa and Pella. In the latter part of the year Mich Coal Co. acquired the mine formerly operated by De Long Coal Co.

Concrete Materials Division (Martin Marietta Corp.) produced sand and gravel from a stationary plant near Eddyville for use in building and road construction.

Miscellaneous clay was produced near Eddyville by Oskaloosa Clay Products Co. for use in manufacturing heavy clay products. No clay was produced by Griffin Pipe Products Co., who discontinued its operation in What Cheer (Keokuk County).

Kaser Construction Co. produced crushed limestone from a portable plant near Oskaloosa. The material was used chiefly for roadbuilding and agricultural purposes.

Marion.—Approximately 397,000 tons of bituminous coal valued at $1.4 million was produced from three underground mines and seven strip mines. The substantial drop in county coal output was attributed to the closing of the Wilkinson Coal Co. strip mine near Knoxville late in 1963 and the No. 3 underground mine of Lovilia Coal Co. early in 1964. Underground producers in 1964 were Liter Coal Co., Inc. (formerly operated by Good Coal Co.), Lovilia Coal Co., and Walter Coal Co. Strip mines were operated by Beard Coal Co., Hopkins Coal Co., Jude Coal Co., Inc., Newton Coal Co., Ver Steeg Coal Co., and Weldon Coal Co.

Three companies produced crushed limestone at stationary and portable plants near Harvey, Lacona, and Pella. The material was used chiefly for roadbuilding and agricultural purposes.

Ver Steeg Coal Co. produced fire clay in conjunction with their coal-mine operation near Knoxville and sold the material for use in making building brick.

Sand and gravel was produced from plants near Knoxville, Pella, and Harvey by Knoxville Sand & Gravel, Pella Construction Co., Ltd., and Riggen Bros., respectively.

Marshall.—Crushed limestone was produced by Concrete Materials Division (Martin Marietta Corp.) from a stationary plant near Ferguson for use in roadbuilding and agricultural purposes.

Sand and gravel was produced by two commercial companies, operating fixed plants near Clemons and Marshalltown. Output was for building and road construction, and fill. The county highway department contracted for paving gravel.

Muscatine.—Wendling Quarries, Inc., produced limestone near Atalissa, chiefly for road construction, agricultural purposes, and riprap.

Sand and gravel was produced by five companies, operating stationary and portable plants near Lone Tree Moscow, and Muscatine.

Polk.—The county ranked second in the State in value of minerals produced with a value of over $15 million.

Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. operated cement plants in Des Moines and West Des Moines, respectively, and produced portland cement types I, II, and III. Masonry cement was also produced by Marquette Cement Manufacturing Co.

Clay was produced near Des Moines by Des Moines Clay Co. and Iowa Clay Pipe Co. The material was used for manufacturing building brick and vitrified sewer pipe.

Sand and gravel was produced commercially by seven companies operating portable and stationary plants in the Des Moines and West Des Moines area. Some gravel was contracted for by the county highway department for use in roadbuilding.

Pottawattamie.—Schildberg Rock Products Co., Inc., produced crushed limestone at portable plants near Council Bluffs and Macedonia. The material was used principally for roadbuilding, agricultural purposes, and riprap.

The county highway department contracted for paving sand.

Poweshiek.—Crushed 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 chiefly for roadbuilding and agricultural purposes.

Scott.—Mineral production of Scott County, the third ranking mineral producing county in the State, was valued at slightly over $14 million. With a plant at Davenport, Dewey Portland Cement Co. produced types I, II, and III portland cement and masonry cement. As part of its major improvement and expansion program, the company planned to add a new kiln to its plant which would increase the plant annual capacity to about 4.5 million barrels.

Lime was produced by Linwood Stone Products Co., Inc., at its plant near Buffalo. The company was the only commercial producer of quicklime and hydrated lime in the State.

Sand and gravel was produced by Builders Sand & Gravel Co., operating a dredge near Princeton.

Clay and limestone were produced near Davenport by Dewey Portland Cement Co. for use in cement manufacturing at their plant in Davenport.

Crushed limestone was also produced by LeClaire Quarries, Inc., Linwood Stone Products Co., Inc., and Weaver Construction Co. at plants near LeClaire, Davenport, and McCausland, respectively.

Sioux.—About 751,000 tons of sand and gravel was produced, chiefly for building, paving, and fill. Plants were operated principally in the vicinities of Boyden, Hawarden, Ireton, and Rock Valley.

Story.—Clay was produced by Nevada Brick & Tile Co. from a pit near their plant at Nevada for use in manufacturing draintile. Crushed limestone was produced at a stationary plant near Ames by Ray Cook Construction Co., Inc., and at a portable plant near Roland by Weaver Construction Co. Production was used chiefly in roadbuilding and agricultural purposes.

Sand and gravel was produced by three companies, operating portable and stationary plants near Ames and Nevada. Output was for building, paving, and fill.

Van Buren.—Nearly 17,000 tons of bituminous coal was produced from a strip mine operated near Eldon by Laddsdale Coal Co., Inc. Crushed limestone was produced commercially from an underground mine operated near Douds by Douds Stone, Inc., and from open quarries operated near Selma and Farmington by Kaser Construction Co. and Triangle Quarries, Inc., respectively. The material was used for road construction, railroad ballast, and agricultural purposes. The county highway department produced limestone for road use and riprap.

Sand and gravel was produced at a stationary plant operated near Farmington by Valley Limestone & Gravel, Inc. Production was used in building and paving.

Webster.—Gypsum was mined by open-pit methods near Fort Dodge by Bestwall Gypsum Co., The Celotex Corp., National Gypsum Co., and United States Gypsum Co. Each company operated processing and fabricating facilities.

Sand and gravel was produced at portable plants operated by Maudlin Construction Co., Welp & McCarten, Inc., and the highway departments of Calhoun and Webster Counties.

Clay was produced by Kalo Brick & Tile Co. near Coalville and by Johnston Clay Works, Inc., and Vincent Clay Products Co. near Fort Dodge. Production was used for manufacturing building brick and other heavy clay products, floor and wall tile, and mortar mix. Lehigh Sewer Pipe & Tile Co. discontinued operations.

Fort Dodge Limestone Co. produced limestone from an underground mine near Fort Dodge for road construction and agricultural use. Northwest Limestone Co. and Welp & McCarten, Inc., operated quarries near Fort Dodge and produced crushed limestone for road use.

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 W. G. Diamond,[1] A. L. Hornbaker,[2] R. G. Hardy,[2] and Margaret O. Oros [2]

VALUE of mineral production in Kansas was relatively stable as compared with previous years. An apparent decrease of $5 million was offset by the value of helium produced in private plants and sold to the United States for storage at Amarillo, Tex. Of 14 mineral commodities produced in Kansas, 9 increased in value and 5 decreased. The principal mineral commodities in order of value were petroleum, natural gas, cement, and natural gas liquids. Mineral output was reported from 103 counties. Mineral fuels and related products comprised 85.8 percent of the total value, nonmetals 13.9 percent, and metals 0.3 percent.

TABLE 1.—Mineral production in Kansas [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	8,201	$25,372	8,483	$25,959
Masonry—thousand 280-pound barrels	387	1,183	384	1,173
Clays—thousand short tons	893	1,104	785	935
Coal—do	1,169	5,311	1,263	5,749
Helium—thousand cubic feet	[2] 46,177	[2] 1,616	[3] 47,332	[3] 1,657
Lead (recoverable content of ores, etc.)—short tons	1,027	222	1,185	310
Natural gas—million cubic feet	732,946	97,482	768,246	96,031
Natural gas liquids:				
Natural gasoline—thousand gallons	165,370	9,811	162,725	8,713
LP gases—do	395,877	15,481	512,747	18,121
Petroleum (crude)—thousand 42-gallon barrels	109,107	317,501	106,252	310,256
Salt [4]—thousand short tons	924	11,993	930	11,799
Sand and gravel—do	12,062	8,676	12,968	9,108
Stone—do	13,558	18,483	14,138	18,912
Zinc (recoverable content of ores, etc.)—short tons	3,508	807	4,665	1,269
Value of items that cannot be disclosed: Natural cement, gypsum, pumice, salt (brine)	XX	3,260	XX	3,277
Total	XX	518,302	XX	513,269

XX Not applicable.

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

[2] Excludes 740,880,000 cubic feet of crude helium valued at $8,472,000 shipped to underground storage at Amarillo, Tex.

[3] Excludes 2,170,512,000 cubic feet of crude helium valued at $24,939,094 shipped to underground storage at Amarillo, Tex.

[4] Excludes salt in brine included with "Value of items that cannot be disclosed."

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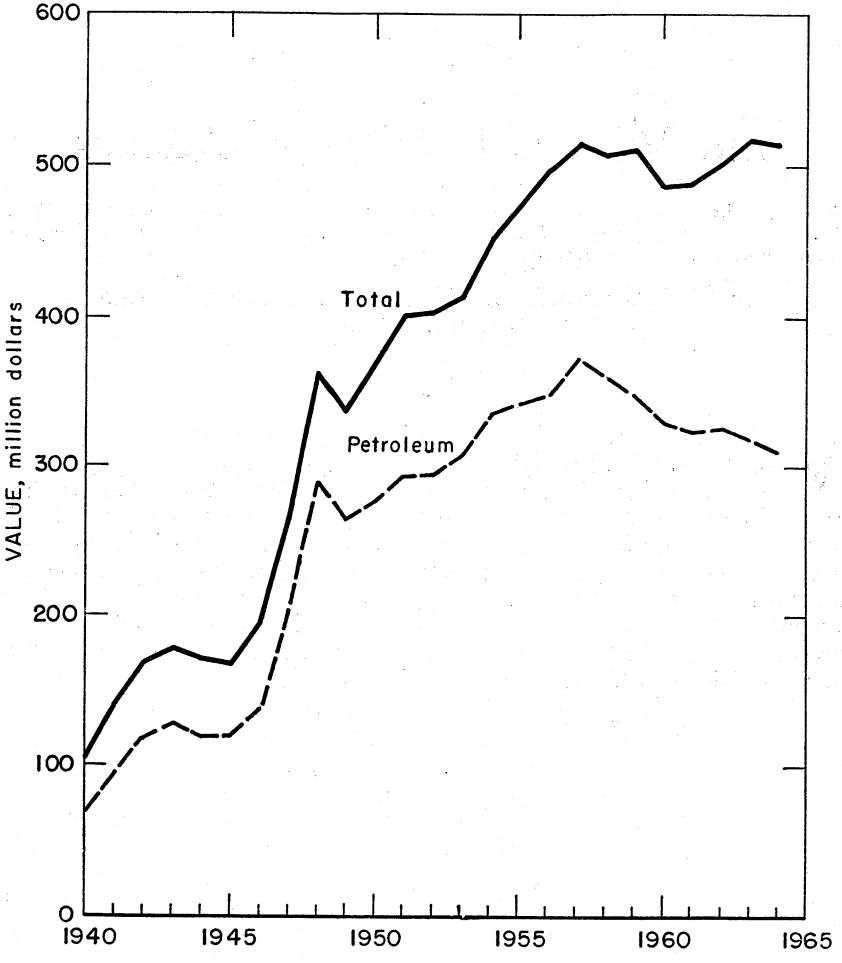


FIGURE 1.—Value of petroleum, and total value of mineral production in Kansas.

According to the Kansas Highway Commission, highway construction contracts approved during the year totaled $80.2 million. Projects authorized included 541 miles of State highways, 148 bridges, 762 miles of county secondary roads, 93 county secondary bridges, and 1,747 miles of road maintenance and resurfacing. An additional 83.1 miles of interstate highways was opened to traffic during 1964. Since enactment of the Federal Highway Act in 1956, $227.2 million has been allocated to Kansas. Of this amount, $12.4 million had not been obligated at yearend.

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

(Millions)

Year	Value	Year	Value
1952	$486	1959	$516
1953	467	1960	486
1954	492	1961	483
1955	513	1962	r 490
1956	529	1963	r 507
1957	509	1964	500
1958	506		

r Revised.

Employment and Injuries.—According to the Employment Security Division of the Kansas Department of Labor, average annual employment in crude petroleum and natural gas industries in 1964 was 12,900, 300 less than in 1963. According to the Workmen's Compensation Commission, State of Kansas, 1,116 on-the-job injuries occurred in the mining industries in 1964. Eleven injuries were fatal; eight fatalities occurred in oil and gas well drilling, and three in nonmetallic mining and quarrying.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours (worked thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	243	57	439	----	14	32
Metal	62	13	104	----	3	29
Nonmetal	1,107	314	2,504	----	55	22
Sand and gravel	962	211	1,833	----	24	13
Stone	2,242	470	3,896	----	39	10
Total	4,616	1,065	8,776	----	135	15
1964: p						
Coal	231	59	400	----	21	52
Metal	70	18	146	----	7	48
Nonmetal	1,105	307	2,457	----	46	19
Sand and gravel	1,035	226	1,970	----	24	12
Stone	2,200	475	3,908	4	36	10
Total	4,641	1,085	8,881	4	134	16

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Total value of mineral fuels produced in 1964 was $440.5 million, $7 million more than that in 1963. Coal, helium, natural gas, and natural gas liquids increased in output and value, and petroleum decreased.

Carbon Black.—Carbon black was produced by Columbian Carbon Co. at Hickok in Grant County, using natural gas and natural gas liquids as feedstock. Output decreased in both quantity and value.

Coal (Bituminous).—Production of bituminous coal increased 8 percent in both quantity and value over that of 1963. Seven strip mines in three counties each reported output of 1,000 tons or more; production of less than 1,000 tons each was credited to six strip mines and one underground mine in Bourbon, Coffey, Linn, and Osage Counties. Overburden excavated at strip mines totaled 36 million cubic yards, an average of over 26 cubic yards for each ton of coal strip-mined. Over 98 percent of total coal mined was mechanically cleaned at three cleaning plants. Coal was shipped by rail, 76 percent, and by truck, 24 percent.

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

Year	Number of mines			Short tons (thousands)	Value (thousands)
	Underground	Strip	Total		
1955–59 (average)				794	$3,534
1960	2	11	13	888	4,197
1961	1	9	10	664	3,102
1962	1	10	11	915	4,249
1963	1	9	10	1,169	5,311
1964		7	7	1,263	5,749

[1] Excludes mines producing less than 1,000 short tons.

Helium.—Three private helium plants, constructed to implement the long-range helium-conservation program, delivered crude helium to the Federal Bureau of Mines for storage in Cliffside gasfield at Amarillo, Tex. Helium was extracted from natural gas en route to fuel markets and transported in the Bureau of Mines pipeline system. Helium was recovered at the Northern Helex Co. plant near Bushton in Ellsworth County, the Cities Service Helex, Inc., plant near Ulysses in Grant County, and the National Helium Corp. plant near Liberal in Seward County.

The Federal Bureau of Mines helium plant at Otis, Rush County, produced and shipped about 44.8 million cubic feet of helium, valued at $1.6 million. This was a slight decrease from the 46.4 million cubic feet shipped in 1963, due primarily to the declining supply of helium-bearing natural gas available to the plant. The Otis plant produces helium having a purity of 99.995 percent; sales are to other Federal agencies and to commercial customers.

Kansas Refined Helium Co. contracted for construction of a liquid helium plant near Otis in Rush County; design and construction contractor was American Messer Corp., New York. The plant will extract helium and produce liquid helium to supply a national distribution network. Announced plant capacity was 500,000 cubic feet of liquid helium per day.

Natural Gas.—Production of natural gas reached a record high. Natural gas was produced from 8,308 wells, compared with 8,266 wells in 1963. Kansas ranked fifth in marketed production. Over 76 percent of the State total was produced in the Hugoton gasfield area, comprising all or part of Finney, Grant, Hamilton, Haskell, Kearny, Morton, Seward, Stanton, and Stevens Counties.

Natural Gas Liquids.—Recovery of natural gas liquids increased 20 percent in volume and 6 percent in value over that of 1963. LP gases comprised 76 percent of total output and 68 percent of total value; recovery of LP gases increased 30 percent in volume and 17 percent in value over that of 1963. Natural gasoline supplied 24 percent of total volume and 32 percent of total value; recovery of natural gasoline decreased 2 percent in volume and 11 percent in value. During the year, Cities Service Oil Co. began operating its plant at Wilburton in Morton County.

Petroleum.—Kansas ranked seventh in volume and value of petroleum production; total output decreased 3 percent in quantity and 2 percent in value from that of 1963. Petroleum producing wells totaled 45,715, compared with 46,951 wells in 1963.

TABLE 5.—Marketed production of natural gas

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1955–59 (average)	550,010	$63,039	1962	694,352	$86,100
1960	634,410	74,226	1963	732,946	97,482
1961	649,083	81,135	1964	768,246	96,031

TABLE 6.—Marketed production of natural gas from the Kansas part of Hugoton gas area

Year	Million cubic feet	Year	Million cubic feet
1960	451,820	1963	556,067
1961	467,842	1964	567,989
1962	r 518,070		

r Revised.

Source: State Geological Survey of Kansas. 1952–57 data from Bull. 133; 1958–64 data from Bull. 179.

TABLE 7.—Important gasfields discovered in 1964

(Thousand cubic feet per day)

Pool or field	County	Initial production	Pool or field	County	Initial production
Gilbert	Barber	874	Reginer	Hodgeman	2,700
Medicine River	do	3,050	Cherry	Meade	5,050
Bordewick East	Edwards	5,500	Fitzpatrick	Rice	7,693
Wohlschlegel	Harper	2,000	Soden	Stafford	3,100

Source: State Geological Survey of Kansas. Oil and Gas Developments in Kansas During 1964. Bull. 179.

TABLE 8.—Leading gasfields[1]

(Million cubic feet)

Field	County	Discovery date	Production			
			1962	1963	1964	Cumulative to Dec. 31, 1964
Hugoton gas area	(2)	1930	518,069	556,067	567,989	7,576,269
Greenwood gas area	Morton	1951	31,277	33,394	42,479	422,254
Medicine Lodge-Boggs	Barber	1927	5,150	6,140	7,367	280,936
Spivey-Grabs-Basil	Harper-Kingman	1949	28,353	30,811	33,222	186,581
Rhodes	Barber	1954	6,616	6,271	3,964	81,292
Hardtner	do	1954	5,061	5,361	4,512	79,730
McKinney	Clark-Meade	1950	7,166	7,356	5,495	65,860
Glick	Comanche-Kiowa	1957	10,959	14,160	16,050	51,640
Boggs Southwest	Barber	1955	2,686	1,922	1,859	46,826
Sparks	Morton-Stanton	1954	5,243	4,605	5,086	46,304
Aetna gas area	Barber	1935	5,775	5,618	5,589	40,153
Richfield	Morton	1948	1,033	1,575	2,040	32,193
Taloga	do	1955	1,734	1,730	1,552	31,775
Liberal-Light	Seward	1951	859	523	502	30,206

[1] Fields with cumulative production in excess of 30 billion cubic feet.
[2] Stevens, Grant, Kearny, Finney, Haskell, Morton, Seward, Stanton, and Hamilton Counties (in descending order of cumulative production).

Source: State Geological Survey of Kansas. Oil and Gas Developments in Kansas During 1964. Bull. 179.

TABLE 9.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1955–59 (average)	112,287	$6,124	105,285	$4,476	217,572	$10,600
1960	115,868	6,694	127,270	6,343	243,138	13,037
1961	132,180	5,790	135,643	5,916	267,823	11,706
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

TABLE 10.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	121,794	$353,395	1962	112,076	$326,141
1960	113,453	329,014	1963	109,107	317,501
1961	112,241	324,376	1964	106,252	310,256

TABLE 11.—Crude petroleum production, indicated demand and stocks in 1964 by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Kansas (end of month)	Month	Production	Indicated demand	Stocks originating in Kansas (end of month)
January	9,317	9,375	7,513	September	8,674	8,555	6,746
February	8,591	8,720	7,384	October	9,003	8,308	7,441
March	9,194	8,857	7,721	November	8,579	8,664	7,356
April	8,921	8,319	8,323	December	9,026	8,838	7,544
May	8,683	8,707	8,299				
June	8,567	9,560	7,306	Total: 1964	106,252	106,279	XX
July	8,944	9,745	6,505	1963	109,107	109,743	XX
August	8,753	8,631	6,627				

XX Not applicable.

Petroleum refineries in the State operated at about 78 percent of capacity, compared with 81 percent in 1963. Daily crude capacity was increased by 2,500 barrels per stream day to a total of 371,975 barrels.[3]

Kansas had 41,262 stripper wells producing oil on January 1, 1964, 1,477 more than in 1962.[4] Petroleum recovered from stripper wells totaled 64.3 million barrels, about 60 percent of Kansas petroleum output, compared with 70.0 million barrels and 64 percent of output in 1962. Oil reserves attributed to stripper wells totaled 450 million barrels, compared with 503 million barrels in 1962.

TABLE 12.—Pipeline runs of crude petroleum by fields[1]

(Thousand 42-gallon barrels)

Field[2]	1960	1961	1962	1963	1964
Bemis-Shutts	4,472	4,116	3,988	3,750	3,568
Chase-Silica	3,219	2,919	3,902	2,814	2,964
El Dorado	4,291	4,239	3,986	3,556	3,141
Fairport				1,044	1,171
Geneseo-Edwards	1,565	1,529	1,454	1,284	1,298
Gladys				1,103	1,106
Gorham	1,311	1,238	1,196	1,386	1,480
Hall-Gurney	3,229	3,291	3,199	3,205	3,328
Hanston-Oppy				1,235	1,092
Kismet			1,099	1,097	881
Kraft-Prusa	2,526	2,317	2,147	2,085	2,032
Lost Springs	1,914	2,350	1,848	1,233	894
Marcotte	1,424	1,258	1,163	1,034	1,010
Morel	1,299	1,239	1,227	1,145	1,148
Pleasant Prairie	1,839	1,719	1,676	1,440	1,126
Ray	1,289	1,306	1,322	1,259	1,210
Ritz-Canton	1,199	1,120	1,396	1,049	1,019
Spivey-Grabs-Basil	2,492	3,726	3,949	3,648	3,400
Trapp	2,752	2,542	2,439	2,874	2,951
Other fields[3]	78,523	77,302	76,035	72,822	71,433
Total	113,344	112,211	112,026	109,063	106,252
Change in field stocks[3]	+109	+30	+50	+44	
Total production[3]	113,453	112,241	112,076	109,107	106,252

[1] Fields with current annual pipeline runs in excess of 1 million barrels.
[2] Breakdown for individual fields by Kansas Geological Survey.
[3] Bureau of Mines figures.

[3] Oil and Gas Journal. V. 63, No. 14, Apr. 5, 1965, p. 158.
[4] Oil and Gas Journal. V. 62, No. 41, Oct. 12, 1964, p. 107.

TABLE 13.—Important oilfields discovered in 1964

Field	County	Initial production (barrels per day)	Field	County	Initial production (barrels per day)
Worner	Atchison	52	Rokey	Nemaha	80
Galatia South	Barton	97	Betz	Ness	101
Cloverdale	Chautauqua	25	Bondurant	do	102
Dortland	Ellis	138	Dunes North	Pawnee	105
Pfeifer	do	120	Petrowsky	Pratt	57
Schoenthaler	do	138	Babcock	Rice	80
Salburn	do	198	Babcock South	do	141
Weitzel Northeast	do	26	Baxter	Russell	217
Horchem	Gove	306	Coal Creek Northeast	do	24
Horchem West	do	101	Donovan Southeast	do	22
Jacka	do	161	Halley	Stafford	84
Valhalla	do	75	Voorhees	Stevens	131
Hanston-Oppy East	Hodgeman	55	Seibel	Trego	79
Moser	Kearny	10	Zeigler	do	87
Rupp	do	86			

Source: State Geological Survey of Kansas. Oil and Gas Developments in Kansas During 1964. Bull. 179.

TABLE 14.—Leading oilfields[1]

Field	County	Discovery date	Production (thousand barrels)			
			1962	1963	1964	Cumulative to Dec. 31, 1964
El Dorado	Butler	1915	3,986	3,556	3,141	260,396
Chase-Silica	Barton, Rice, Stafford	1931	2,902	2,814	2,964	230,273
Bemis-Shutts	Ellis, Rooks	1935	3,988	3,750	3,568	191,403
Trapp	Barton, Russell	1936	2,439	2,875	2,951	186,409
Kraft-Prusa	Barton, Ellsworth	1937	2,147	2,085	2,032	105,145
Hall-Gurney	Barton, Russell	1931	3,199	3,205	3,328	99,078

[1] Fields with cumulative production in excess of 100 million barrels.

Source: State Geological Survey of Kansas. Oil and Gas Developments in Kansas During 1964. Bull. 179.

TABLE 15.—Oil and gas well drilling in 1964, by counties

County	Wells drilled					Unclassified [2]	Total
	Oil	Gas	Oil and gas	Service [1]	Dry		
Allen	59			52		64	175
Anderson	31			22	1	31	85
Atchison	1				5		6
Barber	10	28	2	1	46	1	88
Barton	86	2	2	3	112		205
Bourbon	10			2		12	24
Brown					10		10
Butler	59			39	48		146
Chase					1	1	2
Chautauqua	12				10	23	45
Cherokee						1	1
Cheyenne					1		1
Clark	1	2	1		2		6
Coffey	8			1		8	17
Comanche	1				6		7
Cowley	31	2	1	4	47		85
Crawford	36			21		105	162
Decatur	3			1	6		10
Dickinson	1			1	6		8
Edwards	1	3	1		11		16
Elk	3				6		9
Ellis	79			6	73		158
Ellsworth	16				29		45
Finney		2		1	5		8
Ford	1				6		7
Franklin	7			3	2	20	32
Gove	12			1	29		42
Graham	21			3	41		65
Grant		4			2		6
Greeley					1		1
Greenwood	115			9	46		170
Hamilton		35		2	3		40
Harper	12	3		1	28		44
Harvey	18	1		21	18		58
Haskell	22	4	3		7		36
Hodgeman	25	2		3	59		89
Jackson	14			1	11		26
Jefferson					4		4
Johnson						20	20
Kearny	2	1			4		7
Kingman	28	7	4	5	53		97
Kiowa	6	2	3		17		28
Labette	4			1		69	74
Lane	2				15		17
Leavenworth						12	12
Lincoln					1		1
Linn	23			5		21	49
Logan					1		1
Lyon	1				3		4
McPherson	16			1	21		38
Marion	16	1		1	19		37
Marshall					1		1
Meade		7			15		22
Miami	3	1				68	72
Montgomery	45			13	1	21	80
Morris	2	1			4		7
Morton	8	7	1	1	14		31
Nemaha	1				4		5
Neosho	25			24		188	237
Ness	24			3	63	20	110
Norton	1			1	11		13
Osborne					1		1
Pawnee	22	1	1	1	24		49
Phillips	12			2	9		23
Pottawatomie					3		3
Pratt	13		1	1	30		45
Rawlins	3				12		15
Reno	19	2		41	24		86
Rice	117	9		4	98		228
Riley				1	2		3
Rooks	31			6	34		71
Rush	3	4			18		25
Russell	130	1		32	96		259
Saline	28			4	20		52
Scott	3			1	7		11
Sedgwick	37				25		62

See footnotes at end of table.

TABLE 15.—Oil and gas well drilling in 1964, by counties—Continued

County	Wells drilled					Unclassified *	Total
	Oil	Gas	Oil and gas	Service [1]	Dry		
Seward	2	15	2		9		28
Sheridan	1				6		7
Sherman					2		2
Stafford	57	2		12	73		144
Stanton		1			3		4
Stevens	1	23	2		3		29
Sumner	9	2		1	49		61
Thomas					2		2
Trego	25				39		64
Wabaunsee					8		8
Wichita					2		2
Wilson	31			20	1	96	148
Woodson	19			32	1	61	113
Total: 1964	1,465	175	24	411	1,530	842	4,447
1963	1,503	169	32	376	1,576	786	4,442

* Estimate.
[1] Service wells are waterflood wells, water-input wells, and salt-water disposal wells.

Source: State Geological Survey of Kansas. Oil and Gas Developments in Kansas During 1964. Bull. 179.

TABLE 16.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Product	Proved reserves, Dec. 31, 1963	Changes in proved reserves, due to extensions and new discoveries, in 1964	Proved reserves, Dec. 31, 1964 (production was deducted)	Changes from 1964, percent
Crude oil—thousand barrels	841,349	61,058	796,541	−5
Natural gas liquids [1]—do	169,241	50,657	209,986	+24
Natural gas—million cubic feet	17,994,235	99,291	17,278,142	−4

[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. V. 19, Dec. 31, 1964, pp. 11, 12, 22.

Petrochemicals.—Petrochemical plants were operated in Butler, Crawford, Douglas, Sedgwick, and Wyandotte Counties. During the year, Skelly Oil Co. began constructing additional facilities to produce phenol, cumene, benzene, toluene, xylene, acetone, and naphtha compounds. Annual capacity of the new facilities was to be 547,500 barrels.

NONMETALS

Total value of nonmetals produced in 1964 was $71.2 million, compared with $70.1 million in 1963. Four nonmetals recorded gains in value of production and three recorded decreases.

Cement.—Plants in Allen, Montgomery, Neosho, Wilson, and Wyandotte Counties produced 8.3 million barrels of portland cement, utilizing an average 64 percent of total capacity. Total plant capacity was increased 6 percent during the year; Ash Grove Lime & Portland Cement Co. installed two 450-foot kilns which replaced seven shorter kilns, and increased plant capacity to 2.8 million barrels per year. About 58 percent of the cement was produced by the wet process and

42 percent by the dry process. Shipments totaled 8.5 million barrels valued at $26 million, an increase of over 3 percent in volume and 2 percent in value over that of 1963. Based on reports of five of the six portland cement plants, 69 percent of shipments were by rail and 31 percent by truck. Six plants reported 88 percent of shipments in bulk and 12 percent in paper bags.

Distribution of shipments by type of customer was as follows: Ready-mixed concrete companies, 59 percent; highway contractors, 18 percent; building material dealers, 10 percent; concrete product manufacturers, 7 percent; and miscellaneous customers, 6 percent. About 50 percent of total shipments were within Kansas, 30 percent to Missouri, 8 percent to Oklahoma, 2 percent to Arkansas, 2 percent to Texas, and 8 percent to other States, including North Dakota, Iowa, Minnesota, and Tennessee.

TABLE 17.—Portland cement production and shipments

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1955–59 (average)	9,449	9,306	$27,443	1962	8,235	8,058	$25,134
1960	7,996	7,877	25,194	1963	8,248	8,201	25,372
1961	8,329	8,028	25,605	1964	8,335	8,483	25,959

TABLE 18.—Shipments of portland cement to Kansas consumers

Year	Thousand 376-pound barrels	Year	Thousand 376-pound barrels
1955–59 (average)	6,496	1962	5,331
1960	5,070	1963	5,024
1961	5,770	1964	5,132

Masonry cement was produced at all portland cement plants and at a natural cement plant in Bourbon County. Production of masonry cement decreased 7 percent from that of 1963 and shipments decreased 1 percent. About 44 percent of shipments were within Kansas, 29 percent to Missouri, 18 percent to Oklahoma, 5 percent to Arkansas, and 4 percent to various States, including Texas, Arizona, and Nebraska.

Clays.—Production of clay and shale decreased 12 percent in tonnage and 15 percent in value from that of 1963. The use pattern of Kansas clay and shale was 41 percent for cement, 37 percent for building brick, and 22 percent for lightweight aggregate, sewer pipe, heavy clay products, stoneware, and pottery. Lightweight aggregate was produced from shale in Franklin and McPherson Counties by Buildex, Inc. Sewer pipe was produced by W. S. Dickey Clay Manufacturing Co. Brick manufacturers included Humboldt Brick & Tile Co., Kansas Brick & Tile Co., Acme Brick Co., Cloud Ceramics, and Excelsior Brick Co.

TABLE 19.—Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	928	$1,182	1962	895	$1,091
1960	894	1,224	1963	893	1,104
1961	954	1,225	1964	785	935

Gypsum.—Production of crude and calcined gypsum decreased in tonnage and value. Gypsum was mined underground by National Gypsum Co. near Medicine Lodge, Barber County, and by Bestwall Gypsum Co. at Blue Rapids, Marshall County.

Kansas crude gypsum was used as a retarder in portland cement, as a soil conditioner, as a filler in paper and paint, as mild abrasives, and as a base in insecticides. Principal uses of calcined gypsum were in wallboard and wall plaster.

Perlite.—Crude perlite, mined in Western States, was processed by Lite Weight Products, Inc., at its plant in Kansas City, Wyandotte County. Expanded perlite was used as carrying agent for fertilizer and pesticides, for soil conditioning, building plaster aggregate, concrete aggregate, filler material, and loose-fill insulation.

Pumice.—Pumicite (volcanic ash) was mined by San Ore Construction Co., J. H. Shears & Sons, Inc., and Ernest Hanzlicek in Lincoln County and by Wyandotte Chemical Corp. in Norton County. Volcanic ash was used in cleansing and scouring compounds, hand soaps, dusting powders, and as aggregate in asphaltic concrete. Output was greater than that of 1963.

Salt.—Evaporated and rock salt were produced by six companies in Barton, Ellsworth, Reno, and Rice Counties; tonnage sold or used increased 1 percent, and value decreased 2 percent. One company produced rock salt, three produced evaporated salt, and two produced both rock and evaporated salt.

Meatpackers, livestock raisers, leather tanners, feed dealers, and canners were large consumers of salt. Large amounts also were used for road stabilization and snow and ice removal.

TABLE 20.—Evaporated and rock salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt	
	Quantity	Value	Quantity	Value
1955–59 (average)	422	$7,391	604	$3,203
1960	402	9,358	[1] 811	[1] 4,751
1961	411	9,180	502	2,229
1962	432	9,446	512	2,208
1963	435	9,669	489	2,324
1964	438	9,485	492	2,314

[1] Brine included with rock salt (previously included with evaporated salt) to avoid disclosing individua company confidential data.

Brine was produced in Sedgwick County by Frontier Chemical Co., a division of Vulcan Materials, for manufacturing chlorine, caustic soda, and inorganic compounds. The Atomic Energy Commission continued Project Salt Vault, the study of the feasibility of nuclear waste disposal in natural salt formations in the inactive Carey Salt Co. mine at Lyons in Rice County.

Underground Vault & Storage Co., Inc., maintained industrial storage facilities in a section of the Carey Salt Co. mine at Hutchinson in Reno County.

Sand and Gravel.—Sand and gravel was produced in 85 counties at 136 commercial and 76 noncommercial operations. Over 89 percent of total production was used for building and highway construction. Commercial operations supplied 79 percent of total tonnage and 86 percent of total value. Nearly 86 percent of total production was processed. Shipments of commercial production was 95 percent by truck and 5 percent by rail. Leading producing counties in terms of value were Wyandotte, Sedgwick, Saline, Ellsworth, and Lincoln.

Stone.—Limestone, sandstone, and miscellaneous stone were quarried in 54 counties. Limestone production from 53 counties supplied 95 percent of total tonnage and 94 percent of total value. Crushed limestone was produced in 53 counties at 134 commercial and 27 noncommercial operations. Dimension limestone was quarried and prepared at 10 operations in 6 counties. Crushed sandstone was produced in Atchison, Graham, Lincoln, Neosho, and Norton Counties. Dimension sandstone was quarried in Bourbon County. Crushed miscellaneous stone was produced in Cherokee and Rawlins Counties.

TABLE 21.—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
1955–59 (average)	8,975	$6,333	1,860	$830	10,835	$7,163
1960	8,178	6,148	1,532	660	9,710	6,808
1961	8,975	6,722	2,391	1,059	11,366	7,781
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

TABLE 22.—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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,313	$2,456	3,645	$2,736
Paving	2,814	2,265	3,350	2,638
Fill	876	413	901	390
Other [1]	186	200	209	210
Total	7,189	5,334	8,105	5,974
Gravel:				
Building	366	402	438	401
Paving	1,992	1,683	1,432	1,168
Fill	59	29	66	53
Other [2]	157	155	186	192
Total	2,574	2,269	2,122	1,814
Total sand and gravel	9,763	7,603	10,227	7,788
Government-and-contractor operations:				
Sand:				
Building			17	7
Paving	1,234	605	1,258	637
Other [3]	14	5	63	25
Total	1,248	610	1,338	669
Gravel:				
Building			70	44
Paving	1,051	463	1,333	607
Total	1,051	463	1,403	651
Total sand and gravel	2,299	1,073	2,741	1,320
Grand total	12,062	8,676	12,968	9,108

[1] Includes railroad ballast, other construction, and industrial sand (unground).
[2] Includes other construction and miscellaneous gravel.
[3] Includes fill (1963).

TABLE 23.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Allen	3	$3	Linn	27	$11
Anderson	8	3	Logan	34	45
Barber	69	64	McPherson	35	14
Barton	228	113	Morris	2	1
Bourbon	5	5	Nemaha	40	40
Butler	5	2	Ness	69	30
Chase	45	32	Norton	27	11
Chautauqua	11	12	Osborne	61	22
Clark	24	12	Pawnee	103	74
Clay	101	87	Phillips	24	10
Coffey	22	9	Pottawatomie	79	44
Comanche	33	13	Pratt	160	78
Cowley	388	283	Rawlins	9	9
Decatur	70	44	Reno	410	229
Ellis	208	129	Republic	199	138
Ellsworth	668	542	Rice	249	144
Finney	134	178	Rooks	39	17
Ford	206	142	Rush	9	4
Franklin	12	5	Russell	104	42
Gove	36	18	Saline	757	688
Graham	19	9	Scott	9	11
Grant	28	15	Sedgwick	1,607	916
Greeley	27	11	Sherman	65	42
Harper	158	106	Stevens	34	14
Harvey	159	87	Sumner	131	77
Haskell	35	18	Thomas	101	98
Hodgeman	71	28	Washington	227	156
Jackson	59	24	Wyandotte	1,889	1,465
Jewell	22	8	Other counties [1]	3,579	2,648
Lane	21	11			
Leavenworth	14	17	Total	12,968	9,108

[1] Includes Cheyenne, Cloud, Dickinson, Doniphan, Douglas, Edwards, Geary, Gray, Hamilton, Johnson, Kearny, Kingman, Kiowa, Lincoln, Lyon, Marshall, Mitchell, Neosho, Riley, Seward, Shawnee, Sheridan, Stafford, Trego, Wallace, and Wichita Counties, combined to avoid disclosing individual company data. Undistributed amounts from various counties are also included.

TABLE 24.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Limestone [1]		Miscellaneous stone		Total stone	
	Quantity	Value	Quantity	Value	Quantity	Value
1960	11,446	$14,899	[2] 368	[2] $132	[3] 11,814	[3] $15,031
1961	11,948	16,242	[2] 380	[2] 169	[3] 12,328	[3] 16,411
1962	13,098	17,106	[2] 429	[2] 168	[3] 13,527	[3] 17,274
1963	12,904	17,600	[4] 654	[4] 883	13,558	18,483
1964	13,412	17,747	[4] 726	[4] 1,165	14,138	18,912

[1] Includes diatomaceous marl, limestone for cement, and limestone for lime (1961, 1962, 1963, and 1964).
[2] Includes dimension sandstone.
[3] Excludes crushed sandstone.
[4] Includes dimension and crushed sandstone.

TABLE 25.—Stone sold or used by producers, by kinds and uses

(Short tons)

Uses	1963		1964	
	Quantity	Value	Quantity	Value
Limestone: [1]				
Riprap	997,648	$1,263,220	857,446	$1,015,624
Concrete aggregate and roadstone	8,874,031	11,718,011	9,291,398	12,193,799
Agriculture	439,525	751,862	466,996	760,733
Cement	2,127,194	2,242,798	2,321,089	2,457,552
Dimension	21,744	689,657	14,313	502,499
Other [2]	443,250	934,380	461,055	816,407
Total limestone	12,903,392	17,599,928	13,412,297	17,746,614
Sandstone:				
Crushed	410,839	741,247	626,414	1,076,907
Dimension	447	8,887	447	8,887
Miscellaneous stone	243,066	133,164	98,902	79,644
Total stone	13,557,744	18,483,226	14,138,060	18,912,052

[1] Includes diatomaceous marl.
[2] Includes railroad ballast, cement rock, coal dust, whiting, other filler (1964), and flux (1963).

Principal uses for crushed stone were cement, concrete aggregate, roadstone, riprap, railroad ballast, and agricultural stone; dimension stone was used as building stone, curbing, and flagging. Commercial producers supplied 90 percent of total stone output.

Vermiculite.—Exfoliated vermiculite was produced by Dodson Manufacturing Co. at its plant at Wichita, Sedgwick County. Crude vermiculite was purchased from Zonolite Co., Libby, Mont. Output was greater than in 1963.

Water.—Water resources development continued as Congress passed the Federal Public Works Appropriation bill. The bill authorized spending $58.7 million for construction and detailed planning on 17 U.S. Army Corps of Engineers projects and 9 Bureau of Reclamation projects. The 26 projects included 14 reservoirs, 6 local protection works, and 6 irrigation units.

METALS

The Kansas lead- and zinc-producing area (Cherokee County) is part of the Tri-State district, which also includes northeastern Oklahoma and southwestern Missouri. Further details on Tri-State activity are given in the Oklahoma chapter.

Lead pigments and sulfuric acid were produced by The Eagle-Picher Co. at its lead smelter and acid plant near Galena. Feedstock for the smelter was supplied by captive mines and other producers. Ozark Smelting & Mining Co. operated its pigment plant at Coffeyville.

Lead.—Producing lead mines included the Grace B and Westside No. 2 mines operated by The Eagle-Picher Co. and Big John, Lucky Jew, and Wright mines operated by Mid-Continent Lead & Zinc Co. Other operators included Thompson & Abbott and John Henderson.

Zinc.—Leading producers were The Eagle-Picher Co., Residue Mining Co., and Mid-Continent Lead & Zinc Co.

TABLE 26.—Mine production of lead and zinc, in terms of concentrates 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)
1955–59 (average)	----	5,145	$934	28,753	$2,326	3,834	$1,134	15,515	$3,892
1960	4	1,411	129	4,162	314	781	183	2,117	546
1961	9	1,910	222	4,730	311	1,449	298	2,446	563
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

[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.

REVIEW BY COUNTIES

Mineral production was reported in 103 of the 105 counties, 2 less than in 1963. Sixty counties reported mineral production valued at $1 million or more each, 1 less than in 1963. The five principal mineral producing counties were Grant, Ellis, Seward, Barton, and Russell; these counties accounted for 24 percent of the total value of mineral production in the State. Petroleum was produced in 82 counties, natural gas in 56, and natural gas liquids in 14.

Allen.—The county ranked first in cement production, second in value of clay output, and third in value of stone production. Lehigh Portland Cement Co. at Iola and The Monarch Cement Co. at Humboldt produced portland and masonry cements; limestone and clay for cement were obtained near the plant sites. Humboldt Brick & Tile Co. mined miscellaneous clay for use in heavy clay products. Limestone was quarried and crushed for concrete aggregate and agstone; producers included the Allen County Highway Department, Nelson Quarries, Kunshek Chat & Coal Co., and The Monarch Cement Co.

Anderson.—Murray Limestone Products, Killough-Clark, Inc., and Hunt Rock Co. quarried and crushed limestone for concrete aggregate, roadstone, and agstone (agricultural stone). Gravel for paving and road maintenance was produced by the county highway department.

Atchison.—George W. Kerford Quarry Co., Ralph H. Bromley & Sons Quarry, and the county highway department quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Mid-Continent Stone & Construction Co. produced broken sandstone for use as riprap. Exploratory drilling resulted in discovery of Worner oilfield.

Barber.—Barber County ranked first in gypsum production. Gypsum was mined and processed at Medicine Lodge by National Gypsum Co. The county ranked high in natural gas output; exploratory drilling resulted in two important gasfields, Gilbert and Medicine River. Natural gas liquids were recovered by Skelly Oil Co. at its Medicine Lodge plant. Sand and gravel for building and paving was produced by Whitfield Sand & Gravel, Burl Gaunt, Barber County Highway Department, and Harper County Highway Department.

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TABLE 27.—Value of mineral production in Kansas, by counties

County	1963 r	1964	Minerals produced in 1964 in order of value
Allen	$11,806,863	$11,990,126	Cement, petroleum, stone, clays, natural gas, sand and gravel.
Anderson	1,183,206	1,198,475	Petroleum, stone, natural gas, sand and gravel.
Atchison	307,213	(1)	Stone, petroleum.
Barber	8,850,849	8,777,632	Natural gas, petroleum, gypsum, natural gas liquids, sand and gravel.
Barton	25,733,907	25,083,809	Petroleum, natural gas, salt, sand and gravel, clays.
Bourbon	793,938	690,750	Stone, petroleum, cement, coal.
Brown	6,395		
Butler	19,554,856	18,901,723	Petroleum, stone, natural gas, sand and gravel.
Chase	362,537	364,995	Petroleum, stone, sand and gravel, natural gas.
Chautauqua	2,402,413	2,399,826	Petroleum, stone, natural gas, sand and gravel.
Cherokee	4,668,310	5,757,313	Coal, zinc, lead, stone, clays.
Cheyenne	81,514	(1)	Sand and gravel, petroleum.
Clark	2,126,403	2,093,001	Natural gas, petroleum, sand and gravel.
Clay	92,498	127,111	Sand and gravel, stone, petroleum.
Cloud	582,220	362,850	Clays, sand and gravel, stone.
Coffey	540,601	698,716	Stone, petroleum, sand and gravel, natural gas.
Comanche	1,163,086	1,146,504	Natural gas, petroleum, sand and gravel.
Cowley	12,376,825	12,001,689	Petroleum, natural gas, stone, sand and gravel.
Crawford	(1)	1,857,200	Coal, petroleum, clays, natural gas.
Decatur	1,544,801	1,514,349	Petroleum, sand and gravel.
Dickinson	786,701	723,432	Stone, petroleum, sand and gravel, natural gas.
Doniphan	457,386	229,625	Stone, sand and gravel.
Douglas	255,435	237,828	Sand and gravel, stone, petroleum, natural gas.
Edwards	1,686,275	1,577,802	Petroleum, natural gas, sand and gravel.
Elk	1,151,996	1,227,292	Petroleum, stone, natural gas.
Ellis	27,656,508	27,159,145	Petroleum, sand and gravel, stone.
Ellsworth	16,489,521	15,345,451	Natural gas liquids, petroleum, salt, sand and gravel, clays, natural gas.
Finney	13,016,070	12,819,081	Natural gas, petroleum, natural gas liquids, sand and gravel.
Ford	463,957	418,120	Natural gas liquids, sand and gravel, petroleum, natural gas.
Franklin	879,618	968,537	Petroleum, stone, clays, natural gas, sand and gravel.
Geary	692,770	489,096	Stone, sand and gravel, petroleum.
Gove	268,002	255,158	Petroleum, sand and gravel, stone.
Graham	15,537,011	14,940,272	Petroleum, stone, sand and gravel.
Grant	24,713,739	24,304,687	Natural gas, petroleum, sand and gravel.
Gray	(1)	(1)	Sand and gravel.
Greeley	3,836	11,000	Do.
Greenwood	9,660,061	9,482,217	Petroleum, stone, natural gas,
Hamilton	330,982	327,471	Natural gas, petroleum, sand and gravel.
Harper	4,113,060	5,132,553	Petroleum, natural gas liquids, natural gas, sand and gravel.
Harvey	2,093,039	2,074,385	Petroleum, natural gas, sand and gravel, natural gas liquids.
Haskell	9,783,770	9,614,344	Natural gas, petroleum, sand and gravel.
Hodgeman	5,759,643	5,625,103	Petroleum, sand and gravel, natural gas.
Jackson	89,858	50,411	Sand and gravel, stone, petroleum.
Jefferson	(1)	(1)	Stone.
Jewell	(1)	846,041	Stone, sand and gravel.
Johnson	1,104,390	1,511,097	Stone, sand and gravel, petroleum, natural gas.
Kearny	10,293,700	10,234,069	Natural gas, natural gas liquids, petroleum, sand and gravel.
Kingman	16,548,535	15,147,045	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	3,047,631	3,011,574	Natural gas, petroleum, sand and gravel.
Labette	344,775	334,836	Petroleum, stone, natural gas.
Lane	225,083	242,947	Petroleum, stone, sand and gravel.
Leavenworth	149,036	286,128	Stone, natural gas, petroleum, sand and gravel.
Lincoln	941,494	1,264,464	Stone, sand and gravel, pumice.
Linn	297,666	513,631	Stone, petroleum, natural gas, sand and gravel.
Logan	34,700	45,000	Sand and gravel.
Lyon	539,551	449,091	Petroleum, sand and gravel, stone.
Marion	7,571,247	7,190,922	Petroleum, natural gas, natural gas liquids, stone.
Marshall	1,049,180	767,576	Gypsum, stone, sand and gravel.
McPherson	7,871,806	7,640,149	Petroleum, natural gas, clays, sand and gravel.
Meade	4,074,606	3,997,501	Petroleum, natural gas.
Miami	765,091	790,788	Petroleum, stone, natural gas.
Mitchell	25,540	(1)	Sand and gravel.
Montgomery	5,329,334	6,784,092	Cement, petroleum, stone, clays, natural gas.
Morris	1,558,925	1,370,640	Petroleum, stone, natural gas, sand and gravel.
Morton	16,649,504	16,454,307	Natural gas, petroleum, natural gas liquids.
Nemaha	81,042	56,034	Sand and gravel, petroleum.
Neosho	8,018,696	7,996,201	Cement, petroleum, stone, sand and gravel, clays, natural gas.
Ness	3,067,455	2,995,537	Petroleum, sand and gravel.

See footnotes at end of table.

TABLE 27.—Value of mineral production in Kansas, by counties—Continued

County	1963 r	1964	Minerals produced in 1964 in order of value
Norton	$2,022,377	$2,214,039	Petroleum, stone, sand and gravel, pumice.
Osage	7,936	(1)	Stone.
Osborne	162,524	143,311	Petroleum, sand and gravel.
Ottawa	30,230	----------	
Pawnee	3,330,553	3,257,932	Petroleum, natural gas, sand and gravel.
Phillips	6,260,593	6,045,638	Petroleum, sand and gravel, stone.
Pottawatomie	217,922	359,273	Stone, sand and gravel.
Pratt	4,495,307	4,416,260	Petroleum, natural gas, sand and gravel.
Rawlins	2,298,271	2,247,162	Petroleum, stone, sand and gravel.
Reno	13,998,515	15,152,166	Salt, natural gas liquids, petroleum, natural gas, sand and gravel.
Republic	206,857	147,000	Sand and gravel, stone.
Rice	18,196,551	17,871,465	Petroleum, salt, sand and gravel, stone, natural gas.
Riley	748,627	687,460	Petroleum, sand and gravel, stone.
Rooks	16,212,437	15,857,509	Petroleum, sand and gravel.
Rush	2,890,782	2,895,581	Helium, petroleum, natural gas, sand and gravel.
Russell	25,021,008	24,234,340	Petroleum, natural gas, sand and gravel, stone.
Saline	2,606,727	2,808,534	Petroleum, sand and gravel.
Scott	154,488	161,985	Petroleum, sand and gravel, natural gas.
Sedgwick	11,808,139	11,287,848	Petroleum, salt, natural gas liquids, sand and gravel, natural gas.
Seward	9,356,201	11,412,114	Natural gas liquids, natural gas, petroleum, sand and gravel.
Shawnee	615,365	1,139,268	Stone, sand and gravel.
Sheridan	1,072,807	1,122,327	Petroleum, sand and gravel.
Sherman	178,454	167,265	Do.
Smith	320,732	53,122	Stone.
Stafford	15,923,461	15,563,960	Petroleum, natural gas, sand and gravel.
Stanton	2,806,893	2,764,712	Natural gas, petroleum.
Stevens	20,513,823	20,212,505	Natural gas, petroleum, sand and gravel.
Sumner	8,855,155	8,656,602	Petroleum, sand and gravel, natural gas.
Thomas	75,970	98,000	Sand and gravel.
Trego	4,681,216	4,579,007	Petroleum, sand and gravel.
Wabaunsee	(1)	697,219	Petroleum, stone.
Wallace	(1)	72,203	Stone, sand and gravel.
Washington	(1)	156,000	Sand and gravel.
Wichita	36,917	18,107	Sand and gravel, petroleum.
Wilson	5,722,780	5,064,344	Cement, petroleum, stone, clays, natural gas.
Woodson	2,237,940	2,176,116	Petroleum, stone, natural gas.
Wyandotte	8,183,798	8,156,784	Cement, stone, sand and gravel.
Undistributed	7,393,984	3,463,093	
Total	518,302,000	513,269,000	

r Revised.
1 Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Barton.—Barton County ranked second in value of mineral production and was a leader in petroleum production. Galatia South oilfield was an important discovery during the year. Evaporated salt from brine wells was produced by Pawnee Salt Co. Kansas Brick & Tile Co. used fire clay in building brick. Du Bois & Stone Sand Co., Arkansas Sand Co., James Dirks Sand & Gravel, and the county highway department produced sand and gravel for building, paving and fill uses.

Bourbon.—Natural and masonry cement were produced near Fort Scott by Fort Scott Hydraulic Cement Co., Inc. Dimension sandstone was quarried and prepared near Redfield by Bandera Stone Co. Cullor Limestone Co., Inc., and Fort Scott Hydraulic Cement Co., Inc., quarried and crushed limestone for concrete aggregate, roadstone, agstone, and coal mine dusting. Coal was strip mined by Palmer Coal Co. and Garrett Coal Co. Gravel was obtained from local deposits by various producers.

Butler.—Butler County was a leader in petroleum production and ranked eighth in total value of mineral production. Mobil Oil Co. operated its refinery at Augusta. Mobil Chemical Co. produced carbon

black oils and sodium cresylate solutions, using petroleum fractions as feedstock. Skelly Oil Co. operated its refinery at El Dorado; capacity was increased by 1,000 barrels per stream day, totaling 49,000. Skelly Oil Co. also operated its aromatics complex and produced phenol and other naphtha compounds, using naphtha fractions as feedstock; additional capacity was added in 1964. Vickers Refining Co., Division of Vickers Petroleum Co., Inc., operated its refinery at Potwin. Vickers Petroleum Co., Inc., produced benzene, toluene, xylenes, and other chemicals at its Potwin petrochemical plant using catalytic reformate as feedstock. American Petrofina Co. of Texas operated its refinery at El Dorado.

George M. Myers, Inc., Carr Rock Products Co., Starnes Excavation Co., and the City of El Dorado quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. The county highway department obtained gravel for road maintenance.

Chase.—Dimension limestone was quarried and prepared by J. T. Lardner Cut Stone Co., Bayer Stone, Inc., and H. J. Born Stone Co. Crushed limestone was produced by Anderson-Oxandale and Riddle Quarries, Inc. Chase County Highway Department and Lyon County Highway Department produced gravel for paving and road maintenance.

Chautauqua.—Limestone was quarried and crushed for concrete aggregate, roadstone, and riprap by Sedan Limestone Co. and the county highway department. Gravel for paving was produced for the county highway department. Cloverdale oilfield was an important discovery in 1964.

Cherokee.—The county ranked first in coal production. Pittsburg & Midway Coal Co., Wilkinson Coal Co., and Black Diamond Coal Co. strip mined coal. The entire production of lead and zinc in Kansas was mined in Cherokee County. The Eagle-Picher Co. and Southwest Rock & Chat Co. produced miscellaneous stone (chat) for concrete aggregate, roadstone, and railroad ballast. Miscellaneous clay was mined near Weir by Acme Brick Co. Spencer Chemical Co. produced ammonia, nitric acid, fertilizers, dry ice, and methanol, using natural gas as feedstock, at its plant near Baxter Springs.

Clay.—Limestone was quarried and crushed for concrete aggregate and roadstone by Riddle Quarries, Inc. Building and paving sand and gravel and fill sand was produced by John H. Alsop Sand Co., Clay Center Concrete & Sand Co., Inc., and Fyfe Sand & Gravel Co.

Cloud.—The county ranked first in value of clay production. Fire clay for building brick was mined by Cloud Ceramics. Fyfe Sand & Gravel Co. and the county highway department produced sand and gravel for building, paving, and fill uses. Limestone was quarried and crushed for concrete aggregate and roadstone by the county highway department.

Coffey.—Nelson Bros. Quarries, Anderson-Oxandale, Riddle Quarries, Inc., Jones Construction & Material Co., and Neosho Valley Rock Co. quarried and crushed limestone for concrete aggregate, roadstone, riprap, and agstone. The county highway department produced gravel for paving and road maintenance. S. L. Rogers Coal Co. strip mined coal near Lebo.

Cowley.—The county ranked high in petroleum production. Apco Oil Corp. operated its refinery at Arkansas City. Dimension limestone was quarried and perpared by H. J. Born Stone Co., Silverdale Limestone Co., and John V. Elam. Crushed limestone for concrete aggregate, roadstone, riprap, and agstone was produced by Daniels Stone Co. Building, paving, and fill sand and gravel, railroad sand, and engine sand were produced by Carr Rock Products Co., George M. Myers, Inc., Andrews Sand & Gravel, Inc., Oxford Sand & Gravel Co., McFarland Gravel Co., Wilson Bros., and the county highway department.

Crawford.—Crawford County ranked second in coal production and fifth in value of clay output. Clemens Coal Co. operated two strip mines and Cliff Carr Coal Co. operated one strip mine. W. S. Dickey Clay Manufacturing Co. and Pittsburg Pottery Co., Inc., used fire clay and miscellaneous clay for sewer pipe and stoneware.

Dickinson.—Walker Cut Stone Co., Anderson-Oxandale, and Riddle Quarries, Inc., quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Sand and gravel for building and paving was produced by Shoffner Sand & Gravel Co.

Doniphan.—Limestone was quarried and crushed for concrete aggregate, roadstone, and riprap by West Lake Quarry & Material Co., Wolf River Limestone, Inc., and Everett Quarries, Inc. The county highway department obtained gravel for paving.

Douglas.—Holliday Sand & Gravel Co. and Bowersock Mills & Power Co. produced sand for building and fill uses. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Killough-Clark, Inc. Cooperative Farm Chemicals Association produced ammonia, nitric acid, and fertilizers, using natural gas as feedstock, at its palnt near Lawrence.

Edwards.—Bordewick East gasfield was an important discovery during the year. Sand for paving and fill uses was produced by Kinsley Sand & Gravel Co. and the county highway department.

Elk.—Limestone was quarried and crushed for concrete aggregate, roadstone, railroad ballast, and agstone by Concrete Materials Division, Martin Marietta Corp., and Sedan Limestone Co.

Ellis.—Ellis County ranked first in petroleum production and in total value of mineral production. Dortland, Pfeifer, Schoenthaler, Solburn, and Weitzel Northeast oilfields were important discoveries in 1964. Hunter Ready Mix Co., Inc., Larry F. Werth, Rush County Highway Department, and Ellis County Highway Department produced sand and gravel for building, paving, and fill uses. Limestone was quarried and crushed for concrete aggregate and roadstone by Aubel Asphalt Co. and the county highway department. Hays Cut Stone & Veneer prepared dimension limestone.

Ellsworth.—Ellsworth County ranked first in production of natural gas liquids. Northern Gas Products Co., subsidiary of Northern Natural Gas Co., operated its natural gas liquids extraction plant at Bushton. The company natural gas storage facility in a salt formation was increased by 500,000 barrels, totaling 2.5 million barrels. Northern Helex Co., another subsidiary of Northern Natural Gas Co., operated its helium extraction plant adjacent to the natural gas liquids plant. Independent Salt Co. mined salt near Kanopolis. San Ore

Construction Co., Inc., Shoffner Sand, Inc., Stoppel Construction Co., and the county highway department produced sand and gravel for building and paving. Acme Brick Co. and Kansas Brick & Tile Co. mined clay for building brick.

Finney.—Finney County ranked high in natural gas production. Natural gas liquids were recovered by Northern Natural Gas Co. at its plant near Holcomb. Smith Sand Co., Inc., Southwest Sand Co., Alsop Sand Co., and the county highway department produced sand and gravel, mainly for building and paving.

Ford.—Dodge City Sand Co., Miller Sand & Gravel Co., and the county highway department produced building, paving, and fill sand and gravel. Natural gas liquids were recovered by Skelly Oil Co. at its Minneola plant.

Franklin.—Buildex, Inc., produced expanded shale lightweight aggregate at its plant near Ottawa; shale was mined near the plant. Fogle Quarry, Concrete Materials Division, Martin Marietta Corp., and Killough-Clark, Inc., quarried and crushed limestone for concrete aggregate, roadstone, and agstone. The county highway department obtained gravel for paving and road maintenance.

Geary.—Walker Cut Stone Co., Bayer Construction Co., Inc., Fort Riley Reservation, and the City of Junction City quarried and crushed limestone mainly 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.

Gove.—Rod Bentley Sand & Gravel, Dave Bollinger, and the county road department produced sand and gravel for building and paving. Horchem, Horchem West, Jacka, and Valhalla oilfields were important discoveries in 1964.

Graham.—The county ranked high in petroleum production. Limestone was quarried and crushed for concrete aggregate and roadstone by Anderson-Oxandale. Anderson-Oxandale produced crushed sandstone for riprap use by the State Highway Commission. Building and fill sand were produced by Orville E. Clary and the county highway department.

Grant.—The county led in natural gas production, ranked second in natural gas liquids production, and third in total mineral production value. 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 plant near Hickok. Columbian Carbon Co. produced carbon black at its Hickok plant. Crude petroleum was recovered in the county. The county highway department obtained gravel for paving and road maintenance.

Harper.—Hi-Grade Sand Co. and the county highway department obtained sand and gravel for building, paving, and road maintenance. Mobil Oil Co. operated its natural gas liquids plant in the county. Wohlschlegel gasfield was an important discovery in 1964.

Harvey.—Bryant Sand Co. produced building and paving sand near Burrton. Natural gas liquids were recovered by Kansas Hydrocarbons Co. at its plant near Burrton.

Hodgeman.—Hanston-Oppy East oilfield and Reginer gasfield were important discoveries in 1964. Both discoveries were in the Osagian

producing zone. The county highway department obtained sand for paving and road maintenance.

Jackson.—Limestone was quarried and crushed for concrete aggregate and roadstone by Anderson-Oxandale and G. W. Baker. The county highway department obtained gravel for paving.

Jefferson.—Jefferson County ranked fourth in value of stone produced. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by N. R. Hamm Quarry, Inc., and Roy Baker Quarry, Inc.

Jewell.—Ideal Cement Co. quarried limestone for cement at its plant near Superior, Nebr. Anderson-Oxandale and the county highway department quarried and crushed limestone for concrete aggregate and roadstone. Gravel for paving and road maintenance was obtained by the county highway department.

Johnson.—The county ranked second in value of stone production. Reno Construction Co., Union Construction Co., and Deitz-Hill Development Co. quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Building, paving, fill and filtration sand, and paving gravel were produced by Holliday Sand & Gravel Co. and Builders Sand Co.

Kearny.—The county ranked high in natural gas production. Natural gas liquids were recovered by Colorado Interstate Gas Co. at its Lakin plant and by Kansas-Nebraska Natural Gas Co. at its Deerfield plant. Moser and Rupp oilfields were important discoveries in 1964. Popejoy Sand & Gravel Co. and the county highway department produced building and paving sand and gravel.

Kingman.—Sand and gravel, mainly for building and paving, was produced by Ray Wells and the county highway department. Kansas Hydrocarbons Co. operated its natural gas liquids plant near Cheney.

Kiowa.—Sand for building, paving, fill, and other construction uses was produced by Seacat Sand & Excavation Co., San Ore Construction Co., Inc., and the county highway department.

Labette.—Carr Rock Products Co., the county highway department, and the City of Parsons quarried and crushed limestone for concrete aggregate and roadstone.

Leavenworth.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Concrete Materials Division, Martin Marietta Corp., and Hamm Quarries. Sand for fill and other uses was produced by Missouri Valley Sand, Inc.

Lincoln.—The county ranked fifth in value of stone production and sand and gravel production. Quartzite Stone Co., Inc. quarried and crushed sandstone for concrete aggregate, roadstone, riprap, railroad ballast, and filter use. Limestone was quarried and crushed for riprap by C. W. Roweth Co. Material Producers, Inc., and San Ore Construction Co., Inc., produced paving sand and gravel. Federal Bureau of Reclamation contracted for paving gravel. Volcanic ash was produced by San Ore Construction Co., J. H. Shears & Sons, Inc., and Ernest Hanzlicek.

Linn.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Reno Construction Co., Murray Limestone Products, and Lee Giles Rock Co. Gravel for paving and road maintenance was produced by the county highway department.

Lyon.—Wesley Parks and the county highway department produced sand and gravel for building, paving, and road maintenance. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by W. S. Jones Rock Co.

Marion.—Rounds & Stewart Natural Gasoline Co., Inc., recovered natural gas liquids at its plant near Marion. Riddle Quarries, Inc., The Walt Keeler Co., Inc., and Anderson-Oxandale quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap.

Marshall.—Bestwall Gypsum Co. mined gypsum near Blue Rapids and produced plaster and plaster products. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Koppes Brothers, Bayer Construction Co., Inc., and Hopper Bros. Quarries. Blue River Sand & Gravel Co., Heinzelman Construction Co., and C. V. Garrett produced sand and gravel for building, paving, and fill uses.

McPherson.—National Cooperative Refinery Association operated its petroleum refinery at McPherson. Shale was mined for producing expanded shale lightweight aggregate by Buildex, Inc., at its plant near Marquette. The county highway department obtained sand for paving.

Meade.—Crude petroleum and natural gas were produced in Meade County in 1964. Cherry gasfield was an important discovery in 1964. Initial production was 2,950 thousand cubic feet of natural gas per day.

Miami.—Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Reno Construction Co., L. W. Hayes, Inc., and White-Hruska Quarry, Inc.

Montgomery.—The county ranked third in cement production. Shale and limestone for manufacturing portland and masonry cements were mined by Universal Atlas Cement Division of U.S. Steel Corp. H. & S. Rock Co., Nelson Bros. Quarries, Carr Rock Products, Inc., and the City of Coffeyville quarried and crushed limestone for concrete aggregate, roadstone, riprap, and agstone. CRA, Inc., formerly Cooperative Refinery Association, operated its petroleum refinery at Coffeyville.

Morton.—Natural gas liquids were recovered by Anadarko Production Co. at its Interstate plant near Elkhart and by Cities Service Oil Co. at its Wilburton plant. The county ranked high in natural gas production.

Nemaha.—Crude petroleum was produced in the county. Rokey oilfield was an important discovery in 1964. Gravel for paving was produced by Justin Rottinghaus, Anderson-Oxandale Co., and Uhlig & Reise.

Neosho.—The county ranked second in cement production and sixth in value of stone output. Ash Grove Lime & Portland Cement Co. quarried limestone, sandstone, and shale for portland and masonry cements. Harry Byers & Sons, Inc., O'Brien Rock Crusher, and the county highway department quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Mid-America Refining Co., Inc., operated its petroleum refinery at Chanute.

Ness.—Betz and Bondurant oilfields were important discoveries in 1964. Siebert Sand Co., Inc., and the county highway department produced sand for paving and road maintenance.

Norton.—Van Buskirk Construction Co. quarried and crushed sandstone for riprap. Anderson-Oxandale and the county highway department produced crushed limestone for concrete aggregate, roadstone, and agstone. Gravel for paving and road maintenance was produced by the county highway department. Volcanic ash was mined and prepared near Calvert by Wyandotte Chemical Corp.

Pawnee.—Dunes North oilfield was an important discovery in 1964. Johnson Sand & Gravel Co., Larned Sand & Gravel Co., and the county highway department produced building and paving sand and gravel.

Phillips.—CRA, Inc., formerly Cooperative Refinery Association, operated its petroleum refinery at Phillipsburg. The county highway department produced crushed limestone and sand for paving and road maintenance.

Pottawatomie.—Bayer Stone, Inc., prepared dimension limestone. Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Anderson-Oxandale, Concrete Materials Division, Martin Marietta Corp., Bayer Construction Co., Inc., and Bayer Stone, Inc. Wamego Sand Co. and Anderson-Oxandale Co. produced sand and gravel for building, paving, and fill uses.

Pratt.—Petrowsky oilfield was an important discovery during the year. Whitfield Sand & Gravel, Mrs. Blanche Hogard, and the county highway department produced building, paving, and fill sand and gravel.

Rawlins.—Atwood Sand & Rock Co. and Konkrete Bloc Co. produced crushed opal (miscellaneous stone) for concrete aggregate, roadstone, and roofing granules. Limestone was quarried and crushed for concrete aggregate and roadstone by Anderson-Oxandale. Building sand was produced by Atwood Sand & Rock Co. The county highway department produced paving gravel.

Reno.—Reno County ranked first in salt production and fourth in natural gas liquids output. The Carey Salt Co., Morton Salt Co., and The Barton Salt Co. produced evaporated salt from brine wells. The Carey Salt Co. mined rock salt. J. E. Steele Sand & Gravel, Shears Sand Plant, Hoskinson Sand & Gravel Co., Gravel Products, Inc., Fountain Sand Pit, Haven Sand Co., and the City of Hutchinson produced sand and gravel for building, paving, fill, other construction, and miscellaneous uses. Cities Service Oil Co. recovered natural gas liquids at its fractionation plant in Hutchinson.

Republic.—Sand and gravel for building, paving, and fill was produced by John H. Alsop Sand Co., Reece-Johnson, Inc., and the county highway department. Limestone was quarried and crushed for concrete aggregate and roadstone by the county highway department.

Rice.—The county ranked second in value of salt production. American Salt Co. produced evaporated salt from brine wells and mined rock salt near Lyons. The county ranked high in petroleum output. Babcock and Babcock South oilfields and Fitzpatrick gasfield were important discoveries during the year. Rock Hill Stone & Gravel Co.,

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 Riddle Quarries, Inc., and the county highway department.

Riley.—Kershaw Ready-Mix Concrete & Sand produced sand for building and paving uses. Limestone was quarried and crushed for concrete aggregate and roadstone by Bayer Construction Co., Inc., and Anderson-Oxandale.

Rush.—Shipments of helium with a purity of 99.995 percent from the Federal Bureau of Mines plant at Otis totaled 44.8 million cubic feet. Sand for paving and road maintenance was obtained by the county highway department.

Russell.—The county ranked fourth in value of mineral production, and was a leader in petroleum output. Baxter, Coal Creek, Northeast, and Donovan Southeast oilfields were important discoveries in 1964. The county highway department mined sand and crushed limestone for paving and road maintenance.

Saline.—The county ranked third in value of sand and gravel production. Sand and gravel, mainly for building and paving, was produced by Central Kansas Sand, Inc., Salina Sand Co., Inc., and the county highway department.

Scott.—Century Refining Co. operated its petroleum refinery at Shallow Water. The county highway department obtained sand and gravel for paving and road maintenance.

Sedgwick.—The county ranked second in sand and gravel production, third in salt production, and fifth in recovery of natural gas liquids. Sand and gravel was produced by 15 commercial producers and 1 Government-and-contractor producer in 1964. Leaders were Superior Sand Co., Inc., Dolese Bros. Co., Miles Sand, Inc., Bentley Sand Co., and Associated Material & Supply Co., Inc. Frontier Chemical Co. pumped brine from wells to manufacture chlorine and caustic soda; the company also produced ammonia. 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 vermiculite, using crude vermiculite purchased from Zonolite Co. in Libby, Mont.

Seward.—National Helium Corp. operated its helium extraction plant near Liberal. Natural gas liquids were recovered by National Helium Corp., Anadarko Production Co., and Northern Natural Gas Co. Carlisle Sand Products, Inc., and the county highway department produced sand and gravel for building, paving, and fill uses.

Shawnee.—Sand and gravel was produced by seven commercial operators; the largest was Kansas Sand Co. Limestone for concrete aggregate, roadstone, and agstone was quarried and crushed by Concrete Materials Division, Martin Marietta Corp., and Henry C. Luttjohann, Inc.

Stafford.—The county ranked high in petroleum production. Halley oilfield and Soden gasfield were important discoveries in 1964. Partin Sand & Gravel Co. and the county highway department produced gravel for paving and miscellaneous uses.

Stevens.—The county was a leader in output of natural gas, and ranked fifth in total mineral value. Voorhees oilfield was an im-

portant discovery in 1964. The county highway department produced paving sand and gravel.

Sumner.—Sand and gravel for building, paving, and fill uses was produced by Mulvane Sand Co., Inc., Builders of Mulvane, and the county highway department.

Trego.—Seibel and Zeigler oilfields were important discoveries in 1964. Sand for paving was produced by Siebert Sand Co., Inc. The county highway department mined gravel for paving.

Wallace.—Diatomaceous marl was quarried near Edson by DeLore Division, National Lead Co. Principal uses were as paint filler and whiting material. Paving sand was produced by Siebert Sand Co., Inc., and the county highway department.

Wilson.—The county ranked fourth in value of clay output and fifth in production of cement. Shale and limestone for manufacture of portland and masonry cements were mined by Victor Portland Cement Division, General Portland Cement Co. Shale for building brick was mined by Excelsior Brick Co. and Acme Brick Co. Carr Rock Products Co. and Benedict Rock & Lime Co. quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. American Oil Co. operated its petroleum refinery at Neodesha.

Wyandotte.—The county ranked first in stone and sand and gravel output and fourth in cement production. Lone Star Cement Corp. quarried limestone and manufactured portland and masonry cements at its Bonner Springs plant. Thompson-Strauss Quarries and J. A. Tobin Construction Co. quarried and crushed limestone for concrete aggregate and roadstone. Sand and gravel, mainly for building and paving, was produced by seven producers; the largest producer was Holliday Sand & Gravel Co. Crude perlite, mined in Western States, 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. Reichold Chemicals, Inc., produced phenol-formaldehyde resins, polyvinyl acetate emulsions, and formaldehyde at its chemical plant in Kansas City.

The Mineral Industry of Kentucky

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

By Harold L. Riley [1] and Preston McGrain [2]

MINERAL production value in Kentucky in 1964 increased 3 percent but was 12 percent below that of 1948, the record year. The value of coal production increased 5 percent, and the total tonnage increased 7 percent. From earliest record to date, 3,004 million tons of coal has been mined in Kentucky. Among the States, Kentucky ranked second in production of bituminous coal, ball clay, and fluorspar.

Coal mining dominated the Kentucky mineral industry and supplied 70 percent of the total value for 1964 compared with 68 percent for 1963. Leading companies, based on value of production, were Peabody Coal Co., Pittsburg & Midway Coal Co., Nashville Coal Co. and U.S. Steel Corp.

TABLE 1.—Mineral production in Kentucky [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	5,812	$85	6,014	$96
Clays [2]—thousand short tons	984	2,397	920	1,801
Coal (bituminous)—do	77,350	295,743	82,747	309,896
Fluorspar—short tons	35,072	1,537	38,214	1,693
Lead (recoverable content of ores, etc.)—do	831	179	858	225
Natural gas—million cubic feet	74,634	17,838	77,360	18,257
Petroleum (crude)—thousand 42-gallon barrels	18,344	53,564	19,772	56,746
Sand and gravel—thousand short tons	6,480	6,071	6,560	6,297
Silver (recoverable content of ores, etc.)—troy ounces	1,515	2	1,673	2
Stone—thousand short tons	24,689	34,571	[3] 21,868	[3] 29,594
Zinc (recoverable content of ores, etc.)—short tons	1,461	336	2,063	561
Value of items that cannot be disclosed: Cement, ball clay, natural gas liquids, and dimension sandstone	xx	20,370	xx	19,211
Total	xx	r 432,693	xx	444,379

r Revised. 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, included with "Value of items that cannot be disclosed."

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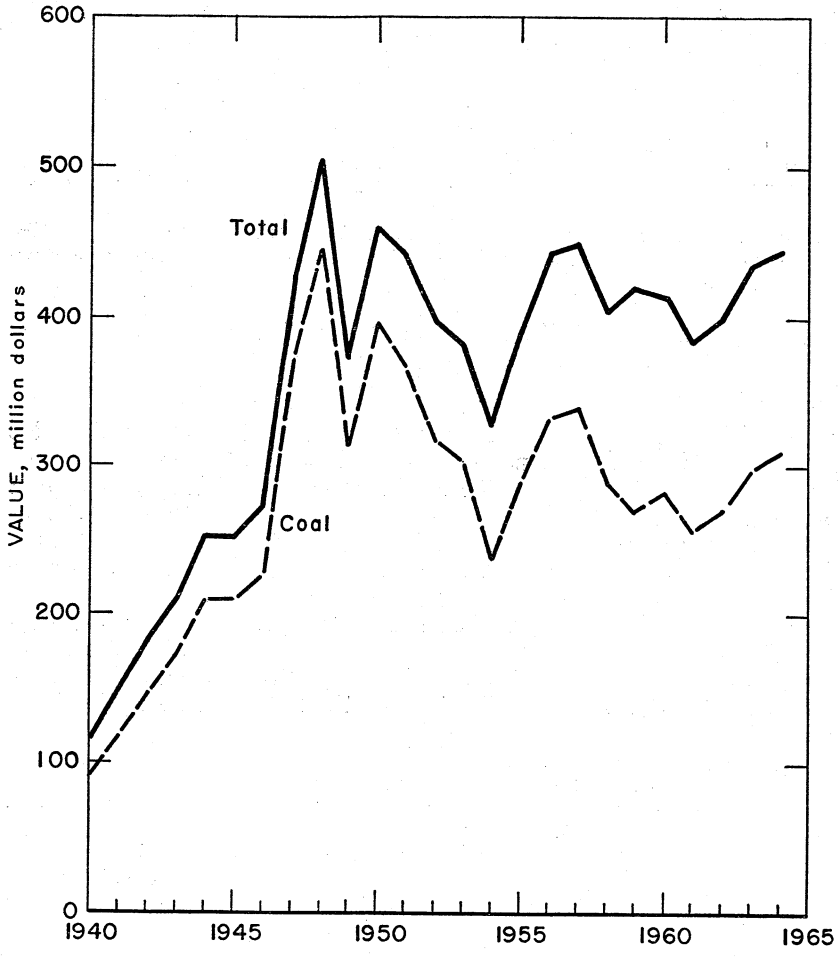


FIGURE 1.—Value of coal and total value of mineral production in Kentucky.

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

(Millions)

Year	Value	Year	Value
1955	$402	1960	$429
1956	458	1961	402
1957	439	1962	423
1958	405	1963	r468
1959	429	1964	480

r Revised.

Trends and Developments.—Peabody Coal Co. entered into a 20-year contract with Florida Power Corp. to deliver coal to the Crystal River, Fla., steam-electric generating plant which was under construction. The plant will consume an average of 850,000 tons of coal

per year. The coal will be shipped by river barge down the Green, Ohio, and Mississippi Rivers to a point below New Orleans and transferred to seagoing barges for transportation across the Gulf of Mexico. Kentucky Electric Steel Co., a new $4 million corporation, has started construction of steel plant facilities near Ashland. The plant has been financed in part by a $2.7 million loan from the Area Redevelopment Administration. Kentucky Carbon Corp. announced plans to open a new million ton per year underground coal mine in Pike County.

Tennessee Valley Authority (TVA) announced the exercise of an option to buy an additional 15.7 million tons at a cost of $47 million under an existing contract with Kentucky Oak Mining Co. at Hazard, Ky. The original contract required deliveries of 30,000 tons per week for a price of $3.00 per ton loaded at shipping points, with an option to increase shipments to 50,000 tons per week at the same price per ton.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	26,620	4,727	37,488	36	1,954	53
Metal						
Nonmetal	407	91	724		26	36
Sand and gravel	384	105	1,014		19	19
Stone	2,416	538	4,459	1	123	28
Total	29,827	5,461	43,685	37	2,122	49
1964: p						
Coal	24,000	4,350	34,260	47	1,770	53
Metal						
Nonmetal	425	89	716	1	35	50
Sand and gravel	350	94	966	1	23	25
Stone	2,135	480	3,960	4	103	27
Total	26,910	5,013	39,902	53	1,931	50

p Preliminary.

Legislation and Government Programs.—Kentucky enacted a law relating to strip mining and reclamation which was designed to cope with strip mine damage in both western and eastern Kentucky.

Congress made funds available for TVA to begin acquisition and development for outdoor recreation and other uses of a strip of land between two reservoirs of the Tennessee and Cumberland Rivers in western Kentucky and Tennessee. TVA and the Peabody Coal Co., a supplier of coal to TVA, planted 400 acres of stripped coal lands with trees, grasses, and shrubs.

The Federal Geological Survey and the Kentucky Geological Survey continued the cooperative program of mapping the geology of the State on 7.5 minute quadrangles.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Production of coal increased 7 percent but was 2 percent below the 1947 record. Bituminous coal was mined at 2,002 mines in 42 counties, compared with 1,993 mines in 42 counties in 1963. Leading counties were Muhlenberg, Pike, Hopkins, and Harlan. Leading producing companies on the basis of tonnage were Peabody Coal Co. ,Pittsburg & Midway Coal Co., River Queen Coal Co., and Nashville Coal Co.

In the eastern Kentucky coal field 1,903 mines in 31 counties produced 44,891,000 tons, compared with 1,894 mines in 31 counties and 41,635,000 tons in 1963. Average production per mine increased from 22,000 tons to 24,000 tons. Underground mines produced 83 percent, auger mines 10 percent, and strip mines 7 percent of the total. Shipments were 81 percent by rail or water and 19 percent by truck. Captive tonnage was 18 percent of the total.

Equipment used at 1,712 underground mines included 1,181 cutting machines, which cut 87 percent of the tonnage; 1,719 power drills, which drilled 82 percent of the tonnage; 367 mobile loading machines, which loaded 46 percent of the tonnage; 55 continuous mining machines, with 7 mobile loaders used in conjunction, which produced 15 percent of the tonnage; and 22 hand-loaded conveyors upon which was loaded 1 percent of the tonnage. Other equipment comprised 845 locomotives, 551 shuttle cars, 674 shuttle buggies and 105 gathering conveyors.

Equipment used at 65 strip mines included 94 power shovels, 6 draglines, 72 bulldozers, 28 power drills, and 115 trucks. An estimated 20.3 million cubic yards of overburden was removed. Equipment used at 126 auger mines included 127 coal recovery augers, 3 power shovels, 56 bulldozers, 1 carryall scraper, 5 power drills, and 104 trucks. Of the total coal production from the eastern Kentucky field, 31 percent was cleaned at 32 cleaning plants, 18 percent was crushed, and 8 percent was treated with oil or other materials.

In the western Kentucky coal field, 99 mines in 11 counties produced 37.9 million tons compared with 99 mines in 11 counties and 35.7 million tons in 1963. Average production per mine increased from 361,000 tons to 382,000 tons. Underground mines produced 33 percent, auger mines less than 0.5 percent, and strip mines 67 percent of the total. Shipments were 87 percent by rail or water and 13 percent by truck. All coal was sold on the open market.

Equipment used at 48 underground mines included 101 cutting machines, which cut nearly 100 percent of the tonnage; 107 power drills, which drilled 95 percent of the tonnage; 92 mobile loading machines, which loaded 94 percent of the tonnage; and 9 continuous mining machines, which mined 5 percent of the tonnage. Other equipment included 84 locomotives, 215 shuttle cars, and 94 gathering conveyors.

Equipment used at 48 strip mines included 95 power shovels, 30 draglines, 118 bulldozers, 49 power drills, and 233 trucks. An estimated 142 million cubic yards of overburden was excavated.

Equipment used at three auger mines included three coal recovery augers, one power shovel, one dragline, and three bulldozers.

Thirty cleaning plants cleaned 71 percent of the coal produced; 54 percent was crushed, and 11 percent treated with oil or calcium chloride.

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

County	1963		1964	
	Short tons	Value	Short tons	Value
Bell	1,394,108	$4,301,127	2,067,620	$7,040,717
Boyd	56,846	205,798	41,164	154,958
Breathitt	252,405	1,288,834	260,164	963,982
Butler	191,829	797,188	187,038	784,653
Carter	29,500	99,710	27,006	107,705
Christian	58,659	291,110	13,573	68,685
Clay	1,283,379	4,981,929	1,484,790	5,848,581
Clinton	4,400	20,988	13,801	57,964
Daviess	848,679	2,202,700	876,601	2,287,545
Elliott	14,895	55,856	13,852	63,580
Floyd	4,364,606	24,051,970	4,679,505	25,404,228
Greenup	3,000	14,850		
Hancock	26,126	84,648	1,000	3,240
Harlan	5,698,200	28,877,010	5,641,856	28,439,463
Henderson	149,510	453,015	155,227	404,270
Hopkins	11,161,795	38,435,234	10,263,283	34,425,922
Jackson	53,628	262,144	44,631	219,443
Johnson	236,758	797,874	261,586	845,556
Knott	2,451,884	6,804,875	2,058,662	6,248,342
Knox	398,493	1,299,957	266,938	931,947
Laurel	176,344	507,319	136,651	523,124
Lawrence	35,281	128,660	8,789	29,069
Lee	80,067	300,251	61,105	244,420
Leslie	2,259,736	9,257,212	1,806,531	7,452,254
Letcher	5,251,255	24,510,717	5,573,790	24,218,520
Magoffin	112,935	338,876	95,805	318,072
Martin	134,010	611,086	196,526	820,329
McCreary	332,796	1,244,657	465,709	1,629,981
McLean	65,292	178,525	18,498	52,349
Morgan	31,804	144,681	36,687	167,363
Muhlenberg	16,203,861	51,686,205	17,634,686	56,225,558
Ohio	3,445,061	11,190,357	4,567,237	14,743,766
Owsley	4,000	18,240	9,200	27,600
Perry	3,663,994	14,386,452	3,944,118	11,295,230
Pike	12,459,052	49,721,521	14,836,047	59,812,149
Pulaski	134,938	369,175	158,212	525,636
Rockcastle	5,660	22,443	1,100	4,620
Union	3,208,293	12,255,306	4,067,691	15,140,064
Wayne	2,580	11,042	52,500	149,000
Webster	356,494	950,688	70,985	184,868
Whitley	698,232	2,523,811	638,263	1,994,444
Wolfe	10,066	59,396	8,744	36,725
Total	77,350,451	295,743,437	82,747,171	309,895,922
Earliest record to date	2,921,000,000	NA	3,004,000,000	NA

NA Not available.

Coke.—Two companies produced coke in Boyd and Marshall Counties, Allied Chemical Corp., and New York Mining & Manufacturing Co.

Petroleum.—Production of crude petroleum increased 8 percent but was 28 percent below the record established in 1959. Fifty-nine of the State's 120 counties produced petroleum. A total of 2,195 wells were drilled in 1964; 823 were completed as oil wells, 231 were completed as gas wells, 104 were water injection wells for secondary recovery, 43 were injection wells for gas storage, and 994 were reported to be dry holes. Hopkins County with a total of 286 wells drilled for the year led the State in this category.

TABLE 5.—Crude petroleum production by counties

County	1963		1964	
	Barrels	Value	Barrels	Value
Adair	76	$222		
Allen	83,486	243,779	69,445	$202,779
Barren	29,962	87,489	19,364	56,543
Bath	5,123	14,959	4,784	13,969
Bell	260	759	82	239
Boyd	273	797	39	114
Breathitt	78,662	229,693	64,132	187,265
Breckinridge	74,910	218,737	55,405	161,783
Butler	229,629	670,517	136,920	399,806
Casey	15,247	44,521	11,604	33,884
Christian	593,137	1,731,960	487,125	1,422,405
Clinton	86,631	252,963	62,039	181,154
Crittenden	171	499	390	1,139
Cumberland	43,706	127,622	42,216	123,271
Daviess	1,646,064	4,806,507	1,610,140	4,701,609
Edmonson	1,015	2,964	1,244	3,632
Elliott	50,175	146,511	49,995	145,985
Estill	172,436	503,513	164,265	479,654
Floyd	17,335	50,618	25,283	73,826
Green	295,405	862,583	185,240	540,901
Greenup			521	1,521
Hancock	214,103	625,180	185,187	540,746
Hardin	1,669	4,873		
Hart	33,851	98,845	50,653	147,907
Henderson	3,537,540	r 10,329,138	4,014,257	10,733,389
Hopkins	1,348,675	3,938,131	1,520,849	4,440,879
Jackson	898	2,622	878	2,564
Johnson	284,361	830,334	393,876	1,150,118
Knott	13,453	39,283	12,320	35,974
Knox	1,707	4,984	1,796	5,244
Laurel	355	1,037	565	1,650
Lawrence	501,252	1,463,656	534,442	1,560,571
Lee	1,904,814	5,562,057	2,467,917	7,206,318
Leslie	2,891	8,442	2,348	6,856
Letcher	8,648	25,252	10,114	29,533
Lincoln	2,545	7,431	3,109	9,078
Logan	1,410	4,117	1,642	4,795
Magoffin	966,705	2,822,778	882,841	2,577,896
Martin	17,288	50,481	14,954	43,666
McCreary	9,133	26,668	4,131	12,063
McLean	810,813	2,367,574	1,167,065	3,407,830
Menifee	1,207	3,524	1,563	4,564
Metcalfe	270,385	789,524	233,179	680,883
Monroe	2,248	6,564	4,006	11,698
Morgan	938	2,739	899	2,625
Muhlenberg	512,755	1,497,245	485,288	1,417,041
Ohio	932,501	2,722,903	891,672	2,603,682
Owsley	883	2,578	934	2,727
Perry	3,093	9,032	26,011	75,952
Pike	38,930	113,676	37,775	110,303
Powell	211,406	617,306	197,285	576,072
Russell	4,497	13,131	2,297	6,707
Simpson	7,675	22,411	5,273	15,397
Taylor	775	2,263	1,016	2,967
Todd	4,431	12,939	3,169	9,253
Union	1,707,414	4,985,649	2,116,903	6,181,357
Warren	43,098	125,846	38,991	113,854
Wayne	19,705	57,539	17,092	49,909
Webster	1,449,248	4,231,804	1,404,979	4,102,539
Whitley	26,447	77,225	18,462	53,909
Wolfe	20,550	60,006	26,029	76,005
Total	r 18,344,000	r 53,564,000	19,772,000	56,746,000
Earliest record to date	r 471,700,000	r 1,098,000,000	491,400,000	1,154,000,000

r Revised.

Source: Kentucky Geological Survey.

The Kentucky Geological Survey published individual oil and gas maps on northern Christian County and Madisonville west, Nortonville, and Sulphur Well Quadrangles. A comprehensive report on the oil and gas geology of Muhlenberg County was also published.

NONMETALS

Barite.—Mafluor Corp. mined barite in Crittenden County for oil well drilling.

Cement.—Kosmos Portland Cement Co. operated the Kosmosdale plant throughout 1964. Shipments of portland cement decreased 25 percent below the previous high set in 1963. Shipments of masonry cement were substantially the same as the 1963 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.

Nine companies mined fire clay at 21 mines in three counties for firebrick and block and fire clay mortar. Leading producers were General Refractories, Harbison-Walker Refractories Co., and Harry Hatfield & Co. Production decreased 51 percent and was 82 percent below the 1951 record. Total production was 104,300 tons valued at $711,800.

Miscellaneous clay was mined by 14 companies at 15 mines in 10 counties for heavy clay products, lightweight aggregate, and cement. Leading producers were Kenlite Division of Kentucky Light Aggregates, Inc., Kosmos Portland Cement Co., and General Shale Products Co. Production increased 6 percent above the high established in 1963. Total production was 816,000 tons valued at $1,090,000.

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. Leading producers were Calvert City Chemical Co. (Dyer's Hill mine) and Nancy Hanks Mines, Inc. (Nancy Hanks mine). Total marketable production was 38,000 tons valued at $1,683,000. Marketable production increased 8 percent but was 73 percent below the 1941 record.

Lime.—Air Reduction Chemical & Carbide Co. calcined sludge to produce captive and open-market byproduct lime in plants in Marshall and Jefferson Counties.

Perlite.—Great Lakes Carbon Corp. of Kentucky expanded perlite, mined in the Western States, at the Florence plant. The perlite was used in manufacturing insulation board. Zonolite Co. expanded perlite at the Wilder plant near Newport.

Sand and Gravel.—Sand and gravel was mined by 22 producers, including the State and county highway departments, at 32 mines in 21 counties. Leading counties were Jefferson, Boone, and Henderson. Leading producers were Standard Materials Corp., Ohio River Sand Co., and Evansville Materials, Inc. Production increased 1 percent over the 1963 record. Of the total production, 83 percent was prepared, 59 percent was hauled by truck, 34 percent by water, and 7 percent by rail.

Stone.—Eighty-four producers crushed limestone at 110 quarries in 66 counties. Leading counties were Livingston, Jefferson, and Fayette. Leading producers were Reed Crushed Stone Co. Inc. (Livingston), Kentucky Stone Co. (Anderson, Breckinridge, Hardin, Jessa-

mine, Laurel, Lee, Logan, Rockcastle, and Todd Counties), and Lambert Bros. (Fayette and Jefferson Counties). Production decreased 11 percent from the 1963 record. Of the total commercial tonnage, 79 percent was hauled by truck, 7 percent by rail, and 14 percent by water.

Kentucky Flagstone Co. and U. F. Coleman quarried dimension sandstone in Logan and Christian Counties.

Vermiculite.—Zonolite Co. exfoliated vermiculite from other States at the Wilder plant.

TABLE 6.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Ballard	24	$14	28	$16
Calloway	41	41	W	W
Carlisle	6	3	19	12
Fulton	10	5	29	15
Graves	64	32	58	29
Hickman	10	5	28	14
Jefferson	2,293	1,914	2,432	2,292
Livingston	101	81	61	49
Lyon	3	1	13	7
Marshall	32	14	40	19
Martin	33	33	----	----
Mason	114	173	68	108
Pike	4	4	4	4
Union	W	W	80	89
Undistributed [1]	3,744	3,751	3,700	3,643
Total	6,479	6,071	6,560	6,297

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Boone, Breckinridge, Daviess, Gallatin, Henderson, Logan, McCracken, Oldham (1963), and Trimble 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	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,011	$1,909	$0.95	1,972	$2,044	$1.04
Paving	2,058	1,870	.91	1,962	1,726	.88
Fill	494	232	.47	616	376	.61
Molding	4	14	3.75	W	W	W
Gravel:						
Paving	1,142	1,195	1.05	1,239	1,300	1.05
Structural	591	733	1.24	614	697	1.14
Fill	167	111	.66	104	61	.59
Total sand and gravel [1]	6,479	6,071	.94	6,560	6,297	.96

W Withheld to avoid disclosing individual company confidential data.
[1] Includes railroad ballast (1963), engine (1963), and other sands; railroad ballast (1963), and other gravel, and uses indicated by symbol W.

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Barren	417,000	$648,350	196,000	$312,200
Bourbon	525,000	525,000	385,000	476,600
Boyle	251,331	384,959	387,596	547,952
Caldwell	1,345,000	1,582,600	W	W
Calloway			105,668	159,604
Carter	566,924	733,884	902,846	1,230,967
Casey	122,000	209,000	105,500	182,250
Christian	1,132,140	1,590,340	1,010,962	1,089,181
Fayette	1,459,776	2,250,895	1,368,724	2,003,856
Franklin	800,146	936,184	W	W
Garrard			94,755	131,357
Greenup	20,000	30,000		
Hardin	1,184,181	1,530,375	695,348	966,995
Hart	W	W	166,115	232,592
Jefferson	1,425,661	2,165,394	1,547,898	2,168,994
Kenton	4,200	6,300	4,333	6,500
Mercer	124,503	182,632	W	W
Monroe	W	W	109,720	168,700
Montgomery	53,265	79,898	63,200	94,800
Morgan	W	W	332,387	445,416
Muhlenberg	W	W	351,054	403,868
Nicholas	45,000	65,000	23,100	56,200
Oldham	557,200	723,800	484,533	618,600
Undistributed [1]	14,653,864	20,885,181	13,533,275	18,296,905
Total	24,687,191	34,529,792	21,868,014	29,593,537

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Adair, Allen, Anderson, Breckinridge, Butler, Clinton, Crittenden, Cumberland, Edmonson, Estill, Fleming, Grayson, Green, Harlan, Harrison, Henry, Jackson, Jessamine, Laurel, Lee, Letcher, Livingston, Logan, Madison, Marion, Meade, Menifee, Metcalfe, Nelson, Ohio, Pendleton, Pike, Powell, Pulaski, Rockcastle, Rowan, Scott, Simpson, Taylor, Todd, Trigg, Warren, Washington, and Wayne Counties, and counties indicated by symbol W.

TABLE 9.—Crushed limestone sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	20,557,484	$29,231,263	$1.42	17,210,017	$23,762,183	$1.38
Agstone [1]	1,824,357	2,497,202	1.37	1,795,999	2,521,667	1.40
Railroad ballast	475,633	522,300	1.10	W	W	W
Stone sand	8,000	13,200	1.65	14,000	21,000	1.50
Other uses [2]	1,821,717	2,265,827	1.24	2,847,998	3,288,687	1.15
Total	24,687,191	34,529,792	1.40	21,868,014	29,593,537	1.35

W Withheld to avoid disclosing individual company confidential data.
[1] Agricultural stone.
[2] Includes riprap, cement, fluxing stone, fertilizer filler, other uses, and uses indicated by symbol W.

METALS

Ferroalloys.—Shipments of ferroalloys, including ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, and ferrochromium-silicon, increased 35 percent over 1963.

Lead.—Byproduct recovery of lead concentrate from fluorspar milling increased 3 percent.

Pig Iron and Steel.—Armco Steel Corp. produced foundry and basic pig iron at Ashland; production was 63 percent greater than 1963.

Steel was produced by Armco Steel Corp. at Ashland and by Interlake Steel Corp. at Newport. Iron ore consumed was 3 percent domestic and 97 percent imported.

Zinc.—The Eagle-Picher Co. began production from the old Hutson zinc mine near Salem in September. Zinc concentrate also was recovered as a byproduct of fluorspar milling. Production increased 41 percent largely as a result of the Hutson mine production.

REVIEW BY COUNTIES

Of the 120 counties, 108 reported production, the same number as in 1963. Leading counties were the large coal and petroleum producers, Pike, Muhlenberg, Hopkins, Harlan, Floyd, Letcher, and Union, which supplied more than 50 percent of the total mineral production value. In addition to detailed county production listed in Table 10, natural gas and natural gas liquids, of undetermined county origin, were produced. The number of wells and footage drilled by counties in this section were published in the Oil and Gas Journal.[3]

Allen.—McLellan Stone Co. (Scottsville quarry) crushed limestone for railroad ballast, agstone, and other uses. Production of crude petroleum decreased 17 percent.

TABLE 10.—Value of mineral production in Kentucky, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value [2]
Adair	W	W	Limestone.
Allen	W	W	Petroleum, limestone.
Anderson	W	W	Limestone.
Ballard	$14,039	$16,000	Sand and gravel.
Barren	735,839	368,743	Limestone, petroleum.
Bath	14,959	13,969	Petroleum.
Bell	4,301,886	7,040,956	Coal, petroleum.
Boone	W	W	Sand and gravel.
Bourbon	525,000	476,600	Limestone.
Boyd	W	253,312	Coal, miscellaneous clay, petroleum.
Boyle	384,959	547,952	Limestone.
Breathitt	1,518,527	1,151,247	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.
Calloway	41,954	W	Sand and gravel, limestone.
Carlisle	3,102	12,000	Sand and gravel.
Carter	1,458,347	1,687,483	Limestone, fire clay, coal.
Casey	253,521	216,134	Limestone, petroleum.
Christian	W	2,584,299	Petroleum, limestone, coal, miscellaneous clay sandstone.
Clay	4,981,929	5,848,581	Coal.
Clinton	W	W	Petroleum, limestone, coal.
Crittenden	W	W	Limestone, fluorspar, barite, petroleum.
Cumberland	W	W	Petroleum, limestone.
Daviess	W	W	Petroleum, coal, sand and gravel, miscellaneous clay.
Edmonson	W	W	Limestone, petroleum.
Elliott	202,367	209,565	Petroleum, coal.
Estill	W	W	Petroleum, limestone.
Fayette	2,250,895	2,003,856	Limestone.
Fleming	W	W	Do.
Floyd	24,102,588	25,078,054	Coal, petroleum.
Franklin	936,184	W	Limestone.
Fulton	5,124	15,000	Sand and gravel.
Gallatin	W	W	Do.
Garrard	W	131,357	Limestone.
Graves	W	W	Ball clay, sand and gravel.
Grayson	W	W	Limestone.
Green	W	W	Petroleum, limestone.

See footnotes at end of table.

[3] Oil and Gas Journal. V. 63 No. 4, Jan. 25, 1965, p. 174.

TABLE 10.—Value of mineral production in Kentucky, by counties[1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value[2]
Greenup	$228,096	$110,451	Fire clay, petroleum.
Hancock	W	802,186	Petroleum, miscellaneous clay, coal.
Hardin	1,535,248	966,995	Limestone.
Harlan	W	W	Coal, limestone.
Harrison	W	W	Limestone.
Hart	W	380,499	Limestone, petroleum.
Henderson	W	W	Petroleum, sand and gravel, coal.
Henry	W	W	Limestone.
Hickman	5,034	14,000	Sand and gravel.
Hopkins	42,373,365	38,866,801	Coal, petroleum.
Jackson	W	W	Coal, limestone, petroleum.
Jefferson	W	W	Cement, sand and gravel, limestone, miscellaneous clay.
Jessamine	W	W	Limestone.
Johnson	1,628,208	1,995,674	Petroleum, coal.
Kenton	6,300	6,500	Limestone.
Knott	6,844,158	6,284,316	Coal, petroleum.
Knox	1,304,941	937,191	Do.
Laurel	W	W	Coal, limestone, petroleum.
Lawrence	1,592,316	1,589,640	Petroleum, coal.
Lee	W	W	Petroleum, limestone, coal.
Leslie	9,265,654	7,459,110	Coal, petroleum.
Letcher	W	W	Coal, limestone, petroleum.
Lincoln	7,431	9,078	Petroleum.
Livingston	W	W	Limestone, fluorspar, zinc, lead, sand and gravel, silver.
Logan	W	W	Limestone, sand and gravel, sandstone, petroleum.
Lyon	1,261	7,000	Sand and gravel.
Madison	W	W	Limestone.
Magoffin	3,161,654	2,895,968	Petroleum, coal.
Marion	W	W	Limestone.
Marshall	13,876	19,000	Sand and gravel.
Martin	694,617	863,995	Coal, petroleum.
Mason	172,900	108,000	Sand and gravel.
McCracken	W	W	Do.
McCreary	1,271,325	1,642,044	Coal, petroleum.
McLean	2,546,099	3,460,179	Petroleum, coal.
Meade	W	W	Limestone.
Menifee	W	W	Limestone, petroleum.
Mercer	W	W	Limestone.
Metcalfe	W	W	Petroleum, limestone.
Monroe	W	180,398	Limestone, petroleum.
Montgomery	79,898	94,800	Limestone.
Morgan	W	615,404	Limestone, coal, petroleum.
Muhlenberg	W	58,046,467	Coal, petroleum, limestone.
Nelson	W	W	Limestone.
Nicholas	65,000	56,200	Do.
Ohio	W	W	Coal, petroleum, limestone.
Oldham	W	618,600	Limestone.
Owsley	20,818	30,327	Coal, petroleum.
Pendleton	W	W	Limestone.
Perry	14,395,484	11,371,182	Coal, petroleum.
Pike	W	W	Coal, petroleum, limestone, sand and gravel.
Powell	W	W	Petroleum, limestone, miscellaneous clay.
Pulaski	W	W	Limestone, coal.
Rockcastle	W	W	Do.
Rowan	897,524	490,153	Fire clay, limestone, miscellaneous clay.
Russell	13,131	6,707	Petroleum.
Scott	W	W	Limestone.
Simpson	W	W	Limestone, petroleum.
Taylor	W	W	Do.
Todd	W	W	Do.
Trigg	W	W	Limestone.
Trimble	W	W	Sand and gravel.
Union	W	21,414,421	Coal, petroleum, sand and gravel, miscellaneous clay.
Warren	W	W	Limestone, petroleum.
Washington	W	W	Limestone.
Wayne	W	W	Coal, limestone, petroleum.
Webster	5,182,492	4,287,407	Petroleum, coal.
Whitley	W	W	Coal, petroleum, miscellaneous clay.
Wolfe	119,402	112,730	Petroleum, coal.
Undistributed[3]	r 297,535,548	230,980,469	
Total	r 432,693,000	444,379,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.

[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.

Barren.—J. F. Pace Construction Co. crushed limestone for concrete, roads, agstone, and stone sand. Production of crude petroleum decreased 35 percent.

Bell.—Coal was produced at 93 mines; 64 were underground mines, 18 were strip mines, and 11 were auger mines. The leading producers were Round Mountain Coal Co. Inc. (No. 4 strip mine), Pruden-Hignite Coal Co. Inc. (No. 1 mine), and Brownies Creek Collieries, Inc. (No. 1 mine).

Boone.—Standard Materials Corp. (Belleview mine) and Kentucky Sand Co. (Taylorsport 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.—Bourbon Limestone Co. Inc. (Snapp quarry) crushed limestone for concrete, roads, and agstone.

Boyd.—Rush Coal Corp. (No. 1 strip mine) and Big Run Coal & Clay Co. (Big Run mine) mined bituminous coal. Three mines produced coal; two were underground operations. Big Run Coal & Clay Co. (Princess mine) mined clay for manufacture of brick. A small quantity of petroleum was produced. Two wells totaling 6,537 feet were drilled. Armco Steel Corp. produced pig iron and steel at the Ashland plant. Allied Chemical Corp. produced metallurgical coke at its Ashland plant.

Boyle.—Caldwell Stone Co. Inc. (Danville quarry) and Boyle County Highway Department (Perryville quarry) crushed limestone for concrete, roads, and agstone.

Breathitt.—Thirteen mines produced coal; 10 were underground operations, 2 were strip mines, and 1 was an auger mine. The leading producers were Breathitt County Coal Corp. (No. 75 strip mine), Ten Mile Coal Co. (No. 9 mine), and Beaver Junction Coal Co. (No. 1 auger mine). Production of crude petroleum decreased 18 percent; 16 wells totaling 19,883 feet were drilled.

Breckinridge.—White Stone Co. (Hardinsburg quarry) and Kentucky Stone Co. (Webster) crushed limestone for concrete, roads, railroad ballast, and agstone. Cloverport Sand & Gravel Co. mined structural and paving sand and gravel. Production of crude petroleum decreased 26 percent; 28 wells totaling 9,021 feet were drilled.

Bullitt.—Kenlite Division of Kentucky Light Aggregates, Inc. (Shepherdsville mine) mined miscellaneous clay for lightweight aggregates.

Butler.—Two strip mines and two underground mines produced coal. The leading producers were Williams Bros. Stripping Corp. (South Hill strip mine) and Key Associates, Inc. (Key strip mine). Gary Bros. Crushed Stone Co. (Morgantown quarry) crushed limestone for concrete, roads, and agstone. Crude petroleum production decreased 40 percent; 27 wells totaling 22,818 feet were drilled.

Caldwell.—Cedar Bluff Stone Co. Inc. and Fredonia Valley Quarries, Inc. (Fredonia quarry) crushed limestone for concrete, roads, and agstone. Five oil wells totaling 10,246 feet were drilled.

Calloway.—Western Materials of Kentucky crushed limestone for concrete, roads, and agstone. Murray Silica Sand Co. mined silica sand for use as a molding sand. The Calloway County Highway Department and the State highway department mined paving gravel.

Campbell.—Zonolite Co. exfoliated crude vermiculite and expanded perlite at the Wilder plant.

Carter.—Valley Stone Co. Inc. (Olive Hill quarry), Acme Stone Co. Inc. (Olive Hill quarry), and Standard Slag Co. (Carter quarry) crushed limestone for concrete, roads, and agstone. Eleven mines produced fire clay for firebrick and block and fire clay mortar. The leading producers were General Refractories Co., Harry Hatfield & Co., and Davis Fire Brick Co. Four mines produced coal; three were underground operations, and one was a strip mine. The leading producers were Elliott County Mining Co. and Lost Creek Coal Co. Two oil wells were drilled totaling 3,523 feet.

Casey.—Casey Stone Co. (Bethel Ridge mine) crushed limestone for concrete, roads, and agstone. Crude petroleum production decreased 24 percent.

Christain.—Hopkinsville Stone Co. Inc. (Hopkinsville quarry), Harry Berry, Inc. (Fort Campbell quarry), and Christian Quarries, Inc. (Hopkinsville quarry) crushed limestone for concrete, roads, agstone, and riprap. V. F. Coleman (Cerulean quarry) quarried a small quantity of dimension sandstone. Dalton Bros. Brick Co. mined miscellaneous clay for use in heavy clay products. Ralph Ligon, Inc. (No. 6 strip mine) was the only coal producer. Production of crude petroleum declined 18 percent; 28 wells totaling 27,206 feet were drilled.

Clay.—Coal was produced by 59 mines; 57 were underground mines, 1 was an auger mine and 1 was a strip mine. The leading producer was Finley Coal Co.

Clinton.—Shamrock Stone, Inc. (Caldwell quarry) crushed limestone for concrete, roads, and agstone. Three underground coal mines were in operation. The leading producer was M & G Coal Co. Nineteen oil wells totaling 24,059 feet were drilled.

Crittenden.—Alexander Stone Co. Inc. quarried limestone for concrete, roads, agstone, and riprap. Mafluor Corp. (Pigmy and Ainsworth mines) mined metallurgical-grade fluorspar and barite for use in oil-well drilling. Kentucky Fluorspar Co. purchased fluorspar for shipment to consumers. Calvert City Chemical Co. treated fluorspar ore from its Dyer's Hill mine in Livingston County, in its flotation mill at Mexico, recovering fluorspar for use in manufacturing hydrofluoric acid. Two wells totaling 2,833 feet were drilled.

Daviess.—Owensboro River Sand & Gravel and Daviess County Sand & Gravel Co. mined sand and gravel for structural uses, paving, and fill. Five coal mines were in operation; three were strip mines, and two were underground mines. The leading producers were Green Coal Co. (K–9 strip mine) and Morris Enterprises (Morris strip mine). Joseph L. Clark Tile Co. (Moselyville mine) mined miscellaneous clay for use in heavy clay products. Crude petroleum production increased 2 percent; 113 wells totaling 114,044 feet were drilled.

Elliott.—Three coal mines, all underground, were in production. Copley Coal Co. (No. 5 mine) was the leading producer. Crude oil production remained substantially the same; 4 wells were drilled totaling 4,081 feet.

Estill.—Estill County Stone Co. Inc. mined limestone for concrete, roads, and agstone. Crude petroleum production decreased 5 percent; 24 holes totaling 19,998 feet were drilled.

Fayette.—Central Rock Co., Inc. (Lexington quarry and mine), Lambert Bros., and Blue Grass Stone Co., Inc., crushed limestone for concrete, roads, and agstone.

Floyd.—Floyd County ranked fifth in the State in total value of mineral production. Coal was produced at 227 mines; 223 were underground mines, and 4 were auger mines. The leading producers were Inland Steel Co. (Wheelwright mine) and Princess Coals, Inc. (No. 1 mine and Permele No. 2 mine). Production of crude petroleum increased 46 percent; 28 wells totaling 54,729 feet were drilled.

Garrard.—Camp Nelson Stone Co., Inc. (Lancaster quarry) crushed limestone for concrete and roads.

Graves.—Kentucky-Tennessee Clay Co. (Kentucky mine) and Old Hickory Clay Co. (Hickory and Lampkin mines) mined ball clay for whiteware, art pottery, floor and wall tile, enameling, for use in foundries and steel works, plastics, exports, and other uses. The State highway department mined paving gravel.

Greenup.—Three mines produced fire clay for firebrick and block, fire clay mortar, and other clay specialties. The leading producers were Harbison-Walker Refractories Co. (Riggs mine) and McCoy Clay Co. (Large mine).

Hancock.—Four mines produced miscellaneous clay for heavy clay products. The leading producers were Cannelton Sewer Pipe Co. (No. 1 mine) and Owensboro Brick & Tile Co. Watken Construction Co. (Carbon No. 2 strip mine) was the only producer of bituminous coal. Crude petroleum production decreased 14 percent; 25 wells totaling 12,109 feet were drilled.

Hardin.—Four quarries produced limestone for concrete, roads, agstone and riprap. The producers were Osborne Bros. (Hardin County and Stephensburg quarries), Kentucky Stone Co. (Upton quarry), and Waters Construction Co. (Elizabethtown quarry).

Harlan.—Harlan County ranked fourth in the State in value of mineral production. Of the 148 coal mines in operation, 123 were underground mines, 11 were strip mines, and 14 were auger mines. The leading producers were United States Steel Co. (No. 32 mine and No. 7 South Main), and Harlan Fuel Co. (Elzo mine). Nally & Boone Stone Co. (Harlan quarry) crushed limestone for concrete, roads, and agstone.

Hart.—Hart Stone Co. (Horse Cave quarry) crushed limestone for concrete, roads, and agstone. Crude petroleum production increased 50 per cent.

Henderson.—Evansville Materials, Inc., dredged sand and gravel for structural, paving, and fill uses. Six mines, all underground operations, produced coal. The leading producers were Dolph Hazelwood Coal Co. (No. 3 mine) and Goldsberry Coal Co. (No. 2 mine). Crude petroleum production increased 13 percent; 75 wells totaling 121,581 feet were drilled.

Hopkins.—Hopkins County ranked third in the State in total value of mineral production. Of the 35 mines that produced coal, 17 were underground mines, 16 were strip mines, and 2 were auger mines. The leading producers were West Kentucky Coal Co. (East Diamond and Pleasant View mines) and Nashville Coal, Inc. (Fies mine). Crude petroleum production increased 13 percent; 239 wells totaling 561,431 feet were drilled.

Jackson.—M. A. Walker Co. Inc. (Indian Creek and Clover Bottom mines) crushed limestone. Coal was mined at one auger mine, two strip mines, and two underground mines. Hamm Coal Co. Inc. (No. 1 auger mine) was the leading producer. Three oil wells totaling 9,567 feet were drilled.

Jefferson.—Kosmos Portland Cement Co. produced masonry and portland cements at the Kosmosdale plant. Limestone was crushed at four quarries and one mine for concrete, roads, and agstone. The major producers were Lambert Bros. (Okolona quarry), Louisville Crushed Stone Co. Inc. (Louisville mine), and Falls City Stone Co. (Fern Creek quarry). Five producers mined sand and gravel for structural, paving, fill, and other uses. Ohio River Sand Co. Inc., E. T. Slider, Inc., and Nugent Sand Co. were the leading producers. Kosmos Portland Cement Co. (Kosmosdale mine) and General Shale Products Co. (Coral Ridge mine) mined miscellaneous clay for use in cement manufacture and heavy clay products. Air Reduction Chemical & Carbide Co. regenerated lime for chemical and industrial uses at the Louisville plant.

Johnson.—Coal was produced at 41 mines, 39 were underground mines, and 2 were auger mines. Tutor Key Coal Co. (No. 1 mine) and Terry Elkhorn Mining Co. (No. 1 auger mine) were the leading producers. Crude oil production increased 39 percent. Nine wells totaling 14,524 feet were drilled.

Knott.—Of the 135 mines producing coal, 127 were underground operations, 7 were auger mines, and 1 was a strip mine. The leading producers were AKP Coal Co. (No. 8 mine), Mountain Top Stripping Co. (No. 1 strip mine), and Pine Bluff Coal Co. (No. 1 auger mine). Crude oil production decreased 8 percent; 17 holes totaling 48,450 feet were drilled.

Knox.—Coal was produced at 63 underground mines, 2 were strip mines, and 5 were auger mines. Jackson Coal Co. (No. 2 mine), Kentucky-Knox Mining Co. (No. 3 auger mine), and Reisenberg Coal Co. (No. 1 mine) were the leading producers. Crude petroleum production increased 5 percent; one well totaling 400 feet was drilled.

Laurel.—Kentucky Stone Co. (Laurel quarry) crushed limestone. Five underground and three strip mines produced coal. The leading producers were Laurel County Coal Co., Inc. (No. 1 mine), Hop Coal Co. (No. 3 strip mine), and Fredricks Coal Co. (No. 2 mine.)

Lawrence.—Four mines produced coal; three were underground mines, and one was a strip mine. C&C Coal Co. (Van Horn No. 1 mine), Branham Coal Co. (No. 1 mine), and Cleary Coal Co. (No. 1 strip mine) were the leading producers. Crude petroleum production increased 7 percent; 50 wells totaling 73,304 feet were drilled.

Lee.—Kentucky Stone Co. (Yellow Rock mine) crushed limestone for concrete, roads, railroad ballast, and agstone. Six mines, all underground operations, produced coal. The leading producers were S&F Coal Co. (S&F Nos. 1 and 2 mines), and Congleton Bros. Coal Co. Inc. Crude petroleum production increased 30 percent; 87 wells totaling 94,450 feet were drilled.

Leslie.—Of the 38 mines that produced coal, 33 were underground operations, 3 were strip mines, and 2 were auger mines. Deby Coal

Co. (Deby No. 2 mine), Smith Coal Sales, Inc. (No. 1 mine), and Mary Gail Co. (No. 3A mine) were the leading producers.

Letcher County.—Letcher County ranked sixth in the State in total value of mineral production. Coal was produced by 237 mines, 216 were underground operations, 3 were strip mines, and 18 were auger mines. Bethlehem Mines Corp. (No. 22 mine), Scotia Coal Co. (Scotia mine), and South East Coal Co. (Polly No. 4 mine) were the leading producers. Levisa Stone Corp. (Jenkins quarry) and Hurricane Gap Quarries, Inc. crushed limestone for concrete and roads. Production of crude petroleum increased 17 percent; 12 wells totaling 40,836 feet were drilled.

Lincoln.—Crude petroleum production increased 22 percent; six wells totaling 1,458 feet were drilled.

Livingston.—Reed Crushed Stone Co. Inc. (Grand Rivers quarry), Three River Rock Co. (Smithland quarry), and Calvert City Chemical Co. quarried limestone for riprap, concrete, roads, and agstone. Calvert City Chemical Co. mined fluorspar ore at the Dyer's Hill mine and treated the ore in the Mexico mill in Crittenden County to recover acid-grade fluorspar. Nancy Hanks Mines, Inc. also produced fluorspar. Byproduct zinc, lead, and silver concentrates were recovered from fluorspar milling. The Eagle-Picher Co. reopened the Hutson zinc mine. Taylor Sand & Gravel Co. (Barkley Dam mine) and the State highway department mined structural sand and paving gravel.

Logan.—Kentucky Stone Co. (Russellville mine) crushed limestone for concrete, roads, agstone, and railroad ballast. Kentucky Flagstone Co., Inc. (Lewisburg quarry) quarried dimension sandstone for rough architectural stone and flagging. Kemp Construction Co. mined sand and gravel for structural and paving uses. Two oil wells totaling 1,266 feet were drilled.

Magoffin.—Nine underground mines produced coal. Tip Top Coal Co. (Nos. 26, 28, and 29 mines) was the leading producer. Crude petroleum production decreased 9 percent; 39 wells totaling 43,993 feet were drilled.

Marshall.—The State highway department mined paving gravel. Air Reduction Chemical & 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.—Coal was produced from seven underground operations. Wolf Creek Coal Co. (No. 1 mine) was the leading producer. Petroleum production decreased 14 percent; six wells totaling 11,208 feet were drilled.

Mason.—J. F. Hardyman Co. mined sand and gravel for structural, paving, and fill uses.

McCreary.—Eleven mines, all underground operations, produced coal. Stearns Coal & Lumber Co., Inc. (Nos. 16–2 and 19 mines) was the leading producer. Crude petroleum production decreased 55 percent; five wells totaling 2,618 feet were drilled.

McLean.—Highview Coal & Construction Co. (Island No. 2 strip mine) was the only coal producer. Crude petroleum production increased 44 percent; 103 wells totaling 179,729 feet were drilled.

Menifee.—A. W. Walker & Son (Indian Creek quarry) crushed limestone for concrete, roads, and agstone. Crude petroleum production increased 29 percent; two wells totaling 1,451 feet were drilled.

Monroe.—Trico Stone, Inc. (Monroe quarry) crushed limestone for concrete, roads, and agstone. Production of crude petroleum nearly doubled.

Montgomery.—Montgomery County Stone Co. (Mount Sterling quarry) crushed limestone for concrete, roads, and agstone.

Morgan.—Licking River Limestone Co. (Zag quarry), Kentucky Road Oiling Co. (Wrigley quarry), and Morgan County Limestone, Inc. (Sandy Hook quarry) produced limestone for concrete, roads, railroad ballast, and riprap. Four mines produced coal; two were underground operations, and two were strip mines. Marshall, Branham & Sheets Coal Co. (No. 3 strip mine) and Daniel Coal Co. (No. 1 strip mine) were the leading producers.

Muhlenberg.—Muhlenberg County ranked second in the State in total value of mineral production. Coal was produced from 19 mines; 8 were underground mines and 11 were strip mines. Peabody Coal Co. (Sinclair and Vogue strip mines), River Queen Coal Co. (River Queen strip mine), and Gibraltar Coal Corp. (Gibraltar strip mine) were the leading producers. Greenville Quarries, Inc. and AAA Stone Co., Inc. crushed limestone for concrete, roads, and agstone. Crude petroleum production decreased 5 percent; 57 wells totaling 78,448 feet were drilled.

Ohio.—Of the 16 mines that produced coal, 7 were underground operations, 8 were strip mines, and 1 was an auger mine. Peabody Coal Co. (Homestead and Ken strip mines) and Riverview Coal Co., Inc. (No. 1 strip mine) were the leading producers. Fort Hartford Stone Co., Inc. (Hartford mine) and State Contracting & Stone (Hartford quarry) produced limestone for railroad ballast, concrete, roads, agstone, and riprap. Crude petroleum production decreased 4 percent; 110 wells totaling 84,924 feet were drilled.

Oldham.—Ohio River Stone Co. (Prospect mine), Joe Clark Stone Co., and Liter's Quarry, Inc. (Crestwood mine), crushed limestone.

Owsley.—Booneville Fuel Co. (No. 1 mine) was the only coal producer. The coal was mined underground. One oil well, 1,361 feet was drilled.

Perry.—Coal was produced at 87 mines, 66 were underground operations, 3 were strip mines, and 18 were auger mines. Blair Fork Coal Co. (Blair Fork mine) and Caperton Coal Co. (No. 1 strip mine) were the leading producers. Crude petroleum production increased substantially; 39 wells totaling 125,072 feet were drilled.

Pike.—Pike County ranked first in the State in total value of mineral production. Of the 615 mines that produced coal, 572 were underground mines, 6 were strip mines, and 37 were auger mines. Eastern Coal Corp. (Stone mine), Kentland Elkhorn Coal Corp. (Kentland No. 1 mine), and Republic Steel Corp. (Republic mine) were leading producers. Johnson Bros. Limestone Co. crushed limestone for concrete and roads. Pike Sand Co. (Walters mine) mined structural sand. Crude petroleum production decreased 3 percent; 37 wells totaling 139,563 feet were drilled.

Powell.—A. W. Walker & Son (No. 213 quarry) and Natural Bridge Stone, Inc. (Stanton quarry) crushed limestone for concrete, roads,

and agstone. H. B. Sipple Brick Co. (Drake No. 1 mine) and Big Run Coal & Clay Co. (West Bend mine) mined miscellaneous clay for use in heavy clay products. Crude petroleum production decreased 7 percent; five wells totaling 4,323 feet were drilled.

Pulaski.—Strunk Construction Co. Inc. (Tateville quarry) and Somerset Stone Co. Inc. (Somerset quarry) crushed limestone for concrete, roads, and agstone. Nine mines produced coal; seven were underground mines, one was a strip mine, and one an auger mine. The leading producer was Ikerd & Bandy Co. Inc. (No. 4C strip and No. 1C auger mines). Three oil wells totaling 3,600 feet were drilled.

Rockcastle.—Kentucky Stone Co. (Mt. Vernon and Mullins mines) crushed limestone for concrete, roads, railroad ballast, and agstone. Skeegs Branch Coal Co. (No. 1 mine), an underground mine, was the only coal producer. Three oil wells totaling 1,314 feet were drilled.

Rowan.—Morehead Limestone, Inc. and Kentucky Road Oiling Co. (Christy quarry) produced limestone for concrete, roads, fluxing stone, and agstone. Seven mines produced fire clay for fire brick and block. General Refractories Co. was the leading producer. Lee Clay Products Co. Inc. mined miscellaneous clay for use in heavy clay products. Two oil wells totaling 1,004 feet were drilled.

Union.—Union County ranked seventh in the State in total value of mineral production. Six mines produced coal, five were underground mines, and one was a strip mine. P&M Coal Mining Co. (DeKoven mine and DeKoven No. 6 mine) and Nashville Coal, Inc. (Uniontown mine) were the leading producers. Union Sand & Gravel Co. (Morganfield mine) mined sand and gravel for structural, paving, and fill uses. Clarks Clay Products Co. mined miscellaneous clay for use in heavy clay products. Crude petroleum production increased 24 percent; 20 wells totaling 31,359 feet were drilled.

Washington.—Nally & Gibson Stone Co. (Washington quarry) crushed limestone for concrete and roads.

Wayne.—One strip mine and one underground mine produced coal. Clinton Coal & Fuel Co., Inc. (Spann Hill strip mine) was the leading producer. Bassett Products Co. (Bassett quarry) crushed limestone for concrete, roads, and agstone. Crude petroleum production decreased 13 percent; 14 wells totaling 11,292 feet were drilled.

Webster.—Crude petroleum production decreased 3 percent; 37 wells totaling 92,489 feet were drilled. Four strip mines and one underground mine produced coal. John Morris Coal Co., Brown & Walker Coal Co. and Quisenberry Bros. Mining Co. were the leading producers.

Whitley.—Of the 57 mines that produced coal, 52 were underground mines, 3 were strip mines, and 2 were auger mines. Twin Peaks Coal Co. (No. 3 mine), Royal Jellico Coal Co. (No. 1 mine), Warren Coal Co. (No. 1 auger mine) were the leading producers. Crude petroleum production decreased 30 percent; 10 wells totaling 11,800 feet were drilled. Corbin Brick Co., Inc. mined miscellaneous clay for use in heavy clay products.

Wolfe.—Three underground mines produced coal. Nickell Coal Co. (No. 2 mine) and C. L. Thompson Coal Co. (Miller mine) were the leading producers. Crude petroleum production increased 27 percent, 26 wells totaling 33,812 feet were drilled.

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 Peter Grandone,[1] Owen W. Jones,[2] and Leo W. Hough [3]

LOUISIANA ranked second in the Nation in value of mineral production for the seventh consecutive year. New records were achieved in production of crude petroleum, natural gas, natural gas liquids, salt, and sulfur.

Hydrocarbon fuels—crude petroleum, natural gas, and natural gas liquids—furnished 95 percent of the total value of mineral output. Discovery of 43 oilfields and gasfields (33 onshore and 10 offshore) allowed proved recoverable reserves of the fuels to reach new highs despite increased production. In quantity of reserves added during 1964, Louisiana ranked first in the Nation for natural gas and natural gas liquids, and second for crude petroleum. Nationally, recoverable reserves showed gains for natural gas, natural gas liquids, and petroleum.

Trends and Developments.—Construction of new plants and expansion of existing plants continued at a high level. The Louisiana State Board of Commerce and Industry approved ad valorem tax exemption applications representing a total investment of $311 million. Applications approved in 1963 for new industrial facilities totaled $245 million. About 74 percent of the 1964 total investment approved was for plants of electric power, petroleum products, chemical, and mineral industries.

Olin Mathieson Chemical Corp. made substantial additions to its pulp and paper plant at West Monroe; Crown Zellerbach was constructing a $40 million pulp and paper mill at St. Francisville and announced addition of a second unit costing $29 million.

To provide for rapid development of gas resources, the industry added five gas processing plants (completed, expanded, or under construction) and more storage space in salt dome caverns for the recovered plant liquids. Additional pipelines were built or planned to connect with offshore gas supplies.

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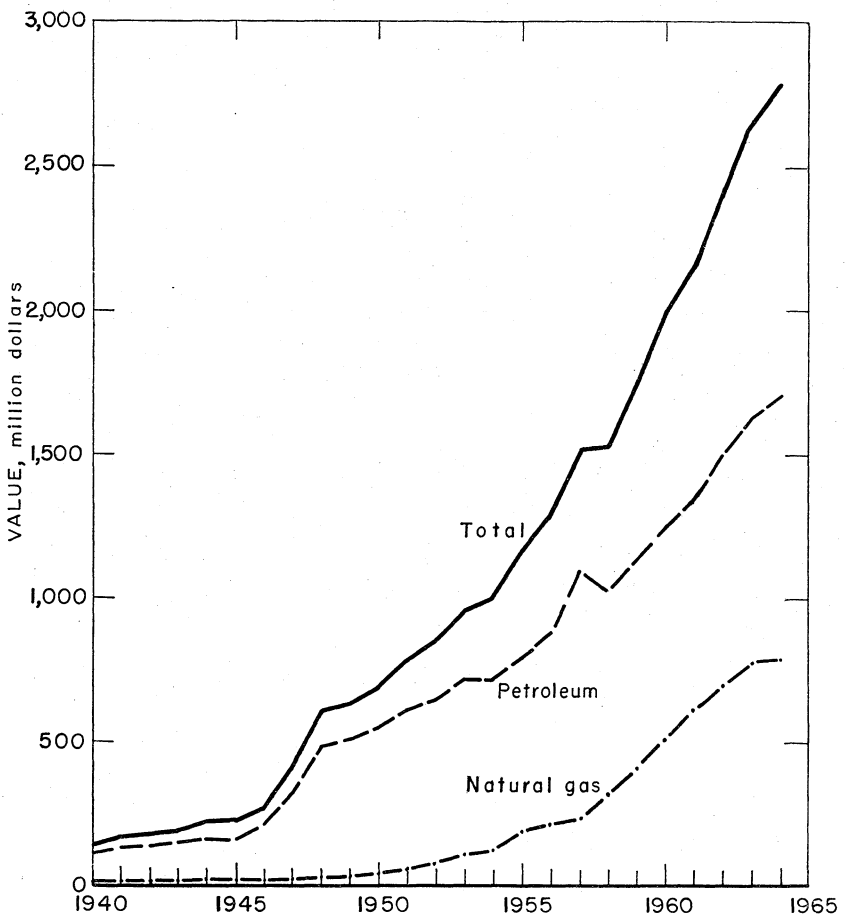


FIGURE 1.—Value of petroleum, natural gas, and total value of mineral production in Louisiana.

The salt industry made significant additions in mining and chemical plants. In St. Mary Parish, production started from a mine at the Cote Blanche salt dome. This brought a total of five coastal domes and one interior dome into production. New facilities to produce chlorine and other chemicals from salt were under construction at Geismar and planned in St. Charles Parish.

TABLE 1.—Mineral production in Louisiana [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clay—thousand short tons	655	$655	780	$797
Lime—do	657	6,862	725	8,312
Natural gas—million cubic feet	3,928,427	777,829	4,175,412	793,328
Natural Gas Liquids:				
Natural gasoline and cycle products—thousand gallons	1,143,707	81,332	1,352,980	91,931
LP gases—do	1,113,670	41,043	1,247,484	45,935
Petroleum (crude)—thousand 42-gallon barrels	515,057	1,608,120	549,698	1,709,622
Salt (common)—thousand short tons	6,199	30,450	6,401	36,056
Sand and gravel—do	12,500	14,701	13,594	15,253
Stone (shell)—do	5,408	7,961	5,459	7,228
Sulfur (Frasch process)—thousand long tons	2,445	48,905	2,733	54,996
Value of items that cannot be disclosed: Cement, gypsum, and miscellaneous stone	xx	20,531	xx	21,550
Total	xx	r 2,638,389	xx	2,785,008

r Revised. 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 r	Year	Value r
1953	$1,101	1959	$1,790
1954	1,093	1960	1,991
1955	1,263	1961	2,141
1956	1,391	1962	2,362
1957	1,504	1963	2,558
1958	1,523	1964	2,722

r Revised.

Final dredging operations were contracted on the $95 million Mississippi River-Gulf Outlet, which shortens the shipping distance between New Orleans and the Gulf by 50 miles. The channel, when opened in 1963, was dredged to interim dimensions of 36 feet deep and 250 feet wide; when finished in 1969, it will be dredged to full project width of 500 feet.

The Louisiana and Texas Sabine River Authorities awarded contracts to construct the $60 million Toledo Bend dam, power plant, and outlet works. Each of the two States were to supply $15 million, and three private power firms were to underwrite the other $30 million. The dam, 75 miles north of Orange, Tex., would impound 4.5 million acre-feet of water. Installation of two turbines would generate 80,000 kilowatts of electricity. Completion was scheduled for 1968.

President Johnson signed a $4.4 billion bill for atomic energy and water projects which included more than $21 million for Louisiana projects. Principal Louisiana projects include: Mississippi River-Gulf Outlet, $9.25 million; Calcasieu River and Pass, $5 million; Calcasieu River Salt Water Barrier, $1 million; Freshwater Bayou, $1.4 million; Comete, $1 million; Bayou Lafourche and Lafourche Jump waterway, $800,000.

Louisiana Power & Light Co. was constructing a second computer-

controlled generating unit at its Little Gypsy steam-electric generating station near Laplace on the Mississippi River. The second unit, which will cost about $26 million and have a capacity of 400,000 kilowatts, was scheduled for completion by the end of 1965. New Orleans Public Service Co. plans to build a $40 million steam-electric generating unit at its Michoud station on the Mississippi River-Gulf Outlet. The capacity of 560,000 kilowatts will be more than twice the capability of the largest steam-electric unit in Louisiana. Company studies indicate the additional power will be needed by 1967. Central Louisiana Electric Co. planned to install a $15-million, 230,000-kilowatt electric generating unit at its Coughlin Station at St. Landry to double capacity of the station when completed in 1966. Steam generation at the three new plants will be by gas fuel.

The Federal Power Commission reported that the total 16,059 million kilowatt-hours generated in 1964 by all Louisiana plants gained 8.2 percent over 1963, compared with a national gain of 7.2 percent. Louisiana's 1964 electric output was about 1.6 percent of the national output—unchanged from 1963.

Legislation.—The dispute concerning State and Federal ownership of mineral rights in Gulf Coast tidelands remained unsettled pending completion of a coastal boundary study. The dispute dates from May 31, 1960, when the U.S. Supreme Court set the 3-mile limit for Louisiana, Mississippi, and Alabama and the 3-league limit for Texas and the Florida Gulf Coast, but failed to fix the coastline—the base from which the 3 miles or 3 leagues would be measured.

Four years prior to the Court decision, Louisiana and the Interior Department reached an "interim agreement" for leasing the disputed tidelands. Under this agreement, still in effect, the so-called Chapman line was drawn roughly along the Louisiana coastline for measuring zone boundaries.

Zone 1 extends 3 miles seaward and belongs to Louisiana. Zone 2 extends from 3 miles to 3 leagues (10½ miles) seaward and is in dispute, not only because Louisiana hopes eventually to have a 3-league boundary but because a more liberal redrawing of the coastline would place part of the zone within the 3-mile limit. Zone 3 lies between the 3-league boundary and an offshore boundary established by the Louisiana Legislature in 1954; this is 3 leagues beyond a navigational boundary established by the U.S. Coast Guard in 1895. Zone 4 is undisputed Federal territory beyond Zone 3.

Under the interim agreement, Louisiana gets all bonus, royalty, and rental payments from lands leased in Zone 1, and the Federal Government gets the same from Zone 4. Payments from Zones 2 and 3 are placed in escrow for disbursement when the dispute is resolved. Under a Federal-State informal agreement, the Louisiana Conservation Department now regulates offshore operations and fixes allowables in all four zones. Whether the United States later will take over this function for the Federal areas as ultimately established has not been decided.

Employment and Injuries.—Employment in Louisiana's petroleum industry in 1964 amounted to 91,800 workers, 2,900 more than in 1963. In mineral production, including fuels (establishments with four or more employees), employment increased about 6 percent. Oil and

gas operations provided 93 percent of employment and 94 percent of wages derived from mineral industries in 1964. Reported employment in Louisiana's total industry group in 1964 averaged 593,956 workers—up about 6 percent.

A 3-month-old labor stoppage at the Continental Oil Co. plant, Lake Charles, ended September 8 when members of the Teamsters International Union voted to accept a new contract. Terms of the contract included a 2 percent wage increase, improved retirement benefits, continued flexibility of working assignments, and privileges of contracting work outside the plant.

A barge-mounted oilfield drilling rig waiting out bad weather in Bayou Bienvenue overturned February 27, trapping two men inside the sleeping quarters. The rig, Bateman Drilling Co.'s No. 5, had been pulled inside the bayou to escape rough weather in Lake Borgne. The unit had just finished two tests in Chandeleur Sound.

A $6 million floating oil rig collapsed and sank 72 miles off the Louisiana coast as a result of an explosion and fire June 30. Two men died and 18 men were missing and presumed dead. Drilling was underway and the well was at a depth of 684 feet when apparently a gas pocket was struck. The gas enveloped the vessel and was ignited by an unknown source. The rig and barge sank within 15 minutes.

Three oilfield workers were killed in an explosion near Dixie, La., November 12. The men, pulling casing, dropped the explosive to shake the casing loose and the blast apparently went off near the top of the hole instead of the bottom.

TABLE 3.—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
1955–59 (average)	40,370	15,190	1,414	5,776	4,408	8,360	16,640	92,158
1960	[3] 40,150	13,350	1,250	6,400	4,300	8,850	16,400	90,700
1961	40,300	12,800	1,150	6,350	4,000	8,700	16,300	89,600
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 [p]	42,900	10,400	950	6,150	4,300	9,900	17,200	91,800

[p] Preliminary.
[1] Employment in petroleum refineries and petrochemicals manufactured in petroleum refineries.
[2] Employment in petrochemical manufacturing facilities located outside petroleum refineries.
[3] Includes 3,300 formerly in service industries.

Source: Louisiana State Department of Labor, Division of Employment Security.

TABLE 4.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	1,032	376	3,011	----------	24	8
Nonmetal	1,617	477	4,122	2	73	18
Sand and gravel	1,047	285	2,402	1	24	10
Stone	872	280	2,325	1	24	11
Total	4,568	1,418	11,860	4	145	13
1964: p						
Metal	905	318	2,546	----------	13	5
Nonmetal	1,770	504	4,361	----------	132	30
Sand and gravel	1,140	310	2,612	----------	20	8
Stone	595	190	1,574	----------	21	13
Total	4,410	1,322	11,093	----------	186	17

p Preliminary.

TABLE 5.—Value of construction contracts awarded

(Thousands)

Type	1961	1962	1963	1964
Residential [1]	$219,412	$271,162	$344,422	$419,174
Nonresidential [2]	175,226	192,929	216,579	289,026
Nonbuilding [3]	194,043	194,836	377,909	287,530
Total	588,681	658,927	938,910	995,730

[1] Includes apartments, hotels, dormitories, and one- and two-family dwellings.
[2] Includes commercial, manufacturing, educational, and other nonresidential buildings.
[3] Formerly reported as Public Works and Utilities.

Source: Louisiana Business Review, Dodge Statistical Research Service. V. 29 No. 2, February 1965, p. 13.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The oil and gas industry of Louisiana continued to expand, and the State maintained its position, second only to Texas in oil and gas production. It remained a major supplier of natural gas liquids and refined petroleum products. At yearend, there were 1,145 oil and gasfields in the State, containing 37,712 producing wells (35,596 in 1963). North Louisiana had 14,338 oil wells and 4,477 natural gas wells producing; south Louisiana onshore had 11,297 oil and 3,201 natural gas producers; offshore, 3,817 oil wells and 582 natural gas wells were producing.

Leasing was intensive in the Louisiana Gulf Coast. Geophysical activity increased slightly onshore, and, markedly offshore. Improved seismic and interpretive techniques encouraged operators to lease acreage in previously prospected areas.

State lease sales totaled $11.1 million for 49,900 acres of Zone 1 leases.

A Federal lease sale in Zone 2 yielded $60.3 million for 32,700 acres. As ownership of this zone was disputed, acreage was offered for bid only by joint consent of the State of Louisiana and the U.S. Government.

No Federal lease sales in Zone 3 or Zone 4 were made during 1964.

The most active leasing in north Louisiana was in the area of Black Lake field, following its discovery in Natchitoches Parish during June. Placid Oil Co. paid a record price of $1,325 per acre for 398 acres owned by the Natchitoches Parish School Board. In other areas of north Louisiana, lease bonuses and lease terms remained stable. Buying continued in the Upper Cretaceous "chalk," productive area of Sabine Parish, and in the Wilcox trend of Catahoula and Concordia Parishes.

Exploration, Development, and Reserves.—Statewide drilling of 5,275 development and exploratory wells (5,754 in 1963) proved 59 percent productive (63 percent productive in 1963). Statewide drilling of 1,102 exploratory wells (1,193 in 1963) proved 20 percent productive (17 percent productive in 1963). Inland drilling of 827 exploratory wells proved 17 percent productive and opened 33 fields—12 oil and 4 gas discoveries in north Louisiana and 6 oil and 11 gas discoveries in south Louisiana.

Offshore well drilling increased to 275 exploration wells (263 in 1963) and 508 development wells (454 in 1963). Ten new fields, 4 oil and 6 gas, were discovered, compared with 12 in 1963.

The Louisiana Department of Conservation granted 6,479 permits to drill during the year, 119 more than in 1963. Abandoned wells totaled 769, compared with 997 in 1963.

TABLE 6.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1964

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	19	25	32	------	4	11	91	--------	83	83
Allen	5	4	15	------	------	8	32	--------	11	11
Ascension	5	------	3	------	------	4	12	--------	21	21
Assumption	3	2	5	1	1	6	18	--------	46	46
Avoyelles	7	------	19	3	------	34	63	--------	3	3
Beauregard	4	------	6	3	------	13	26	--------	52	52
Bienville	2	4	3	------	2	2	13	--------	23	23
Bossier	19	1	18	6	1	16	61	--------	3	3
Caddo	677	8	55	2	------	7	749	--------	10	10
Calcasieu	16	7	28	2	1	18	72	4	66	70
Caldwell	------	3	1	------	------	9	13	--------	18	18
Cameron	28	14	28	3	5	19	97	--------	147	147
Catahoula	38	------	68	7	------	56	169	--------	----------	------
Claiborne	18	13	6	2	1	3	43	--------	9	9
Concordia	40	------	78	14	------	74	206	--------	----------	------
De Soto	15	23	34	------	------	7	79	--------	----------	------
East Baton Rouge	3	------	2	------	------	------	5	--------	----------	------
East Carroll	------	------	------	------	------	1	1	--------	----------	------
Evangeline	8	4	9	1	------	6	28	--------	----------	------
Franklin	1	------	2	1	------	14	18	--------	20	20
Grant	9	------	4	------	------	9	22	--------	7	7
Iberia	7	9	11	1	3	12	43	5	96	101
Iberville	31	2	14	2	------	8	57	--------	62	62
Jackson	------	4	2	------	------	5	11	--------	18	18
Jefferson	29	3	15	------	------	14	61	--------	67	67
Jefferson Davis	22	11	23	------	------	12	68	--------	53	53
Lafayette	1	9	13	------	2	6	31	--------	46	46
Lafourche	59	17	38	2	5	11	132	40	166	206
La Salle	34	1	44	4	1	22	106	--------	3	3
Lincoln	------	11	7	------	1	1	20	--------	8	8
Livingston	------	------	1	------	------	2	3	--------	----------	------

TABLE 6.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1964—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—Continued										
Madison	------	------	------	------	------	2	2	------	------	------
Morehouse	------	14	10	------	------	8	32	------	1	1
Natchitoches	1	9	7	------	2	11	30	------	48	48
Orleans	------	------	------	------	------	1	1	------	------	------
Ouachita	------	37	16	------	2	1	56	------	4	4
Plaquemines	167	8	49	5	1	19	249	------	160	160
Pointe Coupee	18	1	6	5	------	5	35	------	10	10
Rapides	34	------	49	2	------	7	92	------	24	24
Red River	9	3	11	------	------	7	30	------	3	3
Richland	3	------	1	------	------	4	8	------	13	13
Sabine	433	2	292	4	3	33	767	------	10	10
St. Bernard	12	1	5	------	4	13	35	------	41	41
St. Charles	6	3	5	1	------	6	21	37	46	83
St. James	3	------	5	------	------	2	10	------	19	19
St. John the Baptist	------	1	3	------	1	6	11	------	3	3
St. Landry	13	6	15	------	------	11	45	------	24	24
St. Martin	29	4	20	------	------	8	61	------	20	20
St. Mary	48	14	12	1	7	5	87	5	107	112
St. Tammany	------	------	------	------	1	1	2	------	4	4
Tensas	26	4	15	2	------	15	62	------	------	------
Terrebonne	104	25	34	3	2	21	189	------	238	238
Union	------	89	4	------	------	2	95	------	24	24
Vermilion	17	11	27	4	5	24	88	4	175	179
Vernon	------	------	------	------	------	4	4	------	6	6
Washington	------	------	------	------	------	2	2	------	5	5
Webster	6	4	6	1	------	4	21	------	16	16
West Baton Rouge	------	------	2	------	------	1	3	------	------	------
West Carroll	------	------	------	------	------	1	1	------	2	2
Winn	28	------	19	------	1	55	103	------	50	50
Total: 1964	2,057	411	1,197	82	56	689	4,492	95	2,091	2,186
1963	2,479	553	1,075	84	63	783	5,037	40	1,951	1,991
Offshore:										
Bay Marchand	7	------	3	2	------	2	14	------	------	------
Breton Sound	29	------	6	------	2	11	48	------	60	60
Cameron, East	------	4	1	1	1	11	18	------	47	47
Cameron, West	------	3	3	------	4	5	15	------	50	50
Chandeleur Sound	9	2	4	1	1	16	33	------	84	84
Delta, West	88	27	16	10	8	25	174	------	80	80
Eugene Island	26	5	12	3	5	16	67	------	100	100
Grand Isle	22	------	10	3	------	4	39	------	66	66
Main Pass	34	2	6	7	4	8	61	11	44	55
Marsh Island, South	17	3	9	4	4	26	63	------	67	67
Pelto, South	1	------	5	------	1	4	11	------	5	5
Ship Shoal	17	1	9	4	4	18	53	------	81	81
South Pass	56	1	10	3	1	4	75	33	24	57
Timbalier, South	41	------	9	3	------	7	60	------	67	67
Vermilion	1	5	4	1	6	35	52	------	93	93
Total: 1964	348	53	107	42	41	192	783	44	868	912
1963	303	59	92	32	24	207	717	89	560	649
Grand Total: 1964	2,405	464	1,304	124	97	881	5,275	139	2,959	3,098
1963	2,782	612	1,167	116	87	990	5,754	129	2,511	2,640

Source: International Oil Scouts Association. International Oil and Gas Development. Austin, Tex., v. 35 in 1964 Review.

One of the most significant discoveries in north Louisiana in several years was Black Lake field. The field was opened in June by Placid Oil Co.'s, Edenborn, Inc. Well A–2. Initial production was 459 barrels of 45.8°API gravity condensate and 2.65 million cubic feet of gas from perforations at 7,990 to 8,000 feet, in the Pettet formation.

Bayou Henry field, Iberville Parish, was probably one of the better discoveries in south Louisiana onshore during 1964. It is in the

difficult-to-prospect Atchafalaya swamp area and produces from two reservoirs, both of Oligocene age, between 11,500 and 12,200 feet deep. Seven wells, all oil producers, were drilled in the field.

Offshore exploratory drilling in the 16 Continental Shelf areas moved farther seaward into deeper water; drilling and operating costs mounted accordingly. In October, Hurricane Hilda took a heavy toll of offshore structures by destroying 12 large platforms with 45 wells, and sinking at least 3 drilling rigs. The platforms were designed to withstand a storm intensity expected once in 25 years; "Hilda" and two other recent hurricanes, "Audrey" and "Carla," were of an intensity expected only once in 100 years. Future costs will be higher due to design changes to strengthen the structures.

According to The Oil and Gas Journal, 35.2 million feet of hole was drilled in the State during 1964, or 3.8 percent more than the footage drilled in 1963. The number of drilling rigs operating offshore averaged 91 in 1964 and 78 in 1963; for the entire State, the average number was 282 in 1964 and 265 in 1963.

According to American Petroleum Institute figures, proved recoverable reserves of crude oil, natural gas, and natural gas liquids in Louisiana reached new highs in 1964. At yearend the crude oil reserve comprised 16.7 percent of the U.S. reserve, the natural gas reserve was 28 percent of the U.S. total, and the natural gas liquids reserve was 25 percent of the U.S. total. Seventy percent of the total additions to Louisiana crude petroleum reserves was attributed to extensions and revisions of reserves in previously discovered fields, the remainder to new discoveries.

According to The Oil and Gas Journal, 29 percent of the Louisiana crude reserve was offshore.

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
1960	401	125	2,988	3,532	35	75
1961	425	146	3,272	2,643	41	61
1962	477	155	3,525	5,906	45	204
1963	515	2	3,928	3,821	54	143
1964	550	74	4,175	3,711	62	101
	Total proved reserves by Dec. 31, 1964					
1964	5,162		79,076		1,942	

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, v. 15–19 1960–64. Production figures from Bureau of Mines.

Carbon Black.—Output of carbon black from natural gas and petroleum distillates gained about 12 percent. The product was mainly used as an additive in rubber manufacturing.

TABLE 8.—Carbon black production

Year	Million pounds	Year	Million pounds
1955–59 (average)	535	1962	608
1960	631	1963	649
1961	583	1964	726

Natural Gas.—Marketed production of natural gas continued a strong growth trend for the 19th consecutive year, and Louisiana retained second position in the United States as a supplier of natural gas. National demand for gas as a fuel for heating and power and as a raw material for petrochemicals grew rapidly. New and existing 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.

Gas deliveries to Texas Eastern Transmission Co. were started under terms of a 4.4-trillion-cubic-foot sales contract for new gas supplies from south Louisiana holdings of Gulf Oil Corp. Gulf, which will deliver the gas over a 26-year period, completed a 20-inch transmission line, 11 miles long, from West Delta Block 27 field to Venice in Plaquemines Parish where the company was constructing a large gas processing plant to recover condensable liquids. Delivery capacity of the gas line was 500 million cubic feet daily. From Venice, Texas Eastern started transmitting the gas through a new 36-inch line 175 miles to its transmission system to New York. Gulf also started gas delivery of 25.2 million cubic feet daily to Southern Natural Gas Co. Plans were to increase this delivery to 108 million cubic feet daily by 1968.

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]
1955–59 (average)	1,952,200	472,800	2,425,000	2,153,419	$273,039	197,361	74,221
1960	2,691,000	622,000	3,313,000	2,988,414	511,019	219,411	105,145
1961	2,930,100	640,700	3,570,800	3,271,857	611,837	201,989	96,954
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	3,702,300	812,700	4,515,000	4,175,412	793,328	222,477	117,111

[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 gas in pipelines.
[3] Partly estimated. Includes direct waste on producing properties and residue blown to the air.

Delivery of the largest single purchase of natural gas in the U.S. began at Venice when Columbia Gas Systems, Inc., began taking gas from the Plaquemines Parish, West Delta Block 27 field. Total delivery will be 6.1 trillion cubic feet. Humble Oil & Refining Co., Isaac Arnold, and others have contracted to deliver the natural gas from south Louisiana and offshore south Louisiana fields over the next 25 years. Initial deliveries to United Fuel Gas Co., a Columbia subsidiary, will be 235 million cubic feet daily, with increasing delivery

rates in succeeding years to 765 million cubic feet per day by 1969. Columbia constructed 129 miles (55 miles of 30-inch and 74 miles of 24-inch pipe) of line from Venice to its Franklin terminal.

The California Oil Co. and Natural Gas Pipeline Co. of America signed a contract calling for a minimum delivery of 800 billion cubic feet of gas over a 25-year period. The gas will be delivered from Calco's Block 17 and Block 49 fields, offshore from Cameron Parish. Calco will pipe the gas from the offshore fields to a station in Cameron Parish, and a 30-inch line will be laid to connect the station with the Natural Gas Co. compressor station in Montgomery County, Tex.

Atlantic Refining Co. started delivering south Louisiana natural gas to American Louisiana Pipe Line Co. for distribution to the Detroit, Mich., area. Initial gas deliveries were 50 million cubic feet daily from the Jeanerette field, St. Mary Parish. Combined volumes will be increased to 120 million cubic feet daily when a pipeline extension is completed to Atlantic's Bayou Sale field also in St. Mary Parish.

A sales contract for 600 billion cubic feet of gas was signed by Florida Gas Transmission Co. with Pan American Petroleum Corp. and Austral Oil Co. The Florida Gas Co. planned to transmit this gas through 50 miles of 18-inch line from the White Lake field, Vermilion Parish, and 219 miles of 30-inch loop lines between Louisiana and Florida.

Tennessee Gas Pipeline Co. announced additional pipeline contracts for 64 miles of large diameter pipeline and two submerged river crossings, all in south Louisiana. This pipeline, an addition to the company's natural gas gathering system, will extend from the Southwest Pass area to a company compressor station near Port Sulphur, La. The construction program of Tennessee Gas completed in 1964 included 200 miles of large diameter pipeline and 20,000 additional compressor horsepower.

The Federal Power Commission fixed 18.5 cents per thousand cubic feet as the initial "in line" price for natural gas sold from southern Louisiana producing areas. The ruling affects gas produced both on and offshore under contracts entered into from January 1960 through the end of 1962, plus 1.5 cents tax reimbursement whenever applicable. FPC said the price represented "the maximum initial price appropriate in the interest of public convenience and necessity reflecting the current conditions in the industry."

A feasibility study was completed on the Red Snapper pipeline project to deliver oil and gas from Zone 4 fields in Federal waters 30 to 100 miles offshore. The proposed line (organized by 25 companies including Shell Oil Co.) will be a 400-mile, 30-inch, 2-phase pipeline. Tentative plans called for laying the line in a huge arc in the Gulf about 70 miles from shore and providing a central 90-mile long connecting line to Gibson, La., where the gas would be processed through a new gasoline plant and sold to several transmission companies.

There were one active and two planned underground gas storage projects in Louisiana in 1964. South Louisiana Production Co. operated a gas storage reservoir in Holly field, De Soto Parish; total storage capacity of the reservoir represented 1 billion cubic feet "working" storage and a half billion cubic feet "cushion" storage.

Natural Gas Liquids.—Louisiana again ranked second in the Nation as a producer of natural gas liquids. New plants and expansions completed and under construction in 1964 raised the State's daily processing capacity from 11.4 billion cubic feet to 12.1 billion cubic feet (21.8 percent of the Nation's total capacity).

Natural gasoline and cycle products were recovered at 111 gasoline plants and 16 recyling plants (111 gasoline and 15 recyling plants in 1963) in 32 parishes. Increased output of total condensable liquids was attributed mainly to a gain in natural gas produced and processed.

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
1955-59 (average)	792,099	$59,235	376,483	$17,450	1,168,582	$76,685
1960	875,567	66,214	606,023	28,147	1,481,590	94,361
1961	931,176	61,714	806,559	33,214	1,737,735	94,928
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

Recovery of condensable liquids gained about 15 percent and amounted to 14.7 percent of the Nation's annual total. Output was 52 percent natural gasoline, and the remainder, LP gases. Consumption pattern and market development for the condensable liquids were widened aggressively to provide greater outlets for the fast-rising production. Some of the newer markets being developed were flame cultivation, crop drying, and fuel for internal combustion engines. New pipelines completed in recent years provided wider distribution of the fuel for the older domestic-use market.

In Louisiana, the petrochemical industry was a substantial consumer of natural gas liquids, and there were indications that further growth of this market could be expected.

Vast facilities for processing natural gas and for recovering, delivering, and storing the plant liquids were being constructed. The new facilities will alleviate the 1,700 wells shut-in due to lack of markets. Recycling plants, which extract condensable liquids and return the dry gas to the reservoir, were proving profitable.

In north Louisiana, Pan American Petroleum Corp. started operating its 8.5-million-cubic-foot-per-day cycling plant on gas from the Antioch field, Claiborne Parish. In south Lousiana, Texaco Inc., was expanding its 320-million-cubic-foot-per-day gas-processing plant at Paradis, St. Charles Parish. Mobil Oil Co. was expanding its cycling plant near Opelousas, St. Landry Parish. The plant addition was designed to process 26 million cubic feet of gas per day from the Opelousas gasfield.

Humble Oil & Refining Co. started operating its gas-processing plant at Garden City, St. Mary Parish. The plant, second largest of Humble's 23 gas plants, will process 650 million cubic feet of gas per day from Bayou Sale, Lake Sand, Duck Lake, and Garden City

gasfields. Extracted plant liquids, about 12,000 barrels per day, will be pipelined to the company refinery at Baton Rouge. Processed gas will be delivered to the Columbia Gas System for transmission to the Eastern Seaboard. Humble Oil & Refining Co. also contracted to build a $5 million gas-processing plant near Venice, Plaquemines Parish, to process 310 million cubic feet of gas per day from the offshore area, principally Block 27, West Delta field. Liquid recovery will be about 6,000 barrels per day; processed gas will enter the lines of Columbia Gulf Transmission Co. and Southern Natural Gas Co.

Gulf Oil Corp. planned to complete in 1965 a 500 million-cubic-foot-per-day gas processing plant near Venice, Plaquemines Parish. About 20,000 barrels per day of recovered plant liquids will be fed to the company's proposed refinery at the same site.

Shell Oil Co. and 28 other companies were building the North Terrebonne gas processing plant at Gibson, Terrebonne Parish. Processing capacity will be 950 million cubic feet per day of south Louisiana and offshore field gas moving through the lines of United Gas Co. and Transcontinental Gas Pipe Line Corp. To separate the liquid components, Shell was building the fractionator at Geismar (Tebone) which will receive the liquid stream (600,000 gallons per day) from the North Terrebonne plant via a pipeline.

Union Oil Co. of California discontinued its Caillou Island gas processing plant, Terrebonne Parish.

New plant construction to process south Louisiana gas supplies was trending toward larger capacity, refrigeration-absorption systems with low-temperature operating ranges, fuller automation, and use of central fractionators. Central fractionator sites provide for convenient storage and transportation of the liquid components.

Development of underground storage facilities increased availability of natural gas liquids for the growing market. Capacity, as reported by The Oil & Gas Journal survey, was 8.35 million barrels of natural gas liquids, plus 1.60 million barrels of ethylene, for a total capacity of 9.95 million barrels. The underground storage cavities, all in salt domes, were operated by 13 companies in 8 parishes. For future storage possibilities, above-ground refrigerated storage and frozen-earth pits promise to provide economical storage in areas where suitable salt domes do not exist.

In 1964, Wanda Petroleum Co. completed two salt cavities for propane and butane storage in St. Martin Parish. Socony Mobil Oil Co., Goliad Division, planned a salt-dome storage cavity for propane near Geismar, and Warren Petroleum Corp. (Gulf Oil Co.) planned salt-dome storage for propane and butane at Venice, Plaquemines Parish.

Petroleum.—The petroleum industry in Louisiana established a production record of 550 million barrels in 1964—second highest in the Nation. The gain of nearly 7 percent over 1963 production came from new discoveries, both offshore and onshore.

To balance production with indicated demand, the State Conservation Commission adjusted petroleum allowables. Daily allowables, based on the Commission's formula, were reduced from approximately 1,353,000 barrels at the first of the year to 1,036,000 barrels for the May–August period; then they were advanced to 1,436,000 barrels for the November–December period, the largest allowables in the State's

history. The increase in allowables for the last 2-month period represented 17,000 barrels per day in new production and a 1-percent raise in overall allowable production.

Secondary recovery projects (water, gas, or other injections) accounted for 66 million barrels of petroleum, or 12 percent of the 1964 production.

According to a survey [4] Louisiana had 10,886 oil wells classified as "stripper" wells. For 1963, stripper wells represented 40 percent of total oil wells, but only 4 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.

TABLE 11.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955-59 (average)	315,377	$986,944	1963	515,057	$1,608,120
1960	400,832	1,258,138	1964	549,698	1,709,622
1961	424,962	1,338,160			
1962	477,153	1,502,568	1902-64	7,483,956	19,064,318

TABLE 12.—Crude petroleum production, indicated demand, and stocks, in 1964, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks (end of month)	Month	Production	Indicated demand	Stocks (end of month)
January	47,273	46,243	22,454	September	43,976	44,866	20,135
February	44,526	43,636	23,344	October	45,075	42,926	22,284
March	47,274	46,696	23,922	November	46,175	45,425	23,034
April	46,175	46,415	23,682	December	49,473	49,935	22,572
May	45,625	46,527	22,780				
June	43,976	45,119	21,637	Total: 1964	549,698	548,550	xx
July	45,075	46,618	20,094	1963	515,057	516,256	xx
August	45,075	44,144	21,025				

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)	Year	Number of producing wells Dec. 31	Average production per well per day (barrels)
1955-59 (average)	21,638	41.3	1962	26,382	49.6
1960	24,682	44.8	1963	27,638	51.8
1961	24,740	47.1	1964 p	29,452	51.0

p Preliminary.

[4] Interstate Oil Compact Commission. National Stripper Well Survey, Jan. 1, 1964. Oklahoma City, Okla., October 1964.

TABLE 14.—Production of crude petroleum, by districts and selected fields

(Thousand barrels)

District and field [1]	1963	1964
Gulf Coast:		
Onshore: [2]		
Avery Island	2,696	2,531
Bastian Bay	3,369	2,948
Bateman Lake	2,765	2,844
Bay De Chene	2,706	2,713
Bay St. Elaine	7,925	7,705
Bayou Penchant		2,204
Bayou Sale	7,307	7,283
Caillou Island	20,425	22,186
Delta Duck Club		2,550
Delta Farms	2,974	2,635
Duck Lake	3,016	3,143
East and West Hackberry	7,522	8,050
Erath	4,309	3,120
Garden Island Bay	4,740	5,710
Golden Meadow	2,673	2,757
Grand Bay	6,347	6,443
Krotz Springs		4,047
La Fitte	4,850	5,813
Lake Barre	10,231	11,634
Lake Pelto	4,288	4,324
Lake Salvador	3,047	2,888
Lake Washington	10,506	10,242
Leeville	3,745	3,680
Little Lake	2,600	2,597
Main Pass, Blk. 35	4,400	4,371
Paradis	2,395	2,023
Quarantine Bay	5,047	5,043
Rayne		2,520
Romere Pass	3,069	3,029
South Pass, Blk. 24	17,451	19,968
Timbalier Bay	16,948	16,876
Venice	4,554	4,674
Weeks Island	7,191	6,983
West Bay	7,615	8,299
West Black Bay		3,677
West Cote Blanche Island	6,426	7,567
White Castle		2,603
Other	161,375	109,300
Total onshore	354,512	326,980
Offshore [2]		
Bay Marchand, Blk. 2	26,452	25,056
Eugene Island	13,173	13,483
Grand Isle	14,955	17,033
Main Pass, Blk. 69	8,861	10,072
Ship Shoal	5,527	6,808
South Pass, Blk. 27	14,354	16,822
South Timbalier, Blk. 131	1,770	2,279
West Delta	16,522	20,862
Other	4,965	56,756
Total offshore	106,579	169,171
Total Gulf Coast	461,091	496,151
Northern:		
Caddo	6,199	6,387
Cotton Valley	3,708	3,498
Delhi	4,774	4,703
Haynesville	2,638	2,904
Pendleton	3,340	4,896
Other	33,307	31,159
Total Northern	53,966	53,547
Total Louisiana	515,057	549,698

[1] Breakdown for individual fields from The Oil and Gas Journal.
[2] Some fields include onshore and offshore.

TABLE 15.—Crude petroleum production and estimated reserves in Louisiana offshore area

(Thousand barrels)

Offshore area	Number of wells		Production			Estimated reserve Dec. 31, 1964
	1963	1964	1963	1964	Cumulative total	
Bay Marchand: Block 2 [1] [2]	516	493	26,452	25,056	131,025	468,975
Belle Isle [2]	55	64	1,290	1,713	12,349	22,651
Caillou Island [1] [2]	616	684	20,425	22,186	239,795	260,205
Eugene Island:						
Block 18	55	50	2,544	2,396	16,862	23,138
Block 32	31	34	950	958	10,005	24,995
Block 45	10	9	571	532	3,990	7,010
Block 100	17	19	825	627	3,581	16,419
Block 126 [1]	92	92	4,023	4,335	35,953	89,047
Block 128	39	46	2,018	2,094	15,159	44,841
Block 188	23	24	854	1,247	5,729	29,271
Block 208	36	33	1,388	1,294	5,805	29,195
Grand Isle:						
Block 16	190	221	8,770	10,584	41,218	133,782
Block 18	34	35	1,689	1,743	20,223	19,777
Block 47	87	92	4,496	4,706	27,754	72,246
Lake Washington [1] [2]	423	402	10,506	10,242	105,189	194,811
Main Pass:						
Block 41	5	29	434	816	2,202	7,798
Block 46	3		380			
Block 69 [1]	191	236	8,861	10,072	80,209	219,791
Ship Shoal:						
Block 28	22	23	672	1,401	3,307	6,793
Block 197	45	50	2,976	3,445	9,213	50,787
Block 154	36	36	1,455	1,166	11,833	28,177
Block 176	23	24	1,096	796	4,460	17,540
South Pass:						
Block 24 [1] [2]	580	618	17,451	19,968	212,286	537,714
Block 27 [1]	375	406	14,354	16,822	72,843	238,157
South Pelto: Block 20	22	27	839	942	2,959	17,041
Tiger Shoal	23	20	928	923	3,558	6,442
Timbalier Bay [1] [2]	485	469	16,948	16,876	116,375	183,625
South Timbalier: Block 131	43	46	1,770	2,279	6,316	43,684
Vermilion:						
Block 14	41	39	930	1,579	5,425	26,575
Block 120	(3)	(3)	342	(3)	(3)	(3)
West Cameron:						
Block 45	37	33	1,063	803	6,480	18,520
Block 192	38	38	520	516	2,560	17,440
West Delta:						
Block 24	21	21	789	728	2,505	15,495
Block 30 [1]	418	458	16,522	20,134	79,987	320,013
Block 53 [2]	12	14	438	643	7,531	14,469
Total	r 4,644	4,885	r 175,569	189,622	1,304,686	3,206,424

r Revised.
[1] Estimated ultimate recovery of 100 million barrels or more.
[2] Combined onshore and offshore.
[3] Not reported.

Source: The Oil and Gas Journal. V. 63, Jan. 25, 1965, pp. 156–161.

Refineries.—At yearend, there were 14 petroleum refineries in Louisiana. Total crude oil capacity (barrels per calendar day) was 861,100, a gain of approximately 40,000 over 1963.

Crude oil runs to refinery stills totaled 277 million barrels (1 million barrels more than in 1963) and represented about 50 percent of the crude oil production.

Humble Oil & Refining Co. planned to construct an $11-million, 12,200-barrel-per-day hydrocracking unit at its Baton Rouge refinery. The new unit will convert heavier petroleum liquids into high-quality motor gasolines. Completion was scheduled for late in 1965.

Gulf Oil Corp. began preconstruction land fill operations at the site of its multimillion dollar refinery and gas plant complex at Venice, Plaquemines Parish. Gulf has substantial oil and gas production in the area, both offshore and on land, and a deep-water barge and tanker terminal at Ostrica on the Mississippi River. The processing complex will consist of one of the country's largest natural gas processing plants and a 20,000-barrel-per-day refinery. Condensate from the natural gas produced and liquids recovered from the gas processed will provide feedstock for the refinery.

Cities Service Oil Co. planned to convert an existing process operation into a delayed coking unit at its Lake Charles refinery. The coking unit will produce about 180,000 tons of premium quality coke per year.

Shell Oil Co. continued the $20 million modernization and expansion program started in 1963 at its Norco refinery. Included in the program is a major process unit to produce premium quality petroleum coke. This coke will be delivered to a calcining unit to be constructed by Kaiser Aluminum and Chemical Corp. at Norco.

Texaco, Inc., purchased a site on the Mississippi River in St. James Parish to build a refinery with a capacity of 100,000 barrels per day.

Petrochemicals.—Louisiana chemical producers in 1964 completed six projects, were constructing two projects, and announced plans for at least six more projects. At Lake Charles, Continental Oil Co. completed a Molex unit to produce chemical intermediates (olefins) for making "soft" biodegradable detergents. Pittsburgh Plate Glass Co. completed a plant to produce trichlorethylene and perchloroethylene. Olin Mathieson Chemical Co. was adding plant facilities to manufacture 510,000 tons of ammonia and 140,000 tons of urea per year for use as fertilizer.

At New Orleans, Air Products and Chemicals, Inc., announced plans to construct a $25 million chemical complex on the Michoud Canal to produce liquid hydrogen. The company was awarded a $19 million contract to supply liquid hydrogen to the National Aeronautics and Space Administration's program.

At Norco, St. Charles Parish, Shell Oil Co. announced plans to build a $30 million ethylene facility. The new plant, to be supplied with feedstock from Shell's refinery, will be designed for a 500-million-pound annual output of ethylene.

At Avondale, Jefferson Parish, American Cyanamid Co. completed the first addition to its Fortier plant to produce 40 million pounds of methyl methacrylate monomer annually. The monomer, manufactured from Cyanamid Co. hydrocyanic acid, is converted into plastics and artificial fibers. The company also announced a plant expansion program to manufacture 100 million pounds of acrylonitrile annually and 1,000 tons of ammonia and 300 tons of urea per day.

At Laplace, St. John the Baptist Parish, E. I. du Pont de Nemours & Co., Inc., completed its $20 million plant to produce adiponitrile—a chemical intermediate for making nylon. The plant employs about 300 persons. First shipment of the product was made in December 1964.

At Luling, St. Charles Parish, Monsanto Co. started a multimillion dollar program to increase ammonia output and to manufacture am-

monium phosphate fertilizer. Initial capacity of the fertilizer plant will be 240,000 tons per year.

In the Baton Rouge area, chemical plant construction was impressive. At Geismar, Naugatuck Chemical Division of U.S. Rubber Co. completed plant facilities to manufacture 32 million pounds annually of ethylene-propylene synthetic rubber (Royalene). Also at Geismar, Wyandotte Chemical Co. scheduled a $10 million plant expansion to produce urethane raw materials. This will be the plant's fourth expansion in 7½ years.

At Baton Rouge, Enjay Chemical Co., a division of Humble Oil & Refining Co., completed plant units to produce 5 million pounds of neo-acids annually and to increase ethylene capacity to 400 million pounds per year. Enjay also started full-scale production of alpha-olefins at Baton Rouge. Ethyl Corp. announced plans to construct a $10 million plant to produce polyvinyl chloride resins and compounds. Copolymer Rubber & Chemical Co. announced plans to expand its synthetic rubber facilities at Baton Rouge. The new facilities will produce about 20,000 long tons of rubber per year.

NONMETALS

Value of nonmetals (chemical and construction materials) produced in 1964 was $144 million, or 5 percent of total minerals value and a gain of 11 percent from 1963. Combined value of construction materials (clay, lime, cement, gypsum, sand and gravel, and stone or shell) gained 5 percent.

Barite.—Crude barite from Arkansas, Missouri, and foreign countries, was ground at three plants in New Orleans and one in Lake Charles. Output was used mainly in oilwell drilling fluids. Production was about 11 percent more than in 1963, while footage drilled for oil and gas in the State gained about 5 percent.

Cement.—A 7-percent gain in portland cement production at four plants was attributed mainly to public works construction, as indicated by increased value of construction contracts awarded (table 5). Both residential and nonresidential construction exhibited appreciable gains.

Louisiana Cement Co., a division of Oklahoma Cement Co., completed a 1.5-million-barrel annual capacity plant on the Michoud Canal, New Orleans. About 100 persons were employed. Jahncke Services, Inc., was supplying the plant with oystershell dredged from the Mississippi Sound and clay from the floor of Lake Borgne.

Clay.—There was a 19 percent gain in miscellaneous clay produced. Clay used for cement gained about 18 percent. About 182,000 tons of local clay, 47 percent more than in 1963, was used to manufacture heavy clay products at nine brick plants in nine parishes. Lightweight aggregate was produced at Alexandria, Rapides Parish, and Erwinville, Point Coupee Parish.

Gypsum.—Winn Rock, Inc., Winn Parish, mined crude gypsum for retarder in portland cement; output was about 9 percent less than in 1963. National Gypsum Co. at Westwego and U.S. Gypsum Co. and Bestwall Gypsum Co. at New Orleans calcined imported crude gypsum and manufactured plaster, lath, and wallboard.

TABLE 16.—Shipments of portland cement to Louisiana consumers

Year	Thousand barrels	Year	Thousand barrels
1955–59 (average)	8,078	1962	8,875
1960	8,007	1963	9,112
1961	7,865	1964	10,405

TABLE 17.—Miscellaneous clay sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	748	$749	1962	638	$641
1960	749	749	1963	655	655
1961	645	645	1964	780	797

Lime.—Lime production gained about 10 percent. About 70 percent of the total production (calcined and regenerated) was used at chemical plants, 29 percent at paper plants, and 1 percent for construction. Shell was calcined to lime at one paper plant, two chemical plants, and two lime plants; regenerated lime was produced at six paper mills. Lime producers for the open market were U.S. Gypsum Co. at New Orleans and Pelican State Lime Co. at Morgan City.

Nitrogen Compounds.—Air Reduction Sales Co. operated its air separation plant at the old Ronaldson airport near Baton Rouge. Daily production capacity was 30 tons of liquid oxygen, nitrogen, and argon for industrial uses. Air Products and Chemicals, Inc., was constructing a gas plant complex on the Michoud Channel, New Orleans, to separate oxygen, nitrogen and argon from air. Daily capacity will be 1,000 tons of liquid and gaseous components.

Salt.—Output of salt gained about 3 percent owing to increased consumption of rock salt by chemical plants. Evaporated and/or rock salt were produced by six salt companies; brine was produced by six chemical companies. Markets supplied were principally chemicals, municipal street de-icing, water softeners, meat packers, animal feed mixers, and groceries.

Responding to the growing demand for a variety of chemicals from salt, Wyandotte Chemical Corp. contracted to build an $8 million chlorine-caustic soda plant at Geismar, Ascension Parish, to supply chemicals from salt to the huge petrochemical complex at that site.

TABLE 18.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	3,795	$18,385	1962	5,248	$27,407
1960	4,792	21,959	1963	6,199	30,450
1961	4,722	23,357	1964	6,401	36,056

TABLE 19.—Salt production

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt		Brine	
	Quantity	Value	Quantity	Value	Quantity	Value
1961	196	$4,430	1,770	$12,884	2,756	$6,043
1962	246	6,298	2,004	13,531	2,998	7,578
1963	250	5,988	2,294	15,227	3,655	9,235
1964	252	6,080	2,516	16,537	3,633	13,439

Hooker Chemical Corp. planned a $35 million chemical complex in St. Charles Parish. To be situated on the west bank of the Mississippi River, the facilities will consist of a chlorine-caustic soda plant, a chlorinated solvents plant, and a plant to produce high-analysis ammonium phosphate fertilizers. The chlorine-caustic soda plant, costing approximately $20 million, will produce 350 tons of each chemical daily. Some of the chlorine output will go into chlorinated solvents.

At the Cote Blanche Island salt dome in St. Mary Parish, Carey Salt Co. along with Monsanto Co. started salt production.

Sand and Gravel.—Production of 13.6 million tons of sand and gravel, about 9 percent more than in 1963, reflected a small gain in demand for building. Washed sand and gravel amounted to 13 million tons, or 97 percent of the total. Sand use was as follows: Building sand, 55 percent; paving sand, 39 percent; and industrial, other construction, and fill sand, 6 percent. Gravel use was as follows: Building gravel, 54 percent; paving gravel, 43 percent; and other construction and fill gravel, 3 percent. There were 89 sand and gravel operations in 27 parishes.

Jahncke Services, Inc., operated specialized facilities to handle high-purity silica sand to manufacture glass at its plant in New Orleans. Sand for the plant was dredged from West Pearl River between Pearl River and Bogalusa in St. Tammany Parish. The river sand deposits vary considerably in fineness, but are all very clean, and were worked selectively by the two dredges. Sand from the dredges was barged about 50 miles via the river, the Intracoastal Canal, and the Inner Harbor Navigation Canal.

TABLE 20.—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
1955–59 (average)	13,150	$16,170	318	$138	13,468	$16,308
1960	13,935	18,990	384	116	14,319	19,106
1961	11,783	14,729	259	104	12,042	14,833
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

TABLE 21.—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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,283	$2,283	2,613	$2,426
Paving	1,821	1,730	1,843	1,562
Fill	(1)	(1)	15	15
Other [2]	129	73	254	186
Total	4,233	4,086	4,725	4,189
Gravel:				
Building	3,973	5,435	4,600	5,807
Paving	3,760	4,869	3,598	4,625
Fill	82	59	(3)	(3)
Other [4]	77	102	305	338
Total	7,892	10,465	8,503	10,770
Total sand and gravel	12,125	14,551	13,228	14,959
Government-and-contractor operations:				
Sand:				
Paving			8	9
Gravel:				
Building	240	96	188	75
Paving	135	54	170	210
Total	375	150	358	285
Total sand and gravel	375	150	366	294
Grand total	12,500	14,701	13,594	15,253

[1] Included in "Other" commercial sand.
[2] Includes fill (1963), blast, other construction, and ground sand.
[3] Included in "Other" commercial gravel.
[4] Includes railroad ballast, fill (1964), other construction, and miscellaneous gravel.

TABLE 22.—Sand and gravel production in 1964, by parishes

(Thousand short tons and thousand dollars)

Parish	Quantity	Value	Parish	Quantity	Value
Catahoula	358	$522	Red River	62	$22
Claiborne	17	25	St. Bernard	8	9
East Baton Rouge	1,553	1,310	Vermilion	28	33
East Feliciana	1,288	1,111	Vernon	32	48
Lincoln	188	75	Other parishes [1]	9,820	11,867
Livingston	204	220			
Morehouse	36	11	Total	13,594	15,253

[1] Includes Allen, Beauregard, Caddo, Evangeline, Grant, Jefferson Davis, La Salle, Madison, Ouachita, Rapides, St. Helena, St. Tammany, Tangipahoa, Washington, Webster, and West Feliciana, and undistributed amounts from various parishes, combined to avoid disclosing individual company confidential data.

Stone.—Most of the stone produced was shell (clam and oyster). Some miscellaneous stone was produced in Winn Parish for road surfacing and concrete. Lacking an adequate supply of stone, Louisiana relied on shell as a substitute. Shell used for concrete aggregate and road construction was 72 percent; as cement raw material, 24 percent. The remainder was burned to lime, used as paint filler, rubber filler, and mineral food. Total output of shell gained slightly from that of 1963.

Winn Rock, Inc., at Winnfield, operated an asphalt-filler plant; silica sand was purchased for use as base material.

Sulfur.—Shipments of Frasch sulfur were at a record level, exceeding the 1963 total by 12 percent. Delivered prices of sulfur became firm following an advance at midyear in the United States and Canada, and during the year in overseas markets. Sulfur was recovered at refining operations in Lake Charles and Baton Rouge.

Freeport Sulphur Co., the world's largest producer of sulfur in 1964, drew from inventories to ship slightly more than was produced. Production came almost entirely from its Frasch-process mines at Grande Ecaille, Garden Island Bay, Lake Pelto in southeast Louisiana, and Grand Isle off the Louisiana coast.

The consumption pattern in the Nation remained unchanged—about 58 percent of sulfur produced in this country going to the fertilizer industry and the remainder to makers of chemicals, pigments, paper, steel, petroleum products, and a wide variety of other goods.

In the United States, Freeport Sulphur's largest single market was the Tampa, Fla., area where sulfur converted to sulfuric acid was used to process phosphate rock into fertilizer materials. Facilities for storing liquid sulfur at Tampa were increased by one-third.

At Freeport's Joliet terminal, which serves Chicago and the upper Midwest, existing liquid storage capacity was augmented by new facilities for melting and filtering a 200,000-ton stockpile of solid sulfur.

To serve these and other regional terminals, new carriers were added to the existing fleet. For Midwest markets served by the inland waterway system, additional new barges were placed in service. To supply coastal terminals from Florida to Maine, the S.S. Louisiana Brimstone, an ocean-going tanker specially constructed for liquid sulfur transport, went into operation at yearend.

TABLE 23.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1955–59 (average)	2,145	2,149	$54,095	1962	2,363	2,262	$49,772
1960	2,264	2,256	52,639	1963	2,469	2,445	48,905
1961	2,608	2,352	55,164	1964	2,739	2,733	54,996

Almost one-fourth of Freeport's sales were made overseas, and there were major developments during the year in these operations. Sulphur Export Corp. inaugurated a new transatlantic delivery system which for the first time made Louisiana sulfur available to European markets in the liquid state. Two new sister ships chartered by Sulphur Export Corp. started service between the Gulf Coast and a terminal at Rotterdam, Holland. The Rotterdam terminal was expected to handle approximately half a million tons of liquid sulphur annually through its storage tanks and, had storage space for more than 100,000 tons of solid sulfur. A second terminal for liquid sulfur was under construction at Dublin, Ireland.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. produced alumina at its Gramercy and North Baton Rouge plants and aluminum at its reduction plant at Chalmette. The company announced a $12 million expansion and modernization program at the Gramercy, Chalmette, and Baton Rouge plants. The $8 million project at Gramercy would increase capacity of the alumina refinery, substantially expand the isocyanate plant, and increase aluminum fluoride production by 50 percent. The expansion included installation of a new hydrogen fluoride generator. The aluminum fluoride was for company use at its aluminum reduction plants and for sale. New facilities were being installed for drying alumina hydrate to supply feed material for cryolite and aluminum fluoride production. The new drying unit will permit using existing equipment at the Baton Rouge plant to produce commercial grade hydrated aluminas exclusively to meet demands for this product. Completion of the expansion was scheduled for mid-1965. The program at the Chalmette reduction plant will include new billet handling and packaging equipment.

Iron Ore.—The Louisiana Geological Survey was preparing a report on iron ore deposits in central north Louisiana. The proven ore reserves was estimated to be 150 million tons.

REVIEW BY PARISHES

Minerals were produced in all but 1 of the State's 64 parishes. Mineral fuels were produced in 57 parishes; other minerals in 43 parishes. Eight parishes reported mineral production valued at over $100 million; 4 parishes reported between $100 million and $50 million; and 41 other parishes reported mineral production valued at over $1 million.

Acadia.—Exploratory drilling led to discovery of the West Rayne gasfield. The parish ranked first in recovering natural gas liquids valued at $35.9 million. Six gasoline plants and one cycling plant recovered the liquids.

TABLE 24.—Value of mineral production in Louisiana, by parishes[1]

Parish	1963 r	1964	Minerals produced in 1964, in order of value
Acadia	$111,182,931	$114,830,827	Natural gas, natural gas liquids, petroleum.
Allen	11,310,745	11,425,019	Petroleum, natural gas, sand and gravel, natural gas liquids.
Ascension	2,771,463	3,746,591	Petroleum, salt, natural gas.
Assumption	21,016,489	19,189,570	Natural gas, petroleum.
Avoyelles	2,112,698	2,674,700	Petroleum, natural gas liquids, natural gas.
Beauregard	10,086,362	9,421,364	Petroleum, natural gas, natural gas liquids, sand and gravel.
Bienville	10,215,037	9,963,085	Natural gas, petroleum.
Bossier	46,614,788	40,984,361	Natural gas, petroleum, natural gas liquids.
Caddo	33,910,519	34,152,418	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Calcasieu	41,628,087	42,614,975	Petroleum, natural gas, cement, natural gas liquids, lime, salt, clays.
Caldwell	2,226,313	2,516,899	Natural gas, petroleum;
Cameron	153,671,332	159,956,635	Natural gas, petroleum, natural gas liquids, salt, shell.
Catahoula	9,398,973	10,158,775	Petroleum, sand and gravel, natural gas.
Claiborne	24,499,975	25,431,891	Petroleum, natural gas, natural gas liquids, sand and gravel.
Concordia	14,669,456	15,628,391	Petroleum, natural gas, natural gas liquids.

See footnotes at end of table.

TABLE 24.—Value of mineral production in Louisiana, by parishes[1]—Continued

Parish	1963 r	1964	Minerals produced in 1964, in order of value
De Soto	$11,681,833	$11,395,894	Natural gas, petroleum, natural gas liquids.
East Baton Rouge	16,072,214	15,589,849	Cement, lime, petroleum, sand and gravel, natural gas, natural gas liquids, clays.
East Feliciana	W	1,111,000	Sand and gravel.
Evangeline	9,780,883	10,493,367	Petroleum, natural gas, natural gas liquids, sand and gravel.
Franklin	2,509,675	2,772,218	Petroleum, natural gas.
Grant	W	1,037,374	Petroleum, sand and gravel.
Iberia	91,065,400	89,836,921	Petroleum, natural gas, salt, natural gas liquids, clays.
Iberville	34,058,879	38,982,408	Petroleum, salt, natural gas, natural gas liquids.
Jackson	100,534	308,829	Natural gas, petroleum.
Jefferson	106,972,412	115,079,170	Petroleum, sulfur, natural gas, natural gas liquids, shell.
Jefferson Davis	52,699,949	52,360,339	Natural gas, petroleum, natural gas liquids, sand and gravel.
Lafayette	14,001,366	14,316,306	Petroleum, natural gas, clays.
Lafourche	291,046,085	293,951,328	Petroleum, natural gas, natural gas liquids.
La Salle	18,109,481	18,036,487	Petroleum, natural gas, sand and gravel.
Lincoln	26,097,888	25,149,136	Natural gas, natural gas liquids, petroleum, sand and gravel, clays.
Livingston	544,156	448,925	Petroleum, sand and gravel, natural gas.
Madison	1,426,930	959,445	Do.
Morehouse	1,853,198	1,784,797	Natural gas, sand and gravel, petroleum.
Natchitoches	204,894	277,361	Petroleum, natural gas, clays.
Orleans	W	W	Cement, lime, shell.
Ouachita	9,620,306	10,511,417	Natural gas, sand and gravel, petroleum, natural gas liquids, clays.
Plaquemines	518,613,526	575,038,133	Petroleum, natural gas, sulfur, natural gas liquids.
Pointe Coupee	7,377,146	9,158,198	Petroleum, natural gas, natural gas liquids, clays.
Rapides	2,289,623	3,997,528	Petroleum, sand and gravel, natural gas, clays, natural gas liquids.
Red River	872,671	696,807	Petroleum, sand and gravel, natural gas.
Richland	15,421,423	15,287,305	Petroleum, natural gas liquids, natural gas.
Sabine	12,645,841	20,377,907	Petroleum, natural gas.
St. Bernard	12,538,057	16,813,293	Natural gas liquids, petroleum, natural gas, clays, sand and gravel.
St. Charles	42,033,788	40,101,236	Petroleum, natural gas, natural gas liquids.
St. Helena	W	W	Sand and gravel.
St. James	4,480,597	4,942,641	Petroleum, natural gas, natural gas liquids.
St. John the Baptist	3,699,479	3,778,668	Petroleum, natural gas.
St. Landry	45,068,535	49,564,035	Petroleum, natural gas, natural gas liquids.
St. Martin	61,669,001	65,392,870	Petroleum, natural gas, salt, natural gas liquids.
St. Mary	176,949,791	195,065,538	Petroleum, natural gas, natural gas liquids, salt, shell, lime.
St. Tammany	2,386,259	3,364,795	Shell, sand and gravel, natural gas, petroleum, clays.
Tangipahoa	1,393,561	756,459	Sand and gravel, petroleum, clays, natural gas.
Tensas	18,848,121	18,032,086	Petroleum, natural gas, natural gas liquids.
Terrebonne	309,038,220	339,807,345	Petroleum, natural gas, sulfur, natural gas liquids.
Union	15,936,099	15,920,042	Natural gas, petroleum.
Vermilion	144,507,418	147,349,118	Natural gas, petroleum, natural gas liquids, sand and gravel.
Vernon	540	48,000	Sand and gravel.
Washington	W	774,510	Sand and gravel, lime.
Webster	31,674,318	31,015,577	Natural gas, petroleum, natural gas liquids, sand and gravel.
West Baton Rouge	1,103,717	875,494	Petroleum, natural gas, clays.
West Carroll	316,698	271,489	Natural gas.
West Feliciana	W	W	Sand and gravel.
Winn	4,380,281	4,125,790	Petroleum, salt, stone, gypsum, natural gas.
Undistributed	21,983,039	15,355,064	
Total	2,638,389,000	2,785,008,000	

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

[1] East Carroll not listed because no production was reported.

Avoyelles.—Exploratory drilling resulted in completion of 3 oil wells which opened Five Mile Bayou and Wolf Prairie oilfields. Natural gas liquids were recovered at the Eola plant of Anchor Gasoline Corp.

Beauregard.—The South Gordon oilfield was opened. Natural gas liquids were recovered at three plants.

Bossier.—Natural gas liquids were recovered at five gas processing plants. The North Plain Dealing and Swan Lake oilfields were opened.

Caddo.—The parish ranked second in total number of oil and gas wells drilled—749 wells in 1964 (825 in 1963). Most of the drilling was of development wells in the Pine Island area. Natural gas liquids were recovered at four gas processing plants.

At Shreveport, Universal Oil Products Co. manufactured special catalysts for petroleum refinery processes.

Calcasieu.—The Lake Charles Industrial Complex, comprising over a dozen large plants built to facilitate production and processing of crude petroleum, natural gas, natural gas liquids, cement, sulfur, lime, and salt, was one of the most important in the State.

Cameron.—The parish ranked fifth in total value of mineral production and second in value of natural gas. Exploratory drilling of 22 wells offshore proved 5 gas wells and 1 oil well; exploratory drilling of 27 wells onshore proved 3 oil wells and 5 gas wells.

Natural gas liquids were recovered at 12 gas-processing plants.

Catahoula.—Drilling resulted in seven productive oil wells and opened North Willow Lake and Sandy Lake oilfields.

Claiborne.—Natural gas liquids were recovered at three gas-processing plants, including Pan American Petroleum Corp.'s new cycling plant at Antioch.

The Louisiana Geological Survey investigated iron ore deposits in Claiborne and surrounding parishes. Bedded siderite and limonite deposits exposed in hillsides are reportedly similar to deposits in east Texas.

DeSoto.—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. Another gas storage project was planned for the old Grand Cane field.

East Baton Rouge.—Construction of petroleum and petrochemical facilities and expansion of existing facilities were reported in the Baton Rouge area.

Reynolds Metals Co. calcined coke to make electrodes for use in aluminum reduction plants. Ethyl Corp., a principal producer of motor fuel additives, also produced chlorine and caustic soda. Polymer Chemical Division, W. R. Grace & Co., produced polyethylene plastics.

Natural gas liquids were recovered at the Burtville plant of Shell Oil Co. Clay was mined by Acme Brick Co. to manufacture brick. Ideal Cement Co. produced portland, high-early-strength, and masonry cement from shell which was barged up the Mississippi River by a New Orleans supplier. Kaiser Aluminum & Chemical Corp. processed Jamaican bauxite into alumina at its North Baton Rouge plant.

Evangeline.—Natural gas liquids were recovered at Ville Platte plant of Continental Oil Co., and at Mamou plant of Socony Mobil Oil Co. Exploratory drilling of seven wells proved one oil well.

Iberia.—The parish ranked first in salt production; about 50 percent of the State's output came from three large mines. Natural gas liquids were recovered at four plants. Exploratory drilling opened Lake Ferme and Bird Island Bayou gasfields.

Iberville.—The Crescent oilfield and Bayou Henry gasfield were opened.

Jefferson.—Freeport Sulphur Co. produced sulfur at its Grand Isle offshore platform.

The parish ranked fifth in petroleum output, which was valued at $92.1 million. Natural gas liquids were recovered at Little Lake gas processing plant of Humble Oil & Refining Co.

At Avondale, American Cyanamid Co. completed the first addition to its Fortier plant to produce 40 million pounds of methyl methacrylate monomer annually.

Lafourche.—The parish ranked third in total value of minerals produced; second in crude oil produced. The Northeast Houma gasfield was opened. Natural gas liquids were recovered at three gas-processing plants.

Lincoln.—Lincoln Parish, with three natural gasoline plants, ranked third in recovery of natural gas liquids; output was valued at $12 million. Natural gas, petroleum, and sand and gravel also were produced. Ruston Brick Works mined clay at Ruston.

Natchitoches.—The Black Lake field of Placid Oil Co., was one of the most significant discoveries in north Louisiana in several years. At the end of 1964, the field had 10 gas wells, 1 oil well, and 2 dry holes. Although not fully defined, the field was expected to be very large.

Orleans.—Most of the barite ground in the State was from foreign ores and was processed in Orleans Parish by three companies. Alatex Construction Services, Inc., processed crude perlite from Western States into expanded perlite for use in acoustical plasters and concrete aggregate.

At New Orleans, U.S. Gypsum Co. manufactured building lime, quicklime, and hydrated lime at its lime plant adjacent to the company's gypsum products plant and fronting on the Inner Harbor Industrial Canal. Bestwall Gypsum Co. operated its gypsum lath and plaster products plant near New Orleans.

Louisiana Cement Co. started operating its $12 million plant on the Michoud Canal designed to produce 1.5 million barrels of cement annually.

To meet demand in the New Orleans area for high-purity silica sand to manufacture glass, Jahncke Services, Inc., operated its new plant on the industrial canal (slip No. 4) in New Orleans. The plant facilities, started in 1962, had the following capacities in tons per hour: Silica sand, 25; industrial sand, 30; and crushed shell, 12.

Ouachita.—Acme Brick Co. mined clay at Monroe for brick and tile. Natural gas liquids were recovered at the Calhoun plant of Arkansas Louisiana Chemical Corp. and at the Calhoun plant of Southwest Gas Producing Co., Inc.

Plaquemines.—Total value of mineral production, highest in the State, increased from $519 million (revised) in 1963 to $575 million in 1964. The parish ranked first in production of crude petroleum and sulfur and fourth in natural gas. The parish ranked third in total number of oil and gas wells drilled—249 wells as compared with 315 in 1963. West Delta Block 41 oilfield was discovered offshore.

Natural gas liquids were recovered at six gas processing plants.

Gulf Oil Corp. began preconstruction land fill operations for a multimillion dollar refinery and gas plant complex at Venice. Humble Oil & Refining Co. contracted to build a $5 million gas processing plant near Venice.

Sabine.—The parish ranked first in total wells drilled during the year. Rattan gasfield was discovered.

The Louisiana and Texas Sabine River Authorities awarded contracts to construct the $60 million Toledo Bend dam, power plant and outlet works.

St. Bernard.—The parish ranked fourth in the State in value of natural gas liquids, which were recovered at three plants. Drilling proved four gas wells and opened Treasure Bay gasfield.

Tenneco Oil Co. operated its 48,000-barrel-per-day refinery at Chalmette, and Murphy Corp. operated its 22,000-barrel-per-day refinery at Meraux.

Kaiser Aluminum & Chemical Corp. operated its Chalmette aluminum reduction plant.

St. John the Baptist.—At Laplace, E. I. du Pont de Nemours & Co., Inc., started operating its $20 million plant to produce adiponitrile, a chemical intermediate for making nylon.

The South Lake Maurepas gasfield was opened.

St. Mary.—The parish ranked fourth in total value of minerals and in petroleum production, and also produced appreciable quantities of natural gas, natural gas liquids, salt, and shell.

A new salt mine was under development by Carey Salt Co. at Cote Blanche salt dome. The dome, at a depth of 564 feet, is in Cote Blanche Bay and bounded on the north by the Intracoastal Canal.

At Franklin, Cabot Corp. added a facility to produce thermal black from natural gas with an annual capacity of 17 million pounds.

Natural gas liquids were recovered at five plants. Humble Oil & Refining Co. completed a gas-processing plant with a capacity of 640 million cubic feet per day at Garden City.

Freeport Sulphur Co. mined sulfur by the Frasch process from its Lake Pelto mine opened in 1960.

Tensas.—The Caney Bayou oilfield was opened.

Natural gas liquids were recovered at three gas-processing plants.

Terrebonne.—The parish ranked second in total value of minerals produced, first in natural gas production, third in oil production, and fifth in number of wells drilled onshore for exploration and development of petroleum and natural gas.

A combine of 29 oil companies built Louisiana's largest gas processing plant at Gibson. The recovered liquids will be sent by pipeline to a fractionating plant under construction at Geismar. Union Oil Co. of California discontinued its Caillou Island gas-processing plant.

Vermilion.—The parish ranked third in value of natural gas and second in value of natural gas liquids produced. Onshore exploratory drilling resulted in discovery of three oilfields and one gasfield. Two gasfields were discovered offshore.

Natural gas liquids were recovered at six gas processing plants. One of these plants (Cow Island) supplied mixed liquids by pipeline to the Goliad Corp. Riverside fractionator at Geismar on the Mississippi

River. At Geismar, the separated hydrocarbons from the fractionator were supplied as feedstock to the petrochemical plants.

Webster.—Natural gas liquids were recovered by six gas-processing plants. Lime was produced at the Springhill plant of International Paper Co. for plant use.

Winn.—Winn Rock, Inc., at Winnfield, mined about 9 percent less crude gypsum than in 1963. The firm also operated an asphalt-filler rock plant but purchased silica sand for the base material.

The Mineral Industry of Maine

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

By David J. Kusler [1]

THE value of mineral production in Maine rose to a new peak, 13 percent above the previous high, set in 1961, and 25 percent greater than in 1963. All mineral commodities gained, but most important were value increases of materials used in construction, reflecting the accelerated pace of building and, most significantly, highway construction.

After a lapse of nearly half a century, development was underway of copper-zinc-lead-silver deposits in the Blue Hill area of Hancock County.

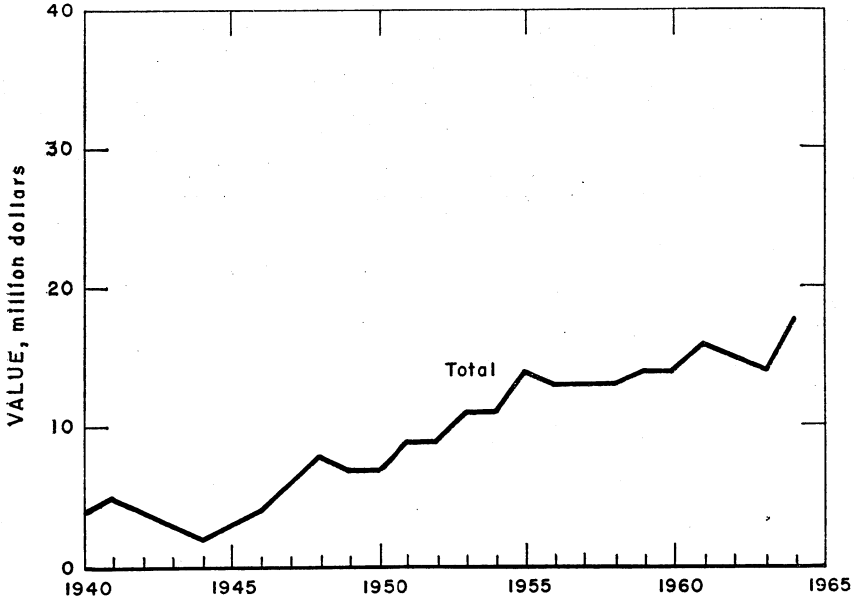


FIGURE 1.—Total value of mineral production in Maine.

[1] Chemist, Bureau of Mines, Pittsburgh, Pa.

TABLE 1.—Mineral production in Maine[1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	42	$55	45	$58
Gem stones	(2)	25	(2)	35
Peat short tons	W	W	6,350	171
Sand and gravel thousand short tons	11,195	4,673	13,552	6,463
Stone do	947	3,581	1,414	4,506
Value of items that cannot be disclosed: Cement and feldspar	XX	5,770	XX	6,341
Total	XX	14,104	XX	17,574

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] Weight not recorded.

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

(Thousands)

Year	Value	Year	Value
1940	$8,418	1953	$10,986
1941	8,861	1954	11,183
1942	6,065	1955	13,414
1943	4,447	1956	12,492
1944	3,578	1957	12,917
1945	3,957	1958	12,681
1946	6,209	1959	13,432
1947	7,435	1960	14,002
1948	9,561	1961	15,637
1949	7,768	1962	r15,056
1950	8,589	1963	r14,380
1951	9,275	1964	17,761
1952	9,949		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal and nonmetal	86	16	136		2	15
Sand and gravel	591	116	971		43	44
Stone	506	124	1,014		40	39
Peat	15	2	15			
Total	1,198	258	2,136		85	40
1964: p						
Metal and nonmetal	150	26	297		2	7
Sand and gravel	715	141	1,175		20	17
Stone	505	117	966		26	27
Peat	37	9	70			
Total	1,407	293	2,508		48	19

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Production and shipments of portland cement, the leading mineral product, increased; masonry cement production and shipments also increased. Dragon Cement Co., Inc., Division of Martin Marietta Corp., was the only cement producer in Maine. The average value per barrel of portland cement and per barrel of masonry cement decreased slightly. Yearend stocks of portland cement were below those of 1963. Two types of portland cement were produced: types I–II (general use) and type III (high-early-strength).

Raw materials consumed in the manufacture of portland cement were cement rock, sand, gypsum, and iron ore; air-entraining compounds, grinding aids, and coloring agents were also used. Shipments of portland and masonry cement were mainly to consumers in the New England States, largely by truck in both bulk quantities and paper bags. Substantial rail shipments were made, however, particularly for bulk quantities. In order of size, the principal consumers of portland cement were ready-mixed-concrete companies, concrete product manufacturers, building material dealers, and highway and other contractors.

Clays.—Miscellaneous clay, used for manufacturing building brick, was the chief clay produced; a limited quantity of fire clay, used in pottery manufacture, was recovered. As in 1963, seven clay operations were active. Production was reported from two pits in Androscoggin County, three in Cumberland, and one each in Hancock and York. As in previous years, Cumberland County led in clay production.

Feldspar.—Continuing an upward trend, production of feldspar increased. Production was limited to various mines in Oxford County. Average unit value for crude material remained $6. All production was crushed at West Paris, Oxford County, by Bell Minerals Co. Processed crude ore from Oxford County and from New Hampshire was marketed mainly for ceramic applications. Ground feldspar shipments were chiefly to consumers in Pennsylvania, Ohio, and Wisconsin. Relatively small quantities were shipped to a few other States and Canada.

Gem Stones.—Old mines, quarries, and dumps, principally in Oxford County, attracted the greatest mineralogical interest, providing gem stones and minerals such as purple apatite, autonite, agate, beryl, gem-quality aquamarine, rose and rutilated quartz, lithium minerals (amblygonite, lepidolite, and spodumene), and amethyst. Other counties in which the recovery of mineral specimens have been reported were Franklin (jade and fossil coral), Sagadahoc (gem tourmaline), Washington (molybdenite and jasper), and York (kyanite, vesuvianite, and amazonite).

Lime.—The Oxford Paper Co., Rumford, Oxford County, used quicklime in the manufacture of paper. The lime was regenerated and reused so that purchases were necessary only to replace losses and thus were relatively small.

Nitrogen Compounds.—Anhydrous ammonia, for use as/or in fertilizers, was produced by Northern Chemical Industries, Searsport, Waldo County.

Peat.—Peat output increased substantially over that reported in 1963, owing largely to the resumption of peat production in Hancock County. Peat was also produced in Washington County. The output from both counties was marketed chiefly as a soil conditioner.

Sand and Gravel.—For the third consecutive year, sand and gravel production set a new record; the 1964 output of 13.5 million tons surpassed the previous year's high by 21 percent. Contributing primarily to the increased output was the continuing expansion of road-building and maintenance, particularly the accelerated effort to complete the final stretch of the Augusta-Bangor interstate highway during 1964. While increased tonnage and value were recorded for both commercial and Government-and-contractor operations, the latter accounted for over two-thirds of the total sand and gravel output and value. Commercial output and value increased 14 and 12 percent, respectively, but the average unit value declined slightly. Paving material accounted for 88 percent of total production, compared with 90 percent in 1963. Paving gravel produced by Government-and-contractor operations increased 37 percent, reflecting the increased activity in highway construction; the value was $0.39 per ton, compared with $0.35 in 1963. Material beneficiated by washing, screening, or other methods comprised 54 percent of the commercial sand and gravel, compared with 57 percent in 1963. Shipments to consumers were predominantly by truck. The counties of Cumberland, Penobscot, Androscoggin, and York, in order of decreasing contribution, accounted for 65 percent of the total commercial output; production was reported from all counties except Piscataquis and Waldo. Output by Government-and-contractor operations was chiefly in Kennebec, Penobscot, Aroostook, and York Counties; the Maine State Highway Commission was the leading producer.

Stone.—Gains of 49 percent in output and 26 percent in value over the 1963 figures were reported for total stone production, owing mainly to greater demand for crushed limestone by the cement industry; contributing in less degree were increases in the production and value for granite, slate, and miscellaneous stone. No output of basalt or sandstone was reported. In terms of value, granite continued to be the leading stone produced. Dimension granite increased moderately in tonnage and value. Output, in order of decreasing value, included dressed architectural and construction stone, curbing and flagging, dressed monumental and rough construction stone, rubble, and rough architectural stone. Output of crushed granite more than doubled, owing mainly to the strong demand for concrete aggregate and roadstone. 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. Knox County continued as the leading limestone producing area; output was also reported in Kennebec, Aroostook, and Somerset Counties. Dimension granite was produced in Hancock, Knox, Waldo, and York Counties; crushed granite was produced in Cumberland, Knox, Penobscot, and York Counties. Slate production was exclusive to Piscataquis County; crushed miscellaneous stone was produced in Cumberland County.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	325	$236	310	$255
Paving	231	173	229	187
Fill	175	72	199	83
Other [1]	69	46	75	53
Total	800	527	813	578
Gravel:				
Structural	181	171	284	306
Paving	656	596	663	506
Railroad ballast	40	29	(2)	(2)
Fill	209	90	220	110
Other	113	50	296	136
Total	1,199	936	1,463	1,058
Total sand and gravel	1,999	1,463	2,276	1,636
Government-and-contractor operations:				
Sand:				
Paving	1,746	612	908	672
Fill	(3)	(3)	3	1
Other	7	2	203	158
Total	1,753	614	1,114	831
Gravel:				
Structural	1	(4)		
Paving	7,433	2,592	10,157	3,994
Other	[5] 9	[5] 3	5	2
Total	7,443	2,595	10,162	3,996
Total sand and gravel	9,196	3,210	11,276	4,827
All operations:				
Sand	2,553	1,141	1,927	1,409
Gravel	8,642	3,532	11,625	5,054
Total	11,195	4,673	13,552	6,463

[1] Includes engine, filtration (1963), and other sand.
[2] Figure withheld to avoid disclosing individual company confidential data; included with other gravel.
[3] Figure withheld to avoid disclosing individual company confidential data; included with other sand.
[4] Less than ½ unit.
[5] Includes fill gravel.

METALS

Shaft sinking started Nov. 21, 1964 and advanced 280 feet to develop a series of base-metals ore deposits near Blue Hill in Hancock County. The work was undertaken by Black Hawk Mining Ltd., a subsidiary of Denison Mines Ltd., Toronto, Ontario. Black Hawk acquired the Potra Mines Corp. in 1964, thus extending its holdings to adjoining ground under lease to Potra. According to Denison Mines the indicated reserve, allowing 10 percent for dilution, was 4.5 million tons comprising 1.2 million tons containing 16.75 percent zinc, 0.55 percent copper, and 0.37 ounce silver per ton; 2.8 million tons containing 1.97 percent copper and 0.41 ounce silver; and 450,000 tons containing 6.75 percent lead, 0.95 percent copper, and 4.25 ounces silver.

Development and mine and plant construction in progress apparently was based on production starting in 1966 at a rate of about 1,000 tons of ore per day.

The exploration division of Denison Mines diamond drilled the Highland property, also in Hancock County, and revealed a 1 million ton deposit containing 0.6 percent copper. Additional drilling was planned at the adjoining Hercules property. Near Castine, Callahan Mining Corp. was exploring properties of Penobscot Mining Co.

The base metal deposits in Hancock County had not been productive since 1918 when the American Smelting and Refining Co. had shipped copper concentrate from the Douglas Mine. Reawakened interest has been stimulated in part by comprehensive Maine Geological Survey publications which also contain excellent bibliographies of earlier reports.[2]

REVIEW BY COUNTIES

The Maine State Highway Commission produced paving sand and gravel in all counties; the output was obtained both by its own crews and by workers under contract. Limited quantities of sand were also produced for highway ice control. Additionally, Acadia National Park in Hancock County, five municipalities in Androscoggin County, one in Cumberland County, two in Hancock County, and one in Penobscot County produced sand and gravel for local street and road maintenance. Sand and gravel was also produced by contractors for governmental agencies in Kennebec, Knox, and Oxford Counties. Crushed granite for road construction was produced by Maine State Highway Commission crews in Penobscot and York Counties.

Androscoggin.—Twelve commercial sand and gravel operations were active, compared with 14 in 1963. Output and value were higher, however, and 70 percent of the material was processed for use chiefly as paving and building material. Principal producers were Lewiston Crushed Stone Co., Inc., Lewiston; Blue Rock Sand and Gravel,

TABLE 5.—Value of mineral production in Maine, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Androscoggin	$377,781	$488,940	Sand and gravel, clays.
Aroostook	560,225	710,945	Sand and gravel, stone.
Cumberland	1,186,177	1,214,250	Sand and gravel, stone, clays.
Franklin	113,724	190,000	Sand and gravel.
Hancock	W	1,058,967	Stone, sand and gravel, peat, clays.
Kennebec	614,357	1,270,678	Sand and gravel, stone.
Knox	W	W	Cement, stone, sand and gravel.
Lincoln	W	132,000	Sand and gravel.
Oxford	222,313	283,667	Sand and gravel, feldspar.
Penobscot	769,035	1,040,000	Sand and gravel, stone.
Piscataquis	W	W	Do.
Sagadahoc	87,556	101,000	Sand and gravel.
Somerset	329,532	542,000	Sand and gravel, stone.
Waldo	W	W	Do.
Washington	W	321,500	Sand and gravel, peat.
York	W	W	Stone, sand and gravel, clays.
Undistributed [1]	9,843,672	10,220,742	
Total	14,104,000	17,574,000	

W Withheld to avoid disclosing individual company confidential data.
[1] Includes value of gem stones that cannot be assigned to specific counties and values indicated by symbol W.

[2] Young, Robert S. Prospect Evaluations, Hancock County, Maine. Maine Geol. Survey, Special Econ. Studies. Series No. 2, Apr. 15, 1962, 113 pp; Prospect Evaluations, Washington County, Maine. Special Econ. Studies. No. 3, May 1963, 86 pp.

Leeds; and G. A. Peterson Co., Auburn. The Morin Brick Co. and the Dennis Brick Co. produced miscellaneous clay from open pits near Auburn for use in brick manufacture.

Aroostook.—Commercial sand and gravel production increased slightly in 1964, but value decreased. The output was largely processed and was used mainly as building and paving material; some fill material was also produced. Producers were Bull Brothers, Inc., Presque Isle; Lawrence E. Burleigh, Houlton; and Bangor Aroostook Railroad, Houlton. McKay Rock Products, Inc., quarried limestone near Presque Isle; the output was used mainly for concrete aggregate and railroad ballast.

Cumberland.—Although commercial sand and gravel production decreased slightly, Cumberland County continued to lead in tonnages and ranked second in value. Fifty-seven percent of the material produced was processed, and the entire output was transported by truck. Most of the total tonnage was used for paving, building, and fill purposes, and the material was produced by Cumberland Sand & Gravel Co., Inc., and Maynard W. Robinson & Sons, both near Cumberland Center; Leroy S. Prout Sand and Gravel, Scarborough; P. E. Hamlin, Portland; Harry C. Crooker & Sons, Inc., Brunswick; Fred H. Jordan, South Portland; and Clifton R. Tandberg, Windham. Granite was quarried near Portland by Cook & Co., Inc., for use as riprap, concrete aggregate, and roadstone. Blue Rock Quarry produced crushed stone for the same uses at Westbrook. Cumberland County led in clay output and value. Miscellaneous clay used for manufacturing building 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 production was more than double that of 1963. Output was from operations near Weld and Wilton; most of the material was unprocessed and was used mainly for building and paving.

Hancock.—Exploration of base metal prospects in the county was continued. Black Hawk Mining Ltd., was developing its mine near Blue Hill with plans to mine 1,000 tons of ore a day.

Dimension granite was produced chiefly as dressed stone for use in construction and architectural applications. Deer Island Granite Corp., Stonington, was the principal producer; Fred Weinninger, Franklin, reported no activity for 1964. Major sand and gravel producers were Blue Hill Gravel Pit, Blue Hill; Harold MacQuinn, Inc., Bar Harbor; and Alvin R. Whitten, Winter Harbor. Peat production, inactive in Hancock County since 1959, was resumed with output reported by Richland Peat Corp., Penobscot. A limited quanity of stoneware clay for use in manufacturing art pottery was recovered by Rowantrees, Inc., from a pit near East Blue Hill.

Kennebec.—Commercial sand and gravel production and value decreased slightly, but Government-and-contractor output continued to increase. Commercial production was reported by V. E. Dunn & Son, Augusta, and Calvin Rundstrom, Gardiner. Stone production rose sharply, owing mainly to greater demand for crushed limestone by the cement industry, and for concrete aggregate and roadstone. Output was produced by Blue Rock Quarry, Sidney.

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Knox.—Dragon Cement Co., Inc., Division of Martin Marietta Corp., produced portland and masonry cement at Thomaston. Cement rock quarried nearby was the principal cement raw material utilized. General use and moderate-heat portland cement, made by the wet process, accounted for the bulk of the output; however, an appreciable quantity of high-early-strength cement was also produced. Knox County continued to lead in stone production. Rockland-Rockport Lime Co., Rockland, and Lime Products Corp., Union, quarried limestone which was used principally for agricultural purposes, paper manufacture, and concrete aggregate. 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 1963, C. R. Wallace & Son, Inc., Warren, was the only sand and gravel producer.

Oxford.—Commercial sand and gravel was produced by Donald E. Wood, Norway, and Brown Co., Woods Accounting Division, Berlin. Output by Government-and-contractor operations increased moderately. Crude feldspar was recovered principally from the Bessey, Conant, Newry, Biron, and Perham mines. Bell Minerals Co., the leading producer, operated the Bessey, Conant, and Newry mines and subleased the Bessey, Conant, and Perham mines to other operators for part of the year. All of the crude material was ground at the Bell Minerals Co. mill at West Paris. Feldspar was ground for ceramic uses, including electrical porcelain, sanitary tile, and pottery, and for soaps and abrasives and metal polishes. Oxford County continued to be the gem collectors' main source of gem materials and mineral specimens.

Penobscot.—Commercial sand and gravel production was 316,000 tons, an 11-percent increase compared with that of 1963, but the unit value declined. Seven principal operations were active, mainly near Lincoln, Stillwater, Bangor, and Orono. The output was used mainly for paving and building and as fill material. The county led in combined (commercial and Government-and-contractor operations) sand and gravel output and value. The Maine State Highway Commission produced crushed granite at a portable crushing plant for use as road material.

Piscataquis.—Portland-Monson Slate Co. recovered slate by the block-caving method at its No. 2 and 4 underground slate mines. The slate was processed at the local finishing mill, mainly for use as heavy switch gear panels and flagging; some of the fabricated products were exported to Canada. As in 1963, no commercial sand and gravel production was reported.

Sagadahoc.—Commercial sand and gravel production increased slightly, compared with the output reported for 1963. Most of the output was used as construction material; a limited quantity was used as fill. Producers reporting were Jack's Pit and Andrew R. Maynard, Inc., both near Topsham, and Almon R. Mitchell, Bath.

Somerset.—Sand and gravel, mainly for building and paving uses, was commercially recovered from pits near Fairfield, Pittsfield, and Smithfield. Crushed limestone for road material was produced at a portable plant near Newport by H. E. Sargent, Inc.

Waldo.—Dimension granite for architectural work was produced by Grenchi & Ellis, Inc., at its Frankfort quarry.

Washington.—Commercial gravel for railroad ballast and other uses was recovered by Maine Central Railroad, East Machias, and Hill & Sennett, Machias. Peat output increased, compared with that of 1963.

York.—John Swenson Granite Co., Inc., of Concord, N.H., quarried dimension granite for dressed architectural stone at the Swenson Pink Quarry, Wells, and the Swenson Green Quarry, York. A limited quantity of crushed and broken stone was also produced for various uses. The Maine State Highway Commission produced crushed granite at a portable crushing plant for use as road material. Commercial output of sand and gravel was 298,000 tons, an increase of 27 percent over production reported in 1963. The output was used mainly as building and paving material and as fill, and was recovered from operations near Biddeford, North Berwick, Saco, Sanford, York, and York Harbor. Morin & Sons, Inc., Eliot, produced miscellaneous clay for manufacturing building brick.

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 Nils A. Eilertsen [1]

MINERAL production in Maryland in 1964 was valued at $74 million, the alltime high for the State and a 5-percent increase over that of 1963. Maryland ranked 36th among the mineral-producing States. Its mineral production was confined to nometallic minerals and fuels. Stone, most of which was crushed, continued to be the principal mineral industry, accounting for over one-third of the total value of State mineral production. Cement, second of importance in value of output, remained an important factor in the State mineral economy with a slight increase in production over that of 1963. The sand and gravel industry, third ranked in value of mineral production, advanced 13 percent over that of 1963. Steady demand for coal enabled the industry to exceed the large percentage increase in value gained in 1963.

Mineral production was reported from every county except Queen Annes. The principal producing counties, in order of decreasing value of output, were Baltimore, Carroll, Prince Georges, Frederick, and Washington. Producers in these counties had mineral production valued at approximately $52.4 million, 71 percent of the State total dollar volume of mineral output during 1964.

TABLE 1.—Mineral production in Maryland [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	580	$897	[2] 635	[2] $798
Coal (bituminous)—do	1,162	4,330	1,136	4,511
Gem stones	([3])	3	([3])	3
Natural gas—million cubic feet	1,633	439	1,381	366
Sand and gravel—thousand short tons	13,310	16,063	15,041	18,071
Stone—do	13,012	26,407	13,348	26,715
Value of items that cannot be disclosed: ball clay (1964), cement (portland and masonry), diatomite (1963), greensand marl, lime, peat, potassium salts, talc, and soapstone	XX	22,111	XX	23,429
Total	XX	70,250	XX	73,893

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes ball clay; included with items that cannot be disclosed.
[3] Weight not recorded.

[1] Mining engineer, Bureau of Mines, College Park, Md.

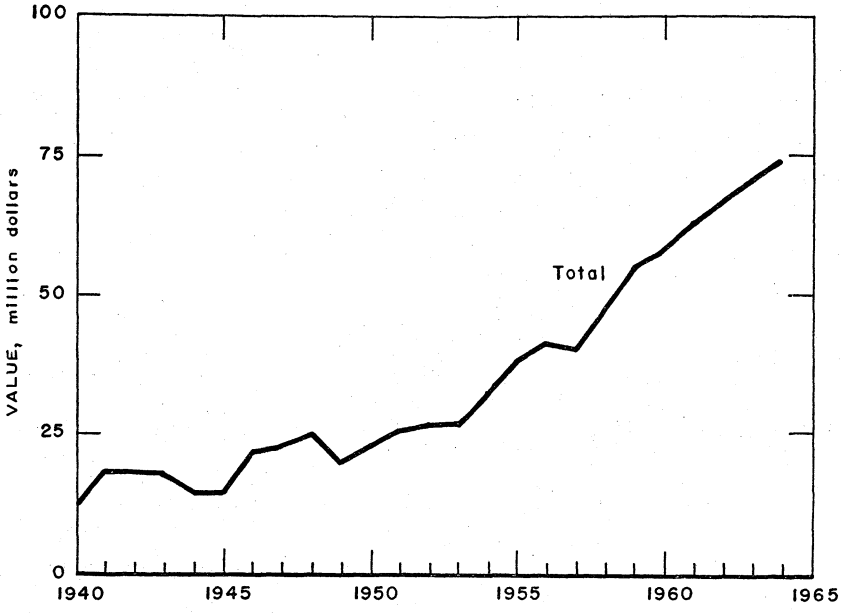


FIGURE 1.—Value of mineral production in Maryland.

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

(Thousands)

Year	Value	Year	Value	Year	Value
1940	$25,424	1949	$22,909	1958	$46,131
1941	32,867	1950	25,620	1959	r 54,171
1942	32,265	1951	28,216	1960	57,472
1943	29,094	1952	r 29,393	1961	r 63,173
1944	25,158	1953	r 28,110	1962	r 67,418
1945	24,010	1954	32,026	1963	r 72,063
1946	30,876	1955	36,422	1964	75,353
1947	28,889	1956	39,916		
1948	27,871	1957	40,088		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal and peat	509	93	746		24	32
Metal						
Nonmetal	264	65	518		26	50
Sand and gravel	955	240	2,080		46	22
Stone	1,233	316	2,672	1	59	22
Total	2,961	714	6,016	1	155	26
1964: p						
Coal and peat	489	91	730	1	25	36
Metal						
Nonmetal	295	71	614		19	31
Sand and gravel	1,270	272	2,350		60	26
Stone	1,470	399	3,478	1	74	22
Total	3,524	833	7,172	2	178	25

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—In terms of value, the production of cement ranked second among the mineral products of the State in 1964. Three plants, one each in Carroll, Frederick, and Washington Counties, were active, producing both portland and masonry cements. Another plant in Frederick County converted purchased portland cement into masonry cement. Virtually all the cement raw materials were obtained locally.

Clays.—Maryland clay deposits yielded ball clay, fire clay, and miscellaneous clay. Ball clay was mined in the Baltimore area for use in pottery, in floor and wall tile, and in manufacturing fire brick and block. Most of the fire clay for refractories was mined in Allegany County, where fire clays are associated with coalbeds.

A total of 605,000 tons of miscellaneous clay was produced in eight counties in 1964. It was used chiefly for manufacturing building brick and other heavy clay products, but was also used in large quantities as an ingredient in cement manufacture.

Gem Stones.—Semiprecious gem minerals and other gem stones suitable for use as specimens or for cutting and polishing were collected by hobbyists. Specimens that were collected include diopside, grossularite garnet, serpentine, beryl, sphene, and uranium minerals. Of particular interest to collectors was williamsite, an impure apple-green variety of serpentine found in Cecil County. A limestone breccia known locally as calico rock or Potomac marble attracts gem stone collectors to Frederick County.

Gypsum.—Gypsum plasters and fabricated products were manufactured at two plants in Baltimore from imported crude gypsum.

Lime.—Total value of quicklime and hydrated lime decreased 9 percent from that of 1963. Production was from three plants in Frederick County.

Marl, Greensand.—An open pit mine near Dunkirk yielded greensand marl, which was processed and sold for agricultural uses.

Perlite.—Expanded perlite was produced at a plant near Washington, D.C., and at two plants near Baltimore from crude perlite mined in Colorado. Over four-fifths of total output was utilized as lightweight aggregate in plaster and concrete.

Pigments.—Manufacture of mineral pigments was an important industry in Maryland in 1964. Two plants near Baltimore produced large quantities of titanium pigments by the sulfate process from ilmenite concentrate. A large variety of finished natural and manufactured iron oxide pigments was produced at a plant in Prince Georges County. Crude material was shipped in from other States.

Potassium Salts.—One company produced as a byproduct a low-grade potassium sulfate at a cement plant at Security, Washington County. The product was sold for agricultural uses.

Sand and Gravel.—Sand and gravel ranked third in value of mineral production in 1964; output was reported from 16 counties, the foremost of which were Prince Georges, Baltimore, Anne Arundel, and Cecil. Pits active in these counties during the year accounted for 85 percent of the value of the total State output. Approximately 46 per-

cent of the sand and gravel dollar sales in 1964 were for structural use; and 33 percent were for highway construction and maintenance. A total of 75 commercial plants were active.

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	1963		1964	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Structural	3,232	$4,091	3,149	$4,271
Paving	2,285	2,831	1,969	2,916
Fill	39	21	(1)	(1)
Other	[2] 366	[2] 801	[3] 1,862	[3] 1,556
Total	5,922	7,744	6,980	8,743
Gravel:				
Structural	2,048	3,698	2,125	4,048
Paving	2,354	2,672	2,677	3,056
Fill	2,231	1,218	1,662	883
Other [4]	555	660	1,087	1,202
Total	7,188	8,248	7,551	9,189
Total sand and gravel	13,110	15,992	14,531	17,932
Government-and-contractor operations:				
Sand	5	2	78	20
Gravel	195	69	432	119
Total sand and gravel	200	71	510	139
All operations:				
Sand	5,927	7,746	7,058	8,763
Gravel	7,383	8,317	7,983	9,308
Total	13,310	16,063	15,041	18,071

[1] Included with "Other."
[2] Includes grinding and polishing, engine, filtration, and glass sand.
[3] Includes glass and fill sand.
[4] Includes railroad ballast and miscellaneous gravel.

Stone.—In terms of value, the stone industry has grown to be the most important mineral industry. Output was reported from quarry operations in 12 counties in 1964. Compared with 1963, production remained nearly static. Stone varieties quarried and mined during the year included limestone, gabbro (reported as basalt), sandstone, marble, and miscellaneous stone (serpentine and mica schist). Crushed limestone comprised over one-half of the stone produced. Baltimore County ranked first in stone production, followed by Frederick County. Dimension stone, quarried for construction and memorials, included granite, sandstone, and mica schist.

Talc and Soapstone.—Talc and soapstone were mined near Marriottsville, Carroll County, and Dublin, Harford County. Most of the output of two producing plants was ground, but a small quantity of crude material was sold.

Vermiculite (Exfoliated).—Crude vermiculite was processed at Beaver Heights in Prince Georges County from material originating outside the State.

MINERAL FUELS

Coal (Bituminous).—Coal mining, which for many years ranked among the foremost components of the mining industry in Maryland, stood at fourth place in value of mineral output in 1964. Output declined 2 percent but its value increased 4 percent. Production was less than one-fourth the 5,333,000 tons mined in 1907, the year of peak output.

Production as in previous years came from mines in Allegany and Garrett Counties in the mountainous western part of the State. A total of 67 mines, 31 of which yielded less than 5,000 tons annually, were active. The largest mines were the strip operations in Garrett County. Six of the larger coal mines furnished 45 percent of the total coal output in 1964.

Coke and Coal Chemicals.—A number of coal chemicals were produced at Sparrows Point, at a plant comprised of 757 slot-type coking ovens. Coproducts included ammonium sulfate, crude tar, crude chemical oil (tar acid oil), soft pitch of tar, crude light oil, benzene, toluene, xylene, and intermediate light oil.

Natural Gas and Petroleum.—Natural gas occurs in Maryland in two areas in Garrett County, the Mountain Lake field and the Accident field. At yearend there were 15 producing wells in the Mountain Lake Park and 1 in the Accident field. Owing to conversion of the Accident field to gas storage by the Texas Eastern Transmission Corp., 18 former producing wells were taken out of production in 1964. In connection with this conversion, six of the former producing wells were deepened and permits were issued to drill nine new wells. A total of 40 wells was planned in this storage field according to Dr. Kenneth D. Weaver, Director, Maryland Geological Survey.

Crude oil transported to the Baltimore area from outside the State was processed at three refineries at which skimming and asphalt plants were operated. These plants had a combined capacity of 29,500 barrels of crude oil per day.

Peat.—Peat production in Maryland increased by more than half in value over that of 1963. Reed-sedge and humus peat were recovered at peat bogs and processed at plants near Accident in Garrett County, and Betterton in Kent County. Output from two companies was sold in bulk and packaged form.

METALS

Copper.—Two plants in the Baltimore area produced electrolytic copper from copper anodes shipped into the State.

Iron and Steel.—Basic and foundry pig iron were produced from imported ores at Sparrows Point southeast of Baltimore. It was reported in the steel trade that the company bought scrap iron on the open market in 1964 for the first time in years. Prices were $26 per ton delivered for No. 2 bundles and $37 and $32 for No. 1 and No. 2 heavy melting scrap, respectively. During the year plans were disclosed for a $30 million capital expenditure, of which $10 million was allotted for a Halogen tinning line and $2.5 million for open coil annealing furnaces at the Sparrows Point plant.

REVIEW BY COUNTIES

Allegany.—Bituminous coal production was confined to the extreme western part of the county. Coal output represented 52 percent of total value of mineral production in the county. Total number of mines operated was 33, of which 17 were strip mines and 16 were underground mines. Strip mining produced 56 percent of the total production (250,000 tons). All of the coal was sold in the open market at average prices per ton of $5.40 for underground and $3.78 for strip mined coal. Largest mine in the county was the Bakerstown No. 6 underground mine of the W. & W. Coal Co.

Production of sand and gravel continued at a high rate. The Manley Sand Division of the Martin Marietta Corp. produced both glass and structural sand. Washed and screened structural and paving sand and gravel was produced by The Cumberland Cement & Supply Co.

TABLE 5.—Value of mineral production in Maryland, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Allegany	$2,389,429	$2,166,485	Coal, sand and gravel, stone, clays.
Anne Arundel	1,842,345	2,409,000	Sand and gravel.
Baltimore	13,317,155	13,494,468	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	4,389,880	3,753,436	Stone, sand and gravel, clays.
Charles	348,000	W	Sand and gravel.
Dorchester	W	W	Sand and gravel, stone.
Frederick	8,485,833	9,108,075	Cement, stone, lime.
Garrett	r 4,133,380	4,183,582	Coal, natural gas, stone, sand and gravel, peat.
Harford	1,549,300	1,590,265	Stone, sand and gravel, clays, talc.
Howard	W	W	Stone.
Kent	38,419	W	Peat, clays.
Montgomery	W	W	Stone.
Prince Georges	8,296,197	9,287,600	Sand and gravel, clays.
St. Marys	W	146,000	Sand and gravel.
Somerset	W	W	Do.
Talbot	W	W	Do.
Washington	W	W	Cement, stone, clays, potassium salts.
Wicomico	112,284	W	Sand and gravel, clays.
Worcester	37,315	37,000	Sand and gravel.
Undistributed	r 25,310,600	27,716,950	
Total	70,250,000	73,893,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data.
[1] Queen Annes County is not listed because no production was reported.

Fire clay producers included Kaiser Refractories and Chemicals Division of Kaiser Aluminum & Chemical Corp., with production from the Big Savage deep and Maryland strip mines near Frostburg, and Yantus & Zubek Coal Co. near Mount Savage. All of the production was used in manufacturing firebrick.

Stone production was limited to limestone crushed for use as concrete aggregate by the Appalachian Stone Division of Martin Marietta Corp. at Corrigansville.

Anne Arundel.—Sand and gravel output increased by nearly half over that of 1963. The county ranked second in production among the sand and gravel producing counties but third in value of output. Production was mainly confined to prepared sand and gravel for building and paving. Leading producers were Arundel Corp., Linthicum;

Reliable Asphalt, Inc., Millersville; Chesapeake Terrace, Inc.; and The Belle Grove Corp., both near Baltimore.

Baltimore and Baltimore City.—Baltimore ranked first among the mineral producing counties in the State, supplying 18 percent of Maryland's mineral value in 1964.

Crushed gabbro (basalt), used mostly for concrete aggregate and road base, was produced by The Arundel Corp. at its Woodbury quarry, The J. E. Baker Co. at its Blue Mount quarry, and Dooley Stone Co. at its quarry near Hyde. A. A. Dyers Delight quarry, now operated by The Arundel Corp., produced crushed miscellaneous stone (serpentine) for building and construction purposes.

Crushed limestone for concrete and roadstone was produced by The Arundel Corp. at the Greenspring quarry near Baltimore. Harry T. Campbell Sons' Corp., a subsidiary of The Flintkote Co., produced crushed limestone at the Marriottsville and Texas quarries for many uses but mainly for concrete aggregate and roadstone. Dimension quartzite for construction (rough), architecture (dressed), and flagging was quarried and prepared for market by the C. E. Weaver Stone Co. near Butler. Oyster Shell Corp. crushed and ground oystershell for poultry grit and poultry lime at its mill in Baltimore.

Using crude imported gypsum, National Gypsum Co. and United States Gypsum Co. produced calcined gypsum products at plants near Baltimore. Expanded perlite for lightweight plaster and concrete aggregate was produced at Baltimore plants of the Zonolite Division of W. R. Grace & Co. and the National Gypsum Co.

Five commercial sand and gravel pits were in operation; the largest was the White Marsh pit and plant of Harry T. Campbell Sons' Corp. A substantial portion of this output was used by the company in preparing ready-mixed concrete. Other large producers of sand and gravel included Nottingham Farms Inc. at its Joppa Road plant and Harry A. Smuck & Sons at its Landsdowne plant. Output from these pits was limited to building and paving sand and gravel, mainly for use in the Baltimore area.

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 entirely for manufacturing building brick. Ball clay was produced by the United Clay Mines Corp.

The Glidden Co. plant at Hawkins Point manufactured titanium pigments from ilmenite concentrate provided by its captive mine and mineral concentrating plant in New Jersey.

Calvert.—Government-and-contractor gravel was produced by the Maryland State Roads Commission for paving. The Kaylorite Corp. (Dunkirk) prepared greensand marl for marketing as a natural soil conditioner.

Carroll.—The county ranked second in the value of mineral production. Lehigh Portland Cement Co. operated its dry process plant at Union Bridge, producing general-use and moderate-heat and high-early-strength portland cements and masonry cement. Large quantities of limestone were mined and crushed by two operators for cement manufacture and for concrete aggregate and roadstone. Clay for cement manufacture was also produced. Liberty Talc Mines, Inc.,

mined soapstone at its Marriottsville mine. Most of mine output was ground in the company's Sykesville plant and marketed chiefly for asphalt filler and roofing. Other markets for ground soapstone were foundry facings and manufacture of insecticides, rubber, grease, and paint.

Cecil.—D. M. Stoltzfus & Son, Inc., crushed gabbro (basalt) for concrete aggregate and roadstone. Granite was quarried for riprap and for crushing to concrete aggregate and roadstone by Maryland Materials, Inc., near North East. Port Deposit Granite Co. quarried granite near Port Deposit, mainly for sawing into rough building block. Harbison-Walker Refractories Co. quarried sandstone for refractory ganister at its Leslie quarry near North East.

Six producers operated seven sand and gravel pits. The largest producer was the Mason-Dixon Sand and Gravel Co. which produced sand and gravel for ready-mixed concrete at its North East and Perryville operations. Two other producers sold processed sand for building purposes, and three others sold bank-run gravel chiefly for paving and fill. Fire clay, including plastic and white clay, and a small quantity of miscellaneous clay were produced at two clay pits near North East.

Charles.—Building sand and building and paving gravel were produced near Waldorf by the Charles County Sand and Gravel Co., Inc.

Dorchester.—J. Edwin Rosser, Inc., Federalsburg, produced building gravel and sand and bank-run material for fill. Oystershell was processed at Cambridge by the J. M. Clayton Co. for poultry grit and poultry lime.

Frederick.—Cement ranked first in the value of county mineral output. Portland and masonry cements were manufactured at Lime Kiln by Alpha Portland Cement Co.

The bulk of the Maryland lime production originated in Frederick County. Three plants were active. The leading producer was S. W. Barrick & Sons, Inc., Woodsboro. Both quicklime and hydrated lime were produced, mostly for agricultural purposes. Le Gore Lime Co. continued operation at its Le Gore plant and quarry, producing both quicklime and hydrated lime, chiefly for agricultural use. Everett V. Moser, Middletown, produced quicklime for agricultural use.

Production of crushed limestone was reported by five operators, the largest of which was the Grove Plant of M. J. Grove Lime Co., Inc., a subsidiary of The Flintkote Co. The bulk of limestone output was for concrete aggregate and roadstone. Other uses were for cement and lime manufacture, railroad ballast, and agstone.

A large rotary kiln plant for production of expanded shale aggregates was completed at Woodsboro.

Garrett.—Bituminous coal output represented 80 percent of the value of the county's mineral production. A total of 34 mines were in operation, of which 15 were strip mines and 19 were underground mines. Strip mines yielded 69 percent of the total coal output (885,000 tons). All of the coal was sold on the open market. Average prices per ton were $3.78 for deep-mined coal and $3.84 for strip-mined output. Buffalo Coal Co., Inc., operating its Laurel No. 1 mine in the Freeport seam, was the leading producer in 1964. Limestone was mined and

crushed for concrete aggregate and roadstone at the Fry and Browning quarries of Vetter Brothers, Inc., 9 miles north of Oakland. Two sandstone quarries owned by Renell Giconi and B. & B. Stone Co. were in operation near Grantsville. Output consisted of rubble and flagging. Production from two sand pits was sold mainly for building purposes. The largest producer was the Silver Knob Sand Co., Inc., at Oakland. The Garrett County Processing and Packaging Corp. recovered reed-sedge and humus peat from a bog near Accident. Output was marketed in packages and in bulk.

Harford.—The largest producers of sand and gravel were the Joppa Sand and Gravel Corp., Joppa, and Stancill's, Inc., Edgewood. Other producers were W. Noble Hamilton & Son, Aberdeen, and N. G. Spencer & Son, Abingdon. Output was used mainly for aggregate in building and paving. Crushed gabbro was produced by D. M. Stoltzfus & Son, Inc., at its Grays Run quarry near Aberdeen and the Gatch Crushed Stone Co. quarry near Churchville. The Arundel Corp. quarried gabbro for riprap at Havre de Grace. Dressed interior building marble and crushed marble for terrazzo were marketed by the Maryland Green Marble Corp. at Cardiff. Crude talc was mined near Dublin by Harford Talc and Quartz Co., Inc. Most of the material quarried was crushed and ground, but a small tonnage of crude was sawed into specified shapes for industrial uses. Stancill's, Inc., mined plastic fire clay from the Wildacres pit near Edgewood for use in manufacturing vitrified sewer pipe.

Howard.—Howard-Montgomery Crushed Stone, Inc., operated its limestone quarry and crushing plant near Clarkesville. Output was marketed for concrete aggregate, roadstone, and paving material. Crushed gabbro for concrete aggregate and roadstone was produced by the Arundel Corp. at the Savage quarry, southwest of Baltimore.

Kent.—Maryland Peat & Humus Co. operated its modern peat processing plant at Betterton. Peat dug from a fresh-water bog with clamshell equipment mounted on barges was treated and sold for general soil improvement uses and for potting soils. Reed-sedge and humus peat was sold in bulk and in packaged form. Miscellaneous clay from a clay pit near Chestertown was used for building brick by Chestertown Brick Company.

Montgomery.—Rockville Crushed Stone, Inc., mined and crushed serpentine at its quarry and plant near Rockville. Output was for general construction purposes. Mica schist was quarried for rough and dressed building stone, flagging, and rubble by Stoneyhurst Quarries near Bethesda.

Prince Georges.—Sand and gravel comprised over nine-tenths of the value of county production. The county continued to rank first in sand and gravel production. Nearly two-thirds of the output was gravel, more than one-half of which was marketed for building and paving uses. Most of the sand production also was sold for building and paving uses. Of the total output of sand and gravel 68 percent was processed before marketing. Among the large producers were Arundel Supply Corp., District Heights; Buffalo Sand & Gravel Co., Washington, D.C.; Silver Hill Sand & Gravel Co., Silver Hill; and A. H. Smith Co., Branchville. The State Highway Department con-

tracted for the purchase of significant quantities of sand and gravel in 1964.

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 plasters and concrete and as a filter aid was produced by Atlantic Perlite Co. at its Washington, D.C. plant.

The Zonolite Co. produced exfoliated vermiculite from imported crude raw material at a plant near Beaver Heights.

The Mineral Pigments Corp., Muirkirk, reported sales of finished natural and manufactured pigments of varying colors; brown, red, and yellow iron oxides predominated.

St. Marys.—Leonardtown Sand and Gravel Co., Leonardtown, marketed processed sand and gravel for building. Bank-run gravel was produced by a contractor for the Maryland State Roads Commission.

Washington.—The mineral economy of the county was based primarily on limestone and shale deposits. The manufacture of portland cement, the major industry in the county, utilizes these raw materials. Marquette Cement Co. quarried limestone at its Security quarry 2 miles east of Hagerstown for captive use and for sale. Quarrying was selective, only those stone horizons suitable for cement raw material were utilized. Masonry cement also was produced by Marquette Cement Co. Crude potassium sulfate for agricultural uses was recovered as a byproduct of cement manufacture, being collected by precipitators during the burning of the cement materials.

The Appalachian Stone Division of Martin Marietta Corp. produced crushed limestone for concrete aggregate and roadstone at Hagerstown, Pinesburg, Hancock, and Boonsboro.

Miscellaneous clay and shale were produced by Victor Cushwa & Sons, Inc., near Williamsport. Shale was sold mainly for cement manufacture and for fertilizer filler. Clay and shale also were used for brick manufacturing.

Wicomico.—The output of six sand and gravel pits was mostly sand. The leading producer was Raymond A. Weisner, Salisbury, who sold unprocessed sand for fill. Gravel was sold for building, fill, and other uses. Salisbury Brick Co., Inc., recovered miscellaneous clay from its pit near Salisbury for manufacturing building brick.

The Mineral Industry of Massachusetts

By Meherwan C. Irani [1]

MINERAL production of Massachusetts rose 11 percent above the 1963 record in value. The increase was due mainly to increased production of aggregates for roads and other construction.

In terms of value, 63 percent of the total mineral production was from Middlesex, Berkshire, and Norfolk Counties. Measured by both quantity and value, Middlesex County ranked first while Berkshire and Norfolk Counties ranked second and third, respectively.

TABLE 1.—Mineral production in Massachusetts [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays short tons	157,442	$213	138,214	$174
Gem stones	(2)	2	(2)	2
Lime short tons	144,889	2,426	171,398	2,703
Sand and gravel do	19,904,708	15,592	21,341,000	16,794
Stone do	5,570,305	14,396	6,518,511	16,663
Value of items that cannot be disclosed: Mineral fuels and nonmetals	XX	32	XX	31
Total	XX	32,661	XX	36,367

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

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

(Thousands)

Year	Value	Year	Value	Year	Value
1940	$13,481	1949	$14,150	1958	$24,104
1941	16,745	1950	18,372	1959	26,086
1942	13,787	1951	18,483	1960	28,098
1943	8,603	1952	19,661	1961	30,849
1944	8,607	1953	17,898	1962	r 30,274
1945	8,444	1954	19,576	1963	r 33,323
1946	13,562	1955	22,677	1964	36,841
1947	13,443	1956	24,545		
1948	14,737	1957	25,192		

r Revised.

[1] Metallurgist, Bureau of Mines, Pittsburgh, Pa.

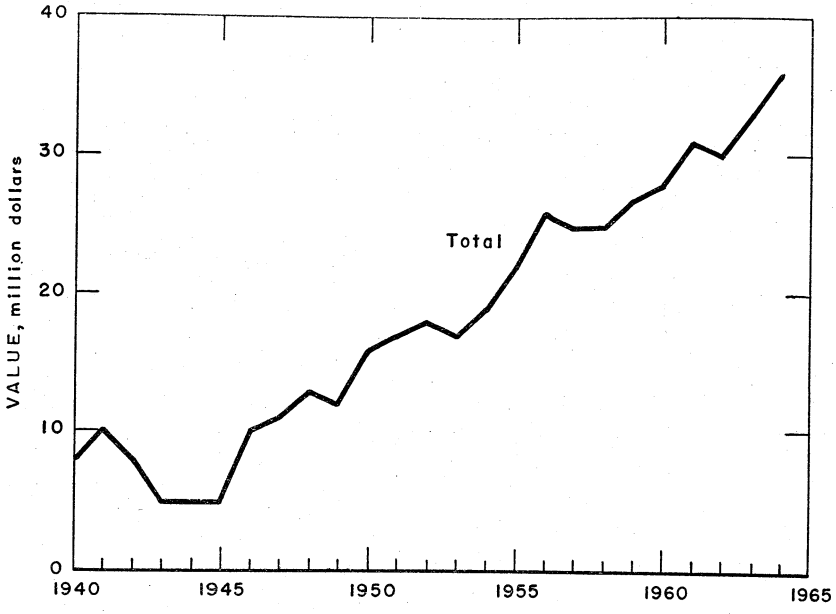


FIGURE 1.—Total value of mineral production in Massachusetts.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Nonmetal and peat	98	22	176	----------	1	6
Sand and gravel	1,301	273	2,260	----------	29	13
Stone	1,009	255	2,066	2	72	36
Total	2,408	550	4,502	2	102	23
1964: p						
Nonmetal and peat	112	27	211	----------	----------	----------
Sand and gravel	1,395	292	2,423	----------	32	13
Stone	1,070	263	2,123	----------	61	29
Total	2,577	582	4,757	----------	93	20

p Preliminary.

REVIEW BY MINERAL COMMODITIES

Clays.—The quantity and value of clay production declined from the 1963 record production by 12 and 18 percent, respectively. The decline in quantity was due to discontinuation of clay mining in Bristol County and lower clay production in Plymouth County. The reported unit value of clay produced in Plymouth County, which was the leading clay producer in the State, was $1.26 per ton, compared with $1.35 per ton reported in 1963. Of the four companies that

mined miscellaneous clay or shale for manufacture of building bricks, one also reported use of shale for manufacture of lightweight aggregate.

Gem Stones.—Specimens of gem stone minerals were collected by hobbyists at unspecified locations. Minerals collected included zircon, beryl, garnet, tourmaline, and apatite.

Lime.—Lime was produced at a high level at three plants in Berkshire County. Owing to a 19-percent decline in production of higher priced building lime, the reported unit price for lime declined from $16.74 per ton in 1963 to $15.77 per ton in 1964. The primary market for burnt lime was the chemical industry, an appreciable quantity was consumed by building industries, and a smaller quantity was used in agriculture.

TABLE 3.—Lime sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1955–59 (average)	137,823	$2,138,640	1962	148,401	$2,337,027
1960	153,710	2,370,059	1963	144,889	2,425,699
1961	144,831	2,306,710	1964	171,398	2,703,276

Peat.—Peat was produced by two companies, one each in Essex and Worcester Counties, at about the same rate as in 1963.

Sand and Gravel.—Sand and gravel, which accounted for 46 percent of the total value of mineral production in the State, rose to new records in both quantity and value. The high level of road building programs carried out by local, State, and Federal authorities contributed significantly to the high level of sand and gravel production. The average value per ton rose slightly, to $0.79 from $0.78 recorded in 1963. Government-and-contractor tonnage was 31 percent of the total sand and gravel sold or used. Sixty percent of the total quantity was consumed in building and paving, and 31 percent was used for fill. Sand and gravel used for paving comprised 30 percent of combined Government-and-contractor and commercial tonnage. Small quantities of commercial sand were used as blast and filtration sand. Production was reported for 208 operations. Middlesex County, which maintained its position as the leading producer, reported a drop of 1.1 million tons, or 19 percent. Total production during the year was 4.7 million tons, compared with 5.8 million tons reported in 1963. The largest increase was registered by Hampshire County, which reported production of 4.3 million tons, compared with 0.6 million tons in 1963, and became the second largest sand and gravel producing county. Other counties with production of over 1 million tons included Bristol, Essex, Franklin, Hampden, Norfolk, and Worcester.

Stone.—Production of stone exceeded by 17 percent the previous record high established in 1963. The production of rough construction granite, dressed construction granite, dressed architectural granite, granite curbing, and flagging all increased. Basalt was mined and crushed chiefly for use as concrete aggregate and road material. Basalt was the State's most important stone commodity in quantity and value. The output and value of miscellaneous stone decreased. Although the quantity of limestone produced was 13 percent higher than

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	2,973	$2,802	3,371	$3,274
Paving	2,410	2,252	2,242	1,972
Fill	1,195	475	421	163
Blast	2	7	5	55
Filtration	1	7	9	15
Railroad ballast	1	1		
Undistributed [1]	735	939	650	993
Total	7,317	6,483	6,698	6,472
Gravel:				
Structural	3,271	3,909	2,960	3,976
Paving	2,678	2,247	2,679	2,565
Fill	1,464	647	1,328	633
Other	819	641	738	822
Undistributed [2]	466	419	379	313
Total	8,698	7,863	8,084	8,309
Total sand and gravel	16,015	14,346	14,782	14,781
Government-and-contractor operations:				
Sand:				
Paving	25	16	23	13
Fill			1	1
Other	23	24	17	20
Total	48	40	41	34
Gravel:				
Paving	1,407	888	1,553	755
Fill	2,435	318	4,961	1,218
Other			4	6
Total	3,842	1,206	6,518	1,979
Total sand and gravel	3,890	1,246	6,559	2,013
All operations:				
Sand	7,365	6,523	6,739	6,506
Gravel	12,540	9,069	14,602	10,288
Total	19,905	15,592	21,341	16,794

[1] Includes molding sand and sand for other uses.
[2] Includes railroad ballast and miscellaneous gravel.

1963, the value was higher by 37 percent. The limestone was used mainly for lime manufacture and as concrete aggregate, roadstone, agricultural stone, rubber and asphalt filler, mineral food, and blast furnace flux.

The quantity and value of dimension stone rose to 132,000 tons and $4.4 million, representing increases of 5 and 2 percent, respectively. The production of concrete aggregate and roadstone increased by 21 percent and accounted for 79 percent of the total stone sold or used in 1964. Production and value of stone used for railroad ballast decreased by 15 and 27 percent, respectively.

As in the previous 2 years, stone was quarried in all counties except Barnstable, Dukes, and Nantucket. Middlesex County was by far the largest stone producer, accounting for 29 percent of production and 40 percent of value of stones produced in the State. Other leading stone producing counties in order of rank were Norfolk, Essex,

Berkshire, and Hampden. However, in terms of value, Berkshire County was second in rank because it was the only producer of limestone, which had a higher unit value than the crushed stones produced in other counties.

TABLE 5.—Stone sold or used by producers, by uses

Use	1963		1964	
	Short tons	Value	Short tons	Value
Riprap	56,378	$96,236	65,833	$92,960
Concrete aggregate and roadstone	4,293,845	7,085,657	5,180,345	8,619,696
Agricultural (limestone)	177,943	558,632	236,078	768,513
Undistributed [1]	1,042,139	6,655,014	1,036,255	7,181,400
Total	5,570,305	14,395,539	6,518,511	16,662,569

[1]Includes dimension stone, furnace flux, railroad ballast, and other uses.

REVIEW BY COUNTIES

Large quantities of basalt and granite were quarried for its own use by the Massachusetts Department of Public Works in Middlesex, Norfolk, Worcester, and Plymouth Counties. The State used the stone for concrete aggregate, roadstone, fill, and riprap. Sand and gravel also was mined either by State crews or under contract by the State Department of Public Works in all counties except Dukes, Essex, Nantucket, Suffolk, and Worcester. Some municipalities also mined sand and gravel for their own use.

TABLE 6.—Value of mineral production in Massachusetts, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Barnstable	$268,045	$240,000	Sand and gravel.
Berkshire	5,120,889	6,334,567	Lime, stone, sand and gravel.
Bristol	2,315,228	2,294,500	Sand and gravel, stone.
Dukes	W	W	Sand and gravel.
Essex	2,601,104	2,892,644	Stone, sand and gravel, peat.
Franklin	823,231	969,000	Sand and gravel, stone.
Hampden	2,563,727	2,112,214	Stone, sand and gravel, clays.
Hampshire	485,986	1,375,000	Sand and gravel, stone.
Middlesex	10,549,346	11,128,510	Stone, sand and gravel.
Nantucket	W	W	Sand and gravel.
Norfolk	4,661,428	5,615,520	Sand and gravel, stone, clays.
Plymouth	913,515	644,347	Do.
Suffolk	385,292	420,702	Stone, sand and gravel.
Worcester	1,941,163	2,308,462	Sand and gravel, stone, peat.
Undistributed [1]	31,749	32,000	
Total	32,661,000	36,367,000	

W Withheld to avoid disclosing individual company confidential data.
[1] Includes value of gem stones that cannot be assigned to specific counties and values indicated by symbol W.

Barnstable.—Concrete Products Co. of Cape Cod, Inc., and Frederick V. Lawrence, Inc., both of Falmouth, mined sand and gravel for building, construction, paving, and fill. Falmouth Cement Work, Inc., Teaticket, mined, produced, and sold unprepared sand, and Whitehead Brothers Co. produced molding sand at Provincetown.

Berkshire.—The county was the only producer of limestone in the State. The four limestone producers were Minerals, Pigments & Metals, Division of Chas. Pfizer & Co., Inc., Adams; John S. Lane & Son, Inc., West Stockbridge; Lee Lime Corp., Lee (two quarries); and United States Gypsum Co., Farnams. Minerals, Pigments & Metals, Division of Chas. Pfizer & Co., Inc., completed a third kiln at the firm's operation. The new kiln was reported to be an ultra-modern fluid bed limekiln.[2] Most of the lime produced in the county was consumed as building lime, for various chemical and industrial uses, and as agricultural lime. Otis Chester Granite Co., Otis, quarried and sold a small quantity of rough dimension granite. Production of sand and gravel was 25 percent higher than in 1963. Fifteen operators reported production of sand and gravel. General Sand & Stone Corp. maintained its position as the leading producer. Other large producers were W. E. Williams, Inc., Lenox Dale; Berkshire Gravel, Inc., Pittsfield; Maxymillian Incorporated, Adams; and Cairo Redi-Mix Corp., Great Barrington.

Bristol.—Output of sand and gravel decreased 2 percent. Government-and-contractor tonnage comprised 17 percent of the total. Sales were chiefly for building, paving, and fill. Nineteen firms were active during the year. Among the leading producers were Assonet Sand & Gravel Co., Inc., Freetown; Morse Sand & Gravel Co., Attleboro; River Sand & Gravel Co., Inc., Pawtucket, R.I.; Joseph Borge & Sons, Inc., Swansea; and Easton Sand and Gravel Corp., North Easton. No clay was mined in the county during the year. Morse Sand and Gravel Co., Attleboro, and Warren Bros. Road Co., Acushnet, quarried basalt for concrete aggregate and roadstone.

Dukes.—Sand and gravel production remained the same as in 1963. Output was used for building, paving, and fill. The chief operators were Goodale Construction Co., Inc., Vineyard Haven, and Grant Brothers, Inc., Edgartown.

Essex.—Trimount Bituminous Products Co., Saugus, and Lynn Sand & Stone Co., Swampscott, quarried basalt, mostly for concrete aggregate, railroad ballast, and riprap. Providence Granite Co., Inc. (formerly operating as Rockport Quarries Co., Inc.), produced dimension granite at its Rockport quarry. Karl A. Persson also quarried dimension granite at Rockport for building and flagging. Production of sand and gravel fell by 13 percent. There were 18 producing plants. The largest producer was Merrimack Materials, Inc., Groveland, producing building and paving sand and building gravel. Georgetown Sand & Gravel Co., Georgetown; Andover Sand & Gravel, Inc., Lawrence; and Essex Sand & Gravel Co., Inc., Andover, produced for paving, building, fill, and ice control.

Andover Sand & Gravel, Inc., recovered peat humus from a bog near Lawrence for sale in bulk.

Franklin.—Franklin County dropped to sixth place from its 1963 second ranking position among sand and gravel producing counties. The drop in production of sand and gravel was 46 percent. There were 10 producing plants. The largest commercial producers were Mackin Sand & Concrete Products, Greenfield; Northfield Washed Sand & Gravel Co., Inc., Northfield; and Warner Bros., Inc., Sunder-

[2] Pit and Quarry. V. 57, No. 1, July 1964, p. 228.

land (Zmetra pit). Basalt was quarried near Deerfield by Warner Bros., Inc. (formerly Greenfield Mass., Broken Stone Co.), for use as riprap, railroad ballast, concrete aggregate, and roadstone.

Hampden.—John S. Lane & Son, Westfield, quarried and crushed basalt for concrete aggregate and railroad ballast. Ouput of sand and gravel fell by 34 percent. Twenty plants produced commercial sand and gravel. The principal commercial operators were John's Trucking Co., Agawam; North Wilbraham Sand & Gravel Corp., Monson; Berkshire Asphalt Co., Inc., Springfield; and John S. Lane & Son, Inc. (Westfield plant), Meriden. The chief uses were paving, building, fill, and ice control. Miscellaneous clay for use in manufacturing building brick was mined by Hampshire Brick Co., Willimansett, and Westfield Clay Products Co., Westfield.

Hampshire.—Production of sand and gravel rose considerably over that of 1963. While the commercial production of sand and gravel was the same as in 1963, Government-and-contractor production increased sharply, raising the county in rank from ninth to second as producer of sand and gravel. Most of the Government-and-contractor production was gravel for highway construction. There were 10 commercial producing plants in the county. The largest producers were D. D. Ruxton Co., Inc., Amherst; Donovan Brothers, Inc., Huntington; and Omasta Brothers, Inc., Northampton. John S. Lane & Son, Inc., quarried basalt at Amherst for concrete aggregate and roadstone. The Zonolite Co., North Billerica, exfoliated domestic vermiculite for sale as lightweight aggregate and insulation.

Middlesex.—Middlesex County maintained its position as the leading producer of sand and gravel in the State. Six operators in the Westfield-Chelmsford region quarried and sold dimension granite. Two of these producers also sold crushed and broken material for riprap and other uses. Dimension stone producers were Guilmette Bros. Corp. and Le Masurier Granite Quarry, Inc. (also some crushed and broken), both near North Chelmsford; Forest Road Granite Co., Inc., Oak Hill Granite Co., and Morris Bros. Granite Co., Inc., all near Westford; and H. E. Fletcher, West Chelmsford (also some crushed and broken granite). The dimension stone sold included rough construction stone, rubble, paving blocks, curbing, and architectural and monumental stone. Production of basalt increased by 42 percent. Most of the production consisted of concrete aggregate and road metal. Producers were Rowe Contracting Co., Malden; Massachusetts Broken Stone Co., Weston; B. & M. Crushed Stone Corp., Ashland; J. B. Condon Corp. and George Brox, Inc., Dracut. Production of commercial sand and gravel declined by 27 percent from the 1963 record, and Middlesex's contribution to the State's total sand and gravel production declined from 29 percent in 1963 to 22 percent during 1964. Fifty-seven percent of the commercial production was gravel. Sixty-seven percent of the sand and gravel produced was screened. The commercial sand and gravel was produced from 28 reported operations. The principal producers were San Vel Contracting Co., Littletown; Burlington Sand & Gravel Co., Inc., Burlington; Pomerleau Brothers, Inc., Westford; J. J. Cronin Co., North Reading; Ashland Sand and Gravel Co., Ashland; New England Sand and Gravel

Co., Inc., Framingham; and Assabet Sand & Gravel Co., Inc., Acton. Production was chiefly sold for building, paving, and fill.

Nantucket.—Nantucket Construction Co. produced mostly bank-run sand for fill near Nantucket.

Norfolk.—Output of sand and gravel rose by 47 percent over that of 1963. The county maintained its position as the third largest producer of sand and gravel in the State. Most of the sand was processed in 27 plants. The largest producers included West Sand & Gravel Co., Walpole; Wrentham Sand & Gravel Co., Wrentham; L. Romano Construction Co., Plainville; Varney Brothers Sand & Gravel, Inc., Bellingham; A. A. Will Sand & Gravel Corp., Canton; and Tresca Brothers Sand & Gravel Inc., Millis. Production was chiefly for building, with most of the remainder for paving and fill. Bates Bros. Seam Face Granite Co., Weymouth, produced dimension granite for rough construction and architectural work and for use as monumental stone. Antonio Roscitto & Sons, Inc., operating the J. S. Swingle quarry at Quincy, was idle during the year. Old Colony Crushed Stone Co., Quincy, and Simeone Stone Corp., Wrentham, produced crushed granite, mostly for concrete aggregate, roadstone, and stone dust. Crushed basalt for similar uses also was quarried by Simeone Stone Corp. at Stroughton. S. M. Larusso & Sons, Inc., quarried miscellaneous stone (rhyolite) at Wrentham. This material was sold for manufacture into roofing granules. Masslite, Division of Blackstone Industries, Inc., Plainville, continued to mine shale and converted it into lightweight aggregate which was sold for use in manufacturing building blocks and concrete.

California Products Corp., Vermiculite Division, Hingham, exfoliated South African vermiculite, mostly for use as concrete and plaster aggregate and for insulation.

Plymouth.—Although production of commercial sand and gravel increased 7 percent, total production declined 29 percent owing to a large reduction in Government-and-contractor tonnage. About 70 percent of the output of commercial sand and gravel was processed, and 60 percent was sand. The leading producers included Marshfield Sand & Gravel, Inc., Marshfield; Whitehead Bros. Co., producing molding sand near Marion; and Petrino Sand & Gravel, Whitman.

There were 21 additional producers. The principal uses for the sand and gravel were for building and road construction. Stiles & Hart Brick Co. continued manufacturing building brick in its beehive kiln. Plymouth Quarries, Inc., East Weymouth, produced rough architectural granite block and rubble for building purposes at its Hingham quarry.

Suffolk.—Crushed basalt for concrete aggregate and roadstone was produced near West Roxbury by West Roxbury Crushed Stone Co. Processed building sand was produced by one operator. United States Gypsum Co., Charleston, manufactured calcined gypsum products from Nova Scotia gypsum. Whitmore Products, Inc., Roslindale, expanded perlite for use as a lightweight aggregate in concrete and plasters, as a soil conditioner, and as insulating material.

Worcester.—Commercial production of sand and gravel was about the same as in 1963, and the county improved its rank from sixth to fourth in 1964. Eighty-eight percent of the production was processed,

and 63 percent consisted of gravel. There was a total of 31 producers in the county. The leading producers included Rosenfeld Washed Sand & Stone Co., Milford; P. J. Keating Co., Lunenburg; Direnzo Brothers Sand & Gravel, Inc., Worcester; De Falco Concrete Corp., Milbury; Worcester Sand & Gravel Co., Shrewsbury; Pine Tree Trusts, Whitinsville; and E. L. Dauphinais, Inc., North Grafton. Most of the sand and gravel was used for building and road construction, and gravel was used for fill. Holden Trap Rock Co., Holden, and Mario Pandolf Co., Inc., near Sterling, quarried and crushed basalt for concrete aggregate and roadstone. Production of basalt was higher than in 1963. The Milford Pink dimension granite quarry of Castellucci & Sons, Inc., was in operation during 1964 and produced rough architectural dimension granite. H. E. Fletcher Co. quarried dressed architectural dimension granite at Milford. Sterling Peat Co. mined reed-sedge peat near Sterling Junction. The peat was sold in bulk and in bags.

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 Michigan Department of Conservation, Geological Survey Division, State of Michigan, for collecting information on all minerals except fuels.

By Donald F. Klyce [1]



MINERAL production in Michigan was valued at $555 million, an alltime high. Increased output of all major minerals, except copper and petroleum, contributed to the record. Much of the increase was due to increased value of shipments of iron ore and cement. Producers of stone, salt, and chemicals also reported substantial gains in sales. Petroleum output declined for the third consecutive year. Iron ore was first in value, followed by cement, copper, sand and gravel, and petroleum. Nonmetals (construction materials and natural saline minerals) accounted for 55 percent of the State total, slightly less than in 1963. Metallic minerals increased to over 34 percent of the total value, while mineral fuels accounted for the remainder.

TABLE 1.—Mineral production in Michigan [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	25,016	$76,944	26,745	$84,316
Masonry—thousand 280-pound barrels	1,684	4,519	1,865	4,954
Clays—thousand short tons	1,958	2,149	2,385	2,592
Copper (recoverable content of ores, etc.)—short tons	75,262	46,361	69,040	45,014
Gypsum—thousand short tons	1,315	4,938	1,421	5,263
Iron ore (usable)—thousand long tons, gross weight	10,789	107,201	13,871	143,979
Lime—thousand short tons	1,371	18,431	1,430	19,246
Magnesium compounds—short tons	266,740	23,062	306,494	23,385
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	152,957	W		
Natural gas—million cubic feet	32,850	8,902	31,558	7,984
Peat—short tons	251,809	2,413	269,074	2,412
Petroleum (crude)—thousand 42-gallon barrels	15,972	45,520	15,601	43,839
Salt—thousand short tons	4,244	33,656	4,345	35,711
Sand and gravel—do	50,458	43,433	51,921	44,405
Silver (recoverable content of ores, etc.)—troy ounces	338,997	434	349,195	452
Stone—thousand short tons	30,316	32,065	34,650	37,002
Value of items that cannot be disclosed: Bromine, calcium chloride and calcium-magnesium chloride, gem stones, iodine, natural gas liquids, potassium salts, and values indicated by symbol W	xx	42,001	xx	54,941
Total	xx	r 492,029	xx	555,495

r Revised.
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).

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.

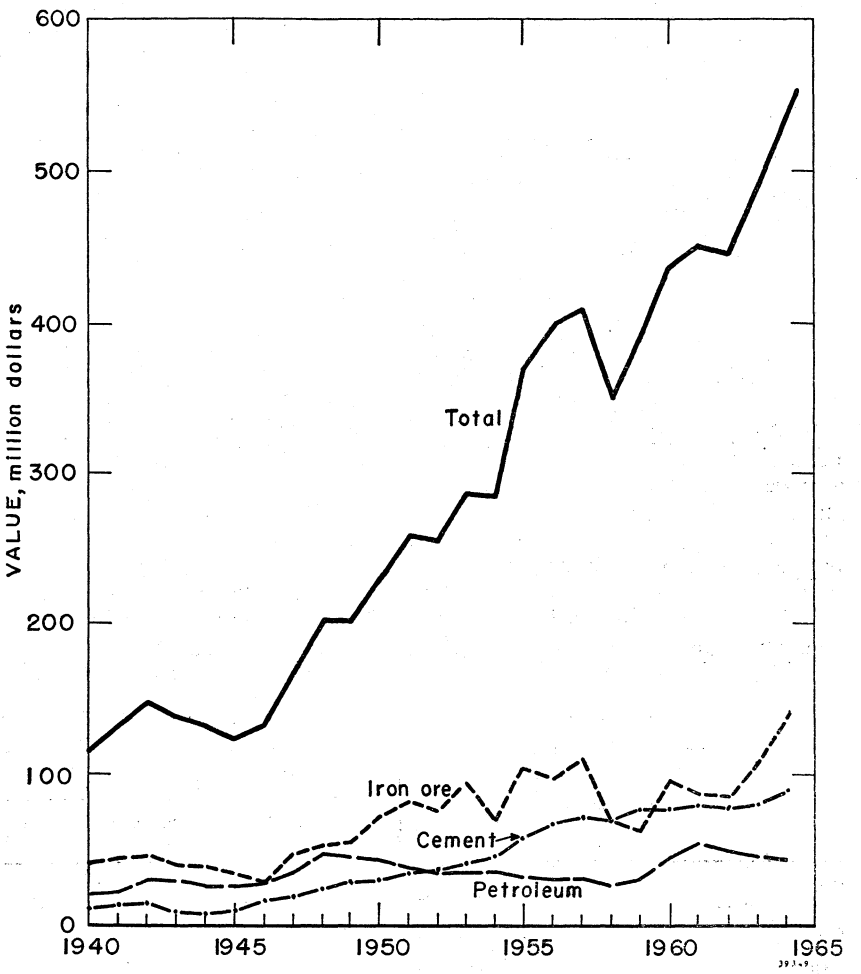


FIGURE 1.—Value of iron ore, petroleum, cement, and total value of mineral production in Michigan.

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

(Millions)

Year	Value	Year	Value
1953	$323	1959	$384
1954	306	1960	431
1955	385	1961	444
1956	396	1962	r 440
1957	412	1963	r 484
1958	352	1964	537

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	5,092	1,380	11,040	6	303	28
Nonmetal	4,298	1,439	11,549	1	158	14
Sand and gravel	2,654	544	4,570	1	59	13
Stone	2,988	864	6,987	1	40	6
Peat	276	45	434		3	7
Total	15,308	4,272	34,580	9	563	16
1964: p						
Metal	5,560	1,547	12,250	1	322	26
Nonmetal	4,355	1,447	11,244	1	45	4
Sand and gravel	2,750	560	4,654	2	81	18
Stone	3,815	1,174	9,351		46	5
Peat	291	54	495		12	24
Total	16,771	4,782	37,994	4	506	13

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of cement continued to increase and were 7 percent larger than in 1963. Average mill values per barrel were more stable than in previous years, and the decline that began in 1962 appears to have abated. The value of portland cement was $3.15 in 1964 compared with $3.08 in 1963; masonry cement was valued at $2.66 in 1964 compared with $2.68 in 1963. Portland cement was produced at nine plants in seven counties. At six of these plants masonry cement also was produced. Total capacity of the plants was 32.7 million barrels. Yearend stocks of portland cement at mills were nearly 2.6 million barrels, 57,000 barrels more than in 1963. About 54 percent of the cement shipped was used in the State. Principal out-of-State shipments were to Ohio, Illinois, Wisconsin, Indiana, and New York. Ready-mixed concrete companies purchased 56 percent of the cement produced, while the remainder went principally to contractors, concrete product manufacturers, and building material dealers.

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	
1955–59 (average)	8	20,221	20,102	$63,607	2,173
1960	9	20,971	21,187	73,082	3,023
1961	9	21,661	21,948	75,172	2,737
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	2,589

Raw materials used in the manufacture of cement included 6.5 million tons of limestone and 2.2 million tons of clay or shale, as well as sand, gypsum, mill scale, slag, iron ore, grinding aids, and air-entraining compounds.

About 655 million kilowatt-hours of electrical energy was used. The wet process was used at eight of the nine plants. The other plant employed the dry process.

Clays.—Miscellaneous clay and shale was mined in 10 counties at 14 pits. About 86 percent of the output was used in cement manufacture. Manufacturers of heavy clay products (sewer pipe, draintile), pottery, and lightweight aggregate utilized the balance. The largest production came from operations in Alpena, Wayne, and Monroe Counties.

Gem Stones.—Small quantities of semiprecious stones, principally agates, thomsonite, and specimens of native copper and hematite, were collected by hobbyists. Most of the gem materials were found in the upper peninsula, chiefly on the beaches of Lake Superior. The material was used for handmade jewelry and for personal gem collections.

Gypsum.—Underground mines in Kent County and quarries in Iosco County were the source of gypsum. The tonnage produced was 8 percent larger than in 1963. The ore was milled and processed at plants in National City, Detroit, and Grand Rapids, as well as at plants in other States. Wallboard, exterior sheathing, lath, and plaster were manufactured. A substantial tonnage of uncalcined gypsum was sold as a cement retarder.

Lime.—The volume and value of lime produced was 4 percent larger than in 1963. Data for regenerated lime (produced by papermills, water purification plants, and acetylene processors) are excluded from the State total value of production. Wayne County led in lime production. Nearly three-quarters of the lime manufactured was used by producers. Nearly all (98 percent) of the lime was consumed within the State. Lime was used in chemical and metallurgical operations, water treatment, and paper and sugar manufacture. Most of the lime manufactured was quicklime. A small tonnage of hydrated lime was produced. The annual lime-burning capacity of the lime plants reporting exceeded 1.7 million tons. During the year construction was started on a 700,000-ton-per-year lime plant by Marblehead Lime Co. in Wayne County.

Natural Salines.—Bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, and potash were extracted from natural well brines at plants in Gratiot, Lapeer, Mason, Manistee, Midland, and Wayne Counties. The value of chemicals produced from natural salines, excluding salt, was about 6 percent higher than in 1963. During the year Wyandotte Chemicals Corp. began producing calcium chloride at its plant in Wayne County.

Perlite.—Perlite was expanded at plants in Iosco, Kent, and Wayne Counties from crude ore mined in New Mexico and Nevada. The material was used in plaster. Although the volume produced was slightly less than in 1963, a price increase resulted in a higher valuation for the 1964 output.

Salt.—Salt was recovered from natural well brines and artificial brines in Gratiot, Manistee, Midland, Muskegon, St. Clair, and Wayne Counties. One underground salt mine was operated in Detroit. Volume of output was 2 percent larger than in 1963, while value of

shipments was 6 percent higher. The principal uses were in chemical manufacture, meatpacking, ice removal, water softening, and animal feed. Purchase of salt for ice control again declined, but increased use in chemical manufacture, principally of chlorine and soda ash, more than made up for the loss.

Sand and Gravel.—Production of sand and gravel totaled nearly 52 million tons—the second highest in the Nation, and a record high for the State. A 20-percent increase in material for use in building offset a 3-percent decline in paving and road sand and gravel. The demand for industrial sand was 20 percent greater than in 1963. Sand and gravel was produced in all counties except Monroe. The Detroit area (Livingston, Macomb, Oakland, Washtenaw, and Wayne Counties), producing 18.7 million tons, accounted for 40 percent of the value and 36 percent of the State sand and gravel production. Production of more than 1 million tons was also reported from each of the following counties: Allegan, Ingham, Kalamazoo, Kent, Ottawa, and Tuscola.

Sand and gravel shipments were about 3 percent greater than in 1963. More than 92 percent of the sand and gravel was processed or treated. More than 48 million tons of sand and gravel was transported by truck, and the remainder was moved by rail or water. Production was reported by 358 commercial operations and 193 Government-and-contractor operations.

Leading producers of sand and gravel, in alphabetical order, included:

American Aggregates Corp.
Construction Aggregates Corp.
Grand Rapids Gravel Co.
Holloway Sand & Gravel Co., Inc.
Holly Sand & Gravel Division.
Michigan Silica Co.
The Nugent Sand Co., Inc.
Pickitt & Schreur, Inc.
Sargent Sand Co.
I. L. Whitehead Co.

Stone.—Limestone, sandstone, marl, and basalt were produced. Over 99 percent of the material was limestone, quarried in 14 counties by 19 commercial producers and 4 county highway agencies. Large quarries in Alpena, Chippewa, Emmet, Mackinac, Monroe, and Presque Isle Counties supplied most of the crushed stone. More than 27 million tons of stone was moved by water from company-operated ports on Lakes Huron and Michigan to steel mills, cement and lime plants, and other industrial consumers.

Limestone shipments were nearly 15 percent larger than in 1963 owing principally to greater demand for fluxstone, crushed stone for cement and lime, other industrial uses, and roadstone. Of the 34.5 million tons of crushed limestone produced, 13.0 million tons was used for flux, 12.2 million tons for cement and lime, 4.6 million tons for roadstone and aggregate, and the remainder for other industrial uses and agricultural purposes. The major producers of limestone, in alphabetical order, included:

Drummond Dolomite, Inc.
Dundee Cement Co.
The France Stone Co.

Huron Portland Cement Co.
Inland Lime & Stone Co.
Michigan Stone Co.
Penn-Dixie Cement Corp.
Presque Isle Corp.
United States Steel Corp.
The Wallace Stone Co.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,827	$3,444	5,754	$4,169
Paving	5,049	4,535	5,135	4,274
Fill	3,092	1,383	3,204	1,412
Molding	2,178	3,896	2,819	5,085
Other [1]	721	1,707	694	1,620
Total	15,867	14,965	17,606	16,560
Gravel:				
Building	4,920	6,293	5,739	7,339
Paving	16,480	13,818	16,254	13,380
Railroad ballast	W	W	210	225
Fill	291	163	350	203
Other [2]	438	423	418	457
Total	22,129	[3] 20,696	22,971	21,604
Total sand and gravel	37,996	[3] 35,662	40,577	38,164
Government-and-contractor operations:				
Sand:				
Building	----	----	107	48
Paving	1,965	1,014	1,659	744
Fill	1,497	516	1,215	394
Other	143	71	127	58
Total	3,605	1,601	3,108	1,244
Gravel:				
Building	66	30	196	76
Paving	8,257	5,947	7,641	4,764
Fill	355	121	347	141
Other	179	72	52	16
Total	8,857	6,170	8,236	4,997
Total sand and gravel	12,462	7,771	11,344	6,241
All operations:				
Sand	19,472	[3] 16,567	20,714	17,804
Gravel	30,986	[3] 26,867	31,207	26,601
Grand total	50,458	[3] 43,433	51,921	44,405

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes blast (1963), engine, glass, grinding and polishing, and other construction and industrial uses (1963–64), and railroad ballast and abrasive sands (1964).
[2] Includes railroad ballast (1963) and other miscellaneous gravel.
[3] Data do not add to total shown because of rounding.

Marl was produced in 16 counties at 36 operations. The largest output was reported from Barry, Calhoun, Cass, and Kalamazoo Counties. Sandstone, used principally for building, was quarried and milled in Baraga and Jackson Counties. The National Park Service reported dredging a few hundred tons of basalt and sandstone at several locations on submerged park lands on Isle Royale for use as rubble and fill.

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
1960			6,801	$58,889	11,615	$97,395	18,416	$156,284
1961			27,516	119,950	7,045	54,057	34,561	174,007
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

TABLE 7.—Crushed and broken stone sold or used by producers, by kinds and uses

(Thousand short tons and thousand dollars)

Kind and use	1963		1964	
	Quantity	Value	Quantity	Value
Basalt: Concrete aggregate and roadstone	15	$15		
Limestone:				
Flux	11,194	12,785	12,969	$14,792
Concrete aggregate and roadstone	3,860	4,616	4,593	5,464
Agriculture	484	838	679	1,147
Cement	8,157	6,455	9,273	7,610
Lime	2,387	2,128	2,956	2,709
Other [1]	4,029	4,987	4,048	5,065
Total	[2] 30,110	31,809	[2] 34,516	[2] 36,788
Marl: Agriculture	169	109	120	83
Sandstone:				
Riprap	[3]	[3]		
Concrete aggregate and roadstone	7	9		
Foundry	[3]	[3]		
Total	[2] 8	9		
Grand total	30,302	31,942	34,636	36,871

[1] Includes limestone for asphalt and miscellaneous filler, chemicals, dust for coal mines, mineral food, poultry grit, railroad ballast, riprap, stone sand, and other uses (1963–64), and whiting or whiting substitutes (1964).
[2] Data do not add to total shown because of rounding.
[3] Less than ½ unit.

Sulfur.—Byproduct sulfur was recovered from crude petroleum in Detroit by the Marathon Oil Co., using the Parsons process. Leonard Refineries, Inc., used the hydrofining process at Alma to recover sulfur.

Vermiculite.—Crude vermiculite, mined in southern and western States, was exfoliated at Dearborn by Zonolite Division, W. R. Grace & Co.

METALS

Metals accounted for 34 percent of the total value of mineral production, a 3 percent increase over that of 1963.

Copper.—Production of copper in terms of recoverable metal was 8 percent less than in 1963. The value of output decreased only 3 percent as the average weighted price increased to 32.6 cents per pound, compared with 30.8 cents in 1963. The price quoted by primary producers for delivered electrolytic copper at the beginning of 1964

was 31 cents per pound. The price advanced to 32 cents on March 17 and remained at 34 cents from September 23 until yearend. The price fluctuated around that point until the end of the year when it closed at 34.16 cents. Copper production was interrupted in August, September, and October by strikes at the Copper Range Co. and its subsidiary, White Pine Copper Co. The company mines, reclamation plant, mills, and smelter were shut down during the strike period.

Calumet & Hecla, Inc., operated seven mines, one reclamation plant, and one smelter in Houghton and Keweenaw Counties. Work began on construction of surface installation of the Kingston mine of Calumet & Hecla, Inc., in June. The Kingston was the first new native copper mine to be developed in Michigan in over 30 years.

TABLE 8.—Mine production of copper in 1964, by months, in terms of recoverable metal

Month	Short tons	Month	Short tons
January	6,510	August	6,265
February	6,080	September	1,130
March	6,385	October	3,560
April	6,675	November	6,255
May	6,350	December	6,480
June	6,555		
July	6,795	Total	69,040

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
1955–59 (average)	12	3	5,862,048	1,873,706	56,659	$37,853,593
1960	9	3	5,600,290	2,192,818	56,385	36,199,170
1961	10	3	7,109,924	2,122,286	70,245	42,147,000
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

Copper Range Co. operated the Champion mine and the Freda mill in Houghton County. The mill concentrated ore from the mine and tailings from the Redridge sands. White Pine Copper Co. operated a mine, mill, and smelter in Ontonagon County.

Iron Ore.—Iron ore shipments increased to nearly 13.9 million long tons from 10.8 million in 1963. Value of shipments increased 34 percent to $144 million. Most of the gain was due to increased shipments of concentrates from low grade ores. Shipments of this material accounted for 47 percent of total iron-ore shipments, compared with 43 percent in 1963, and for 59 percent of the value of shipments in 1964. A total of 14 underground mines and 5 open-pit mines were active all or part of the year. Almost 73 percent of the crude ore mined came from open-pit operations, compared with 64 percent in 1963. Average iron content of usable ore produced was 57.93 percent natural. The average weighted mine value of Michigan iron ore, without respect to grade, was $10.38 per long ton, compared with $9.94 in 1963.

Michigan iron ore was shipped to producers of pig iron and steel,

except for a small quantity used in manufacturing iron oxide pigments. About 96 percent of the ore was shipped by rail to ore docks in Ashland, Wis., and in Escanaba and Marquette, Mich., then by water to lower Lake ports. The remainder was all-rail shipments to consuming districts. The lake shipping season for Michigan iron ores opened at Escanaba on April 3 and closed at the same port on December 18.

TABLE 10.—Crude iron ore[1] data, in 1964, by counties and ranges
(Thousand long tons)

County and range	Stocks of crude ore Jan. 1	Production		Shipments		Stocks of crude ore Dec. 31
		Underground	Open pit	Direct to consumers	To beneficiation plants	
County:						
Dickinson			3,448		3,448	
Gogebic	637	1,227		1,403		460
Iron	678	3,076		3,126		627
Marquette	2,375	1,816	13,086	1,224	14,534	1,520
Total	[2] 3,689	6,119	16,534	5,753	17,982	[2] 2,608
Range:						
Gogebic	637	1,227		1,403		460
Marquette	2,375	1,816	13,086	1,224	14,534	1,520
Menominee	678	3,076	3,448	3,126	3,448	627
Total	[2] 3,689	6,119	16,534	5,753	17,982	[2] 2,608

[1] Exclusive of iron ore containing 5 percent or more manganese.
[2] Data do not add to total shown because of rounding

TABLE 11.—Usable iron ore shipped from mines, by ranges[1]
(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total
1955-59 (average)	5,115	3,595	2,322	11,032
1960	4,881	4,018	1,892	10,792
1961	4,141	3,881	1,362	9,384
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

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.

TABLE 12.—Usable iron ore produced, by ranges[1]
(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total
1955-59 (average)	4,960	3,599	2,343	10,903
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
1854-1964	330,807	[2] 270,514	[2] 248,710	850,031

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.
[2] Distribution by range partly estimated before 1906.

At yearend, estimated reserves of iron ores in Michigan totaled 81 million long tons,[2] not including about 1.8 billion tons of low-grade hematite ore.

According to a study by the Michigan Department of Conservation,[3] the average mining cost per ton (delivered at Lake Erie ports) for underground mines was $9.99 in 1964, compared with $10.51 in 1963. Labor costs increased in 1964 to $2.68 a ton from $2.64, while taxes (excluding Federal income tax) dropped to $0.49 from $0.72 in 1963. Deferred costs also dropped significantly to $0.56 from $0.73. The following costs also were lower in 1964—general overhead, $1.49 from $1.55; transportation, $3.05 from $3.09. Federal income tax increased to $0.26 per ton from $0.24, while royalty costs increased to $0.31 from $0.29. Marketing cost remained at $0.08 per ton. On the Gogebic Range delivered costs per ton averaged $11.47 in 1964, compared with $12.07 in 1963; on the Marquette Range costs dropped to $11.49 from $11.82; and on the Menominee Range costs also dropped to $8.64 from $9.09.

Pig Iron and Steel.—Pig iron and steel were manufactured in the Detroit area. Pig iron shipments and value were 13 percent higher than in 1963. Basic, bessemer, foundry, and low-phosphorus grades were produced. According to the American Iron & Steel Institute, Michigan steel production was more than 9.4 million tons, about 12 percent greater than in 1963.

Silver.—Silver was recovered from copper ore mined at the White Pine mine. Concentrates from a silver-recovery circuit in the White Pine mill were smelted separately for delivery to electrolytic refineries where the silver was recovered. Silver contained in fire refined copper is not recovered but is marketed as a constituent of lake copper.

MINERAL FUELS

Natural Gas and Natural Gas Products.—Slightly more than half of the State gas production came from oil well gas; the remainder from gasfields. St. Clair County had the largest gas production, nearly 39 percent of the State total. About 31 percent of the output came from the Albion-Pulaski-Scipio-Trend fields in Calhoun, Hillsdale, and Jackson Counties. Other major gas-producing areas were in Macomb, Missaukee, and Roscommon Counties. Nearly 94 percent of the gas came from these wells, while fields in 20 counties yielded the remainder. Four new gasfields were opened in 1964, increasing the producible gasfields to 83. However, only 32 fields produced gas for commercial sale.

Production of natural gasoline and liquefied petroleum gases was nearly 22 percent greater than in 1963. The top fields supplying gas for processing were Albion-Scipio, Boyd, and Belle River Mills. The new Willow River plant, which was opened in December 1963, processes gas delivered via interstate pipeline from Southwestern States. Most of the gain in total production came from this plant.

Peat.—Peat shipments increased nearly 7 percent, reversing a decline reported in 1963. Michigan was the leading peat-producing

[2] Geological Survey Division, Michigan Department of Conservation. General Statistics Covering Costs and Production of Michigan Iron Mines. June 1965, 15 pp.
[3] Work cited in footnote 2.

State with over 42 percent of the national output. Peat was produced in 15 counties with 90 percent coming from Lapeer, Lenawee, Oakland, and Sanilac Counties. Peat was marketed principally as a soil conditioner. None was sold for fuel.

Petroleum.—The decline in petroleum production continued with a loss of only 371,000 barrels in 1964, compared with 1.1 million barrels in 1963. The fields of the Albion-Pulaski-Scipio-Trend produced nearly 9.3 million barrels, about 60 percent of the State total and only 68,000 barrels less than in 1963. According to data published in the Annual Statistical Summary of Michigan's Oil and Gas Fields, 1964, by the Geological Survey, Michigan Department of Conservation, no significant oil reserves were found or developed that would offset the decline in State output.

Undeveloped acreage under lease decreased to 1.4 million acres from 1.8 million acres in 1963.

Activity in geophysical exploration was about the same as in 1963. Most geophysical work was done in the eastern and northern part of the State. Five gravimeter crews worked a total of 38 crew-months and 6 seismograph parties worked a total of 7 crew-months. New oilfield discoveries in 1964 increased the number of active fields to 184. Four new pools were added to older fields. Seven pools or fields were abandoned and one pool converted to gas storage and secondary recovery. A total of 506 wells (exploratory and development) were completed in 1964, compared with 591 in 1963.

The ratio of discoveries to exploratory tests increased to 1:19 in 1964 from 1:13 in 1963. Twelve discoveries were made in 1964 of which eight wells were in the Devonian geologic system, three in the Mississippian, and one in the Silurian.

Petroleum was produced in 43 counties in 1964, all in the lower peninsula. Twelve refineries had a nominal crude-oil refining capacity of 184,000 barrels per day.

Fluid injection was used in producing about 3.6 million barrels of petroleum and 1.5 billion cubic feet of gas. More than 45 million barrels of fluid, mostly brines, were injected into producing formations through 327 wells. From the same fields, more than 45 million barrels of fluid, nearly all brine, was produced.

REVIEW BY COUNTIES

Mineral production was reported from all counties in Michigan. The value of output increased in 46 counties and decreased in 37 counties. More than $1 million in minerals was produced in each of 43 counties. Marquette County led in value of production.

Allegan.—About 1 million tons of sand and gravel was produced by several commercial operators and the county road commission. Owing to decreased demand for road materials, output was reduced by about half a million tons. Four pits yielded marl for agricultural use. Natural gas production fell to 438 million cubic feet, 29 percent less than in 1963, while petroleum output declined to 250,000 barrels from 262,000 in the previous year. Small quantities of reed-sedge and moss peat were dug from bogs near Middleville and Wayland. It was sold in bulk for soil improvement and for packing plants, shrubs, etc.

TABLE 13.—Value of mineral production in Michigan, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value
Alcona	$158,935	$178,000	Sand and gravel.
Alger	54,253	69,000	Do.
Allegan	1,860,432	[2] 1,347,433	Petroleum, sand and gravel, peat, stone, natural gas.
Alpena	W	W	Cement, stone, clays, sand and gravel.
Antrim	204,664	216,986	Clay, sand and gravel.
Arenac	1,315,214	1,247,038	Petroleum, stone, sand and gravel.
Baraga	242,320	44,850	Sand and gravel, stone.
Barry	406,172	443,214	Sand and gravel, petroleum, stone.
Bay	7,585,143	8,359,197	Cement, petroleum, lime, sand and gravel.
Benzie	139,901	13,000	Sand and gravel.
Berrien	567,968	1,072,741	Sand and gravel, stone.
Branch	94,622	102,920	Do.
Calhoun	8,081,390	[2] 6,782,895	Petroleum, sand and gravel, stone, natural gas.
Cass	370,244	270,749	Sand and gravel, petroleum, stone.
Charlevoix	23,469	42,000	Sand and gravel.
Cheboygan	246,165	202,189	Sand and gravel, stone.
Chippewa	4,236,858	3,324,830	Stone, sand and gravel.
Clare	1,579,679	[2] 1,736,725	Petroleum, sand and gravel, natural gas.
Clinton	269,239	319,604	Sand and gravel, clays.
Crawford	417,593	[2]264,145	Petroleum, sand and gravel, natural gas.
Delta	195,834	170,146	Sand and gravel, stone.
Dickinson	12,252,971	17,808,288	Iron ore, sand and gravel, stone.
Eaton	548,814	505,861	Stone, sand and gravel, clays, peat.
Emmet	9,810,176	8,968,440	Cement, stone, sand and gravel.
Genesee	746,675	709,376	Sand and gravel, petroleum.
Gladwin	1,248,025	1,315,528	Petroleum, sand and gravel.
Gogebic	6,696,225	11,680,042	Iron ore, sand and gravel.
Grand Traverse	84,226	106,000	Sand and gravel.
Gratiot	W	W	Salines, salt, sand and gravel, petroleum, natural gas.
Hillsdale	12,773,619	[2] 14,741,652	Petroleum, sand and gravel, stone, natural gas.
Houghton [3]	47,586,022	45,959,919	Copper, sand and gravel.
Huron	1,046,163	978,621	Stone, sand and gravel, lime, petroleum.
Ingham	1,005,097	972,096	Sand and gravel, peat.
Ionia	217,362	382,000	Sand and gravel.
Iosco	4,349,206	4,822,188	Gypsum, sand and gravel.
Iron	24,451,943	23,514,489	Iron ore, sand and gravel.
Isabella	1,467,209	[2] 1,742,337	Petroleum, sand and gravel, stone, natural gas.
Jackson	6,999,256	[2] 5,844,547	Do.
Kalamazoo	1,184,488	1,250,698	Sand and gravel, stone, peat.
Kalkaska	68,245	72,043	Petroleum, sand and gravel.
Kent	3,945,931	[2] 3,686,003	Sand and gravel, gypsum, petroleum, peat, natural gas.
Keweenaw	(4)	(4)	Copper, sand and gravel, stone.
Lake	56,098	110,968	Sand and gravel, petroleum.
Lapeer	1,287,262	1,682,723	Peat, salines, sand and gravel, petroleum.
Leelanau	100,828	51,000	Sand and gravel.
Lenawee	1,154,032	1,418,847	Cement, sand and gravel, peat, clays, petroleum.
Livingston	2,901,954	[2] 2,736,000	Sand and gravel, natural gas.
Luce	50,220	40,000	Sand and gravel.
Mackinac	W	W	Stone, sand and gravel.
Macomb	2,657,366	[2] 2,028,025	Sand and gravel, petroleum, natural gas.
Manistee	16,507,558	18,909,056	Salines, salt, sand and gravel.
Marquette	W	W	Iron ore, sand and gravel.
Mason	W	W	Salines, lime, sand and gravel, petroleum, natural gas.
Mecosta	190,627	[2] 248,123	Sand and gravel, petroleum, peat, stone, natural gas.
Menominee	673,832	781,177	Lime, sand and gravel.
Midland	W	W	Salines, salt, petroleum, sand and gravel, natural gas.
Missaukee	1,466,781	[2] 1,265,072	Petroleum, sand and gravel, natural gas.
Monroe	W	W	Cement, stone, clays, petroleum, peat.
Montcalm	1,119,196	[2] 1,077,159	Petroleum, sand and gravel, natural gas.
Montmorency	97,888	76,211	Sand and gravel, petroleum.
Muskegon	2,077,078	[2] 1,915,869	Salt, sand and gravel, petroleum, natural gas.
Newaygo	227,599	[2] 170,608	Sand and gravel, petroleum, stone, natural gas.
Oakland	6,839,509	[2] 7,393,223	Sand and gravel, peat, petroleum, natural gas.
Oceana	1,236,000	855,040	Petroleum, sand and gravel.
Ogemaw	1,091,672	[2] 1,035,098	Petroleum, sand and gravel, natural gas.
Ontonagon	(4)	(4)	Copper, silver, sand and gravel.
Osceola	985,614	[2] 887,699	Petroleum, sand and gravel, stone, natural gas.
Oscoda	53,148	28,055	Sand and gravel, petroleum.
Otsego	29,714	[2] 52,000	Sand and gravel, natural gas.
Ottawa	2,567,226	[2] 2,627,931	Sand and gravel, petroleum, stone, natural gas.
Presque Isle	W	W	Stone, sand and gravel.
Roscommon	667,528	[2]714,813	Petroleum, sand and gravel, natural gas.
Saginaw	452,054	480,329	Clays, petroleum, lime, sand and gravel.
St. Clair	16,486,562	[2] 16,183,055	Salt, cement, petroleum, sand and gravel, clays, peat, natural gas.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Michigan, by counties[1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
St. Joseph	W	$211,300	Sand and gravel, stone, peat.
Sanilac	$966,130	1,148,822	Peat, sand and gravel, lime.
Schoolcraft	95,981	71,000	Sand and gravel.
Shiawassee	369,228	671,032	Sand and gravel, clays, peat.
Tuscola	2,003,801	2,209,389	Sand and gravel, petroleum, lime, peat.
Van Buren	355,564	323,459	Sand and gravel, petroleum, stone.
Washtenaw	1,332,645	[2] 938,456	Sand and gravel, petroleum, natural gas.
Wayne	41,805,111	[2] 47,394,260	Lime, cement, salt, sand and gravel, clays, stone, petroleum, salines, natural gas.
Wexford	59,275	114,000	Sand and gravel.
Undistributed [5]	r 219,532,171	268,377,411	
Total	r 492,029,000	555,495,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data.
[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 and Ontonagon Counties.
[4] Value of mineral production is included in that of Houghton County.
[5] Includes values for natural gas, natural gas liquids, gem stones, and some petroleum (1963), and some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

Alpena.—Huron Portland Cement Co., subsidiary of National Gypsum Co., produced portland and masonry cements at the world's largest cement plant at Alpena. During the year, ground was broken for construction of a second 460-foot kiln to be operational by mid-1965. Cement clinker production was to be increased by 2 million barrels per year. This was one phase of an expansion plan that will increase the Alpena plant capacity to 24 million barrels per year by 1975. Clay and limestone for use at the cement plant were produced in the Alpena area. About half a million tons of sand and gravel for building and road use were produced in the county.

Antrim.—Shale was mined for use in manufacturing cement at the Petoskey plant of Penn-Dixie Cement Corp. The county road commission produced gravel for road use.

Arenac.—Nearly 331,000 barrels of petroleum was recovered from nine fields, with the Deep River, Sterling, and Clayton fields producing the major portion. Sand and gravel for building, paving, and fill, and crushed limestone for highway use were produced in the county.

Baraga.—Sandstone for use in building construction was quarried and milled at Arnheim by Superior Natural Redstone Quarry. The county road commission produced sand and gravel for road use.

Barry.—About half a million tons of sand and gravel was mined from pits throughout the county. Marl for agricultural use was obtained from pits near Caledonia and Nashville. A small quantity of petroleum was recovered from the Hope and Johnstown fields.

Bay.—Aetna Portland Cement Co. produced portland and masonry cements at Bay City. The Monitor Sugar Division of the Robert Gage Coal Co. produced lime for use in sugar refining. About 352,000 barrels of petroleum was recovered from six fields, with Kawkawlin and Essexville fields contributing the major portion. Bay Refining, Division Dow Chemical Co., refined crude oil at Bay City. The State highway department contracted for production of road gravel.

Berrien.—Industrial sand (engine and molding) was mined near Bridgman and Sawyer. Sand and gravel for building, paving, and fill was obtained from pits throughout the county. Nearly 1 million tons of material was produced. Marl was dug from two pits near Three Oaks.

Branch.—Sand and gravel, used principally for building, paving, and fill, was produced at plants principally in the vicinities of Coldwater and Union City. Marl for agricultural use was dug from pits near Fremont and Kinderhook and dipped from a lake near Colon.

Calhoun.—Although petroleum production dropped nearly half a million barrels, the county maintained its second place in output, with production of 2.3 million barrels. About 3.9 billion cubic feet of natural gas was produced, slightly less than in 1963. About 635,000 tons of sand and gravel for building, road construction, and fill was produced, about triple the amount reported in 1963. Marl was obtained from pits near Burlington and Union City and sold for agricultural use.

Cass.—The Jefferson field yielded about 9,000 barrels of petroleum, a decrease from 15,000 barrels in 1963. Marl was obtained from five pits and sold for agricultural use. Sand and gravel was produced from fixed plants in the Dowagiac and Niles areas and at portable plants at several sites in the county.

Cheboygan.—Limestone was quarried and crushed at two plants near Afton. It was sold for flux, roadstone, and agricultural use. Approximately 220,000 tons of sand and gravel was produced in the county, mostly with portable plants. Much of it was used for road construction and maintenance.

Chippewa.—Fluxstone, roadstone, and agricultural limestone were produced from a large quarry and crushing plant on Drummond Island. Sand and gravel production dropped sharply from that of 1963 as demand for road materials declined.

Clare.—Petroleum production of 614,000 barrels was reported from 12 fields. A major portion came from the Hamilton field. Gas production of nearly 193 million cubic feet was about the same as in 1963. A small quantity of road gravel was produced.

Clinton.—Clay, used in the manufacture of vitrified sewer pipe, was mined near Grand Ledge. About 361,000 tons of sand and gravel was produced for fill, paving, and building purposes. Harmon Sand & Gravel Co. of St. Johns and Floyd Lindsey, Maple Rapids, reported production for the first time in 1964.

Crawford.—Beaver Creek field yielded about 85,000 barrels of oil and 440 million cubic feet of natural gas. The State highway department and county road commission produced or contracted for gravel for fill and road construction and maintenance.

Delta.—Bichler Bros. of Escanaba quarried and crushed limestone for concrete aggregate and roadstone, and produced sand and gravel for building and road use. A large quantity of road materials, mostly gravel, was produced at other plants at several sites in the county.

Dickinson.—The Hanna Mining Co. operated the Groveland open-pit iron mine, concentrator, and pelletizing plant near Randville. The company installed a scavenger circuit to treat a portion of the tailings material.

Superior Rock Products Co. operated a quarry near Randville and produced limestone for use as terrazzo and ornamental concrete. Felch Quarry Co. operated a limestone quarry near Felch and produced material for roofing granules and other uses. Sand and gravel was produced for building and road use.

Eaton.—Clay was mined near Grand Ledge and used in the manufacture of vitrified sewer pipe. Cheney Limestone Co. quarried limestone at Bellevue and produced rubble, roadstone, and agricultural limestone. Reed-sedge peat was dug from a bog near Charlotte and sold for soil improvement. About 324,000 tons of sand and gravel was obtained from pits throughout the county. Much of the material was used for road construction and maintenance.

Emmet.—Penn-Dixie Cement Corp. produced portland and masonry cements at Petoskey. The company began an extensive modernization and expansion program during 1964 that included construction of a 525-foot kiln and raw mill to replace four existing kilns and raw mills, filtering tanks, and waste heat system. Plant capacity will be increased to 3 million barrels annually when construction is completed in 1965. Limestone was quarried near the plant for use in manufacturing cement. Gravel for road use was mined in the county.

Genesee.—About 926,000 tons of sand and gravel was produced in the county at six fixed plants and at four portable plants. The material was used for building and road construction and fill. The Otisville field yielded a small quantity of petroleum.

Gladwin.—Nearly half a million barrels of petroleum was produced from 13 fields, with the Grout and North Buckeye fields having the largest output. A small amount of sand and gravel was produced near Gladwin.

Gogebic.—Pickands Mather & Co. produced direct-shipping iron ore from two underground mines, Geneva and Peterson, the only active iron mines remaining on the Gogebic Range. Output was substantially greater than in 1963. Sand and gravel production totaled 280,000 tons and was used mainly for building and road construction.

Gratiot.—Michigan Chemical Corp. produced bromine, calcium-magnesium chloride, magnesium compounds, and salt from natural well brines at St. Louis. During the year construction was started on a $2 million plant to produce granular calcium chloride. Initial capacity of 40,000 tons per year was planned with operations to start in the spring of 1965. The plant will furnish the basis for expansion of other brine chemical products of the company, but the principal market for the output was expected to be calcium chloride for ice control on highways. Leonard Refineries, Inc., operated a crude oil refinery at Alma. The company also recovered byproduct sulfur using the hydrofining process. About 67,000 barrels of petroleum was produced from the Sumner field. A small quantity of natural gas was recovered from the North Star field. Production of 412,000 tons of sand and gravel was reported by five operators.

Hillsdale.—The county continued to lead the State in petroleum output with more than 5 million barrels reported, 800,000 barrels more than in 1963. Nearly 4 billion cubic feet of natural gas was produced. During the year 82 wells were completed in the county; 54 were dry holes and 28 were oil wells.

Marl for agricultural use was produced near Hillsdale. About 535,000 tons of sand and gravel was produced, mostly for building and road construction and maintenance.

Houghton.—Copper was produced by Calumet & Hecla, Inc., Copper Range Co., and Quincy Mining Co. Calumet & Hecla operated the Centennial No. 2, Centennial No. 3, Osceola No. 13, and Kingston mines. At the Kingston mine, construction on the surface installation neared completion at yearend, and underground development was expected to be completed by the middle of 1965. The company also operated a smelter near Hubbell and the Tamarack Reclamation plant. Copper Range Co. operated the Champion mine and Freda mill, which treated the Champion ore as well as tailings from the Redridge sands.

Quincy Mining Co. operated a reclamation plant at Hubbell and a smelter at Hancock. The company had taken action through the Quincy Mine Hoist Association to preserve the buildings and equipment connected with the No. 2 shaft, sunk in 1857. The project, to be completed and open to the public by June 1966, included the hoist, an observation floor on the No. 2 shaft house, and a scenic railroad using the rolling stock of the old narrow gage Quincy & Torch Lake Railroad.

The Limestone Mountain Co. quarry was idle in 1964. Sand and gravel for building and paving was produced in the county.

Huron.—Hydrated lime for use in sugar refining was produced by the Michigan Sugar Co. at Sebewaing. The Wallace Stone Co. (Division J. P. Burroughs & Son, Inc.) quarried and processed limestone at Bay Port. The material was used for rubble, riprap, roadstone, railroad ballast, and agricultural limestone.

Sand and gravel used mostly for building and paving was produced at several sites. A small quantity of petroleum was recovered from the Dwight and Grant fields.

Ingham.—More than 1.1 million tons of sand and gravel was produced, principally in the Holt, Lansing, and Mason areas. It was used mostly for road construction and maintenance, building, and fill. The Lansing Board of Water & Light recovered lime from calcium carbonate precipitated in the water purification process. A small quantity of reed-sedge peat was produced from a bog near Lansing by Winn's Peat Corp.

Iosco.—National Gypsum Co. quarried gypsum at Tawas City and processed crude ore at a plant at National City. At the same plant crude perlite, mined in New Mexico, was expanded for use in building plaster. United States Gypsum Co. operated a gypsum quarry at Alabaster. The material was used in manufacturing wallboard and other building products in plants at Detroit and Grand Rapids. Michigan Gypsum Co. operated a quarry near Whittemore. The crude material was sold as a cement retarder.

Road material was produced with a portable plant from a gravel pit near Greenbush.

Iron.—The Hanna Mining Co. mined and shipped iron ore from the Wauseca, Hiawatha, and Homer underground mines. On November 20, mining ceased at Shaft No. 1 of the Hiawatha mine owing to depletion of ore. Inland Steel Co. operated the Bristol and Sherwood mines.

Over half a million tons of sand and gravel was produced at several locations. The sand was produced by The Hanna Mining Co. for filling stopes at their mines in the county. The gravel was used for road construction.

Isabella.—Petroleum output declined to 362,000 barrels from 402,000 in 1963. Production was reported from 11 fields. The Wise field yielded a small quantity of natural gas. Leonard Refineries, Inc., refined crude oil at Mount Pleasant.

Nearly 1 million tons of sand and gravel was mined from pits at several sites. It was used for fill, building, and paving. Gatehouse Brothers produced marl from a site near Weidman.

Jackson.—Petroleum output declined for the third year to about 1.9 million barrels from 2.3 million in 1963. Natural gas production of 2 billion cubic feet was nearly as great as in the previous year.

About 680,000 tons of sand and gravel was produced, mostly for building and paving purposes. Limestone was quarried and crushed near Parma for concrete aggregate, roadstone, and agricultural use. Marl was dug from a pit near Horton. Sandstone for use mostly as building stone, flagging, and rubble was quarried and milled at three sites near Napoleon.

Kalamazoo.—Reed-sedge peat was dug from bogs near Kalamazoo and Scotts and sold for general soil improvement. Marl, for agricultural use, was obtained from pits in the Climax and Vicksburg areas. Nearly 1.3 million tons of sand and gravel was produced principally for use in road construction and maintenance.

Kalkaska.—Petroleum was recovered from the Beaver Creek and Excelsior fields. No natural gas production was reported during 1964. The county road commission mined sand and gravel for its own use.

Kent.—Gypsum was produced from underground mines by Bestwall Gypsum Co. and Grand Rapids Gypsum Co. The crude material was processed at company-owned plants and used in manufacturing wallboard, plaster, and other building products.

Perlite, mined in Nevada, was expanded at the Bestwall plant and used in plaster. Nearly 2.7 million tons of sand and gravel was produced, mostly in the Grand Rapids area. Peat was dug from bogs and sold for soil improvement and horticultural use. Petroleum and natural gas were recovered with the Walker field yielding the major portion.

Keweenaw.—Sand and gravel was produced by the county road commission for its own use. The National Park Service dredged basalt and sandstone at Isle Royale for use at Isle Royale National Park, which is located in the county.

Copper produced by Calumet & Hecla, Inc., from the No. 4 Ahmeek Peninsula, Allouez No. 3, and Seneca mines is included with Houghton County.

Lapeer.—Calcium-magnesium chloride was extracted from well brines at Mayville by Wilkinson Chemical Corp. Several peat bogs, near Imlay City, yielded reed-sedge peat for soil improvement and horticultural use. Production of 341,000 tons of sand and gravel was reported; most was for road use. About 35,000 barrels of petroleum was recovered from the Rich field.

Lenawee.—Portland cement was manufactured at Cement City by Peninsular Portland Cement Division of General Portland Cement Co.

Comfort Brick & Tile Co. manufactured draintile from clay mined near Tecumseh. Reed-sedge peat was dug from bogs near Adrian and Tecumseh.

About half a million tons of sand and gravel was produced at several sites in the county. Principal use was for road construction and repair. The Macon Creek and Medina fields yielded a small quantity of petroleum.

Mackinac.—Inland Lime & Stone Co., Division of Inland Steel Co., operated the Port Inland quarry. On July 30, the company shipped its 100th million ton of high calcium limestone from its Upper Peninsula operation. United States Steel Corp. operated the Cedarville limestone quarry. Both companies maintain large processing plants, as well as port facilities for shipping the material by water transport to industrial consumers. Road materials, mostly gravel, were mined at several sites in the county. Output was only one-third of the 1963 shipments.

Macomb.—Sand and gravel production totaled 2.8 million tons, compared with 3.5 million in 1963. The decline reflects decreased demand for building and road materials in the northeastern portion of the Detroit metropolitan area. Natural gas output tripled to 5.3 billion cubic feet from 1.7 billion in 1963. Production came from the Lenox and Ray fields. A small quantity of petroleum was recovered.

Manistee.—Bromine, calcium-magnesium chloride, and magnesium compounds were extracted from natural well brines of the Filer formation. Salt was recovered from artificial brines. In the Manistee area plants were operated by Great Lakes Chemical Corp., Manistee Salt Works, Michigan Chemical Corp., Morton Chemical Co., Morton Salt Co., and Standard Lime & Cement Co. Packaging Corp. of America produced regenerated lime for its own consumption by calcining calcium carbonate sludge in a rotary kiln.

Nearly half a million tons of sand and gravel was produced. The gravel was used mostly for road construction and maintenance, while the sand was sold for industrial purposes.

Marquette.—The county maintains first position in the State in value of minerals produced. Iron ore mines were operated by Cleveland-Cliffs Iron Co., Jones & Laughlin Steel Corp., and North Range Mining Co. Cleveland-Cliffs' $50-million Empire mine complex, near Negaunee, had its first full year of operation. The annual rated capacity is 1.2 million tons of pellets with iron content in excess of 63 percent. The Empire beneficiating plant is the first in the United States to use full autogenous mills, grinding 90 percent of the magnetic ore to 500 mesh. Flotation was used to upgrade the concentrate. The single-line grate kiln pelletizing system is the largest in the world. County iron ore shipments were up 36 percent. The output of underground mines was up 20 percent and open-pit mines 46 percent. Sand and gravel production totaled 658,000 tons and was used for building and road construction, railroad ballast, and fill.

Mason.—Chemicals (bromine, calcium chloride, calcium-magnesium chloride, and magnesium compounds) were extracted from well brines

in the Ludington area by the Dow Chemical Co. Harbison-Walker Refractories Co. produced refractory magnesia from purchased magnesium hydroxide. Industrial sand (molding, grinding, polishing, and engine) as well as road gravel were produced.

The Dow Chemical Co. produced quicklime at Ludington. About 230,000 barrels of petroleum was produced from six fields. About 13 million cubic feet of natural gas was produced from the Logan field.

Mecosta.—Reed-sedge peat was dug from a bog near Lakeview and marl from pits near Mecosta. Both were sold for soil enrichment and improvement. Sand and gravel was mined throughout the county, mostly with portable equipment. Principal uses were for building and road construction. About 26,000 barrels of oil and 129 million cubic feet of natural gas were recovered from fields in the county.

Menominee.—Limestone Products Division of North Western-Hanna Fuel Co. produced quicklime and hydrated lime at Menominee. The lime was used in the manufacturing or processing of a wide range of industrial and chemical products. Nearly half a million tons of sand and gravel was produced, mostly for road construction and maintenance.

Midland.—Bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, and potash were recovered from natural well brines at Midland by The Dow Chemical Co. The company also recovered salt from artificial brines. Kaiser Aluminum & Chemical Corp. produced refractory magnesia from purchased magnesium hydroxide. Molding sand and sand and gravel for building and paving were produced near Midland. About 260,000 barrels of petroleum and 8 million cubic feet of natural gas were produced in the county.

Missaukee.—About 449,000 barrels of petroleum and 1.2 billion cubic feet of natural gas were recovered, principally from the McBain, East Norwich, Enterprise, Falmouth, and Forward fields. A small quantity of road gravel was produced for the State highway department.

Monroe.—Portland and masonry cements were produced by Dundee Cement Co. Raw materials (clay and limestone) were mined at the plant site. Clay for art pottery was mined near South Rockwood by F. W. Ritter Sons Co. Limestone for flux, roadstone, ballast, and agricultural use was quarried and crushed at Maybee, Monroe, and Ottawa Lake.

Humus and reed-sedge peat was dug from bogs near Ida and Petersburg and used for soil improvement. About 8,000 barrels of petroleum was produced, mostly from the Deerfield field.

Montcalm.—About 285,000 barrels of petroleum and 89 million cubic feet of natural gas were produced from a dozen fields. Largest output was reported from the Edmore and Reynolds fields. Sand and gravel output more than doubled to 569,000 tons because of increased demand for road use. Crude oil was refined by Crystal Refining Co. at Carson City.

Muskegon.—At Montague, Hooker Chemical Corp. recovered salt from artificial brines, and Union Carbide Corp. produced hydrated lime as a byproduct at their acetylene producing operation. The hy-

drated lime was sold for construction, agricultural, and industrial uses. About 631,000 tons of sand and gravel was produced. In addition to sand and gravel for building and road construction, a considerable tonnage of industrial sand was produced.

About 10,000 barrels of petroleum and 9 million cubic feet of natural gas were produced from several small fields. Crude oil was refined at Muskegon by Marathon Oil Co. and Naph-Sol Refining Co.

Newaygo.—Natural gas production at the Ensley field dropped to 51 million cubic feet from 119 million in 1963. About 21,000 barrels of petroleum was recovered from six fields. A pit near Grant yielded marl for agricultural use. Approximately 214,000 tons of sand and gravel was produced throughout the county, mostly with portable plants. Output was chiefly for building and road construction.

Oakland.—More than 8.1 million tons of sand and gravel was produced, the largest output of any county in the State. The material was used principally for building and road construction in the Detroit metropolitan area.

Humus and moss peat was dug from bogs in the Clarkston, New Hudson, and Novi areas. It was sold for soil improvement. The Northville field (Oakland County portion) yielded small quantities of petroleum and natural gas.

Oceana.—About 170,000 barrels of petroleum was produced from nine fields with the largest output reported from the Eldridge and Pentwater fields. Over 700,000 tons of sand and gravel was produced, mostly for road construction and maintenance.

Ogemaw.—Petroleum (336,000 barrels) and natural gas (645 million cubic feet) were produced. Nearly all production came from the Rose City and West Branch fields. Osceola Refining Co. refined crude oil at West Branch. About 237,000 tons of sand and gravel was produced.

Ontonagon.—White Pine Copper Co. (subsidiary of Copper Range Co.) operated a mine, mill, and smelter at White Pine. Output of both copper and silver was reduced chiefly because of a 7-week labor strike. In May a fire in the White Pine mine stopped production for 10 days. Exploratory drilling during 1964 indicated 60 million tons of additional reserves. Development of the longwall mining program continued. One longwall panel has been in operation for nearly a year on an experimental basis and is heavily instrumented to provide data on the behavior of rock under conditions created by the method. A second panel is planned for 1965.

About 398,000 tons of sand and gravel was produced in the county and used for road construction and maintenance.

Osceola.—Petroleum output totaled 265,000 barrels, and 219 million cubic feet of natural gas was produced from nine fields. Marl was dug from a pit near Tustin. About 224,000 tons of sand and gravel was produced from pits near Evart and Hersey.

Ottawa.—Nearly 2.1 million tons of sand and gravel was produced. Although most of the material was used for building, paving, and fill, some industrial sand was included. A small amount of marl was obtained from pits in the Hudsonville and Jenison areas.

About 267,000 barrels of petroleum was produced at five fields with the Dennison and Walker fields accounting for most of the output. Natural gas output totaled 170 million cubic feet.

Presque Isle.—Crushed limestone was produced at Rogers City by United States Steel Corp., and at Alpena by Presque Isle Corp. The material was shipped by water to steel mills, cement plants, and other industrial consumers. Large quantities were also sold for concrete aggregate, roadstone, and agricultural purposes. At Onaway, a small quantity of dimension limestone was milled mainly for building use by Onaway Stone Co.

More than half a million tons of sand and gravel was produced, mostly for road material.

Roscommon.—Nearly 1 billion cubic feet of natural gas and 193,000 barrels of petroleum were recovered. Most of the production came from the Headquarters and St. Helen fields. About 349,000 tons of sand and gravel was produced, nearly all with portable plants.

Saginaw.—Aetna Portland Cement Co. mined clay near Saginaw for use in manufacturing cement. Michigan Sugar Co. produced hydrated lime for use in sugar refining. Petroleum totalling 32,000 barrels was produced from five fields. Paving sand and gravel was produced for the State highway department.

St. Clair.—Peerless Cement Co., Division of American Cement Corp., produced portland and masonry cements at Port Huron. Clay was mined at the Smith Creek pit for use at the plant. Salt was recovered from artificial brines by Diamond Crystal Salt Co. at St. Clair and by Morton Salt Co. at Marysville. Reed-sedge peat was obtained from a bog near Capac. About 403,000 tons of sand and gravel was produced for building and paving use. Nearly 883,000 barrels of petroleum and 12.3 billion cubic feet of natural gas were recovered from 12 fields. The county natural gas output was the largest in the State.

St. Joseph.—Reed-sedge peat was dug from a bog near Three Rivers and sold for soil improvement. In the same area and at Nottawa, marl was obtained from pits and sold for agricultural use. Sand and gravel for building and road use was produced at several sites in the Three Rivers and White Pigeon areas.

Sanilac.—Peat was produced at Minden City and Sandusky. It was sold both in bulk and in packaged form for soil improvement and as a potting material. Michigan Sugar Co. produced hydrated lime at Croswell for use in sugar refining. About 673,000 tons of sand and gravel was produced, much of it for road material.

Shiawassee.—Clay was mined at Corunna for use in manufacturing vitrified sewer pipe. Reed-sedge peat was obtained from a bog near Ovid. About 720,000 tons of sand and gravel was produced; this was double the amount reported in 1963.

Tuscola.—Michigan Sugar Co. produced hydrated lime at Caro for sugar refining. Moss peat was dug at Kingston and sold for soil improvement. Nearly 1.9 million tons of sand and gravel was produced. Although much of the material was sold for building and road construction, a substantial quantity of molding sand was reported. More than 82,000 barrels of petroleum was recovered from four fields.

Van Buren.—Industrial sand (molding and engine) was produced at Covert and South Haven, while road gravel was produced with portable plants at sites throughout the county.

A pit near Paw Paw yielded marl for agricultural use. About 24,000 barrels of petroleum was recovered at four fields.

Washtenaw.—About 921,000 tons of sand and gravel was produced, compared with 1.5 million in 1963, reflecting a lessened demand for road construction materials.

About 31,000 barrels of petroleum and 216 million cubic feet of natural gas were produced from the Northville field.

Wayne.—The county ranked third in value of mineral production, and the total was $5.6 million greater than in 1963. Sand and gravel output totaled over 4.3 million tons, nearly twice the production reported in 1963. Material for road construction and maintenance accounted for much of the increase.

Salt was mined at Detroit by International Salt Co., Inc., and recovered from artificial brines at Wyandotte by Pennsalt Chemicals Corp. and Wyandotte Chemicals Corp.

Portland and masonry cements were produced at two plants in Detroit by Peerless Cement Co., Division of American Cement Corp. The company mined clay for cement at Allen Park. Wyandotte Chemicals Corp. produced portland cement at Wyandotte. Clay was mined at Livonia and used in producing lightweight aggregates. Draintile was manufactured from clay mined at Flat Rock.

Quicklime was produced in Detroit by Solvay Process Divison of Allied Chemical Corp. and at Wyandotte by Wyandotte Chemicals Corp. Marblehead Lime Co. started construction in the River Rouge area of a lime plant with a designed annual capacity of 700,000 tons.

Calcium chloride was produced for company use and for sale by Wyandotte Chemicals Corp. Limestone was produced by the Michigan Foundation Quarry Co., Inc., for concrete aggregate and roadstone.

United States Gypsum Co. operated a calcining and board plant in Detroit. The company also expanded perlite at the Detroit plant. Zonolite Division, W. R. Grace & Co., exfoliated vermiculite at a plant in Dearborn. Marathon Oil Co. recovered byproduct sulfur from crude oil, using the Parsons process, at its Detroit refinery. A crude oil refinery was also operated by Socony-Mobile Oil Co. at Trenton. According to data published by the Michigan Geological Survey,[4] the crude oil refinery of Petroleum Specialities, Inc., at Flat Rock was inactive. The Wayne County portion of the Northville field yielded 16,000 barrels of petroleum and 376 million cubic feet of natural gas.

[4] Geological Survey Division, Michigan Department of Conservation. Annual Statistical Summary 2, Michigan's Oil and Gas Fields, 1964. 1965, 17 pp.

The Mineral Industry of Minnesota

By L. F. Heising [1] and M. G. Sikich [2]

MINNESOTA continued as the leading iron ore producing State, supplying 59 percent of the total usable ore shipped from mines in the United States. Iron-bearing ores (including manganiferous ores) accounted for 91 percent of the total value of the State's mineral production. Shipments of taconite concentrate increased by 14 percent to reach a record 19.1 million tons.

Increases in total value were recorded for sand and gravel, stone, peat, grinding pebbles, and portland cement. Masonry cement increased in quantity, but value decreased slightly. Value and quantity decreases were recorded for lime and manganiferous ore.

TABLE 1.—Mineral production in Minnesota [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	199	$298	213	$319
Iron ore (usable) thousand long tons, gross weight	45,435	408,486	49,626	449,289
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	347,336	W	188,481	W
Peat short tons	8,110	294	19,188	405
Sand and gravel thousand short tons	30,462	23,318	35,817	25,907
Stone do	3,898	11,027	3,588	12,297
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
Total	XX	453,543	XX	497,495

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 included with "Value of items that cannot be disclosed."

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

(Millions)

Year	Value	Year	Value
1953	$656	1959	$341
1954	408	1960	507
1955	572	1961	436
1956	548	1962	r 416
1957	593	1963	r 425
1958	394	1964	456

r Revised.

[1] Supervising mining engineer, Bureau of Mines, Minneapolis, Minn.
[2] Supervisory industry economist, Bureau of Mines, Minneapolis, Minn.

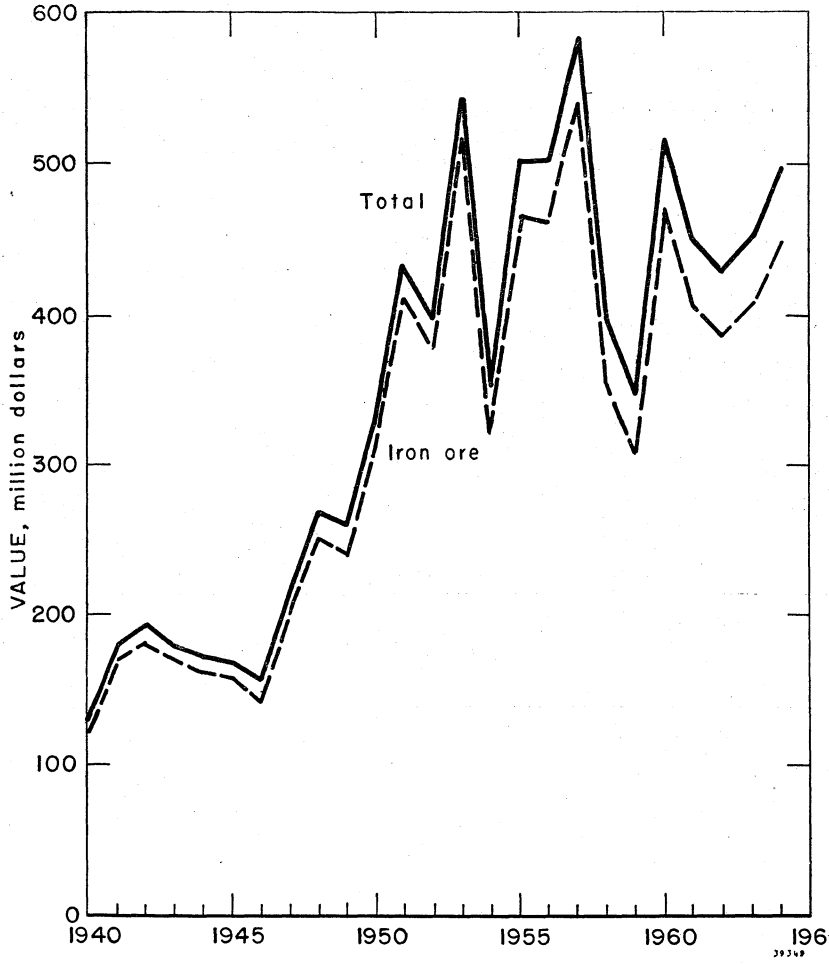


FIGURE 1.—Value of iron ore shipments and total value of mineral production in Minnesota.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	8,696	2,369	18,952	3	67	4
Nonmetal	216	56	450		35	78
Sand and gravel	2,360	377	3,228	2	43	14
Stone	1,623	414	3,426	1	65	19
Peat	63	6	45		1	22
Total	12,958	3,222	26,101	6	211	8
1964:[p]						
Metal	9,790	2,574	20,512	3	40	2
Nonmetal	220	57	460	1	28	63
Sand and gravel	2,550	403	3,441	2	38	12
Stone	1,780	459	3,905		95	24
Peat	88	6	47			
Total	14,428	3,499	28,365	6	201	7

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

METALS

Iron Ore.—Shipments of taconite concentrate set a new record high of 19.1 million tons, about 2.4 million tons above 1963, and comprised 38 percent of the total shipments of iron ore. Erie Mining Co. (Pickands Mather & Co., operating agent) and Reserve Mining Co. each set new production records. The United States Steel Corp.

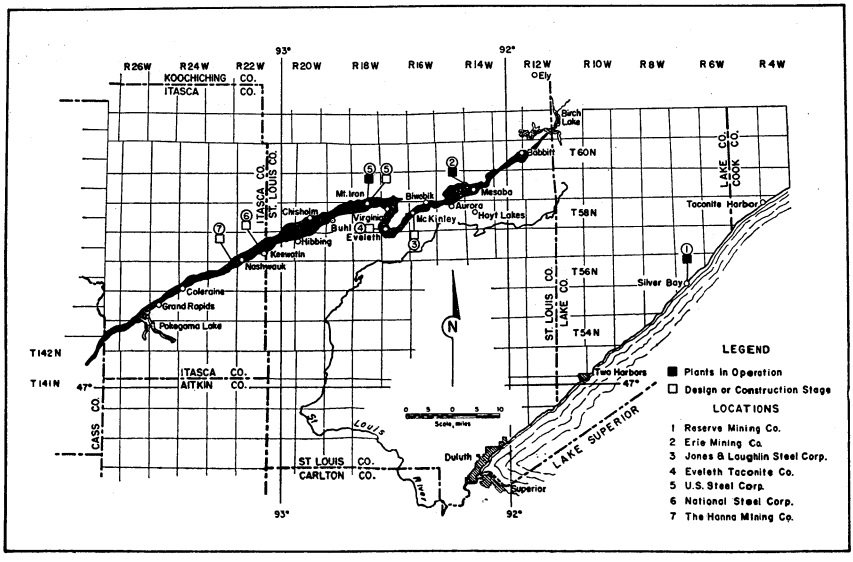


FIGURE 2.—Locations of currently operating and proposed Mesabi Range taconite-processing plants.

continued operations at its pilot taconite facilities near Mountain Iron.

An amendment to the Minnesota State Constitution, approved by voters in the November election, guaranteed the taconite industry certain taxation limitations for a period of 25 years. After the passage of the amendment, United States Steel Corp., National Steel Corp., and The Hanna Mining Co. (the latter in conjunction with Inland Steel Corp. and Wheeling Steel Corp.) announced plans to build taconite plants near Mountain Iron, Keewatin, and Cooley, respectively. Plants in the planning and initial construction phases have a proposed 10.5 million ton annual pellet capacity. Including presently operating plants and those announced, Minnesota will have in the near future a minimum of 30 million tons of annual taconite pellet capacity. Jones & Laughlin Steel Corp. was engaged in evaluating a magnetic taconite property near Biwabik.

The last active underground mine on the Mesabi Range, the Albany mine operated by the Pittsburgh Pacific Co., was closed indefinitely ending an era in Mesabi Range mining. At yearend a number of open pit mines were closed. New mines in development stages included the Thunderbird mine (Eveleth Taconite Co.) and the Dunka River mine (Pickands Mather & Co.), both future large-scale open pit taconite operations.

Early in the year, the Eveleth Taconite Co. started construction of a taconite concentrating plant near Forbes.

W. S. Moore and Northern Natural Gas Co. continued their research to develop a new roasting method to process low-grade nonmagnetic ores. The Hanna Mining Co. initiated a pilot-scale research program relative to production of prereduced pellets.

Lake Erie base prices for iron ore were unchanged from 1963. Average weighted mine value for Minnesota iron ore was $9.05 per ton, a slight increase in value per ton over 1963 due to a higher proportion of taconite concentrate shipped.

TABLE 4.—Crude iron ore[1] data, in 1964, 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 beneficiation plants	
County:						
Crow Wing	41	351	149	476		65
Fillmore [2]			774		774	
Itasca			26,810	109	26,702	
St. Louis	r 663	1,066	80,930	9,856	72,106	696
Total	r 704	1,417	108,663	10,441	99,582	761
Range:						
Cuyuna	41	351	149	476		65
Mesabi	r 663	29	107,741	9,965	97,771	696
Vermilion		1,036			1,036	
Spring Valley District			774		774	
Total [3]	r 704	1,417	108,663	10,441	99,582	761

r Revised.
[1] Exclusive of ore containing 5 percent or more manganese.
[2] Includes ore from three properties in Olmsted County.
[3] Data do not add to totals shown because of rounding.

TABLE 5.—Usable iron ore [1] data, in 1964, 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	81	513	252	530	65
Fillmore [2]	28	420	198	410	38
Itasca	1,283	9,657	5,343	9,565	1,374
St. Louis	r 3,512	38,464	21,866	39,121	2,855
Total	r 4,904	49,054	[3] 27,660	49,626	4,332
Range:					
Cuyuna	81	513	252	530	65
Mesabi	r 4,518	47,256	26,699	47,662	4,112
Vermilion	277	865	510	1,024	117
Spring Valley District	28	420	198	410	38
Total	r 4,904	49,054	[3] 27,660	49,626	4,332

r Revised.
[1] Exclusive of ore containing 5 percent or more manganese.
[2] Includes ore from three properties in Olmsted County.
[3] Data do not add to 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
1955–59 (average)	1,779	52,465	1,185	364	55,793
1960	1,166	54,442	1,361	473	57,442
1961	1,095	41,199	930	491	43,715
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

[1] Exclusive of iron ore containing 5 percent or more manganese.

TABLE 7.—Iron ore [1] shipped from Minnesota mines

(Thousand long tons)

Year	Crude ore to concentrators	Beneficiated			Total usable ore [2]	Proportion of beneficiated to total usable ore (percent)
		Agglomerates	Other	Total		
1955–59 (average)	56,369	6,234	19,090	25,324	55,665	45.49
1960	88,060	11,489	21,693	33,182	54,723	60.63
1961	79,825	14,366	17,698	32,064	44,699	71.73
1962	85,729	14,085	18,744	32,829	44,295	74.11
1963	93,082	16,857	21,110	37,967	45,435	83.56
1964	99,582	19,267	19,917	39,184	49,626	78.96

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Direct-shipping and beneficiated ore.

TABLE 8.—Dates of first and final cargoes of iron ore at U.S. upper Great Lakes ports

Port and dock	1963		1964	
	First	Final	First	Final
Ashland, Wis.:				
C&NW	May 19	Nov. 14	May 26	Oct. 23
Soo Line	do	do	do	Do.
Duluth, Minn.: DM&IR	Apr. 29	Nov. 11	Apr. 4	Nov. 24
Escanaba, Mich.: C&NW	Apr. 19	Dec. 16	Apr. 3	Dec. 18
Marquette, Mich.:				
Soo Line	May 21	Nov. 21	Apr. 29	Dec. 3
LS&I	Apr. 25	Dec. 5	Apr. 12	Dec. 13
Silver Bay, Minn.: Reserve	Apr. 23	do	Apr. 9	Dec. 11
Superior, Wis.:				
GN	Apr. 25	Dec. 11	Apr. 5	Do.
NP—Soo Line	Apr. 29	Oct. 24	Apr. 16	Oct. 27
Taconite Harbor, Minn.: Erie	do	Dec. 7	Apr. 2	Dec. 9

Source: Skillings' Mining Review.

Nearly all the iron ore shipped from Minnesota was for use in manufacturing pig iron and steel. Small quantities were sold for use in heavy-medium concentrators and for manufacturing paint and cement.

Approximately 97 percent of the ore shipped was hauled by rail from the mines to Lake Superior harbors, transported by vessel to lower Lake ports, and thence to consuming districts. The remainder was shipped all-rail to consumers. Some Minnesota ore was consumed at the Duluth plant of the American Steel & Wire Division of United States Steel Corp.

The Federal Area Redevelopment Administration and the Minnesota Iron Range and Rehabilitation Commission approved a technical assistance grant to the University of Minnesota Mines Experiment Station to help establish a pilot plant to demonstrate methods of upgrading low-grade Mesabi iron ores.

The Federal Bureau of Mines continued research on beneficiation of nonmagnetic taconites and semitaconites at its Minneapolis Research Center. Several reports and articles describing the Bureau's activities and results were published.[3]

Manganiferous Ore.—Ferruginous manganese ore shipments (containing 10 to 35 percent manganese, natural), which had increased sharply in 1963, decreased 46 percent in 1964. Manganiferous iron ore (containing 5 to 10 percent manganese, natural) was shipped mainly from stocks on hand from production of previous years.

Five Cuyuna Range mines, all in Crow Wing County, produced manganiferous ore. Stockpile shipments were made from the Robert mine. Producing companies were The Hanna Mining Co. and Pittsburgh Pacific Co. Pittsburgh Pacific Co. produced ore from the Alstead, Mangan No. 1, and Sultana-Hopkins mines.

The Federal Area Redevelopment Administration and the Minnesota Iron Range Resources and Rehabilitation Commission approved

[3] Frommer, D. W., M. M. Fine, and L. Bonicatto. Anionic Flotation of Silica from Western Mesabi and Menominee Range Iron Ores. BuMines Rept. of Inv. 6399, 1964, 25 pp. Fine, M. M., P. L. Woolf, and N. Bernstein. Experimental Production and Smelting of Prereduced Iron Ore Pellets. BuMines Rept. of Inv. 6523, 1964, 28 pp. Fine, M. M., and W. C. Wahl. Iron Ore Pellet Binders from Lignite Deposits. BuMines Rept. of Inv. 6564, 1964, 18 pp.

technical assistance grants to Cuyuna Range Mineral Research, Inc., to test Cuyuna Range low-grade, manganiferous iron ores. The A.R.A. and I.R.R.C. sponsored research at the University of Minnesota Mines Experiment Station to demonstrate the feasibility of producing a high-grade manganese product from Cuyuna Range tailing rejects resulting from the R–N direct reduction process.

The Federal Bureau of Mines continued research at its Minneapolis Research Center developing methods of utilizing Cuyuna Range low-grade manganese ores. A report describing techniques and results was published.[4]

The price of manganiferous ores (containing more than 5 percent manganese, natural) has been generally that of Old Range non-Bessemer iron ore. This price was based on the combined natural iron and manganese content, plus a premium for the natural manganese in excess of 5 percent.

TABLE 9.—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)	
1955–59 (average)	429,871	39.47	6.24	104,155	33.73	12.27	534,026
1960	345,426	38.97	7.15	48,349	34.37	12.74	393,775
1961	80,603	32.05	9.01	81,750	35.58	12.29	162,353
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

[1] Direct-shipping and beneficiated ore.

NONMETALS

Abrasive Stones.—Grinding pebbles and tube-mill liners were produced by Jasper Stone Co. from a quartzite quarry near Jasper, Rock County. Sales of grinding pebbles increased in both quantity and value, whereas sales of tube-mill liners increased in quantity but decreased in value.

Cement.—Portland and masonry cements were produced at Duluth by the Universal Atlas Cement Division of United States Steel Corp., the only producer in Minnesota. Increases were recorded for both quantity and value of portland cement shipments, but the value of masonry cements shipped dropped slightly from 1963. Portland cement output included types I and II (general use and moderate heat) and portland-slag cement. Raw materials used in manufacture of portland cement included limestone, sand, gypsum, slag, iron dust, air-entraining aids, and grinding aids. Shipments of portland and masonry cements were primarily to Minnesota, North Dakota, and Wisconsin, with lesser shipments to Michigan and South Dakota.

[4] Joyce, F. E., Jr., and Charles Prasky. Sulfatization of Manganese Minerals and Selected Gangue Materials. BuMines Rept. of Inv. 6514, 1964, 11 pp.

Several major companies constructed distribution plants in the Minneapolis-St. Paul metropolitan area to facilitate rapid truck delivery of bulk cement. Shipments to the distribution centers were generally by rail from producing plants.

Clays.—Total production of miscellaneous clay increased 7 percent in quantity over that of 1963. Chief reason for the gain was an increase in output of clay used in manufacturing lightweight aggregate. Output of fire clay decreased from 1963.

Clay production was reported from operations in Brown, Carlton, Goodhue, Ramsey, Redwood, and Hennepin Counties. Material was used for manufacture of lightweight aggregate, building brick, vitrified sewer pipe, floor and wall tile, and other products. Red Wing Potteries, Inc., produced dinnerware and art pottery at its plant at Red Wing, chiefly from raw materials produced in other States.

The Minnesota Geological Survey investigated sources of kaolin and other clays in Minnesota and published their findings in Reports of Investigations.[5]

Gem Stones.—Small 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. The material was used for handmade jewelry and for personal gem collections.

Lime.—Total output of lime decreased 10 percent in quantity and 11 percent in value from 1963. Lime was produced at Chaska, Carver County; at Moorhead, Clay County; and at Crookston and East Grand Forks, Polk County, by American Crystal Sugar Co. Quicklime produced by American Crystal Sugar Co., used for sugar refining, represented a substantial share of the total State lime production.

Cutler-Magner Co., the only commercial producer of lime, operated a plant at Duluth, using Michigan limestone. Most of the lime produced was consumed in Minnesota with lesser shipments to neighboring States. About 93 percent of the State total lime production was for chemical and other industrial uses.

Perlite.—Western Mineral Products Co. and Minnesota Perlite Corp. produced expanded perlite from raw material mined in Nevada and New Mexico. Sales of expanded perlite increased 39 percent over those in 1963. The expanded perlite was used as a lightweight aggregate in plaster and concrete, and for soil conditioning and other miscellaneous uses.

Sand and Gravel.—Production of sand and gravel exceeded by 18 percent the previous record high established in 1963 largely due to increased construction. Building use increased 8 percent; paving, 19 percent; fill, 39 percent; and railroad ballast, 17 percent over that of 1963. Special sands used in glass manufacture, molding, grinding and polishing, oil formation fracturing, sand blasting, and engine use increased 10 percent overall in quantity over that of 1963.

Production was reported from every county. The 10 major producing counties, which produced 47 percent of the total, in order of

[5] Parham, W. E., and R. K. Hogberg. Kaolin Clay Resources of the Minnesota River Valley-Brown, Redwood, and Renville Counties, A Preliminary Report. Minnesota Geological Survey Rept. of Inv. 3, 1964, 43 pp. Sloan, R. E. The Cretaceous System in Minnesota. Minnesota Geological Survey Rept. of Inv. 5, 1964, 64 pp.

production were: Hennepin, St. Louis, Washington, Otter Tail, Dakota, Polk, Ramsey, Itasca, Clay, and Rice. Major increases in production were reported from St. Louis and Itasca Counties. Sixty-four percent of the total output was supplied by 302 commercial operators; Government-and-contractor operations supplied the remainder. About 89 percent was shipped by truck, 5 percent by river barge, and 6 percent by rail.

Stone.—Total stone production decreased 8 percent, whereas value increased 12 percent, compared with 1963. The increase in value was attributed mainly to increased sales of dimension granite and limestone for architectural purposes.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,282	$2,591	3,488	$2,697
Paving	1,568	1,056	2,165	1,318
Fill	489	215	564	247
Molding	58	238	W	W
Railroad ballast	4	2	24	15
Other [1]	218	634	295	991
Total	5,619	4,736	6,536	5,268
Gravel:				
Building	2,414	3,416	2,682	3,763
Paving	10,836	8,258	12,161	8,285
Railroad ballast	384	198	431	251
Fill	447	295	942	513
Other	70	50	185	140
Total	14,151	12,217	16,401	12,952
Total sand and gravel	19,770	16,953	22,937	18,220
Government-and-contractor operations:				
Sand:				
Paving	2,056	1,096	2,535	1,381
Fill	49	23	158	54
Other	7	1	14	5
Total	2,112	1,120	2,707	1,440
Gravel:				
Building	26	14	------	------
Paving	8,090	5,061	9,902	6,154
Fill	393	146	258	88
Other	72	24	13	5
Total	8,581	5,245	10,173	6,247
Total sand and gravel	[2] 10,692	6,365	12,880	7,687
All operations:				
Sand	[2] 7,730	[2] 5,855	9,243	6,708
Gravel	22,732	17,462	26,574	19,199
Grand total	30,462	[2] 23,318	35,817	25,907

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes foundry (1963), blast, engine, filler, glass, grinding and polishing, oil (hydrafrac), pottery porcelain, tile, and other construction and industrial sands (1963-64), and molding sand (1964).
[2] Data do not add to total shown because of rounding.

Limestone was produced in 16 counties in the south-central and southeastern parts of the State. Major producing counties by value were Blue Earth, Winona, Le Sueur, Scott, Washington, and Olmsted. Dimension limestone increased in value and quantity, but decreased output of crushed and broken limestone resulted in a slight decrease in total value compared with the 1963 figure. Methods of shipping commercial crushed and broken limestone were truck (89 percent), water (10 percent), and rail (1 percent).

TABLE 11.—Granite sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough monumental thousand cubic feet	17	$54	7	$25
Dressed monumental do.	78	808	93	950
Other [1] do.	235	2,960	352	4,157
Total approximate thousand short tons [2]	27	3,822	38	[3] 5,133
Crushed and broken:				
Riprap thousand short tons	5	9	W	W
Concrete aggregate and roadstone do.	78	149	80	158
Stone sand do.	8	2	69	9
Other [4] do.	469	554	360	504
Total do.	[3] 561	[3] 715	[3] 510	671
Grand total do.	[3] 589	4,537	[3] 547	5,804

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes granite for rough and dressed architectural use.
[2] Average weight of 166 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 granite for riprap (1964), railroad ballast, and poultry grit.

TABLE 12.—Limestone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction and rubble thousand short tons	5	$42	6	$44
Rough architectural thousand cubic feet	W	W	W	W
Sawed do.	22	99	40	259
House stone veneer do.	106	290	W	W
Cut do.	150	1,538	158	1,731
Flagging do.	W	W	W	W
Total approximate thousand short tons [1]	29	2,020	30	2,323
Crushed and broken:				
Riprap thousand short tons	24	27	19	28
Concrete aggregate and roadstone do.	2,656	3,192	2,371	2,792
Agriculture do.	426	665	412	645
Other [2] do.	61	356	66	399
Total do.	[3] 3,166	[3] 4,241	[3] 2,869	[3] 3,865
Grand total do.	3,195	[3] 6,260	2,899	6,188

W Withheld to avoid disclosing individual company confidential data; included with "Total."
[1] Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.
[2] Includes limestone for mineral food (1963), flux, asphalt, fertilizer, and poultry grit.
[3] Data do not add to total shown because of rounding.

Granite production increased 28 percent in value over 1963. Principal reason for the increase was a 34-percent increase in value of dimension granite mainly for building use. Quantity and value of crushed and broken granite production decreased 9 percent and 6 percent, respectively, from 1963 figures. Granite production was reported from Big Stone, Kanabec, Lac qui Parle, Mille Lacs, Redwood, Renville, Stearns, and Yellow Medicine Counties. Finishing plants were operated at St. Cloud, Cold Spring, and Delano.

Quartzite production from Rock and Nicollet Counties increased 45 percent over 1963 output. Increases were recorded for concrete aggregate and roadstone, fill, filter use, riprap, and refractory purposes. A decrease was recorded for poultry grit. Shipments were mainly by truck (65 percent), with the remainder by rail.

Crushed and broken basalt for concrete aggregate, roadstone, and railroad ballast was produced in St. Louis County by Zenith Dredge Co. All material was shipped by truck.

Calcareous marl for agricultural use was produced by two companies from operations in Cass and Wadena Counties. Output was 34 percent less than that of 1963.

Sulfur.—Elemental sulfur was produced at Great Northern Oil Co.'s Pine Bend refinery, Dakota County, as a byproduct of oil refinery operations. Sales increased in quantity and value, compared with 1963.

Vermiculite.—Exfoliated vermiculite, expanded from crude vermiculite mined in Montana, was produced by three companies at plants in Minneapolis and St. Paul. Value of sales decreased about 10 percent because of lesser demand for building insulation. Material was sold for lightweight aggregate in plaster and concrete, insulation, litter, fireproofing, and acoustical purposes.

MINERAL FUELS

Peat.—Eight companies reported peat production from operations in Aitkin, Carlton, Itasca, Otter Tail, Pine, Rice, and St. Louis Counties. Sales of peat increased substantially in quantity and in total value; average value per ton decreased 42 percent. Moss peat was the predominate type of peat produced, but some reed-sedge and humus also were produced.

Peat was sold for soil improvement, litter, and other horticultural uses. It was sold in bulk and in polyethylene bags varying in size from 1 quart to 6 cubic feet.

REVIEW BY COUNTIES

Mineral output was reported from every county in the State. Sand and gravel was produced in each of the State's 87 counties; stone was produced in 29 counties. St. Louis County, with its large-scale mining industry, contributed 76 percent of the State total value. Itasca County, which contributed 15 percent of the State total, ranked second.

Mineral value of 14 counties was valued at over $1 million. Mineral output increased in 48 counties and decreased in 39. Virtually all gains or decreases, except in iron-ore producing counties, were attributed to demand for road construction materials.

TABLE 13.—Value of mineral production in Minnesota, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Aitkin	$66,852	$356,000	Sand and gravel, peat.
Anoka	W	W	Sand and gravel.
Becker	W	W	Do.
Beltrami	W	134,000	Do.
Benton	151,189	109,000	Do.
Big Stone	547,812	402,352	Stone, sand and gravel.
Blue Earth	1,331,468	1,776,355	Do.
Brown	221,371	351,519	Sand and gravel, clays.
Carlton	419,163	469,648	Peat, sand and gravel, clays.
Carver	408,368	364,932	Sand and gravel, lime.
Cass	135,962	122,160	Sand and gravel, stone.
Chippewa	198,060	204,000	Sand and gravel.
Chisago	129,550	157,000	Do.
Clay	1,063,095	1,341,605	Sand and gravel, lime.
Clearwater	7,598	14,000	Sand and gravel.
Cook	17,958	62,000	Do.
Cottonwood	W	126,000	Do.
Crow Wing	5,670,232	4,657,656	Iron ore, manganiferous ore, sand and gravel.
Dakota	1,273,201	1,338,791	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	234,557	147,000	Sand and gravel.
Faribault	335,229	427,000	Do.
Fillmore	3,308,806	W	Iron ore, stone, sand and gravel.
Freeborn	282,004	164,000	Sand and gravel.
Goodhue	522,754	553,889	Sand and gravel, stone, clays.
Grant	47,843	45,000	Sand and gravel.
Hennepin	3,062,455	3,809,157	Sand and gravel, clays.
Houston	W	W	Stone, sand and gravel.
Hubbard	53,083	151,000	Sand and gravel.
Isanti	102,413	33,000	Do.
Itasca	72,799,306	74,828,569	Iron ore, sand and gravel, peat.
Jackson	160,463	188,000	Sand and gravel.
Kanabec	250,320	271,145	Sand and gravel, stone.
Kandiyohi	393,660	249,000	Sand and gravel.
Kittson	35,794	121,000	Do.
Koochiching	156,656	46,000	Do.
Lac qui Parle	587,155	784,415	Stone, sand and gravel.
Lake	231,276	103,000	Sand and gravel.
Lake of the Woods	186,123	137,000	Do.
Le Sueur	1,546,887	1,688,266	Sand and gravel, stone.
Lincoln	51,516	W	Sand and gravel.
Lyon	297,818	261,000	Do.
McLeod	236,996	123,000	Do.
Mahnomen	W	35,000	Do.
Marshall	71,558	155,000	Do.
Martin	198,794	168,000	Do.
Meeker	W	159,000	Do.
Mille Lacs	391,902	W	Stone, sand and gravel.
Morrison	75,426	80,000	Sand and gravel.
Mower	680,317	473,284	Stone, sand and gravel.
Murray	37,978	W	Sand and gravel.
Nicollet	259,930	351,320	Sand and gravel, stone.
Nobles	127,169	W	Sand and gravel.
Norman	W	247,000	Do.
Olmsted	1,029,421	1,116,579	Stone, sand and gravel, iron ore.
Otter Tail	1,094,945	802,310	Sand and gravel, peat.
Pennington	99,531	41,000	Sand and gravel.
Pine	178,453	146,600	Sand and gravel, peat.
Pipestone	100,377	185,000	Sand and gravel.
Polk	1,202,282	1,409,323	Sand and gravel, lime.
Pope	187,392	192,000	Sand and gravel.
Ramsey	678,593	805,250	Sand and gravel, clays, stone.
Red Lake	23,789	23,000	Sand and gravel.
Redwood	270,217	369,619	Sand and gravel, stone, clays.
Renville	426,458	415,937	Sand and gravel, stone.
Rice	473,291	617,975	Sand and gravel, stone, peat.
Rock	388,333	576,186	Sand and gravel, abrasives, stone.
Roseau	142,814	74,000	Sand and gravel.
St. Louis	337,242,991	377,761,743	Iron ore, cement, sand and gravel, lime, stone, peat.
Scott	872,095	818,370	Stone, sand and gravel.
Sherburne	149,526	82,000	Sand and gravel.
Sibley	370,868	77,000	Do.
Stearns	3,228,276	4,208,021	Stone, sand and gravel.
Steele	306,181	312,360	Sand and gravel, stone.
Stevens	108,694	161,000	Sand and gravel.
Swift	224,905	294,000	Do.
Todd	W	139,000	Do.
Traverse	39,244	78,000	Do.
Wabasha	306,945	172,290	Stone, sand and gravel.
Wadena	95,435	36,930	Sand and gravel, stone.
Waseca	49,440	23,000	Sand and gravel.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Minnesota, by counties—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Washington	$2,272,633	$2,155,310	Sand and gravel, stone.
Watonwan	70,798	148,000	Sand and gravel.
Wilkin	60,651	W	Do.
Winona	1,220,895	1,095,581	Stone, sand and gravel.
Wright	W	197,000	Sand and gravel.
Yellow Medicine	340,598	413,661	Stone, sand and gravel.
Undistributed [1]	1,918,862	4,760,892	
Total	453,543,000	497,495,000	

W Withheld to avoid disclosing individual company confidential data.
[1] Includes some sand and gravel and stone that cannot be assigned to specific counties, and values indicated by symbol W.

Aitkin.—Colby Pioneer Peat Co. and Kimball & Sons Co. produced peat for horticultural use near Wawina and Hill City, respectively. Approximately 532,000 tons of sand and gravel was produced primarily for road construction. Three commercial companies operated portable plants in the vicinities of Hill City, Jacobson, and Malmo. The State and county highway departments produced and contracted for paving sand and gravel.

Anoka.—Molding and foundry sands were produced at a stationary plant by the Minnesota Silica Sand Co. near Anoka. The county highway department produced and contracted for paving gravel for road construction.

Becker.—Becker County Sand & Gravel Co. produced material for paving, building, engine use, and railroad ballast at a stationary plant near Detroit Lakes. Megarry Bros., Inc., produced paving gravel at a portable plant near Wolf Lake. The State highway department produced sand and gravel for their use in road construction.

Beltrami.—About 216,000 tons of sand and gravel was produced. The material was used mainly for road construction. Minnesota Peat Co. which produced in 1963, was temporarily idle.

Big Stone.—Cold Spring Granite Co. and Delano Granite Works, Inc., quarried granite near Ortonville, and Odessa, respectively. The rough stone was dressed at plants in Cold Spring and Delano. Sand and gravel for road construction and building purposes was produced near Odessa by Hallett Construction Co. The State and county highway departments produced and contracted for road construction material.

Blue Earth.—Mankato Stone Co. and Vetter Stone Co. produced dimension limestone at Mankato mainly for architectural use. Mankato Ag Lime & Rock Co. and Lundin Construction Co. produced crushed and broken limestone for road construction, agricultural use, and riprap. Sand and gravel for road construction, building, and other uses was produced by North Star Concrete Co., Guaranteed Gravel & Sand Co., and Hiniker Sand & Gravel Co. at fixed plants at Mankato. The county highway department contracted for paving gravel.

Brown.—About 396,000 tons of sand and gravel was produced for road construction, building, and other uses. Fixed plants were operated by Math N. Schumacher at Springfield, and Wallner Construction Co., Inc., at New Ulm. Roberts Bros., Hallett Construction Co.,

and the State highway department operated portable plants. The county highway department contracted for its needs. Ochs Brick & Tile Co. produced shale for building brick and lightweight aggregate from a pit near Springfield.

Carlton.—About 285,000 tons of sand and gravel was produced by three governmental units and five companies from pits near Cloquet, Carlton, and Moose Lake. The material was used for road construction, building, and railroad ballast. Red Wing Peat Corp. produced peat for soil improvement at a bog near Cromwell. Nemadji Tile & Pottery Co. produced clay at Moose Lake for manufacture of floor and wall tile.

Carver.—American Crystal Sugar Co. produced quicklime at Chaska and used the entire output for sugar refining. Sand and gravel for various purposes was produced at fixed plants near Hamburg and Chaska by Wm. Mueller & Sons and Rosenwinkel Sand & Gravel Co., Inc., respectively.

Clay.—About 1 million tons of sand and gravel was produced at fixed and portable plants near Glyndon, Felton, Hawley, Moorhead, Sabin, and Ulen. Output was 64 percent greater than in 1963 due to increased activity in road construction. Quicklime was produced by American Crystal Sugar Co. at Moorhead for use in sugar refining.

Cook.—Erie Mining Co. shipped 7.9 million tons of taconite concentrate pellets from Taconite Harbor. Pellets were produced at Erie's large processing plant near Hoyt Lakes, St. Louis County.

Sand and gravel for building use was produced at a fixed plant at Grand Marais by Edwin E. Thoreson, Inc. Paving gravel was produced by Ulland Bros., Inc., operating portable plants near Hovland and Tofte. The State and county highway departments contracted for sand and gravel for road construction.

Crow Wing.—Total shipments of manganiferous iron ores decreased 46 percent from 1963. Iron ore shipments were about equal to those of 1963. Operating companies and mines from which iron and/or manganiferous ores were shipped were as follows:

Company:	*Mines*
The Hanna Mining Co.	Hillcrest Extension and Robert.
Inland Steel Co.	Armour No. 2.
Pickands Mather & Co.	Rabbit Lake.
Pittsburgh Pacific Co.	Alstead, Mangan No. 1., and Sultana-Hopkins.

The above mines were open pits with the exception of the Armour No. 2 underground mine. About 90 percent of the iron ores shipped was classed as direct shipping; the remainder was concentrate. The Hanna Mining Co. shipped from stockpiles at the Robert and Hillcrest Extension.

The Hanna Mining Co. announced plans to reopen the Algoma underground mine, closed in 1931, as an open pit operation. The overburden lying on the orebody was to be stripped during the 1964–65 winter stripping season. Crude ore from the Algoma mine will be beneficiated at Hanna's Maroco plant before shipment.

Ripley Sand & Gravel, Inc., and Les Roberts Sand, Gravel & Excavating Co. operated fixed sand and gravel plants near Brainerd. Material produced was used for road construction, building, fill, and

other uses. C. L. Stodolka Co., Inc., operated a portable plant near Brainerd and produced paving gravel. The county highway department produced and contracted for gravel for road construction.

Dakota.—Sand and gravel production increased to 1,382,000 tons, an 11-percent gain over 1963. Northwestern Gravel Co., Inc., and Standard Building Material Co. operated fixed plants. Portable plants were operated by Alexander Construction Co., Inc., Craig J. Alexander, Bituminous Surface Treating Co., Cords Concrete Products Co., Jay W. Craig Co., Kimmes-Bartelma Construction Co., Inc., Edward Kraemer & Sons, Inc., and Herman Storlie. The county highway department produced and contracted for sand and gravel for road construction, and the State highway department contracted for paving gravel. Swanson Aggregate, Inc., was sold to Alexander Construction Co., Inc. Edward Kraemer & Sons, Inc., produced crushed limestone for roadstone and agricultural use. Byproduct sulfur was recovered by the Claus process at the Pine Bend refinery of Great Northern Oil Co.

Faribault.—About 479,000 tons of sand and gravel was produced by a commercial company and contractors for the State and county highway departments. The Winnebago County Highway Department of Iowa contracted for paving gravel. H. R. Loveall produced gravel for road construction from a pit near Winnebago.

Fillmore.—Iron ore shipments from Fillmore County mines were 362,000 tons, 19 per cent less than in 1963. Virtually the entire output was shipped by rail to consuming furnaces at Granite City, Ill. The Hanna Mining Co. shipped 354,000 tons from its Spring Valley mine group. Schroeder Mining Co. shipped from the Krueger and Plenge properties.

About 238,000 tons of crushed limestone was produced by 5 companies for road construction and agricultural use. Output increased 10 per cent over 1963 due to increased road construction activity. Demand for agricultural limestone dropped due to drought conditions. Portable plants were operated by Kappers Construction Co. near Fountain, Hadland & Vreeman near Ostrander, and Quarve & Anderson Co. near Lanesboro. Hector Construction Co. abandoned its Lanesboro quarry after removal of stockpile. Pederson Bros. operated a fixed plant near Harmony.

Approximately 77,000 tons of sand and gravel was produced. Fixed plants were operated at Peterson by Allen Thompson, and at Lanesboro by Bothun & Torgerson Sand & Gravel Co. The State highway department operated a portable plant for road construction material.

Goodhue.—A total of 182,717 tons of crushed limestone was produced. Mann Construction Co. operated various quarries near Red Wing for road construction and agricultural use. Kielmeyer Construction Co. operated a portable plant near Kenyon for road construction material. Quarve & Anderson Co. and Valley Limestone Co. operated portable and fixed plants, respectively, near Zumbrota for construction aggregate and agricultural use.

Red Wing Sewer Pipe Corp. produced and used plastic fire clay to manufacture vitrified sewer pipe. The company operated three pits, Thomforde, Pottery, and Hinsch, near Goodhue. About 575,000 tons of sand and gravel was produced for building, road construction, and fill. Plants were operated near Frontenac, Lake City, Red Wing,

and Zumbrota. The State and county highway departments produced and contracted for their requirements for road construction.

Hennepin.—Total value of county mineral production increased 24 percent over 1963 primarily due to an increase in sand and gravel output. About 4.4 million tons of sand and gravel was produced, mostly in the Minneapolis suburban areas. Output was for road construction, building, fill, ice sanding, and other uses. The major tonnage was produced at fixed plants. Commercial operators included Alexander Construction Co., Inc., Craig J. Alexander, Anderson Aggregates, Inc., Barton Contracting Co., Consolidated Materials Co., Chas. M. Freidheim Co., Glacier Sand & Gravel Co., J. V. Gleason Co., Inc., Hedberg & Sons Co., Hopkins Sand & Gravel Co., Industrial Aggregate Co., Keller Bros. Gravel Co., Kimmes-Bartelma Construction Co., Inc., Landers-Norblom-Christenson Co., Mapco Sand & Gravel Co., and the Oscar Roberts Co. The State and county highway departments produced and contracted for sand and gravel for road construction purposes.

Clay was produced by North Central Lightweight Aggregate Co., Inc., and used to make sintered lightweight aggregate.

Exfoliated vermiculite was produced in Minneapolis by Western Mineral Products Co. and B. F. Nelson Manufacturing Co. from crude material mined in Montana. Output was sold for insulation, for plaster aggregate, for fireproofing, and for acoustical use. Expanded perlite was produced in Minneapolis by Western Mineral Products Co. and Minnesota Perlite Corp. from crude perlite mined in Nevada and New Mexico. Output was sold for soil conditioning, for texture paint, and as a lightweight aggregate in concrete and plaster.

Houston.—Hector Construction Co., Inc., operated portable crushing plants at five quarries and produced 143,000 tons of limestone for roadstone, as well as 4,000 tons of paving sand from a pit near Houston. Botcher Contractors Co. operated two quarries near Hokah and produced crushed and broken limestone for agricultural and road construction purposes.

Itasca.—Total value of Itasca County mineral output increased 3 percent, primarily due to an equivalent increase in iron ore shipments. Itasca County mineral output represented 15 percent of the State total value. Mining operations continued to be depressed from former years because of the greater use of taconite concentrate and high grade foreign ores which have restricted the sale of natural ores. All mines operated were open pits. About 99 percent of the usable iron ore shipments were concentrate. Operating companies and mines from which iron ore was shipped were as follows:

Company:	*Mines*
Cleveland-Cliffs Iron Co	Canisteo, Hawkins, 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.
Pacific Isle Mining Co	St. Paul.
Pickands Mather & Co	Bennett, Danube, and West Hill.
United States Steel Corp	Arcturus and Plummer.

Cleveland-Cliffs Iron Co. shipped ore from the Hawkins stockpile. The Hawkins mine was shut down in 1962. Shipments from Pick-

ands Mather & Co. Bennett mine were from stockpile. Jones & Laughlin Steel Corp. closed down its pioneer flotation plant for retreating Hill Annex tailings. This plant was the first commercial flotation plant on the Mesabi Range. Magnetic separation equipment was added to the Hill Annex heavy-medium plant and minor flow sheet changes were made.

The Hanna Mining Co. began site preparation for two magnetic taconite plants with a combined annual capacity of 4.4 million tons of pellets. The announcment of the company's plans to build these plants was made after approval of the taconite amendment by the Minnesota electorate at the November election. The National Steel Pellet Co., to be located near Keewatin, will have an annual capacity of 2.4 million tons. National Steel will own 85 percent of the company, while The Hanna Mining Co. will own the remainder and manage the company. The second plant that Hanna will build will be near Nashwauk. Inland Steel Corp. and Wheeling Steel will participate and receive a pro rata share of the planned 2-million-ton annual capacity.

The United States Steel Corp. and The Hanna Mining Co. continued research at Coleraine and Cooley, respectively. Hanna initiated studies of methods of reducing normal iron oxide pellets to the prereduced form. The United States Steel Corp. continued its research on methods of converting nonmagnetic semitaconite to artificial magnetite.

Federal Bureau of Mines experimental blast furnace tests have established that substantial decreases in coke rates and corresponding higher production rates result from the use of prereduced pellets.[6]

About 1 million tons of sand and gravel was produced. Output was used for road and general construction and other uses. Commercial plants were operated by Neil Baker Co. and Hawkinson Construction Co., Inc., at Grand Rapids, and Megarry Bros., Inc., at Wawina. The State and county produced and contracted for their needs.

Arrowhead Peat Co. produced peat from a bog near Wawina for horticultural use.

Kanabec.—Rough granite from the Cold Spring Granite Co. Mora Gray quarry was processed at the company's Cold Spring plant and sold for architectural and monument purposes. Sand and gravel was produced for road construction by 4 commercial operations at portable plants near Mora and Grasston. The county operated a portable plant to produce a portion of its needs and contracted for the remainder.

Lac qui Parle.—North Star Granite Corp. quarried granite near Odessa. The rough stone was finished at the company's plant at St. Cloud for monumental purposes. Cold Spring Granite Co. quarried granite at its Red quarry near Odessa and shipped rough stone to its Cold Spring plant for processing. Output was for architectural and monumental purposes. Bellingham Granite Co. and Dakota Granite Co. quarried granite near Bellingham for monument use. Northern Quarry Corp. quarried granite for monumental purposes near Louisburg.

[6] Melcher, N. B. Smelting Prereduced Pellets in an Experimental Blast Furnace. Minnesota Univ., Proc. 24th Ann. Min. Symp. 1963, pp. 47–53.

About 383,000 tons of sand and gravel was produced. Operating portable plants were Duininck Bros. & Gilchrist, Fairway Construction Co., Johnson Road Co., Inc., and the State and county highway departments. W. J. Stolpman operated a fixed plant near Rosen. Output was for paving, fill, and building use.

Lake.—Reserve Mining Company operated its large taconite plant at Silver Bay at capacity throughout the year. About 29 million tons of crude taconite, mined at the Peter Mitchell mine near Babbitt, St. Louis County, was processed in 1964. A record 9.5 million tons of concentrate was shipped.

Ulland Bros., Inc., and Two Harbors Aggregate Co. operated plants near Two Harbors and Winton, respectively, and produced sand and gravel for building and road construction use. The county highway department produced and contracted for sand and gravel used in road construction. The State highway department contracted for its road construction requirements.

Le Sueur.—The Babcock Co. produced dimension limestone near Kasota. Principal products were cut stone and stone veneer. Part of the output was marketed as marble for interior trim and facings. Some material was sold as rough stone for construction purposes. Ed. Swartout produced limestone for use as roadstone and riprap at a quarry near Kasota.

Gopher State Silica, Inc., produced silica sand from the Jordan Sandstone formation near Le Sueur. Output was used for manufacturing glass, for molding, in oilfield fracturing, as filler, in foundry uses, for filter, and for pottery. The Babcock Co. produced sand for grinding and polishing use. Sand and gravel for road construction, for paving, and for building was produced by Glander Sand & Gravel Co., Lundin Construction Co., Inc., Zarnott Construction Co., and Ed. Swartout. The county highway department produced or contracted for sand and gravel for road construction. The State highway department contracted for paving sand and gravel.

Mille Lacs.—Granite for architectural and monumental purposes was produced by Cold Spring Granite Co. at its Diamond Grey quarry near Isle. The rough stone was processed at the company's Cold Spring plant. Jay W. Craig Co. produced 168,000 tons of sand and gravel for road construction at a portable plant near Princeton. Mille Lacs Sand & Gravel Co. produced 20,000 tons of sand and gravel for building and other uses. The State highway department produced about 4,000 tons of paving sand and gravel, and the county purchased 14,000 tons for road use.

Mower.—Value of mineral production in Mower County dropped 30 percent from 1963, which was a record year because of freeway construction requirements. About 413,000 tons of sand and gravel for road construction, building, and other uses was produced. Six commercial companies operated fixed and stationary plants near Austin and Adams. The county highway department contracted for paving gravel. Martin Bustad & Son produced 52,000 tons of crushed limestone at a fixed plant near Austin for roadstone and agricultural use. Osmundson Brothers operated a portable plant and produced 153,000 tons of crushed limestone for agricultural use and road construction. Hickok Calcium White Rock Co. produced 120 tons of limestone near LeRoy for fluxstone, roadstone, poultry grit, and fertilizer.

Nicollet.—New Ulm Quartzite Quarries, Inc., produced crushed quartzite at a fixed plant near New Ulm. Production was sold for concrete aggregate, refractories, poultry grit, riprap, and other uses. About 274,000 tons of sand and gravel was produced for paving, building, and other uses. Courtland Ready Mix Co., Hallett Construction Co., and North Star Concrete Co., operated fixed plants at Courtland, St. Peter, and Judson, respectively. The State and county highway departments contracted for sand and gravel for road construction.

Olmsted.—Schroeder Mining Co. produced iron ore from the Baker, Bernard, and Partello properties near Chatfield. Most of the output was shipped by rail to consuming furnaces at Granite City, Ill. A portion was used in cement manufacture. About 600,000 tons of sand and gravel, an increase of 64 percent over 1963, was produced. Quarve & Anderson Co., Riverside Sand & Gravel Co., and Rochester Sand & Gravel, Inc., operated fixed plants at Rochester. The State, the county, and the city of Rochester purchased sand and gravel for highway maintenance and construction. Quarve & Anderson Co. also operated five quarries and produced crushed limestone for roadstone and agricultural use.

Otter Tail.—About 1.4 million tons of sand and gravel was produced, 45 percent above 1963 output, because of increased demand for road construction materials. The following companies furnished the commercial production: Mark Sand & Gravel Co.; John Dieseth Co.; Thomas Leo Horstman; K&G Aggregate, Inc.; J. D. Nelson Excavating Co.; and Soo Line Railroad Co. The State and county highway departments produced and contracted for paving sand and gravel.

Northland Peat Co. produced peat near Underwood for general soil improvement.

Polk.—Value of mineral production increased 17 percent over that of 1963 due to increased production of sand and gravel for road construction. About 1.2 million tons of sand and gravel was produced for road construction, building, railroad ballast, fill, and other uses. Commercial operations included Great Northern Railway Co., Megarry Bros., Inc., Northern Sand & Gravel, Inc., Spring Gravel Co., C. L. Stodolka Co., Inc., and Thorson Gravel Co. The State and county highway departments produced and contracted for their sand and gravel needs. The American Crystal Sugar Co. produced quicklime at Crookston and East Grand Forks. Shaft kilns with coke as a fuel were used. Output was used for sugar refining.

Ramsey.—Approximately 1.2 million tons of sand and gravel was produced for building, road construction, and other uses. Arsenal Sand & Gravel Co. operated a fixed plant, and Jay W. Craig Co. a portable plant, near New Brighton. Alexander Construction Co., Inc., operated a portable plant at various locations. The State highway department contracted for sand and gravel for road construction use. Twin City Brick Co. produced about 31,000 tons of shale for building brick manufacture. Dimension limestone was quarried at St. Paul by Sebesta Stone Co. for rubble and flagging. The MacArthur Co. produced exfoliated vermiculite at its St. Paul plant from crude vermiculite mined in Montana. The exfoliated product was sold as building insulation, plaster and concrete aggregate, and steam pipe insulation.

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Redwood.—Ochs Brick & Tile Co. produced miscellaneous clay near Redwood Falls for processing at its Springfield brick plant. View Quarry Co. quarried granite near Belview for architectural purposes; Johnson Quarry Co. produced no granite in 1964. About 535,000 tons of sand and gravel was produced for building, road construction, fill, and other uses. Chapman Gravel Co. and Walnut Washed Sand & Gravel Co. operated fixed sand and gravel plants near Belview and Walnut Grove, respectively. Portable plants were operated by Duininck Bros. & Gilchrist, Kimmes-Bartelma Construction Co., Inc., and Werner & Unzeitig. The State highway department produced sand and gravel for road repairs, and the county highway department produced and contracted for paving material.

Renville.—Dimension granite for architectural and monumental purposes was produced from the Rainbow quarry near Morton by Cold Spring Granite Co. The rough stone was processed at the company's Cold Spring plant. Approximately 299,000 tons of sand and gravel was produced. Commercial operations included Danube Washed Sand & Gravel Co., Duininck Bros. & Gilchrist, John Enestvedt Gravel Pit, Fairway Construction Co., Johnson Road Co., Inc., and Morton Aggregate, Inc. Operations were near Danube, Sacred Heart, Bird Island, and Morton. Output was for road construction, building, fill, and other uses. The county produced and contracted for paving gravel.

Rice.—Crushed limestone for roadstone and agricultural use was produced by Bryan Rock Products, Inc., at a portable plant near Northfield. Faribault Quarries produced dimension and crushed limestone near Faribault for use as roadstone, rubble, and riprap. Kielmeyer Construction Co. produced crushed limestone near Nerstrand for use as roadstone. Union Lake Peat Products Co. produced reed-sedge peat near Northfield for use in soil improvement.

About 884,000 tons of sand and gravel was produced from operations near Northfield, Faribault, and Dundas. The 83-percent increase over 1963 output was attributed to increased road construction activity. Commercial operators included: Charles W. Bickel; James Condon Sand & Gravel; Hallett Construction Co.; Kielmeyer Construction Co.; and Owatonna Aggregate Corp. The State and county highway departments contracted for paving materials.

Rock.—Grinding pebbles and tube-mill liners were produced by Jasper Stone Co. from a quartzite quarry near Jasper. Some broken stone was sold as riprap. About 585,000 tons of sand and gravel was produced in the county. Hallett Construction Co. and Pronk & Son operated fixed plants near Luverne and Leota, respectively. C. H. Hatting Gravel Co., Inc., operated a portable plant near Luverne. Output was used for road construction, fill, building, and other uses. The county contracted for paving gravel.

St. Louis.—The value of St. Louis County mineral output increased 12 percent over that of 1963 and represented 76 percent of the State total. The principal reason for the gain was a 12-percent increase in iron-ore shipments, the county's principal mineral product, which furnished 98 percent of the total county value. St. Louis County mines supplied 79 percent of the total usable iron ore shipped from the State. Operating companies and mines shipping iron ore in 1964 were:

	Mines
Mesabi Range:	
The Hanna Mining Co	Agnew No. 2-South Agnew, Douglas-Duncan, Morton-South Eddy, Pierce group and Weggum.
Inland Steel Co	Dean.
Jones & Laughlin Steel Corp	Schley group.
Pacific Isle Mining Co	Brunt, Iroquois, and Wacootah.
Picklands Mather & Co	Bennett Annex, Embarrass, Erie Commercial, and Mahoning.
Pittsburgh Pacific Co	Albany group, Albany Lean-ore Stockpile, Cloquet Lean-ore Stockpile No. 3, Leonidas, Lincoln, Meadow, Missabe Mountain, Spruce, Wyoming, and Wyoming Annex.
Republic Steel Corp	Susquehanna.
Reserve Mining Co	Peter Mitchell.
Rhude & Fryberger	East Bay and Wade.
Snyder Mining Co	Wanless, Webb-Sellers Triangle, Whiteside, and Woodbridge.
United States Steel Corp	Burt Stockpile No. 41, Hull-Rust group, Kosmerl, Pilotac, Rouchleau group, Sherman group, and Stephens.
E. A. Young, Inc	Minnewas.
Vermilion Range:	
United States Steel Corp	Pioneer.
Zenith Mining Co	Zenith.

The only operating underground mine in the county at the close of the year was the Pioneer mine of United States Steel Corp. at Ely, on the Vermilion range. Shipments from the Zenith and Albany underground mines were from stockpiles. At the year's end a number of open pit mines were closed, including the Embarrass mine (Pickands Mather & Co.), Webb mine (Snyder Mining Co.), Susquehanna mine (Republic Steel Corp.), Albany mine (Pittsburgh Pacific Co.), and the Hull-Rust group (United States Steel Corp.). The Hull-Rust group of United States Steel Corp., since its opening in 1896, produced 349 million tons, about 14 percent of the total 2.5 billion Mesabi Range iron-ore shipments.

After passage of the taconite amendment in November, the United States Steel Corp. began site preparation for a 4.5 million ton taconite plant on the Continental Divide north of Mountain Iron. United States Steel Corp. continued operations at its pilot taconite plant near Mountain Iron. Concentrate was shipped to its Extaca plant near Virginia for agglomerating. Eveleth Taconite Co., owned by Ford Motor Co. (85 percent) and Oglebay Norton Co. (15 percent), began construction of a 1.6 million-ton-per-year taconite plant near Forbes, expected to be in operation in late 1965. Water requirements for plant operations will be drawn from the St. Louis River. Authority to construct an inflatable fabric dam was approved by the State and Federal Governments. Jones & Laughlin Steel Corp. was engaged in evaluating a magnetic taconite property near Biwabik.

Shipments of taconite concentrates reached a record high. Over 38 percent of the State's total iron ore output was taconite concentrate. Erie Mining Co. (Pickands Mather & Co., operating agents) produced taconite pellets throughout the year at its large-scale operations near Hoyt Lakes. The taconite pellets from its Hoyt Lakes plant were hauled 73 miles over the company-owned railroad to Erie's shipping

port at Taconite Harbor. Erie continued design modification and improvement on plant production units and continued exploration and development work at a new mine near Dunka River to supplement its crude ore supply. Reserve Mining Co. mined nearly 29 million tons of crude taconite at its Peter Mitchell mine near Babbitt. The crude material was crushed to about 3-inch size at the mine site and shipped over an interplant railroad to Silver Bay for processing.

The Hanna Mining Co. did not operate the Agnew No. 2, Weggum, or the South Agnew. Shipments from these properties were from stockpile. Its largest producer was the Morton-South Eddy group with the Pierce group a very close second; each group produced over 2 million tons.

Jones & Laughlin Steel Corp. leased the inactive Gilbert mine of United States Steel Corp. and will operate it in conjunction with the Schley group. The company's lease on the State of Minnesota's Bruce mine was canceled early in May. Only exploration work had been done on this property.

Major producing mines operated by United States Steel Corp., in order of tonnage produced, were the Stephens, Rouchleau group, Sherman group, Pilotac, Pioneer, and Hull-Rust group. Production from these mines was 15 percent over that of 1963. The Snyder Mining Co. operated the Whiteside mine and shipped stockpile material only from Webb-Sellers. In connection with its Whiteside mine operations, the company mined ore from the Wanless and Kosmerl properties held by Cleveland-Cliffs and United States Steel Corp., respectively. Pittsburgh Pacific Co. shipped concentrate stockpiles from properties which were not operated during 1964: Cloquet Lean-ore Stockpile No. 3, Meadow, and Wyoming. Production was reported from the Albany group, Leonidas, Lincoln, Missabe Mountain, and Wyoming Annex mine. At the season's close, leases were canceled or operations closed at the following operations: Albany group, Albany Lean-ore Stockpile, Cloquet Lean-ore Stockpile No. 3, Leonidas, Meadow, and Wyoming.

Pickands Mather & Co. operated the Mahoning and Embarrass mines. The Embarrass mine was closed down at the end of the season, and the property was sold to The Dow Chemical Co. as a site for an explosives plant to manufacture metallized-ammonium nitrate blasting agents. Bennett Annex mine shipments were from stockpiles.

American Steel and Wire Division of United States Steel Corp. produced basic pig iron, steel, and coke at Duluth. During periods of maximum production, two blast furnaces and six of the nine available open hearths were operated. In 1963, one blast furnace was idle; but in 1964, the second furnace operated 100 days.

Universal Atlas Cement Division of United States Steel Corp., produced portland and masonry cements at its plant in Duluth. Total output and value increased slightly. Cutler-Magner Co. produced quicklime and hydrated lime at Duluth; a 7-percent decrease in production and value was recorded. Products were used for paper manufacture, mason's lime, steel production, water purification, and other uses.

Peat was produced by St. Louis County Peat Products Co. Inc. near

Central Lakes, and was sold mainly for soil improvement and other horticultural purposes.

Sand and gravel was produced by 11 commercial companies and the State and county highway departments. About 2.5 million tons were produced, mainly for road construction, building, railroad ballast, and fill.

Scott.—About 206,000 tons of crushed and broken limestone was produced near Savage and Shakopee for roadstone, asphalt filler, agricultural use, and riprap. Producing companies were B & R Rock Products, Byran Rock Products, Inc., and Landers-Norblom-Christenson Co. About 167,000 tons of sand and gravel, a 31-percent decrease from 1963, was produced. Commercial operators included Belle Plaine Sand & Gravel, Haferman & Stark, Inc., Minnesota Quartz Co., and Shakopee Sand & Gravel. Plants were operated near Belle Plaine, Jordan, and Shakopee. Output was used for road construction, fill, and sand blasting. The State highway department contracted for paving sand and gravel.

Stearns.—Mineral production value increased 30 percent over 1963 due to increased demands for architectural stone. Cold Spring Granite Co. produced granite chiefly for architectural and monumental purposes from five quarries near Cold Spring, St. Cloud, and St. Joseph. The rough blocks were processed at finishing plants in St. Cloud and Cold Spring. Delano Granite Works, Inc., operated its Rockville quarry and shipped the rough stone to its plant at Delano for processing. Output was sold for achitectural use and for monuments. North Star Granite Corp. produced granite from two quarries near St. Cloud and processed the stone at its St. Cloud finishing plant for use as monuments. Shiely-Petters Crushed Stone Co., Inc., produced crushed granite for use as railroad ballast, roadstone, and stone sand.

About 257,000 tons of sand and gravel, used for road construction, building, and other uses, was produced. Fixed plants were operated by A. C. Petters Co., Inc., near St. Cloud, and Richmond Sand & Gravel Co. near Richmond. C. L. Stodolka Co., Inc., operated a portable plant near Royalton. The State and county highway departments produced and contracted for paving sand and gravel.

Washington.—About 2 million tons of sand and gravel were produced for road construction, building, and fill. Commercial producers included: Alexander Construction Co., Inc.; Cemstone Products Co.; Jay W. Craig Co.; R. J. Jager Gravel Co.; Kimmes-Bartelma Construction Co., Inc.; Moelter Construction Co., Inc.; Carl Olinger; Shalander & Shaleen; and J. L. Shiely Co. The county highway department produced paving sand.

Bryan Rock Products, Inc., Nienaber Contracting Co., and J. L. Shiely Co. produced crushed limestone at plants near Marine-on-St. Croix, Lake Elmo, and St. Paul Park, respectively. Products were used for roadstone, riprap, and agricultural purposes.

Winona.—Value of mineral production was $1.1 million, a drop of 10 per cent from 1963 due to a lessening of road construction activity. Dimension limestone was produced by Biesanz Stone Co., Inc., at Winona, chiefly for architectural use. Derricks used to lift quarry stone were replaced by fork lifts. Crushed limestone was produced

by Fred Fakler, Hector Construction Co., Inc., Patterson Quarries, Inc., and Quarve & Anderson Co., operating portable plants near Winona, Dresbach, St. Charles, and Rollingstone, respectively. Output was for roadstone and agricultural use. Jay W. Craig Co. and Winona Aggregate Co. produced sand and gravel at Minnesota City and Winona, respectively. The material was used for road construction and building. The state and county highway departments contracted for paving sand and gravel.

Wright.—Delano Granite Works, Inc., operated a sawing and finishing plant at Delano, processing rough granite quarried by the company in Big Stone and Stearns Counties. Sand for building and paving was produced at a portable plant near South Haven by Edward Schram Washed Sand & Gravel. The county highway department contracted for paving gravel.

Yellow Medicine.—Crushed and broken granite for riprap and railroad ballast was produced near Granite Falls by The Green Company. Signet Quarry Co., which produced dimension granite in 1963, did not operate its quarry in 1964. About 248,000 tons of sand and gravel for road construction, building, fill, and other uses was produced. Deutz & Crow Co., Inc., operated a fixed plant at Canby, and John Dieseth Co. and Johnson Road Co., Inc., operated portable plants near Clarkfield. The Sate highway department produced paving sand and gravel. The county highway department contracted for paving gravel.

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 decreased 4 percent to $212.2 million. Mineral fuels—petroleum, natural gas, and natural gas liquids—represented 87 percent of the total value.

TABLE 1.—Mineral production in Mississippi [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	1,235	$5,968	1,331	$6,130
Natural gas million cubic feet	176,807	31,825	181,414	31,385
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	28,757	1,755	27,485	1,644
Liquefied petroleum gases do	24,541	956	23,277	780
Petroleum (crude) thousand 42-gallon barrels	58,619	161,788	56,777	151,595
Sand and gravel thousand short tons	6,825	7,056	7,825	8,569
Stone (includes shell, 1964) do	1,267	1,267	1,553	1,557
Value of items that cannot be disclosed: Cement, lime, magnesia	XX	9,579	XX	10,533
Total	XX	r 220,194	XX	212,193

r Revised. 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	Year	Value
1955	$134,890	1959	$188,496	1962	r $207,218
1956	143,443	1960	198,993	1963	r 213,723
1957	144,198	1961	209,037	1964	205,795
1958	151,715				

r Revised.

[1] Petroleum and natural gas engineer, Bureau of Mines, Bartlesville, Okla.
[2] Acting Director, Mississippi Geological Survey, Jackson, Miss.

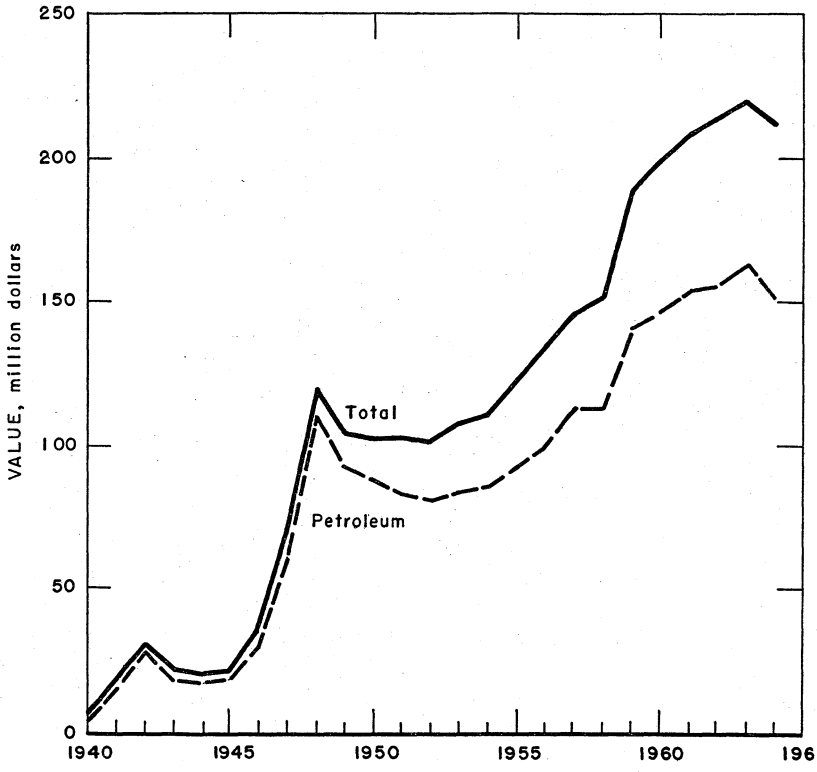


FIGURE 1.—Value of petroleum and total value of mineral production in Mississippi.

Chandeleur Pipeline Co., a wholly owned subsidiary of Standard Oil Co. of Kentucky, constructed a 72-mile, 12-inch pipeline to transmit 30 million cubic feet of gas per day from the California Oil Co. Main Pass, Block 41 field, near the mouth of the Mississippi River, to the Pascagoula refinery for use as fuel. Cost of the project was nearly $6 million.

Construction continued near Gainesville, Hancock County, on a $500 million, 13,500-acre, static testing facility for Saturn- and Nova-class rockets for the National Aeronautics and Space Administration. Active construction contracts worth $88 million were in effect at year-end; about 2,500 workers were engaged in the work. Projects worth $7.5 million had already been completed.

Mississippi Power and Light Co. started constructing one of the largest single electric generating units in the world on the bank of the Mississippi River near Vicksburg. When completed in 1967, the plant will have a capacity of 500,000 kilowatts, raising the company generating capacity from 700,000 kilowatts to more than 1.2 million kilowatts. Cost will be about $40 million; the plant will ultimately employ between 40 and 50 persons. Two similar units were planned, also near Vicksburg.

The Pearl River Valley Water Supply District completed the $25 million Ross R. Barnett Reservoir near Jackson. It covers 31,000 acres and has a capacity of 300,000 acre-feet, largest in the State. The reservoir assured a long-range water supply for future industrial development for the entire central Mississippi area.

The U.S. Army Corps of Engineers started constructing flood control structures on the Pearl River at Jackson; 6,290 acres of urban land will be protected. Comprehensive studies for overall development of water resources of the Pearl and Pascagoula River Basins, initiated in 1963, continued. The Area IV Mineral Resource Office of the Federal Bureau of Mines was assisting in this work by supplying mineral resource studies of the basins involved.

Legislation.—A law was passed permitting the State Oil and Gas Board to order unitization of oil and gasfields when 85 percent of all operators, royalty owners, and other interests approve. Unitization has resulted in increased recovery of oil and gas through better application of engineering principles.

Humble Oil and Refining Co. was awarded a 5-year lease by the State Mineral Lease Commission on the 800,000 acres in Mississippi Sound. Humble paid $105,055 for the option on the entire acreage, plus a $100,000 selective bonus on two 10,000-acre blocks. The area extends from the Louisiana line to the Alabama line in the waters of the Gulf of Mexico. Humble commenced geophysical work in the area and was drilling below 12,000 feet on a well in Hancock County less than 4 miles from the coastal waters. The venture was to be drilled to 16,500 feet.

Employment and Injuries.—Overall mineral industry employment decreased 2 percent and constituted 1.4 percent of the total labor force; wages and salaries remained practically unchanged, according to the Mississippi Employment Security Commission. Employment in petroleum and natural gas industries decreased 3 percent and constituted 86 percent of the labor force in mineral industries; wages and salaries decreased 2 percent. Employment figures for retail filling stations for 1962, 1963, and 1964 were revised to include stations employing fewer than four persons (not covered by the employment law).

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 by-products of petroleum or used in the refining of petroleum [2]
1961	5,330	401	235	2,450	2,698	94
1962	5,232	392	202	2,376	r 4,850	92
1963	5,548	586	178	2,292	r 4,900	366
1964	5,300	700	150	2,300	5,250	300

r Revised.
[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.

TABLE 4.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal						
Metal						
Nonmetal	697	175	1,408		32	23
Sand and gravel	513	136	1,193		34	28
Stone	225	66	536		8	15
Total	1,435	377	3,137		74	24
1964: p						
Coal						
Metal						
Nonmetals	625	155	1,242		24	19
Sand and gravel	520	135	1,212	1	19	16
Stone	545	151	1,211		10	8
Total	1,690	441	3,665	1	53	15

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Value of natural gas, natural gas liquids, and crude petroleum declined for the first time in 12 years.

Mississippi again ranked ninth among the oil-producing States. The five leading petroleum-producing counties were Pike, Adams, Lincoln, Jones, and Jasper, in descending order.

Total drilling activity followed the national trend with an increase of almost 3 percent. Average depth of all holes drilled was 8,128 feet, 346 feet less than in 1963; total footage drilled decreased from 6.2 million feet to 5.8 million feet, according to the "Oil and Gas Journal."

Twenty new field discoveries were Beverly, Alloway, Southwood, North Lake Mary, and Magnolia in Adams County; Northeast Smithdale in Amite County; County Lake, Morgan Creek, Zeigler Creek, and Lowry Lake in Franklin County; Pisgah in Rankin County; Barber Creek in Scott County; Mount Olive (gas) in Smith County; and Pinckneyville, Pine Creek, Cypress Branch, Crooked Creek, Turkey Creek, Pleasant Valley, and Belmont Lake in Wilkinson County.

Mississippi Geological Survey published Bulletin 104, "Geologic Research Papers 1964." One of the papers, "Well Logging by Mississippi Geological Survey," pointed out that through this program a deep water well was logged, revealing a major structural anomaly in northern Yazoo County.

According to the "Mississippi State Oil and Gas Bulletin" as of December 31, 1964, the State had 271 oil pools and 51 gas pools producing in 249 fields; the 3,531 wells capable of producing represented a net decrease of 22 wells from the 1963 total.

Natural Gas.—Marketed production of natural gas was 181.4 billion cubic feet, valued at $31.4 million, based on an average unit price of 17.3 cents per thousand cubic feet, compared with 18 cents in 1963 and 19 cents in 1962.

Five counties—Forest, Jefferson Davis, Marion, Walthall, and Adams—supplied 72 percent of the State's natural gas production.

Reserves dropped 125,863 million cubic feet and represented 0.8 percent of the national reserve (0.9 percent in 1963). The ratio of reserves to yearly production was 13:1 compared with 14:1 in 1963 and 16:1 in 1962.

TABLE 5.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1964, by counties

County	Drilling							Geophysical (reflection seismograph), crew-weeks
	Proved field wells			Exploratory wells			Total	
	Oil	Gas[1]	Dry	Oil	Gas	Dry		
Adams	41		64	5		74	184	3
Amite	16		16	1		13	46	
Attala						1	1	
Bolivar								1
Calhoun						2	2	
Carroll								43
Chickasaw		1	1				2	
Choctaw						1	1	
Claiborne						2	2	
Clarke	7		1			7	15	73
Clay		2					2	
Coahoma								1
Copiah								14
Covington			1			3	4	17
Forrest		4	7				11	4
Franklin	52		42	4		74	172	
George								23
Greene	1		2			1	4	50
Hancock						2	2	48
Harrison						2	2	5
Hinds	4		2			2	8	31
Holmes								9
Humphreys								5
Issaquena						2	2	9
Itawamba		1	1			1	3	
Jackson						2	2	15
Jasper	1		1			2	4	108
Jefferson	9	1	6			32	48	1
Jefferson Davis	1	3	2			1	7	4
Jones	12		3			4	19	49
Lamar	3	1					4	7
Lawrence						2	2	5
Leake						1	1	
Leflore								2
Lincoln	2		4			4	10	
Madison	5		1			11	17	18
Marion	2	12	3			1	18	3
Monroe						3	3	
Newton						2	2	39
Pearl River		1				3	4	43
Perry	1					2	3	12
Pike	9		11			4	24	
Rankin	4		2	1		4	11	58
Scott				1		4	5	70
Sharkey								3
Simpson	2					2	4	66
Smith	11	1	5		1	8	26	62
Stone						1	1	28
Sunflower								1
Tallahatchie								4
Walthall	8		6			5	19	4
Warren	1					1	2	9
Washington						5	5	4
Wayne	6		5			13	24	151
Webster						1	1	
Wilkinson	15		13	7		46	81	6
Yazoo	3		3			3	9	15
Total:								
1964	216	27	202	19	1	354	819	1,123
1963	258	26	231	16	2	264	797	1,048

[1] Includes condensate.

The Mount Olive gasfield in Smith County in the southern half of the State, was discovered.

Mississippi Valley Gas Co. had a working storage capacity of 707 million cubic feet of gas in the Amory field of Monroe County; United Gas Pipe Line Co. could store 4,850 million cubic feet in the formations of the Jackson Dome, in Rankin and Hinds Counties. At year-end, the State's gas storage capacity totaled 5,557 million cubic feet.

The Federal Power Commission (FPC) set a new price ceiling of 20.6 cents per thousand cubic feet on natural gas sales from Mississippi fields. The order was retroactive to sales contracts signed between November 27, 1957, and May 16, 1963. It affects 25 contracts signed by 17 independent producers under temporary FPC authority at prices up to 22.9 cents per thousand cubic feet.

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

	Proved reserves, Dec. 31, 1963	Changes in proved reserves, due to extensions and new discoveries in 1964	Proved reserves, Dec. 31, 1964 (production was deducted)	Change from 1963 (percent)
Crude oil—thousand barrels	384,909	27,462	356,567	−7
Natural gas liquids [1]—do	33,148	2,467	32,875	−1
Natural gas—million cubic feet	2,481,627	68,556	2,355,764	−5

[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. V. 19, Dec. 31, 1964, pp. 11, 12, 22.

TABLE 7.—Marketed production of natural gas [1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1955-59 (average)	168,102	$19,740	1962	170,271	$32,351
1960	172,478	32,426	1963	176,807	31,825
1961	172,543	32,093	1964	181,414	31,385

[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.—Natural gas liquids output decreased 5 percent in volume and 11 percent in value; the average price dropped from 5.1 cents per gallon in 1963 to 4.8 cents per gallon in 1964.

Reserves of natural gas liquids dropped 273,000 barrels, according to the American Gas Association, and constituted 0.4 percent of the national reserves, as in 1963. Ratio of reserves to yearly production remained almost unchanged at 27 to 1.

Humble Oil and Refining Co. completed a gasoline plant in the Sandy Hook field of Marion County. Input capacity was 20 million cubic feet per day; output was 790 gallons per day of combined gasoline and liquefied petroleum gases.

Total capacity of the State's natural gas processing and cycling plants was 432.2 million cubic feet per day, essentially the same as in 1963, 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 1964: Propane, 986,000 barrels; butane, 300,000 barrels; and LP gases, 1,786,000 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
1955–59 (average)	24,262	$1,589	10,066	$483	34,328	$2,072
1960	23,648	1,552	10,151	564	33,799	2,116
1961	25,135	1,625	15,510	700	40,645	2,325
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

Petroleum.—Production of crude oil decreased 3 percent in volume and 6 percent in value. Average price dropped to $2.67 per barrel, compared with $2.76 in 1963. Pike, Adams, Lincoln, Jones, and Jasper Counties supplied about 52 percent of the State's crude oil production.

Discovery of 20 fields matched the record year of 1952.

Barber Creek in Scott County was the most significant discovery because it confirmed the Smackover Formation as an oil producer in Mississippi after the Bienville Forest Smackover discovery of 1963. The Barber Creek discovery produced from 14,550 to 14,568 feet and was 11 miles northwest of Bienville Forest, thereby confirming a postulated northwest-southeast trend. The search for Smackover Lime oil production was intense during the year in Scott, Smith, Leake, Newton, and Jasper Counties. Two attempts to confirm the Bienville Forest discovery by offsets were unsuccessful.

Reserves of crude oil in Mississippi dropped 28,342,000 barrels, according to the American Petroleum Institute; this constituted 1.2 percent of the national reserves, unchanged from the two previous years. Ratio of reserves to yearly production dropped slightly, from 6.6:1 in 1963 to 6.3:1.

In 1964, the National Stripper Well Association classified 260 wells as stripper wells in 1963. They represented 7 percent of the producing oil wells and 1.6 percent of the State's 1963 reserves.

Three of the State's four plants refined 15.5 percent of the annual crude oil production and increased their capacity slightly to 30,200 barrels per stream day. The fourth plant, the Standard Oil Co. of Kentucky refinery at Pascagoula, processed Louisiana crude oil exclusively.

The decreased oil production was largely due to reduced production in the Little Creek field unit of Lincoln and Pike Counties. Waterflooding secondary recovery methods have been underway in this field for a number of years, and it produced at the approximate rate of 16,000 barrels of oil per day during 1963. The 1964 production was at the rate of approximately 13,000 barrels of oil per day. Additional water injection wells, which may increase the production rate, were authorized during the latter part of the year.

TABLE 9.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Production	Value	Year	Production	Value
1955-59 (average)	41,324	$112,009	1962	55,713	$154,882
1960	51,673	146,235	1963	58,619	161,788
1961	54,688	154,220	1964	56,777	151,595

TABLE 10.—Crude petroleum production, indicated demand, and stocks in 1964, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Mississippi
January	4,897	4,966	2,282
February	4,666	4,334	2,614
March	4,997	5,384	2,227
April	4,680	4,343	2,564
May	4,659	4,372	2,851
June	4,753	4,763	2,841
July	4,673	4,711	2,803
August	4,665	4,666	2,802
September	4,570	4,356	3,016
October	4,900	5,103	2,813
November	4,508	4,549	2,772
December	4,809	4,971	2,610
Total:			
1964	56,777	56,518	XX
1963	58,619	58,801	XX

XX Not applicable.

The Mississippi State Oil and Gas Board approved a pilot waterflood project in the Eucutta field of Wayne County.

Petrochemicals.—Coastal Chemical Corp. was constructing the world's largest single-train ammonia plant near Yazoo City. The 1,000-ton-per-day plant will use the M. W. Kellogg Co. catalytic, steam-methane reforming processing for production of raw synthesis gas. MEA absorption of CO_2 and methanation will both be used to purify the gas before ammonia synthesis. Completion of the $12 million facility was scheduled for late 1965.

General Tire and Rubber Co. Chemical Plastics Division announced a $2 million expansion of its plant near Columbus; completion was scheduled for early 1965.

Reichhold Chemicals, Inc., was building a $3 million plant in Gulfport to produce synthetic resins from natural gas and petroleum for floor covering and rubber compounds. The plant will be financed by a bond issue offered by Harrison County Development Corp. and will include a deepwater terminal. Production is expected to start in 1965; employment will be about 150 persons initially and will increase to 400 later.

Spencer Chemical Division of Gulf Oil Corp. announced plans to build a 40-million-pound-per-year formaldehyde plant adjacent to the company's nitrogen-producing facility at Vicksburg. The decision was based on growing requirements of the rapidly expanding southern pine plywood industry for formaldehyde and formaldehyde-bearing resins.

TABLE 11.—Crude petroleum production by fields [1]

(Thousand 42-gallon barrels)

Field	1960	1961	1962	1963	1964
Baxterville	5,901	5,949	5,808	5,823	5,822
Bolton	1,457	1,136	1,127	1,256	1,190
Brookhaven	1,924	1,571	1,498	1,545	1,456
Bryan	2,487	3,391	2,068	2,017	1,773
Cranfield	1,099	901	905	863	513
Dexter	(2)	(2)	(2)	(2)	1,566
Diamond	1,166	924	751	640	571
Eucutta	1,363	1,261	1,151	1,088	1,232
Heidelberg	3,302	3,974	3,737	3,620	3,491
La Grange and North and South	1,453	1,471	1,322	1,234	1,236
Little Creek	5,669	6,431	5,384	6,107	5,589
McComb	2,533	2,949	4,383	4,482	4,379
Pistol Ridge Maxie	1,000	651	736	762	658
Raleigh	2,157	1,820	1,392	1,573	1,511
Smithdale	(2)	(2)	(2)	(2)	1,019
Soso	3,901	3,418	2,998	2,643	2,380
Tinsley	3,234	2,991	2,835	2,855	2,650
Yellow Creek and North and West	1,170	1,222	1,492	1,409	1,276
Other fields [3]	11,857	14,628	18,126	20,702	18,465
Total	51,673	54,688	55,713	58,619	56,777

[1] Based on "Oil and Gas Journal" data adjusted to Bureau of Mines total.
[2] Included with "Other fields."
[3] Bureau of Mines data.

NONMETALS

Cement.—Production of portland cement increased 7 percent; output of masonry cement increased 5 percent.

A Jackson consultant under contract to the Area Redevelopment Administration (ARA) completed a feasibility study concerning establishing a portland cement plant in Smith County. The plant would cost $7.2 million and would have 4,000-barrel-per-day capacity. At yearend, no further action had been taken by ARA on the project.

TABLE 12.—Shipments of portland cement to Mississippi consumers

Year	Thousand barrels	Year	Thousand barrels
1955–59 (average)	2,380	1962	3,704
1960	3,324	1963	3,999
1961	3,603	1964	4,108

Clays.—Clay production was 8 percent over that of 1963, establishing a record for the fifth consecutive year. Miscellaneous clay was used for manufacturing heavy clay products and lightweight aggregate. Ball clay was produced in Panola County.

The Mississippi Geological Survey, in cooperation with the Mississippi Research and Development Center, published Bulletin 103, "Survey of Lightweight Aggregate Materials in Mississippi." The Federal Bureau of Mines published a report [3] which included a discussion of the lightweight aggregate industry in Mississippi.

Mississippi Geological Survey Bulletin 102, "Geologic Research Papers 1963," contains a chapter on the "Geology of the Northeast

[3] Diamond, W. G., and H. F. Robertson. Expanded Clay and Shale Lightweight Aggregate Industry in the Southcentral United States. BuMines Inf. Circ. 8233, 1964, 50 pp.

Quarter of the West Point, Mississippi Quadrangle and Related Bentonites."

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 clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1955-59 (average)	209	$2,373	100	$992	342	$343	651	$3,708
1960	238	2,900	181	1,287	598	599	1,017	4,786
1961	228	2,836	226	1,547	650	651	1,104	5,034
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

Magnesium Compounds.—H. K. Porter Co., Inc., at Pascagoula established new monthly production records of periclase (in the sea water plant) and of basic brick; production in both divisions was approaching design capacity, according to company officials. Production of magnesium compounds increased about 30 percent over that of 1963. Magnesium-bearing lime, made from dolomite mined in Alabama, was used in the process.

Perlite.—Johns Manville Perlite Co., Adams County, reported production of expanded perlite for the first time in Mississippi, using crude perlite from Western States.

Salt.—The Atomic Energy Commission (AEC) detonated a 5-kiloton nuclear device in Tatum Salt Dome near Baxterville as part of its Project Dribble on October 22, 1964. Officials said the explosion, in a tamped shaft at 2,700 feet, probably created a cavity 120 feet in diameter.

Sand and Gravel.—Sand and gravel output increased 15 percent in volume and 21 percent in value. Production was reported from 26 of the State's 82 counties; leading producing counties in order of value were Copiah, Forrest, Washington, Adams, DeSoto and Warren. These six counties produced 55 percent of the tonnage and 54 percent of the value.

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
1955-59 (average)	5,407	$5,031	628	$495	6,035	$5,526
1960	6,068	5,522	113	46	6,181	5,568
1961	5,536	5,314	384	589	5,920	5,903
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

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	902	$766	1,015	$863
Paving	863	738	1,109	958
Other [1]	211	207	144	222
Total	1,976	1,711	2,268	2,043
Gravel:				
Building	1,719	1,888	1,787	2,007
Paving	2,325	2,498	3,187	3,519
Railroad ballast			33	17
Other [2]	286	169	204	285
Total	4,330	4,555	5,211	5,828
Total sand and gravel	6,306	6,266	7,479	7,871
Government-and-contractor operations:				
Sand:				
Paving	280	272	153	2 7
Fill			10	
Gravel:				94
Paving	239	518	175	398
Other			8	8
Total sand and gravel	519	790	346	698
Grand total	6,825	7,056	7,825	8,569

[1] Includes fill, other construction, and industrial sand.
[2] Includes fill, other, and miscellaneous gravel.

Stone and Shell.—Offshore recovery of oyster and clam shell in Harrison County resumed during the year.

Sulfur.—The quantity and value of recovered sulfur were back up to 1962 levels after a 47-percent decline in 1963. Sulfur was recovered from refinery gases at the Mississippi Gulf Refining Co. refinery near Purvis, Lamar County.

National Sulphur Co. successfully concluded 2 years of experimenting with a small pilot plant in the two-well Loring field of Madison County and planned to install a permanent plant with a scheduled capacity of 12 long tons of sulfur per day. Feedstock consists of gases produced from the Smackover Lime by the two condensate wells.

REVIEW BY COUNTIES

Adams.—The county led the State in oil well drilling activity and five new oilfields were discovered. The county ranked second in total value of minerals produced and second in petroleum output and accounted for 10 percent of the State's petroleum production and about two-thirds of its regenerated lime output. First production of expanded perlite in the State was reported by Johns Manville Perlite Co.

Forrest.—The county continued to lead in natural gas production, producing about 19 percent of the State's natural gas. The county ranked second in quantity and value of sand and gravel produced.

Franklin.—Exploratory drilling resulted in discovery of four oilfields. The county ranked second in oil well drilling activity.

Hancock.—Partial operation was scheduled to start in 1965 at the National Aeronautics and Space Administration static test center near Gainesville for Saturn- and Nova-class launch vehicles.

Harrison.—Jahncke Service, Inc., resumed dredging oyster and clam shell in Mississippi Sound.

Hinds.—The county retained its lead in quantity and value of miscellaneous clay mined and used for manufacturing lightweight aggregates, face brick and other clay products.

Jefferson Davis.—The county reached second place in production of natural gas and accounted for nearly 18 percent of the State production.

Jones.—The county ranked fourth in value of petroleum produced, accounting for 9 percent of the State production.

Lincoln.—The county ranked third in value of petroleum produced, accounting for 9 percent of the State output.

Marion.—The county, third in natural gas production, produced 15 percent of the State total.

Marshall.—Holly Springs Brick and Tile Co. and Southern Brick and Tile Co. mined fire clay and miscellaneous clay from open pits to make building brick.

Monroe.—The county retained its lead in value of clay production, accounting for 34 percent of the State total. Bentonite was mined from open pits and processed for mold making, absorbing, filtering and decolorizing.

Panola.—Substantial production of ball clay for glass-refractory use and washed sand and gravel for highway and structural uses was reported.

Pike.—The county led in total value of minerals, petroleum, and natural gas liquids, accounting for 13, 16 and 51 percent, respectively, of the State's total.

Rankin.—The county led in production of crushed marl and limestone used for manufacturing cement. Exploratory drilling resulted in discovery of the Pisgah oilfield. Marquette Cement Manufacturing Co., one of the State's two cement plants, produced portland and masonry cement at Brandon.

Scott.—Discovery of the Barber Creek oilfield confirmed the Smackover Limestone as an oil producer, after last year's Bienville Forest discovery in Smith County opened Smackover production in the State.

Smith.—Exploratory drilling resulted in discovery of the Mount Olive gasfield.

Tippah.—The county ranked second in value of clay produced and was again the only county in which fuller's earth was produced.

Warren.—The county produced crushed marl and limestone for manufacturing cement. Mississippi Valley Portland Cement Co., one of the State's two cement plants, produced portland and masonry cement.

Wilkinson.—The county ranked third in total drilling activity and was the site of seven oilfield discoveries.

TABLE 16.—Value of mineral production in Mississippi, by counties[1]

County	1963 r	1964	Minerals produced in 1964 in order of value
Adams	$22,277,000	$19,091,943	Petroleum, natural gas, sand and gravel, natural gas liquids.
Alcorn	W	W	Clays.
Amite	4,850,570	4,586,983	Petroleum, natural gas, sand and gravel.
Attala	W	W	Clays.
Bolivar	70,772	73,000	Sand and gravel.
Carroll	W	W	Clays.
Chickasaw	13,988	16,373	Natural gas, clays.
Claiborne	----------	16,068	Natural gas.
Clarke	1,367,799	1,107,974	Petroleum, natural gas.
Clay	425,489	438,745	Natural gas, sand and gravel, petroleum, natural gas liquids.
Copiah	W	1,296,000	Sand and gravel.
Covington	1,389,609	1,087,455	Petroleum, natural gas.
De Soto	W	W	Sand and gravel.
Forrest	8,803,690	8,601,166	Natural gas, petroleum, sand and gravel, natura gas liquids, clays.
Franklin	4,476,340	5,756,470	Petroleum, natural gas.
Greene	254,529	205,351	Do.
Hancock	250,414	182,515	Natural gas, petroleum.
Harrison	120,055	W	Shell, sand and gravel.
Hinds	4,331,920	3,657,606	Petroleum, clays, natural gas, sand and gravel.
Holmes	W	W	Sand and gravel.
Itawamba	479,574	581,698	Clays, natural gas.
Jackson	W	W	Magnesium compounds, lime.
Jasper	14,115,540	12,760,277	Petroleum, natural gas.
Jefferson	3,727,387	3,017,382	Do.
Jefferson Davis	4,898,565	6,040,999	Natural gas, petroleum.
Jones	16,193,095	14,949,105	Petroleum, natural gas, natural gas liquids, clays.
Lamar	13,219,159	12,236,754	Petroleum, natural gas.
Lauderdale	107,366	78,829	Clays.
Lawrence	702	2,246	Petroleum, natural gas.
Lee	W	W	Clays.
Leflore	----------	W	Sand and gravel.
Lincoln	16,334,421	14,495,467	Petroleum, natural gas, natural gas liquids, clays.
Lowndes	336,188	339,250	Sand and gravel, clays.
Madison	494,001	552,747	Petroleum, natura lgas.
Marion	6,999,224	7,591,605	Natural gas, petroleum, sand and gravel, natural gas liquids.
Marshall	W	W	Clays.
Monroe	3,093,529	2,875,675	Clays, natural gas, sand and gravel, petroleum.
Noxubee	W	W	Clays.
Panola	881,962	W	Clays, sand and gravel.
Pearl River	4,168,435	3,315,908	Natural gas, petroleum, sand and gravel, clays.
Perry	359,990	339,056	Sand and gravel, petroleum.
Pike	27,727,581	26,732,283	Petroleum, natural gas liquids, natural gas.
Pontotoc	4,800	7,000	Clays.
Prentiss	8,525	5,125	Do.
Rankin	5,807,511	6,532,294	Cement, petroleum, stone, natural gas.
Scott	16,777	68,829	Petroleum, sand and gravel.
Sharkey	1,056	----------	
Simpson	4,204,811	3,430,046	Petroleum, natural gas.
Smith	9,125,374	9,437,590	Petroleum, clays, natural gas, stone, sand and gravel.
Stone	----------	W	Sand and gravel.
Sunflower	W	W	Clays.
Tate	2,059	----------	
Tippah	W	W	Clays.
Tishomingo	W	W	Sand and gravel.
Walthall	7,247,766	7,315,347	Petroleum, natural gas.
Warren	W	W	Cement, sand and gravel, stone.
Washington	W	W	Sand and gravel.
Wayne	9,969,798	9,532,324	Petroleum, natural gas.
Wilkinson	2,479,387	2,766,011	Petroleum, sand and gravel, natural gas.
Yalobusha	W	W	Sand and gravel.
Yazoo	9,040,938	8,287,308	Petroleum, sand and gravel, natural gas.
Undistributed	10,516,304	12,784,196	
Total	220,194,000	212,193,000	

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: Benton, Calhoun, Choctaw Coahoma, George, Grenada, Humphreys, Issaquena, Kemper, Lafayette, Leake, Montgomery, Neshoba, Newton, Oktibbeha, Quitman, Tallahatchie, Tunica, Union, Webster, and Winston.

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 Andrew Kuklis [1] and William C. Hayes [2]

THE mineral industry of Missouri produced minerals and mineral fuels valued at a record $189.3 million in 1964. Output of nonmetals accounted for 67 percent of the total mineral-production value, metals for 26 percent, and mineral fuels for the remaining 7 percent.

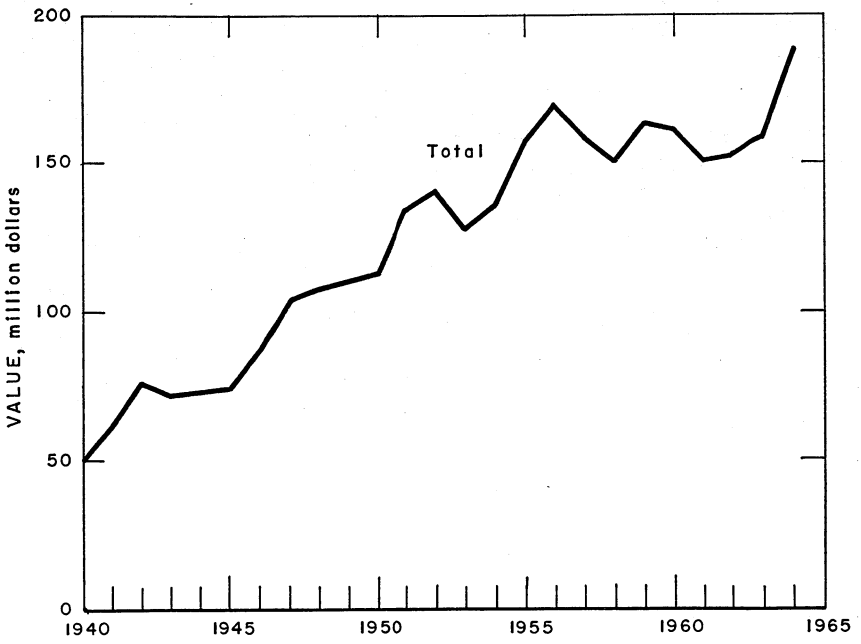


FIGURE 1.—Total value of mineral production in Missouri.

[1] Mining engineer, Bureau of Mines, Area IV Mineral Resource Office, Bartlesville, Okla.
[2] Director and state geologist, Division of Geological Survey and Water Resources, Rolla, Mo.

Despite an increase of more than $3.8 million in nonmetallic products in 1964, its percentage of total mineral production declined 11 percent from the 78 percent reported in 1963. Greater output in the metals segment of the industry caused the change. Gains in value of metals resulted from new iron production at the Pea Ridge mine, a higher price for lead that created an incentive for increased production, and full-scale operation of the St. Joseph Lead Co. lead mines following an 8-month strike which ended in April 1963. The six leading mineral commodities, in order of value, were stone, cement, lead, iron ore, lime, and sand and gravel.

Missouri's first-mined underground storage cavern for liquefied petroleum gas products was placed in use in Lawrence County at yearend; completion of the $2-million project was announced by Continental Oil Co. and Cities Service Oil Co. The cavern consists of a series of tunnels at a depth of 319 feet in the Northview shale. It covers an area almost 200 by 300 feet, having a capacity of 3.4-million gallons. Pipelines will deliver liquefied petroleum-gas products from refineries and gasoline plants in Oklahoma and Kansas to the facility for distribution.

Economic Indicators.—According to the U.S. Department of Commerce, manufacturing activity in Missouri, as measured by value added by manufacture, rose to more than $4 billion in 1964. Value added by manufacture is the value of factory shipment plus cost of materials utilized.

Contracts for future construction in the State were more than $1 billion in 1964, an increase of 18 percent over that of 1963. Residential construction accounted for 43 percent of this expenditure and nonresidential for 31 percent; the remaining 26 percent was for public works and utilities.

TABLE 1.—Mineral production in Missouri [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asphalt (native)—short tons	1,779	$15	1,522	$13
Barite—do	286,750	3,680	266,814	3,451
Cement:				
Portland—thousand 376-pound barrels	12,402	41,640	12,378	42,618
Masonry—thousand 280-pound barrels	417	1,345	334	1,046
Clays—thousand short tons	1,746	4,467	1,966	4,874
Coal (bituminous)—do	3,174	13,196	3,254	13,285
Copper (recoverable content of ores, etc.)—short tons	1,816	1,119	2,059	1,343
Iron ore (usable)—thousand long tons gross weight	345	3,085	1,116	14,907
Lead (recoverable content of ores, etc.)—short tons	79,844	17,246	120,148	31,479
Lime—thousand short tons	1,240	14,386	1,219	14,328
Natural gas—million cubic feet	100	27	108	26
Petroleum (crude)—thousand 42-gallon barrels	53	150	65	163
Sand and gravel—thousand short tons	10,653	12,260	11,483	13,380
Silver (recoverable content of ores, etc.) thousand troy ounces	132	168		
Stone—thousand short tons	30,885	46,130	31,487	47,984
Zinc (recoverable content of ores, etc.)—short tons	321	74	1,501	408
Total	XX	r 158,988	XX	189,305

r Revised. 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	Year	Value
1953	$135	1959	$159
1954	142	1960	159
1955	154	1961	151
1956	157	1962	154
1957	159	1963	r 161
1958	154	1964	186

r Revised.

Personal income rose to $11.4 million, 5 percent higher than the $10.9 million reported in 1963. Gains were made by every major industry except farming; the sharpest increase was in the construction industry. Per-capita income was reported at $2,595, an increase of $87 over that of 1963. Most of the 3.5-percent gain in per-capita income in 1964 represented an increase in real purchasing power, as consumer prices increased only about 1 percent from the 1963 levels. Missouri, reporting $105.17 per-capita State tax in 1964, ranked eighth in the Nation.

Employment.—Employment in the metal-mining segment of the mineral industry increased due to the new iron and lead mines in southeast Missouri. Despite increased production, the coal-mining industry reported a decrease in employment. An investment in more productive equipment to compensate for higher wages was the principal factor.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	498	121	904	----	20	22
Metal	2,120	434	3,486	----	205	59
Nonmetal and native asphalt	872	170	1,369	----	29	21
Sand and gravel	710	169	1,437	----	26	18
Stone	4,304	1,085	8,929	2	168	19
Total	8,504	1,979	16,125	2	448	28
1964: p						
Coal	474	125	840	----	30	36
Metal	2,285	594	4,803	5	254	54
Nonmetal and native asphalt	998	205	1,660	1	44	27
Sand and gravel	765	182	1,549	1	32	21
Stone	4,160	1,076	8,832	3	149	17
Total	8,682	2,182	17,684	10	509	29

p Preliminary.

The mineral industry enjoyed a full productive year; no segment of the industry reported serious labor disputes. At yearend, negotiation was initiated between the St. Joseph Lead Co. and AFL–CIO, affecting 1,300 employees at the company's Bonne Terre, Flat River, Viburnum, and Indian Creek mines and processing facilities. Under

a new 2-year nationwide contract, basic wages of coal miners rose to $25.25 per day in April 1964; another dollar will be added to the basic wage on January 1, 1965.

Exploration.—Exploration in Missouri was largely confined to outlining mineralization discovered by drilling and geophysical survey teams over the past several years. The ore-bearing rock or pay target ranged in depth from 800 to 3,000 feet and hence necessitated large exploration expenditures.

Government Programs.—The State highway department announced expenditure and obligations for construction purposes during 1964 totaling $156.7 million. The works covered 924 miles of road in all areas of the State, including 170 miles on interstate systems, 431 miles on primary-system improvements, 26 miles of urban-system and 497 miles of secondary-road improvements.

Much of the area in the new "lead belt" is Federal forest land and, as such, required prospecting permits for drilling and mineral leases for mining. According to the Clark National Forest 1964 Annual Review at yearend, there were 66 prospecting permits covering 53,400 acres, and 21 mineral leases covering 20,500 acres. Compared with 1963, acreages under prospecting permits decreased 34 percent, but acreages under mineral leases increased 38 percent. Income from land rental and royalty totaled $125,000, exceeding income derived from timber for the first time in history.

American Zinc, Lead and Smelting Co. acquired exploration leases on an additional 1,600 acres of land in the Boss-Bixby area. Drilling and geophysical exploration to date have enhanced the iron-copper-lead deposit discovered several years ago.

Research in the development of Missouri mineral resources was continued by the Federal Bureau of Mines. A copper-lead-zinc-conservation survey of the State was completed for inclusion in a nationwide report.

A geological-research station was authorized for construction on 2,000 acres of Tyson Valley land in Missouri. The facility, jointly operated by the Department of Earth Sciences, Washington University, and the Federal Geological Survey, will be utilized for research in geophysics, earth magnetism, geological engineering, slope erosion, and ground-water flow.

The Defense Department's Advanced Research Projects Agency awarded a $2-million contract for the study of high-performance materials to the Monsanto Co. and Washington University. Research will be conducted jointly in developing a tough, high-strength, lightweight material for space systems.

Transportation.—Pipelines, railroads, and barges transport vast quantities of mineral products in and out of Missouri and, as such, constitute an important segment of the mineral industry in the State. Cities Service Oil & Gas Co. constructed a 23-mile, 20-inch lateral from the Sedalia, Mo., line westward to the east Kansas City area at a cost of $2.3 million.

The Federal Power Commission approved the Oklahoma-Illinois Gas Pipeline Co. proposal to construct a $64-million natural-gas pipeline from gasfields in Oklahoma to the St. Louis area. Approval was

based on a ruling that public interest requires presence of a competitive company in the area, which has been supplied by Mississippi River Corp. Oklahoma-Illinois Pipeline Co. proposed to sell natural gas principally to industrial firms in St. Louis and other communities along the line. Barge transportation on the Mississippi River at St. Louis was reported at 32.3-million tons. The Frisco Railroad received authority from the Interstate Commerce Commission to construct a 41-mile rail line extending from Dent County to Crawford, Iron, and Reynolds Counties.

Water.—The Missouri Water Pollution Board installed three quality-control monitoring stations on the Missouri River for the purpose of recording concentration of pollutants in the river. Washington University scientists were studying the diversity of pollutants in the Nation's water supply. The State Water Pollution Board issued regulations governing discharge of water pollutants. The board must be notified immediately of any accidental spills or discharges of sewage, industrial water, or other polluting substances into streams. The U.S. Army Corps of Engineers has been authorized to expend $23.6 million in Missouri for navigation, flood control, power, reclamation, water storage, and bank erosion.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Output of nonmetals was $3.8 million higher than that of 1963. Increases in the rate of highway construction and building of private residences, schools, hospitals, and other institutional structures contributed to the rise in production of industrial minerals such as cement, clay, lime, sand and gravel and stone. The more important nonmetals in order of value, were stone, cement, lime, and sand and gravel.

The Pittsburgh Plate Glass Co. was studying engineering plans for construction of a multimillion-dollar float-glass plant near Crystal City having a capacity of 50 million square feet of glass annually.

Ruberoid Co.'s $5-million roofing-granule plant was about 75 percent complete at yearend. Operation of the facility was expected by mid-1965, and approximately 100 workers will be employed. Precambrian felsites from Iron County will be utilized as raw material.

An expansion program announced by Harbison-Walker Refractories Co. included construction of a new rotary kiln at its plant near Fulton. Principal function of the unit is the manufacture of refractory specialty products.

Kaiser Refractories, Division of Kaiser Aluminum & Chemical Corp., planned to spend several million dollars within the next 5 years for general modernization of facilities near Mexico. A 12,500-square-foot building was under construction, and the new equipment installed was expected to make the plant one of the most efficient in the United States.

Barite.—The State continued as the leading producer in the Nation in 1964. Lower output in 1964 was due to the static price level over the past several years and to an increase in imports, principally from Mexico and Peru.

Crude barite was mined in 16 pits, all in Washington County. Leading producing companies included Magnet Cove Barium Corp., Milwhite Mud Sales, and National Lead Co. At yearend, barite held in stock by producers totaled 31,503 tons, about 24 percent more than in 1963. Crushing and grinding plants in St. Louis and Washington Counties processed about 74 percent of the State's barite production; the remainder was processed in Arkansas and Texas. Crushed and bleached products gained, but unbleached products declined more than 3 percent.

TABLE 4.—Barite sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1955-59 (average)	311,609	$3,798,886	1962	303,945	$3,994,104
1960	180,702	2,587,820	1963	286,750	3,679,764
1961	227,323	3,051,663	1964	266,814	3,450,530

Principal uses, in order of importance, were drilling mud, glass, paint, rubber, and other chemical products. The use of Missouri barite for drilling mud has been declining for a number of years.

Cement.—Masonry and portland cement were manufactured at two plants in St. Louis County and at one each in Cape Girardeau, Jackson, and Ralls Counties.

Shipments of masonry cement exceeded $1 million but were lower than those of 1963. Price per barrel declined to $3.13 from $3.22 reported in 1963. The plants prepared masonry cement by mixing portland cement, finely ground limestone, and a plasticizer additive. Yearend stocks of masonry cement totaled 488,000 barrels, a decrease of 2 percent. Shipments of portland cement approximated those of 1963. The price per barrel rose to $3.44 from $3.36 reported in 1963, and resulted in a 2-percent increase in the value of shipments. At yearend cement in stock totaled 1.5-million barrels, the same as in 1963.

TABLE 5.—Portland cement production and shipments

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1955-59 (average)	12,212	12,092	$38,183
1960	12,606	11,856	40,915
1961	11,940	11,839	41,142
1962	12,239	12,739	44,004
1963	12,692	12,402	41,640
1964	12,399	12,378	42,618

Missouri cement plants operated at 78 percent of capacity compared with 80 percent in 1963. A substantial part of the cement capacity was in obsolete equipment and plants, and extensive competition was forcing the industry to modernize and expand beyond current consumption. Excess capacity resulted in a trend to vertical integration within the industry to acquire control of captive markets.

TABLE 6.—Shipments of portland cement to Missouri consumers

Year	Thousand 376-pound barrels	Year	Thousand 376-pound barrels
1955–59 (average)	7,775	1962	8,814
1960	7,684	1963	8,990
1961	8,066	1964	10,266

Service remains an important factor in marketing and, consequently, cement producers were building bulk storage and distribution facilities in major market centers.

The industry consumed 282.1-million kwhr of electrical energy, most of which was purchased. The wet process was used in about 67 percent of portland-cement production; the remainder was manufactured by the dry process.

Universal Atlas Cement Co., Division of United States Steel Corp., was modernizing and enlarging production equipment at its cement plant near Hannibal. The company was building a single 620-foot kiln to replace a smaller kiln. The facility will utilize computer-controlled automation systems.

The River Cement Co., subsidiary of Mississippi River Corp., was building a $25-million cement plant near Selma, Jefferson County. Initial capacity will be 3-million barrels per year; however, the plant was designed to utilize a 560-foot kiln, and capacity may be doubled. Shipments were expected to be made by barge and rail to distribution facilities in St. Louis and other major cities in the Midwest. The plant was scheduled for completion in 1965 and will provide employment to 100 workers.

Dundee Cement Co., subsidiary of Holderbank Cement Co., Zurich, Switzerland, planned to construct a 7-million-barrel-annual-capacity $55-million cement plant near Clarksville, Pike County. The important production unit in the plant is the single 760-foot long 25-foot-diameter kiln, largest in the world. Completion of the highly automated facility was scheduled for late 1966; it will employ about 200 workers.

Clays.—After a decline in shipments for several years, clay (fire and miscellaneous), sold and used, rose 13 percent in quantity and 9 percent in value over that of 1963. High level of activity in the construction and steel industries accelerated the sale of refractories and lightweight aggregate.

Fire clay was mined in 15 counties and comprised about one-half the tonnage and 80 percent of the value of clay sales. Important uses were refractory products, high-alumina brick, chemicals, and mortar.

Miscellaneous clay was produced in 10 counties; output increased 7 percent in quantity and 8 percent in value as compared with 1963. Important uses of miscellaneous clay were building brick, cement, lightweight aggregate, sewer pipe, pottery, and other heavy clay products.

TABLE 7.—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
1955–59 (average)	1,580	$6,188	901	$902	2,481	$7,090
1960	[2] 1,541	6,208	999	999	2,540	7,207
1961	[2] 1,112	4,020	1,020	1,020	2,132	5,040
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

[1] Includes diaspore and burley clay.
[2] Includes ball clay.

Lime.—Most of the lime output went to out-of-State markets. The 1964 average value of 1 ton of lime was $11.75 compared with $11.60 in 1963 and $11.65 in 1962. The static price level over the past several years was due to overcapacity in the industry. Increased consumption was expected because of new markets in steelmaking, soil stabilization, and manufacture of calcium-silicate products.

The Galloway plant of Ash Grove Lime & Portland Cement Co. installed a unique revolving-circular-hearth kiln. New equipment permitted the immediate application of high-temperature-calcining heat to the feedstock, a direct contrast to normal lime burning practices in which maximum firing temperature is provided near the discharge end. The kiln was producing 125 tons per day of 97-percent lime.

TABLE 8.—Lime sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	1,367	$15,310	1962	1,176	$13,703
1960	1,254	14,701	1963	1,240	14,386
1961	1,173	13,873	1964	1,219	14,328

Sand and Gravel.—The sand and gravel industry in Missouri established a new production record during 1964; output rose 8 percent in quantity and 9 percent in value over that of 1963. Continued high level of activity in all phases of construction accounted for the increase.

Construction was the principal market for sand and gravel, utilizing 90 percent of the tonnage produced. Industrial markets consumed 9 percent, and the remaining 1 percent was other markets. Output of sand and gravel came from 141 plants in Missouri; of these, 50 were stationary, 30 portable, and the remaining 61 plants were a dual type. Stationary plants produced about 70 percent of the output. Total sand and gravel transportation, including Government-and-contractor, was 78 percent by truck, 13 percent by railroad, and 9 percent by waterway and other methods.

Commercial operations in Missouri numbered 76 and produced 10.8-million tons or 94 percent of the output. Five sand and gravel

operators produced over 500,000 tons each for a total of 3.3-million tons; 29 plants were in the 100,000-to-500,000 range and supplied 6.3-million tons; 42 plants produced up to 100,000 tons each for a total of 1.2-million tons. Sand comprised 56 percent of the tonnage of sand and gravel produced in Missouri, gravel the remaining 44 percent. Missouri sand sold at an average price of $1.30 per ton, gravel for a fraction under $1.00 per ton.

Stone.—Granite, limestone, marble, miscellaneous stone, and/or sandstone were mined in 76 counties; output gained 2 percent in quantity and 4 percent in value.

TABLE 9.—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
1955–59 (average)	8,313	$9,181	1,147	$854	9,460	$10,035
1960	9,631	11,194	576	407	10,207	11,601
1961	8,744	10,266	627	422	9,371	10,688
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

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,658	$3,334	3,622	$3,243
Paving	902	915	1,213	1,172
Fill	397	341	421	371
Industrial glass	450	1,164	469	1,166
Other [1]	638	2,149	684	2,357
Total	6,045	7,903	6,409	8,309
Gravel:				
Building	2,156	2,307	2,595	3,033
Paving	1,452	1,247	1,279	1,139
Fill	8	6	199	86
Other [2]	147	117	279	195
Total	3,763	3,677	4,352	4,453
Total sand and gravel	9,808	11,580	10,761	12,762
Government-and-contractor operations:				
Sand:				
Paving	85	103	43	49
Gravel:				
Building	42	30		
Paving	718	547	679	569
Total sand and gravel	845	680	722	618
Grand total	10,653	12,260	11,483	13,380

[1] Includes molding, filtering, railroad ballast, and other construction, industrial, and ground sand.
[2] Includes railroad ballast and miscellaneous gravel.

TABLE 11.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adair	1	$1	Mississippi	2	$3
Boone	71	75	Moniteau	17	14
Buchanan	215	222	Montgomery	136	111
Butler	19	11	Morgan	63	52
Callaway	59	49	Ozark	4	6
Camden	15	12	Pemiscot	343	343
Chariton	4	4	Phelps	15	15
Christian	34	26	Pike	15	14
Cole	156	147	Polk	3	2
Dallas	20	16	Pulaski	71	79
Daviess	102	125	Reynolds	2	2
Dent	5	4	St. Clair	9	6
Douglas	288	141	St. Louis	5,233	6,398
Dunklin	148	134	Stone	17	14
Franklin	294	297	Sullivan	8	8
Gasconade	4	3	Taney	4	3
Hickory	14	12	Texas	6	10
Howard	51	46	Vernon	6	4
Jefferson	538	985	Warren	20	17
Laclede	26	20	Webster	19	15
Lafayette	98	101	Wright	24	19
Lincoln	193	198	Other counties [1]	2,998	3,509
McDonald	33	24			
Miller	80	83	Total	11,483	13,380

[1] Includes Barry, Cape Girardeau, Cooper, Crawford, Gentry, Howell, Jackson, Jasper, Lawrence, Lewis, Livingston, Maries, Monroe, Nodaway, Osage, Perry, Ralls, St. Charles, St. Francois, Ste. Genevieve, Stoddard, Washington, and Wayne Counties combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

TABLE 12.—Stone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value	Quantity	Value
Dimension and building:				
Rough construction—short tons	13,765	$302,206	7,294	$383,779
Flagging and rubble—do	12,750	48,804	21,336	83,289
Rough architectural—cubic feet	W	W	W	W
Dressed (cut or sawed)—short tons	W	W	W	W
Total—approximate short tons	38,412	2,263,828	38,553	2,432,454
Crushed and broken:				
Riprap—short tons	3,557,218	3,109,493	2,482,274	2,216,059
Concrete aggregate, roadstone, etc—do	17,496,786	23,570,633	18,244,289	25,045,716
Railroad ballast—do	261,193	146,314	338,599	173,783
Agricultural—do	2,684,423	4,601,017	3,303,573	5,475,150
Cement—do	3,313,242	3,313,242	3,473,596	3,473,596
Other [1]—do	3,533,267	9,125,223	3,605,832	9,167,071
Total—do	30,846,129	43,865,922	31,448,163	45,551,375
Grand total—do	30,884,541	46,129,750	31,486,716	47,983,829

W Withheld to avoid disclosing individual-company confidential data; included in total.
[1] 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.

Limestone, because of its widespread availability and numerous uses, dominated the stone industry; production of over 30.6-million tons valued at $44.6 million accounted for 97 percent of output and 93 percent of total value. More than half of the limestone output was utilized for concrete aggregate and/or roadstone. Other important uses were for cement, agricultural limestone (aglime), and riprap.

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

Year	Granite		Marble		Limestone	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1960	3,806	$233	148,930	$1,737	26,410,534	$35,475
1961	4,532	295	139,477	2,125	24,852,463	33,716
1962	4,452	286	W	W	27,900,975	40,889
1963	2,958	317	W	W	r 29,776,088	r 42,711
1964	3,226	292	W	W	30,567,256	44,586

Year	Sandstone		Miscellaneous stone [1]		Total stone	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1960	2,811	$42	614,287	$391	27,180,368	$37,878
1961	2,948	42	631,250	399	25,630,670	36,577
1962	[2] 2,943	38	495,226	345	28,876,422	44,006
1963	[2] 3,655	55	576,111	484	30,884,541	46,130
1964	[2] 2,208	29	560,137	452	31,486,716	47,984

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Total stone."
[1] Chat; also includes small quantity of other stone.
[2] Excludes crushed sandstone: included with "Total stone."

Dimension granite was produced in Iron County; value of output was lower than in 1963. Commercial-grade marble was mined in five counties: Jasper, Greene, Jefferson, Ste. Genevieve, and Madison. Important uses were for building and terrazzo chips; output was higher than that of 1963.

Lower output was reported for miscellaneous stone and sandstone. Four operators produced miscellaneous stone, principally waste prod-

TABLE 14.—Stone production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Boone	613	$846	Livingston	316	$545
Buchanan	385	528	Maries	70	91
Caldwell	174	243	Mercer	213	280
Callaway	1,139	1,422	Miller	42	77
Camden	13	16	Moniteau	42	74
Cedar	50	84	Monroe	85	114
Clark	172	195	Newton	39	65
Clay	967	1,451	Pike	244	366
Clinton	90	150	Putnam	47	69
Dade	64	110	Ray	522	1,018
Daviess	237	429	St. Charles	612	844
DeKalb	310	418	St. Clair	337	453
Dent	(1)	(1)	St. Francois	1,286	1,157
Franklin	191	230	Ste. Genevieve	2,691	7,270
Grundy	168	239	St. Louis	5,190	6,257
Howard	257	269	Saline	425	553
Iron	13	304	Shelby	8	9
Jackson	3,403	4,633	Vernon	52	80
Jefferson	378	580	Wright	120	170
Johnson	287	417	Other counties [2]	9,772	15,308
Lafayette	364	434			
Linn	99	186	Total	31,487	47,984

[1] Less than ½ unit.
[2] Includes Audrain, Barry, Barton, Bates, Cape Girardeau, Cass, Cooper, Gentry, Greene, Harrison, Henry, Holt, Jasper, Knox, Lawrence, Lewis, Lincoln, Madison, Marion, Montgomery, Nodaway, Oregon, Perry, Pettis, Phelps, Platte, Ralls, Randolph, Scotland, Scott, Shannon, Taney, Warren, Wayne, and Worth Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

ucts from lead-zinc mining, for road base, railroad ballast, roofing granules, and fluxing. Dimension sandstone was prepared for building purposes by two operators in Shannon and Vernon Counties.

The Ruberoid Co. plant near Annapolis, Iron County, was nearly completed at yearend; full-scale operation was expected in 1965. Felsitic rock will be mined and processed into roofing granules.

METALS

Production of four metals, lead, iron, copper, and zinc, was valued at $48.1 million, significantly higher than that of 1963. Lead and iron ores were the principal minerals mined. Silver-bearing residues, coproducts of refining operations at the Herculaneum smelter, were not processed for silver in 1964.

Significant developments affecting the metal industry and economy of the State highlighted the year. Eight major companies were developing large base-metal resources in the new "lead belt" and iron district of southeast Missouri. New mines and processing facilities in various stages of construction will raise lead production to about 350,000 tons of recovered metal annually. Annual iron-ore production was scheduled to be raised to more than 3 million tons of high-grade iron pellets. Capital expenditures totaling about $200 million have been obligated and include the following projects.

Granite City Steel Co. and Laclede Steel Co., two major steel producers in the St. Louis area, announced plans to double their steelmaking capacity. Granite City Steel planned to spend $120 million during the period 1965–67 for capital improvements, including construction of an 80-inch, fully computerized, continuous hot-strip mill; a new basic oxygen-furnace plant capable of producing 2.2 million ingot tons annually; and a continuous galvanizing facility. The Laclede Steel Co. $10-million-expansion programs included construction of two electric-arc furnaces having a capacity of 150 tons per charge. Capacity of the company's open-hearth furnace was about 620,000 ingot tons annually; output will increase to about 800,000 ingot tons annually when expansion is completed.

Copper.—Copper contained in the 3 million tons of lead ore mined in St. Francois County was recovered as a coproduct in smelting operations. In 1964, a ton of copper was recovered for each 1,444 tons of ore processed compared with 1,791 tons in 1963.

Iron Ore.—Significantly contributing to the greatly increased output of iron ore was the commencing of pelletizing at the Meramec Mining Co. Pea Ridge facility near Sullivan, Washington County in February. The underground mine produced over 1 million tons of Precambrian magnetite ore which was processed into high-grade iron pellets for shipment to Bethlehem Steel Corp., Johnstown, Pa., Armco Steel Corp., Hamilton, Ohio; Sheffield Division of Armco Corp., Kansas City, Mo.; and Lone Star Steel Co., Daingerfield, Tex. The facility was a $52-million joint venture of St. Joseph Lead Co. and Bethlehem Steel Corp. At full capacity, the five pelletizing furnaces will produce annually 2 million tons of iron-ore pellets containing about 68 percent iron. Output of the mine will be equally shared by St. Joseph Lead Co. and Bethlehem Steel Corp., with the latter company acting as sales agent.

Pilot Knob Pellet Co., jointly owned by Hanna Mining Co. and Granite City Steel Co., announced a $23-million project for construction and development of an iron-ore mine, beneficiating-pelletizing plant, and related facilities near Pilot Knob. The facility was expected to produce about 1 million tons of high-grade ore pellets per year for shipment to the Granite City plant in the metropolitan St. Louis area. The magnetite deposit, discovered several years ago by Hanna exploration teams, ranges in depth from 400 to 1,500 feet. Frazier-Davis Co., a St. Louis contractor, began to sink a 20-foot-diameter 1,600-foot-deep production shaft at yearend. The project was scheduled for operation by mid-1967. When completed, the new mine and plant will employ about 250 workers; 175 were employed at the Iron Mountain mine, which will be phased out.

TABLE 15.—Iron ore (usable)

(Thousand long tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955-59 (average)	378	$3,534	1962	346	$3,188
1960	365	3,760	1963	345	3,085
1961	341	3,633	1964	1,116	14,907

TABLE 16.—Ferrous scrap and pig iron consumption

(Thousand short tons)

Year	Ferrous scrap	Pig iron	Total scrap and pig iron
1960	828	45	873
1961	869	24	893
1962	865	29	894
1963	908	33	941
1964	1,029	40	1,069

Crude iron-ore output at the Iron Mountain mine of M. A. Hanna Co., Missouri Division, was 5 percent higher than in 1963. The ore was concentrated to 54 percent iron and shipped to the Granite City Steel Co. steel complex near St. Louis under a long-term contract.

Brown iron ore was mined by open-pit methods in Howell County by three operators for shipment to an out-of-State industry.

Lead.—Missouri ranked first among the States in lead production, a position it has held for 56 of the last 57 years. Output of recoverable lead in the State remained at 42 percent of domestic-mine output. Lead was recovered from 5-million tons of ore produced in Crawford, Iron, St. Francois, and Washington Counties; of this amount, 40 percent came from mines in the western extension of the southeast Missouri "lead belt," compared with 38 percent in 1963 and 31 percent in 1962. Recoverable metal attributed to ore mined in the new district exceeded 50 percent of the State output in 1964, thus reflecting the higher grade of ores.

National Lead Co. and Bunker Hill Co. announced a development agreement involving the Higdon lead-zinc ore body discovered several years ago near Fredericktown. The ore body reportedly contains about 10-million tons of lead-zinc ore, and indications were favorable for development of additional ore. Bunker Hill planned

to spend about $3.5 million to bring the property into production. Under the agreement, the two companies would share equally in the profits after exploration and development costs have been recovered.

St. Joseph Lead Co. authorized expenditures of $12 million for development of the Fletcher mine and processing plant near Bunker. At yearend, the first ore shaft was reported at more than 800 feet of the projected 1,300-foot depth. Drilling of the second shaft was scheduled to start in early 1965. The mill had a projected capacity of 5,000 tons per day. The company's No. 29 mine in south Washington County was completed and operating at full capacity at yearend. The three producing mines in the Viburnum area supplied ore to operate the mill at its designed capacity of 7,000 tons per day.

St. Joseph Lead Co. awarded Treadwell Corp. a contract for project management, engineering, and design for enlarging and modernizing lead-smelting facilities at Herculaneum. A plant capacity of more than 200,000 tons of refined lead annually was planned. The $11-million expansion program was scheduled for completion in late 1966.

Missouri Lead Operating Co., a joint venture of American Metal Climax, Inc., and Homestake Mining Co., announced discovery of a lead deposit near Buick of sufficient size to support a mining operation for many years. Shaft sinking and construction of other related facilities was scheduled for 1965. The company was investigating feasibility of constructing a lead smelter to treat lead-concentrate production from new mines developed in the area.

A Magmont Mining Co. lead ore discovery north of Buick, a joint venture of Magnet Cove Barium Corp. and Montana Phosphate Products, was reported in a quarterly report issued by the former company. Results of extensive drilling indicate that the property contains about 15-million tons of ore comparable in grade to that mined in the new "lead belt." Construction of a mine and mill were planned to begin in early 1965.

TABLE 17.—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)	Old tailing (short tons)	Troy ounces	Value (thousands)	Short tons	Value (thousands)
1955-59 (average)		6,424,881	904,260	267,567	$242	1,542	$1,053
1960	5	5,897,813		15,594	14	1,087	698
1961	7	5,242,779		11,793	11	1,479	887
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

Year	Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955-59 (average)	118,765	$32,607	2,452	$616	$34,518
1960	111,948	26,196	2,821	728	27,636
1961	98,785	20,350	5,847	1,345	22,593
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

TABLE 18.—Mine production of lead and zinc in southeastern and central 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)
1955–59 (average)	167,908	$28,383	4,174	$349	118,765	$32,607	2,452	$616
1960	155,781	23,105	5,602	446	111,948	26,196	2,821	728
1961	137,862	18,720	11,024	973	98,785	20,350	5,847	1,345
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

[1] Based on southeastern and central Missouri ore "dirt" and old tailing 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 19.—Tenor of lead and zinc ore milled and concentrates produced in southeastern Missouri

		1963	1964
Concentrate production:			
Lead	short tons	109,960	167,630
Zinc	do	666	3,115
Concentrate obtained from:			
Lead	percent	3.38	3.38
Zinc	do	0.02	0.06
Metal content of ore: [1]			
Lead	do	2.45	2.42
Zinc	do	0.01	0.03
Average lead content of galena concentrate	do	74.09	73.14
Average zinc content of sphalerite concentrate	do	53.60	53.55
Average value per ton:			
Galena concentrate		$136.91	$167.78
Sphalerite concentrate		r $74.64	$65.71
Total material milled	short tons	3,253,245	4,965,814

r Revised.
[1] Figures represent metal content of crude ore only as recovered in the concentrate; data on tailing losses not available.

TABLE 20.—Mine production of copper, lead, and zinc in 1964 by months, in terms of recoverable metals

Month	Copper (short tons)	Lead (short tons)	Zinc (short tons)
January	182	10,332	1
February	164	9,121	32
March	209	10,732	161
April	215	9,680	148
May	187	9,397	96
June	177	10,126	23
July	161	9,970	115
August	145	9,626	58
September	152	9,769	122
October	143	10,200	131
November	161	10,012	292
December	163	11,183	322
Total:			
1964	2,059	120,148	1,501
1963	1,816	79,844	321

Demand for lead continued at a high level because of increased uses, principally in batteries and gasoline additives. Lead consumption in the United States has increased more rapidly than mine production, creating a competitive market for concentrates and pressure on the metal price. The price of lead rose to 16 cents per pound at year-end; the increase was the fourth one in the year for a total of 3.5 cents.

Zinc.—Zinc contained in 2-million tons of lead ores mined in Crawford, Iron, and Washington Counties was recovered as a coproduct in milling operations. In 1964, 1 ton of zinc concentrate was recovered for each 640 tons of crude ore milled compared with 3,575 tons in 1963. No zinc was produced in the Missouri part of the Tri-State district for the seventh consecutive year.

MINERAL FUELS

Three mineral fuels supplied 7 percent of the total mineral-producing wealth in Missouri. Valued output approximated that produced in 1963. Coal was the most important commodity produced; leading counties include Henry, Macon, Boone, and St. Clair.

Missouri coal and heavy oil resources constituted the principal source of mineral fuels in 77 of the 114 counties. Missouri coal was used mainly as fuel for generating electrical energy. The Associated Electric Cooperative was constructing a $30-million steamplant near Thomas Hill, Randolph County. The single unit will have a capacity of 150,000 kilowatts for distribution to 41 Rural Electric Association cooperatives having 250,000 rural customers, mostly in the northern and western parts of Missouri. The annual 300,000 tons of coal will be supplied by Peabody Coal Co. Bee Veer mines.

Oil sands cover an area of several hundred square miles in the west central portion of the State. Two pilot-plant experimental recovery projects were active in this area. Large areas were under lease.

Coal.—About two-thirds of the output of coal was utilized as fuel in steam-generated electric powerplants. The economics of using coal in steam-generated plants improved because of a reduction in transportation costs due to the development of unitized trains, mine-mouth generation plants, and transmission of electrical energy via high-voltage lines to marketing areas.

Sixteen stripping operations in nine counties accounted for nearly all the coal mined in Missouri; about 1 percent came from four underground mines. No auger production was reported. Overburden removed by stripping operations during 1964 totaled 54-million cubic yards. The average cost of producing 1 ton of coal in Missouri was $4.08 compared with $4.16 in 1963 and 1962.

TABLE 21.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	2,966	$12,347	1962	2,896	$12,057
1960	2,890	12,450	1963	3,174	13,196
1961	2,938	12,567	1964	3,254	13,285

Missouri coal was processed in crushing and/or cleaning plants. A total of 3.15-million tons or 97 percent of output was crushed in nine plants. Six cleaning plants processed nearly 2-million tons of coal or 61 percent of the production. A small quantity was oil treated. Coal was transported by railroad and waterway, 55 percent; by truck, 13 percent; and by other methods, 32 percent.

Petroleum and Natural Gas.—Crude oil was produced from about 100 wells in 6 counties; St. Louis County was the largest producer. Output was slightly higher than that of 1963. Marketed production of natural gas was reported from gasfields in Clinton and Caldwell Counties. The Turney gasfield in Clinton County accounted for most of the output. Natural gas was used locally for heating purposes.

In 1964, 12 holes totaling 13,000 feet were drilled in 7 Missouri counties in search of oil and/or gas; all were dry.

REVIEW BY COUNTIES

Mineral production was reported in 106 of the 114 counties in Missouri, 1 more than in 1962. No mineral production was reported in Andrew, Benton, Bollinger, Carroll, Carter, New Madrid, Ripley, and Schuyler Counties. Twenty-three counties reported mineral production valued at $1 million or over, 1 more than in 1963. The five leading mineral-producing counties, St. Louis, St. Francois, Washington, Ste. Genevieve, and Cape Girardeau, accounted for more than 55 percent of the total value of mineral production in the State.

Adair.—Billy Creek Coal Co., Inc., mined coal at the Baiotto underground mine near Novinger, most of this was sold to the Kirksville city powerplant. Paving sand was produced for the State highway department.

Atchison.—Petroleum was the only mineral commodity produced in the county. Five wells pumped oil from the Tarkio pool. Two unsuccessful exploration holes totaling 2,825 feet were drilled for oil.

Audrian.—Mineral value rose 24 percent, due mainly to higher clay output. The county ranked first in fire-clay production. Seven companies mined refractory clays in nine pits; Havener mine was the largest and accounted for 37 percent of the county's output. Molino Lime Quarry Co., Inc., produced crushed limestone for roadstone and aglime.

Barry.—Limestone was quarried and crushed for aglime and roadstone by Douthitt Lime Co. east of Purdy. Paving gravel was produced for the State highway department.

Barton.—Stone output accounted for an increase of 42 percent in total mineral value. John J. Stark, contractor, quarried and crushed limestone for aglime and road surfacing near Lamar. Bar-Co Roc Asphalt Co. mined asphaltic sandstone for road surfacing material; output declined in value for the third consecutive year.

Bates.—Two companies at three locations quarried and crushed limestone for aglime and road surfacing; Alvis Rock Products, Inc., was the largest producer. Shell Oil Co. was conducting pilot-plant studies on fire flooding of heavy oil deposits near Rich Hill. Exploratory drilling for oil to a depth of 455 feet was unsuccessful. Breckenridge Feed & Grain Co. built a fertilizer plant near Rich Hill to

TABLE 22.—Value of mineral production in Missouri, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Adair	W	$133,424	Coal, sand and gravel.
Atchison	W	14,980	Petroleum.
Audrain	$1,044,000	1,293,280	Clays, stone.
Barry	210,371	64,970	Stone, sand and gravel.
Barton	W	W	Stone, asphaltic sandstone.
Bates	339,723	W	Stone.
Benton	3,910	----	
Boone	3,294,579	3,249,753	Coal, stone, sand and gravel, clays.
Buchanan	486,819	750,448	Stone, sand and gravel.
Butler	20,846	11,200	Sand and gravel, clays.
Caldwell	192,183	242,782	Stone, natural gas.
Callaway	1,115,083	2,151,192	Stone, clays, coal, sand and gravel.
Camden	60,451	27,590	Stone, sand and gravel.
Cape Girardeau	13,334,975	13,673,447	Cement, stone, clays, sand and gravel.
Carroll	4,119	----	
Carter	10,237	----	
Cass	312,759	412,959	Stone, clays, petroleum.
Cedar	83,948	84,000	Stone.
Chariton	906	4,000	Sand and gravel.
Christian	13	26,000	Do.
Clark	369,436	W	Stone, coal.
Clay	1,356,095	1,450,591	Stone.
Clinton	r169,715	149,810	Stone, natural gas.
Cole	208,290	147,000	Sand and gravel.
Cooper	607,996	299,500	Stone, sand and gravel.
Crawford	3,563,522	6,149,257	Lead, sand and gravel, clays, zinc.
Dade	223,724	190,219	Stone, coal.
Dallas	----	16,000	Sand and gravel.
Daviess	371,240	554,442	Stone, sand and gravel.
De Kalb	W	417,904	Stone.
Dent	----	4,390	Sand and gravel, stone.
Douglas	218,750	141,000	Sand and gravel.
Dunklin	W	134,000	Do.
Franklin	724,668	596,584	Sand and gravel, stone, clays.
Gasconade	967,981	1,125,868	Clays, sand and gravel.
Gentry	W	W	Stone, sand and gravel.
Greene	3,413,331	3,677,415	Stone, lime.
Grundy	284,839	239,324	Stone.
Harrison	W	W	Do.
Henry	5,551,473	6,537,729	Coal, stone.
Hickory	----	12,000	Sand and gravel.
Holt	W	W	Stone.
Howard	86,685	315,008	Stone, sand and gravel.
Howell	726,695	363,498	Iron ore, sand and gravel.
Iron	4,036,678	6,814,442	Lead, stone, zinc.
Jackson	11,572,320	11,605,087	Cement, stone, sand and gravel, clays, petroleum.
Jasper	2,629,503	2,858,740	Stone, sand and gravel.
Jefferson	1,358,309	1,565,013	Sand and gravel, stone.
Johnson	279,190	416,649	Stone.
Knox	W	W	Do.
Laclede	37,714	20,000	Sand and gravel.
Lafayette	660,224	535,306	Stone, sand and gravel.
Lawrence	160,377	101,067	Do.
Lewis	W	803,603	Sand and gravel, stone.
Lincoln	313,249	315,750	Sand and gravel, stone, clays.
Linn	205,184	185,750	Stone.
Livingston	378,367	636,720	Stone, clays, sand and gravel.
Macon	W	W	Coal.
Madison	W	W	Stone.
Maries	133,457	142,225	Stone, clays, sand and gravel.
Marion	W	1,034,092	Stone, lime.
McDonald	28,766	24,000	Sand and gravel.
Mercer	W	279,837	Stone.
Miller	157,732	160,000	Sand and gravel, stone.
Mississippi	----	3,000	Sand and gravel.
Moniteau	88,367	88,250	Stone, sand and gravel.
Monroe	400,746	394,344	Clays, stone, sand and gravel.
Montgomery	736,728	967,482	Stone, clays, sand and gravel.
Morgan	41,003	52,000	Sand and gravel.
Newton	86,100	65,317	Stone.
Nodaway	W	370,896	Stone, sand and gravel.
Oregon	W	W	Stone.
Osage	W	55,369	Clays, sand and gravel.
Ozark	2,978	6,000	Sand and gravel.
Pemiscot	W	343,000	Do.
Perry	W	W	Stone, sand and gravel.
Pettis	W	W	Stone.

See footnotes at end of table.

TABLE 22.—Value of mineral production in Missouri, by counties [1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Phelps	$141,477	$87,588	Stone, clays, sand and gravel.
Pike	378,053	379,738	Stone, sand and gravel.
Platte	W	193,272	Clays, stone.
Polk	10,866	2,000	Sand and gravel.
Pulaski	93,453	79,000	Do.
Putnam	506,783	578,544	Coal, stone.
Ralls	6,875,527	8,154,061	Cement, stone, clays, sand and gravel.
Randolph	311,059	W	Stone.
Ray	W	1,017,707	Do.
Reynolds	8,857	2,000	Sand and gravel.
St. Charles	1,536,516	1,506,117	Stone, sand and gravel, clays.
St. Clair	1,953,241	1,292,557	Coal, stone, sand and gravel.
St. Francois	14,627,199	21,910,124	Lead, iron ore, lime, copper, stone, sand and gravel.
St. Louis	32,214,723	31,925,879	Cement, sand and gravel, stone, clays, petroleum.
Ste. Genevieve	17,439,475	17,575,887	Lime, stone, sand and gravel.
Saline	1,100,295	552,503	Stone.
Scotland	W	W	Do.
Scott	W	W	Do.
Shannon	W	W	Do.
Shelby	W	8,708	Stone.
Stoddard	W	W	Sand and gravel.
Stone	12,522	14,000	Do.
Sullivan	10,264	8,000	Do.
Taney	W	W	Stone, sand and gravel.
Texas	28,198	10,000	Sand and gravel.
Vernon	313,085	290,060	Coal, stone, sand and gravel, petroleum
Warren	286,723	254,209	Clays, stone, sand and gravel.
Washington	5,678,588	20,028,080	Iron ore, lead, barite, zinc, sand and gravel.
Wayne	143,311	W	Stone, sand and gravel.
Webster	23,335	15,000	Sand and gravel.
Worth	W	W	Stone.
Wright	47,885	189,072	Stone, sand and gravel.
Undistributed	r 12,580,211	8,725,391	
Total	r 158,988,000	189,305,000	

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 1963 or 1964: Andrew, Bollinger, New Madrid, Ripley, and Schuyler.

produce bulk fertilizer and store all grades of dry manufactured fertilizer and liquid nitrogen.

Benton.—No mineral production was reported. The U.S. Congress approved $2.5 million for Kaysinger Bluff Reservoir construction and road relocation during fiscal year 1965. The multipurpose project is on the Osage River and will ultimately cost $154 million.

Boone.—Boone County ranked third in value of coal mined. The Peabody Coal Co. Mark Twain mine near Hinton accounted for the county's coal production. Limestone was quarried and crushed for aglime and roadstone by Adrian Materials Co., Boone Quarries, Inc., Brown Quarries, Inc., and Garretts City Quarry Co. Columbia Sand Co. processed sand and gravel for building and paving. Fire clay and shale were mined by Columbia Brick & Tile Co. and processed into building bricks.

Buchanan.—Value of mineral production rose significantly, due to higher output of sand and gravel and stone. Three commercial operators at four locations quarried and crushed limestone for aglime, road surfacing, and riprap; George W. Kerford was the largest producer and accounted for nearly half of the output. Pioneer Sand Co. processed sand for building, paving, railroad ballast, and fill in St. Joseph.

Caldwell.—Value of stone rose 26 percent; demand was generated by an active highway construction program in the area. Everett Quarries, Inc., Farmers Rock & Lime Co., and Kingston Stone Co. quarried and crushed limestone for aglime, roadstone, and riprap. Some natural gas was produced from two wells in the Polo gasfield and used locally.

Callaway.—The county ranked third in value of clay output and seventh in value of coal and stone production. Limestone was quarried and crushed for aglime, railroad ballast, riprap, and road material by Auxvasse Stone & Gravel Co., McMenamy Materials, Inc., Mo-Con., Inc., of Fulton, Sulgrove Mining & Quarry Co., and Trager Quarries, Inc. Fire clays were processed into firebrick and block, high-alumina brick, mortar, and clay crucibles by Harbison-Walker Refractories Co., H. K. Porter Co., Inc., Kaiser Refractories, Division of Kaiser Aluminum & Chemical Corp., and Walsh Refractories Corp. Clayton-Hensley strip-mined coal at its Hammitt pit. Callaway Sand Co. processed sand for building and paving near Mokane.

Cape Girardeau.—The county ranked second in value of cement and miscellaneous clay output and sixth in stone production. Marquette Cement Manufacturing Co. produced cement, utilizing clay and limestone from company-operated quarries near Cape Girardeau. The Federal Materials Co., Inc., and Farmers Limestone Co. quarried and crushed limestone for aglime, riprap, and road material. Miscellaneous shale was mined at two pits for building brick and pottery by Ceramo Co., Inc., and Kasten Clay Products, Inc. Cape Girardeau Sand Co. processed sand for building, paving, and fill. The Mississippi Embayment was drilled for oil and/or gas to a depth of 1,270 feet; the hole was reported a duster. Two bond issues, totaling $475,000, were approved by Jackson City voters for use in constructing a plant which will be leased to Lee-Rowan Co., a producer of metal products. About 85 workers are expected to be employed.

Cass.—Mineral output rose 28 percent due to increased stone production. Limestone was quarried and crushed for aglime, riprap, and road material by Deitz-Hill Development Co., Hackler & Limpus Quarry, and Marino & Hoover Construction Co., Inc. Acme Brick Co. processed miscellaneous clay into building brick near Harrisonville. A small quantity of petroleum was produced. The Clark-Miller oil pool was purchased by Layton Oil Co.

Cedar.—Limestone was quarried and crushed for aglime and roadstone by George M. Baker Co. Work on the 4,900-foot embankment for Stockton Dam was initiated in May 1964 by the Ames Construction Co. of Oklahoma City, prime contractor. The U.S. Army Corps of Engineers multipurpose project on the Sac River is scheduled for completion in 1968; $4 million was authorized for expenditure during fiscal year 1965.

Clark.—Value of stone and coal, the only minerals produced, declined from the 1963 level. Limestone was quarried and crushed for aglime and road-surfacing material by Baker Quarry Co. Coal was strip mined for local markets by Hamlin Bros. Coal Co.

Clay.—Value of stone output rose 7 percent because of an active road-building program in the Kansas City area. Limestone was quarried

and crushed for aglime, riprap, and road material by Everett Quarries, Inc., Kansas City Concrete Co., Midwest Precote Co., and J. H. Oldham Stone Co. Commercial production of copper powder from copper ores and scrap was initiated by the Monsanto Co. at a Kansas City facility. Chemetal Corp. granted the rights to utilize its patented process to Monsanto.

Clinton.—Everett Quarries, Inc., quarried and crushed limestone at two locations for aglime, riprap, and roadstone. Five gas wells in the Turney gasfield supplied Plattsburg with natural gas for heating purposes.

Cooper.—Castle Bros. Quarry Co. and Hall & Riley Quarries quarried and crushed limestone for aglime, riprap, and road-surfacing material. Sand for paving was processed by the Missouri River Sand & Gravel Co. The State highway department contracted for paving gravel.

Crawford.—The county ranked third in recovered lead and zinc metals. St. Joseph's No. 27 mine in southeast Crawford County produced lead ores which were transported by truck to the Viburnum mill in Iron County for processing. Zinc metal was recovered from the lead ores. Clyde Deaton, Inc., and G. J. Marr Materials produced sand and gravel for building, paving, and fill. The State highway department contracted for paving gravel. Walsh Refractories Corp. mined fire clay for firebrick and block.

Dade.—Limestone was quarried for aglime and roadstone by Allen Quarries. Tyler & Claypool Coal Co. strip-mined coal east of Arcola. The Cawlfield Mining Co. conducted mineral exploration east of Greenfield; five holes totaling about 2,000 feet were drilled.

Daviess.—Value of mineral production rose significantly because of increased stone and sand and gravel production; demand was generated by an active highway-construction program in the county. Limestone was quarried and crushed at two locations for aglime and roadstone by Snyder Quarries, Inc. Bethany Falls Transit Mixed Concrete Co., Snyder Quarries, Inc., and Hallett Construction Co. mined sand and gravel for building, paving, and miscellaneous purposes.

Franklin.—Meramec Aggregates, Inc., Pacific Pebbles, Inc., and Washington Sand Co. processed sand and gravel for building purposes. Paving sand and gravel was contracted by the State highway department. Four commercial operators at five locations quarried and crushed limestone for aglime, riprap, and roadstone; George P. Dawson, Inc., was the largest producer. Kaiser Refractories, General Refractories Co., and Walsh Refractories Corp. mined fire clay at seven pits for processing into firebrick and block, high-alumina brick, mortar, and clay crucibles.

Planning funds for the Meramec State Park Reservoir were included in an appropriation bill approved by the U.S. Congress. The dam will be built near Sullivan and will create a 12,600-acre lake extending into adjoining Crawford County.

Gasconade.—Mineral output increased 16 percent over that of 1963, due principally to higher production of fire clay. The county ranked second in fire-clay output. Eight companies mined fire clay in 43 pits for use in manufacturing refractories; A. P. Green Fire Brick Co. and Kaiser Refractories were the largest producers. Gravel was processed for paving near Herman by George J. Engeman.

Gentry.—Mineral output rose 30 percent, due to an increase in demand for stone for an active highway-construction program in the county. Albany Gravel Co., Inc., quarried and crushed limestone for aglime and roadstone; it also produced building and paving sand and gravel.

Greene.—Greene County ranked fifth in stone output and third in lime, which were the only minerals produced. Limestone was quarried and crushed for aglime and roadstone by the Ash Grove Lime & Portland Cement Co., Conco Quarries, Inc., Graystone Quarry Co., and Griesemer Stone Co. Hydrated lime and quicklime were manufactured from limestone quarried by Ash Grove Lime & Portland Cement Co. at the Galloway plant. Carthage Marble Corp. sawed and cut marble blocks at its Phoenix quarry for processing at its Carthage plant into commercial-grade building stone.

Henry.—The county ranked first in value of coal output. Five strip mines were active, two were operated by Peabody Coal Co. and one each by Bevier Coal Co., Hoppe Coal Co., and Madole Bros. Coal Mine. Limestone was quarried and crushed for aglime, riprap, and roadstone by Davis Rock Co., Williams Rock Co., Inc., and Williams Rock Mining Co., Inc.

Howard.—Output of stone and sand and gravel increased significantly, due to an active highway-building program. Limestone was quarried and crushed for aglime, riprap, and roadstone by Glasgow Quarries, Inc., and Green Quarries, Inc.

Howell.—The county ranked first in brown iron-ore production. Plateau Iron Ore Corp., Schroeder Mining Co., and Shook & Fletcher Supply Co. mined and washed brown iron ores. Gravel for paving purposes was quarried by Doss & Harper Gravel Co. near Peace Valley.

Iron.—The county ranked second in recovered lead and zinc metals. St. Joseph Lead Co.'s No. 28 mine produced lead ore for beneficiation in the Viburnum mill. The Heyward Granite Co. quarried and processed dimension granite near Graniteville for building and monumental stone. The Pilot Knob Pellet Co. started sinking a 20-foot-diameter mine shaft north of Ironton.

American Zinc-Lead Mining Co. was utilizing three drilling rigs for mine and milling data on the previously discovered iron-copper-ore deposit in the Boss-Bixby area. Development of new lead mines near Buick were announced at midyear by Missouri Lead Operating Co. and Magmont Mining Co.

Jackson.—The county ranked sixth in value of mineral output, sixth in sand and gravel, fourth in cement, and third in miscellaneous shale and stone production. Due to a heavy demand by residential and industrial construction in the Kansas City area, stone and cement contributed the greatest dollar value. Missouri Portland Cement Co. manufactured masonry and portland cement at its Sugar Creek plant near Independence; limestone and shale were obtained from company-operated quarries. Limestone was quarried by nine commercial and one Government-and-contractor operation for aglime, roadstone, and miscellaneous purposes; Beyer Crushed Rock Co., Stewart Sand & Material Co., and Union Construction Co. were the principal producers. George & Clark Stone Contractors prepared dimension limestone for rough-construction, rough-architectural, and dressed-build-

ing stone. Gerald Hodgins Building Rock Quarries produced building stone and rubble. Stewart Sand & Material Co. processed sand for building, paving, and fill. Miscellaneous clay was mined at two pits for manufacture of heavy-clay products by Acme Brick Co. Crude vermiculite shipped from Libby, Mont., was exfoliated at the Zonolite Co., Kansas City plant; output increased 11 percent in value over that of 1963. A small quantity of crude oil was produced from 21 wells.

Jasper.—Highway construction in the area required large quantities of stone as well as sand and gravel and resulted in increased production. Carthage Crushed Limestone Co., Independent Gravel Co., Nelson Quarries, and Valentine Supply quarried and crushed limestone for aglime, roadstone, and miscellaneous purposes. Carthage Marble Corp. prepared commercial-grade marble for rough building stone, dressed building stone, and monumental stone. Chat was sold for railroad ballast, roofing, and other uses by American Zinc, Lead and Smelting Co., and Independent Gravel Co. Independent Gravel Co. produced sand for grinding, polishing, and other purposes and gravel for paving and railroad ballast. Solar Nitrogen Chemical Co., jointly owned by Atlas Chemical Co. and Standard Oil Co., completed a $3-million facility for producing ammonium-nitrate prills for use as blasting agents.

Jefferson.—Total mineral output increased 15 percent over that of 1963. Higher production of sand and gravel and stone, the only minerals produced, was due to increased output of industrial sand for manufacturing glass and of stone for building and highway construction. The county ranked second in value of sand and gravel production. Unground, high-purity silica sand for use in plate-glass manufacturing, molding, grinding, and polishing was mined by Pittsburgh Plate Glass Co., Masters Bros. Silica Sand Co., and Manley Sand Division of Martin-Marietta Corp. Sand and gravel for building and other purposes was produced by Ficken Material Co., and paving gravel was produced by the county highway department and contracted by the State highway department. One Government-and-contractor and six commercial operators quarried and crushed limestone for aglime, riprap, railroad ballast, and roadstone; Bussen Quarries, Inc., was the largest producer. Commercial-grade marble was quarried for various uses including terrazzo, by Marble Products Co. of Georgia. The first phase in constructing River Cement Co.'s $25-million plant was awarded to J. S. Alberici and Massman Construction Co., both of St. Louis; completion of the entire facility was scheduled for mid-1965. Allis-Chalmers was contracted to build a 510-foot-long rotary kiln. The Pittsburgh Plate Glass Co. was studying engineering plans for the construction of a float-glass plant, having an annual capacity of 50-million square feet. St. Joseph Lead Co. was expanding smelter operations at Herculaneum.

Johnson.—Output of stone increased significantly due to an active highway construction program. Limestone was quarried and crushed for aglime and roadstone at five locations, three operated by Deitz-Hill Development Co. and one each by Marr Bros. Quarry and Reno Construction Co.

Knox.—Value of stone output rose 13 percent due to an increase in use for soil conditioning and construction. Knox County Stone Co., Inc., and McSorley Lime & Rock Co., Inc., quarried and crushed limestone for aglime and road-surfacing material. Two exploratory holes testing the Lincoln Fold for oil and/or gas were drilled; both were dry.

Laclede.—The State highway department contracted for paving gravel. The Orla magnetic anomaly, south of Lebanon, was being studied for potential mineralization.

Lafayette.—Limestone was quarried and crushed for aglime, riprap, and roadstone by Deitz-Hill Development Co., Red Stone Co., and J. A. Tobin. Sand for building, paving, and other purposes was processed by Glasgow Sand Co. and Raymond Drivers Sand Co.

Lawrence.—Limestone was quarried and crushed for aglime and roadstone by Rose Quarry. Paving gravel was produced for the State highway department.

Lewis.—Valued output of mineral commodities rose significantly over 1963, due principally to increased production of sand and gravel. The county ranked fourth in value of sand and gravel output. Missouri Gravel Co. processed sand and gravel for building purposes south of LaGrange. Hamill Lime Co. and Missouri Gravel Co. quarried and crushed limestone for aglime and roadstone. Spencer Chemical Co. completed a $75,000 bulk fertilizer-blending plant near La Belle. The facility will stock a number of fertilizer grades, bagged fertilizer, and straight nitrogen.

Lincoln.—Kimaterials and Glacial Sand & Gravel Co. processed sand and gravel for building, paving, and fill. Paving gravel was also produced for the State highway department. Dawson Dameron, Presley & Roberts, and Watson Quarry, Inc., quarried and crushed limestone for aglime and roadstone. Harbison-Walker Refractories Co. mined fire clay near Whiteside for processing into firebrick and block, high-alumina brick, and mortar.

Livingston.—Increased output of stone accounted for a significant rise in value of mineral production for Livingston County. Limestone was quarried and crushed for aglime, riprap, and roadstone by Farmers Rock & Lime, Inc., Fred McVey Quarry, Trager Quarries, Inc., and Green Quarries, Inc. Midland Brick & Tile Co. mined and processed miscellaneous clay for brick and tile and other heavy-clay products. Cooley Gravel Co. processed sand for building and fill purposes, and paving sand was contracted by the State highway department. Forest City Basin Exploration Co. drilled two holes in search for oil and/or gas near Chillicothe; both were dry.

Macon.—The county ranked second in coal output, principally due to the Bee-Veer strip mine, the State's largest, operated by Peabody Coal Co. The company spent 2 weeks moving its 65-cubic-yard shovel, dubbed Big David, 6 miles north of Ardmore. The huge 3,500-ton machine traveled over specially built oaken mats (22 by 16 by 1½ feet). Coal reserves in the new area are of sufficient size to permit economic operation for about 10 years. The mine, under a long-term contract, will supply coal to the Thomas Hill powerplant now in the construction phase. Peabody Coal Co. also was building

an 8-mile rail spur to the new location; completion was scheduled for February 1965.

Madison.—Commercial-grade marble was crushed for terrazzo chips by the Marble Products Co. of Georgia; output rose 11 percent. Bunker Hill Co. was drilling the Higdon lead-zinc property northeast of Fredericktown to obtain data on milling and mining methods. The State Public Service Commission authorized Union Electric Co. to construct power-transporting facilities to the Higdon mine. The Missouri Pacific Railroad canceled plans to remove its Fredericktown railroad spur because of new mine development in the area. Bunker Hill Mining Co. will ship zinc concentrates by rail to its Idaho smelter.

Maries.—Limestone was mined and crushed for aglime and roadstone by Smith Quarries near Belle. Kaiser Refractories mined fire clay at the Birkner pit for processing into firebrick and block, high-alumina brick, and other refractories. Paving gravel was produced for the State highway department.

Marion.—Hydrated lime and quicklime were manufactured by the Marblehead Lime Co.; limestone came from a company-operated quarry. The company also quarried limestone for asphalt filler and soil conditioner. S. D. Fessenden & Sons produced limestone for aglime and roadstone. American Cyanamid Co. announced construction of a $15-million nitrogen-products fertilizer plant near Hannibal; capacity of the facility will be 173,000 tons of nitrogen solutions and ammonia nitrate annually. Completion was scheduled for early 1966 and approximately 100 workers will be employed. The only exploration hole drilled in the county in search for oil and/or gas was a duster.

Mercer.—Output of stone increased significantly due to an active highway-building program in the area. Stark-Cole Quarry, Gene McClain, and Wilcox Quarries mined and crushed limestone for aglime, riprap, and road surfacing material.

Miller.—C. W. Roweth Co., Elam Construction Co., Inc., and Kagee Mining Co., Inc., processed sand and gravel for building, paving, railroad ballast, and fill. The State highway department contracted for paving gravel. Benco Quarries, Inc., quarried and crushed limestone for aglime and roadstone southwest of Eugene.

Mississippi.—Paving sand was produced for the State highway department. No mineral production had been reported in Mississippi County since 1954.

Monroe.—The county ranked fifth in fire clay mined. Christy Firebrick Co. and Gilliam Mining Co. mined fire clay for use in horizontal zinc retorts; Walsh Refractories Corp. processed fire clay into firebrick and block. Hamilton Lime Co. and Wilkerson Bros. quarried and crushed limestone for aglime, riprap, and roadstone. Wilkerson Bros. produced and the county highway department contracted for paving gravel.

Montgomery.—Limestone was quarried and crushed for aglime and roadstone by McClain Lime Quarry. General Refractories Co., Kaiser Refractories, and Wellsville Fire Brick Co. mined fire clay at seven pits for use in manufacturing firebrick and block, high-alumina bricks, and other refractories. Two Rivers Sand & Gravel Co. pro-

duced and the State highway department contracted for sand and gravel for building and paving.

Newton.—The Southwest Lime Co. quarried and crushed limestone for aglime, roadstone, asphalt filler, and filter beds. American Tripoli Division of the Carborundum Co. processed tripoli ores at its Seneca plant for use as abrasives and foundry facings; output increased 14 percent in value over that of 1963. Tripoli ores came from company-operated mines in Oklahoma.

Nodaway.—Mineral output rose significantly because of higher production of stone. The demand was generated by an active highway-building program. Concrete Materials and Construction Co. and Turner Quarries, Inc., mined and crushed limestone for aglime and road-surfacing material. Earl Wilson Sand Co. processed sand and gravel from the Platte River for building purposes and other uses near Conception Junction.

Osage.—A. P. Green Fire Brick Co., H. K. Porter Co., Inc., and Kaiser Refractories mined fire clay at four pits for manufacturing firebrick and block. The State highway department and the county highway department produced sand and gravel for paving purposes.

Ozark.—Lick Creek Sand & Rock Corp. processed sand and gravel for building and paving south of Gainesville. Kerr-McGee Oil Industries of Oklahoma City conducted exploratory drilling on 360 acres of optioned land southwest of Caulfield. Zinc-lead mineralization was studied in the vicinity of the Alice and Rex mines by company geologists; no discoveries were announced.

Perry.—Gibbar Bros., Inc., quarried and crushed limestone for aglime, riprap, and road-surfacing material, and produced paving gravel.

Pettis.—An active highway-construction program accounted for increased sale of stone. Limestone was mined and crushed for concrete aggregate by W. J. Menefee Construction Co.

Phelps.—Limestone was mined and crushed for aglime and roadstone by Bray Construction Co. and Nivens Lime Quarry. Three pits, two mined by A. P. Green Fire Brick Co. and one by H. K. Porter Co., Inc., supplied fire clay for processing into firebrick and block. Grisham Sand & Gravel Co. processed sand and gravel for building purposes and gravel for paving and fill.

Pike.—Limestone was quarried and crushed for aglime, riprap, and concrete aggregate at five locations; two operated by Hamill Lime Co. and one each by Galloway Limestone Co., Magnesium Mining Co., and Smith's Grandview Quarries. The State highway department contracted for paving gravel.

Platte.—Miscellaneous clay was mined and processed into lightweight aggregate by Carter-Waters Corp. near New Market. Everett Quarries, Inc., mined and crushed limestone for aglime and concrete aggregate. Sandstone was quarried for riprap by Mid-Continent Stone & Construction Co.

Putnam.—Mineral output rose 13 percent over that of 1963, due principally to higher coal production. The county ranked fifth in value of coal output. Three underground mines operated by Henry T. Clark Coal Co., Rowland Coal Co., and Veach & Garr Coal Co. and two strip mines operated by Husted Bros. Coal Co. and Kirk-

ville Coal Co. produced coal. Limestone was quarried and crushed for aglime and roadstone by Bailey Limestone Co., Inc. George Medlin Drilling Co. drilled two holes in search for oil and/or gas; both were dry.

Ralls.—Total mineral-production value ranked seventh in the State; the county also ranked third in cement and fourth in miscellaneous clay production. Masonry and portland cement was manufactured by Universal Atlas Cement Division of United States Steel Corp.; clay and limestone came from company-operated quarries. Central Stone Co. quarried and crushed limestone for aglime and concrete aggregate. Paving gravel was processed by Edward B. Cooper near New London. Universal Atlas Cement is building a modern cement-production facility near Hannibal. A new single kiln, about 620 feet long and utilizing the wet process, will be one of the largest cement-clinker-producing units in the United States. The production facility will be designed to operate under one of the most complete computer-controlled systems in the cement industry.

Randolph.—Increased stone output was due to an active highway-building program in the area. Limestone was quarried and crushed for aglime and concrete aggregate by N. J. Cooksey Quarry Co., Potter Stone Quarry, and Green Quarries, Inc. Fateley Coal Co. mined a small quantity of coal for local markets. A $30-million steamplant was being built by the Associated Electric Cooperative near Thomas Hill. The facility will generate 150,000 kw of electricity for distribution to 41 Rural Electric Association cooperatives in northern and western Missouri. Coal, approximately 300,000 tons annually, will be supplied from the Peabody Coal Co.'s Bee-Veer mine.

Ray.—A significant increase in stone output was reported due to an active highway-building program in the area. Four quarries, two operated by Green Quarries, Inc., and one each by Orrick Stone Co. and Steva Stone Co. crushed limestone for aglime, riprap, and concrete aggregate.

Reynolds.—St. Joseph Lead Co. named its new Reynolds County lead mine "The Fletcher Mine" in honor of Andrew Fletcher, company president during the period 1947–60. At yearend shaft sinking had reached a depth of over 800 feet of the projected 1,300 feet. The mine will be electrically serviced by two 34.5 kilovolt lines, 18 miles long, installed by the Arkansas-Missouri Power Co. at an estimated cost of $750,000. The Ozark Lead Co. lead-mine project, northwest of Ellington, will include a production shaft and utility shaft; the latter was being drilled to a depth of 1,200 feet. At yearend, it was reported at 750 feet, with completion expected in early 1965.

St. Charles.—The county ranked third in sand and gravel output. Tavern Rock Sand Co. produced sand for use in manufacturing glass, molding, ferrosilicon, and other industrial sands. Joerling Bros., O'Fallon Quarry & Supply Co., St. Charles Quarry Co., and Schiermeier Quarry mined and crushed limestone for aglime, riprap, and roadstone. General Refractories Co. mined fire clay at the Kilker mine for firebrick and block. Miscellaneous clay was mined for processing into building brick by Highland Fire Clay Co. The Mon-

santo Co. refined uranium and thorium for the Atomic Energy Commission at the Weldon Spring plant.

St. Clair.—The Pioneer mine of Pittsburg & Midway Coal Co. was closed at midyear and the facility dismantled. The A. L. Childer's mine produced coal near Osceola. Two commercial operators and one Government-and-contractor operator quarried and crushed limestone for aglime and concrete aggregate. Paving gravel was produced for the State highway department.

St. Francois.—St. Francois County mineral-production value was second highest in the State. The county ranked first in copper and lead and second in lime and iron ore. The Federal mine of St. Joseph Lead Co. produced over 2.9-million tons of lead ore. The Hanna Mining Co., Missouri Division, mined iron ore at the Iron Mountain mine; its entire production went to Granite City Steel Co. Dead-burned dolomite for refractory purposes was produced by the Valley Dolomite Corp.; stone came from a company-operated quarry. The company reported sales of aglime and concrete aggregate. St. Joseph Lead Co. mined limestone at two locations for aglime. Chat, derived from lead and iron-ore milling, was used principally for road surfacing material, railroad ballast, and fluxing; producers included St. Joseph Lead Co. and Trap Rock Material & Engineering Co. Sand and gravel was processed for building purposes near Leadwood by Mount Sand & Gravel Co.

St. Louis.—St. Louis County mineral production, valued at $31.9 million, was highest in the State. The county also ranked first in cement, miscellaneous clay, and sand and gravel and second in stone output. Alpha Portland Cement Co. and Missouri Portland Cement Co. manufactured portland and masonry cement; limestone and shale came from company-operated quarries. Limestone was quarried and crushed at 10 commercial operations for use as aglime, concrete aggregate, flux, riprap, and asphalt filler; Vigus Quarries, Inc., was the largest producer. Dimension limestone was prepared for building purposes by Riverview Stone &Material Co. and West Lake Quarries Material Co. Sand and gravel was produced by 17 operators for building, paving, fill, and miscellaneous purposes. Unground and ground industrial sand was mined for glass, molding, grinding, polishing, and other industrial uses by Pioneer Silica Products Co. Miscellaneous clay was mined at five pits for processing into heavy-clay products. H. K. Porter Co., Inc., and Alton Brick Co. mined fire clay to manufacture fire brick and block. Columbian Carbon Co., a subsidiary of Cities Service Co., is building a multimillion-dollar facility to produce synthetic iron oxide for use chiefly as a coloring pigment; completion is scheduled for early 1965. Crude perlite, shipped from Colorado and New Mexico, was expanded at the plant of J. J. Brouk & Co. in St. Louis; output was greater than that of 1963. Vermiculite was exfoliated for plaster, concrete, and loose-fill insulation at a Zonolite Co. plant; valued output was higher than in 1963. The Florrissant pool produced petroleum from 38 wells.

Ste. Genevieve.—The county ranked fourth in total value of mineral output and first in lime and stone production. Hydrated lime and quicklime were produced by Mississippi Lime Co. at its Ste. Genevieve

plant; limestone came from a company-operated quarry. The company also sold crushed limestone for glass, whiting, poultry grit, rubber filler, asphalt filler, coal mine rock dust, flux, aglime, and roadstone. Menefee Crushed Stone Co., Inc., and Roth Building Stone Co. quarried and crushed limestone for aglime, riprap, and concrete aggregate. Dimension limestone was cut for building stone, curbing, and flagging by Roth Building Stone Co. Commercial-grade marble was prepared for rough building purposes by Tennessee Marble Co. and Weiler Marble Co. Ed L. Bauman processed sand and gravel for building and paving purposes near Ste. Genevieve.

Saline.—Limestone was quarried and crushed for aglime, concrete aggregate, and riprap by Gilliam Rock, Inc., Hall & Riley Quarries, and W. J. Menefee Construction Co.

Scotland.—Stone output rose significantly, due to an active highway-building program. Limestone was quarried and crushed for aglime and concrete aggregate by the Kaser Construction Co. near Memphis.

Shannon.—Limestone was quarried and crushed for aglime by Crider Bros. Lime Co. Dimension sandstone was prepared for building purposes by Ozark Stone Products, Inc.

Stoddard.—Sand and gravel output rose significantly due to an active road-maintenance program. Brown Sand & Gravel Co., Inc., and Keener Gravel Co., Inc., processed sand and gravel for building and paving.

Vernon.—The county ranked sixth in coal production. Nichols Coal Co., Jones Coal Co., and Ellis Coal Co. strip-mined coal for local markets. Limestone was quarried and crushed for aglime and concrete aggregate by George M. Baker Co. and Jones Coal & Rock Co. Dimension sandstone was prepared for building purposes by Missouri Native Stone Corp. Montevallo Township Road Department, Osage Township Road Department, and Blue Mound Township Road Department produced and contracted for paving gravel. Two small pools produced oil.

Warren.—Harbison-Walker Refractories and Kaiser Refractories mined fire clay for manufacturing firebrick and block, high-alumina brick, and mortar. Limestone was quarried and crushed for aglime and concrete aggregate by Sprick Quarry. Paving gravel was produced and contracted by the county department of roads and the State highway department.

Washington.—Washington County's mineral production was the third highest in the State; Meramec Mining Co. iron-ore pellet production significantly contributed to the output. The county also ranked first in barite, iron, and zinc and fourth in lead output. The Pea Ridge mine of Meramec Mining Co. commenced shipment of iron-ore pellets in February. The pelletizing facility produced over 800,000 tons of high-grade iron ore pellets for shipment to out-of-State steel industries. Washington County accounted for 14 percent of the recovered lead metal produced in Missouri; production came from the Indian Creek mine of St. Joseph Lead Co. Zinc metal totaling 751 tons was recovered as a byproduct in milling Indian Creek lead ores. The St. Joseph Lead Co. Viburnum No. 29 production shaft in south Washington County was placed in production on November 1, 1964. Barite was mined at 16 pits by 11 companies; leading pro-

ducers were Milwhite Mud Sales Co., Magnet Cove Barium Corp., General Barite Co., De Soto Mining Co., and National Lead Co. Paving gravel was produced for paving by Charles Pfizer & Co., Inc., near Mineral Point. St. Joseph Lead Co. was studying plans to sink another production shaft in the Indian Creek ore body.

Wayne.—Valued output of stone and sand and gravel, the only minerals produced in Wayne County, increased 16 percent over that of 1963. Limestone was quarried and crushed for aglime by Harris Lime Co. Williamsville Stone Co. processed sand and gravel for building purposes near Poplar Bluff.

Wright.—Valued mineral output in Wright County rose significantly; higher output was due to an active road-building program in the area. Limestone was quarried and crushed for aglime and concrete aggregate by W. H. Bennett Quarries, Inc., and Mason Rock Co. Paving gravel was produced for the State highway department.

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 W. N. Hale [1] and R. W. Knostman [1]

VALUE of mineral production reached a near record level, second only to that of 1956 ($213.8 million), and 16 percent above the corresponding 1963 figure. Copper production accounted for most of the increase; completion of a 42,000-ton-per-day copper concentrator at Butte and the resumption of near-normal operations by The Anaconda Company increased production 30 percent. Gold and silver output and value increased, and the value of lead and zinc rose, despite a drop in output from 1963 levels. Manganese shipments registered a sharp increase. Crude petroleum output was about the same as that of 1963 and had the highest value of any product.

TABLE 1.—Mineral production in Montana [1]

Mineral	1963		1964	
	Quanity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	38	$45	49	$59
Coal (bituminous and lignite) do.	343	967	346	925
Copper (recoverable content of ores, etc.) short tons	79,762	49,133	103,806	67,682
Gold (recoverable content of ores, etc.) troy ounces	18,520	648	29,115	1,019
Iron ore (usable) thousand long tons, gross weight	13	89	15	99
Lead (recoverable content of ores, etc.) short tons	5,000	1,080	4,538	1,189
Lime thousand short tons	114	1,290	136	1,385
Manganese ore and concentrate (35 percent or more Mn) short tons, gross weight	5,260	W	20,264	W
Manganiferous ore and concentrate (5 to 35 percent Mn) do.	1,688	W	3,638	W
Natural gas million cubic feet	30,026	2,253	25,188	1,965
Petroleum (crude) thousand 42-gallon barrels	30,870	75,323	30,647	74,621
Sand and gravel thousand short tons	14,319	13,756	16,017	17,840
Silver (recoverable content of ores, etc.) thousand troy ounces	4,242	5,426	5,290	6,840
Stone thousand short tons	6,109	7,081	7,345	8,477
Zinc (recoverable content of ores, etc.) short tons	32,941	7,576	29,059	7,904
Value of items that cannot be disclosed: Barite, cement fluorspar, gem stones, gypsum, natural gas liquids, peat, phosphate rock, pumice (1964), talc, uranium ore, vermiculite, and values indicated by symbol W	XX	r17,351	XX	21,430
Total	XX	r 182,018	XX	211,435

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] Excludes fire clay and bentonite; included with "Value of items that cannot be disclosed."

[1] Mineral specialist, Bureau of Mines, Albany, Oreg.

The value of sand and gravel rose sharply due to increased State highway department requirements and usage at the Bureau of Reclamation Yellowtail Dam project. Stone and cement production values jumped about 20 percent, phosphate rock value rose 17 percent, and smaller increases were recorded for most other nonmetal commodities.

Important nonmetal developments included petroleum refinery expansions, construction of a phosphate rock concentrator, and development of a silica deposit. Capacity expansions at the two petroleum refineries at Billings included added facilities for recovering sulfur at the Montana Sulphur & Chemical Co. plant, Billings. The Douglas Creek phosphate mine flotation concentrator, Granite County, was completed and placed in operation; phosphate rock was upgraded and shipped to company fertilizer plants at Trail and Kimberley, British Columbia. Pacific Silica Co. developed the Basin silica deposit, Jefferson County.

Consumption, Trade, and Markets.—Business indicators were mixed; seven increased and six decreased. A high level of future construction activity was indicated by $83.3 million in heavy-engineering awards and by a 38.4-percent increase in contracts granted by the State highway department. Mineral production increased 16.2 percent, and cement shipments to and within Montana rose 7.7 percent.

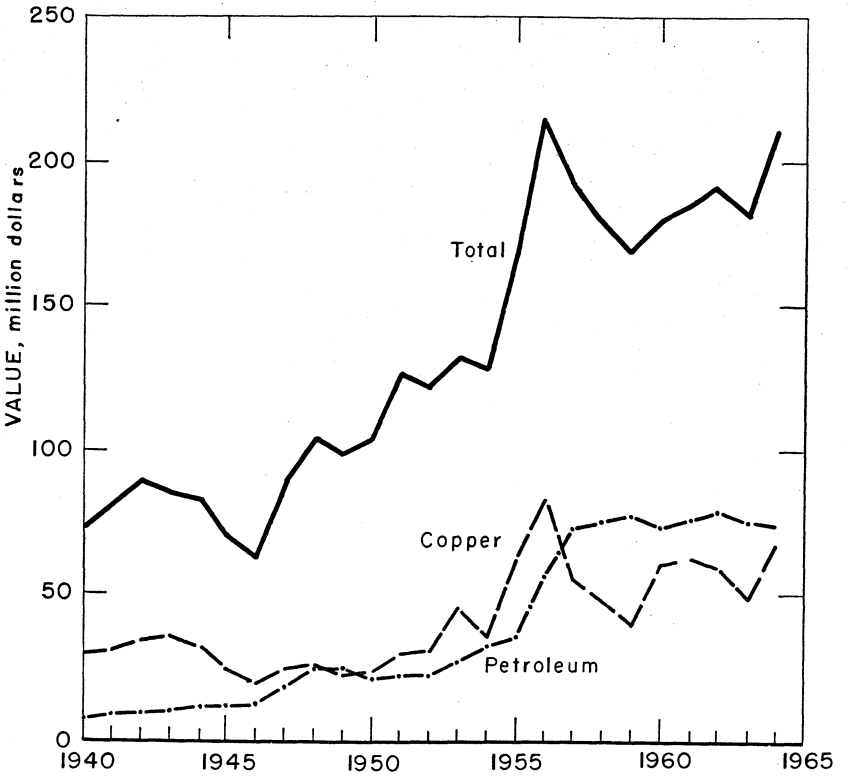


FIGURE 1.—Value of copper, petroleum, and total value of mineral production in Montana.

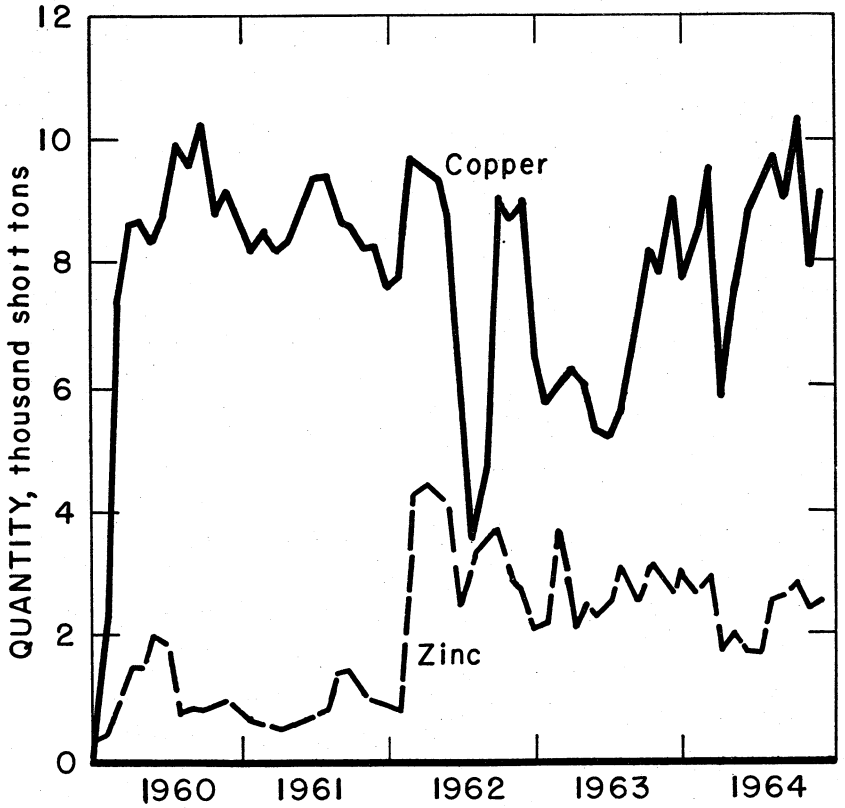


FIGURE 2.—Mine production of copper and zinc in Montana, by months, in terms of recoverable metals.

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

(Millions)

Year	Value	Year	Value
1955	$158	1960	$172
1956	189	1961	r 181
1957	188	1962	r 184
1958	182	1963	r 176
1959	166	1964	197

r Revised.

Employment.—The Anaconda Company continued to experience a shortage of miners despite steps taken to recruit and train personnel. Efforts to obtain unemployed miners from former coal-mining regions of Appalachia resulted in several hundred men finding jobs in Butte mines. In addition, the company trained over 260 men from southwestern Montana as student miners.

TABLE 3.—Indicators of Montana business activity

	1963	1964 p	Change, percent
Personal income:			
Total ..... million dollars	1,553.0	1,539.0	−0.9
Per capita ..... dollars	2,215.0	2,183.0	−1.4
Construction activity:			
Building permits ..... million dollars	31.8	32.2	+1.3
Heavy engineering awards ..... do	75.3	83.3	+10.6
Highway construction contracts awarded ..... do	48.2	66.7	+38.4
Cement shipments to and within Montana ..... thousand 376-pound barrels	1,497.5	1,613.1	+7.7
Cash receipts from farm marketings ..... million dollars	403.8	356.3	−11.8
Mineral production ..... do	182.0	211.4	+16.2
Annual average employment:			
Total nonagricultural industries ..... thousands	174.6	174.3	−0.2
Total manufacturing ..... do	22.4	21.9	−2.2
Lumber and timber industries ..... do	8.5	8.6	+1.2
Metal-mining and primary-metal industries ..... do	7.3	8.1	+11.0
Contract construction ..... do	12.3	10.7	−13.0
Transportation and utilities ..... do	17.6	17.4	−1.1

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
1955–59 (average)	10,440	6,900	820	2,720	4,220	1,100
1960	7,400	4,500	700	2,200	3,800	900
1961	7,100	4,200	700	2,200	3,600	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 p	7,500	4,800	900	1,800	3,300	1,200

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	1960	1961	1962	1963	1964
Mining:					
Average weekly earnings	$103.74	$108.14	$111.24	$113.85	$114.76
Average weekly hours	39.9	40.2	41.2	41.2	38.9
Average hourly earnings	$2.60	$2.69	$2.70	$2.77	$2.95
Metal mining:					
Average weekly earnings	$101.79	$106.52	$107.25	$110.76	$111.97
Average weekly hours	39.0	39.6	39.0	39.0	37.7
Average hourly earnings	$2.61	$2.69	$2.75	$2.84	$2.97
Primary-metals processing:					
Average weekly earnings	$96.53	$102.40	$102.82	$105.74	$110.40
Average weekly hours	39.4	40.0	39.7	39.9	40.0
Average hourly earnings	$2.45	$2.56	$2.59	$2.65	$2.76

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
1955–59 (average)	488	10,533	$54,745	$5,197
1960	492	6,641	36,031	5,426
1961	480	7,453	44,092	5,916
1962	464	6,882	41,800	6,075
1963	421	6,837	43,107	6,316
1964	433	7,163	45,225	6,314

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	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal and peat	119	13	106		1	9
Metal	3,659	1,061	8,487	6	163	20
Nonmetal	712	173	1,385	1	46	34
Sand and gravel	820	178	1,423		46	32
Stone	756	179	1,435	1	29	21
Total	6,066	1,604	12,836	8	285	23
1964: p						
Coal and peat	123	14	112	1	1	18
Metal	3,710	1,089	8,809	4	170	20
Nonmetal	785	212	1,690	1	38	23
Sand and gravel	825	192	1,539		37	24
Stone	740	171	1,372		32	23
Total	6,183	1,678	13,522	6	278	21

p Preliminary.

The displacement of workers caused by the cessation of copper concentrating at Anaconda on October 30 seriously affected the community. Many workers commuted from Anaconda to jobs at the new Butte concentrator, but the highly automated operation at Butte required considerably fewer men than did the Anaconda concentrator. Approximately $675,000 in government funds was allotted for training former millworkers for other occupations.

Government Programs.—The Office of Minerals Exploration (OME) approved four new contracts. Wayne Erickson received a $61,500 contract for silver exploration in Beaverhead County. Vitro Minerals Corp. gained approval of a $93,740 gold exploration project in Fergus County. Work in Jefferson County was conducted by Ruby Silver Mines, Inc., under a $132,800 agreement. B.L.M.W. Mining Co. received a $20,550 contract for silver and gold exploration in Madison County. Government participation was 50 percent of the contract totals.

REVIEW BY MINERAL COMMODITIES

METALS

Aluminum.—Anaconda Aluminum Co. operated its Columbia Falls primary aluminum plant at capacity for the third consecutive year.

Construction of a third potline to increase capacity to about 100,000 tons annually continued. Operation of the new potline was scheduled to begin in the third quarter of 1965.

Pilot plant production of alumina from clays was continued by The Anaconda Company at Anaconda. Construction of an alumina-from-clay plant, based on the process developed at Anaconda, was tentatively scheduled to begin in 1966 near company-controlled clay deposits in Georgia.

Copper.—Output of copper rose 30 percent over the 1963 total because the 42,000-ton-per-day copper mill (Clyde E. Weed concentrator) at Butte was completed, and with The Anaconda Company increased production from Butte district mines. The 1963 output had been reduced because the equipment transfer from the mill at Anaconda to the Butte concentrator necessitated a curtailment in mine production. Output from the new concentrator was gradually increased throughout the year until sufficient capacity was attained to handle all copper ore from Butte mines. Copper concentrating at the Anaconda Reduction Works ended on October 30.

The Berkeley open pit yielded 56,693 tons (55 percent of the State total), while output from the Butte Hill mines (Mountain Con, Steward, and Leonard) totaled 41,730 tons. Over 12.2 million tons of ore containing 0.5 percent copper or more was extracted from the Berkeley pit, while the 1.4 million tons from the deep-level mines contained nearly 3.6 percent recoverable copper. Recovery of copper precipitate increased to 4,164 tons from 1,354 tons in 1963 as a large quantity of low-grade dump material (averaging about 0.3 percent copper) from the Berkeley pit was treated.

Gold.—Production of gold was the highest since 1961, largely due to the sharp rise in copper output from which gold was recovered as a byproduct. Of the nearly 21,000 ounces recovered by The Anaconda Company from Butte district mines, 15,889 ounces was from the Berkeley pit. The second largest individual output was from the Gold Bug mine of Northern Continental, Inc., in the Little Rockies district of Phillips County. Placer production rose to 292 ounces, with the largest output coming from the McMillan property in Mineral County.

Vitro Minerals Corp. continued to examine, by diamond drilling and other exploration methods, a portion of the Judith Mountains near Lewistown. The firm was awarded a $93,740 OME contract in July; government participation was to be $46,870.

Iron Ore.—Production of iron ore was entirely from the Iron Cross mine near Radersburg, Broadwater County. Ralls & Harris Bros. operated the mine until R & S Iron Co. purchased the property on June 1. The ore, mined by open-pit methods, was used by the cement industry.

Lead.—Production of lead declined 9 percent from the 1963 total, but the value rose 10 percent because of a higher average price for the metal. As in the past, most of the lead was a byproduct of zinc recovered from the Butte district and the slag-fuming operation at East Helena. Of the 630 tons not produced by The Anaconda Company, the largest single portion (256 tons) was from the Maulden mine of Ida B. Hand, Beaverhead County. Lead also was recovered by Anaconda from manganese ore in the purchased government low-grade stockpile.

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)
1955–59 (average)	120	11	9,445	30,713	$1,075	5,215	$4,720
1960	129	13	12,317	45,922	1,607	3,607	3,265
1961	135	17	12,792	35,377	1,238	3,490	3,227
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
1862–1964	----------	----------	NA	17,729,800	404,996	846,989	640,153

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	85,215	$57,210	13,015	$3,694	50,143	$12,220	$78,919
1960	91,972	59,046	4,879	1,142	12,551	3,238	68,298
1961	104,000	62,400	2,643	544	10,262	2,360	69,770
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
1862–1964	7,961,549	2,715,932	932,739	146,539	2,771,099	529,757	4,437,378

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer mines), ore milled, and ore, old slag, and copper precipitates 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 1964, 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	13	914	410	611	2,200	100	6,700
Dry gold-silver	19	17,256	5,745	194,220	26,100	33,100	118,500
Dry silver	35	43,469	661	378,831	196,700	125,700	176,900
Total	67	61,639	6,816	573,662	225,000	158,900	302,100
Copper	7	13,613,530	18,517	3,312,067	196,861,700	----------	200
Lead	21	6,359	141	29,507	124,700	946,700	208,800
Lead-zinc	6	201	24	3,265	500	31,100	30,400
Zinc	3	1,080,743	2,490	1,306,184	2,027,600	5,364,300	40,501,400
Total	37	14,700,833	21,172	4,651,023	199,014,500	6,342,100	40,740,800
Other lode material:							
Dry gold-silver and silver old tailings [2]	6	17,714	832	64,187	44,700	97,800	169,700
Cleanings and assay sweeps	3	30	3	1,059	----------	17,200	3,000
Copper precipitates	1	----------	----------	----------	8,327,800	----------	----------
Zinc slag	1	91,650	----------	----------	----------	2,460,000	16,902,400
Total lode material	110	14,871,866	28,823	5,289,931	207,612,000	9,076,000	58,118,000
Placer	8	(3)	292	28	----------	----------	----------
Total	118	14,871,866	29,115	5,289,959	207,612,000	9,076,000	58,118,000

[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] 28,650 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)
1955-59 (average)	7	277	1,509	[3] 4	1	39	8	278	1,548
1960	2	2	41	11	8	94	13	10	135
1961	5	30	82	12	4	50	17	34	132
1962	3	7	64	2	4	46	5	11	110
1963	2	2	16	6	5	40	8	8	56
1964	[4] 5	27	270	3	2	22	8	29	292

[1] Combined to avoid dixclosing individual company confidential data.
[2] Owing to rounding, individual items may not add to totals shown.
[3] Includes surface and underground (drift) placers.
[4] Includes 2 dragline dredges, 1 small shovel, and 2 hydraulic operations.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	12	1	395	$14	166,494	$215
Broadwater	4		4	(1)	431	1
Deer Lodge	2		1	(1)	1,236	2
Fergus	1		1	(1)	69	(1)
Granite	11		1,197	42	211,502	273
Jefferson	18		1,042	36	60,645	78
Lewis and Clark	18		184	6	8,331	11
Madison	8		461	16	8,726	11
Meagher	2	3	22	1	569	1
Missoula	1		1	(1)	3,468	4
Powell	5	3	102	4	8,768	11
Silver Bow	10		20,999	735	4,613,997	5,966
Unassigned	3		37	1	57	(1)
Undistributed [2]	15	1	4,669	163	205,666	266
Total [3]	110	8	29,115	1,019	5,289,959	6,840

County	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Beaverhead	16	$10	299	$78	105	$29	$346
Broadwater	W	W	4	1	8	2	
Deer Lodge	(1)	(1)					
Fergus			(1)	(1)	(1)	(1)	(1)
Granite	104	68	1	(1)	6	2	335
Jefferson	14	9	79	21	101	27	172
Lewis and Clark	1	1	1,252	328	8,480	2,306	2,652
Madison	1	1	2	1	2	1	29
Meagher	(1)	(1)	25	7	5	1	9
Missoula	(1)	(1)	13	4	31	8	17
Powell	W	W	13	3	W	W	19
Silver Bow	103,600	67,547	2,678	702	20,239	5,505	80,455
Unassigned	(1)	(1)			1	(1)	2
Undistributed [2]	69	45	172	45	82	22	542
Total [3]	103,806	67,682	4,538	1,189	29,059	7,904	84,633

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 Cascade, Flathead, Judith Basin, Mineral, Park, Phillips, Ravalli, and Sanders Counties; and items indicated by symbol W.
Owing to rounding, individual items may not add to totals shown.

TABLE 12.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	4				
Concentration and smelting of concentrates	21,142	4,775,213	198,996,000	5,745,300	40,708,700
Total	21,146	4,775,213	198,996,000	5,745,300	40,708,700
Direct smelting:					
Ore	6,842	449,472	243,500	755,700	334,200
Old tailings	832	64,187	44,700	97,800	169,700
Copper precipitates			8,327,800		
Old slag				2,460,000	16,902,400
Cleanings and assay sweeps [1]	3	1,059		17,200	3,000
Total	7,677	514,718	8,616,000	3,330,700	17,409,300
Placer	292	28			
Grand total	29,115	5,289,959	207,612,000	9,076,000	58,118,000

[1] Combined to avoid disclosing individual company confidential data.

Manganese.—Shipments of both manganese ore and concentrate (35 percent or more manganese) and manganiferous ore and concentrate (5 to 35 percent manganese) were more than triple the 1963 output. A sharp rise in the use of manganese nodules for producing ferromanganese by The Anaconda Company at the Anaconda Reduction Works, Anaconda, Deer Lodge County, coupled with a substantial increase in demand for battery-grade manganese produced by Taylor-Knapp Co., caused the increase in manganese concentrate shipments. Manganiferous ore and concentrate (5 to 35 percent manganese) shipments were mostly by Taylor-Knapp, but small quantities of crude ore were sold by Anaconda.

The Anaconda Co. continued shipping from the low-grade manganese stockpile at Butte, purchased from the Government in 1962, to the Anaconda Reduction Works for concentrating. More than 60,000 tons of concentrate was produced and pumped to the sintering plant for producing manganese nodules. The nodules were shipped for metallurgical and chemical uses and were consumed in producing ferromanganese. The Anaconda ferromanganese plant was operated approximately 4 months, the first production since 1962.

Taylor-Knapp mined 11,747 long tons of ore from the Moorlight group near Philipsburg, Granite County, from which 5,444 tons of manganese concentrate and 3,063 tons of manganiferous concentrate were recovered. As in 1962 and 1963, Anaconda did not mine manganese ore.

Silver.—Output of silver increased 25 percent. It was recovered largely as a byproduct of copper (63 percent) and zinc (25 percent) from the Butte district. The largest production outside of Silver Bow County came from Granite County (211,502 ounces).

As a result of increased demand and higher prices for silver, interest continued in exploring and developing silver-bearing properties in the State. The Anaconda Company conducted geochemical soil sampling and other exploration at the company-owned Flathead property in Flathead County. Midnite Mining Co. began diamond drilling at

properties in Flathead County. Champion Silver Mining Co. completed shaft sinking and crosscutting at the Champion mine, Deer Lodge County, to develop ore cut previously by diamond drillings. Spokane National Mines, Inc., continued exploration and development at the New Departure mine in the Blue Wing district of Beaverhead County and concentrated ore in a flotation mill at Bannack. United Buffadison Mines, Ltd., of Toronto, Ontario, Canada, continued a diamond-drilling program started in 1963 at the Crystal property near Basin, Jefferson County. Work was initiated at properties in Beaverhead, Jefferson, and Madison Counties under OME loans granted during the year.

Thorium.—Interest in thorium-bearing deposits in the Lemhi Pass area was buoyed by the announcement that Dow Chemical Co. had optioned properties in the Idaho portion of the area.

Uranium.—Production of uranium ore increased over that of 1963 but was less than the tonnage mined in 1962. All production was by St. Clair, Inc., from the Dandy and Marie No. 2 underground mines in Carbon County.

Zinc.—A rise in metal price resulted in a 4-percent increase in the value of zinc production despite a 3,880-ton drop in output from that of 1963. All but 370 tons was produced by The Anaconda Company from operations at Butte and from the slag-fuming facility at East Helena. Approximately 8,450 tons was recovered from fuming old slag at East Helena, and 20,239 tons came from dumps, stockpiles, and mines at Butte.

The largest production was from the Badger State mine, where ore was extracted by block-caving and cut-and-fill mining methods. Ore also was shipped from the Anselmo mine and dump, Syndicate open pit and dump, Orphan Girl dump, and the Emma stockpile. Processing ore from the Government low-grade manganese stockpile purchased in 1962 continued to yield significant amounts of zinc. Block caving of zinc ore at the Badger State mine was described.[2]

The Anaconda electrolytic zinc plant at Great Falls recovered 125,334 tons of zinc from foreign and domestic concentrates, according to the company annual report to shareholders. The plant was operated at capacity (162,000 tons per year) from March through June, but output was curtailed to 75 percent of capacity during the remainder of the year because of a zinc concentrate shortage. The plant was closed by a labor dispute for 2 weeks in January.

NONMETALS

Asbestos.—Zonolite Division, W. R. Grace & Co., at Libby, Lincoln County, continued testing methods for recovering short-fiber tremolite asbestos as a coproduct with vermiculite.

Galaxy Mining Co., Billings, recovered short-fiber anthophyllite asbestos from the Karst property, Gallatin County, for testing purposes.

Barite.—Tonnage of crude barite ground decreased 46 percent, and the quantity of ground barite shipped to consumers was 51 percent less than in 1963.

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[2] Mitchell, Ronald J. Anaconda Block Caves Zinc Ore at the Badger Mine. Metal Min. & Processing, November 1964, pp. 19–21.

Ore was mined, beneficiated, and ground near Greenough, Missoula County, by Baroid Division, National Lead Co. Processed material, largely used as a weighting agent in oil well drilling mud, was shipped to Pacific Northwest, Rocky Mountain State, and Alaskan consumers.

Cement.—The quantity and value of cement shipments increased 21 and 22 percent, respectively, over 1963 totals. Output was by Kaiser Cement & Gypsum Corp. (Jefferson County) and Ideal Cement Co. (Gallatin County). Destinations within the State accounted for 66 percent of the cement sold. Shipments also were made to Colorado, Idaho, North Dakota, Oregon, Utah, and Wyoming.

Limestone, shale, and silica raw materials for making cement were quarried near the plants. Iron ore used at the Ideal Cement Co. operation came from northwestern Montana, and iron-bearing slag used by Kaiser Cement & Gypsum Corp. was from East Helena. Gypsum used at both operations was mined at Fergus County deposits near Lewistown. The Kaiser Cement & Gypsum Corp. plant was described in a report.[3]

Clays.—Miscellaneous clay and shale sold or used by producers increased 29 percent, and output of fire clay more than doubled that of 1963. Bentonite output from Carter County was the highest in the State's history; it was the first recorded production since 1959.

Miscellaneous clay and shale for making heavy clay products, such as building brick, was mined in Fergus and Yellowstone Counties. Jefferson County was the source of shale used in manufacturing cement. Shale from Cascade and Yellowstone Counties was bloated for use as lightweight aggregate. Fire clay for making firebrick, fireblock, and saggers was dug in Cascade and Deer Lodge Counties.

Fluorspar.—Roberts Mining Co., the only producer, mined fluorspar in Ravalli County. Ore from the Crystal Mountain mine was trucked 26 miles to a company-owned sizing and heavy-media separation plant at Darby. Metallurgical-grade fluorspar was marketed largely to the steel industry.

Gypsum.—Output and value of crude gypsum mined decreased 8 percent compared with 1963 totals. Production, from two mines in Fergus County, was calcined and sold as ground gypsum; some uncalcined material was used as a retarder in portland cement.

Lime.—Output of lime increased 19 percent, and value was 7 percent above the 1963 total.

In Deer Lodge County, The Anaconda Company made quicklime for metallurgical use. Elliston Lime Co., in Powell County, produced and marketed lime for industrial use. Three sugar companies, operating four plants, made lime for refining sugar in Big Horn, Missoula, Richland, and Yellowstone Counties.

Phosphate Rock.—The quantity and value of marketable phosphate rock increased 12 and 17 percent, respectively, over the 1963 production. Mining was conducted in Beaverhead, Granite, Powell, and Silver Bow Counties.

In Powell County, rock of suitable grade for processing without further beneficiation was produced at the Anderson-Brock and Relyea

[3] Mitchell, Ronald J. Permanente Plant—New Montana Bonanza. Rock Products Min. & Processing, v. 67, No. 2, February 1964, pp. 57–62.

mines near Garrison and the Gimlet and Luke mines near Avon. Phosphate rock from the Anderson-Brock, Gimlet, and Luke mines was shipped to fertilizer plants in Canada; material from the Relyea mine went to consumers in the Rocky Mountain States.

Rock from the Maiden Rock mine in Silver Bow County and the Canyon Creek and East La Marche mines in Beaverhead County, all near Melrose, was hauled 23 miles to the Silver Bow plant of Victor Chemical Works, Division of Stauffer Chemical Co., where it was washed and reduced to elemental phosphorus. The phosphorus, kept in the molten state by means of steam-heated storage tanks, was pumped from the storage tanks to rail tank cars for shipment to company processing plants at Chicago Heights, Ill., and South Gate and Richmond, Calif.

In Granite County, initial output was recorded for the Douglas Creek mine flotation concentrator by Montana Phosphate Products Co. Rock from the Douglas Creek mine was upgraded at the 300,000-ton-annual-capacity concentrator. The concentrate, containing 31 percent P_2O_5, was shipped to company fertilizer plants at Trail and Kimberley, British Columbia, Canada.

Rock mixed with phosphoric acid was treated thermally, in the presence of water vapor, to defluorinate the rock for use as a supplement in animal feeds by Rocky Mountain Phosphates, Inc., at Garrison, Powell County.

Sand and Gravel.—Most of the advance in sand and gravel output was attributed to increased road construction and maintenance by the State highway department. Also, demand continued high at the Bureau of Reclamation Yellowtail Dam project. Commercial firms operated 56 plants in producing 2.8 million tons.

Of the 56 counties in the State, 49 had sand and gravel production. Output exceeded 1 million tons in Big Horn, Gallatin, Madison, Missoula, and Yellowstone Counties.

Use distribution of sand and gravel output was road material, 80 percent; building, 13 percent; and miscellaneous uses, including fill and railroad ballast, 7 percent.

Stone.—Quantity and value of stone output advanced 20 percent to 7.3 million tons valued at $8.5 million. Stone was produced in 38 counties, and output exceeded 1 million tons in Jefferson County.

Miscellaneous (unclassified traprock) stone, basalt, granite, limestone, sandstone, and travertine were produced. Miscellaneous stone, largely for use in road construction, was the principal stone quarried; output totaled 5.5 million tons valued at $5.7 million. Miscellaneous stone was produced in 34 counties; Gallatin, Granite, Jefferson, and Yellowstone Counties had output exceeding 400,000 tons. Limestone, ranking second in quantity of output, was produced in Broadwater, Carbon, Deer Lodge, Gallatin, Granite, Jefferson, and Powell Counties. Output of 1 million tons valued at $1.5 million was used in making cement and lime. Sandstone, quartz, and quartzite output for use as industrial silica totaled 140,747 tons, valued at $508,329. The material, produced in Beaverhead, Deer Lodge, Gallatin, and Jefferson Counties, was used as a silica component in manufacturing cement and as a flux at phosphate and copper reduction plants; some was shipped out of the State for use in making ferrosilicon.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	721	$1,057	801	$1,121
Road material	1,707	1,641	1,519	1,440
Fill	240	167	291	209
Railroad ballast	131	82	39	35
Other [1]	73	72	114	78
Total	2,872	3,018	2,764	2,883
Government-and-contractor operations:				
Building			1,274	1,615
Road material	11,350	10,678	11,291	12,940
Fill	69	45	671	393
Other [1]	27	15	17	9
Total	11,446	10,738	13,253	14,957
All operations:				
Building	721	1,057	2,075	2,736
Road material	13,057	12,319	12,810	14,380
Fill	309	211	962	602
Railroad ballast	131	82	39	35
Other [1]	101	87	131	87
Grand total [2]	14,319	13,756	16,017	17,840

[1] Sand and gravel used for miscellaneous and unspecified purposes.
[2] Data may not add to totals shown because of rounding.

Sulfur.—Production and shipments of high-purity elemental sulfur by Montana Sulphur & Chemical Co., contingent upon oil-refining operations of Continental Oil Co. and Humble Oil & Refining Co., increased compared with 1963 totals. Due to capacity increases at the two petroleum refineries, facilities were added to the sulfur-producing plant to recover additional sulfur.

Talc.—Production and value of talc increased 3 and 15 percent, respectively, compared with 1963 production. Talc, mined by three companies, came from one mine in Beaverhead County and from six mines in Madison County. The material was ground and sized at plants in Beaverhead, Gallatin, and Lewis and Clark Counties. Some was shipped for processing to plants at Grand Island, Nebr., Ogden, Utah, and Los Angeles, Calif. Two companies in Beaverhead and Madison Counties, in addition to processing fine material in standard roller-type grinding mills, produced micron-sized talc in fluid-energy mills.

There was a significant change in the quantity of talc consumed by the ceramics and paper industries. Uses were as follows (1963 percentages are in parentheses): Ceramics, 18 percent (11 percent); paint, 30 percent (33 percent); paper, 25 percent (32 percent); and exports and miscellaneous uses, including insecticides, textiles, toilet preparations, rice polishing, and rubber, 27 percent (24 percent).

Vermiculite.—Crude vermiculite output was 6 percent lower than that of 1963. The open-pit mine near Libby, Lincoln County, of Zonolite Division, W. R. Grace & Co., continued to be the principal source of vermiculite in the United States. Material was selectively

mined from 20-foot benches and trucked to a transfer point for distribution of waste and ore before shipment by conveyor to a mill. At the transfer point, waste passed over screens to a disposal area, and material passing through screens fell through a 185-foot inclined shaft and was carried 1,200 feet on a 24-inch belt conveyor to mill feed bins. At the mill, waste was scalped from the vermiculite by means of a dry- and wet-milling circuit; both circuits utilized gravity concentrating methods. Concentrate from the mill was hauled by aerial tram to storage bins at Rainy Creek Reservoir, from there it was trucked 3 miles to storage facilities near the Kootenai River. The material was carried by conveyor across the river to rail cars on a Great Northern Railway siding. Most of the concentrate was shipped out-of-State to exfoliating plants; however, some was expanded by a company at Great Falls.

MINERAL FUELS

Coal.—Output of bituminous coal and lignite was 345,847 tons, compared with 343,000 tons in 1963. Of 13 active mines in 8 counties, 11 were underground, and 2 were open-pit operations.

Bituminous coal came from nine mines in four counties. Six underground mines in Musselshell County accounted for most of the output. Some was produced at underground mines in Blaine and Carbon Counties and at an open-pit operation in Big Horn County.

Lignite was produced at four mines in four counties. Largest output was from an open pit in Richland County; underground operations in Custer, Powder River, and Sheridan Counties also produced lignite.

Petroleum and Natural Gas.[4]—Recovery of crude petroleum totaled 30.6 million barrels valued at $74.6 million, compared with production of 30.9 million barrels value at $75.3 million in 1963. Petroleum represented about 35 percent of the Montana mineral production value. Of the total crude oil produced, over 59 percent came from the Williston Basin; 34 percent was recovered from three fields, the Pine and Cabin Creek fields in the Williston Basin and the Elk Basin field in southcentral Montana. Each field had output exceeding 3 million barrels. Other fields exceeding 1 million barrels were Lookout Butte, Pennel, and Poplar-East in the Williston Basin; Sumatra in central Montana; and Fred and George Creek and Cut Bank in northern Montana.

Marketed production of natural gas totaled 25.2 billion cubic feet, compared with 30 billion cubic feet in 1963. Withdrawal of natural gas continued to be highest in the Cut Bank-Reagan field, with output totaling 7.5 billion cubic feet. Cedar Creek field ranked second with production of 3.5 billion cubic feet. Over 2 billion cubic feet was withdrawn from the Bowdoin and Keith Block fields, and fields exceeding 1 billion cubic feet were Big Coulee, Cabin Creek, Dry Creek, and Whitlash. The tax structure of the gas-producing industry in Montana was studied.[5]

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[4] Montana Oil and Gas Conservation Commission. Montana Oil and Gas Statistical Bulletin and Annual Review. V. 8, 1964.

[5] Harnish, D. H., Jr. A Comparative Tax Study of Montana's Gas-Producing Industry. State of Montana, BuMines and Geol. Spec. Pub. 30, 1964, 17 pp.

Drilling totaled 412 wells; 144 yielded oil, 16 were gas discoveries, and 252 were dry. As a result of the Fred and George Creek and Flat Coulee successes in northern Montana, there was increased exploration and development in that area. The most extensive drilling program in the State was in Toole County, near the Fred and George Creek field, where 56 development wells and 57 exploratory projects were drilled. Completed were 34 oil and 5 gas discoveries; 74 were dry holes. Average depth per well drilled in the county was less than 2,500 feet. Forty wells were drilled in Liberty County near the Flat Coulee field. Completions totaled 12 oil and 4 gas discoveries; 24 were dry holes. Average depth drilled per well in the county was less than 3,000 feet. Renewed activity in northeastern Montana in Sheridan and Roosevelt Counties, where 58 wells were drilled (40 exploratory projects), led to successful completion of 3 Devonian discoveries. Amerada Petroleum Corp., while reworking a former Silurian producer in the Outlook field (Sheridan County), completed the well for a flow of 263 barrels of oil per day from the Duperow formation (Devonian). Development drilling yielded one successful offset producer from the same formation. Murphy Oil Co. in Roosevelt County completed a discovery well flowing 145 barrels of oil and 60 barrels of water per day from the Nisku member of the Winterburn formation (Devonian). The discovery, the most westerly success in the Williston basin, was named Volt field; development was underway. A discovery also was completed from two zones in the Nisku member by Murphy Oil Co. east of the Tule Creek field in Roosevelt County, and another Devonian pool was discovered south of the Tule Creek field.

Eleven refineries processed 32 million barrels of crude oil, 3.9 million barrels more than in 1963. Montana wells supplied 38 percent of the crude oil refined; the remainder came from Canadian (13 percent) and Wyoming (49 percent) wells. Continental Oil Co. increased capacity of its Billings refinery from 15,300 barrels per day to 35,500 barrels per day. A products pipeline was completed by the company from the Billings refinery to Casper and Sinclair, Wyo. At Casper the pipeline had access to the Wyco pipeline to Denver, Colo., and at Sinclair the pipeline connected with the Pioneer pipeline to Salt Lake City, Utah.

Five secondary recovery projects by waterflooding were started—one each in the Ash Creek, Cut Bank, and Ivanhoe fields and two in the Kevin-Sunburst field. Twenty-five waterflooding secondary-recovery projects were active, and cumulative injections of water to field formations since waterflooding began in the State through 1964 totaled 72.9 million barrels. Three waterfloods in southcentral Montana had cumulative injections totaling 10.2 million barrels; 4 projects in central Montana had received 14.5 million barrels; 3 fields in the Williston basin had received 28.5 million barrels; and 15 projects, mainly in the Cut Bank and Kevin-Sunburst fields, in northern Montana had received 19.7 million barrels of water. The greatest source of injection water for waterflooding was from the Fox Hills and Madison formations in the Williston basin; from the Madison formation in northern and southcentral Montana; and from the Third Cat Creek member of the Kootenai formation in central Montana.

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Water produced with oil was disposed of by returning it to the water-bearing parts of the petroleum-reservoir formations or to other porous and permeable formations. The greatest amount of water produced with oil was in the Williston basin, and a number of oil companies operated their own disposal-injection systems at many fields in the basin. The water, much of it saline, was injected mainly to the Dakota, Judith River, Lakota, Madison, Red River, and Swift formations. In northern Montana, water produced with oil from the Pondera and Red Creek fields was injected into the Bow Island and Madison formations. In central Montana, water produced with oil from the Big Wall and Melstone fields had been injected into the Tyler formation. Water from the Melstone field was used for watering livestock by nearby ranchers, and water produced with oil at the Big Wall field was returned to maintain pressure on the oil-productive Tyler formation. In southcentral Montana oil fields, recovery of petroleum from reservoirs was effected mainly by gas-depletion drive mechanisms; therefore, extensive disposal systems were not required. Water produced with petroleum was used in secondary recovery.

REVIEW BY COUNTIES

Mineral production for 1964 was reported from 54 of the State's 56 counties. Silver Bow County accounted for 34 percent of the total mineral-output value. Only counties with significant metal, nonmetal, or fuels developments are discussed in the following review.

Beaverhead.—Twelve lode mines supplied 22,005 tons of ore from which 338 ounces of gold, 166,488 ounces of silver, 16 tons of copper, 299 tons of lead, and 105 tons of zinc were recovered. The largest lead production (256 tons) came from the Maulden mine (Ida B. Hand), and the leading gold output (135 ounces) was from the Shafer group, both in the Argenta district. Spokane National Mines, Inc., the largest silver producer in the county, began producing a bulk concentrate at a flotation mill near Bannack, utilizing ore from the company New Departure mine in the Blue Wing district. The concentrate was trucked to the American Smelting and Refining Company lead smelter at East Helena. Crude ore smelted at the Anaconda Reduction Works at Anaconda yielded 7,894 ounces of silver from the Hecla mine (Lively Mining Co.) Bryant district, and over 11,600 ounces of silver from the Polaris mine (Lee M. James), Polaris district.

Phelps Dodge Corp. did not continue its exploration of the Ermont and New Mineral properties in the Argenta district. Grand Deposit Mining Co. discontinued work at the Excelsior property in the Bannack district. Wayne Erickson was awarded an OME grant for exploration in the Elkhorn district; government participation was to be one-half of the $70,190 contract.

Phosphate rock, produced by Victor Chemical Works at the Canyon Creek and East La Marche mines, was shipped to the Victor elemental phosphorus plant at Silver Bow. Talc from the Smith-Dillon mine of Tri-State Minerals Co. was shipped for processing to a company mill at Barratts.

TABLE 14.—Value of mineral production in Montana, by counties

(Thousand dollars)

County	1963	1964	Minerals produced in 1964, in order of value
Beaverhead	W	W	Phosphate rock, stone, sand and gravel, silver, lead, talc, zinc, gold, copper.
Big Horn	$1,875	$1,943	Sand and gravel, petroleum, lime, natural gas, coal.
Blaine	431	495	Petroleum, natural gas, sand and gravel, stone, coal.
Broadwater	257	107	Iron ore, stone, zinc, lead, sand and gravel, silver, gold, copper.
Carbon	8,932	9,563	Petroleum, stone, natural gas, coal, sand and gravel, uranium.
Carter	1,399	1,695	Sand and gravel, clays, stone, petroleum.
Cascade	680	942	Sand and gravel, stone, clays, silver, lead, zinc, gold.
Chouteau	724	540	Sand and gravel, stone.
Custer	508	265	Sand and gravel, coal, stone.
Daniels	----	6	Sand and gravel.
Dawson	5,962	4,198	Petroleum, sand and gravel, stone.
Deer Lodge	781	1,077	Lime, stone, sand and gravel, silver, clays, copper, gold,
Fallon	21,380	20,544	Petroleum, natural gas.
Fergus	W	W	Gypsum, stone, sand and gravel, clays, lead, silver, zinc, gold.
Flathead	288	744	Sand and gravel, stone, silver, copper, lead, gold, zinc.
Gallatin	W	W	Cement, sand and gravel, stone.
Garfield	----	(1)	Stone.
Glacier	2,393	2,356	Petroleum, sand and gravel, stone.
Golden Valley	----	22	Sand and gravel.
Granite	757	3,132	Phosphate rock, sand and gravel, stone, manganese, silver, copper, manganiferous ore, gold, zinc, lead.
Hill	136	84	Sand and gravel, stone.
Jefferson	W	W	Cement, stone, sand and gravel, silver, gold, zinc, lead, clays, copper.
Judith Basin	178	24	Sand and gravel, lead, zinc, silver, gold.
Lake	210	265	Sand and gravel, stone, peat.
Lewis and Clark	3,344	3,538	Zinc, sand and gravel, lead, stone, silver, gold, copper.
Liberty	1,489	1,810	Petroleum, natural gas.
Lincoln	W	W	Vermiculite, sand and gravel, stone.
Madison	W	2,231	Sand and gravel, talc, stone, gold, silver, copper, lead, zinc.
McCone	428	659	Petroleum.
Meagher	18	310	Sand and gravel, stone, lead, zinc, gold, silver, copper.
Mineral	50	997	Sand and gravel, stone, copper, lead, silver, zinc, gold.
Missoula	1,433	1,937	Sand and gravel, stone, barite, lime, zinc, silver, lead, copper, gold.
Musselshell	3,322	3,086	Petroleum, coal, sand and gravel.
Park	609	W	Stone, sand and gravel, gold, silver.
Petroleum	----	42	Sand and gravel.
Phillips	246	W	Silver, natural gas, gold, sand and gravel, zinc, copper, stone, lead.
Pondera	376	324	Sand and gravel, stone, petroleum.
Powder River	97	17	Sand and gravel, coal.
Powell	W	W	Phosphate rock, sand and gravel, lime, stone, silver, gold, lead, copper, zinc.
Prairie	9	9	Sand and gravel.
Ravalli	W	W	Fluorspar, sand and gravel, stone, copper, gold, silver.
Richland	1,459	1,149	Coal, petroleum, lime, sand and gravel.
Roosevelt	6,984	6,045	Petroleum, sand and gravel.
Rosebud	4,352	3,279	Petroleum.
Sanders	140	82	Sand and gravel. lead, silver, copper, zinc.
Sheridan	3,355	3,771	Petroleum, sand and gravel, stone, coal.
Silver Bow	61,562	$1,973	Copper, silver, zinc, manganese, gold, lead, sand and gravel, phosphate rock, stone, manganiferous ore.
Stillwater	139	----	
Sweet Grass	69	----	
Teton	26	62	Stone, petroleum, sand and gravel.
Toole	2,163	4,360	Petroleum, stone, sand and gravel, natural gas.
Treasure	425	39	Sand and gravel.
Valley	281	1,139	Sand and gravel, stone.
Wheatland	157	352	Do.
Wibaux	----	169	Sand and gravel, pumice, stone.
Yellowstone	3,288	2,899	Sand and gravel, stone. petroleum, lime, clays.
Combined counties [2]	r 18,630	17,584	
Undistributed [3]	20,676	25,570	
Total	r 182,018	211,435	

r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] Less than $500.

[2] Petroleum and natural gas production from fields underlying two or more counties. See Combined Counties section.

[3] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

Big Horn.—Recovery of crude oil from four fields totaled 116,257 barrels. Initial production of the Lodge Grass field came from a reservoir in the Tensleep sandstone. Limestone was calcined for use at the Holly Sugar Corp. Hardin plant. Sand and gravel requirements at the Bureau of Reclamation Yellowtail Dam project remained at 1.2 million tons.

Broadwater.—Ralls & Harris Bros. produced 7,443 long tons of iron ore from the Iron Cross mine near Radersburg prior to June 1 when the property was purchased by R & S Iron Co.; 7,257 long tons was extracted by R & S Iron Co. during the last 7 months of the year. The Iron Magnet mine, which yielded 3,488 long tons in 1963, was not operated. Gold, silver, lead, and zinc were mined at three operations. The Winston mining district was studied.[6]

Carbon.—The county continued to rank second in value of nonmetals and fuels output ($9.6 million). Recovery of crude oil from the Elk Basin field, second largest source of oil in the State, was 3.5 million barrels. Withdrawal of natural gas from the Dry Creek field totaled 1.1 billion cubic feet. Brophy Coal Co. mined bituminous coal at the Brophy No. 2 mine.

Carter.—The county was the leading source of clay in the State. Bentonitic clay for use in oil-well drilling mud was produced by National Lead Co. Production of crude oil from the Repeat field was 3,000 barrels less than that of 1963.

Cascade.—The only active metal-mining was at the Lexington mine of Lexington Silver Lead Mining Co.

According to The Anaconda Company annual report, 141,000 tons of electrolytic copper was produced at the Great Falls refinery. Recovery of cadmium at the electrolytic zinc plant averaged 83,000 pounds per month. Recovery was improved by installation of a new leaching plant to process purification residue. There was a sharp increase in the tonnage of fire clay mined at the Armington pit for refractory use at the Anaconda smelter in Deer Lodge County.

Dawson.—Recovery of crude oil from six fields was 1.5 million barrels, a slight decline from the 1963 total. The Gas City field was the principal source. Initial production of the Bloomfield field was from a Dawson Bay Formation reservoir.

Deer Lodge.—Production was recorded from two small silver mines. Champion Silver Mining Co. continued exploration and development of the Champion mine in the Oro Fino (Dry Cottonwood) district.

Rehabilitation and transfer of usable milling equipment from the copper concentrator at the Anaconda Reduction Works to the new Butte concentrator was completed, and all copper concentrating at Anaconda was discontinued at the end of October. A portion of the copper-concentrating equipment not transferred to Butte was used to improve grinding of zinc ore in order to attain improved separation of lead- and zinc-bearing minerals in the resulting concentrates.

Fluid-bed reactors, originally used to roast copper ore at Anaconda, were being converted to treat zinc concentrate. Zinc concentrate from Butte district ore, in addition to certain custom concentrates,

[6] Earll, F. N. Economic Geology and Geochemical Study of the Winston Mining District, Broadwater County, Montana. Montana BuMines and Geol. Bull. 41, November 1964, 56 pp.

were roasted at Anaconda before shipment to the electrolytic zinc plant at Great Falls for reduction to slab zinc.

The Anaconda Co. began operating a beryllium refining pilot plant at Anaconda to produce high-purity metal by an electrolytic process. The plant was reported to be the first of its type in the United States.

Anaconda continued to treat manganese ore from the purchased government low-grade stockpile. The company annual report indicated that 21,408 tons of manganese nodules was produced, the first such production since 1962. Approximately 6,170 tons of ferromanganese also was produced. The company recovered 1,516 tons of arsenic trioxide, the least since 1952, from arsenic-bearing copper ore.

The Anaconda smelter was operated at capacity throughout much of the year. The company concentrate from Nevada operations normally smelted at Anaconda was diverted to the American Smelting and Refining Company smelter at Tacoma, Wash. The diversion was necessary because the Anaconda smelter capacity was insufficient to handle the large increase in raw materials from company operations in the West.

Output of limestone mined at Brown's quarry increased; the material was calcined to quicklime for use at The Anaconda Company ore-processing metallurgical operations.

Fallon.—Crude oil production declined from 8.7 to 8.4 million barrels. The Cabin Creek field accounted for 3.1 million barrels, and the Pennel and Lookout Butte fields contributed 2.7 and 1.7 million barrels, respectively, to the total. Initial production, from reservoirs of the Interlake-Red River formations, was recorded for the Wills Creek South field. Natural gas withdrawal from three fields was 4.9 billion cubic feet, compared with 5.8 billion cubic feet in 1963. Cedar Creek field, the second most important source in the State, yielded 3.5 billion cubic feet; 1.2 billion cubic feet came from the Cabin Creek field, and the remainder was from the Plevna field.

Fergus.—A small quantity of gold-silver ore was extracted at the Thomas No. 1 mine in the Cone Butte district. Vitro Minerals Corp. continued to examine, by diamond drilling and other exploration methods, a portion of the Judith Mountains near Lewistown.

Gypsum was mined near Heath by United States Gypsum Co. and near Hanover by Ideal Cement Co. Clay mined at pits near Lewistown was used by Lewistown Brick & Tile Co. to make heavy clay products. Less sand and gravel was mined than in the previous year.

Flathead.—Three base- and precious-metal mines were operated. The largest production was from the Flathead mine by Waino Lindbom under a lease from The Anaconda Company.

Considerable silver exploration was conducted in the Hog Heaven (Flathead) district. Midnite Mines, Inc., Spokane, Wash., began diamond drilling at two properties in the area and entered into an agreement with Lindy Mining Corp. to spend up to $50,000 exploring ground leased from Northen Pacific Railway Co. and the State of Montana. The Anaconda Co. conducted geochemical soil sampling and other exploration in the vicinity of the Flathead mine, and preparations were begun for underground work to check results of the surface examination. The Montana Bureau of Mines and Geology con-

ducted geochemical soil sampling in the area. The Northern Pacific Railway continued to appraise company-owned land in the region.

The 68,835 tons of aluminum ingot produced at the Anaconda Aluminum Co. plant at Columbia Falls exceeded the previous record output established in 1963 by nearly 1,500 tons. Employment at the plant totaled 1,229 at the end of November—574 in plant operations and maintenance and 655 in constructing the third potline.

The geology of portions of four quadrangles in the southeastern part of the county was described.[7]

Gallatin.—Value of nonmetallic mineral production declined slightly compared with that of 1963. The Ideal Cement Co. plant at Trident was the leading mineral industry operation in the county. Limestone output for manufacturing cement, from the Trident quarry adjacent to the cement plant, ranked the county second in stone production. The county also was the second ranking source of sand and gravel as a result of increased requirements by the State highway department.

Glacier.—Crude oil output from six fields totaled 860,000 barrels, compared with 942,000 barrels in 1963.

Granite.—Base- and precious-metal production was from 11 mines. The largest production was from the Black Pine mine in the Henderson district from which James Hunter and John C. Bork & Sons trucked silver ore; Ben Walkup moved old tailings to the copper smelter at Anaconda. Significant amounts of silver ore were produced by John McDonald at the New Seattle-Dolly Quartz mine at Maxville.

Late in the year, Taylor-Knapp Co. shipped a small quantity of ore from the Moorlight group (True Fissure mine) to the Anaconda zinc concentrator at Anaconda and prepared to make further shipments in 1965. This was the first zinc production by the company since September 1962. The Philipsburg firm began negotiations with Contact Mining Co. (Scratch Awl mine) and Trout Mining Co. (Algonquin mine) to combine the three firms' adjoining properties into a single mining unit to be operated by Taylor-Knapp. Under terms of the proposed agreement, the properties were to be connected by a main haulageway, and zinc ore was to be hoisted through the Algonquin shaft and concentrated at the Algonquin mill.

Battery-grade manganese ore continued to be the major product of Taylor-Knapp Co. This product was best suited for use in dry-cell batteries not requiring a high drain rate, such as those used in flashlights, entrance lights, and blinker lights for construction projects.

Montana Phosphate Products Co. completed constructing a 300,000-ton-annual-capacity flotation concentrator. Phosphate rock from the Douglas mine near Hall, upgraded at the mill to a concentrate containing 31 percent P_2O_5, was shipped to Canada in closed-hopper rail cars. Phosphate fertilizers were manufactured from the upgraded material by Consolidated Mining & Smelting Co. of Canada, Ltd.

Jefferson.—Eighteen metal mines yielded 19,647 tons of ore. The leading gold, silver, and copper output came from the Basin Jib mine in the Basin (Cataract) district. Most of the lead and zinc production was from the Alta-Custer mine (Lahey Leasing Co.), Colorado district.

[7] Johns, Willis M. Progress Report on Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana. Part 6. Southeastern Flathead County and Northern Lake County. Montana BuMines and Geol. Bull. 42, December 1964, 66 pp.

United Buffadison Mines, Ltd., continued exploring claims in the Crystal mine area (Basin district). Diamond drilling was completed to depths exceeding 150 feet below the Crystal mine workings or 500 feet below the surface.

Ruby Silver Mines, Inc., received a $132,800 OME contract for exploration in the Lowland mining district; government participation was 50 percent of the contract total.

Cement production was up sharply at the Kaiser Cement & Gypsum Corp. Montana City plant, the county's leading nonmetallic mineral industry operation. The county ranked first in stone production, largely because of demand for miscellaneous stone at State highway department projects. Greater tonnage of limestone was quarried at the Montana City quarry by Kaiser Cement & Gypsum Corp. Initial output of silica-bearing material from the Basin quarry by Pacific Silica Co. was shipped to Pacific Northwest consumers for manufacturing ferrosilicon.

Judith Basin.—The Liberty mine, Barker district, was the only metal mine recording production.

Lewis and Clark.—lead and zinc recovered from old smelter slag at The Anaconda Company slag-fuming plant, located adjacent to the American Smelting and Refining Company lead smelter at East Helena, accounted for most of the value of metal output in the county. The production of 1,230 tons of lead and 8,451 tons of zinc was slightly below the 1963 totals.

Relatively small amounts of base- and precious-metal ore were extracted at 17 mines in 7 mining districts. The largest output was by Louis Peura from old silver tailings shipped from the Peck millsite in the Helena district. Carlos Hieber shipped 114 ounces of gold from the Emma Miller property in the Marysville district.

The Anaconda Company and Bear Creek Mining Co., a subsidiary of Kennecott Copper Corp., staked mining claims and leased property aggregating nearly 20,000 acres in the vicinity of the Mike Horse mine near Rogers Pass. Anaconda drilled several holes that intersected zones of low-grade copper.

Liberty.—Recovery of crude oil from three fields in the county continued to increase. Output totaled 635,000 barrels, compared with 468,000 barrels in 1963. Natural gas withdrawals declined to 4.8 billion cubic feet from 5.7 billion cubic feet in 1963. Principal gasfields were Keith Block (2.3 billion cubic feet) and Whitlash (1.4 billion cubic feet).

Madison.—The largest individual output from the eight producing mines came from the Pacific mine (Pacific Mines, Inc.) in the Virginia City district. B.L.M.W. Mining Co. received a $20,500 OME contract for exploration in the Fairweather district.

Sand and gravel requirements for use in road construction by the State highway department were over 1 million tons. Talc was mined by three companies at six operations: American Chemet Corp. (Bozo-Lobo, Madison, and Rebish & Ike mines), Sierra Talc & Chemical Co. (Yellowstone mine), and Tri-State Minerals Co. (Regal and Treasure State mines).

McCone.—Crude oil recovery from three fields totaled 277,000 barrels. Initial production of the Weldon field was from a structural-trap reservoir in the Kibbey sandstone.

Meagher.—Production from the Yellowstone mine (Hamilton Mines, Inc.) in the Castle Mountain district accounted for most of the metal output in the county.

Mineral.—The Bunker Hill Co. terminated exploration of the Nancy Lee property in the Keystone district near Superior after sinking the shaft 400 feet, establishing two new levels, and conducting an intensive ore search during the 3-year period after the mine was leased in July 1961. Bunker Hill mined about 60 tons of lead ore per day just prior to terminating the lease; the ore was trucked to the company concentrator at Kellogg, Idaho. Late in the year, E. G. Smith, former operator of the mine, again leased the mine from Nancy Lee Co., reactivated the mill, and made several shipments of concentrate to the East Helena smelter.

McIsaac Mining & Tunneling Co., Sudbury, Ontario, Canada, employed 12 men in reopening the Mineral King mine near Saltese; however, operations were recessed in August following an explosion that caused the death of two miners.

Missoula.—Ward Development, Inc., extracted 818 tons of silver ore from the Ward mine, the only active metal-producing operation in the county. The geology and ore deposits of the Clinton mining district were described.[8]

Barite was mined at the Elk Creek mine 9 miles southeast of Greenough by Baroid Division, National Lead Co. Ore was trucked to a company gravity-concentrating plant at Greenough for processing. Coarse quartz and granite-bearing tailings were dug from a settling pond at the Greenough operation and sold to the State highway department for use in road construction. Limestone was calcined to quicklime by American Crystal Sugar Co. for use at its refinery.

Musselshell.—Crude oil recovery dropped from 1.2 million barrels in 1963 to 1.1 million barrels. The Big Wall, Ivanhoe, and Keg Coulee fields furnished most of the output. Initial production was from four fields. A stratigraphic-trap reservoir in the Tyler "B" sandstone yielded oil in the Keg Coulee North field. Structural-trap reservoirs containing oil were discovered in the Lakota formation, Mason Lake field; and the Amsden formation, Pole Creek and Gage Southwest fields.

Bituminous coal output from six mines was 31,500 tons, 2,300 tons less than in 1963.

Phillips.—Northern Continental, Inc., the second largest gold producer in the State, operated the Gold Bug mine in the Little Rockies district.

Powell.—The largest metal production was from an open-pit operation at the Silver Reef mine (K & R Mining Co.) in the Zozell district. Over 1,000 ounces of silver and 10 tons of lead came from the Negros mine in the Nigger Hill district. Louie Eich and Charles Sullivan operated two draglines, two crawler tractors, two pressure pumps for water, and a washing plant at a placer gold operation (Pioneer mine) in the Pioneer district.

[8] Hintzman, Davis E. Geology and Ore Deposits of the Clinton Mining District, Missoula County, Mont. Montana BuMines and Geol. Bull. 40, May 1964, 38 pp.

Phosphate rock production was less than in 1963. Operations of Montana Phosphate Products Co. (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. Limestone was calcined and marketed as quicklime and hydrated lime by Elliston Lime Co.

Richland.—Lignite production increased moderately from the Savage mine by Knife River Coal Mining Co. at Sidney. Output was used as fuel at a coal-fired steam-electric plant at Sidney by Montana-Dakota Utilities Co. Crude oil output from the Sidney-Brorson and Spring Lake fields totaled 174,000 barrels. Limestone was calcined to quicklime by Holly Sugar Corp. for use at its refinery.

Roosevelt.—Crude petroleum production from 12 fields totaled 2.3 million barrels, compared with 2.6 million barrels in 1963. The county ranked third as a petroleum source. Initial production, from structural-trap reservoirs of the Nisku formation, was recorded for the Tule Creek East, Tule Creek South, and Volt fields.

Rosebud.—Crude oil recovery declined from 1.7 million barrels in 1963 to 1.3 million barrels. Most of the drop resulted from reduced output at the Sumatra field, the leading source of oil.

Sanders.—Two metal mines were operated by lessees. Lead ore was extracted at the Jack Waite mine in the Eagle district, and 57 tons of ore from the Raven mine (Thompson River district) yielded 1,742 ounces of silver and 4 tons of copper.

Sheridan.—Crude oil output from seven oilfields totaled 1.5 million barrels, an increase of 200,000 barrels over the 1963 total. Initial production came from the Flat Lake field where a stratigraphic-trap reservoir in the Madison formation yielded oil.

Silver Bow.—Production of gold, silver, copper, lead, and zinc from the Butte district furnished 95 percent of the value of precious- and base-metal output in the State.

Summit Valley (Butte) District.—The long-range plan to increase copper production in the district moved nearer to reality with completion of a new copper concentrator and acceleration of development designed to tap high-grade deposits at depth. Production at the highly automated concentrator at Butte was gradually increased until a sustained capacity output was attained. Operating methods and equipment at the new facility were described in three publications.[9]

The Butte deep-level program to develop high-grade ore for blending with low-grade pit ore to achieve suitable millheads resulted in deepening the Kelley No. 1 shaft (36 feet by 7 feet) to the 5,847-foot point. Upon completion of connecting haulageways, the shaft was to be used for centralized hoisting from deep levels of the Mountain Con, Leonard, and Steward mines. Four of the five shaft compartments were to be equipped with hoisting skips with a combined capability of raising more than 7,000 tons per day from the 4,600 level. Over 1,000 feet of the planned 1,650-foot, 4,600-level haulageway from the Moun-

[9] Chemical & Engineering News. Butte Mining Perks Up With New Concentrator. July 27, 1964, pp. 40–42.
Chemical Engineering. Process Innovators Concentrate on Copper Ore. Aug. 3, 1964, v. 71, No. 16, pp. 46, 48, 50.
Wraith, William Jr., and T. G. Fulmor. Anaconda's Butte Concentrator. Min. Eng., May 1964, pp. 55–73.

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			
1955–59 (average)	19	1	9,331	23,339	4,786
1960	11		12,169	21,819	2,918
1961	11	1	12,635	18,391	2,765
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
1882–1964			[2] 305,721	2,383,799	633,525

Year	Copper (short tons)	Lead (short tons	Zinc (short tons)	Total value (thousands)
1955–59 (average)	85,096	9,777	43,634	$75,760
1960	91,754	1,889	4,755	63,980
1961	103,788	435	1,384	65,881
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
1882–1964	7,921,808	408,356	2,358,089	3,767,537

[1] Does not include gravel washed.
[2] Complete data not available: 1904–64.

tain Con mine to the Kelley No. 1 shaft was completed. A connection from this haulageway was ultimately to provide passage to the Steward mine. Haulageways were planned to connect the shaft with the 4,200 level of the Leonard and Belmont mines. All haulageways were to be of sufficient size to accommodate 36-inch-gage track and 120-cubic-foot cars capable of carrying 5 tons.

Deepening of the Kelley No. 2 shaft to a depth of 939 feet below the 3,000 level was begun late in the year. Upon completion, the shaft was to replace the High Ore shaft as the central pump station for the district. Replacement of the High Ore shaft, located near the edge of the Berkeley pit, was necessary because of a planned pit expansion. Sinking of the circular Neversweat 69-degree inclined shaft was continued by Centennial Development Co. The shaft was intended mainly for ventilation of the Steward mine.

Leaching of Berkeley pit low-grade material containing 0.1 to 0.4 percent copper was begun in January. Leach ore was piled on an impervious asphalt pad (3¼ inches thick) designed to minimize the loss of pregnant solutions. Warm water (85° F) from Butte mines, with the addition of a small amount of sulfuric acid, was percolated through the leach dumps before being directed to the precipitation plant for recovery of the copper in solution.

A 12-day strike by employees of the Butte, Anaconda & Pacific Railway in April forced Anaconda to close its mines and concentrator at Butte and the smelter at Anaconda. The railway company had reduced employment about 20 percent to 400 workers in the year just prior to the strike as a result of reduced copper ore shipments to Anaconda following completion of the Butte concentrator. Anaconda reported that although more than 625,000 man-shifts were worked during the year, there was not a single fatality in the Butte mines.

Phosphate rock production from the Maiden Rock mine near Melrose by Victor Chemical Works was lower than that of 1963. Elemental phosphorus was produced at the company's Silver Bow plant.

Toole.—Production of crude oil increased 1 million barrels to 1.7 million barrels. Greater output was largely the result of developing the Fred and George Creek field where crude oil recovery totaled 1.2 million barrels. Natural gas withdrawals were 1 billion cubic feet. Kevin-Sunburst field continued to be the major source of natural gas.

Yellowstone.—Crude oil recovery from the two fields in the county totaled 211,000 barrels, 9,000 barrels more than in 1963. Elemental sulfur was recovered by Montana Sulphur & Chemical Co. from oil-refinery waste gases.

The county ranked first in the State in sand and gravel production. Shale from the Lockwood Flats pit was expanded to lightweight aggregate by Montana Liteweight Aggregate Co. near Billings. Clay, dug near Billings by Lovell Clay Products Co., was used to make heavy clay products. Limestone was calcined to quicklime 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, McCone, Prairie, and Wibaux.—Crude oil recovery from the Pine field, the largest source of petroleum in the State, totaled 3.9 million barrels, a decline of 400,000 barrels from that of 1963. Over 699 million cubic feet of natural gas was withdrawn from the field.

Garfield and Petroleum.—Output of crude petroleum from the Cat Creek field was 240,000 barrels, an increase of 6,000 barrels over the 1963 total.

Glacier and Toole.—The Cut Bank field yielded 1.9 million barrels of crude petroleum, 100,000 barrels more than the 1963 total. Natural gas withdrawals from the adjoining Cut Bank-Reagan field, the leading source of natural gas in the State, totaled 7.5 billion cubic feet.

Golden Valley and Stillwater.—Natural gas withdrawn from the Big Coulee field totaled 1 billion cubic feet, a 54-million-cubic-foot increase over the 1963 total.

Musselshell and Rosebud.—The Bascom and Stensvad fields yielded 420,000 barrels of crude petroleum, about 146,000 barrels less than the 1963 output.

Pondera and Teton.—Crude oil production from the Pondera and Pondera Coulee fields was 406,000 barrels. Production in 1963 was 437,000 barrels.

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] David M. McRoberts,[2] and Joseph N. Harstead [3]

VALUE of mineral production in Nebraska was 7 percent less than in 1963 due largely to an $11.1 million drop in value of crude petroleum and petroleum products. Heavy demand by the construction industry resulted in substantial gains for sand and gravel and stone. The remaining mineral products—cement, lime, clay, and pumice—showed slight to moderate losses.

The value of petroleum, natural gas, and natural gas liquid production was $55 million, representing 60 percent of the total for the State mineral output.

Of the 93 counties, 84 reported production in 1964; Kimball County led with 20 percent of the value of the State mineral output.

Government Programs.—Government construction projects used large quantities of cement, stone, and sand and gravel. State highway

TABLE 1.—Mineral production in Nebraska [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	148	$148	143	$143
Gem stones	(2)	5	(2)	5
Natural gas (marketed)—million cubic feet	13,051	2,454	11,155	1,707
Natural gas liquids:				
LP gases—thousand gallons	25,931	1,207	24,556	1,092
Natural gasoline and cycle products—do	10,119	687	9,587	627
Petroleum (crude)—thousand 42-gallon barrels	21,846	61,824	19,113	51,605
Sand and gravel—thousand short tons	11,166	10,680	14,641	15,748
Stone—do	3,700	6,192	3,779	6,417
Value of items that cannot be disclosed: Cement, lime, and pumice	XX	15,710	XX	14,615
Total	XX	r 98,907	XX	91,959

r Revised. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

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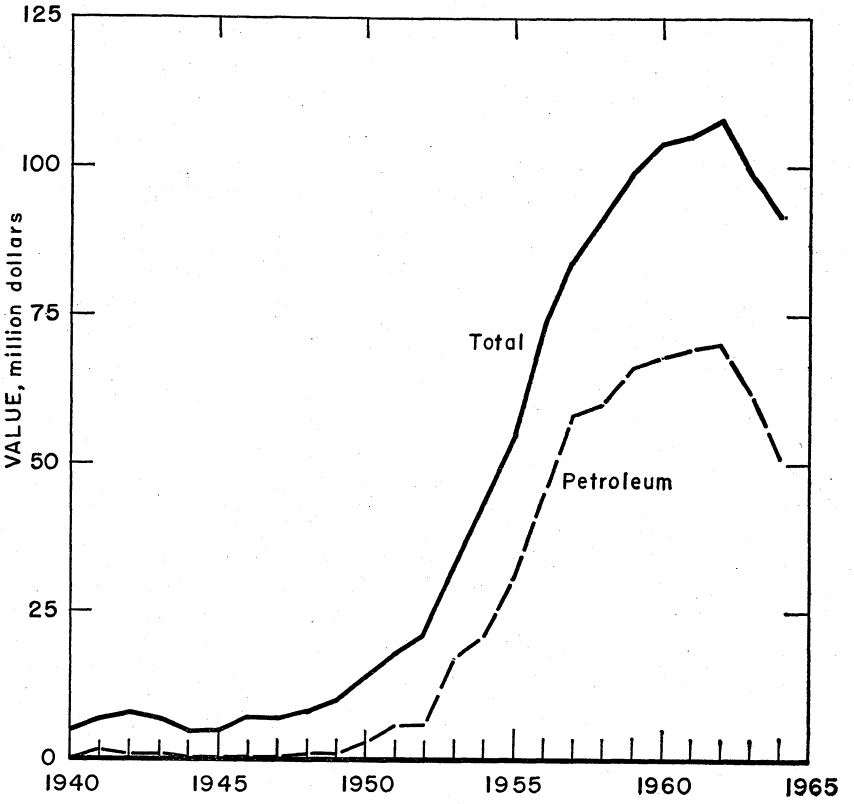


FIGURE 1.—Value of petroleum and total value of mineral production in Nebraska.

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

(Thousands)

Year	Value	Year	Value
1953	$36,539	1959	$99,621
1954	45,366	1960	103,733
1955	58,111	1961	104,543
1956	75,088	1962	r 106,518
1957	82,582	1963	r 97,584
1958	90,156	1964	90,634

r Revised.

contracts awarded during the year increased by 5.7 percent to $44.8 million.[4] By yearend, 206 of the 478.1 miles[5] designated in the National System of Interstate and Defense Highways was open to traffic; 15.7 miles of highway was under construction; and 256.4 miles was in the design or right-of-way acquisition stages.

[4] Engineering News-Record. State Highway Contract Awards Will Jump to a Record High. V. 174, No. 12, Mar. 25, 1965, pp. 30–32.
[5] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65–10, Feb. 11, 1965.

Concrete structures for distribution of irrigation water were built at the Kansas River, North Platte River, Ainsworth, and Farwell Projects of the Federal Bureau of Reclamation. Contractors for the U.S. Army Corps of Engineers were engaged in several projects in various parts of the State; repair or building of dams, dikes, and levees and stabilization of river channels all absorbed commercially important quantities of construction raw materials.

Effective January 1, 1964, the Nebraska Oil and Gas Conservation Commission announced a reduction in the levy on oil and gas for support of commission activities from 2 mills to 1 mill per dollar of wellhead value.

The Federal Bureau of Mines completed a study of oil recovery by waterflooding and initiated investigations of pozzolanic materials and lightweight aggregates.

Employment and Injuries.—Table 3, compiled from data collected by the Federal Bureau of Mines, shows employment and injuries in the mineral industries for 1963 and 1964, excluding mineral fuels.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Nonmetal	20	5	38			
Sand and gravel	1,028	213	2,032	2	16	9
Stone	570	159	1,325		12	9
Total	1,618	377	3,395	2	28	9
1964: p						
Nonmetal	15	4	33			
Sand and gravel	1,350	279	2,664	4	21	9
Stone	575	165	1,377	1	8	7
Total	1,940	448	4,074	5	29	8

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Natural Gas.—Natural gas production—52 percent casing head gas from oil wells and 48 percent dry natural gas from gas wells—totaled 3.6 billion cubic feet, 28 percent below the 1963 figure. Production was principally from Cheyenne (52 percent of the total output), Kimball (23 percent), and Deuel (14 percent) Counties.

Natural Gas Liquids.—Production of LP gases (propane and butane) decreased 1.4 million gallons or 5 percent. Output of natural gasoline and cycle products decreased 532,000 gallons or 5 percent. The liquids were recovered at four plants, two in Cheyenne County and one each in Kimball and Deuel Counties. Daily throughput of the

four plants averaged 48.9 million cubic feet, 72 percent of total capacity. The Antelope Gas Products Co. plant in Banner County was shut down; gas previously processed was diverted to the company plant in Kimball County.

Petroleum.—Crude petroleum production decreased 13 percent to the lowest level since 1956. Kimball, Banner, and Cheyenne Counties in the Denver-Julesburg basin led the State production.

Red Willow County in the Cambridge Arch area dropped from third to fourth place. Two fields, Sleepy Hollow in Red Willow County and Singleton in Banner County, each produced more than 1 million barrels. Average value of crude oil was $2.73 per barrel (Denver-Julesburg), $2.52 (Cambridge Arch), and $2.30 (Falls City). The weighted average value was $2.70.

According to the Nebraska Oil and Gas Conservation Commission,[6] secondary oil production comprised nearly 43 percent of the total oil output. On January 1, 1965, 68 active secondary-recovery projects were in operation in 62 fields in 6 counties. Of the 68 projects, 65 were in the Denver-Julesburg basin and 3 were in the Cambridge Arch area.

Drilling activity declined for the third consecutive year; 461 wells were completed, compared with 523 wells in 1963. The wildcat success ratio, however, improved from 1:12 to 1:10. Discoveries were limited to the Denver-Julesburg basin and the Cambridge Arch area.

The Cooperative Refinery Association plant at Scottsbluff, the only refinery in the State, processed 929,000 barrels of oil, a decrease of 4.3 percent.[7]

TABLE 4.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1963	1964	Principal fields in 1964 in order of production
Banner	5,454	4,985	Singleton, Willson Ranch, Vowers, Olsen, Kenmac.
Cheyenne	3,287	3,081	Juelfs-Gaylord, Reimers, Doran, Cook, Preble.
Dundy	18	16	Pierce Lake, East Indian Creek, Highland, Rock Canyon.
Frontier	(1)		
Furnas	2	1	Wilsonville.
Garden	8	10	Richards, McCord.
Harlan	57	41	South Alma.
Hayes	9	5	Blackwood Creek.
Hitchcock	216	220	Reiher, Dry Creek.
Kimball	6,703	6,313	Sloss, Kimball, Aue-Griffith, Enders, Heidemann, Long, Houtby, Jacinto.
Lincoln	13	14	Red Willow Creek.
Morrill	969	950	Olsen, Lindberg, Dunlap, Waitman.
Red Willow	4,365	2,707	Sleepy Hollow, Silver Creek, Ackman, Northwest Sleepy Hollow.
Richardson	91	72	Dawson, Falls City, Barada.
Scotts Bluff	654	698	Cedar Valley, Canal, Minatare.
Total	21,846	19,113	

[1] Less than ½ unit.

Source: Nebraska Oil and Gas Conservation Commission. Nebraska, Division of Nebraska Resources. Nebraska on the March (Annual Oil Issue). V. 17, No. 3, May 1965, pp. 8–10.

[6] Nebraska, Division of Nebraska Resources. Nebraska On The March (Annual Oil Issue). V. 17, No. 3, May 1965, pp. 3–5.
[7] Work cited in footnote 6.

TABLE 5.—Wildcat and development well completions in 1964, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Banner	6		31	37	225,800
Box Butte			2	2	9,000
Buffalo			1	1	4,400
Chase			3	3	13,400
Cheyenne	5	1	29	35	177,300
Dawson			1	1	3,600
Deuel			1	1	3,700
Dodge			1	1	
Dundy			1	1	5,100
Furnas	1		4	5	17,700
Garden			4	4	13,700
Gosper			1	1	3,800
Grant			1	1	4,600
Harlan			2	2	8,700
Hayes			4	4	17,800
Hitchcock	2		7	9	42,300
Howard			1	1	3,700
Johnson			1	1	
Kearney			3	3	15,200
Keya Paha			1	1	2,600
Kimball	7		35	42	274,500
Lincoln			3	3	13,400
McPherson			2	2	9,000
Morrill	1		11	12	53,300
Nance			1	1	3,100
Otoe			2	2	
Red Willow			8	8	28,400
Richardson			6	6	
Scotts Bluff	2		40	42	214,300
Sioux			7	7	35,600
Total	24	1	214	239	1,204,000
Development:					
Banner	25		23	[1] 49	307,700
Cheyenne	12		23	[1] 36	182,500
Garden			1	1	3,400
Hayes			1	1	4,300
Hitchcock	1		2	3	12,800
Kimball	31	1	24	56	358,400
Lincoln			1	1	5,000
Morrill	4		6	10	49,300
Red Willow	29		11	[1] 41	149,600
Scotts Bluff	10		14	24	117,700
Total	112	1	106	[2] 222	1,190,700
Total all drilling	136	2	320	[2] 461	2,394,700

[1] Includes 1 service well.
[2] Includes 3 service wells.

Source: Oil and Gas Journal.

NONMETALS

Cement.—Shipments of portland and masonry cements by Ash Grove Lime & Portland Cement Co. of Louisville and by Ideal Cement Co. of Superior dropped 7 percent. In addition to intrastate shipments, comprising 84 percent of sales, cement was sold to consumers in Iowa, Kansas, Minnesota, and South Dakota.

Clays.—Clay output, from Cass, Douglas, Jefferson, Lancaster, and Otoe Counties, declined 3 percent. Uses were for manufacturing brick and cement.

Lime.—Four plants of The Great Western Sugar Co.—located at Bayard, Gering, Mitchell, and Scottsbluff—and the Grand Island plant of American Crystal Sugar Co. produced and consumed the entire output of lime in the State, which, with coproduct carbon dioxide, was used in manufacturing beet sugar.

Perlite.—Crude perlite mined in New Mexico and Utah was expanded by Western Mineral Products Co. of Omaha for use as an aggregate in plaster and concrete.

Pumice.—Crude pumice mined at the LaMaster property in Lincoln County was processed at the Callaway plant of LaRue-Axtell Pumice Co. The finished product was used in scouring and polishing compounds and as a paint additive.

Sand and Gravel.—Output of sand and gravel, produced in 81 of 93 counties, increased 31 percent, reaching a record of 15 million tons. Highways, including paving and structures, absorbed 72 percent, buildings 24 percent, and other uses 4 percent. The five leading producers were Behrens Construction Co., Central Sand & Gravel, Lyman-Richey Sand & Gravel Corp., McCann Sand & Gravel Co., and Western Sand & Gravel Co.

Stone.—Stone (limestone) output of 3.8 million tons exceeded that of any previous year. Half of the production was used as aggregate in concrete and as base-course and road-surfacing material. Large quantities of crushed and broken limestone were required in manufacturing cement and as riprap. Smaller amounts were used in soil

TABLE 6.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	208	$242	Keith	185	$230
Antelope	97	116	Kimball	18	18
Banner	8	8	Knox	172	197
Boone	W	W	Lancaster	80	80
Brown	229	254	Lincoln	830	897
Buffalo	523	625	Loup	24	23
Burt	2	2	Madison	305	360
Butler	242	277	Merrick	189	207
Cass	W	W	Morrill	148	133
Cedar	158	160	Nance	132	154
Chase	90	78	Nuckolls	94	106
Cherry	4	4	Otoe	122	122
Cheyenne	74	74	Pawnee	2	2
Clay	150	166	Perkins	61	33
Colfax	111	117	Phelps	99	123
Cuming	428	472	Pierce	163	171
Custer	303	315	Platte	608	699
Dawes	40	40	Polk	W	W
Dawson	305	360	Red Willow	169	177
Dixon	55	58	Richardson	72	77
Dodge	737	791	Rock	19	19
Douglas	1,228	1,214	Saline	352	344
Dundy	48	48	Sarpy	634	627
Fillmore	56	56	Saunders	1,090	1,191
Franklin	W	W	Scotts Bluff	289	341
Frontier	69	80	Seward	212	212
Furnas	58	65	Sheridan	5	5
Gage	338	320	Sherman	50	50
Garden	10	8	Sioux	52	52
Garfield	8	7	Stanton	132	149
Gosper	19	19	Thayer	113	139
Greeley	24	29	Thomas	W	W
Hall	556	628	Thurston	W	W
Hamilton	174	174	Valley	42	53
Harlan	W	W	Washington	2	2
Hayes	W	W	Wayne	31	31
Hitchcock	62	64	Webster	84	97
Holt	131	129	Wheeler	11	13
Hooker	W	W	York	179	173
Howard	49	49	Undistributed	951	1,019
Jefferson	188	232			
Kearney	138	141	Total	14,641	15,748

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

conditioning and as a mineral filler in various products. A small quantity of dimension stone (rubble) was produced. Major producers were Ash Grove Lime & Portland Cement Co., City Wide Rock & Excavation Co., Fort Calhoun Stone Co., Hopper Bros. Quarries, and United Rock Construction, Inc. Cass County yielded 61 percent of total stone output.

Talc.—Crude talc mined in California, Montana, and Utah was processed by Sierra Talc Co. at Grand Island for use in manufacturing ceramics, cosmetics, paint, paper, rubber, textiles, and tile.

Vermiculite.—Western Mineral Products Co. of Omaha exfoliated vermiculite from mines in Montana for use as insulating material, litter, and plaster aggregate.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	2,759	$2,703	2,407	$2,492
Paving	974	931	1,333	1,410
Fill	331	208	455	416
Industrial:				
Other	(1)	(1)	----	----
Total	4,064	3,842	4,195	4,318
Gravel:				
Construction:				
Building	790	822	1,153	1,400
Paving	4,650	4,503	4,837	5,651
Railroad ballast	(2)	(2)	(2)	(2)
Fill	132	81	48	46
Other	----	----	1	1
Miscellaneous	258	231	----	----
Total	5,830	5,637	6,039	7,098
Total sand and gravel	9,894	9,479	10,234	11,416
Government-and-contractor operations:				
Sand:				
Building	(3)	(3)	----	----
Paving	323	329	1,840	1,822
Total	323	329	1,840	1,822
Gravel:				
Paving	949	872	2,567	25,10
Total sand and gravel	1,272	1,201	4,407	4,332
All operations:				
Sand	4,387	4,171	6,035	6,140
Gravel	6,779	6,509	8,606	9,608
Total	11,166	10,680	14,641	15,748

[1] Withheld to avoid disclosing individual company confidential data; included with construction sand used as "Fill."

[2] Withheld to avoid disclosing individual company confidential data; included with construction gravel used as "Fill."

[3] Less than ½ unit.

TABLE 8.—Stone sold or used by producers, by uses

Use	1963		1964	
	Short tons	Value	Short tons	Value
Dimension stone: Rubble	16,295	$74,164	12,432	$59,282
Crushed and broken stone:				
Riprap	851,911	1,171,119	757,059	1,011,220
Concrete and roadstone	1,661,340	2,833,739	1,842,154	3,246,637
Agriculture	W	W	196,138	320,135
Other	[1] 1,170,762	[1] 2,113,432	[2] 971,321	[2] 1,779,782
Total	3,684,013	6,118,290	3,766,672	6,357,774
Total stone	3,700,308	6,192,454	3,779,104	6,417,056

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes stone used in cement, feed, other filler, paint, and rubber filler.
[2] Includes stone used in asphalt filler, cement, lime, other filler, poultry grit, and rubber filler.

METALS

Although Nebraska had no metallic mineral production in 1964, antimony, bismuth, lead, silver, and some metallic byproducts were recovered at the American Smelting and Refining Co. (Asarco) lead refinery in Omaha from lead bullion and other lead-bearing materials shipped from out-of-State sources.

REVIEW BY COUNTIES

Banner.—The Singleton field, largest producing oilfield in the county, yielded 1.2 million barrels of oil. Of 65 producing oilfields, 3 partly in other counties, 9 produced more than 100,000 barrels. Casing head gas production decreased 21 percent.

Buffalo.—Seven commercial operators, crews and a contractor for the Buffalo County Highway Department, and a contractor for the Nebraska Department of Roads produced sand and gravel, used mostly for road construction; small quantities were used for building construction and for fill.

Cass.—The county yielded 2.3 million tons or 61 percent of the stone production in the State. This was the only mineral commodity with increased output. Hopper Bros. Quarries was the largest of eight producers of limestone in the State. Ash Grove Lime & Portland Cement Co. and United Rock Construction, Inc., were second and third in production.

Cement, the most valuable mineral commodity in the county, was produced by Ash Grove Lime & Portland Cement Co. at Superior. This company also had the largest clay production, which was used in manufacturing cement. The county led the State in clay production.

Sand and gravel produced by Lyman-Richey Sand & Gravel Corp., Fedde Sand and Gravel, and by contractors for the Nebraska Department of Roads was used for highway and building construction.

Cheyenne.—The county ranked first in gas and third in petroleum production; 62 percent of the gas was from gas wells and 38 percent from oil wells. Dry gas was produced at nine fields; the largest, the Southwest Sidney, yielded 3 billion cubic feet. Petroleum was pro-

TABLE 9.—Value of mineral production in Nebraska, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value
Adams	$144,000	$242,000	Sand and gravel.
Antelope	69,000	116,000	Do.
Banner	r 15,833,000	13,667,000	Petroleum, natural gas, sand and gravel.
Boone	W	W	Sand and gravel.
Boyd	9,000		
Brown	67,000	254,000	Sand and gravel.
Buffalo	830,000	625,000	Do.
Burt		2,000	Do.
Butler	202,000	277,000	Do.
Cass	14,967,777	14,487,005	Cement, stone, sand and gravel, clays.
Cedar	139,000	160,000	Sand and gravel.
Chase		78,000	Do.
Cherry	50	4,000	Do.
Cheyenne	r 11,924,000	10,467,000	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
Clay	220,000	166,000	Sand and gravel.
Colfax	87,000	117,000	Do.
Cuming	W	472,000	Do.
Custer	W	W	Sand and gravel, pumice, stone.
Dawes	2,660	58,000	Sand and gravel, stone.
Dawson	338,050	360,000	Sand and gravel.
Deuel	551,000	453,000	Natural gas, LP gases, natural gasoline.
Dixon	98,358	76,068	Sand and gravel, stone.
Dodge	764,000	791,000	Sand and gravel.
Douglas	1,153,262	1,271,811	Sand and gravel, stone, clays.
Dundy	51,000	91,000	Sand and gravel, petroleum.
Fillmore	111,000	56,000	Sand and gravel.
Franklin	108,000	107,000	Do.
Frontier	19,000	80,000	Do.
Furnas	104,000	68,000	Sand and gravel, petroleum.
Gage	204,821	441,106	Sand and gravel, stone.
Garden	52,000	35,000	Petroleum, sand and gravel.
Garfield	10,000	7,000	Sand and gravel.
Gosper		19,000	Do.
Greeley	25,000	29,000	Do.
Hall	W	W	Sand and gravel, lime.
Hamilton	128,000	174,000	Sand and gravel.
Harlan	185,000	212,000	Petroleum, sand and gravel.
Hayes	37,000	66,000	Sand and gravel, petroleum.
Hitchcock	r 634,000	658,000	Petroleum, sand and gravel.
Holt	74,000	129,000	Sand and gravel.
Hooker	W	W	Do.
Howard	24,000	49,000	Do.
Jefferson	W	W	Sand and gravel, clays.
Kearney	98,000	141,000	Sand and gravel.
Keith	122,000	230,000	Do.
Kimball	r 19,663,000	18,409,000	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
Knox	154,000	197,000	Sand and gravel.
Lancaster	283,330	W	Stone, sand and gravel, clays.
Lincoln	361,050	935,000	Sand and gravel, petroleum.
Loup	11,000	23,000	Sand and gravel.
Madison	274,000	360,000	Do.
Merrick	208,000	207,000	Do.
Morrill	r 3,360,000	2,787,000	Petroleum, sand and gravel, lime, natural gas.
Nance	W	154,000	Sand and gravel.
Nemaha	W	W	Stone.
Nuckolls	W	W	Cement, sand and gravel.
Otoe	W	W	Sand and gravel, clays, stone.
Pawnee	W	124,500	Stone, sand and gravel.
Perkins	18,000	33,000	Sand and gravel.
Phelps	114,000	123,000	Do.
Pierce	114,000	171,000	Do.
Platte	684,000	703,980	Sand and gravel, stone.
Polk	W	W	Sand and gravel.
Red Willow	r 12,314,000	7,486,000	Petroleum, sand and gravel, natural gas.
Richardson	344,958	362,267	Petroleum, stone, sand and gravel.
Rock		19,000	Sand and gravel.
Saline	157,000	344,192	Sand and gravel, stone.
Sarpy	1,039,656	1,038,525	Do.
Saunders	293,000	1,195,049	Do.
Scotts Bluff	r 2,402,000	2,575,000	Petroleum, sand and gravel, lime, natural gas.
Seward	W	W	Sand and gravel, stone.
Sheridan		5,000	Sand and gravel.
Sherman		50,000	Do.
Sioux	18,070	139,390	Stone, sand and gravel.
Stanton	90,000	149,000	Sand and gravel.
Thayer	236,000	139,000	Do.
Thomas	22,000	W	Do.
Thurston	W	W	Stone.

See footnotes at end of table.

TABLE 9.—Value of mineral production in Nebraska, by counties[1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Valley	$39,000	$53,000	Sand and gravel.
Washington	W	W	Stone, sand and gravel.
Wayne		31,000	Sand and gravel.
Webster	47,000	97,000	Do.
Wheeler	10,000	13,000	Do.
York	85,000	173,000	Do.
Undistributed[2]	7,178,841	7,126,431	
Total	r 98,907,000	91,959,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] The following counties are not listed because no production was reported: Arthur, Blaine, Box Butte, Dakota, Grant, Johnson, Keya Paha, Logan, and McPherson.
[2] Includes gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

duced from 66 fields, 2 of which were partly in Kimball County. The largest, the Juelfs-Gaylord field, yielded 335,000 barrels. Petroleum output declined 6 percent and gas output (casing head and dry) 33 percent. Casing head and dry gas were processed by The Marathon Oil Co. West Sidney plant and by the Kansas-Nebraska Natural Gas Co., Inc., Huntsman plant. The Huntsman field, formerly a gas producer, was used for gas storage.

Custer.—Sand and gravel produced by Otis Larreau, Middle Loup Sand & Gravel, Inc., and contractors for the Custer County Highway Department and Nebraska Department of Roads totaled 303,000 tons, compared with 18,000 tons in 1963. Most of the output was used in highway construction.

Pumice from a mine in Lincoln County was processed at Calloway. Production decreased 34 percent. Minor stone production was recorded.

Deuel.—Production from the Big Springs and West Big Springs gasfields, 42 percent below that of 1963, was processed at the Big Springs plant of Kansas-Nebraska Natural Gas Co., Inc. Casing head gas from nearby oilfields also was processed at the plant.

Dodge.—Sand and gravel production (737,000 tons) by commercial operators and contractors for the Nebraska Department of Roads was used for building and highway construction and as railroad ballast.

Douglas.—Output of sand and gravel, totaling 1.2 million tons, by eight commercial operators and a contractor for the Nebraska Department of Roads made this county the largest producer in the State. Construction of buildings and of highways consumed 58 and 34 percent, respectively; 8 percent was used for fill.

Stone production in the county, by contractors for the Nebraska Department of Roads, increased substantially; clay production was continued by Omaha Brick Works. At Omaha, Western Mineral Products Co. processed perlite and vermiculite produced from deposits in other States. Lead-bearing materials from plants outside the State were processed at the Asarco Omaha lead refinery.

Hall.—Four commercial operators and contractors for the Nebraska Department of Roads produced sand and gravel for buildings (8 percent) and highways (81 percent); 11 percent was used for miscellaneous purposes.

Quicklime was produced and used by American Crystal Sugar Co. for sugar refining. Crude talc from out-of-State was processed and marketed by Sierra Talc Co.

Kimball.—The county was first in petroleum production with 6.3 million barrels and second in gas production with 2.2 billion cubic feet. The Sloss field, largest in the county, yielded 987,000 barrels. Fifteen other fields produced more than 100,000 barrels each. Gas production was about 91 percent casing head. Output was from 128 fields, 3 partly in other counties.

Output of natural gas liquids (LP gases and natural gasoline) increased 43 percent. The gas was processed at the Antelope Gas Products Co. Kimball plant.

Sand and gravel produced by crews of the Kimball County Highway Department and a contractor for the Nebraska Department of Roads was used for construction and maintenance of State and county highways.

Lancaster.—Stone output—crushed and broken limestone—was used for agricultural purposes, road building, and riprap. Contractors for the Nebraska Department of Roads produced sand and gravel for highway construction. Yankee Hill Brick Manufacturing Co. produced clay for manufacturing building brick and tile. Output ranked the county second in the State in clay production.

Lincoln.—Sand and gravel, produced by two commercial operators, a contractor for the Nebraska Department of Roads, and crews and contractors for the Lincoln County Highway Department, was three times that of 1963. Highway construction absorbed all of the output.

Pumice mined at the LaMaster mine was processed at a plant in Custer County.

Morrill.—Petroleum production fell 2 percent. The largest field, Lindberg, produced 253,000 barrels. Each of the other 13 fields, 1 partly in Banner County, produced less than 100,000 barrels. Crude petroleum comprised 92 percent of the total mineral value.

Lyman-Richey Sand & Gravel Corp., a contractor for the Nebraska Department of Roads, and crews of the Morrill County Highway Department produced sand and gravel. Principal uses were for building and highway construction. Quicklime produced by The Great Western Sugar Co. was used for beet-sugar refining at its Bayard plant.

Nuckolls.—Portland and masonry cements were produced at the Superior plant of Ideal Cement Co.; output was slightly below that of 1963. Production of sand and gravel by two commercial operators and by contractors for the Nebraska Department of Roads was more than double the 1963 output. Most of this aggregate was used in highway construction.

Red Willow.—Petroleum production fell 38 percent because output from the Sleepy Hollow field, largest in the State, was 45 percent less than in 1963. Three of the other 13 fields in the county produced more than 100,000 barrels each. The petroleum output, valued at $7.3 million, was 98 percent of the total mineral value and $5 million below the 1963 figure. Wildcat drilling fell sharply; only eight wells were drilled, and none was successful. Development drilling dropped from 64 to 41 wells.

Sand and gravel produced by three companies and by contractors for the Nebraska Department of Roads was triple the 1963 output; 78 percent was used for road construction.

Richardson.—Petroleum production from the Dawson, Falls City, and Barada fields decreased 21 percent.

Two additional operations increased stone production, Wittwer Bros., Inc., Findlay Quarry, crews of the Richardson County Highway Department, and contractors for the Nebraska Department of Roads produced sand and gravel of which virtually all was used in highway construction.

Sarpy.—Four commercial operators produced sand and gravel for building and road construction and sand for fill; a contractor for the Nebraska Department of Roads produced sand and gravel for highway construction. Stone output decreased 19 percent with one less operator reporting.

Saunders.—Production of sand and gravel by five commercial operators and a contractor for the Nebraska Department of Roads was triple that of 1963. Output was used for fill and for building and highway construction.

Scotts Bluff.—A 7-percent increase in petroleum production resulted from the discovery of two new oilfields (Minatare and North Minatare), which yielded over 134,000 barrels during the last 7 months of 1964. Of the six fields in the county, the Cedar Valley and Canal fields were the largest producers, with outputs of 347,000 and 151,000 barrels, respectively. The Cooperative Refinery Association refined crude oil from Wyoming fields at its plant at Scottsbluff. The plant was the only oil refinery in the State and, according to the Nebraska Oil and Gas Commission, processed 929,000 barrels of crude oil, a decrease of 4.3 percent.

Sand and gravel was produced by five companies, crews of the Scotts Bluff County Highway Department, and contractors for the Nebraska Department of Roads. Road building consumed 62 percent of the output.

The Great Western Sugar Co. produced quicklime for use in beet-sugar refining at its Gering, Mitchell, and Scottsbluff plants.

The Mineral Industry of Nevada

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, betwen the Bureau of Mines, United State Department of the Interior, and the Nevada Bureau of Mines

By L. E. Davis,[1] and Roy Y. Ashizawa[2]

NEVADA's 1964 mineral production was highlighted by a continuing rise in nonmetallic mineral production and a marked increase in petroleum output that did not quite compensate for a decline in metals. Metals represented about 63 percent of the total value, nonmetallic minerals nearly 36 percent, and mineral fuels the remainder.

Exports continued as a major factor in the economy of the iron ore industry. Copper production was adversely affected by labor strikes and mining problems at the Liberty pit, White Pine County, resulting in lower outputs (byproduct) of recoverable gold and silver. Increased activity in State highway projects resulted in a sharp rise in sand and gravel production.

TABLE 1.—Mineral production in Nevada[1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate short tons, antimony content			33	$20
Barite short tons	120,450	$760	148,974	1,261
Copper (recoverable content of ores, etc.) do	81,738	50,351	67,272	43,861
Gem stones	(2)	100	(2)	100
Gold (recoverable content of ores, etc.) troy ounces	98,879	3,461	90,469	3,166
Gypsum short tons	890,000	3,216	799,057	2,894
Iron ore (usable) long tons, gross weight	772,133	3,921	911,238	5,048
Lead (recoverable content of ores, etc.) short tons	1,126	243	809	212
Mercury 76-pound flasks	4,944	937	3,262	1,027
Perlite short tons	22,910	192	15,603	135
Petroleum (crude) thousand 42-gallon barrels	118	W	255	W
Sand and gravel short tons	9,688,000	10,513	14,142,000	14,427
Silver (recoverable content of ores, etc.) troy ounces	214,976	275	172,447	223
Stone short tons	639,000	1,101	788,007	1,396
Sulfur ore long tons	586	11	274	5
Talc and soapstone short tons	4,243	50	5,322	58
Zinc (recoverable content of ores, etc.) do	571	131	582	158
Value of items that cannot be disclosed: Clays, diatomite, fluorspar, lime, magnesite, molybdenum concentrates (content), peat (1964), pumice, salt, tungsten concentrate, uranium ore, and values indicated by symbol W	XX	r 10,215	XX	11,146
Total	XX	r 85,477	XX	85,137

r Revised. W Withheld to avoid disclosing company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

[1] Physical scientist, Bureau of Mines, San Francisco, Calif.
[2] Mineral specialist, Bureau of Mines, San Francisco, Calif.

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

(Thousands)

Year	Value	Year	Value
1952	$71,124	1959	$69,094
1953	79,254	1960	75,360
1954	95,691	1961	79,505
1955	107,950	1962	79,521
1956	109,506	1963	81,272
1957	84,585	1964	77,851
1958	71,989		

Consumption, Trade, and Markets.—Nevada was dependent on processors outside the State for all its mineral fuels and metal requirements, and virtually all its nonmetallic mineral needs other than materials of construction. All talc and fluorspar outputs were shipped to California customers. Most of the barite, perlite, and sulfur and some gypsum was shipped out of the State in crude form. Some limestone and much of the lime produced went to consumers in California and Arizona. All crude oil production was consigned to refineries in California or Utah.

With few exceptions, metal ores, concentrates, precipitates, and residues were processed in out-of-State mills and smelters. The one smelter (copper) in the State was dependent on Nevada ores. All usable iron ore was exported or shipped to steel plants outside the State. A tungsten carbide plant utilized purchased tungsten concentrates, principally from foreign sources. An electrolytic manganese dioxide plant operated on ores produced in New Mexico and Mexico. A titanium metal plant used imported minerals as a raw material source.

Trends and Developments.—Exploration and development at metal mines and prospects were maintained at a high level. Exploration for silver ore was conducted in Esmeralda, Lander, Lincoln, Mineral, Nye, Pershing, and White Pine Counties. In the latter two instances development had reached the stage where beneficiation plants were either under construction or completed before yearend. Several companies were exploring for gold in northern Eureka County, near the property under development by Newmont Mining Co. Exploration for copper in the Copper Basin area, Lander County, was concluded and economic studies begun. Two iron ore exploration projects in Lyon County were completed and awaiting decisions on development and production. Exploration for mercury ore was underway at Elko, Humboldt, Lincoln, and Nye County prospects, and three Pershing County mercury mines were reactivated in 1964. The Pan American mine, Lincoln County, was under development with planned treatment of the low-grade zinc-lead ore in the Caselton mill near Pioche.

Nevada Cement Co. completed its cement facility at Fernley, Lyon County, and began producing cement clinker by yearend. The Eureka County barite grinding and flotation plant of National Lead Co. completed shakedown runs. A gypsum wallboard plant was under construction near Apex, Clark County, with a scheduled completion date before mid-1965. The interest of Naturalite Corp. in a Lyon County pumice deposit was purchased by Kaiser Sand and Gravel Co., and

a lightweight aggregate plant planned for completion in 1965. Foote Mineral Co. purchased equipment and processing facilities in Silver Peak, Esmeralda County, and began exploring for lithium in the nearby Clayton Valley brine deposit under a lease and option arrangement.

The Eagle Springs oil field, Nye County, was extended easterly when Texota Oil Co. successfully completed new wells in the area.

Legislation and Government Programs.—Public land orders withdrew about 76,000 acres of land from mineral location under U.S. mining laws. Over 33,000 acres was withdrawn by the Bureau of Reclamation in Clark County, about 21,000 acres by the Atomic Energy Commission in Nye County, and nearly 11,000 acres by the Bureau of Land Management in Clark County. Land orders also restored about 42,000 acres to mineral location and leasing, 27,000 acres of which, in Pershing County, was conveyed to the Federal Government on an exchange of lands. For the first 6 months of the year Nevada received a U.S. Treasury check for $222,945.61 in bonuses, royalties, and rentals covering mineral leases and permits—more than the State had received for the entire year of 1963 or 1962. The amount due Nevada for the last 6 months of 1964 had not yet been announced.

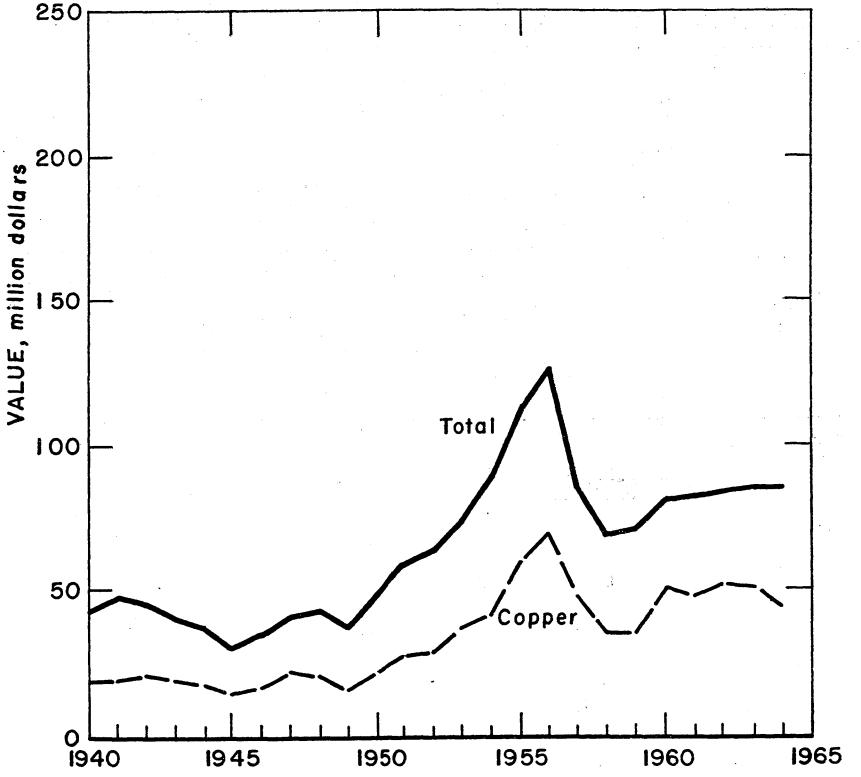


FIGURE 1.—Value of copper, and total value of mineral production in Nevada.

Of the eight Nevada producers who had been certified since enactment of the Lead-Zinc Stabilization Program in October 1962, two were still current as of December 31, 1964. During 1964, five producers received payments totaling $7,037 for production of 118.9 tons of lead and 321.4 tons of zinc. No applications were certified in 1964, but one was in process at yearend.

The Bureau of Mines provided consulting services to the Atomic Energy Commission during 1964 on preshot and postshot surveys of several 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.

For the year ending December 31, 1964, the Office of Minerals Exploration (OME) received 59 requests for application forms from persons interested in exploring for Nevada minerals. Eight applications were processed during the period—five for silver-gold and one each for silver, silver-lead-zinc, and silver-gold-manganese. Contracts were awarded for four of the eight applications. One of these was rescinded later, and two contracts, awarded to one applicant, later were cancelled at the applicant's request. The other four applications were denied. Two contracts terminated that had been in force prior to and during part of 1964, leaving but one contract in force at yearend.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	1,621	438	3,515	----	78	22
Nonmetal and peat	711	204	1,633	----	29	18
Sand and gravel	643	143	1,144	----	24	21
Stone	200	44	355	----	2	6
Total	3,175	829	6,647	----	133	20
1964: p						
Metal	2,040	567	4,505	3	110	25
Nonmetal and peat	761	190	1,523	----	38	25
Sand and gravel	940	209	1,670	----	18	11
Stone	125	26	204	----	3	15
Total	3,866	992	7,902	3	169	22

p Preliminary.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—About 71 tons of antimony ore was shipped from the Last Chance (Antimony King) mine, Lander County, to the antimony smelter in Laredo, Tex. William Inman shipped 17 tons of antimony ore from his Burl antimony prospect, Pershing County, to a customer in Dallas, Tex. About 300 tons of antimony ore in bins at the White Caps mine, Nye County, was destroyed by fire. The Stevens (Clifton) mill at Austin was being rebuilt to treat antimony ores by flotation. A small quantity of antimony ore was stockpiled at the mill. Custom milling of silver ores also was contemplated.

Copper.—Production of recoverable copper dropped 18 percent in quantity below that of 1963. The value was nearly $6.5 million lower and the lowest since 1959. The decline resulted largely from a labor strike at the White Pine County operations of Kennecott Copper Corp. during July and August and slides in the company's Liberty pit early in April that interrupted normal mining operations and forced the company to use ore from a marginal area. Twelve mines, six of which yielded a high percentage of the total, accounted for the State output. The Anaconda Co. at Weed Heights, Lyon County, and Kennecott continued to dominate the Nevada copper industry. Lesser tonnages of copper were recovered as a byproduct from complex lead, zinc, and silver ores and minor quantities were recovered from old tailings, mine dumps, and residues.

At Kennecott's McGill smelter a change was made in casting blister copper from 400-pound to 6,000-pound cakes for speedier handling and greater safety. At Weed Heights, Anaconda was preparing to leach large mine dumps containing low copper values.

Interest in exploration for copper ore, somewhat below that in 1963, was limited primarily to prospects in Elko, Lander, and Lincoln Counties.

Gold.—Gold output was 8 percent below that in 1963. Lode production was down 9 percent, principally because of lower byproduct recovery at base-metal mines. Eight lode gold mines yielded 70 percent of the total gold output. Byproduct gold at other lode mines accounted for 29 percent of the lode production and over 28 percent

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)
1955–59 (average)	108	10	10,682	87,247	$3,054	868,291	$786
1960	72	9	12,013	58,187	2,037	707,291	640
1961	62	10	12,067	54,165	1,896	388,426	359
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
1904–64 [4]			NA	15,419,469	387,701	316,945,777	218,027

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	72,202	$48,880	4,232	$1,196	3,152	$801	$54,717
1960	77,485	49,745	987	231	420	108	52,761
1961	78,022	46,813	1,791	369	453	104	49,541
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
1904–64 [4]	2,960,422	1,200,553	394,356	62,885	484,507	93,777	1,962,943

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 1964, 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
Clark	2		W	W	W	W
Douglas	2		W	W	W	W
Elko	4		2	$70	4,055	$5,243
Eureka	1				1,231	1,592
Lander	3	1	590	20,650	8,160	10,551
Mineral	3		128	4,480	1,896	2,451
Nye	1	2	913	31,955	88	114
Pershing	3	1	W	W	6,787	8,776
Undistributed [2]	19	2	88,836	3,109,260	150,230	194,247
Total	38	6	90,469	3,166,415	172,447	222,974

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Clark	12,900	$4,205	865,800	$113,420	W	W	$117,625
Douglas			1,200	157			157
Elko	600	196	51,300	6,720	53,600	$7,290	19,519
Eureka	500	163	23,600	3,092	811,500	110,364	115,211
Lander			53,200	6,969	1,200	163	38,333
Mineral	4,000	1,304	60,100	7,873	400	54	16,162
Nye			W	W			32,069
Pershing	300	98	41,400	5,424	2,000	272	14,570
Undistributed [2]	134,525,700	43,855,378	521,400	68,303	295,300	40,161	47,267,349
Total	134,544,000	43,861,344	1,618,000	211,958	1,164,000	158,304	47,620,995

W Withheld to avoid disclosing individual company confidential data.
[1] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal rights to property.
[2] Includes Churchill, Esmeralda, Humboldt, Lincoln, Lyon, Washoe, White Pine Counties, and counties indicated by symbol W.

of the total. Placer gold recovery rose 41 percent above that of 1963, but contributed less than 2 percent of the total. A high percentage of the recovered placer gold came from three dragline operations and one drift mine operated by leasers.

Newmont Mining Corp. began development of its gold property in Eureka County, northwest of Carlin in the Lynn district of the Maggie Creek area, and expected mine production to begin by mid-1965. In September, construction began on a 2,000-ton-per-day cyanide mill at the property with a completion date scheduled to mine operations. Atlas Corp., Phillips Petroleum Co., Kerr-McGee Oil Industries, Inc., American Exploration Co., and Sierra De-Oro Mining Co. were exploring for gold in the same general area. Increased interest in gold properties was in evidence throughout the State.

Iron Ore.—Shipments of usable iron ore rose 18 percent in quantity and 28 percent in value, indicating production of higher grade ore, compared with 1963. Ninety percent of the output was exported to Japan. The major producer was the Standard Slag Co. Minnesota mine and plant, Douglas County. Substantial production also came from the Eureka and Pershing County mines of Nevada-Barth Corp., the Humboldt County mine of Jackson Mountain Mining Co., and the Pershing County operations of Nevada Iron Ore Co. Several hundred tons of iron ore produced at the Iron Blossom mine, Storey County, was shipped to the Nevada Cement Co., Lyon County.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	13	394,358	63,266	15,170			
Gold-silver	1	60	99	2,880	100		300
Silver	9	20,073	31	25,111	25,300	187,700	124,700
Copper	5	12,963,616	25,379	103,337	134,497,700		
Lead	7	1,990	146	15,584	14,500	484,000	142,300
Zinc	3	1,491	2	1,792	1,200	36,900	884,700
Total	38	13,381,588	88,923	163,874	134,538,800	708,600	1,152,000
Other lode material:							
Gold (slag)	[2]	6	237	108		100	300
Lead residue	[2]			228	5,200	856,100	10,500
Old tailings	[2]	1,476	87	8,066		53,200	1,200
Total	[2]	1,482	324	8,402	5,200	909,400	12,000
Total lode material	38	13,383,070	89,247	172,276	134,544,000	1,618,000	1,164,000
Placer	6	[3]	1,222	171			
Total all sources	44	13,383,070	90,469	172,447	134,544,000	1,618,000	1,164,000

[1] Details will not necessarily add to totals shown, because some mines produce more than one class of material.
[2] From property not classed as a mine.
[3] 28,620 cubic yards.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc, in 1964, 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 and cyanidation:					
Ore	63,243	15,363			
Concentration and smelting of concentrates:					
Ore	24,828	124,426	131,569,000	185,400	123,400
Direct smelting:					
Old tailings	87	8,066		53,200	1,200
Ore	852	24,085	2,969,800	523,200	1,028,600
Lead residue		228	5,200	856,100	10,500
Slag	237	108		100	300
Total	1,176	32,487	2,975,000	1,432,600	1,040,600
Placer	1,222	171			
Grand total	90,469	172,447	134,544,000	1,618,000	1,164,000

A 4-year drilling program by United States Steel Corp., on its Lion claims, Lyon County, revealed large iron (and copper) deposits. One mining authority placed the reserve at 500 million tons of ore containing 20 to 30 percent iron and 0.3 percent copper. The ore would have to be beneficiated. United States Steel stated it had no immediate plans to place the property in production. Utah Construction and Mining Co. announced that development at its Dayton iron ore deposit, near Carson City, had indicated a reserve of 45 million tons of ore suitable for beneficiation and sale as either pellets or sinter.

Lead.—Recoverable lead production dropped 28 percent from that in 1963. The decline was due chiefly to greatly reduced shipments of

residues by Manganese, Inc., from its former manganese ore processing facility, Clark County. Even so, this source supplied over 50 percent of Nevada's lead production. Lead and silver ores contributed 30 and 12 percent, respectively, with the remainder a byproduct of complex base metal ores. Higher unit prices for lead stimulated exploration for lead- and silver-bearing ores during the year, particularly in Eureka, Lander, Lincoln, and Mineral Counties.

Federal Resources Corp. drilled the Simon mine, Mineral County, and began sinking a three-compartment shaft to handle production from a developed lead-silver ore body.

Mercury.—Mercury production continued the decline begun in 1961 despite a market price that averaged about $125 a flask higher. About the same quantity of ore was treated but 34 percent less mercury was recovered and nearly 16 percent fewer flasks were shipped, including shipments from stocks. The Cordero mine, Humboldt County, yielded more than 90 percent of the State total. Only one other property, the Ione mine in Nye County, produced and shipped more than 100 flasks of the metal.

The higher unit price in 1964 stimulated considerable exploration and development.

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]	
1955–59 (average)	37,751	5,679	7,497	793	11	6,483	$1,611,960	37
1960	47,734	6,981	5,307	840	-------	7,821	1,648,354	20
1961	103,088	13,705	26,013	353	1	7,486	1,479,308	21
1962						6,573	1,256,823	14
1963	42,768	4,908	356	36	-------	r 4,944	936,641	11
1964	42,635	3,181	653	81	-------	3,262	1,026,845	21

r Revised.
[1] Includes mercury recovered from miscellaneous dump material.
[2] Value calculated at average New York price.

Molybdenum.—Kennecott Copper Corp. recovered molybdenite in its McGill concentrator, White Pine County, as a byproduct of copper ore mined in the nearby Robinson district. Production and shipments were appreciably below the 1963 level because of a prolonged labor strike.

The Anaconda Co. continued surface exploration by diamond drilling at the Hall molybdenum property north of Tonopah, Nye County.

Silver.—Recoverable silver output declined for the fourth consecutive year, reaching an alltime low. The decline was attributed to inactivity at the Copper Canyon mine, Lander County, where silver was recovered as a byproduct, the closing of an old silver-tailing treatment plant, Esmeralda County, and to curtailed production at two Lincoln County mines—the Bristol Silver and Tempiute (lead-silver). Over 81 percent of the total silver output came as a byproduct from four mines—the two major copper producers in Lyon and White Pine Counties, the Ward Group (Silver King) in White Pine County, and the Getchell gold mine, Humboldt County. The remaining lode pro-

duction came from the ores of 11 gold properties, 8 silver mines, 5 lead mining operations, and 2 zinc producers. About 9,000 ounces of silver came from reworked dumps, tailings, slag piles, and residues. Placer gold operations contributed only 171 ounces to the total.

As a result of increasing demand for silver, exploration remained at a high level throughout 1964. Exploration in excess of assessment requirements was underway in Clark, Douglas, Elko, Esmeralda, Eureka, Lander, Lincoln, Mineral, Nye, Pershing, Storey, and White Pine Counties. In September, Mid-Continent Uranium Corp. and Sunshine Mining Co. agreed to develop and explore the Mohawk mine, Esmeralda County, by diamond drilling preparatory to driving a 7,500-foot crosscut from the Sixteen-to-One mine, which had been under development. The venture would include rehabilitation of the nearby Nivloc mine, idle since 1943. The Pixie claims, Lander County, were being diamond-drilled by Cortez Joint Venture of San Francisco, under an OME contract. Silver States Consolidated reported it had blocked out a large reserve of silver and gold ore at the Crown Point (Rochester) mine, Pershing County, and was proceeding with test and development work. Mountain Copper Co., Ltd. explored at the Mineral Hill silver mine, Eureka County, where the last reported production was in 1937. Newmont Mining Corp. conducted an extensive drilling program on the Halifax group of silver claims near Tonopah, Nye County.

The Bristol Silver mine, Lincoln County, was explored by deep drilling on the 1,200 level in an attempt to develop additional reserves. Silver King Mines, Inc., placed its mill on stream in White Pine County, and began treating silver-lead-zinc ore from the company mine at Ward Mountain.

Tungsten.—No tungsten mining was reported, but stocks of tungsten concentrate produced in previous years were shipped to a California paratungstate plant by Hubert Welch, Nye County, and partners of the now dissolved Minerva Scheelite Mining Co., White Pine County. Kennametal, Inc., operated a tungsten carbide plant near Rawhide, Mineral County, on foreign concentrate and small quantities of concentrate received from Arizona and Oregon. Kennametal also operated a plant at Fallon, Churchill County, where finished tungsten carbide powder blends were prepared to customer specification.

Uranium.—Apex Minerals Corp. (formerly Apex Uranium, Inc.) increased production at its Early Day mine, Lander County, and U.S. Mining Explorations produced from the Lowary group of claims, Washoe County. The latter property had been idle since 1959. Production and shipments of contained U_3O_8, to a Salt Lake City plant, were more than double those of 1963.

Zinc.—Production of recoverable zinc rose slightly from that in 1963, and was the highest since 1957. The increase was due chiefly to by-product recovery from lead ore of the Hamilton mine, White Pine County, where mine production was more than eight times that of 1963. The Mountain View mine, Eureka County, was the major zinc producer, yielding nearly 70 percent of the State total. The Hamilton mine and the Ward group (silver ore), White Pine County, supplied most of the remainder. A few tons of zinc were recovered in the treatment of residue and dump material in Clark County.

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The Pan American mine, Lincoln County, was under development as a joint venture of Grand Deposit Mining Co. and Combined Metals Reduction Co. The Pan American, long known as a low-grade zinc-lead-silver deposit, will be developed for a 1,000-ton-per-day operation. Drilling was underway in search of higher grade ore. The Combined Metals 1,700-ton mill at Caselton will be reactivated to treat the ore.

Other Metals.—Activity at beryllium mines and prospects was limited to continued exploration on the Leavitt claims in the Virgin Mountains, Clark County.

Electrolytic battery-grade manganese dioxide was produced in the Clark County plant of American Potash & Chemical Corp., from Mexico and New Mexico ores received from brokers in Arizona and Texas.

Owners of the Overlook Group of nickel claims in Lander County reported exploration and development only. The Clark County facilities of Titanium Metals Corp. of America produced titanium metal and alloys, using imported rutile from Australia.

NONMETALS

Barite.—Production of primary barite increased 6 percent, and the tonnage sold or used rose 24 percent above that of 1963. Mines in Elko and Lander Counties yielded 97 percent of the total. Major producers were Magnet Cove Barium Corp., FMC Corp., D. A. Mining Co., Hugh Hullinger, and Tom Norris in Lander County and National Lead Co. in Elko County. Lesser tonnages were mined and shipped by Yuba Minerals & Milling Co., Lander County; Estabrook Barite Co., Elko County; H. A. Horton, Humboldt County; D. J. Garrick, Eureka County; and Olsen Mud Service, Mineral County. Some crude barite was shipped from these properties to grinding plants in California and Utah.

Magnet Cove's grinding plant at Battle Mountain operated throughout 1964 and National Lead's new grinding and flotation mill began operation during the year, giving Nevada its second barite processing plant. The new mill replaced a facility formerly operated by National Lead in California.

Cement.—Construction of the first Nevada portland cement facility was completed near Fernley, Lyon County, by Nevada Cement Co., a subsidiary of Centex Construction Co. of Texas. The plant equipment included a 5- by 5-foot impact crusher, an 11.5- by 17-foot single-compartment ball mill, a 5,000-ton blending system, an 11- by 400-foot kiln, a 9.5- by 30-foot finishing tube mill, eight silos and three bins with storage capacity for 156,000 barrels of cement, and four dust collectors. The kiln was put on stream and production of cement clinker begun in December. Shipments of finished cement from the 1.2-million-barrel-per-year dry-process plant were expected to begin early in 1965.

Clays.—Silicates Corp. mined bentonite from company-owned deposits in Clark, Esmeralda, and Nye Counties. In all instances the mineral was prepared and sold for use in cosmetics and pharmaceuticals. Industrial Minerals & Chemical Co. mined fuller's earth from its Lyon County deposit and prepared the material for use as a pelletizing agent.

All other Nevada clay deposits were idle throughout the year.

Diatomite.—Sales of crude and prepared diatomite rose 15 percent in quantity above the 1963 figures, but the average unit value dropped 5 percent because of the relatively larger tonnage of lower grade material sold for lightweight aggregate and miscellaneous uses. Five deposits were worked—one each in Churchill, Esmeralda, Lincoln, Pershing, and Storey Counties. A Mineral County property was idle throughout the year. Production at the Lincoln County deposit was small and the output was sold for use as a soil aid and as a mineral filler in animal and poultry feeds. Domestic and foreign shipments by major producers were about equally divided, with demand highest for filtration and filler grades.

Great Lakes Carbon Corp. was experimenting with bulk loading at its Dicalite plant, Esmeralda County, in an attempt to reduce handling costs for the filler product, which was being bagged and trucked to the railhead at Mina, 35 miles from the mine and plant.

Fluorspar.—Fluorspar was mined and shipped from two Nye County mines—metallurgical grade from the Crowell mine to west coast steel plants and lower grade material from the Goldspar deposit to the Monolith Cement Co. plant in California. Also, Wells Cargo, Inc., shipped stockpiled metallurgical grade fluorspar to California steel plants but its mine remained idle. Production was below that of 1963, as were shipments of lower grade mineral, but the tonnages shipped for metallurgical use rose slightly.

Gypsum.—Output of crude gypsum was 10 percent below that in 1963; however, sales of agricultural gypsum rose more than 1,000 tons. Production of crude was from one deposit in Pershing County and two in Clark County. A gypsum products company was negotiating for a third Clark County deposit, but definite plans had not developed by yearend. U.S. Gypsum Co. mined gypsum in Pershing County for use in its Washoe County products plant. The Flintkote Co. mined gypsum and produced lath, plaster, and wallboard in Clark County. Fiberboard Paper Products Co. produced crude gypsum near Apex, Clark County. Most of the gypsum was washed before shipment to Fibreboard's plants in California, but some was stockpiled under a storage dome adjacent to the site of the company's new board plant that was expected to be on stream about August 1965.

Lime.—Nevada's only lime producer, The Flintkote Co., operated three plants in Clark County—at Apex (quicklime), Sloan (hydrated lime), and Henderson (quicklime and hydrated lime). The quantities produced and shipped and the value of shipments were virtually unchanged from 1963 with declines in quicklime offset by increases in hydrated lime. Although most shipments were destined for southern California customers, consignments were made to other Western States, including Alaska. The demand for construction use rose; that for chemical and industrial uses declined.

Lithium Compounds.—During 1964, Foote Mineral Co. acquired the permits and leases in Clayton Valley, Esmeralda County, of Leprechaun Mining & Chemical, Inc. After preliminary evaluation of the brines, Foote installed brine wells, solar evaporation ponds, and auxiliary facilities in preparation for the recovery of mineral values in the brines, principally lithium chemicals. Laboratory investigations

also were underway to establish the economic and technologic feasibility for recovery of other chemicals in the brines. In September, Foote purchased buildings and equipment at Silver Peak, including water rights and power facilities, and began adapting them to brine processing. The company expected to produce lithium chemicals on a limited basis during the second half of 1965, with commercial production scheduled for early 1966.

Magnesite and Brucite.—Near Gabbs, Nye County, Basic, Inc. operated open-pit magnesite and brucite mines, a milling plant, a flotation plant, rotary kilns for deadburning, Herreshoff furnaces for lightburning, and a special products plant for grinding, blending, and bagging various refractory materials. A high percentage of the crude magnesite output was consumed by the company in making caustic-calcined and refractory magnesias. Also, shipments of crude magnesite and brucite (stockpile) were made to customers outside the State. Magnesite production, consumption, and shipments exceeded 1963 figures.

Perlite.—Production and sales of crude perlite dropped to the lowest level since 1948. Output was limited to two deposits in Lincoln County and one in Pershing County. Crude mineral from the latter deposit was expanded at a Washoe County wallboard plant and some Lincoln County perlite was expanded in Clark County for concrete and plaster aggregate. Most shipments were consigned to out-of-State expanding plants. Only 29 percent went to California, an appreciable decline from 1963. The Hurry Up perlite claims (Perlex mine), Esmeralda County, were idle throughout 1964.

Pumice (Volcanic Cinder).—Kaiser Sand & Gravel Co. purchased the interest of Naturalite Corp. in a Lyon County pumice deposit. Naturalite was to continue production until Kaiser can phase the operation into planned facilities. Output from this property was prepared for concrete aggregate. Two volcanic cinder deposits, one each in Nye and Ormsby Counties, produced material for use as lightweight aggregate. Pumicite from Lincoln County was processed and shipped for use as a pozzolanic concrete admixture, and a small quantity of pumicite produced in Mineral County was used in concrete by the producer.

Salt.—Solar evaporated salt was harvested from the surface of a dry lakebed near Sand Springs, Churchill County. Some of the crude salt was sold locally to meat packers and dairies, and used in mixes for surfacing roads, however, most of the production was shipped to out-of-State customers.

Sand and Gravel.—Output of sand and gravel, second only to copper as Nevada's most important mineral commodity, rose 46 percent in quantity and 37 percent in value above the 1963 figures. Sand and gravel was produced in all 17 counties. The most notable output gains occured in Clark, Humboldt, Lander, and Nye Counties. Nevada State Department of Highways projects alone required more than 9 million tons of sand and gravel, an increase of nearly 5 million tons over 1963 demand. Nearly 12 million tons was produced with portable or semiportable plant equipment; over 2 million tons was produced at stationary plants.

Of the 111 active sand and gravel operations in the State during 1964, 42 were classified as commercial and 69 as Government-and-contractor. Thirteen of the 42 commercial producers had outputs of over 100,000 tons each, and together produced 4.2 million tons of material valued at $5.8 million.

The combined production of glass and molding sands from deposits in the Overton area, Clark County, was essentially the same as in 1963.

TABLE 9.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1963		1964	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Glass	W	W	W	W
Molding	W	W	W	W
Building	564,503	$1,321,716	807,000	$1,354,000
Paving	W	W	74,000	207,000
Fill	77,015	43,835	32,000	28,000
Other	109,998	248,860	W	W
Gravel:				
Building	579,431	1,304,212	754,000	1,170,000
Paving	1,550,566	1,504,330	2,409,000	2,827,000
Railroad ballast	2,234	1,489	5,000	11,000
Fill	360,309	351,418	297,000	314,000
Other	W	W	W	W
Undistributed sand and gravel [1]	301,216	900,538	412,000	1,107,000
Total sand and gravel	3,545,272	5,676,398	4,790,000	7,018,000
Government-and-contractor operations: [2]				
Sand:				
Building			13,000	13,000
Paving	106,429	131,585	230,000	134,000
Other			16,000	11,000
Total	106,429	131,585	259,000	158,000
Gravel:				
Building	101	113	70,000	70,000
Paving	5,879,980	4,559,854	8,991,000	7,148,000
Fill	119,350	119,350	10,000	10,000
Other	36,620	25,660	22,000	23,000
Total	6,036,051	4,704,977	9,093,000	7,251,000
Total sand and gravel	6,142,480	4,836,562	9,352,000	7,409,000
All operations:				
Sand	1,094,805	2,503,176	1,491,000	2,659,000
Gravel	8,592,947	8,009,784	12,651,000	11,768,000
Grand total	9,687,752	10,512,960	14,142,000	14,427,000

W Withheld to avoid disclosing individual company confidential data.
[1] Includes items indicated by symbol W.
[2] Includes figures for State, counties, municipalities, and other Government agencies.

Stone.—Production of stone rose 23 percent in 1964, principally because of stockpiling of the material for railroad ballast in Eureka County and increased demand for Clark County limestone by industrial consumers in southern California. Also, highway crews in Churchill and Ormsby Counties used larger quantities of basalt and granite (including decomposed granite) in the maintenance of roads than in 1963. The tonnages of dimension and crushed sandstone, quartz, and quartzite produced in the northern and eastern counties were virtually unchanged from 1963 figures, despite inclement weather

and the closing of several established operations. Marble quarried for terrazzo in Mineral County was also unchanged. A substantially lower tonnage of calcareous marl was withdrawn from stockpiles than in 1963, at quarries in Nye and Washoe Counties and shipped for use as filler. Relatively small quantities of miscellaneous stone were quarried in Clark, Esmeralda, and Lincoln Counties, but overall requirements for this material in highway projects throughout the State were appreciably above the 1963 figures.

Sulfur.—The Crofoot sulfur deposit, Humboldt County, was the source of sulfur ore shipped for use as a soil aid. Production and shipments were less than half those in 1963. Sulfur ore mined from a California deposit in previous years was used in making acid at a copper-leaching plant, Lyon County.

Talc and Soapstone.—Only three talc mines and two soapstone deposits, all in Esmeralda County, were active. Mine production rose appreciably, and shipments to grinders, principally in California, were above those of 1963.

Water.—The Bureau of Mines was conducting a study of water requirements and uses in the State's mineral industries.

Sierra Pacific Power Co. drilled four test holes in the Beowawe Geyser basin, Eureka County, to check geologic structures and to provide data for feasibility studies of the thermal power electrical generating potential of the basin. A 5,000-foot well was drilled at Brady's Hot Springs, Churchill County, by Earth Energy, Inc., Division of Pure Oil Co. The company made down-hole and surface temperature evaluations and shut-in and open-hole pressure tests which indicated sufficiently favorable conditions to warrant further drilling and testing. No work was done in the development of thermal energy sources at Darrough Hot Springs, Nye County, or at Pyramid Lake, Washoe County.

MINERAL FUELS

Peat.—A peat bog was opened in the Amargosa Desert, Nye County, near Death Valley Junction, Calif. A few tons of the reed-sedge material was shredded and sold in bulk for use on golf courses. This was the first report of peat production from Nevada in recent years.

Petroleum.—The Eagle Springs field, Nye County, continued as the State's only oilfield. Production was more than double that in 1963, largely because of an easterly extension of the field by Texota Oil Co. At yearend five wells were producing and one well was shut-in. Substantial leasing activity resulted from the field extension. About 2 million acres was under lease and further exploratory attempts were anticipated.

REVIEW BY COUNTIES

Each of Nevada's 17 counties reported production of three or more mineral commodities. However, output in four counties—Clark, Humboldt, Lyon, and White Pine—represented 77 percent of the total mineral value in 1964. These four counties yielded most of the State's copper, gold, gypsum, mercury, and stone, and nearly one-half its sand and gravel. In addition, all lime production was from Clark County.

TABLE 10.—Value of mineral production in Nevada, by counties

County	1963	1964	Mineral produced in 1964 in order of value
Churchill	$738,283	$425,517	Sand and gravel, stone, salt, silver, gold.
Clark	12,447,737	13,811,757	Sand and gravel, lime, gypsum stone, lead, zinc, copper, clays, silver, gold.
Douglas	1,619,136	2,154,885	Iron ore, sand and gravel, silver, lead, gold.
Elko	1,685,337	1,273,068	Sand and gravel, barite, stone, zinc, lead, silver, mercury, copper.
Esmeralda	642,283	660,649	Diatomite, talc and soapstone, sand and gravel, clays, mercury, stone, lead, silver.
Eureka	783,143	1,437,530	Iron ore, sand and gravel, stone, zinc, barite, lead, silver, copper.
Humboldt	3,804,220	5,445,283	Gold, iron ore, sand and gravel, mercury, stone, silver, sulfur ore, barite, zinc, copper, lead.
Lander	948,468	1,792,036	Sand and gravel, barite, gold, antimony, uranium, silver, lead, zinc.
Lincoln	205,699	157,814	Perlite, fluorspar, sand and gravel, diatomite, pumicite, silver, stone, lead, zinc.
Lyon	26,404,690	25,722,203	Copper, sand and gravel, diatomite, silver, gold, clays.
Mineral	79,106	129,559	Sand and gravel, barite, stone, lead, gold, silver, copper, mercury, zinc, pumicite.
Nye	r 1,559,366	3,123,118	Magnesite, sand and gravel, petroleum, fluorspar, mercury, gold, volcanic cinder, stone, clays, peat, tungsten, silver, lead.
Ormsby	W	240,443	Sand and gravel, volcanic cinder, stone.
Pershing	3,659,655	3,807,650	Diatomite, iron ore, gypsum, perlite, sand and gravel, mercury, silver, antimony, lead, gold, zinc, copper.
Storey	1,301,401	1,581,699	Diatomite, pumice, sand and gravel, iron ore.
Washoe	2,554,287	2,559,054	Sand and gravel, gold, stone, uranium, silver.
White Pine	26,889,349	20,714,015	Copper, gold, molybdenum, silver, sand and gravel, lead, tungsten, zinc, stone.
Undistributed [1]	154,840	100,720	
Total	r 85,477,000	85,137,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes gem stones, mercury, gold, silver, lead, and zinc that cannot be assigned to specific counties and value indicated by symbol W.

Churchill.—Sand and gravel was produced by Government and contractors for use in the construction and repair of Interstate Route 80 near Brady's Hot Springs, U.S. Highway 95 near Fallon, and U.S. Highway 50 near Frenchman. Output was only about one-half that of 1963. Local building and paving sand and gravel needs were supplied chiefly by Tedford Trucking Co. from pits near Fallon. County crews quarried basalt and decomposed granite at several locations for use in the maintenance of roads. Aquafil Co. mined diatomite southeast of Nightingale and processed the material in a Lyon County plant.

Solar evaporated salt was harvested from a dry lakebed near Sand Springs for Fallon Development Co. The product was sold for deicing streets and highways. Also in the Sand Springs area, a small tonnage of ore containing recoverable silver and gold was mined and shipped from the Lorraine mine.

Clark.—Sand and gravel production totaled 5.7 million tons, of which nearly 5 million tons was crushed and/or screened at stationary and portable plants. Requirements for local building construction declined, but the tonnages produced for use in roads and road structures were more than double the 1963 figure. Nevada Department of Highways requirements were by far the largest. The agency produced, purchased, and contracted for more than 3 million tons, used principally in the construction of Interstate Route 15 through Las Vegas and Glendale, and in U.S. Highway 95 from Las Vegas north

to Mercury junction at the Nye County line. Industrial sands were produced in the Overton area and sold to glass manufacturers and for foundry use. Simplot Silica Products, the major producer, worked two pits and operated two plants in the area. The Flintkote Co. quarried limestone at Apex for the production of quicklime and at Sloan for production of hydrated lime. At Henderson, the company produced both products, and at Blue Diamond, mined gypsum for use in its nearby wallboard plant. Fibreboard Paper Products Corp. mined gypsum near Apex and shipped it to company-owned wallboard plants and out-of-State cement producers. Fibreboard was building a wallboard plant, scheduled for completion late in 1965, at the mine site.

Dimension quartz was quarried near Las Vegas by W. C. Scott and sold for building stone and flagging. Miscellaneous stone from the White Rock quarry near Henderson was prepared for use as roofing granules. The State Department of Highways contracted for miscellaneous stone used in highway structures and road construction. Silicates Corp. mined a small tonnage of bentonite from the Frances pit near Las Vegas and sold it to manufacturers of cosmetics and pharmaceuticals.

In the Goodsprings district, ore mined at the Copper King property in 1963 was treated to recover copper and silver. Dump material from the Yellow Pine mine was shipped to a smelter for recovery of zinc, lead, copper, silver, and gold. Lead residues from the old plant site of Manganese, Inc. also yielded zinc, copper, and silver.

Nevada Perlite Co. operated an expanding plant in Las Vegas using perlite purchased from a Lincoln County producer.

Douglas.—Standard Slag Co. operated its Minnesota open-pit iron mine and concentrator near Wabuska throughout the year and increased production and shipments of usable iron ore about 25 percent. The entire output was exported to Japan.

Savage Construction, Inc., of Carson City was the principal sand and gravel producer. Most of the output came from pits in the Gardnerville area and was used as concrete aggregate. State highway maintenance crews obtained sand and gravel from various deposits for use in road repair.

Silver ore was shipped from the Danite mine, Gardnerville district, and Silver Queen mine, Red Canyon district. The latter ore also contained recoverable lead.

Elko.—Sand and gravel production dropped to about half that in 1963. Most of the output was by Government crews and contractors for use in highway construction projects—Interstate Route 80 in the Elko, Halleck, and Pequop Summit areas, and U.S. Highways 40 and 93 in the Wells area. Local sand and gravel building and paving requirements were supplied from pits near Elko. Crushed quartz for exposed aggregate use was supplied by Aggregate Supply Co. from the Goliath quarry near Jiggs.

National Lead Co. worked its Rossi barite mine and trucked the ore to the company's new grinding plant and flotation mill at Dunphy. Estabrook Barite Co. shipped stockpiled crude barite to a California grinder. The company did not work its Marvel claims in 1964.

Ore from the Gold Note mine, Delano district, yielded several tons

of lead and zinc, and several thousand ounces of silver. In the Aura and Edgemont districts, minor tonnages of ores were mined that contained recoverable silver and lead. A few flasks of mercury were retorted from ores mined at two prospects in the Ivanhoe district.

Esmeralda.—Great Lakes Carbon Corp. worked its diatomite deposit at Basalt and produced grades of material by air separation to meet specifications for paint, paper, and insecticide manufacturers. The company began experimenting with a bulk loading facility to eliminate bagging and to reduce handling costs. The entire State talc and soapstone production came from three talc mines and two soapstone properties in the Lida-Palmetto area. The entire output was consigned to California grinders. About 5,000 tons of sand and gravel was obtained from county pits by highway maintenance crews for use in repairing roads. These crews also quarried stone on public lands for use in roads and highway structures. Silicates Corp. mined bentonite from the Blanco pit near Mina and sold it to cosmetic and pharmaceutical manufacturers.

A few flasks of mercury was recovered in furnacing ore from the Poor Boy mine in the Fish Lake Valley district. Lead ore mined from the Hoot Owl property, Hornsilver district, also yielded recoverable silver.

Eureka.—Nevada-Barth Mining Corp. mined hematite ore at the Barth open-pit iron mine near Carlin for export to Japan. Production and shipments rose 33 percent from those in 1963.

Sand and gravel was produced and used by a contractor in constructing a section of Interstate Route 80. State and county crews obtained sand and gravel at several locations for use in road maintenance and repair. Southern Pacific Co. crushed, screened, and stockpiled miscellaneous stone from a Palisade quarry for use as riprap and railroad ballast.

Ore from the Mountain View mine, Lone Mountain district, yielded over 400 tons of zinc and some lead, silver, and copper. This mine was the State's major source of zinc in both 1963 and 1964. Newmont Mining Co. was developing its Carlin gold mine, Lynn district, and constructing a cyanide treatment plant. In the Eureka district, Consolidated Eureka Mining Co. was continuing underground development at the Diamond mine, and Hecla Mining Co. was conducting development and repair work at the Ruby Hill project. American Exploration & Mining Co. was exploring the Cortez mine, Cortez district, for silver-lead ore.

Crude barite was mined and shipped from the Queen Ann (Carlin) deposit near Carlin to grinders in California and Utah.

Humboldt.—Goldfield Corp. operated the Getchell gold mine and cyanide treatment plant throughout the year and shipped bullion to the Selby smelter in California. This mine yielded much of Nevada's lode gold output. Ores and dump material from three properties in the Winnemucca district contained a few ounces of recoverable gold and silver. Ore from the S. P. Lease in the same area yielded substantial amount of gold and silver, and some lead and zinc. Dump material from the National mine, Paradise Valley district, was treated to recover gold and silver. Production of iron ore from the underground Iron King mine in the Jackson Mountains rose 67 percent

above that in 1963. The lump ore was shipped to steel plants in the Great Lakes area and the fines were exported to Japan. The Cordero mine, McDermitt district, accounted for 92 percent of the State's mercury output and 93 percent of the shipments, despite a 36-percent drop in production, from 1963. The drop in output resulted from the lower grade of ore treated. Mercury ores from the Cahill and Finnell properties were retorted to recover small quantities of the metal, and production began at the Paradise (Buckskin Peak) property, which yielded a few flasks of mercury.

Sand and gravel production rose more than 1 million tons from that in 1963. Most of the output was used in the construction of sections of Interstate Route 80 near Valmy, and U.S. Highway 95 near Orovada. Commercial requirements for building and paving sand and gravel were supplied principally from John Etchart's stationary plant at Winnemucca. Government crews obtained the materials at several locations for their own use. Dimension sandstone was quarried by Wegman Bros. on the Wadsworth claim near Denio and dressed in Winnemucca for use in building construction. Barite from the Little Britches claims was shipped to a California grinder. The Horton barite claims were idle in 1964. Sulfur ore was produced from the Crofoot property near Sulphur for out-of-State agricultural use. Production was about half that of 1963.

Lander.—Contractors for the State Department of Highways produced over 1 million tons of sand and gravel and used the materials in constructing a section of Interstate Route 80. Highway crews produced an additional 7,000 tons for road maintenance. Six barite properties were active in the Battle Mountain area. The major producers were FMC Corp. (Mountain Springs deposit) and Magnet Cove Barium Corp. (Greystone group). Most of the crude barite was consigned to California and Utah grinders, but Magnet Cove ground its own production and two other producers, Hugh Hullinger and Tom Norris, shipped most of their output to the National Lead Co. mill at Dunphy, Nev.

Three lode gold mines were active in 1964—the New Pass, New Pass district; McCoy, McCoy district; and the Cahill, Birch Creek district. The ores of these mines also contained recoverable silver. In the Battle Mountain district, old tailings shipped from the Galena mine yielded about 26 tons of lead and 8,000 ounces of silver plus minor quantities of zinc and gold. Stream gravels at the Dahl placers were worked with small-scale hand equipment (sluices) to recover placer gold and silver. Antimony ore, mined from the Last Chance (Antimony King) mine, was shipped to a Texas smelter. Ted Stevens was completing the reconstruction and activation of his concentrator at Austin preparatory to milling ores from several antimony mines and prospects. Custom milling of silver ores also was planned. Apex Minerals Corp. shipped uranium ore from its Early Day mine near Austin to a Utah processing plant. The company's Rundberg mine was under exploration by a lessee.

Lincoln.—Combined Metals Reduction Co. shipped crude perlite from the Hollinger deposit near Pioche to out-of-State customers and to a Las Vegas, Nev., block plant. Crude perlite was shipped from stockpile at the Mackie property near Caliente to a California expand-

ing plant. Wells Cargo, Inc., shipped stockpiled fluorspar from its Carp mine to a California steel plant. Diatomite, produced from the Robin claims at Panaca, was dried, ground, and bagged for shipment to out-of-State customers. Pumicite was obtained from the Lory Free pit near Panaca and prepared for use as a pozzolanic material.

R. D. Wilkin produced sand and gravel from a pit near Pioche and prepared the material for use in public work projects. Various sand and gravel pits were worked by Ted Deck and his highway maintenance crew for materials needed in road repair. Miscellaneous stone was quarried on public lands and used in the construction of access roads.

A small tonnage of silver ore produced from the Tempiute mine, Tempiute district, contained recoverable silver, lead, and zinc. The Bristol Silver mine, Jack Rabbit district, and the Pan American mine, Comet district, were under exploration and development during the year. Exploration was underway at the Andie Anderson mercury prospect near Coyote Summit and some equipment had been moved in for the proposed mill.

Lyon.—The copper (oxide) leaching plant and copper (sulfide) concentrator of The Anaconda Co. at Weed Heights was in full production throughout the year. Plant products, precipitates and concentrates, were shipped to the company's Montana smelter. The copper concentrate contained recoverable gold and silver. All other metal mines in the county were idle in 1964 although there was appreciable exploration and development activity, particularly for iron ore.

Diatomite, mined by Aquafil Co. in Churchill County, was processed in the company's Fernley plant and shipped to customers outside the State. Industrial Minerals & Chemical Co. mined fuller's earth from the Jupiter pit near Weeks. The material was sold for use in pelletizing, and as a filtering and clarifying agent. The Nevada Cement Co. plant between Fernley and Wadsworth was completed and cement clinker produced before yearend. The company mined limestone and marl from a quarry south of Fernley, and clay from a Washoe County deposit near Pyramid Lake, and purchased iron ore from a Storey County producer, for use as cement raw materials.

Sand and gravel output was about double that in 1963. Large quantities were used in the construction of a section of Interstate Route 80 near Fernley, and in repairing and widening U.S. Highway 95 Alternate between Wabuska and Silver Springs. Sand and gravel needs for concrete aggregate were supplied by Dayton Sand and Gravel Co. and Carson Ready Mix, from deposits in the Dayton area.

Mineral.—Contractors for the State Department of Highways produced sand and gravel for road construction and repair. Near Hawthorne, Hawthorne Ready-Mix produced and prepared sand and gravel for its own use. Olsen Mud Service Co. mined crude barite from the Columbus deposit south of Mina and shipped the ore to an affiliate at Harbor City, Calif. Sonora Marble Aggregates Co. quarried and crushed marble for terrazzo at its quarry near Luning. Pumicite was obtained from the Pumco Aggregates pit east of Mina and used locally for lightweight aggregate.

Lead ore containing recoverable silver, gold, copper, and zinc, from the New Potosi mine, Candelaria district, and a small tonnage of silver

ore mined in the Hawthorne district, were shipped to a California smelter. Copper ore was shipped from stockpile at the Digmore mine, Whiskey Flat district, to a Montana smelter for recovery of copper, silver, and gold. Mercury ores from the Cardinal mine, Pilot Mountain district, and from a prospect near Mina, were retorted to recover small quantities of the metal. Near Rawhide, Kennametal, Inc. operated its tungsten carbide plant on tungsten concentrate purchased from foreign sources and out-of-State producers.

Nye.—Basic, Inc., Nevada's sole producer of magnesite and brucite, processed most of its output in company facilities near Gabbs. The calcined products were shipped to company plants in other States, chiefly for use in making refractories. Basic also shipped crude magnesite and brucite. No brucite was mined in 1964 and shipments were made from stockpile. The company mined opaline silica near Gabbs for its own use. Metallurgical grade fluorspar was mined and shipped from the Crowell mine, near Beatty, to a California steel plant, and mine-run fluorspar was shipped from the nearby Goldspar property to the producer's cement plant at Monolith, Calif.

Contractors for the Atomic Energy Commission produced and prepared large tonnages of sand and gravel for use at the Nevada Test Site. Government crews and contractors also produced large tonnages of these materials for use in structures and roads, principally in the Mercury, Tonopah, and Beatty areas. Calcareous marl was shipped from stockpile at the Silimagi property for use as a mineral filler in making livestock and poultry feeds. Cind R Lite Co. hauled volcanic cinder from its Cinder Cone deposit near Beatty to its block plant in Las Vegas for use as lightweight aggregate. Silicates Corp. mined bentonite on its New Discovery claims near Beatty and sold it to manufacturers of cosmetic and pharmaceuticals.

Nye County was the source of the only commercial crude oil production in Nevada. The Eagle Springs field was extended easterly during 1964 by Texota Oil Co. on a farmout from Shell Oil Co. The extension stimulated leasing activity in the area before yearend. Reed-sedge peat was produced from a bog in the Amargosa Desert north of Death Valley Junction, Calif., and sold in bulk for golf-course use.

Mercury production at the Ione deposit, Union district, and the Red Bird mine, Antelope district, was virtually at the 1963 level. Ores from the Ione were furnaced to recover the metal; those from the Red Bird were retorted. In the Manhattan district, cleanup operations at the Midas mine yielded a few ounces of gold and silver. Dump material from the Tybo mine, Tybo district, was treated to recover minor quantities of silver and lead. Ancient riverbed gravels were worked by dragline on the Georgie claims, Manhattan district, to recover placer gold and silver. Several hundred ounces of gold and some silver were recovered in working bench gravels on the Nevada Porphyry property, Round Mountain district. The Welch tungsten prospect near Gabbs was worked and the concentrate shipped to a California paratungstate plant.

Ormsby.—Savage Construction Co. and Tedford Trucking Co. worked deposits along the Carson River for sand and gravel used in local paving projects. Crews for Carson City obtained sand and

gravel in the same area for the repair and maintenance of streets. L. A. Winters used volcanic cinder from the Cinderlite deposit near the Carson City airport for lightweight concrete aggregate. Granite was quarried and used in the repair and maintenance of county roads.

Pershing.—The Eagle-Picher Co. mined diatomite at the Tunnel Hill deposit, Velvet district, and processed it at the Colado plant. The plant product was a high-purity material sold principally for filtration purposes. Crude gypsum was quarried at Empire by U.S. Gypsum Co. to supply its wallboard plant near Gerlach, Washoe County. The plant also used perlite hauled from the Pearl Hill quarry near Lovelock. Larry Starr produced and prepared gravel near Lovelock for local building projects. State and county crews produced sand and gravel at several locations for use in the repair and maintenance of roads.

Nevada-Barth Corp. worked the Southern Pacific leases in sections 15 and 29 for direct shipping iron ore. The latter property required a period of extensive stripping. The output from both properties was exported to Japan. Nevada Iron Ore Co., Inc., mined iron ore from its property in section 30. The ore was put over a magnetic pulley and the magnetic fraction shipped to domestic steel plants. Seven mercury mines and prospects were active in 1964, two of which (Eastern Star and Darrah) had production in 1963. Only three producers—Eastern Star, Loretta, and Mobley & Coon—reported recovery of more than 10 flasks of the metal. Lead ore shipped from the Good View mine, White Horse district, contained 20 tons of lead and 5,800 ounces of silver plus recoverable gold, copper, and zinc. In the Rochester district, silver ore from the Wabash mine yielded silver, lead, and zinc, and gold ore from the Kings Ransom property was treated to recover gold and silver. In the same area, the Crown Point (Rochester) mine was under development by Silver States Consolidated Mining Co. preparatory to mining a blocked-out silver-gold ore body. The company had a treatment plant in the planning stage. William Inman shipped about 17 tons of antimony ore from his Burl prospect near Lovelock to a customer in Dallas, Tex. Stream gravels were worked at the Thacker Lease on Willow Creek to recover a few ounces of placer gold and silver.

Storey.—Over one-third of the Nevada diatomite output was produced at The Eagle-Picher Co. Celatom open-pit mine. The material was processed in the company's nearby Clark Station plant. The plant product, a lower grade material than that from the company's Pershing County plant, was shipped to domestic and foreign customers for a variety of industrial uses. Naturalite Corp. produced lightweight aggregate and decorative cut block at its pumice deposit near the Lyon County line. Contractors for the State Department of Highways produced about 90,000 tons of sand and gravel for use in construction of a section of Interstate Route 80.

Several hundred tons of iron ore from the Iron Blossom mine, northeast of Virginia City, was trucked to Lyon County for use in cement. The Gooseberry mine, southeast of Clark Station, was being explored and developed from both surface and underground, for gold-silver ore.

Washoe.—Over 2 million tons of sand and gravel was produced from deposits along the Truckee River, adjacent streams, and from alluvial deposits. About 70 percent of the total was processed by commercial producers at stationary and portable plants in the Reno-Sparks-Vista area. More than 1 million tons was produced for paving use. Work on Interstate Route 80 between the California line and the Reno-Sparks area was the principal outlet for the materials. Requirements for sand and gravel in commercial building projects were down from the 1963 level. State and county crews and contractors and contractors for the Bureau of Indian Affairs produced and used about 570,000 tons of sand and gravel during the year.

The Double Check calcareous marl quarry at Flannigan was idle in 1964, but shipments were made from stockpile to producers of animal feed and for agricultural purposes. Argillaceous (clayey) material was obtained from a deposit near Nixon and used in the Lyon County cement plant. U.S. Gypsum Co. produced plaster and wallboard in its plant near Gerlach, using gypsum and perlite from company-owned quarries in Pershing County.

Gold ore from the Olinghouse mine, Olinghouse district, was treated to recover a few ounces of gold and silver. Green Hill Development Co. operated draglines to work ancient riverbed gravels on the Cabin and Sunday Evening claims and recovered placer gold and silver. Uranium ore was shipped from the Lowary group of claims, Pyramid district, to a Salt Lake City, Utah, processing plant.

White Pine.—In the Robinson district, copper ores from the Liberty pit and the Veteran pit stockpile, were treated in the Kennecott Copper Corp. McGill concentrator and smelter. Much of the State's gold, silver, and copper and all of its molybdenum was recovered in the treatment of these ores. Lead ore was shipped from the Hamilton mine, White Pine district, to a Utah smelter for recovery of gold, silver, copper, lead, and zinc. Silver ore from the Pine Nut property and dump material from the Mountain View mine, Cherry Creek district, were treated at the Utah smelter for recovery of the same five metals. Silver King Mines, Inc. placed its mill on stream at Lackawanna Hot Springs near East Ely and by yearend began treating ore from the company mine at Ward Mountain. The last of the stockpiled tungsten concentrate, produced in previous years at the Everit mine of the Minerva Scheelite Mining Co., was shipped to a California paratungstate plant.

Sand and gravel production dropped sharply from the 1963 output. Building projects in the Ely area were supplied from the Spring Valley pit and preparation plant of Buck's Supply Co. State highway crews and contractors produced appreciable quantities of sand and gravel for use in road maintenance and in construction of State Route 38 near Lund. Dimension quartzite was quarried at the Star Dust property near Baker by a lessee who sold the stone for architectural block and flagging.

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 Stanley A. Feitler [1]

A RECORD for value of mineral production was set for the third consecutive year. The 1964 value, $7.3 million, was 20 percent greater than that of 1963. More than 98 percent of the total comprised sand and gravel, stone, and clay for building and highway construction.

TABLE 1.—Mineral production in New Hampshire [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays short tons	r 46,875	r $40	45,620	$40
Sand and gravel do	7,581,026	4,376	8,768,000	4,996
Stone do	137,258	1,566	202,164	2,138
Value of items that cannot be disclosed: Feldspar and gem stones	XX	109	XX	128
Total	XX	r 6,091	XX	7,302

r Revised. 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
1940	$2,168	1953	$2,041
1941	2,785	1954	2,276
1942	2,340	1955	r 2,764
1943	2,894	1956	r 3,393
1944	2,229	1957	3,384
1945	1,418	1958	3,938
1946	2,219	1959	4,625
1947	1,722	1960	5,450
1948	1,734	1961	5,426
1949	1,724	1962	6,011
1950	2,102	1963	r 6,199
1951	1,512	1964	7,375
1952	2,209		

r Revised.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

Legislation and Government Programs.—Public Law 88–379, the Water Resources Research Act of 1964, was enacted. This law authorizes each State to establish a water resources research institute at a land grant college or other institution. The institutes are to conduct basic and applied research on water resources development and to train scientists in these fields. Federal funds are to be available for the support of the program.

Public Service Co. of New Hampshire announced plans to expand generating capacity at its Merrimack power station at Bow, N.H. The proposed addition would be a 350,000-kilowatt, coal-fired steamplant about 3 times the capacity of the present plant.[2]

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal						
Metal						
Nonmetal	87	19	151		6	40
Sand and gravel	432	92	756		15	20
Stone	132	29	230		8	35
Total	651	140	1,137		29	26
1964[p]:						
Coal						
Metal						
Nonmetal	60	10	78		1	13
Sand and gravel	500	106	875		10	11
Stone	155	34	278		9	32
Total	715	150	1,231		20	16

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

Clays.—Miscellaneous clay for building brick was produced from pits in Grafton, Rockingham, and Strafford Counties. More than 15 million bricks were manufactured during the year.

Feldspar.—Crude feldspar ore, mined at the Salo, Surry, and Windham mines, was hand sorted and trucked to the Golding-Keene Co. mill in Cheshire County. After fine grinding, the feldspar was sold for use in ceramics and as an abrasive in soaps and scouring compounds. Principal destinations of the ground material were New York, Connecticut, and Massachusetts; smaller quantities were shipped to five other States. Ruggles Mining Co. shipped selectively mined, hand-sorted, high-potash feldspar from the Ruggles mine, Grafton County, to a grinding mill in Oxford County, Maine.

Gem Stones.—More amateur collectors of gem stones and mineral specimens were active than in 1963. In Grafton County, the phosphate minerals ludlamite and eosphorite were recovered at the Palermo mine and lazulite from a pegmatite near Groton. Green beryl, pale aquamarine, and golden beryl, including some of gem quality, were found at the Island mine in Cheshire County. Minerals pro-

[2] Coal Age. V. 69, No. 9, September 1964, p. 44.

duced in Carroll County included topaz, amethyst, smoky quartz crystals, and arfvedsonite.

Mica.—Less wet-ground mica was produced in Merrimack County than in 1963, but the average value per ton was higher, resulting in a 6-percent increase in total value. The finely ground mica was used in paint, rubber, and wallpaper. Most of the scrap mica for grinding originated in India, but some was from Brazil. No mine production of mica was reported in New Hampshire.

Sand and Gravel.—Ninety-three percent of the sand and gravel produced was washed, screened, or otherwise prepared. The output of commercial sand and gravel decreased 10 percent in tonnage, but the total value increased 3 percent. The average value was $1.01 per ton, 12 cents higher than in 1963. Of the 30 commercial plants in operation during the year, 7 produced more than 100,000 tons, 14 plants handled 25,000 to 100,000 tons, and 9 had output of less than 25,000 tons. Shipments were 80 percent by truck and 19 percent by railroad; 1 percent was unspecified as to the method of shipment. All Government-and-contractor output was delivered by truck. A commercial plant in Rockingham County shipped trainloads of washed sand and gravel to a producer of ready-mixed concrete in Boston, Mass., during the "open" season (April through November). Sand and gravel for highway construction and maintenance was produced by crews of the Concord Commissioner of Public Works, Merrimack County.

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)	
	1963	1964	1963	1964
Belknap	86	416	272	127
Carroll	26	101	1,315	----
Cheshire	154	466	1,664	42,024
Coos	1	495	3,074	2,283
Grafton	101	464	33,972	7,335
Hillsboro	738	471	743	10,955
Merrimack	W	1,085	3,311	7,229
Rockingham	341	1,317	297	1,066
Strafford	W	295	----	59
Sullivan	82	168	----	846
Unspecified	2,850	607	----	----
Total	4,379	5,885	44,648	71,924

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

Stone.—Production of both dimension and crushed stone increased sharply in quantity and value compared with that of 1963. The average value per ton for stone computed from table 1 figures is a composite of three widely different price groups. Crushed stone for construction was valued at $1 to $2 per ton; rough dimension stone (curbing, flagging, and paving blocks) was $20 to $40 per ton; and dressed dimension stone (architectural and monumental) was more than $100 per ton. John Swenson Granite Co., Inc., Merrimack County, produced dressed architectural and monument stone, curbing, and flagging at its Concord finishing plant. Rough quarry blocks

were from the nearby Swenson Gray quarry and from quarries in other States. Granite blocks from the Kitledge quarry in Hillsboro County were finished in the Milford plant of Barretto Granite Corp. Kitledge granite was used for construction, monuments, curbing, and paving blocks.

Crews of the New Hampshire Department of Public Works and Highways produced granite for fill and riprap in all counties except Carroll. Miscellaneous stone was produced in Rockingham County for use in construction. Quartz mined in Hillsboro and Sullivan Counties was crushed for use as exposed aggregate in decorative concrete.

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.

TABLE 5.—Value of mineral production in New Hampshire by counties

County	1963	1964	Minerals produced in 1964 in order of value
Belknap	W	W	Sand and gravel, stone.
Carroll	W	W	Sand and gravel, gem stones.
Cheshire	$448,027	$664,085	Sand and gravel, feldspar, stone, gem stones.
Coos	W	W	Sand and gravel, stone.
Grafton	435,833	639,352	Sand and gravel, feldspar, clays, stone, gem stone.
Hillsboro	1,468,856	1,832,884	Stone, sand and gravel.
Merrimack	1,084,586	1,303,108	Sand and gravel, stone.
Rockingham	953,118	1,164,309	Sand and gravel, stone, clays.
Strafford	r 269,929	219,773	Sand and gravel, clays, stone.
Sullivan	135,387	242,143	Stone, sand and gravel.
Undistributed [1]	1,295,588	1,236,169	
Total	r 6,091,000	7,302,000	

rRevised. W Withheld to avoid disclosing individual company data.
[1] Includes value of sand and gravel and gem stones not assigned to specific counties and values indicated by symbol W.

Belknap.—Tilton Sand & Gravel, Inc., produced sand and gravel for building, paving, fill, and other uses from a pit near Tilton.

Carroll.—Sand and gravel for fill and a quantity of building gravel were recovered from pits near Ossipee and Madison.

Cheshire.—Cold River Sand & Gravel Corp., North Walpole, and Keene Sand & Gravel, Inc., Keene, produced sand and gravel for building, paving, and fill. Most of the output was washed and screened; oversized gravel was crushed. Golding-Keene Co. mined feldspar at the Salo and Windham mines in Alstead Township and the Surry mine in Surry Township. The ore was trucked to the treatment plant near Alstead where it was crushed and ground. Golding-Keene Co. did not operate the Turner mine in 1964.

Coos.—The Gray Construction Corp., Colebrook, and Lessard Sand & Gravel Co., Inc., Gorham, prepared sand and gravel for building, paving, and fill. Brown Co., Berlin, produced bank-run material which was used to improve access roads on company-owned forest lands.

Grafton.—Sand and gravel for building, paving, and fill was recovered from pits at Campton, Lebanon, West Lebanon, Littleton,

and Plymouth. Most of the output was processed, and all was delivered by truck. Ruggles Mining Co. produced potash feldspar for a feldspar grinder at West Paris, Oxford County, Maine. Densmore Brick Co., Lebanon, mined miscellaneous clay for manufacturing brick.

Hillsboro.—This county continued to lead the State in value of mineral production. Blocks of granite produced at the Kitledge quarry by flame cutting and wire sawing were finished at the Barretto Granite Corp. plant in Milford. The finished stone was used principally as architectural and construction stone, monuments, curbing, and paving blocks. Sand and gravel was produced by five operators for use as concrete aggregate and in highway construction. J. J. Cronin Co., Manchester, produced more than half of the sand and gravel tonnage reported in Hillsboro County. Mineral Materials, Inc., South Lyndeboro, mined and crushed quartz for use as exposed aggregate in decorative concrete.

Merrimack.—The county ranked second in value of mineral production. Manchester Sand, Gravel & Cement Co., Inc., operated a gravel pit at Hooksett to produce sand and gravel for building and paving. A quantity of engine sand was shipped. Most of the output was trucked to consumers; about 5 percent was delivered by railroad. Crude granite blocks from the Gray quarry were processed at its Concord finishing plant by John Swenson Granite Co., Inc. The principal products were architectural stone, slabs for monuments, and curbing.

Rockingham.—Manchester Sand, Gravel & Cement Co., Inc., Raymond, produced washed and screened sand and gravel for shipment by railroad to a ready-mixed concrete operation in Boston. Bank-run sand and gravel for fill was recovered by L. Chester & C. W. Simpson from a pit near Exeter. Iafolla Crushed Stone Co., Inc., Portsmouth, mined and crushed stone for concrete aggregate, roadstone, and riprap. Iafolla also produced sand and gravel for paving and fill. Clay for building brick was recovered from pits near Epping and Exeter. National Gypsum Co. calcined gypsum and expanded perlite at its Portsmouth plant. The perlite was mined in Colorado, and the expanded product was used in building plaster.

Strafford.—Dover Sand & Gravel, Inc., produced sand and gravel, principally for concrete aggregate, from two pits in Dover. Minor quantities of sand were used for paving and ice control. Iafolla Crushed Stone Co., Inc., recovered paving material from a pit in Madbury. Miscellaneous clay for manufacturing building brick was mined at Gonic by The Kane-Gonic Brick Corp.

Sullivan.—Mineral Materials, Inc., New London, and Quartz, Inc., Acworth, mined and crushed quartz for use as exposed aggregate in decorative concrete. Eaton Jones Sand & Gravel Co., Inc., produced sand for building, paving, and fill from its Newport pit. The Yuhas and Sargeant mines, formerly a source of feldspar for Golding-Keene Co., were idle.

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 New Jersey mineral production set a record high for the third consecutive year. Value rose to $78.2 million, a 7-percent increase over that of 1963. Although output of one of the State's major mineral products, iron ore, continued to decline, the decrease was offset by greater demand for stone and sand and gravel, the leading minerals. Increased construction of residential and commercial buildings and a vigorous highway construction program resulted in higher output of stone and sand and gravel. Slight to moderate increases in value also were reported for all other mineral commodities except iron ore, lime, greensand marl, and peat.

Work was started on an underground liquid natural gas storage facility at Carlstadt, the first of its kind in the United States. Expansions in the State's gypsum-processing industry were initiated. Some interest in the State as a possible oil or natural gas producer was reported.

TABLE 1.—Mineral production in New Jersey [1]

	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	498	$1,392	500	$1,441
Gem stones	(2)	9	(2)	10
Peat—short tons	23,685	241	W	W
Sand and gravel—thousand short tons	16,672	25,245	17,661	27,079
Stone—do	11,229	25,654	12,326	28,461
Zinc [3] (recoverable content of ores, etc.)—short tons	32,738	7,855	32,926	8,935
Value of items that cannot be disclosed: Iron ore, lime, magnesium compounds, manganiferous residuum, greensand marl, titanium concentrate (ilmenite), and items indicated by symbol W	XX	12,880	XX	12,246
Total	XX	73,276	XX	78,172

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] Weight not recorded.

[3] 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.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.

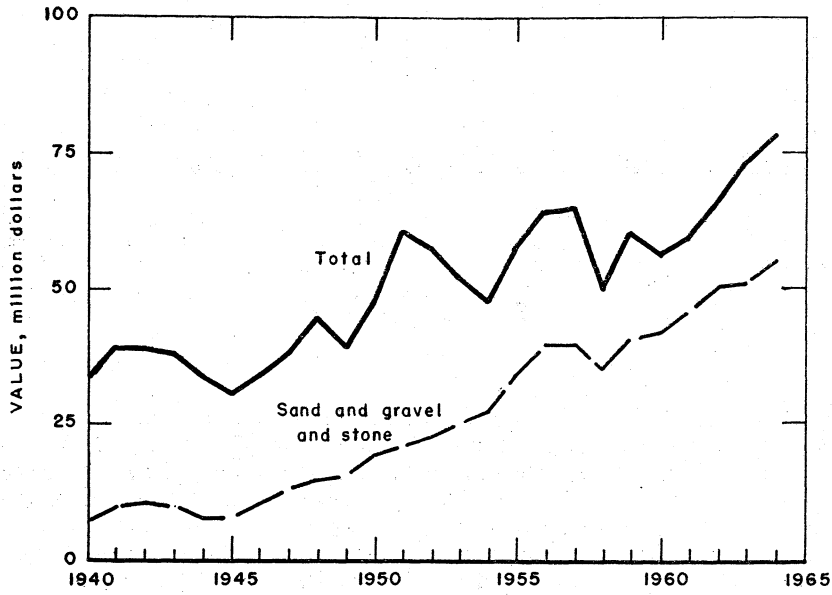


FIGURE 1.—Value of sand and gravel, and stone, and total value of mineral production in New Jersey.

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

(Thousands)

Year	Value	Year	Value
1940	$75,188	1953	$56,555
1941	83,722	1954	50,003
1942	78,519	1955	60,519
1943	72,235	1956	64,748
1944	63,912	1957	65,499
1945	56,866	1958	50,640
1946	53,194	1959	58,291
1947	53,810	1960	55,917
1948	57,014	1961	58,857
1949	49,594	1962	r 65,414
1950	58,585	1963	r 72,713
1951	66,985	1964	76,205
1952	63,749		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	601	159	1,272	2	79	64
Nonmetal	413	96	771		19	25
Sand and gravel	1,319	315	2,627	1	56	22
Stone	1,129	286	2,360		72	31
Peat	13	2	18		1	54
Total	3,475	858	7,048	3	227	33
1954: p						
Metal	590	144	1,159	2	44	40
Nonmetal	420	118	948	1	21	23
Sand and gravel	1,345	330	2,739		62	23
Stone	1,215	296	2,422	1	53	22
Peat	8	2	14			
Total	3,578	890	7,282	4	180	25

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Five companies operated cement distribution terminals in the State. Cement produced in New York and Pennsylvania was shipped to terminals operated by Atlantic Cement Co., Bayonne; Dragon Cement Co., Division of Martin Marietta Corp., Elizabethport; Allentown Portland Cement Co. and Penn-Dixie Cement Corp., both at Jersey City; and Universal Atlas Cement Division, U.S. Steel Corp., Newark.

Clays.—Total clay production was virtually the same as in 1963. Output of fire clay increased 13 percent, but miscellaneous clay production declined 3 percent. Miscellaneous clay supplied most of the tonnage, but fire clay had a greater value. Miscellaneous clay, recovered principally in Middlesex and Somerset Counties, was used exclusively for manufacturing heavy clay products, such as building brick and vitrified sewer pipe. Production of clay for manufacturing lightweight aggregate was discontinued in Middlesex County because of dust-control problems and difficulty in marketing excessive quantities of fines resulting from the crushing operation. Most of the fire clay, produced only in Middlesex and Cumberland Counties, was used in manufacturing refractory products. Quantities of fire clay also were used in manufacturing architectural terra cotta, floor and wall tile, and pottery and stoneware, as a filler in linoleum and insecticides, and as rotary-drilling mud. Of the six clay-producing counties, Middlesex and Somerset Counties led and ranked second, respectively, in output.

Gem Stones.—More than 5,000 collectors visited the mine dumps at Franklin, Sussex County, to collect the wide variety of minerals for which the locality is noted. Fees paid for admittance to the collecting area were being used to establish a small museum in the town of Frank-

lin. Also in Sussex County, valuable specimens were recovered at the Farber limestone quarry near Newton.

Gypsum.—Calcined gypsum was produced at plants in Bergen, Burlington, and Camden Counties from crude material shipped from out-of-State mines and imported from Newfoundland. The calcined gypsum was used in manufacturing plaster, lath, sheathing, wallboard, and other building materials. Kaiser Gypsum Co., Inc., began construction of a gypsum calcining and fabricating facility at Delanco Township, Burlington County. Initial production will begin late in 1965.

Iodine.—New Jersey continued as an important area for the consumption of crude iodine. Thirteen plants throughout the State reported consumption of iodine and iodine compounds for use in medicine, sanitation, and the chemical industry. Most of the crude material was imported. Organic and inorganic compounds were produced from resublimed iodine. Total consumption of organic and inorganic iodine was 516,000 pounds.

Lime.—Output and value of hydrated lime produced in Sussex County was below that of 1963. Demand for hydrated lime used in construction, agriculture, water purification, and sewage treatment decreased compared with that of previous years.

Magnesium Compounds.—Output and value of refractory magnesia increased; a higher unit value also was reported. The material was produced at a plant in Cape May County from sea water and dolomite purchased from out-of-State sources. Various magnesium compounds were produced at a plant in Warren County from purchased material.

Marl, Greensand.—Output and value of greensand marl dropped sharply below that of 1963. Only one producer in Gloucester County was active. The Burlington County operation was closed in September 1963. The greensand marl produced in Gloucester County was used for water softening.

Mica.—Muscovite block and film mica was fabricated at five plants in the State. In addition, synthetic flake mica was produced by Molecular Dielectrics, Inc., Clifton, and Synthetic Mica Co., Division of Mycalex Corp. of America, West Caldwell. The synthetic material was used in manufacturing glass-bonded mica ceramic materials. Molecular Dielectrics, Inc., also produced synthetic mica crystals for splitting and punching.

Perlite.—Plants in Mercer, Middlesex, Passaic, and Union Counties expanded crude perlite mined in the Southwestern United States. The expanded material was used as loose-fill insulation, and in acoustical plaster, ultra-lightweight concrete and soil conditioning.

Pigments.—Various metal-based pigments were produced at eight plants. Iron oxide pigments were manufactured in Essex, Mercer and Middlesex Counties; lead pigments in Middlesex County; and zinc pigments in Bergen County. Titanium dioxide was produced at one plant each in Camden and Middlesex Counties. The metal-based pigments were produced primarily for manufacturing paint.

Sand and Gravel.—Greater activity in highway and building construction resulted in higher output of sand and gravel. Production increased 6 percent in quantity and 7 percent in value, compared with that of 1963. The output was virtually all commercial production.

Building and paving sand and gravel accounted for 69 percent of the commercial production. Demand also increased for industrial sands, principally by foundries and the glass industry. Ground sand, produced in Cumberland, Middlesex, and Ocean Counties, was sold mainly to foundries and as a filler. Other uses included abrasive, chemical, pottery, porcelain, tile, and glass manufacturing. Eighty-four percent of the commercial production was processed. Of sand and gravel sent to consumers, over 15 million tons was shipped by truck, 1.6 million tons by rail, and the remainder by water and other methods. Morris County was the leading sand-and-gravel-producing area, but Cumberland County ranked first in value because of production of higher priced industrial sands. Other important producing areas, all with production exceeding 1 million tons, were Ocean, Burlington, Camden, and Middlesex Counties. Output by Government-and-contractor operations was reported only in Atlantic County.

TABLE 3.—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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	5,031	$5,309	5,013	$5,173
Paving	2,995	2,539	2,756	2,439
Fill	1,526	567	1,074	478
Glass	748	2,780	773	2,901
Molding	1,570	5,043	1,672	5,262
Grinding and polishing	22	64		
Blast	122	653	139	649
Engine	27	93	(1)	(1)
Filtration	38	141	(1)	(1)
Ground	143	1,211	153	1,377
Other [2]	412	753	976	1,623
Total	12,634	19,153	12,556	19,902
Gravel:				
Building	2,244	4,065	2,839	4,829
Paving	1,187	1,674	1,517	1,731
Fill	430	181	498	312
Other [3]	169	169	248	303
Total	4,030	6,089	5,102	7,175
Total sand and gravel	16,664	25,242	17,658	27,077
Government-and-contractor operations:				
Sand:				
Paving			1	1
Other	4	2	2	1
Total	4	2	3	2
Gravel: Paving	4	1		
Total sand and gravel	8	3	3	2
All operations:				
Sand	12,638	19,155	12,559	19,904
Gravel	4,034	6,090	5,102	7,175
Total	16,672	25,245	17,661	27,079

[1] Included with "Other."
[2] Includes fire or furnace and other sand and items indicated by footnote 1.
[3] Includes other and miscellaneous gravel.

Stone.—Production of stone increased 1.1 million tons and was 10 percent greater than that of 1963. All of the production was crushed or broken; no dimension stone was produced. Nearly 10.4 million tons of stone was crushed and sized for use as concrete aggregate and roadstone.

Basalt (traprock) was the principal stone quarried and accounted for 87 and 81 percent of the total tonnage and value, respectively. Production was reported from seven counties; Somerset and Passaic Counties continued to lead in output. Over 9.2 million tons was used for concrete aggregate and roadstone; the remainder was sold for riprap, railroad ballast, roofing granules and other uses. Limestone continued to rank second in value and was produced by two companies in Sussex County. Principal uses were as agricultural stone (agstone), concrete aggregate, filler material, additive in livestock feed, and limekiln feed.

Output of granite increased, but a lower average unit value was reported. Production was by four companies, three in Morris County and one in Hunterdon County. Most of the output was for concrete aggregate and roadstone, but some was sold for riprap and fill. Marble quarried in Warren County was crushed for terrazzo. Miscellaneous stone, used exclusively for concrete aggregate, was produced in Passaic County. Oystershell, recovered in Gloucester County, was ground for poultry grit and lime.

Three quarries, two basalt and one limestone, were awarded Certificates of Achievement in Safety in National Safety Competition for working the entire year without any disabling injuries.

Sulfur.—Shipments of sulfur recovered as a byproduct in the liquid purification of gas increased 12 percent and totaled 54,000 long tons valued at $1.3 million. The average value per long ton increased $0.21 to $23.41. Four plants, two in Gloucester County and one each in Middlesex and Union Counties, recovered elemental sulfur. Most of the sulfur was sold for manufacturing sulfuric acid, but part of the output was retained for captive use for various chemical processes. Hydrogen sulfide was recovered at a refinery in Union County. Liquid sulfur storage and transshipment terminals were operated by Freeport Sulfur Co., at Warners (Linden); Pan American Sulfur Co., at Newark; and Texas Gulf Sulfur Co., at Carteret and Paulsboro. Total storage capacity was 72,500 long tons.

Vermiculite (Exfoliated).—Crude vermiculite, imported and shipped from other States was exfoliated at plants in Essex and Mercer Counties. The processed material was used as loose fill insulation, plaster, and concrete aggregate and for agricultural and miscellaneous uses.

METALS

New Jersey continued as a leading area for smelting and processing a wide variety of primary and secondary nonferrous metals. Iron and steel was produced in Burlington and Essex Counties. Ferrous and nonferrous metal castings were produced at numerous foundries throughout the State. Active research programs were conducted by metal processors and were directed toward developing new products and production techniques. Many iron and steel scrap dealers col-

lected, separated, and processed material for the domestic market and for export. Dealers in the metropolitan Northeast were particularly active in the export market.

Ferroalloys.—Total production and shipments of ferroalloys increased compared with that of 1963, but value declined. Shieldalloy Corp., Newfield, Gloucester County, continued as the State's only ferroalloy producer.

Iron Ore.—For the fifth consecutive year output and value of iron ore continued to decline. The Washington mine in Warren County was closed in April. Economically minable ore was depleted, and equipment and buildings were to be dismantled. The State's only remaining active mine was the Scrub Oaks mine in Morris County. Output from both mines was beneficiated by magnetic separation and most of the concentrate was shipped to Conshohocken, Pa., for consumption in company-owned blast furnaces. Some of the output was sold to other steel producers. Magnetite concentrate, mined and beneficiated in previous years, was shipped from stockpiles in Morris County for use as heavy media in beneficiation processes and in concrete.

Titanium.—Production and value of ilmenite concentrates mined in Ocean County increased, but the average value was lower than that of 1963. Output from a titanium-bearing sand deposit was processed and shipped as a concentrate to a company-owned titanium dioxide plant in Baltimore, Md., for processing into white paint pigment.

Zinc.—Although work at the Sterling Hill zinc mine was curtailed August 19 to September 21 by a labor dispute, output and value continued to increase, following the trend established when the mine was reopened late in 1961. Average unit values also were higher because a heavy demand for zinc products during the year gradually raised the price of prime Western slab zinc. Output from the underground mine was crushed and shipped direct to the company-owned smelter at Palmerton, Pa.

MINERAL FUELS

Coke and Coal Chemicals.—Koppers Co., Inc., at Kearney, Hudson County, operated a merchant oven-coke plant. Coal chemical materials recovered from the 120 slot-type ovens included monoammonium phosphate, crude coal tar, crude light oil, intermediate light oil and crude naphthalene.

Natural Gas.—Construction was started on the first frozen-earth underground liquid natural gas storage facility in the United States at Carlstadt, Bergen County. A 2-million-cubic-foot hole, 115 feet in diameter and 165 feet deep, will be dug and will be capable of storing 1 billion cubic feet of natural gas at atmospheric pressure. The hole will be unlined but will be covered with an insulated aluminum roof supported by piles driven into bedrock. A liquefaction plant to convert the natural gas to liquid for storage at 259° F also will be built. The $7 million facility was being constructed for Transcontinental Gas Pipe Line Corp. to supply demands for natural gas during peak periods in the metropolitan New York areas.[2]

[2] Engineering News-Record. V. 172, No. 9, Feb. 27, 1964, p. 24.

Peat.—Reed-sedge peat was recovered from bogs in Sussex County. Output, sold in bulk and in packages, was used for soil conditioning and enriching mushroom beds.

Petroleum.—Total crude oil capacity of active petroleum refineries as of January 1, 1964, was 515,950 barrels per day, 14,000 less barrels than that of 1963. Gasoline output capacity per day was 155,400 barrels. Catalytic and thermal cracking accounted for 64 percent; the remainder represented reforming capacity. Refineries were operated by California Oil Co., Perth Amboy; Cities Service Oil Co., Linden; Hess Oil & Chemical Co., Sewaren; Humble Oil & Refining Co., Bayonne and Linden; Socony Mobil Oil Co., Paulsboro; and Texaco Inc., Westville. For the second consecutive year an exploratory drilling operation was unsuccessful. In 1964, a 3,772-foot well was drilled in Cumberland County, but no petroleum or natural gas was discovered.

REVIEW BY COUNTIES

Mineral production was reported for all counties except Salem. The leading mineral-producing areas, in decreasing order of value, were Sussex, Somerset, Morris, and Cumberland Counties. Value increases were reported for eight counties; the greatest increase was in Sussex County because of increased value of zinc and manganiferous residuum.

TABLE 4.—Value of mineral production in New Jersey, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Atlantic	$442,188	$433,000	Sand and gravel.
Bergen	1,541,560	1,530,000	Sand and gravel, clays.
Burlington	2,437,066	2,367,286	Do.
Camden	1,787,640	1,948,000	Do.
Cape May	W	W	Magnesium compounds, sand and gravel.
Cumberland	9,215,231	9,423,126	Sand and gravel, clays.
Essex	W	W	Stone.
Gloucester	648,548	578,500	Sand and gravel, greensand marl, stone.
Hudson	----	W	Stone.
Hunterdon	1,132,439	1,337,386	Do.
Mercer	W	W	Do.
Middlesex	2,424,917	2,391,327	Sand and gravel, clays.
Monmouth	940,966	956,000	Sand and gravel.
Morris	10,251,882	9,794,088	Iron ore, sand and gravel, stone.
Ocean	4,308,562	5,561,030	Sand and gravel, ilmenite.
Passaic	6,358,909	5,763,602	Stone, sand and gravel.
Somerset	11,543,809	12,961,942	Stone and clays.
Sussex	11,996,866	13,727,188	Zinc, stone, manganiferous residuum, sand and gravel, lime, peat.
Union	W	W	Stone.
Warren	1,947,677	634,882	Iron ore, sand and gravel, stone.
Undistributed[2]	6,297,714	8,764,811	
Total	73,276,000	78,172,000	

W Withheld to avoid disclosing individual company confidential data.
[1] No production reported in Salem County.
[2] Includes value of gem stones and some sand and gravel (1963) not assigned to specific counties and values indicated by symbol W.

Atlantic.—Production of commercial sand and gravel decreased 16 percent below that of 1963 and totaled 521,000 tons. The decline was due primarily to less active operations than in the previous year. Output, consisting chiefly of construction material, was shipped to consumers by truck and rail. Quantities of molding sand also were produced. The principal producers were Walter A. Daminger, Ham-

monton, and Mays Landing Sand & Gravel Co., Inc., Mays Landing. Other operations were located at Bargantown, Folsom, Hammonton, Cedar Lake, and Somers Point. Atlantic Sand & Gravel Co., Folsom, and Ole Hansen & Sons, Inc., Pleasantville, were not in operation during the year. Crews of the Atlantic County Road Department produced sand at Pleasantville for road maintenance. The County Road Department also obtained sand from a pit near Egg Harbor.

Bergen.—Prepared construction sand and gravel was produced at three operations; output was below that of 1963. Producers were Braen Sand & Gravel Co., Wyckoff; Samuel Braen & Co., Mahwah; and McKee Bros., Inc., Ramsey. Miscellaneous clay for manufacturing building brick was recovered near Moonachie. Barrett Division, Allied Chemical Corp., produced calcined gypsum and fabricated gypsum building products at its South Kearney plant. Zinc oxide and leaded zinc oxide pigments were manufactured by Royce Chemical Co., Carlton Hill.

Burlington.—The county ranked fourth in output of sand and gravel. Production was reported from seven operations and consisted chiefly of processed material used for construction. Over 2.1 million tons of material was produced, 5 percent more than in 1963. Principal producers were Amico Sand & Gravel Co., Riverside; American Dredging Co., Burlington; Lockhart, Inc., Riverton; and Warner Co., Philadelphia, Pa. Church Brick Co. mined miscellaneous clay near Fieldsboro for manufacturing building brick. National Soil Conservation, Inc., closed its greensand marl plant November 26, 1963, and the business was being liquidated. National Gypsum Co. produced calcined gypsum at its Burlington plant.

Camden.—Production of sand and gravel totaled 1.5 million tons, 23 percent greater than that of 1963. Most of the material was used for construction, but substantial quantities of molding sand also were produced. Over 83 percent of the material was processed. Tri-Borough Sand & Stone, Inc., Gibbsboro, was the leading producer. Other principal producers were Con-Agg, Inc., Chews Landing; Ward Sand and Materials Co., Pennsauken Township; and George F. Pettinos, Inc., with plants at Grenloch, Penbryn, and Williamstown Junction. The Alliance Clay Product Co., Winslow Junction, mined miscellaneous clay for manufacturing building brick. Crude gypsum, imported from Newfoundland, was calcined and processed into plaster and gypsum building products at the Camden plant of Flintkote Co. New Jersey Zinc Co. produced titanium dioxide from ilmenite concentrate at its Gloucester City plant.

Cape May.—Northwest Magnesite Co., Cape May, produced refractory magnesia from purchased dolomite and sea water. Production at the plant was curtailed in July because of a labor dispute and for the first half of August because of a breakdown of production facilities. Increased construction activity in the county resulted in greater demand for sand and gravel from local producers. Output increased sharply and totaled 591,000 tons. Producers were Courtland Sand & Gravel Co., Cape May Court House; John F. Gandy, Marmora; Matalucci Bros., Avalon; and Tuckahoe Sand & Gravel, Tuckahoe.

Cumberland.—Cumberland County ranked second in tonnage and led in value as a sand-and-gravel-producing area. Output increased 3

percent; value was 2 percent greater than that of 1963. Most of the output was sand for manufacturing glass and for molding purposes. In addition, blast, engine, and filter sand, as well as building and paving and other construction sand and gravel, was produced. Fourteen operations were active, mostly near Millville, Vineland, and Port Elizabeth. The entire county output was processed material. Fifty-eight percent of the production was shipped to consumers by truck and the remainder by rail. Ground sand was produced by Pennsylvania Glass Sand Corp. and National Glass Sand Corp., both near Millville. Plastic fire clay was recovered at Millville by Daniel Goff Division, Jessie S. Morie & Son, Inc.

Essex.—Orange Quarry Co., West Orange, produced basalt for concrete aggregate, roadstone, and riprap. The company installed an additional small third-stage crusher to improve its product. Part of the output was sold to nearby communities for road maintenance and repair. M. L. Kernan Quarry, South Orange, also produced basalt for concrete aggregate and roadstone. Vermiculite Industrial Corp. at Port Newark produced exfoliated vermiculite. E. I. du Pont de Nemours & Co., Inc., manufactured iron oxide pigments (hydrated ferric oxide) at Newark.

Gloucester.—Sand and gravel production totaled 338,000 tons, 8 percent less than that of 1963. Output was used principally for construction and was recovered mostly from operations near Bridgeport, Gibbstown, and Mount Ephraim. Furnace sand was recovered near Downer and molding sand near Grenloch. Inversand Co. mined greensand marl near Sewell. The greensand (natural zeolite) was sold to water-treating equipment manufacturers to soften water. Joseph Bauder & Sons, Franklinville, processed osytershell for poultry grit and lime. Byproduct sulfur was recovered in the liquid purification of gas by the modified Baehr process at the Eagle Point (Westville) plant of Freeport Sulphur Co. Socony Mobil Oil Co., using the Claus process, recovered sulfur at its Paulsboro refinery.

Hudson.—Callanan Traprock Corp. mined and processed basalt at its newly built Laurel Hill plant near Secaucus. Output was used exclusively for concrete aggregate and roadstone.

Hunterdon.—Lambertville Quarry Co. produced basalt for concrete aggregate, riprap, and railroad ballast at Lambertville. Basalt also was produced by Houdaille Construction Materials, Inc., at Oldwick for concrete aggregate and roadstone. Granite for concrete aggregate and riprap was produced by Anthony Ferranti & Sons near Clinton. No dimension miscellaneous stone (argillite) was produced by Delaware Quarries.

Mercer.—Pennington Quarry Co., Pennington, quarried diabase (traprock) for use as riprap, concrete aggregate, roadstone, and railroad ballast. Inmates of the Mercer County Workhouse, Trenton, produced basalt for concrete aggregate and roadstone. The workhouse improved facilities by adding a new conveyor belt at their crushing operation. Black, brown, red, and yellow iron oxide pigments were manufactured by Columbian Carbon Co., Trenton. Zonolite Div., W. R. Grace & Co., produced exfoilated vermiculite and expanded perlite at its Trenton plant.

Middlesex.—Decreased highway and building construction activity

affected county output of sand and gravel. Production totaled 1.5 million tons, 33 percent below that of 1963. Most of the output was used as building, paving, and fill material, but industrial sands also were produced. Ground sand was produced at the Old Bridge plant of South River Sand Co. Other producers follow: Crossman Co., Sayre & Fisher Co., and Whitehead Bros. Co., all near Sayreville; Buck Realty Co., Inc., and Herbert Sand Co., Inc., both near East Brunswick; Buck Bros., Inc., Edison; Dalenbach Sand Co., Milltown; Glenn-Rock Concrete Products Co., Jamesburg; and Raritan River Sand Co., Nixon. Fifty-eight percent of the county sand and gravel output was processed, compared with 46 percent in 1963.

The county continued to lead among the six clay-producing counties, supplying 47 percent of the State's total clay tonnage. Compared with 1963, fire clay output increased but miscellaneous clay production declined, resulting in a 4-percent decrease of total clay output. The miscellaneous clay was used for manufacturing building brick and heavy clay products. Fire clay was used mostly by the refractory market, but quantities also were used for manufacturing pottery and stoneware, floor and wall tile, architectural terra cotta, and rotary drilling mud. Principal fire clay producers follow: Almasi Clay Co., Woodbridge; Crossman Co., South Amboy; McHose Clay Co., Edison; Such Clay Co., Sayreville; Valentine Fire Brick Division of A. P. Green Fire Brick Co., Perth Amboy and Woodbridge; and Marcus S. Wright, Inc., Milltown. Sayre & Fisher Co. produced both miscellaneous clay and plastic fire clay at Sayreville. Oschwald Brick Works near Cliffwood and Natco Corp. near Keasbey produced miscellaneous clay.

The Anlin Co. of New Jersey, Perth Amboy, recovered sulfur by the Amine gas purification and modified Claus processes. Columbian Carbon Co., Monmouth Junction, and Stabilized Pigments Inc., New Brunswick, manufactured red iron oxide pigments (calcined copperas). National Lead Co., Perth Amboy, manufactured titanium dioxide and lead pigments. Coralux Perlite Corp. of New Jersey, Metuchen, expanded crude perlite mined and shipped from New Mexico.

Monmouth.—Sand and gravel production totaled 813,000 tons, 6 percent greater than that of 1963. Seventy-nine percent of the output was processed and sold mostly for building and paving aggregate. Producers follow: Bennett Sand & Gravel Co., Manasquan; Fary's Gravel Pit, Inc., New Shrewsbury; Hause Gravel Co., Asbury Park; New Jersey Gravel & Sand Co., Farmingdale; Joseph Scarano, Wayside; Frank Z. Sindlinger, Inc., Wall Township; and Walling & Son, Hazlet.

Morris.—The Scrub Oaks iron ore mine of Alan Wood Steel Co., Dover, was active throughout the year, but output was below that of 1963. Development at the underground mine, consisting of raising, drifting, and diamond drilling, continued in 1964. The magnetite ore was magnetically beneficiated, and most of the concentrate was shipped to the company steel plant at Conshohocken, Pa. The company also crushed and processed mine wastes and mill tailings (granite) for sale as concrete aggregate and fill. In addition, the company produced sand for building and paving and other uses at Dover.

The Mt. Hope iron ore mine of Shahmoon Industries, Inc., continued idle, but the company made shipments of stock from previous years for use as heavy media and in concrete. The company continued operation of its granite quarry near Mt. Hope. The crushed stone was sold for concrete aggregate and roadstone. Substantial tonnages of granite also were quarried by Braen Industries, Inc., at Riverdale.

Morris County led in sand and gravel production but ranked second in value among the 14 producing counties. Output totaled 3.5 million tons, an increase of 9 percent over that of 1963. Eighty-three percent of the production was processed and used exclusively as construction material. Houdaille Construction Materials, Inc., with plants at Kenvil and Riverdale, was the largest producer. Other leading producers were Conklin Bros., Montville, and Pequannock Sand and Gravel Division, The Union Building & Construction Corp., Pequannock.

Ocean.—Output and value of sand and gravel increased 55 and 57 percent, respectively. Most of the output was processed construction material, but quantities of industrial sand, ground and unground, also were produced. Houdaille Construction Materials, Inc., and Ralph Clayton & Sons, both near Lakewood, were the leading producers of construction sand and gravel. New Jersey Pulverizing Co., Bayville, produced industrial sands. Other construction sand and gravel was produced at operations near Barnegat, Forked River, Lacey Township, New Shrewsbury, and Staffordville. Brown and Burdge, Point Pleasant Ocean, producers of sand and gravel in previous years, went out of business. The Glidden Co. produced ilmenite concentrate at its Lakehurst mine and concentrating plant near Jackson. The concentrate was shipped to the company plant in Baltimore, Md., for conversion to titanium dioxide.

Passaic.—Passaic County continued to rank second among the stone-producing counties of the State; output decreased 11 percent below that of 1963. Six basalt and one miscellaneous stone quarries were active. Most of the stone was used for concrete aggregate and roadstone, but part of the output was used for riprap and roofing granules. Basalt producers follow: 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 & Construction Corp., Clifton. Miscellaneous stone (gneiss) was quarried near Pompton Lakes by Passaic Crushed Stone Co., Inc. Sowerbutt Quarries, Inc., added a conveyor and installed a dust collector.

Four sand and gravel operations were active, producing building and fill material. Production totaled 463,000 tons, 12 percent greater than that of 1963. Producers were Van Orden Sand & Gravel Co., Inc., Ringwood and Wayne, and Herbert J. Hinchman & Son, Inc., and Van Decker Bros., Inc., both near Wayne.

Somerset.—Somerset County led the stone-producing counties with basalt production of 5.4 million tons valued at $12.8 million. Tonnage was below that of 1963, but the value increased owing to higher unit values. Most of the stone was sold for concrete aggregate and roadstone, but quantities also were used for riprap, railroad ballast, roofing granules, and filler material. Basalt producers follow: Hou-

daille Construction Materials, Inc., Millington and Bound Brook; Dock Watch Quarry Pit, Inc., Martinsville; Fanwood Stone Crushing & Quarry Co., Watchung; Kingston Trap Rock Co., Kingston; Minnesota Mining & Manufacturing Co., Belle Mead; and Somerset Crushed Stone Division, Anthony Ferrante & Sons, Inc., Bernardsville. The Millington quarry and plant of Houdaille Construction Materials, Inc., was awarded a National Safety Competition Certificate of Achievement in Safety for working 40,830 man-hours without any disabling injuries. New Jersey Shale Brick & Tile Manufacturing Co. and American Vitrified Products Co., both near Somerville, and Natco Corp., Middlebush, mined miscellaneous shale for manufacturing heavy clay products.

Sussex.—Manganiferous zinc ore was recovered from the Sterling Hill mine near Ogdensburg. The ore was crushed and shipped direct to a smelter at Palmerton for recovery of zinc and byproduct manganiferous residuum. Development at the underground mine consisted of raising, drifting, and diamond drilling. Most of the ore was mined by cut and fill methods. Square set and shrinkage stopes also were used. Mining efficiency was improved by replacing hand tools with air tools and acquiring new rock drills. Improvements also were made at the crushing plant.

Limestone was quarried and crushed by Limestone Products Corp. of America, Newton, and Farber White Limestone Co., Franklin, and sold for a wide variety of uses. Limestone Products Corp. burned limestone at its Lime Crest plant and produced hydrated lime for construction and for agricultural and chemical applications. The company added equipment to its crushing operation to meet higher quality standards of its customers. Farber White Limestone Co. improved its dust collection system and installed a new bag-loading facility. The company also had a noteworthy safety record; it was awarded a Certificate of Achievement in Safety for having worked 45,700 man-hours without a disabling work injury. Sand and gravel production, which increased 21 percent, was used mostly for building and paving. Sparta Sand & Gravel Co., Inc., Sparta, and Limestone Products Corp. of America, Lime Crest, were the principal producers. Production also was reported from operations near Andover and Lafayette. Hyper-Humus Co., Newton, and Netcong Natural Products, Stanhope, produced reed-sedge peat from nearby bogs. Thousands of amateur gem and mineral collectors visited old mine dumps near Franklin. The area was noted for its mineral specimens, chiefly fluorescent calcite, franklinite, willemite, and zincite.

Union.—Houdaille Construction Materials, Inc., quarried basalt at Summit for concrete aggregate, roadstone and riprap. The company competed in the Quarry Group of the National Safety Competition, and the Summit operation was awarded a Certificate of Achievement in Safety. The quarry and plant worked 40,665 man-hours without any disabling injuries. General Chemical Division, Allied Chemical Corp., recovered sulfur by the general chemical process at its Bayway plant. Hydrogen sulfide was recovered by amine absorption at the Bayway refinery of Humble Oil & Refining Co. Certified Industrial Products, Inc., Hillside, produced expanded perlite.

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Warren.—The Washington iron ore mine of Allan Wood Steel Co. at Dover was closed on April 30. The company reported that all economically minable magnetite ore was depleted. Output for the first 4 months of the year was concentrated and shipped to Conshohocken, Pa., for consumption in the company's blast furnaces. Production of sand and gravel was virtually the same as that of 1963. Most of the output was processed for construction. Producers were Houdaille Construction Materials, Inc., Carpentersville; Stockel Concrete Co., Phillipsburg; Van Horn Sand & Gravel Co., Belvidere; and Harry W. Folkner, Buttzville. Marble, used exclusively for terrazzo, was quarried and crushed by Royal Green Marble Co. at Phillipsburg. The Great Meadows peat bog of Mt. Bethel Humus Co. was abandoned. A variety of refined magnesium compounds including chloride, sulfate, and trisilicate were produced by J. T. Baker Chemical Co. at Phillipsburg.

The Mineral Industry of New Mexico

By W. E. Burleson [1] and Paul Biggs [2]

NEW Mexico production of minerals was valued at $720.1 million, a new high in mineral-industry history for the State, exceeding by $29. 2 million the record set in 1961.

Mineral fuels contributed 67 percent, $484.5 million, of the total of the State; nonmetals 18 percent, $130.3 million; and metals 15 percent, $105.3 million. The value of fuels increased $23.9 million, 5

TABLE 1.—Mineral production in New Mexico [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	600	$6	W	W
Carbon dioxide (natural)—thousand cubic feet	854,339	63	816,168	$61
Clays—thousand short tons	W	140	[2] 104	[2] 167
Coal (bituminous)—do.	1,945	5,629	2,969	9,763
Copper (recoverable content of ores, etc.)—short tons	83,037	51,151	86,104	56,140
Fluorspar—do.			137	3
Gem stones	[3]	45	[3]	45
Gold (recoverable content of ores, etc.)—troy ounces	7,805	273	6,110	214
Gypsum—thousand short tons	179	656	W	W
Helium—thousand cubic feet	79,624	2,787	84,526	2,958
Lead (recoverable content of ores, etc.)—short tons	1,014	219	1,626	426
Lime—thousand short tons	27	377	25	352
Manganese ore (35 percent or more Mn) short tons, gross weight	5,362	137	5,794	149
Manganiferous ore (5 to 35 percent Mn)—do.	41,144	W	46,657	300
Mica (scrap)—short tons	W	W	6,922	105
Natural gas—million cubic feet	808,377	96,197	878,720	101,932
Natural gas liquids:				
LP gases—thousand gallons	728,200	21,801	739,190	21,641
Natural gasoline and cycle products—do.	291,388	17,555	356,047	21,570
Perlite—short tons	259,113	2,212	286,329	2,568
Petroleum (crude)—thousand 42-gallon barrels	109,941	316,574	113,863	326,565
Potassium salts—thousand short tons, K_2O equivalent	r 2,643	r 101,458	2,675	104,866
Pumice—thousand short tons	322	850	260	760
Salt—do.	r 54	r 472	62	559
Sand and gravel—do.	8,402	12,843	8,781	10,160
Silver (recoverable content of ores, etc.) thousand troy ounces	256	328	242	313
Stone—thousand short tons	2,509	4,236	2,760	4,244
Uranium ore—short tons	2,304,577	41,372	2,093,350	38,203
Vanadium—do.	23	W	W	154
Zinc (recoverable content of ores, etc.)—do.	12,938	2,976	29,833	8,115
Value of items that cannot be disclosed: Cement, iron ore, molybdenum, and values indicated by footnote 2 and symbol W	xx	8,249	xx	7,791
Total	xx	r 688,606	xx	720,124

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] Excludes fire clay, included with "Value of items that cannot be disclosed."
[3] Weight not recorded.

[1] Mining engineer, Bureau of Mines, Socorro, N. Mex.
[2] Petroleum engineer, Bureau of Mines, Laramie, Wyo.

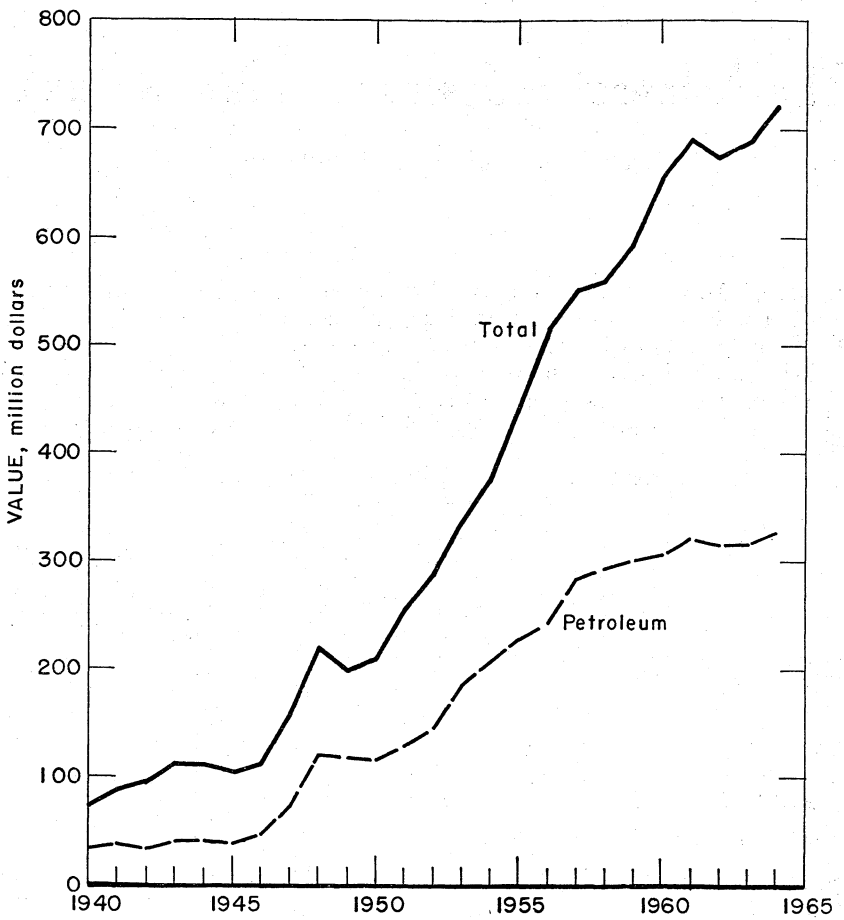


FIGURE 1.—Value of petroleum and total value of mineral production in New Mexico.

percent; nonmetals $64,000, less than 0.5 percent; and metals $7.6 million, 8 percent.

Substantial increases in the mineral-fuels group were in coal, 73 percent, and gasoline from natural gas liquids, 23 percent. Of the total, five mineral fuels increased and two declined in value. The overall increase was attributed principally to the output of coal, natural gas, natural gasoline, and petroleum. The State continued to lead the Nation in output of perlite, potassium salts, and uranium ore.

Vast multimillion-dollar developments and expansions were on stream or nearing completion to increase production of bituminous coal, natural gas, natural gas liquids, petroleum, gypsum, potassium salts, sand and gravel, stone, copper, lead, molybdenum, and zinc. Of significant importance were potash-refinery expansions and sinking operations completed at two new shaft mines; mine and plant expansions at an open-pit copper mine; development of a large copper property; completion of a thermoelectric powerplant and increased

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

(Millions)

Year	Value	Year	Value
1953	$377	1959	$599
1954	404	1960	650
1955	457	1961	r 683
1956	521	1962	r 660
1957	544	1963	r 669
1958	563	1964	691

r Revised.

coal utilization; plant and pipeline construction for natural gas, natural gas liquids, and petroleum; reactivation of a lead mine and continued production from zinc mines; added plant expansion at a gypsum operation; preparations for open-pit mining and mill installation at a molybdenum deposit; the start of tunneling at the San Juan-Chama Diversion Project; and the reopening of silver, copper, and lead-zinc mines caused by the increase in market price.

Employment and Injuries.—Table 3 shows employment and injuries in the mineral industries for 1963 and 1964, excluding mineral fuels except coal.

Government Programs.—After studying the vast reserves of coal ranging in thermal quality from 10,000 to 12,000 Btu per pound of coal in New Mexico, Utah, and Wyoming, the Federal Power Commission and other agencies reported [3] the economically attractive coal fields adaptable to large-scale strip mining that could supply nearby thermoelectric powerplants.

The Denver Mining Research Center, Federal Bureau of Mines, and International Minerals & Chemical Corp. (IMC) of Carlsbad continued feasibility studies on rock mechanics and longwall mining methods at the company potash mine.

The New Mexico State Highway Commission awarded contracts for $38.3 million for constructing the National System of Interstate and Defense Highways, $17.4 million for Federal-aid projects (ABC contracts), $1.7 million for State highways, and expended $9.9 million in repairing and maintaining existing highways. Expenditures planned for 1965 were $68.8 million, a 20-percent increase.

On September 16, the Secretary of the U.S. Department of the Interior announced that Federal financial assistance would be increased for silver exploration, effective on and after September 30. The announcement reported maximum participation by the Office of Minerals Exploration of 75 percent of the cost of exploration for silver, an increase from the 50-percent maximum authorized July 26, 1961. The increased assistance on exploration loans caused considerable interest in potentially producing silver mines in idled mining areas.

The Federal Bureau of Reclamation announced in April the award of a $13.8 million contract to Azotea Contractors, the joint venture firm of Dugan Graham Co., Inc., San Francisco, Calif., and Gibbons & Reed Co. and Boyles Bros. Drilling Co., Salt Lake City, Utah, to bore the Azotea tunnel (12.7 miles long) from New Mexico into Colorado at the San Juan-Chama project with tunnel opening near Chama. Total projects costing in excess of $89 million were scheduled for com-

[3] National Power Survey. A Report by the Federal Power Commission, 1964. Part 1, October 1964, p. 262.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	298	59	464		12	26
Metal	3,864	928	7,421	2	341	46
Nonmetal	2,801	932	7,465	1	179	24
Sand and gravel	632	125	1,034		27	26
Stone	283	70	562		10	18
Total	7,878	2,114	16,946	3	569	34
1964: p						
Coal	309	61	470		11	23
Metal	4,420	1,086	8,687	2	409	47
Nonmetal	2,805	942	7,517	5	217	30
Sand and gravel	660	131	1,081	3	32	32
Stone	355	77	613		22	36
Total	8,549	2,297	18,368	10	691	38

p Preliminary.

pletion in 1971. A 76-ton drilling "mole" was being used to bore the 13-foot 3-inch diameter tunnel successfully.

Certified participation of the Federal Lead-Zinc Stabilization Program totaled $320.52 for mine output equivalent to 0.9 ton of lead and 18.2 tons of zinc metal.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—Continental Carbon Co. and United Carbon Co. plants in Lea County continued producing carbon black from natural gas. The quantity of natural gas used in producing 54.6 million pounds of carbon black was 15.7 billion cubic feet. Average yield was 3.2 pounds of carbon black per thousand cubic feet of gas.

Carbon Dioxide.—Carbon dioxide was produced from wells in Harding County.

Coal (Bituminous).—Output of bituminous coal from 11 mines increased to 94 percent of the production level reached in 1922; maximum output of 4 million tons was reached in the State in 1918. Production was from three underground mines in Colfax County, two strip mines and one underground mine in McKinley, one of each type of operation in San Juan, two underground mines in Rio Arriba, and one underground mine in Sandoval. Increased coal consumption at thermal powerplants and greater demand at steel plants accounted principally for the gain.

Multimillion-dollar expansions were being continued at the York Canyon mine of Kaiser Steel Corp., Colfax County.

Arizona Public Service Co. completed installing the third 225-megawatt unit at its Four Corners plant near Farmington. The unit cost $25 million, and it increased the total capacity of the plant to 575 megawatts. Utah Construction & Mining Co. produced coal for the plant at the nearby Navajo open-pit mine.

Helium.—The Federal Bureau of Mines Navajo helium plant, located at Shiprock, San Juan County, produced a total of 84.5 million cubic feet of helium, valued at $3 million, during the year. This was an increase of 4.9 million cubic feet, or about 6 percent, over the 1963 production. The helium was extracted primarily from certain natural gas produced from the Table Mesa field, and was shipped from a rail terminal at Gallup to Federal and commercial customers on the west coast. The Navajo plant operated on a continuous 24-hour-per-day schedule throughout the year.

Natural Gas.—Because of increased demand for natural gas in the marketing area, volume and value of natural gas produced in 1964 increased. Productive capacity in New Mexico had exceeded demand for many years.

Thirty-seven natural gas plants in five counties recovered natural gasoline and LP gases. The plants had a combined daily capacity of 2.8 billion cubic feet and an average throughput of 2.4 billion cubic feet. Unused rated capacity was only 15 percent above average throughput. Additions to existing plants or construction of new plants would be necessary to meet increased peak loads.

Information compiled by the New Mexico Oil Conservation Commission and published by the New Mexico Oil & Gas Engineering Committee [4] showed that 17,558 oil wells and 7,652 gas wells produced 875 billion cubic feet of gas; 52 percent of this production came from wells in the southeastern part of the State. The northwestern fields comprised 11 percent of the 713 oil and gas pools in the State; output from these fields was 426.7 billion cubic feet from 6,210 natural gas wells. The southeastern fields produced 465.9 billion cubic feet of gas from 17,093 oil and gas wells, of which 58 percent (270.5 billion cubic feet) was produced from oil wells at 528 of the total 632 pools; the balance was from gas wells. There were 405 gas wells completed in the State.

In southeastern New Mexico, tests drilled to 10,000 feet in the Pennsylvanian and Devonian yielded several gas wells. Announced planning for gas pipelines and plants in the area were interpreted to indicate sizable natural reserves.

Major emphasis in the northwestern part of the State was on additional drilling in the Basin Dakota gas field.

Southern Union Gas Co. drilled several tests in Tijeras Canyon, east of Albuquerque, in search of rock formations suitable for underground gas storage. An underground storage project in the Entrada formation at 200 feet would permit the company to store gas during warm months to meet peak cold-weather demands.

Los Angeles County, Calif., issued an order in January that only natural gas could be used for fuel by industry. As a major portion of the natural gas consumed in southern California was from New Mexico fields, the order strengthened demand for New Mexico natural gas.

Natural Gas Liquids.—The State was ranked fourth in the Nation in production of natural gas liquids and proved reserves. Natural gasoline, butane, and propane were extracted from oil-well gas at 29 plants in the southeastern counties and at 8 in the northwestern counties.

[4] New Mexico Oil & Gas Engineering Committee. Annual Report. V. 1–2, 1964, p. 2.

TABLE 4.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1963	1964	Principal fields (those producing more than 1 million barrels) in 1964 in order of production
Chaves	5,214	6,723	Caprock.
Eddy	15,550	15,270	Empire Abo, Loco Hills, Grayburg Jackson.
Lea	76,395	79,752	Vacuum, Justis, Monument, Denton, Hobbs, Maljamar, Gladiola, Lusk, Eunice, Crossroads, Lovington, Blinebry, Drinkard, Langlie Mattix.
McKinley	144	121	
Rio Arriba	1,527	1,585	
Roosevelt	2,996	2,124	Milnesand.
Sandoval	11	12	
San Juan	8,104	8,276	Horseshoe, Bisti.
Total	109,941	113,863	

Source: New Mexico Oil & Gas Engineering Committee. Annual Report, 1964. V. 1-2, 1965, 594 pp.

Recovery of natural gasoline increased 22 percent in quantity; recovery of LP gases (butane and propane) increased 2 percent in quantity but decreased 1 percent in value. The annual report of the New Mexico Oil & Gas Engineering Committee showed 841 billion cubic feet of gas processed. Of the residual gas, 40 billion cubic feet was used for plant fuel and 8 billion for lease fuel, 730 billion was sold to pipeline companies, 9 billion was used for repressuring, and 6 billion was vented. The recovery of natural gasoline was 9.7 million barrels; of butane, 5.8 million; of propane, 4.6 million; and of mixed natural gasoline and liquefied gases, 5.5 million.

The sale of the Ciniza plant by El Paso Natural Gas Products Co. to Shell Oil Co. was reflected in the annual report of the New Mexico Oil & Gas Engineering Committee;[5] the same report showed an output of 5.5 million barrels of composite products by extraction plants.

Petroleum.—Petroleum production was greater than in any previous year. The State retained its position as sixth in the Nation in output of oil, 25 million barrels below fifth-ranked Wyoming.

After 4 successive years of decline, the total number of wells drilled increased 219, to 1,501 wells; this was fewer, however, than in any of the previous 10 years, excepting 1963. Exploration drilling declined in both eastern and western New Mexico. Development drilling in eastern New Mexico and gas-development drilling in western New Mexico increased significantly. Drilling for oil and gas in the deeper zones accounted for the increase in eastern New Mexico, whereas development of the Basin-Dakota gas area accounted for the increase in western New Mexico. Eastern New Mexico again led the State in oil and gas production.

Output was from 17,570 oil wells, 15,651 in the southeastern counties (Chaves, Eddy, Lea, and Roosevelt) and 1,919 in the northwestern counties (McKinley, Rio Arriba, Sandoval, and San Juan). Major production was from the southeastern Permian Basin fields, providing 91 percent of the total. Included were 3.9 million barrels of distillate obtained from an additional 7,652 wells; the 6,210 in the northwestern counties produced 65 percent of the distillate. Production was from 713 pools, 572 of which were classified as oil and 141 as gas; 81 pools, 44 oil and 37 gas, were in the northwestern counties.[6]

[5] New Mexico Oil & Gas Engineering Committee. Annual Report, 1964. V. 2, 1965, p. 113.

[6] New Mexico Oil Conservation Commission. 1964 Oil & Gas Statistics.

TABLE 5.—Wildcat- and development-well completions in 1964, by districts and counties

District and county	Oil	Gas	Dry	Total	Footage
East New Mexico:					
Wildcat:					
Chaves	8		21	29	84,000
Curry			2	2	10,000
De Baca			3	3	10,200
Eddy	8	6	51	65	385,600
Guadalupe			2	2	4,400
Lea	7	5	57	69	574,300
Luna			2	2	10,100
Roosevelt	1		8	9	43,700
San Miguel			1	1	400
Union			1	1	6,500
Total	24	11	148	183	1,129,200
Development:					
Chaves	63		7	[1] 75	241,800
Eddy	160	21	39	[2] 239	921,500
Lea	382	9	115	[3] 518	3,393,000
Roosevelt	43	8	9	60	298,800
Total	648	38	170	[4] 892	4,855,100
West New Mexico:					
Wildcat:					
Catron			2	2	5,200
McKinley			5	5	3,300
Rio Arriba		1	5	6	30,400
Sandoval			4	4	11,300
San Juan	4	3	41	48	180,500
Torrance			1	1	1,900
Total	4	4	58	66	232,600
Development:					
McKinley	1		2	3	2,800
Rio Arriba	14	89	9	112	524,800
Sandoval		1	2	3	11,700
San Juan	29	197	14	[5] 242	1,411,500
Total	44	287	27	[5] 360	1,950,800
Total all drilling	720	340	403	[6] 1,501	8,167,700

[1] Includes 5 service wells.
[2] Includes 19 service wells.
[3] Includes 12 service wells.
[4] Includes 36 service wells.
[5] Includes 2 service wells.
[6] Includes 38 service wells.

Source: Oil and Gas Journal.

In an unusual operating unit agreement for an area of eastern Chaves County, Humble Oil Co. proposed a plan that would go beyond the normal development and operation stages and included testing and selecting methods of secondary recovery. This proposal would permit testing water flooding in part of a field before actual delineation of the field.

NONMETALS

Mineral production of nonmetals accounted for 18 percent of the total output value for the State. In declining order of value, the principal commodities produced were potassium salts, sand and gravel, cement, stone, and perlite.

Barite.—Production of barite was the same as in 1963. All output was mined, crushed, and bagged in Socorro County for shipment to markets in the State. It was used mostly as a constituent for heavy-drilling muds in oil-well exploration and development.

Cement.—Production of portland and masonry cements at the Tijeras plant, Ideal Cement Co., Bernalillo County, decreased slightly. Sales to ready-mixed-concrete firms increased, but sales to highway contrac-

tors decreased. Most of the output was used in the State; some shipments were made to consumers in Arizona, Colorado, Oklahoma, Texas, and Utah.

Clays.—Miscellaneous-clay production increased substantially; that of fire clay declined. Fire clay was mined and sold at one operation each in Hidalgo and Luna Counties; miscellaneous clay was produced from two operations in Bernalillo County, and one each in Dona Ana, Grant, and Luna Counties. Clay output was not reported this year from McKinley County; however, production at a new mine and plant was started in Grant County. One property changed ownership in Dona Ana County, and one was consolidated with another in Luna County. Fire clay was used at smelter furnaces, and miscellaneous clay, for cement and building materials.

Fluorspar.—For the first year since 1959, fluorspar was mined. Total output of 137 tons was from a mine in Dona Ana County and was used in steelmaking.

Gem Stones.—Agate, amethyst, aragonite, chalcedony, jasper, Mexican onyx, petrified wood, quartz crystal, smithsonite, and turquoise were collected by individuals, mineralogical societies, and gem dealers.

Gypsum.—Quantity and value of gypsum production from three open-pit mines in Sandoval and Santa Fe Counties increased significantly. Three-quarters of the output was calcined and used for manufacturing wallboard lath and other building products. Crude gypsum was sold for use as a retarder in manufacturing portland cement. Consumers of gypsum were American Gypsum Co., Albuquerque plant; Ideal Cement Co., Tijeras plant; and Kaiser Gypsum Co., Inc., Rosario plant.

Lime.—The only producer of hydrated lime in the State was Kennecott Copper Corp., Chino Mines Division, Grant County, which produced and used 7 percent less. Decreased production was caused directly by the midyear labor strike at the Chino operation. The hydrated lime was used at the copper concentrating plant and for water purification.

Mica.—A total of 6,922 tons of scrap mica was produced from three open-pit and one underground mine, two in Rio Arriba County and one each in Santa Fe and Taos. Although combined output increased, the value decreased. The principal buyer and processor of crude mica was Minerals Industrial Commodities of America, Inc. (M.I.C.A., Inc.), Pojoaque. The dry-ground product was used in paints and for roofing.

Perlite.—New Mexico accounted for 82 percent of the U.S. perlite production in 1964. Four-fifths of the production came from three open-pit mines in the No Agua area, Taos County, and the remainder from an open-pit mine near Grants, Valencia County. In the No Agua area, crude perlite was crushed, screened, and sized to grade at com-

TABLE 6.—Crude perlite sold or used by producers

Year	Short tons	Value (thousands)	Year	Short tons	Value (thousands)
1960	240,593	$2,119	1963	259,113	$2,212
1961	245,654	2,159	1964	286,329	2,568
1962	258,164	2,143			

pany-owned plants near each mine and transported by truck to company-owned railroad-loading facilities in nearby Antonito, Colo. Perlite producers, in descending rank of output, were Johns-Manville Products Corp., Great Lakes Carbon Corp., United States Gypsum Co., and United Perlite Corp. All producers shipped dry-milled products to company-owned and other expanding plants outside the State. Perlite products were used principally in building plaster, cement material for oil-well exploration and development, filter aids, insulation and fire-resistant material, lightweight aggregate, and soil additives.

Potash.—For the second consecutive year, New Mexico supplied the Nation with 92 percent of the total output of potassium salts. Establishing new highs for output and value, production of crude potash ores (sylvinite-langbeinite) increased by 942,000 tons. Salt shipments increased from 4.2 to 4.8 million tons, and the price increased from $22.53 to $23.00 per ton. The quantity (K_2O equivalent) of stockpiled

TABLE 7.—Potassium salts production and sales

(Thousand short tons)

Year	Crude salts, mine production		Marketable potassium salts					
			Production			Sales		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value (thousands)	Gross weight	K_2O equivalent	Value (thousands)
1960	15,071	2,841	4,138	2,440	$82,645	4,092	2,412	$81,653
1961	15,653	2,934	4,281	2,523	96,380	3,882	2,281	87,415
1962	14,115	2,619	3,758	2,208	85,124	4,206	2,476	95,851
1963	16,414	3,083	r 4,504	r 2,643	r 101,458	r 4,213	r 2,484	r 94,925
1964	17,356	3,122	4,585	2,675	104,866	4,815	2,814	110,772

r Revised.

products decreased from 409,000 to 270,000 tons. The crude-ore grade (K_2O equivalent) averaged 18 percent, compared with 18.8 percent in 1963. Shipments to foreign countries accounted for 20 percent of total sales output.

Production commenced from two recently developed shaft mines, and output was scheduled to begin in late 1965 from another multimillion-dollar refinery and shaft mine in Eddy County. The six potash producers, five in Eddy County and one in Lea, continued important processing-plant expansions and mine developments.

Pumice.—Output of crude and processed pumice, scoria, and volcanic cinders decreased 19 percent in quantity and 11 percent in value. Decreased use of pumice as a constituent in lightweight concrete aggregate was the most important cause; however, other minor declines occurred in consumption of abrasives and concrete admixtures. Production and sales of pumice and volcanic cinders gained through use in cleaning and scouring compounds and for ballast. Crushed and sized materials also were sold for use as decorative stonework, filtering agent, insulating material, and soil additive, and in manufacturing matches and paints. Total output was from 10 mines and 8 plants operated by 11 companies in 7 counties.

Salt.—Salt was recovered mainly as a byproduct of refining potash salts in the vicinity of Carlsbad, Eddy County. It was also produced by solar evaporation of brine at Salt Lake, north of Quemado in Catron County. Principal markets for the product were feed dealers, State and county highway departments, stock raisers, and water-softener sales and service establishments. Salt brine was transported and used in exploration and development oil-well drilling. Total output came from eight operations, seven in Eddy County and one in Catron County. Carlsbad Salt Products, Inc. (Eddy County), ceased operations, and Curtis Salt Co. acquired the operation of the Rocky Mountain Salt Co. (Catron County). Total salt sold, excluding brine, was 66 percent to markets in the State, 24 percent to Arizona, 9 percent to Texas, and a small amount to Mexico.

Sand and Gravel.—Sand and gravel production from pits in 29 counties was 5 percent above that of 1963; output value declined 21 percent. Building and road construction throughout the State continued

TABLE 8.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Bernalillo	1,387	$1,662	Otero	258	$237
Catron	61	65	Quay	95	102
Chaves	654	715	Rio Arriba	111	137
Colfax	88	88	Roosevelt	128	193
Curry	44	55	Sandoval	365	464
De Baca	120	154	San Juan	352	400
Dona Ana	570	605	San Miguel	259	286
Eddy	14	13	Santa Fe	428	481
Grant	215	223	Sierra	113	114
Guadalupe	457	574	Socorro	513	794
Hidalgo	492	627	Taos	213	180
Lea	53	66	Torrance	271	272
Lincoln	71	90	Valencia	220	221
Los Alamos	105	121			
Luna	98	89	Total	8,781	10,160
McKinley	1,026	1,132			

at a high rate. Output was from 133 operations, 78 by commercial operators and 55 by Government crews and contractors. Production by Government crews and contractors represented 47 percent of the total; of that, 76 percent was for the State highway department, 6 percent for county governments, 17 percent for Federal agencies, and 1 percent for municipalities. Of the total production of 8.8 million tons, 6.1 million tons or 69 percent was used for highway construction and paving; 2.3 million tons or 26 percent, for building construction; and the remaining 388,000 tons or 5 percent, for engine sand, fill, railroad ballast, and miscellaneous uses.

Building sand and gravel was priced at $1.24 per ton, and paving sand and gravel, at $1.15 per ton. The average value of all sand and gravel produced was $1.16 per ton.

Leading producers, listed in order of output, were Brown Construction Co., Albuquerque Gravel Products Co., Springer Transfer Co., M. M. Sundt Construction Co., and Allison & Haney, Inc.

A U.S. Department of Commerce report [7] stated that of a total of

[7] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65–10, Feb. 11, 1965.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	971	$1,272	1,024	$1,223
Paving	179	233	210	269
Fill	43	23	47	48
Industrial: Engine	2	7	W	W
Total	1,195	1,535	1,281	1,540
Gravel:				
Construction:				
Building	782	1,064	973	1,298
Paving	2,052	2,498	2,256	3,069
Railroad ballast	W	W	6	4
Fill	106	50	130	68
Miscellaneous	38	47	14	21
Total	2,978	3,659	3,379	4,460
Total sand and gravel	4,173	5,194	4,660	6,000
Government-and-contractor operations:				
Sand:				
Building	3	4	20	19
Paving	100	58	21	12
Fill			101	87
Total	103	62	142	118
Gravel:				
Building	102	101	285	306
Paving	4,024	7,486	3,604	3,660
Fill			90	76
Total	4,126	7,587	3,979	4,042
Total sand and gravel	4,229	7,649	4,121	4,160
All operations:				
Sand	1,298	1,597	1,423	1,658
Gravel	7,104	11,246	7,358	8,502
Total	8,402	12,843	8,781	10,160

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

1,002.6 miles designated as a part of the Interstate Highways System in the State, 417.9 miles was open to traffic. Of this total, 311 miles was completed to full and acceptable standards and 106.9 miles was made adequate for present traffic. Work in progress on December 31 included 98.5 miles under construction and 274.2 miles in the engineering and right-of-way planning stage. Major projects on the Interstate System were sections on Interstate Highway 25 that transverses the State from north to south, on Interstate Highway 40 that crosses the State from east to west, and Interstate Highway 10 that extends across the southern half of the State.

Stone.—Production of stone was reported by 23 counties from 48 operations, an increase of 2 counties and 5 operations. Principal producing counties were Bernalillo, Guadalupe, Lea, and McKinley. Crushed and broken stone was used as concrete aggregate, precast concrete building material, and railroad ballast, and was widely used as highway material. Government-and-contractor users such as the

TABLE 10.—Stone production in 1964, by counties

County	Short tons	Value	County	Short tons	Value
Bernalillo	W	W	Rio Arriba	120	$4,000
Catron	1,151	$1,726	Roosevelt	W	W
Chaves	W	W	Sandoval	34,941	73,376
Curry	159,124	230,723	San Juan	847	1,271
Dona Ana	2,190	3,285	San Miguel	2,285	9,755
Eddy	139,295	212,857	Santa Fe	245	402
Grant	89,109	112,667	Sierra	5,004	7,506
Guadalupe	706,723	1,060,085	Socorro	5,136	7,704
Hidalgo	3,601	5,402	Taos	W	W
Lea	281,347	413,615	Valencia	W	W
Luna	15,336	27,297	Undistributed	1,240,649	1,966,874
McKinley	W	W			
Otero	72,981	105,481	Total	2,760,084	4,244,026

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

State highway department, county highway departments, and Federal agencies reported 1.5 million tons of all types of crushed and broken stone used in road construction and for building purposes. Crushed limestone was also used for manufacturing cement and lime and as a flux in refining copper. Dimension granite, marble, and sandstone were produced and used as building material and for decorative purposes.

Sulfur.—Output of elemental sulfur, recovered from sour gases at natural gas extraction plants, increased 22 percent. Total output of byproduct sulfur was extracted at plants in Eddy and Lea Counties. Most sales were to markets in the State and Texas. Sulfur was used as an additive in stock feed and in producing sulfuric and muriatic acids.

Vermiculite.—Vermiculite was purchased by Southwest Vermiculite Co. and exfoliated at its plant at Albuquerque. The processed material was used as a lightweight concrete aggregate and for miscellaneous uses.

TABLE 11.—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
1960	9,418	$21,750	1,869	$2,492	696,268	$927,717	-------	-------
1961	2,025	2,025	-------	-------	1,164,575	1,516,250	80	$11,029
1962	148,858	201,758	-------	-------	918,483	1,298,410	W	W
1963	6,716	8,211	996	25,997	1,264,243	2,017,667	W	W
1964	42,941	81,376	190	4,140	1,260,898	1,936,041	W	W

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1960	64	$1,105	569,001	$739,312	1,276,620	$1,692,376
1961	115,331	87,587	571,098	588,775	1,853,109	2,205,666
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	[1] 6,724	[1] 10,086	1,449,331	2,212,383	2,760,084	4,244,026

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

METALS

Copper.—The State ranked fourth in the Nation in copper output. Copper production increased 4 percent in quantity and 10 percent in value. A strong copper market accounted for the steady price increase from $0.306 per pound to $0.337. Copper was produced at 29 mines represented by 42 operations, including 17 leach operations, a gain of 6 operations over the total in 1963. About 99 percent of the output came from the Chino and Bayard (Continental) mines in Grant County and Bonney-Miser's Chest in Hidalgo County. Eleven counties reported production.

Copper ore yielded 68 percent of the copper output; leach-precipitate operations recovered 31 percent; the remaining 1 percent came from ore mined for gold, silver, lead, and zinc.

Major expansions and improvements continued at the Chino open-pit mine and other operations of Kennecott Copper Corp., Grant County, and the Bonney-Miser's Chest mine and mill, Banner Mining Co., Hidalgo County. United States Smelting, Refining and Mining Co. (USSR&M Co.) announced the discovery of a multimillion-ton copper-ore deposit adjoining its Continental mine near Bayard, Grant County, followed by a program of mine development during midyear. Diversified Mines, Inc., reopened the 85 mine of Phelps Dodge Corp., Hidalgo County. During midyear, a labor strike affected all operations of the Chino mine and plants.

Gold.—Gold was recovered from 18 lode mines and 1 placer mine in 7 counties. Eighty-six percent of the gold was recovered as a byproduct of copper ore mined at the Bayard (Continental), Bonney-Miser's

TABLE 12.—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)
1955–59 (average)	47	1	6,964	2,987	$104	254	$230
1960	33		7,804	5,423	190	304	275
1961	39	1	7,751	6,201	217	283	261
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
1848–1964	NA	NA	NA	2,257,124	52,334	73,423	58,324

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	60,692	$41,388	3,316	$969	19,327	$4,769	$47,460
1960	67,288	43,199	1,996	467	13,770	3,553	47,684
1961	79,606	47,764	2,332	480	22,900	5,267	53,989
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
1848–1964	2,591,664	1,111,432	339,056	47,669	1,297,020	248,678	1,518,437

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.

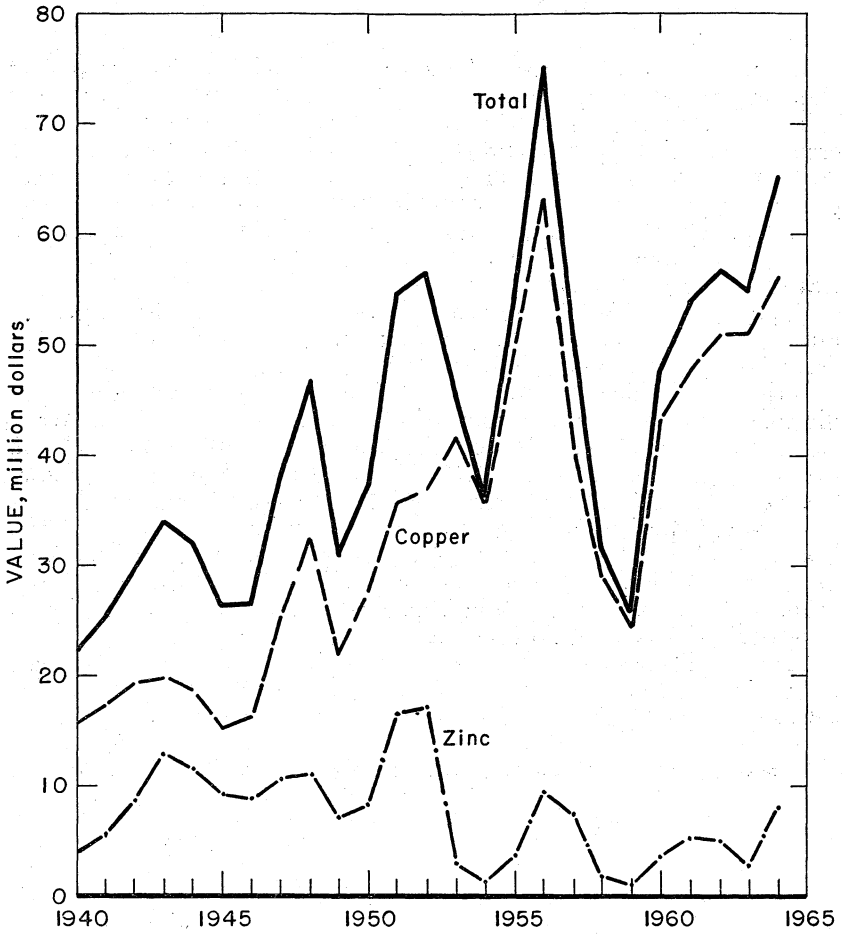


FIGURE 2.—Value of mine production of copper and zinc and total value of gold, silver, copper, lead, and zinc in New Mexico. The value of gold, silver, and lead produced annually has been relatively small.

Chest, and Chino mines; the Chino and Bonney-Miser's Chest mines were the leading producers.

Iron Ore.—Output of magnetite ore from open-pit mines in Grant and Socorro Counties increased. Except for a small quantity of direct-shipping ore, most of the ore was concentrated to about 60-percent iron before shipment. Approximately one-fourth of the ore was used to produce sponge iron; the remainder was used as an additive in manufacturing cement. Dotson Minerals Corp. of Socorro was the principal producer.

Lead.—Lead production, from ores mined at 16 mines in 6 counties, a gain of 6 mines and 1 county (Lincoln), increased 60 percent in quantity and 95 percent in value. Factors contributing to the increase of total output were the reopening of lead-zinc mines closed during most of 1963, reopening mines that had suspended operations for several years, and improvement of the lead market price from $0.1265 to $0.16 per pound.

TABLE 13.—Mine production of gold, silver, copper, lead, and zinc in 1964, by counties, in terms of recoverable metals

County	Mines producing		Lode material sold or treated [1] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
Catron, Dona Ana, and Eddy [2]	3	--	8,361	163	$5,705	11,105	$14,358
Grant	14	--	7,774,341	3,844	134,540	128,785	166,519
Hidalgo	3	--	81,516	1,992	69,720	68,480	88,545
Lincoln	1	--	150	1	35	750	970
Luna	2	--	21	--	--	110	142
Sandoval	2	--	1,010	--	--	6	8
San Miguel	1	--	2	--	--	4	5
Santa Fe	--	1	--	1	35	--	--
Sierra	6	--	658	25	875	2,746	3,551
Socorro	8	--	15,539	84	2,940	30,398	39,305
Taos	1	--	21	--	--	21	27
Total:							
1964	41	1	7,881,619	6,110	213,850	242,405	313,430
1963	25	--	7,443,289	7,805	273,175	256,475	328,062

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Catron, Dona Ana, and Eddy [2]	63	$40,979	(3)	$66	(3)	$81	$61,189
Grant	84,244	54,927,447	858	224,901	28,648	7,792,243	63,245,650
Hidalgo	1,763	1,149,183	22	5,698	1	123	1,313,269
Lincoln	--	--	1	144	(3)	95	1,244
Luna	1	619	--	--	--	--	761
Sandoval	3	1,923	--	--	--	--	1,931
San Miguel	(3)	98	--	--	--	--	103
Santa Fe	--	--	--	--	--	--	35
Sierra	2	1,336	9	2,332	5	1,387	9,481
Socorro	28	18,060	736	192,871	1,179	320,647	573,823
Taos	(3)	163	--	--	--	--	190
Total:							
1964	86,104	56,139,808	1,626	426,012	29,833	8,114,576	65,207,676
1963	83,037	51,150,792	1,014	219,024	12,938	2,975,740	54,946,793

[1] Does not include tonnage of precipitates shipped or gravel washed.
[2] Combined to avoid disclosing individual company confidential data.
[3] Less than ½ unit.

Of the total 1,626 tons of lead output, 53 percent was derived from six Grant County mines, and 45 percent from five mines in Socorro County; the remainder came from mines in Catron, Hidalgo, Lincoln, and Sierra Counties. The Linchburg mine of The New Jersey Zinc Co. and the Kearney mine of American Zinc, Lead and Smelting Co. (formerly American-Peru Mining Co.) were ranked first and second, respectively, in total lead output. The higher price increase resulted in examination of mines that had been idled in metal-mining areas. Of additional importance was the reactivation of the Ground Hog Unit mines of American Smelting and Refining Co. (Asarco), near Vanadium, Grant County, idle since July 1957.

Manganese Ore.—The Black Canyon mine, near Socorro, was the source of manganese ore in the State. The output of manganese by L. A. Goret & Valente Aguilar was crushed and sized ore and shipped to Henderson, Nev.

Ferruginous manganese ore, containing less than 35 percent manganese, was mined from open pits in Grant County and shipped to the steel plant of The Colorado Fuel and Iron Corp., Pueblo, Colo.

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TABLE 14.—Mine production of gold, silver, copper, lead, and zinc in 1964, by classes of ore or other source materials, in term 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	3	35	25	160	800	500	----
Dry gold-silver	3	15,478	540	26,899	304,800	44,000	1,300
Dry silver	11	527	4	3,362	4,500	1,900	1,100
Total	17	16,040	569	30,421	310,100	46,400	2,400
Copper	13	7,464,064	5,251	104,744	117,184,800	----	41,600
Lead	1	119	4	368	700	32,600	2,000
Lead-zinc	6	16,926	78	29,996	31,600	1,627,800	2,668,300
Zinc	4	384,318	203	74,961	489,900	1,515,800	56,924,600
Total	24	7,865,427	5,536	210,069	117,707,000	3,176,200	59,636,500
Other lode material:							
Copper precipitates	3	33,757	----	----	54,190,600	----	----
Lead-zinc	(2)	152	4	1,915	300	29,400	27,100
Total	3	33,909	4	1,915	54,190,900	29,400	27,100
Total "lode" material	42	7,915,376	6,109	242,405	172,208,000	3,252,000	59,666,000
Placer	1	----	1	----	----	----	----
Total all sources	43	7,915,376	6,110	242,405	172,208,000	3,252,000	59,666,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material
[2] From properties not classed as mines.

Molybdenum.—Molybdenum concentrate was recovered principally as a byproduct of the treatment of copper and some uranium ores, and from test and sample projects being conducted at a molybdenum property. Total output and value of molybdenum increased 35 percent and 50 percent, respectively. The operations of Chino Mines in Grant County accounted for most of the molybdenum recovered in the State.

Treatment of uranium-bearing lignite ash from North Dakota mines containing a significant quantity of molybdenum required re-

TABLE 15.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	5,533	210,079	117,360,500	3,144.700	59,634,400
Direct-smelting:					
Ore	572	30,411	485,900	77,900	4,500
Cleanup	4	1,915	300	29,400	27,100
Copper precipitates	----	----	54,190,600	----	----
Total	576	32,326	54,676,800	107,300	31,600
Leaching of copper ore	----	----	170,700	----	----
Placer	1	----	----	----	----
Grand total	6,110	242,405	172,208,000	3,252,000	59,666,000

moving the molybdenum to meet the U.S. Atomic Energy Commission (AEC) specifications for uranium oxide. Uranium ores from the Ambrosia Lake area contained very small quantities of molybdenum which was recovered in the milling process with molybdenum from the lignite ash. Molybdenum recovered from lignite ash was credited to North Dakota.

Multimillion-dollar contracts at the Questa mine of Molybdenum Corporation of America (Molycorp), Taos County, were awarded for preparation work at the large open-pit molybdenum mine and concentrator. Mill production was scheduled for yearend 1965.

Silver.—Silver was produced at 32 mines compared with 19 in 1963, but output declined 5 percent largely because of a drop in the silver recovered at mines in Grant and Hidalgo Counties. Important silver-producing mines in descending order of production were the Kearney, Grant County; Bonney-Miser's Chest, Hidalgo County; Chino, Grant County; and Linchburg, Socorro County; these produced 73 percent of the silver in the State. The price of silver stabilized at $1.293 per ounce.

Uranium Ore.—New Mexico, for the sixth consecutive year, led the Nation in total output of uranium ore and concentrate. The 2.1 million tons of ore mined represented a decrease of 9 percent in quantity. Output in 1964 was 60 percent of the quantity and the value of the alltime high recorded in 1962. Lower output was the direct result of the AEC stretchout program, announced in November 1962; since then adjustments in output at mines have been made to meet the reduction in the AEC procurement program for uranium oxide.

Production of uranium ore was from 55 operations, 13 less than in 1963. Major production continued to be from McKinley County (41 operations), followed by Valencia (6 operations) and San Juan Counties (6 operations). Other producing counties were Grant and Santa Fe. Uranium ore processed averaged 0.22 percent, similar to the weighted grade of 1963.

Five processing mills operated throughout the year, one of which had signed a stretchout agreement with AEC for delivery of uranium concentrate through December 31, 1970. A revised contract with Kermac Nuclear Fuels Corp. (Grants) was approved on August 28. Purchase contracts with Homestake-Sapin Partners (Grants), United Nuclear Corp. (Grants), and Vanadium Corporation of America (VCA) (Shiprock) were being negotiated at yearend.

Vanadium.—Vanadium was recovered from some uranium ores mined and processed in the State. The Shiprock plant of VCA was operated during the year.

Zinc.—Zinc output ranked third in value of metals produced in the State. Output from 20 mines in 7 counties—a gain of 11 mines and 3 counties—increased 131 percent in quantity and 173 percent in value. The five leading zinc-producing mines in rank of output were the Kearney, Hanover, Oswaldo, Princess, and Linchburg; these produced 99 percent of the total output of the State. Except for the Linchburg mine in Socorro County, all were in Grant County. The important increases in zinc output and value were caused principally by continual operations at the Hanover and Oswaldo mines, reactivations of the Princess and Linchburg mines, and a price increase for zinc from $0.130 per pound to $0.145 per pound during the year.

REVIEW BY COUNTIES

Bernalillo.—Cement output and clay and limestone for manufacturing cement provided most of the income from mining and mineral processing in the county. The Tijeras plant of Ideal Cement Co. was operated most of the year, except during maintenance work. Clay mined at the Kinney mine, Kinney Brick Co., Inc., was used for manufacturing building brick. Output of the Tijeras mine of Ideal Cement Co. was used for manufacturing cement. Scoria (pumice) for manufacturing building block and associated products was mined by Edgar D. Otto & Son, Inc., from the Blackbird mines, near Isleta. Jack Hamilton produced some crushed limestone for use as concrete aggregate and road material.

TABLE 16.—Value of mineral production in New Mexico, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Bernalillo	$10,219,570	$8,765,430	Cement, sand and gravel, stone, clays, pumice.
Catron	97,648	94,622	Sand and gravel, silver, salt, gold, stone, copper, lead, zinc.
Chaves	r 16,084,146	20,773,059	Petroleum, sand and gravel, stone, natural gas.
Colfax	1,932,066	3,743,559	Coal, sand and gravel.
Curry	W	285,723	Stone, sand and gravel.
De Baca	W	154,000	Sand and gravel.
Dona Ana	543,328	748,769	Sand and gravel, pumice, copper, clays, stone, fluorspar, silver, zinc.
Eddy	r 149,965,512	152,625,604	Potassium salts, petroleum, natural gas, natural gasoline, LP gases, salt, stone, sand and gravel, copper, silver.
Grant	55,760,360	65,328,281	Copper, zinc, molybdenum, lime, manganiferous ore, lead, sand and gravel, silver, gold, stone, clays, uranium ore, iron ore.
Guadalupe	399,000	1,634,085	Stone, sand and gravel.
Harding	169,356	60,602	Carbon dioxide (natural).
Hidalgo	1,533,400	W	Copper, sand and gravel, silver, gold, lead, stone, clays, zinc.
Lea	r 296,090,560	308,843,779	Petroleum, natural gas, natural gasoline, LP gases, potassium salts, stone, sand and gravel.
Lincoln	29,122	W	Sand and gravel, pumice, silver, lead, zinc, gold.
Los Alamos	143,000	121,000	Sand and gravel.
Luna	180,141	W	Sand and gravel, clays, stone, copper, silver.
McKinley	37,358,297	34,004,601	Uranium ore, coal, sand and gravel, petroleum, stone, molybdenum, vanadium.
Mora	70,000	----------	
Otero	558,769	342,481	Sand and gravel, stone.
Quay	627,500	102,000	Sand and gravel.
Rio Arriba	r 12,993,304	13,843,482	Natural gas, petroleum, LP gases, natural gasoline, sand and gravel, pumice, mica (scrap), coal, stone.
Roosevelt	r 10,884,548	7,993,056	Petroleum, natural gas, LP gases, sand and gravel, natural gasoline, stone.
Sandoval	1,461,329	1,027,809	Sand and gravel, gypsum, stone, petroleum, pumice, coal, copper, silver.
San Juan	r 76,745,108	86,374,602	Natural gas, petroleum, LP gases, coal, natural gasoline, helium, sand and gravel, vanadium, uranium ore, stone.
San Miguel	W	295,858	Sand and gravel, stone, copper, silver.
Santa Fe	1,545,534	1,052,520	Sand and gravel, pumice, gypsum, uranium ore, stone, mica (scrap), gold.
Sierra	412,037	130,987	Sand and gravel, stone, silver, lead, zinc, copper, gold.
Socorro	1,004,232	W	Sand and gravel, zinc, lead, manganese ore, iron ore, silver, copper, stone, barite, gold.
Taos	1,916,857	2,444,765	Perlite, sand and gravel, mica (scrap), stone, molybdenum, copper, silver.
Torrance	----------	272,000	Sand and gravel.
Union	W	W	Pumice.
Valencia	W	W	Uranium ore, perlite, sand and gravel, stone.
Undistributed [1]	r 9,881,151	9,061,330	
Total	r 688,606,000	720,124,000	

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.

Sand and gravel production was reported from 14 operations that handled 1.4 million tons of aggregate; Albuquerque Gravel Products Co. and Springer Transfer Co. were the principal producers. Contractors produced for the State highway department.

American Gypsum Co. continued expanding plant facilities and operated 7 days a week to reach monthly objectives of about 10 million linear feet of 4-foot-wide wallboard. Gypsum for plant use was trucked from near San Ysidro, Sandoval County. American Gypsum Co. merged with Freesdale Laboratories, Inc.; its subsidiaries were operated as a division of American Gypsum Co.

Catron.—Sand and gravel from three operations, approximately two-thirds of the total county value reported, decreased slightly. Production of gold, silver, and associated metals from the Bearup mine, Thomas Consolidated Mines, Inc., near Glenwood, increased. Salt from the solar-evaporation facilities at Salt Lake, northwest of Quemado, was shipped by Curtis Salt Co., which took over operations from Rocky Mountain Salt Co. early in 1964. Sales were to New Mexico and Arizona.

Chaves.—Petroleum and natural gas represented 95 percent of the value of county production. Although exploratory drilling declined, total drilling increased from 208,400 feet in 1963 to 325,800 feet in 1964. Average depth of wells drilled in 1964 (excepting five service wells) was 3,291 feet. Shell Oil Co. continued assembling a large unitized area in eastern Chaves and western Lea Counties. The unitized area was to be developed for eventual secondary-recovery operations.

For each barrel of oil produced, 2.56 barrels of water was also produced.

Total sand and gravel produced at eight operations exceeded that of 1963 by 39 percent. Crushed limestone and miscellaneous stone from two operations were used at highway projects. Contractors working for the State highway commission were the principal producers.

Colfax.—Coal production value, more than double that of 1963, represented 98 percent of the total of all mineral output; the remainder was sand and gravel produced by a Government-and-contractor operator. No stone was produced.

Coal was mined by Kaiser Steel Corp. at the underground Koehler mine on the Raton seam near Raton. The entire production, mined by continuous mining machines, was mechanically cleaned and washed at the Koehler preparation plant; 95 percent of the output was shipped to California for manufacturing coke at the Kaiser Fontana steel plant. Julius Seidel operated the Franks No. 1 mine on the Yankee seam, and Talbott Coal Co. furnished coal from the Talbott mine; coal was trucked to markets from each of the underground mines.

Kaiser Steel Corp., following experimental testing in 1963, began a multimillion-dollar expansion at its York Canyon mine about 35 miles west of Raton. The program was to further develop the mine, erect a modern coal-preparation plant and other associated facilities, and to plan a railway spur. Output will be a high-grade metallurgical-quality coking coal, from the Raton area.

Dona Ana.—All commodities, except stone, had increased production. Sand and gravel output, from 11 operations, accounted for 81 percent of the total value. Contractors for the U.S. Army Corps of Engineers handled the largest quantity. Nu-Tex Brick Co. acquired the hold-

ings of El Paso Brick Co. during midsummer, and continued to produce clay from the Brickland pit for manufacturing building bricks. Associated Materials Co., Builders Block & Supply Co., Inc., and Volcanic Cinder Co. supplied volcanic cinders for use in concrete-aggregate building materials. Silver, copper, and zinc metals recovered from a small quantity of concentrate contributed to the total mineral value of the county. Fluorspar was mined and shipped from the Ruby mine, W & J Mines, for use in steel manufacturing.

Eddy.—The county was ranked first in the State in the value of potassium salts produced, second in the value of petroleum produced, and second in the total value of mineral output with a $2.7 million increase over that in 1963. Of the total mineral production, potassium salts accounted for over 50 percent of the value. Natural gas, natural gasoline, potassium salts, and crude salt increased significantly in production; the overall gain, however, was partly offset by the decreased output of natural gas liquid products, petroleum, sand and gravel, and stone.

Duval Corp. completed an extensive mine development program at its Nash Draw potash mine, 13 miles south of its Saunders mine and refinery, and began shipping langbeinite ore to the Saunders plant in September. The mine was developed by circular shafts Nos. 5 and 6 sunk to a depth of 900 feet. Two ore beds at the 900- and 1,075-foot levels were connected by a slope. Sylvite occurred at the 900-foot level, and langbeinite was found at the 1,075-foot level. The crude potash ore was shipped over a spur railway to the Saunders plant.

At the Saunders plant and refinery, a new refinery was completed where sulfate of potash magnesia and sulfate of potash were recovered. The original refinery at Saunders continued to recover other potash salts, which were marketed by the company.

Oil, natural gas, and natural gas products represented 33 percent of value of all mineral output in Eddy County. Exploratory drilling declined by 12 wells, to 65, whereas development drilling increased by 82 wells, to 220. Average depth of wells drilled was 4,586 feet, 639 feet deeper than the average for 1963. The increase in average depth drilled reflected the drilling to the Pennsylvanian zones.

Southern Union Gas Co. invested $1 million in gathering lines, processing plant, and lines to existing transmission lines to handle gas from the Indian Hills field west of Carlsbad. The gas was to be marketed in the Artesia-Carlsbad-Hobbs-Roswell area.

Marathon Oil Co. was considering a 100-million-cubic-feet-per-day gas-processing plant for the Indian Hills gasfield. National Gas Pipeline Co. of America announced plans to build a pipeline from the Indian Hills gasfield to existing lines near Borger, Tex., costing about $27.5 million.

IMC increased potash production and quality-product control through the installation of an air-separation process placed on stream late in 1963. Other expansions included improvement in mine communication and a program to study efficiency, costs, and methods of processing lower grade ores.

National Potash Co. completed sinking two 700-foot circular shafts; a 12-foot-diameter service shaft, and a 15-foot-diameter production shaft, at the Eddy mine 15 miles east of Carlsbad during midsummer. Production of crude ore beginning in September was shipped by railroad to the Lea mine and refinery in Lea County for processing.

Potash Company of America (PCA) continued major improvements in metallurgy and quality of potassium-salt products. The company continued to improve its low-bed continuous miners and started a mining method for pillar extraction. PCA agreed to sell all company properties to Standard Oil Co. (New Jersey) in the fall; the transaction was being contested by the Federal Government as monopolistic.

In June, Southwest Potash Corp. announced a $2 million project to expand output of mine and refinery by 17 percent and to enlarge capacity to produce granular size muriate for shipment.

United States Borax & Chemical Corp. continued improvements at its mine and refinery. The company established a new mining method for removing support pillars in worked-out areas. Many of the designated pillars of ore were recovered by entering the pillar boundary near the top and mining the pillar internally.

Kermac Potash Co. continued mine development and refinery construction at the company's new mine and 1,500-ton-per-day processing plant. All of the multimillion-dollar projects were progressing to anticipated completion by yearend 1965.

Crude salt tailings from potash refineries was sold to suppliers for processing and marketing. Salt sold by seven operators increased in quantity and value. New Mexico Salt Co. and The Salt Supply Co., Inc., were the principal handlers of crude salt; The Great Salt Lick, Inc., was the major producer of finished products. Fifty-five percent of the output was sold to feed dealers and mixers.

Sand and gravel output decreased from five operations producing 167,000 tons in 1963 to two commercial operators with a total output of the State metal value and 84 percent of the total value of mineral declined slightly in quantity and value.

The Rose Pearl Mining Co. did some exploration.

Grant.—Copper production in Grant County represented 52 percent of the State metal value and 84 percent of the total value of mineral output in the county. Zinc production more than doubled. Declining in production were gold, iron ore, lead, lime, sand and gravel, and silver.

Most of the molybdenum in the State, and part of the gold and silver output in the county were byproducts from copper ore produced from the Chino open-pit mine at Santa Rita, operated by Chino Mines. The company stated in its annual report that 7,026,000 tons of ore was mined, compared with 6,648,000 tons in 1963, and that the average grade of ore milled was 19.6 pounds of copper per ton, compared with 17.6 pounds per ton in 1963. Also, copper produced at Chino from all sources, including that recovered from the ore milled and dump-material leached, was 81,372 tons, compared with 80,629 tons in 1963. Work continued on improvements to expand copper production capacity by an anticipated 24 percent, by 1967. The $6 million program was to include mining equipment, additional cone-type precipitators, a major water-development project, and smelter facilities. During 1964, the company added six new large-capacity diesel-electric dump trucks and mine-shop facilities, costing $1 million. The first full year following conversion from rail to truck haulage at the Chino pit was completed with successful handling of ore and waste material totaling 64,000 tons per day. Computer procedure for design of pit layouts was used for pit design on ore evaluations. Early in the year,

operation at the mine and smelter returned to a 7-day week, following a 6-day week for 18 months. A labor strike, lasting from July 9 to August 14, directly affected all operations of the company, and caused some decrease in gold and silver output and prevented potential copper production.

The Hanover and Oswaldo mines, operated by The New Jersey Zinc Co., were ranked, respectively, the second and third principal zinc producers in the county. The mines were operated throughout the year following a shutdown period for most of 1963. The Hanover mill of the company, at Hanover, was operated on ore supplied by the El Tigre (Socorro County), Hanover, Oswaldo, and Royal John mines, and by the Linchburg mine, in Socorro County, owned by the company and leased to L. A. Patten and Associates.

American Zinc, Lead and Smelting Co. purchased the remaining holdings in mining and milling properties in the Silver City area from Peru Mining Co. The Kearney mine, operated by the company throughout the year, was the principal producing zinc mine in the State. Exploration projects were continued at the mine.

Bayard (Continental) mine, owned by USSR&M Co. and operated by lessee L. A. Patten and Associates, continued as the second largest producer of copper in the county and the third largest in the State. In mid-May the company started production of zinc ore at the Princess mine, operated by contractor Frank Van Cleave, following a rehabilitation period; all ore was trucked to the company concentrator at Vanadium for milling. Other lessees of the company were Louis L. Osmer (Continental) and T & E Mining Co. (Zuniga).

On May 20, USSR&M Co. announced the discovery of a multimillion-ton copper-ore deposit, containing about 2.15 percent copper, adjoining its Continental mine near Bayard. Shaft sinking was begun during the 3d quarter of 1964 at the Continental No. 2 (3-compartment service) and No. 3 (5-compartment production) shafts. Limited production of copper ore was scheduled to begin from the 1,500-foot production shaft by yearend 1965.

An important development was the reactivation of the Star shaft mine of the Ground Hog Unit of Asarco near Vanadium, which had been idle since July 1957. Rehabilitation of the mine was begun during November, with lead-zinc production to follow early in 1965.

Copper Leaching Co., Silver City, prepared a heap-leaching operation at the Morgan and Ohio claim group near Tyrone, starting in February; copper precipitate was produced commencing in June. Harris Production Corp. produced copper precipitate from the leaseheld Copper Mountain-Liberty Bell claim group near Tyrone. United States Lime and Mining Corp. acquired the operation of Harris Production Corp. during midyear, and continued to develop the open-pit mine and expand heap-leach facilities. Eleven operators recovered copper from leach operations of the copper-bearing water of Santa Rita Creek. The Royal John mine of G.F. & G. Mining Co. was the largest producer of any of the six mines that produced gold, silver, copper, lead or zinc bearing ores.

Manganiferous ore was shipped from the Boston Hill area to steel plants. A small shipment of magnetite ore was produced from the John Brown open-pit mine by United States Lime & Mining Corp.

A decrease in value of nonmetal production of about $500,000 was caused mostly by the decline in sand and gravel used in highway con-

struction. Produced principally by contractors for the State highway commission, crushed and broken stone output gained.

Financed by the Area Redevelopment Administration, Reese Mining and Manufacturing Co. erected a brick-manufacturing plant near Silver City and began producing brick on September 30. Clay for brick processing was mined at the company open-pit Sky Crest mine.

Lightweight-aggregate concrete block for building and decorative purposes was produced by Elgin Block Co., Silver City.

The Floyd Collins mine of A. A. Leach yielded some uranium ore, the first such production in the history of the county.

Guadalupe.—The value of sand and gravel produced by four operators increased slightly and accounted for about one-third of the total value of mineral output in the county. Crushed limestone and miscellaneous stone produced by three contractors for the State highway department accounted for the other two-thirds of the total value. The principal producer was Allison & Haney, Inc.

Harding.—Principal carbon dioxide producers in descending order of rank of production were Carbonic Chemicals Corp., Schwartz Carbonic Co., and R. W. Adams. New applications included the use of carbon dioxide as a liquid refrigerant, a coolant for liquid oxygen and other gases and equipment used in experimental work, in missile firing, and in research, for processing food materials, and fog seeding to clear airfield runways.

Hidalgo.—Copper output, mostly from the Bonney-Miser's Chest mines of Banner Mining Co.—the State's second largest copper producer—supplied 59 percent of the total mineral value. According to the Banner Mining Co. annual report, the mines were operated the entire year, producing 66,400 tons of ore—a decrease of 12,600 tons compared with that of 1963. Metal content of the 6,308 tons of concentrate produced from the ore milled was 1,615 ounces of gold, 51,975 ounces of silver, and 3,319,648 pounds of copper. Development was continued at a near-normal rate; the 36-inch-diameter drill hole was nearing completion to a depth of 1,500 feet, to provide fresh air to the northern part of the mine. A large exhaust fan was to be installed near the hole at the surface.

The Henry Clay mine, owned by Werner Lake Nickel Mines, Ltd., and operated under Henry Clay Mines, Inc., produced high-silica copper-lead-bearing gold-silver ore which was shipped to the Asarco smelter at El Paso, Tex. Operations were discontinued in May 1964; the property was leased to Diversified Mines, Inc., which was scheduled to start mining operations in 1965.

Diversified Mines, Inc., leased the 85 mine of Phelps Dodge Corp., near Lordsburg, and, following a $250,000 rehabilitation project started in May, mined copper-bearing gold-silver ore shipped for fluxing ore to the El Paso smelter. The company planned to ship 4,000 tons monthly during 1965. The company completed rehabilitating the shaft at the Venus mine in April.

Fire clay from the Pratt mine was produced by Phelps Dodge Corp. for use at the company smelters and for resale.

Sand and gravel output by four operators sold for $627,000, as compared with $80,000 during 1963. Most of the material was produced for the State highway commission.

Lea.—The county continued to lead the State in mineral-value output. Crude oil, natural gas, and gas products represented 99 percent

of the Lea County mineral-production value. Wells in Lea County produced 70 percent of the oil in the State. Value of crude, gas, and gas products in 1964 was 4 percent above that of 1963.

Wildcat drilling in the county declined 32 percent, whereas development drilling increased by 37 percent. The 587 wells drilled in the county amounted to 39 percent of the wells drilled in the State. Average depth of wells drilled was 6,759 feet, 448 feet less than the 1963 average.

New drilling and producing depth records were set in 1964 at the Pure Oil Co. well No. 1 Red Hills Unit, in sec. 32, T 25 S, R 33 E, in southwest Lea County. Initial daily flow was 10.4 million cubic feet of gas from the Devonian interval of 17,476 to 17,684 feet. Oil and gas were found in Pennsylvanian zones above the Devonian.

A mid-December survey of drilling activity [8] showed Lea County in third place in the Nation.

Shell Oil Co. purchased from Gulf Refining Co. 232 miles of gathering line and 57 miles of trunk line in Lea County, and Winkler County, Tex. Magnolia Pipe Line Co. announced plans to build a 38-mile pipeline in Lea and Chaves Counties to serve the Tobac and Flying M fields.

On September 1, Phillips Petroleum Co., operator of the 2,400-acre Ranger Lake unit, approved drilling of one of the deepest wells in New Mexico. Over 3 million barrels of oil was expected to be recovered in 10 years from the Pennsylvanian formation at 10,300 feet. At full development the project was to include 13 producing and 8 injection wells.

Of the nonmetals produced, potassium salts increased slightly, stone and sand and gravel declined.

National Potash Co. mined and processed potash ore at its Lea mine and refinery, and installed additional compacting facilities. Production from the company new Eddy shaft mine, in Eddy County, was shipped by railroad to the Lea refinery for blending with Lea mine ore before processing.

All sand and gravel was produced and sold by one commercial operator; miscellaneous crushed stone was produced by two commercial producers and crews of the county highway department.

Lincoln.—Output value of pumice gained 35 percent; sand and gravel, 500 percent. Metal mining was resumed with small quantities of silver, gold, lead, and zinc recovered from the Bird mine by Silver Bar Mining Co.

Luna.—Fire clay produced by Mathis & Mathis from the Lucretia mine was used at smelters. International Brick Co., Inc., consolidated with Rio Brick Co., produced clay from the Springtime mine for manufacturing brick at the company plant near El Paso, Tex. Four commercial operators supplied all the sand and gravel; stone was produced by three operators. Copper ore was mined at the Canon Nos. 1 and 2 mine by J. Ramsey & E. Bluth and at the Garlon Nos. 1, 2, and 3 mine by E. C. Gardner.

McKinley.—The county again led in uranium-ore production in the State. The value of mineral output decreased principally because of lower production of uranium ore and sand and gravel. Molybdenum was recovered for the first time in the county.

[8] Oil and Gas Journal. V. 62, No. 52, Dec. 28, 1964, p. 95.

Approximately 1.7 million tons of uranium ore was produced from 41 operations, compared with 1.8 million tons from 52 operations during 1963. Value of uranium ore output ($30.7 million) was 80 percent of the State total, a decrease of 7 percent for the county. Principal producing companies included Homestake-Sapin Partners, Kermac Nuclear Fuels Corp., and United Nuclear Corp. Kermac Nuclear Fuels Corp. uranium mill operated throughout the year, and the mill of United Nuclear Corp. continued to remain on standby. A stretchout purchase agreement between AEC and Kermac Nuclear Fuels Corp. for deliveries of uranium concentrate through December 31, 1970, was signed in August. United Nuclear Corp. placed its Sandstone mine on standby in July. Homestake-Sapin Partners purchased the Entrada mine in the Grants area from Stella Dysart.

Some uranium-bearing sandstone contained significant amounts of vanadium which was recovered at mills with vanaduim recovery units. Other uranium ores containing lesser quantities of vanadium were processed at mills without vanadium recovery units. Vanadium in these ores was concentrated in vanaduim-rich solutions and was recovered at mills with the necessary facilities.

Uranium-bearing lignite ash from deposits in North and South Dakota processed at the Kermac Nuclear Fuels Corp. mill contained molybdenum in sufficient quantities to contaminate the recovered uranium oxide. Some uranium ores from New Mexico also contained molybdenum in very small quantities. A molybdenum recovery circuit was installed at the Kermac Nuclear Fuels Corp. uranium mill primarily for the removal of molybdenum in the lignite ash but also for the recovery of the molybdenum in the sandstone ores. Quantities recovered were credited to the State of origin.

Coal production, from three operations, increased in quantity and decreased slightly in value. The Navajo Tribal Enterprises, operating the Window Rock underground mine, mined and supplied open markets from the 144-inch Mesa Verde seam; The Pittsburgh & Midway Coal Mining Co., at the McKinley strip mine, crushed all of the output from the 66-inch Blue bed and supplied Arizona Public Service Co. at Joseph City, Ariz.; and Sundance Coal Co., operating the Sundance strip mine, crushed most of the coal from the 72-inch Black Diamond seam and sold it in open markets.

Sand and gravel, output value declining from $2.4 million to $1.1 million, was produced at nine operations. The principal producer was M. M. Sundt Construction Co. Crushed limestone was produced by W. A. Hamilton, Jr., Construction Co., for road material.

Quantity and value of petroleum produced in McKinley County declined for the second straight year. Average depth of eight wells drilled, seven of which were dry holes, was 762 feet. An average of 3 barrels of water was produced with each barrel of oil.

Rio Arriba.—The county was ranked fifth in the State in value of oil, natural gas, and gas products. Petroleum and associated products amounted to 97 percent of the county mineral production values. Value of oil produced increased $198,000; natural gas and gas products increased $1 million.

The number of wells drilled dropped from 183 to 118. Footage drilled in 1964 was 397,500 less than in 1963; average depth per well dropped by 501 feet to 4,705 feet. Six exploratory wells netted one gas discovery.

Coal production by Carrillo Bros. from the Rainbow mine, and by Stanley Idzior from the Caranta No. 3 mine increased significantly; that from the Caranta mine was the first reported output in several years. Coal output from the underground mines supplied open markets.

Scrap mica continued to be mined by M.I.C.A., Inc., from the Joseph mine near Ojo Caliente and by John W. Moran from the Blowout 1, 3, and 4 mines near Petaca. In addition to that mined by M.I.C.A., Inc., scrap mica was purchased and processed at its Pojoaque grinding mill (Santa Fe County) to produce finely ground mica for markets. Pumice mined by General Pumice Corp. at its Cullum mine was used as a concrete aggregate for building material. Sand and gravel was produced by one commercial operator and by crews of the Federal Bureau of Indian Affairs and a contractor for the U.S. Forest Service. Total output was 111,000 tons. New Mexico Granite produced dimension stone for building construction.

The San Juan-Chama Project, near Chama—referred to as the Azotea Tunnel—was to be advanced by a 76-ton drilling "mole." The 45-foot-long machine designed to drill a 13-foot 3-inch-diameter hole for a distance of 12.7 miles from opposite sides of the Continental Divide was scheduled to start January 1965.

Roosevelt.—The county was ranked sixth in value of oil and associated products.

Although development drilling increased from 45 to 60 wells in 1964, the number of completed oil wells exactly equaled the number for 1963 (43). Exploratory drilling dropped from 15 wells in 1963 to 9 wells in 1964. Average well depth dropped to 4,964 feet, or 519 feet per well.

The mineral value of stone production increased; that of sand and gravel decreased. Crushed stone was produced and used for highway construction. Sand and gravel used for building was produced by Sam Sanders, Inc.

Sandoval.—The 30-percent decrease in mineral value was primarily due to a decline in the output of sand and gravel. Three contractors of the State highway commission and two commercial operators produced 365,000 tons of paving gravel for use on road projects. Allison & Haney, Inc., produced crushed basalt for the Federal Bureau of Public Roads.

Crude gypsum was mined from the San Ysidro mine by White Mesa Gypsum Co. The gypsum was trucked to the American Gypsum Co. wallboard plant at Albuquerque (Bernalillo County). Gypsum was produced for Ideal Cement Co. by Duke City Gravel Products Co. From the Big Chief mine near Jemez, Big Chief Mining Co. produced pumice used for concrete aggregate and soil additive.

Copper ore from the Cuprite-Copper Glance mine was produced by Cuba Mining Co. Silver ore was mined and shipped by Long Green Mining Co. from its Long Green mine. Bituminous coal at the Padilla underground mine of Padilla's Coal Mine was mined from the 108-inch Mesa Verde seam for shipment by trucks to open markets.

San Juan.—The county was ranked third in the State in value of mineral and petroluem production. Oil and gas production values increased 10 percent to $78 million. Increased oil production came from waterflood projects and new wells in the western part of the

county. Major drilling effort was the completion of 197 gas wells, mostly in the Basin Dakota area. New gas wells, drilled to meet future market demand, did not add materially to existing gas reserves. Overall drilling increased from 235 to 288 wells; average well depth increased from 4,356 to 5,528 feet.

Shell Oil Co. purchased the El Paso Natural Gas Products Co. refining and marketing properties for $37 million; in this transaction the only refinery involved in New Mexico was the Ciniza plant east of Gallup. The Federal Government ordered El Paso Natural Gas Co. to sell its interests in The Pacific Northwest Pipe Line Co.

The Federal Bureau of Mines extracted helium from natural gas at its Shiprock helium plant.

Utah Construction & Mining Co. continued to operate the Navajo strip mine which was ranked as the eighth largest coal producer in the U.S. Large 120-ton-capacity tractor-trailer units were replacing smaller truck units as part of an improvement program. The coal was used at the Arizona Public Service Co. Four Corners thermoelectric powerplant. The power company installed a third 225-megawatt unit—expanding the generating capacity to 575 megawatts. Because of the increase in consumption for power generation, output of coal was to reach an annual rate of 2.6 million tons. George R. Simpson & Hollis L. Tate continued to mine coal for local distribution from the 66-inch seam of the Hogback No. 13 underground mine.

Value of uranium ore from six operations was $66,921, 34 percent less than in 1963. The AEC stretchout program for uranium oxide procurement resulted in a decline in output at uranium mines. VCA operated its Navajo plant at Shiprock.

Vanadium occurring in significant quantities in uranium-bearing sandstone was treated at mills with vanadium recovery units. Vanadium also was recovered from vanadium-rich solutions from other uranium processing mills.

Production of sand and gravel increased from 275,000 tons to 352,000 tons, gaining 11 percent in value. Production was by four commercial operators and two Government contractors. The State highway commission was the principal consumer. Fenix & Scisson produced crushed limestone for road projects of the Federal Bureau of Reclamation.

Continental Oil Co. completed its Rattlesnake field well No. 155 near Shiprock for an initial flow of 18 barrels of oil and 1,040 barrels of water a day from the Dakota formation; the field was discovered 40 years ago.

San Miguel.—Significant increases in output of sand and gravel and stone accounted for a fivefold gain in total mineral value. Five sand and gravel operations—three commercial and two Government-and-contractor—produced 259,000 tons. The State highway commission was the principal consumer. New Mexico Mavalo Stone Co. and Ortiz Bros. Stone produced dressed stone and flagging, respectively. A small quantity of silver- and copper-bearing ore was produced at the Mary Alice and Star Dust mines.

Santa Fe.—A 49-percent decrease in value of sand and gravel was a major cause of the 32-percent decline in value of mineral output.

Four commercial operators producing sand and gravel from five operations supplied 160,000 tons; two Government-and-contractor

operators produced 268,000 tons at three pits for AEC at Los Alamos and the State highway commission. Gypsum produced by Kaiser Gypsum Co., Inc., from the company open-pit mine was used in manufacturing wallboard at its Rosario plant.

Pumice and scoria production was 281,715 tons. Copar Pumice Co., Inc., the major producer, mined pumice from an open pit west of Espanola, and crushed and screened the output into marketable products at its processing plant near Pojoaque. At its La Cienega mine, Crego Block Co., Inc., mined scoria for manufacturing building blocks. At Santa Fe, James H. Rhodes & Co. operated its grinding plant, processing pumice from the Cullum mine worked by General Pumice Corp. (Rio Arriba County).

In Rio Arriba and Santa Fe Counties, M.I.C.A., Inc., mined crude mica and purchased the output of other mines for processing at its Pojoaque mica-grinding mill. The product was used in paints and building materials. J. W. Jones Construction Co. and O. D. Cowart Construction Co. produced crushed and broken granite for riprap and crushed limestone for road materials for the State highway commission.

Uranium ore production from one operation declined. The Valirie Ann placer mine yielded a small quantity of gold from washing gravels in the San Pedro area. Earlcrest Resources, Ltd., Vancouver, British Columbia, Canada, planned an exploration drilling program at the San Pedro and Carnahan mines.

Sierra.—Value of sand and gravel produced decreased from $405,000 to $114,000, partly accounting for a 68-percent reduction in total mineral value. Six mines in the Hillsboro, Kingston, and Winston areas produced 658 tons of ore. Increased prices for copper, lead, and zinc stimulated activities in areas with idle mines.

Socorro.—Eight mines yielded either gold, silver, copper, lead, or zinc, or a combination of these metals, valued at $574,000 compared with two mines producing $6,800 in 1963. L. A. Patten and Associates, operating the Linchburg mine under lease from The New Jersey Zinc Co., was the leading producer. The ore was shipped to The New Jersey Zinc Co. Hanover mill for concentration. Other producing mines included the Bingham Prospect mine operated by Riebold & Barr, lessee of United States Lime & Mining Corp.; the El Tigre by George L. Harrison; the Nitt by William R. Dobson; the Queen group by Mrs. Sadie Papa; the Waldo by Robert Chamberlin; and two mines operated individually, one by United States Lime & Mining Corp. and one by Michelle Mining. Improvements at the Copper Empire mine by Indiana Copper Co. included expansion of facilities for copper leaching. The stable market price of copper, lead, and zinc generated interest in idle mines, many of which were examined preparatory to possible reopening.

Following rehabilitation of the Black Canyon mine in 1963, production of manganese ore by L. A. Goret & Valente Aquilar (Socorro) began in January. The ore was crushed, screened, and graded for shipment at the partnership plant near Socorro.

Magnetite ore was mined at the Jones Camp open-pit mine by Dotson Minerals Corps.

A. B. Baca Mining and Milling continued to produce barite at the Elaine mine. The barite was finely ground and bagged for shipment at the Baca mill for use in the preparation of drilling muds.

Sand and gravel was produced at two commercial and one Government-contractor operation. Paving sand and gravel, mostly gravel, was supplied by Brown Construction Co. and Universal Constructors, Inc., for road construction on the Interstate Highway System. Sandstone was produced by Brown Construction Co. for the State highway commission. County stone output dropped from 128,000 tons in 1963 to 5,000 tons in 1964.

Taos.—Perlite accounted for most of the value of the mineral production. It was mined in the No Agua area at open-pit mines operated by Great Lakes Carbon Corp., Johns-Manville Products Corp., and United Perlite Corp.

The scrap-mica output was from the To-Jo Nos. 1, 2, and 3 mines of Great Western Mining Co. The Copper Hill mine, operated by W. Wagner, yielded a silver- and copper-bearing ore.

Two commercial and two Government-and-contractor operators increased the total output value of sand and gravel from $12,000 to $180,000. Commercial operators produced sand and gravel for use as building material, sand for highway filling, and gravel for road paving. Paving gravel was produced by Government crews for the U.S. Forest Service and the State highway commission.

Calspar Mining Co. intermittently explored and developed a calcite deposit near Penasco.

Molycorp continued to explore and develop its Questa molybdenite mine. Two contracts were awarded; Western Contracting Corp. began the initial stripping of the Northeast zone of molybdenum mineralization for development of the open-pit mine; Western Knapp Engineering Co., a division of Arthur G. McKee & Co., started constructing the 10,000-ton-a-day mill and installation of a crusher plant and associated facilities. Stripping operations began in late August, and mill erection in September. Production was scheduled for early 1966. A 40-ton-per-hour bulk sampling plant and a 100-ton-per-day flotation mill, initiated in 1963, were completed to facilitate sample evaluation. Sample-mill operations produced some molybdenite concentrate. The annual report of the company stated that the feasibility study reported an open-pit reserve of proven and probable ores of 20.5 million tons of 0.297 percent molybdenite; further development and evaluation of the deposit had increased the ore reserve by approximately 50 percent. Based on the study, the planned mill capacity was increased from 8,000 tons per day to 10,000 tons per day. Development of the mine and erection of the milling plant was to cost $29.1 million. A major residential subdivision was being developed at Questa to accommodate company employees.

Valencia.—Decreases in uranium production and reduction in sand and gravel output accounted largely for the 12-percent decline in mineral value.

The county, however, continued to rank second in the State in uranium ore production. Production of uranium ore was from the Jackpile and Paguate mines of The Anaconda Company; the San Mateo mine of El Paso Natural Gas Co., later operated by United Nuclear Corp.; Section 30 mine of Rare Metals Corp.; and the Mesa mine of Mesa Mining Co. United Nuclear Corp. purchased the San Mateo uranium mine from El Paso Natural Gas Co. Uranium ore was processed at The Anaconda Company mill and two mills operated by Homestake-Sapin Partners during the year. Throughput at process-

ing mills was adjusted to meet new production schedules based on the negotiation of new purchase contracts with AEC according to its stretchout program of uranium oxide procurement through 1970.

United States Gypsum Co. produced perlite at its Hill No. 7 open-pit mine, and crushed crude perlite at its plant near Grants for shipment to company-owned plants in various parts of the Nation.

Four commercial operators at four operations supplied a total of 63,000 tons of sand and gravel. The material was used for building, paving, fill, and for engine-sand. Two Government contractors produced 31,000 tons of paving gravel for the Federal Bureau of Indian Affairs; two contractors produced 72,000 tons of paving gravel for the State highway commission; and county crews produced 27,000 tons each of fill sand and gravel for the county highway department. Of the total sand and gravel produced by Government contractors and crews, 103,000 tons was processed. O. D. Cowart Construction Co. produced and crushed 13,939 tons of miscellaneous stone for road building for the Federal Bureau of Indian Affairs.

Ultra Marbles, Inc., quarried marbleized travertine at the Omission quarry; the stone was cut and polished at the company plant near Albuquerque for use as a decorative and building stone.

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 Stanley A. Feitler [1]



VALUE of mineral output in New York rose to a record high of $288.4 million, 11 percent greater than in 1963. Increased cement production accounted for more than half of the rise, but substantial production increases were recorded for zinc, iron ore, stone, sand and gravel, and titanium concentrate. The active mineral industry reflected the high level of the national economy, particularly in the metal and construction industries. New York 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.

TABLE 1.—Mineral production in New York [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays, thousand short tons	1,598	$2,186	1,499	$1,993
Emery, short tons	6,732	119	9,214	172
Gem stones	(2)	10	(2)	10
Gypsum, thousand short tons	647	3,339	653	3,321
Lead (recoverable content of ores, etc.), short tons	1,009	218	732	192
Natural gas, million cubic feet	3,962	1,169	3,125	963
Peat, short tons	21,358	178	32,574	261
Petroleum (crude), thousand 42-gallon barrels	1,679	7,707	1,874	8,321
Salt, thousand short tons	4,782	34,228	4,816	34,216
Sand and gravel, do	37,381	37,274	39,282	38,583
Silver (recoverable content of ores, etc.), thousand troy ounces	20	25	13	17
Stone, thousand short tons	26,611	44,549	29,141	46,669
Zinc (recoverable content of ores, etc.), short tons	53,495	12,304	60,754	16,525
Value of items that cannot be disclosed: Abrasive garnet, cement, iron ore, lime, talc, titanium concentrate, and wollastonite	XX	115,768	XX	137,202
Total	XX	r 259,074	XX	288,445

r Revised.
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

[1] Mining Engineer, Bureau of Mines, Pittsburgh, Pa.

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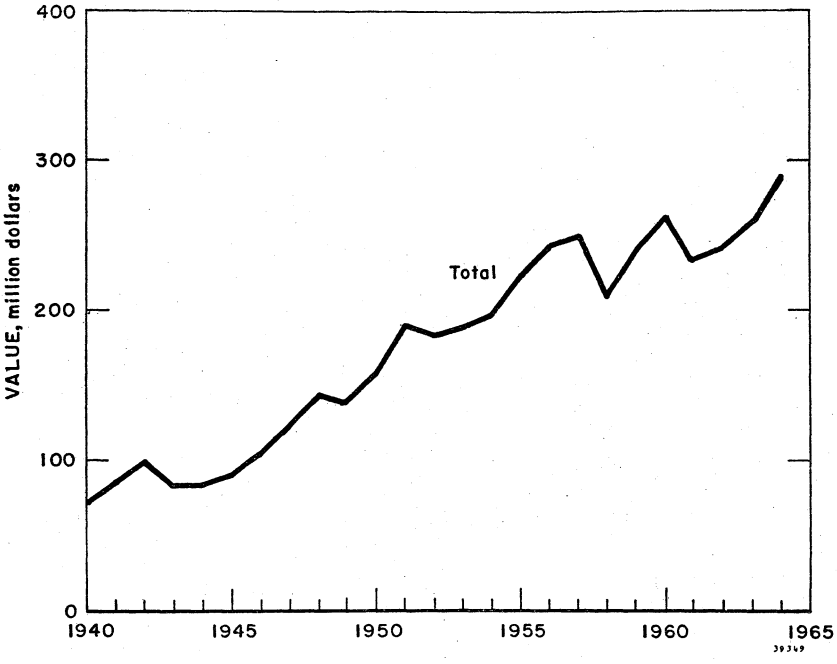


FIGURE 1.—Total value of mineral production in New York.

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

(Millions)

Year	Value	Year	Value
1940	$171	1953	$205
1941	195	1954	206
1942	216	1955	226
1943	186	1956	236
1944	186	1957	246
1945	182	1958	207
1946	175	1959	236
1947	188	1960	257
1948	198	1961	236
1949	182	1962	r 239
1950	201	1963	r 258
1951	227	1964	283
1952	213		

r Revised.

Trends and Developments.—The new metals research laboratory of International Nickel Co. in Sterling Forest, Orange County, was completed and formally opened in October. The 300-man staff of the laboratory included scientists, engineers, and supporting personnel. The facility was designed to perform basic and applied research on metals. Construction was started on an addition to the National Gypsum Co. research center at Tonawanda, Erie County. The new building was planned to house research about fire resistance and sound transmission of building materials.

The U.S. Atomic Energy Commission announced plans to reactivate its boron production plant at Model City, Niagara County.

The third unit of the Consolidated Edison Co. Ravenswood generating plant, Queens County, was under construction. The million-kilowatt unit was designed to burn coal which will be delivered in unit trains. The two existing generating units at the Ravenswood plant burn oil. A new atomic energy power plant was under construction by Niagara Mohawk Power Corp. at Nine Mile Point on the shore of Lake Erie, east of Oswego. Completion was scheduled for 1968.

Legislation and Government Programs.—The Federal Water Resources Research Act of 1964, Public Law 88–379, was enacted. This law authorizes each State to establish a water resources research institute at a land grant college or other institution. The institutes are to conduct basic and applied research on water resources development and to train scientists in these fields. Federal funds were to be available for the support of the program.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	1,725	431	3,444	1	28	8
Nonmetal	2,318	610	5,027	1	134	27
Sand and gravel	1,831	372	3,070	1	88	29
Stone	4,064	1,000	8,088	----	80	10
Peat	20	3	26	----	1	39
Total	9,958	2,416	19,655	3	331	17
1964: p						
Metal	1,715	465	3,744	----	56	15
Nonmetal	2,310	600	4,925	1	141	29
Sand and gravel	2,000	396	3,212	2	68	22
Stone	4,290	1,021	8,300	2	93	11
Peat	28	5	36	----	2	56
Total	10,343	2,487	20,217	5	360	18

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives (Artificial).—Electro Minerals Division of The Carborundum Co. and General Abrasives Co., Inc., manufactured artificial abrasives in Niagara County. Both quantity and value of output was significantly greater than that of 1963. White, high-purity aluminum oxide was principally used as an abrasive; silicon carbide was also used as an abrasive, as well as for refractory and other nonabrasive purposes.

Cement.—New York State ranked fifth in quantity and value of cement shipments. Portland, masonry, and natural cements were produced, but portland cement accounted for 96 percent of the quantity and value. Shipments of portland cement increased 23 percent in quantity and 25 percent in value. The average value per barrel increased by $0.05 to $3.08, reversing the downward trend in prices. As for masonry cement, shipments increased in both tonnage and value, although the average price per barrel was lower than that of 1963. Natural cement shipments decreased in quantity and value as compared with those of 1963. Cement production was reported from 13 plants of which 10 produced portland and masonry cements, 2 produced portland cement exclusively, and 1 plant produced masonry and natural cements. Cement-producing counties in decreasing order of value of shipments were Albany, Columbia, Ulster, Greene, Erie, Warren, Schoharie, and Onondaga.

The principal raw materials for manufacturing portland cement were cement rock and limestone, of which 7.7 million tons was used. In addition, the following tonnages of other raw material were consumed: Clay and shale, 361,000; gypsum, 184,000; sand and slag, 64,000; and iron materials, 28,000. Air-entraining compounds, grinding aids, fly ash, and bauxite also were used. The industry consumed 672 million kilowatt-hours of electrical energy of which 97 percent was purchased from public utility companies and 3 percent was generated using recovered heat from stack gases.

Forty-five percent of portland cement shipments was consumed within the State. Shipments of more than 1 million barrels each were made to Connecticut, Massachusetts, and New Jersey; shipments also were made to consumers in 14 other States and District of Columbia. A small quantity of portland cement was exported. Distribution of portland cement shipments by type of customer was as follows: Ready-mixed concrete companies, 66 percent; concrete product manufacturers, 11 percent; building material dealers, 9 percent; highway and other contractors, 11 percent; and miscellaneous consumers and governmental agencies, 3 percent. Most shipments were in bulk (93 percent). Deliveries were by truck, 67 percent; railroad, 22 percent; and waterway, 11 percent.

Portland cement plant capacity was 8 percent higher than in 1963. Plants using the wet process comprised 76 percent of total capacity, an increase of 6 percent. Utilization of plant capacity was 9 percent higher than that of 1963. Increased shipments and improved plant utilization were partly the result of sales through distant distribution

centers which were supplied by ocean freight. Yearend stocks of portland cement were 8 percent lower than those of 1963.

The newly installed kiln and auxiliary equipment which increased annual capacity to 4 million barrels was in operation at Hudson Cement Division, Colonial Sand & Stone Co., Inc., Ulster County. This company increased its fleet of barges and self-loading cement boats. The Alpha Portland Cement Co. new Greene County plant was used as a central manufacturing center to supply markets previously served by the old plant of the company at the same locality and by an old plant in Pennsylvania.

Clays.—Quantity and value of clay and shale production decreased 6 percent and 9 percent, respectively, compared with that of 1963. Reduced demand resulted in a 22-percent decrease in the quantity of clay and shale used in manufacturing building brick. Production of clay and shale for cement increased 12 percent, and for lightweight aggregate output was 2 percent greater than in 1963. Clay for art pottery, export, and other uses was produced at virtually the same rate as that of 1963. Albany slip clay, mined in Albany County, was used in art pottery, clay crucibles, and as a bond for abrasive wheels and shapes. Some slip clay was exported. Lightweight aggregate plants operating in the Hudson River Valley were Northern Lightweight Aggregate, Inc.; Nytralite Aggregate, Inc.; Hudson Lightweight Stone Division of Colonial Sand & Stone Co., Inc.; and Hudson Valley Lightweight Aggregate Corp. Onondaga Lightweight Aggregate Corp. in central New York and Anchor Concrete Products, Inc., in western New York also made lightweight aggregate.

Emery.—The entire U.S. production of emery was recovered from four open pit mines in Westchester County. The emery was processed for general abrasive purposes and for use as an aggregate in heavy-duty nonslip floors. Total tonnage, total value, and average value per ton were greater than that of 1963.

Garnet.—Precisely sized garnet recovered from an open-pit mine in Warren County was sold for use in glass grinding and polishing, coated abrasives, and metal lapping. The tendency to break into sharp edged cubes enhances the abrasive properties of garnet from this deposit. Garnet recovered as a byproduct of wollastonite mining in Essex County was processed for use in sand blasting, skidproof paints, and as an abrasive medium for tumbling semiprecious stones. Shipments from both areas were greater than those of 1963.

Gem Stones.—Mine dumps, rock outcrops, and quarries continued to attract gem and mineral collectors and amateur lapidarists. Among the minerals recovered were beryl, garnet, quartz, hematite, magnetite, graphite, and the feldspar minerals. Gem garnet was produced commercially in Warren County near North Creek.

Graphite (Manufactured).—Graphite Products Division of Great Lakes Carbon Corp. and Carbon Products Division of Union Carbide Corp. produced manufactured graphite from petroleum coke at Niagara Falls. Products consisted of anodes, electrodes, other finished shapes, and graphite blanks that were finished by the user. Speer Carbon Co., a Division of Air Reduction Co., Inc., began construction of expanded facilities at its Niagara Falls electric furnace plant.

Gypsum.—The quantity of crude gypsum produced was slightly greater than that of 1963, but the total value was lower because the average price per ton decreased by $0.07 to $5.09. Gypsum was recovered from five underground mines; three in Erie County, and one each in Genesee and Monroe Counties. All gypsum consumed in the crude (uncalcined) state was used as a retarder in portland cement. Output of calcined gypsum decreased 8 percent in tonnage and 9 percent in value, compared with that of 1963. Calcining plants in Bronx, Richmond, and Rockland Counties used crude gypsum that was imported or shipped from mines in other localities. Heat for calcining was generated by oil at one plant, coal at three plants, and gas at three plants. The major use for calcined gypsum was in manufacturing wallboard and lath and in the formulation of various types of plaster; other uses were in manufacturing plate glass, pottery plasters, industrial molding, and art and casting plasters. New York ranked fifth in value of crude gypsum produced.

TABLE 4.—Crude gypsum production

(Thousand short tons and thousand dollars)

Year	Active mines	Quantity	Value	Year	Active mines	Quantity	Value
1955–59 (average)	5	1,001	$4,300	1962	5	601	$3,122
1960	5	755	3,928	1963	5	647	3,339
1961	5	663	3,441	1964	5	653	3,321

Lime.—Lime production increased 9 percent in quantity and 6 percent in value as compared with that of 1963. Most of the lime was produced in oil-fired rotary kilns for chemical and other industrial uses; 94 percent of the output was used by the producing companies. Hydrated lime was used for chemical purposes (81 percent) and for construction (19 percent). Most of the lime was consumed in New York State, but some shipments were made to Michigan, New Jersey, Ohio, and Canada. Paper plants in Niagara and Essex Counties regenerated lime for use in paper manufacture.

Magnesium Compounds.—Carborundum Metals Co., Division of the Carborundum Co., recovered a small quantity of magnesium chloride as a byproduct of zirconium production at its Akron, Erie County, plant.

Perlite.—Production of expanded perlite decreased in both quantity and value, but the average value per ton was higher than in 1963. Crude perlite mined in Colorado and Nevada was expanded at six plants—three in Erie County and one each in Bronx, Genesee, and Onondaga Counties. The most important use for expanded perlite was in accoustical building plaster which accounted for 85 percent of the total tonnage. Smaller quantities were used for soil conditioning, ultralightweight concrete aggregate, low-temperature insulation, and filter aid.

Salt.—New York ranked third among the salt-producing States in tonnage and value. Production exceeded that of 1963 by 1 percent but because prices were lower, the total value was virtually the same.

The most important uses for evaporated salt, based on tonnage, were for manufacturing soda ash, chlorine, and other chemicals. Significant quantities also were used in a variety of industrial and food processes as well as for seasoning. The principal uses for rock salt were for ice control on highways and in the manufacture of chemicals. Salt in brine was used mainly for the manufacture of chemicals. Rock salt was mined in Livingston and Tompkins Counties, and salt was produced from wells in Onondaga, Schuyler, and Wyoming Counties.

TABLE 5.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	3,850	$28,466	1962	4,456	$32,236
1960	4,008	30,763	1963	4,782	34,228
1961	4,149	30,761	1964	4,816	34,216

Sand and Gravel.—A large increase in Government-and-contractor production of sand and gravel for highway construction and maintenance was responsible for the overall increase in total output. Output of commercial sand and gravel decreased 4 percent in tonnage and value. The average value of all commercially produced sand and gravel was $1.08, the same as that of 1963, but industrial sand for molding, engine, filtration, and other uses increased to $3.50 per ton from $3.23 in 1963. Of the 318 active commercial sand and gravel operations, more than 1 million tons was reported by 3 plants; from 500,000 to 1 million tons at 7 plants and from 200,000 to 500,000 tons at 17 plants. Shipments were by truck, 83 percent; by railroad, 1 percent; and by waterway, 16 percent. Eighty-two percent of the output of commercial plants was washed and screened as compared with 83 percent in 1963; unprocessed bank-run material was used principally for fill. Leading producing counties were Suffolk with 6.1 million tons and Nassau with 4.5 million tons. The average value of Government-and-contractor sand and gravel was $0.77 per ton, $0.02 higher than that of 1963. Sand and gravel production was reported from 54 of the State's 62 counties.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	9,125	$10,570	8,820	$9,947
Paving	5,358	5,659	4,886	5,003
Fill	1,191	528	859	383
Molding	162	632	W	W
Engine	W	W	24	42
Filtration	19	25	W	W
Other	1,443	875	1,467	928
Undistributed [1]	52	95	190	707
Total	17,350	18,384	16,246	17,010
Gravel:				
Building	4,249	5,670	4,237	5,982
Paving	4,006	4,569	3,649	4,111
Fill	1,605	881	1,811	1,027
Undistributed [2]	641	601	668	662
Total	10,501	11,721	10,365	11,782
Total sand and gravel	27,851	30,105	26,611	28,792
Government-and-contractor operations: [3]				
Sand:				
Building	13	20	78	135
Paving	455	309	579	394
Fill	1,730	729	2,459	1,025
Other	386	166	439	181
Total	2,584	1,224	3,555	1,735
Gravel:				
Building	3	2	3	2
Paving	4,208	4,194	5,312	5,637
Fill	2,735	1,749	3,801	2,417
Total	6,946	5,945	9,116	8,056
Total sand and gravel	9,530	7,169	12,671	9,791
All operations:				
Sand	19,934	19,608	19,801	18,745
Gravel	17,447	17,666	19,481	19,838
Total	37,381	37,274	39,282	38,583

W Withheld to avoid disclosing individual company confidential data.
[1] Includes blast sand (1963), ground sand (1963), other industrial sand, and data indicated by symbol W.
[2] Includes railroad ballast and other gravel.
[3] Includes data for State, counties, municipalities, and other government agencies.

TABLE 7.—Sand and gravel production by Government-and-contractor operations, by counties

(Thousand short tons)

County	1963	1964	County	1963	1964
Cattaraugus	----	14	Onondaga	268	84
Cayuga	3	50	Ontario	65	16
Chautauqua	208	155	Orange	109	176
Chemung	11	25	Orleans	8	10
Clinton	90	6	Oswego	50	81
Columbia	33	16	Otsego	89	62
Delaware	2	8	Rensselaer	59	59
Dutchess	27	48	St. Lawrence	77	246
Essex	12	3	Saratoga	44	111
Franklin	89	32	Schenectady	33	15
Genesee	58	31	Schuyler	34	38
Herkimer	16	48	Steuben	116	116
Jefferson	10	45	Suffolk	33	47
Lewis	5	12	Washington	25	----
Livingston	12	----	Wayne	112	140
Montgomery	13	34	Undistributed [2]	7,796	10,766
Niagara	(1)	2			
Oneida	23	175	Total	9,530	12,671

[1] Less than half unit.
[2] Includes data unspecified by counties.

Stone.—The value of stone production increased 5 percent as compared to that of 1963, ranking second in value among the 20 mineral commodities mined in the State. Increased output was reported for most types of stone, but a few—including crushed basalt, crushed marble, and dimension sandstone—decreased in both tonnage and value. Stone was produced in 39 of the 62 counties. Among the leading counties in decreasing order of value were Dutchess, Rockland, Onondaga, Erie, and Ulster, all of which had output valued at more than $3 million. Stone mined in each of eight other countries was valued at from $1 million to $3 million. Production of all types of crushed and broken stone increased 10 percent in tonnage and 5 percent in value; the average value per ton decreased by $0.07 per ton to $1.54 as compared with that of 1963.

Crushed limestone was used chiefly for concrete aggregate, roadstone, cement, and lime. Other uses included agricultural stone (agstone), asphalt filler, riprap, fluxing stone, and whiting. Production of limestone valued at more than $2 million was reported for Dutchess, Onondaga, Erie, Ulster, Monroe, and Albany Counties. A small quantity of dimension limestone was produced in Onondaga County.

Basalt (traprock) production decreased 12 percent, compared with that of 1963, but the average value per ton was unchanged. Basalt, mined only in Rockland County, was used principally for concrete aggregate and roadstone. Sandstone was produced as both dimension and crushed stone, mainly in Sullivan, Delaware, and Broome Counties. Output of dimension sandstone decreased 1 percent, but the tonnage of crushed sandstone increased 14 percent. The principal uses for dimension sandstone in decreasing order of value were flagging, sawed and dressed architectural stone, and rough construction stone. Delaware County ranked first in value of dimension sandstone; Sullivan County had the greatest value of crushed sandstone.

Slate was mined, sawed, sculped, and split for use as flagging, roofing, and structural stone in Washington County. Both quantity and

value of output were greater than those in 1963. The average value per ton of dimension slate increased from $34.92 in 1963 to $39.94. No production of crushed slate was reported. Miscellaneous stone was mined and crushed in Clinton and Rensselaer Counties for concrete aggregate and roadstone. Marble mined in St. Lawrence and Westchester Counties was crushed and ground for a variety of uses. Dimension granite, quarried in Westchester and Essex Counties was used for rough construction, dressed construction, rubble, rough architectural, and curbing stone. Granite mined in Warren and Westchester Counties was crushed for use mainly as concrete aggregate and roadstone.

TABLE 8.—Crushed and broken limestone sold or used by producers by uses

(Thousand short tons and thousand dollars)

Use	1963		1964	
	Quantity	Value	Quantity	Value
Riprap	209	$312	75	$129
Concrete aggregate and roadstone	14,261	25,578	15,344	26,622
Agricultural	399	1,250	338	1,224
Railroad ballast	497	848	477	815
Cement	5,869	4,506	7,290	6,021
Miscellaneous uses, including fluxing stone and lime	1,880	2,908	2,302	3,054
Total	23,115	35,402	25,826	37,865

Talc.—The quantity and value of talc mined were greater than in 1963, and New York continued to be the leading talc-producing State. Two companies mined and processed talc in the Gouverneur district of St. Lawrence County. The crude rock was trucked to nearby mills where it was dried and finely ground for use principally in ceramics, paint, and floor and wall covering. Lesser quantities were used in rubber, paper, and as a mineral pulp filler in other products.

Vermiculite.—Crude vermiculite mined in other States was exfoliated at a plant in Cayuga County. The expanded material was used for loose-fill insulation, agriculture, lightweight concrete aggregate, and building plaster aggregate.

Wollastonite.—Wollastonite was mined and ground in Essex County by Cabot Minerals Division, Cabot Corp. for a filler use in paints and plastics, and as an ingredient in ceramic products. Adirondack Development Corp. produced a small quantity of wollastonite from its Lewis and Deerhead deposits for use in developing milling processes and in market development.

METALS

Aluminum.—New York State ranked fourth in the Nation in tonnage and in value of primary aluminum production. Output was from the Massena plants of Aluminum Company of America and Reynolds Metal Co. Chevrolet Division of General Motors Corp. expanded facilities at its Massena Aluminum Foundry. The foundry is supplied with molten aluminum from the nearby potlines of Reynolds Metals Co. Aluminum, Ltd., Montreal, gained complete con-

trol of Alroll, Inc., Oswego County, which operates an aluminum rolling mill. The acquisition was challenged by the Justice Department under the Celler-Kefauver anti-merger section of the Clayton Act.

Ferroalloys.—Both quantity and value of ferroalloy shipments were lower than those of 1963. As compared with 1963, the quantity shipped increased for silicomanganese, silvery pig iron, ferrochrome silicone, ferrocarbon titanium, ferrotungsten, and ferrovanadium; the quantity decreased for ferromanganese, ferrosilicon, ferrochromium, chromium briquets, ferroaluminum-zirconium alloy, and ferrocolumbium. An 80 percent drop in the value of ferrochromium shipments, although partly offset by an increase in silvery pig iron, war principally responsible for the 20 percent decrease in the total value of ferroalloys. In line with Union Carbide Corp. plans to discontinue ferroalloy production at the Niagara Falls plant, the stepdown in output was continued by Union Carbide Corp., Metals Division.

TABLE 9.—Ferroalloy producers in 1964

Company	Location	Type of furnace	Ferroalloys produced [1]
Hanna Furnace Corp	Erie County, Buffalo	Blast	Silvery pig iron.
Pittsburgh Metallurgical Co	Niagara County, Niagara Falls.	Electric	SiMn, FeSi, FeCr, silvery pig iron.
Titanium Alloy Manufacturing Division of National Lead Co.	do	do	FeTi, FeB, FeZr.
Union Carbide Corp., Metals Division	do	do	FeCr, FeTi, FeW, FeB, FeCb, FeV, FeCr Si.

[1] Symbols: SiMn, silicomanganese; FeSi, ferrosilicon; FeCr, ferrochromium; FeTi, ferrotitanium; FeW, ferrotungsten; FeB, ferroboron; FeCb, ferrocolumbium; FeZr, ferrozirconium; Fe V, ferrocovanadium, FeCr Ss, ferrichrome silicon.

Iron Ore.—The quantity of crude ore mined increased 12 percent and the quantity of usable ore shipped increased 11 percent as compared with 1963 quantities. The value of shipments increased 13 percent, reflecting a 22-cent-a-ton increase in average value as compared with that of 1963. Magnetite ore was produced from underground mines in Clinton and Essex County and opencut operations in Essex County and St. Lawrence County. All of the crude ore was beneficiated before shipment and 89 percent of the concentrate was agglomerated. The Brimfield hematite mine in Oneida County was idle during the entire year.

Iron and Steel.—Shipments of pig iron amounting to 5.1 million tons valued at $321 million were reported by 5 companies operating 6 plants, 4 in Erie County and 1 each in Niagara and Rensselaer Counties. Basic pig iron made up 83 percent of the total; other classes of pig iron in decreasing order of tonnage were malleable, low-phosphorus, foundry, and Bessemer. Most of the iron ore was of domestic origin, but some was imported from Canada and Chile. Manganiferous ore was received from Brazil, Canada, and Africa. In addition to hot metal and pig iron, materials used in blast furnaces were limestone, dolomite, mill cinder and scale, flue dust, open-hearth and Bessemer slag, coke, anthracite coal, and scrap iron and steel.

With production of 6 million tons, New York ranked seventh among steel-producing states. Most of the output was made by open-hearth and the basic oxygen process. Electric furnace steel production increased 19 percent to 177,000 tons.

Construction of two new basic oxygen steelmaking units was completed at the Lackawanna plant of Bethlehem Steel Co. late in 1964. Each furnace has a capacity of 250 tons per heat, and the two furnaces have a combined annual capacity of 2 million tons. This installation replaced 14 old, open-hearth furnaces which had a combined capacity of 1 million tons per year. More than 98 percent of the dust and iron oxide is removed from the stack gas before it is discharged into the atmosphere. An oxygen plant has been constructed nearby to supply each furnace. Large, additional expenditures for expansion and modernization of the Lackawanna plant were underway or in the planning stage. Among the projects were improvement in the production and shipping facilities for structural shapes and installation of lime-burning facilities. Modernization of the iron ore sintering facilities at the Lackawanna plant was completed early in the year.

Roblin-Seaway Industries, Inc., started continuous steel casting at its Dunkirk plant. The continuous steel-casting machine was fed with molten steel from two electric furnaces. The steel was cast in the form of billets which were transported to the Roblin plant in North Tonawanda where they were shaped and rolled.

Hanna Furnace Corp. relined and modernized one of the 4 blast furnaces in its Union Ship Canal pig iron-producing plant. Air Reduction Co., Inc., started construction of a 650-ton-per-day, oxygen-nitrogen plant. Plans included placing an oxygen pipeline direct to the Republic Steel Corp., plant for oxygen lancing.

Lead.—The Balmat mine in St. Lawrence County was the only lead producer in the State. Output of metal decreased 27 percent, but the value only 12 percent because the average price of lead was higher than in 1963. Lead was processed by National Lead Co., Brooklyn, to produce red lead and litharge. Electric Auto-Lite Battery Corp., Niagara Falls, manufactured black lead oxide.

Silver.—The quantity of silver recovered from lead concentrates shipped from the Balmat mine, St. Lawrence County, was 35 percent less than that of 1963. Silver recovery reflected 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. The quantity shipped was 15 percent higher than that of 1963. Ilmenite concentrate was used principally in the manufacture of titanium dioxide pigment.

Zinc.—New York replaced Idaho as the second-ranking zinc producing State in the Nation. Substantial increases in both the production and value were reported for the Balmat & Edwards mines in St. Lawrence County. Growing demand for zinc products resulted in higher prices for the metal.

Zirconium.—Refractories and compounds of zirconium were manufactured in New York although no ore of zirconium was mined in the State. Zirconium oxide was manufactured by Titanium Alloy Manufacturing Division of National Lead Co., Niagara Falls, and Harbison-Carborundum Corp., Falconer, Chautauqua County. Zirconium ferro-

alloy was manufactured by Union Carbide Corp., Metals Division and Titanium Alloy Manufacturing Division of National Lead Co., Niagara Falls. Zirconium ingot was produced from sponge by Carborundum Metals Co. at its Akron (N.Y.) plant. Harbison-Carborundum and Titanium Alloy also produced zirconia-containing refractories.

TABLE 10.—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)	
1955–59 (average)	2	594,275	66,505	$60	1,074	$308	54,653	$13,010	$13,378
1960	2	701,197	49,324	45	775	181	66,364	17,122	17,348
1961	2	592,438	40,507	37	879	181	54,763	12,595	12,813
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

TABLE 11.—Mine production of silver, lead, and zinc, in 1964, by months, in terms of recoverable metals

Month	Silver (troy ounces)	Lead (short tons)	Zinc (short tons)	Month	Silver (troy ounces)	Lead (short tons)	Zinc (short tons)
January	1,942	102	5,035	August	1,156	70	5,952
February	1,343	73	4,218	September	596	37	5,244
March	1,649	89	4,723	October	788	51	5,831
April	1,551	83	4,606	November	865	47	4,809
May	745	41	4,283	December	1,577	77	5,989
June	568	32	5,074				
July	526	30	4,990	Total	13,306	732	60,754

MINERAL FUELS

Coke and Coal Chemicals.—Three companies operated a total of 855 slot coke ovens in one merchant and two furnace plants. Allied Chemical Corp. produced coke and coal chemicals consisting of ammonia liquor, crude coal tar, crude chemical oil, and crude light oil in 120 ovens at its Buffalo plant. The crude light oil was further refined into benzene, toluene, and xylene at the company Syracuse plant. Bethlehem Steel Co. operated a captive byproduct coke plant, comprising 535 ovens, at its Lackawanna plant. Donner-Hanna Coke Corp., jointly owned by Republic Steel Corp. and Hanna Furnace Co., produced coke and various coal chemicals in 200 ovens at its Buffalo plant.

Of the 3.3 million tons of coke consumed in New York, 94 percent was used at blast furnace plants; most of the balance was used in foundries and other industrial plants; less than 1 percent was used for residential heating. Consumption of coke breeze amounted to 257,000 tons.

Natural Gas.—Quantity and value of output decreased 21 percent and 18 percent, respectively, compared with those of 1963. Estimated proved recoverable reserves of natural gas, according to The American Gas Association, were 133.5 billion cubic feet, 1.2 billion greater than

at the end of 1963. Of the total recoverable reserves, 95.2 billion cubic feet was estimated to be in underground storage and 38.3 billion cubic feet was native gas. Producing gas wells totaled 1,150 at yearend, 50 more than in 1963. Gas storage facilities with an estimated capacity of 102.6 billion cubic feet were operated by five companies in seven south-central and southwestern counties.

Of the 30 wells drilled to develop and extend gas fields, 13 were drilled to the Queenston formation of Ordovician age, 15 to the Medina formation of Silurian age, 1 to the Clinton formation of Silurian age, and 1 to the Oriskany formation of Devonian age. Wildcats totaled 59. Ten holes drilled to the Precambrian system were plugged and abandoned. The Theresa formation of Cambrian age was tested by five holes, three were dry and two were plugged back to a shallower horizon. One test well in Ulster County was drilled to 8,489 feet and abandoned; no geologic information was released. Medina sandstone was tested by 13 holes of which 9 were dry and 4 were gas producers. Two holes were drilled to the Clinton formation; one was plugged and abandoned, the other became the discovery well of the Hamilton gas pool in Madison Township, Madison County. The Oriskany sandstone was tested by 12 wildcats, resulting in 10 dry holes and 2 holes which were plugged-back and completed at a shallower depth. One test of the Onandaga limestone of Devonian age resulted in a dry hole. The Upper Devonian system was tested for gas and oil by 15 shallow wildcats; 1 of these was the discovery well of the Smithville Flats pool, producing gas from the Hamilton group of Middle Devonian age.

TABLE 12.—Marketed production of natural gas

(Million cubic feet and thousand dollars)

Year	Quantity	Value	Average value (cents per thousand cubic feet)	Year	Quantity	Value	Average value (cents per thousand cubic feet)
1955–59 (average)	3,265	$959	29.4	1962	4,262	$1,198	28.1
1960	4,990	1,542	30.9	1963	3,962	1,169	29.5
1961	5,742	1,694	29.5	1964	3,125	963	30.8

Peat.—Quantity and value of peat production exceeded that of 1963, but the average value decreased $0.30 to $8.02 per ton. Production of humus peat from Cattaraugus, Orange, and Westchester Counties was greater than that of reed-sedge which was recovered in Orange and Seneca Counties. Most of the increase in tonnage and value was for humus, although the average value per ton decreased $0.42. Production of reed-sedge peat was virtually the same as in 1963, but the average value increased $1.09 per ton. Most of the peat was cultivated, air-dried, and shredded before shipment which was approximately two-thirds bulk and one-third packaged. Most of the output was used for soil improvement, but quantities were used for potting soils, seed inoculant, mushroom beds, and other applications.

Petroleum.—Production of petroleum increased in quantity and value, but the average value dropped to $4.44 from $4.59 per barrel in 1963. Petroleum was produced from an estimated 12,800 wells in Allegany, Cattaraugus, and Steuben Counties in southwestern New

York. Average production was 0.4 barrel per well per day. Crude oil produced in New York State was treated in Pennsylvania refineries.

The total number of development wells completed in the State was 157—68 fewer than in 1963; 90 were completed in the Allegany Field (Allegany and Steuben Counties), and 67 were completed in the Cattaraugus Field (Cattaraugus County).

The proved reserve of crude oil at the end of 1964, as estimated by The American Petroleum Institute, was 13.6 million barrels, compared with 18.4 million barrels at the end of 1963. The decrease was accounted for by production, 40 percent, and downward revision of previous estimates, 60 percent.

Daily capacity of the three petroleum refineries operating within the State was 90,200 barrels for distillation and 35,250 barrels for cracking and reforming. Crude oil treated in these refineries originated in Montana, Oklahoma, Texas, Illinois, and foreign countries. Frontier Oil Refinery Corp., Division of Ashland Oil & Refining Co., operated a skimming, cracking, and asphalt plant at Tonawanda. Mobil Oil Co. operated refineries at Brooklyn and Buffalo; the Brooklyn plant had facilities for cracking only; the Buffalo plant had facilities for skimming, cracking, and asphalt.

TABLE 13.—Petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value	Average value per barrel	Year	Quantity	Value	Average value per barrel
1955–59 (average)	2,412	$10,175	$4.22	1962	1,589	$7,309	$4.60
1960	1,813	8,412	4.64	1963	1,679	7,707	4.59
1961	1,658	7,892	4.76	1964	1,874	8,321	4.44

TABLE 14.—Well completions and drilling footage for field wells and wildcats in 1964

Type of well	Field wells[1]		Wildcats[1]		Total	
	Well completions	Drilling footage	Well completions	Drilling footage	Well completions	Drilling footage
Crude	123	122,986			123	122,986
Gas	30	57,634	15	51,488	45	109,122
Dry	21	27,235	36	147,592	57	174,827
Service	48	43,376			48	43,376
Total	222	251,231	51	199,080	273	450,311

[1] Oil and Gas Journal. V. 63, No.4, January 25, 1965.

REVIEW BY COUNTIES

Albany.—Portland cement produced by Atlantic Cement Co., Inc., at Ravena had wide geographic distribution. The leading States of destination were Connecticut, Florida, Maryland, Massachusetts, New Jersey, New York, South Carolina, and Virginia. Cement was delivered to most of the company distribution centers by ship. The company mined limestone at a nearby quarry but purchased all other raw materials.

Limestone was quarried by The Callanan Road Improvement Co. at South Bethlehem. The stone was crushed and screened for use principally as concrete aggregate, roadstone, railroad ballast, and blast-furnace flux. Crushed limestone was also used for agstone and riprap. Atlantic Cement Co., Inc., mined limestone for cement at its Ravena quarry. The stone was moved to the nearby cement plant of the company by belt conveyor system. Heldeberg Bluestone & Marble, Inc., mined bluestone (graywacke) at its East Berne quarry and produced dressed cut stone for architectural use.

TABLE 15.—Value of mineral production in New York, by counties[1][2]

County	1963	1964	Minerals produced in 1964 in order of value
Albany	$17,620,103	$25,865,350	Cement, stone, clays, sand and gravel.
Allegany	396,415	406,000	Sand and gravel.
Broome	1,066,038	1,298,029	Sand and gravel, stone, clays.
Cattaraugus	1,146,193	1,041,000	Sand and gravel, peat.
Cayuga	686,123	686,000	Stone, sand and gravel.
Chautauqua	120,192	150,000	Sand and gravel.
Chemung	W	W	Do.
Chenango	257,594	195,000	Do.
Clinton	W	W	Iron ore, stone, sand and gravel.
Columbia	W	W	Cement, stone, sand and gravel, clays.
Cortland	W	W	Sand and gravel.
Delaware	1,115,355	1,256,461	Stone, sand and gravel.
Dutchess	W	W	Stone, sand and gravel, clays.
Erie	14,160,511	14,931,499	Cement, stone, sand and gravel, gypsum, clays.
Essex	W	W	Iron ore, ilmenite, wollastonite, sand and gravel, stone, garnet.
Franklin	182,566	145,462	Stone, sand and gravel.
Fulton	246,440	269,000	Sand and gravel.
Genesee	2,808,785	2,862,498	Gypsum, stone, sand and gravel.
Greene	14,883,426	12,260,447	Cement, stone, sand and gravel, clays.
Hamilton	4,500	W	Sand and gravel.
Herkimer	W	W	Stone, sand and gravel.
Jefferson	930,561	914,756	Do.
Lewis	W	W	Do.
Livingston	W	W	Salt, sand and gravel, stone.
Madison	508,084	712,691	Stone, sand and gravel.
Monroe	3,459,412	4,179,825	Stone, sand and gravel, gypsum.
Montgomery	505,472	864,000	Stone, sand and gravel.
Nassau	5,889,509	W	Sand and gravel, clays.
Niagara	3,865,161	3,757,379	Lime, stone, sand and gravel.
Oneida	2,174,771	2,339,750	Stone, sand and gravel.
Onondaga	17,354,455	18,148,305	Lime, salt, stone, cement, sand and gravel, clays.
Ontario	1,476,031	1,219,000	Sand and gravel, stone.
Orange	1,470,919	1,768,055	Sand and gravel, clays, peat, stone.
Orleans	157,770	W	Sand and gravel.
Oswego	W	327,000	Do.
Otsego	193,543	202,459	Stone, sand and gravel.
Putnam	W	W	Sand and gravel.
Rensselaer	1,233,033	1,289,023	Sand and gravel, stone.
Rockland	W	W	Stone, sand and gravel.
St. Lawrence	34,252,560	39,788,203	Iron ore, zinc, talc, stone, sand and gravel, lead, silver.
Saratoga	1,089,826	1,148,453	Stone, sand and gravel.
Schenectady	204,170	244,000	Sand and gravel.
Schoharie	W	W	Cement, stone, clays, sand and gravel.
Schuyler	W	W	Salt, sand and gravel.
Seneca	257,935	340,284	Stone, peat.
Steuben	601,154	W	Sand and gravel.
Suffolk	6,242,046	5,844,000	Do.
Sullivan	W	W	Stone, sand and gravel.
Tioga	404,610	327,000	Sand and grave.
Tompkins	W	W	Salt, stone, sand and gravel.
Ulster	13,174,489	17,866,790	Cement, stone, clays, sand and gravel.
Warren	W	W	Cement, garnet, stone, sand and gravel.
Washington	789,991	840,987	Stone, sand and gravel.
Wayne	395,993	319,300	Do.
Westchester	806,064	930,278	Stone, sand and gravel, emery, clays, peat.
Wyoming	W	W	Salt, stone.
Undistributed[3]	r 106,942,720	123,706,225	
Total	r 259,074,000	288,445,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data.
[1] Bronx, Kings, New York, Queens, Richmond, and Yates 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 and petroleum, gem stones, and sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

Powell & Minnock Brick Works, Inc., mined miscellaneous clay at its S. & S. pit for manufacturing building brick. A new stiff-mud-extrusion plant for face brick was completed and was in operation part of the year. The older Powell & Minnock's plant, which used clay from the P. & N. pit, was permanently closed and dismantled in June. Northern Lightweight Aggregate, Inc., mined shale near Cohoes for use in lightweight aggregate manufacture in its recently enlarged plant. Industrial Mineral Products, Inc., successor to Rex Clay Products Co., Inc., mined and dried slip clay for pottery, refractories, and abrasive bonding material.

Whitehead Brothers Co. produced molding sand from a pit near Slingerlands. J. H. Maloy, Inc., produced bank-run gravel for paving. Albany Gravel Co., Inc., produced sand for construction and gravel for paving from its Cedar Hill Plant at Bethlehem.

Allegany.—The Buffalo Slag Co., Inc., and Alfred Atlas Gravel & Sand Corp., both near Alfred, produced sand and gravel for building, paving, fill, and sand for ice control on highways. At Friendship, Thomas Moogan also produced sand and gravel for building, paving, and ice control.

Bronx.—National Gypsum Co., calcined crude gypsum and expanded perlite at its Bronx plant. The calcined gypsum and expanded perlite were used in manufacturing building products at the Bronx and other National Gypsum Co. plants.

Broome.—Sand and gravel production, consisting principally of processed material for building, paving, and fill, was produced from pits near Vestal and Binghamton. Arborio and Arborio, Windsor, and Corbisello quarries, Binghamton, mined and crushed sandstone (graywacke) for use as concrete aggregate, roadstone, and riprap. Dimension sandstone was mined by Paul Tompkins Estate and W. R. Strong & Son. The quarry blocks were finished in plants at Hancock and Deposit. Miscellaneous clay was mined near Binghamton by Binghamton Brick Co., Inc., for manufacturing building brick.

Cattaraugus.—Ten commercial sand and gravel operations were active during 1964, producing principally processed material for building, paving, and ice control. Pits were located near Allegany, Franklinville, Gowanda, Olean, and Onoville. Commercial output totaled 857,000 tons valued at $1 million. Sue Peat Co., recovered cultivated and shredded humus peat from a bog near Hinsdale.

Cayuga.—Limestone was mined and processed for use in bituminous highway surfacing material, concrete aggregate, and railroad ballast. Shipments were by truck and railroad. J. J. Harrington and Jay W. Robinson & Son, both near Auburn, produced processed sand and gravel for building, paving, and fill. John W. Dougherty, Inc., produced bank-run gravel from a pit near Sennett. Zonolite Co. exfoliated crude vermiculite at its Weedsport plant.

Chautauqua.—W. Lee Bull, Inc., Stow, and Sack's Pit, Bemus Point, produced sand and gravel for building.

Chemung.—Sand and gravel for building and paving was produced from pits near Big Flats, Breesport, Elmira, and Horseheads.

Chenango.—The Bundy Concrete Co., Sherburne, produced sand and gravel for building and paving. B. & B. Builders Supplies, Inc.,

recovered sand and gravel for ready-mixed concrete from a pit near Greene.

Clinton.—Iron ore (magnetite) was mined by sublevel stoping at the Republic Steel Corp., Chateaugay Mine, Lyon Mountain. Additional blocks of ore were prepared for mining. Iron ore concentrate was mixed with anthracite coal and limestone and sintered before shipment. Output was used in manufacturing pig iron and steel. Mine waste (gneiss) was crushed and screened for concrete aggregate, roadstone, and other uses. Limestone was quarried at Plattsburgh by Plattsburgh Quarries, Inc., for use as concrete aggregate and roadstone. The quarry of International Lime & Stone Corp. at Chazy was inactive during the year, but sales were made from stockpiles. Sand and gravel was produced from pits at unspecified localities. International Lime & Stone Corp., Chazy, discontinued the manufacture of lime.

Columbia.—Cement plants were operated by Lone Star Cement Corp., Greenport, and Universal Atlas Cement Division, United States Steel Corp., Hudson. Both companies produced limestone from nearby quarries to supply the kilns, and the latter mined shale at its own quarry to supply alumina. Cement was shipped principally to New York, Connecticut, Massachusetts, and other Northeastern States. Catskill Mountain Stone Corp., Hudson, and A. Colarusso & Son, Inc., Greenport, produced limestone for concrete aggregate, roadstone, agstone, and fill. Sand and gravel for building and paving was produced from pits near Martindale and Livingston.

Cortland.—Cortland Ready Mix, Inc., and Aggregate Materials Corp. produced sand and gravel for building, paving, and fill from pits near Cortland. Most of the output was washed and screened.

Delaware.—Production of dimension sandstone (bluestone) was reported by Johnson & Rhodes Bluestone Co. (East Branch), W. R. Strong & Son, Deposit (Masonville), and Willis Hankins and Paul Tompkins Estate (both of Hancock). The stone was finished for use as flagging, curbing, sawed architectural stone, and irregular shaped stone. Cooney Bros., Inc., Hancock, produced crushed sandstone for use as concrete aggregate and roadstone. Sand and gravel was produced for highway construction at various locations.

Dutchess.—New York Trap Rock Corp. produced limestone for concrete aggregate, roadstone, and riprap at its Clinton Point quarry near Wappingers Falls. Shipments were 86 percent by waterway; the remainder, by truck. The Clinton Point operation had been entered in the National Safety Competition and was awarded a citation for working throughout 1964 without a disabling work injury. Dutchess Quarry & Supply Co., Inc., Pleasant Valley, also mined limestone for concrete aggregate and roadstone. A total of 707,000 tons of sand and gravel was produced from 17 commercially operated pits. Most of the output was processed and used for building, paving, and fill. Beacon Brick Corp. mined miscellaneous clay and shale for the manufacture of building brick near Beacon.

Erie.—Portland and masonry cements were produced at Buffalo by Lehigh Portland Cement Co. and Penn-Dixie Cement Corp. Raw materials used in making cement at these plants included limestone, shale, clay, gypsum, sand, iron ore, and mill scale. The finished cement

was shipped principally to consumers in New York and western Pennsylvania.

Limestone produced at Akron by County Line Stone Co., Inc., and at Lancaster by Buffalo Crushed Stone Co. and Lancaster Stone Products Corp. was used for concrete aggregate, roadstone, railroad ballast, and agstone. Federal Crushed Stone Corp., Cheektowaga, mined and crushed limestone for concrete aggregate and roadstone. The latter company participated in the National Safety Competition and received a citation for having worked without a disabling injury during 1964. Buffalo Crushed Stone Co. installed screens and other equipment needed for production of stone sand. County Limestone Co. installed a grinding mill to produce agstone.

Erie County, with sand and gravel output of 1.7 million tons, ranked third in the State. Most of the material was used for construction of buildings and highways. Among the principal producers were Clarence Sand & Gravel Corp., Clarence; Pine Hill Concrete Mix Corp., Lancaster; and Dan Gernatt Gravel Products, Inc., Collins.

Bestwall Gypsum Co. and National Gypsum Co. mined crude gypsum underground in the Clarence Center Area and calcined the ore in nearby plants for use in the manufacture of wallboard and other building products. Crude perlite mined in Colorado was expanded for use in building plaster by both National and Bestwall. The Akron mine (Bestwall) was entered in the National Safety Competition and earned a citation for having worked without a disabling injury during the year. Universal Atlas Cement Division, United States Steel Corp., mined gypsum at Clarence Center for use as a retarder in portland cement. Buffalo Perlite Corp. expanded perlite at its Cheektowaga plant for use as a low-temperature insulation, ultralightweight concrete aggregate, loose fill insulation, soil conditioner, building plaster, and filter aid.

Erie County continued to be an important producer of miscellaneous clay and shale, although the output was slightly less than that of 1963. Clay for cement, comprising more than half of total production, was mined by Penn-Dixie Cement Corp. and Hamburg Shale Co., Inc. Acme Shale Brick Co., Inc., Lake View, and Buffalo Brick Corp., West Falls, mined miscellaneous clay and sale for building brick. Anchor Concrete Products, Inc., mined shale for lightweight aggregate near Jewettville, and Boston Valley Pottery Co., Hamburg, produced clay for use in making flowerpots.

Essex.—National Lead Co. mined mixed ilmenite-magnetite ore at its MacIntyre Development near Tahawus. The ore was mined in an open cut consisting of nine benches having an average height of 44 feet. Two 6-cubic-yard electric shovels were installed in the pit to replace three smaller loading units. Separate ilmenite and magnetite concentrates were prepared and agglomerated before shipment. The ilmenite was used in the manufacture of pig iron and steel, but quantities also were used for heavy media, ballast, and in deadburned dolomite. Magnetite ore, mined mainly by sublevel stoping by Republic Steel at its Old Bed-Harmony mine at Mineville was concentrated and agglomerated at the nearby mill and sintering plant. The output was used in manufacturing pig iron and steel at the various Republic Steel Corp.

plants. Mine development work during the year consisted of driving drifts, raises, and sublevels.

Cabot Minerals Division, Cabot Corp., produced wollastonite and byproduct garnet (andradite) from room and pillar stopes at its Willsboro mine. The wollastonite was beneficiated and finely ground for use as a filler in paints and plastics and as an ingredient in ceramics. Additional stope areas were prepared for mining by drifting and raising. Adirondack Development Corp. mined a small quantity of wollastonite by open pit and continued to develop processing techniques and to make market studies. Sand and gravel was produced for building, paving, and fill from pits near Keeseville and Saranac Lake. Lake Placid Granite Co. produced dimension stone from its Lake Placid granite quarry near Jay. International Paper Co. regenerated lime used in the manufacture of paper.

Franklin.—Adirondack Stone Quarries, Inc., Burke, produced dimension sandstone. Sawing techniques were used to produce sawed and cut architectural stone, flagging, and irregular-shaped facing stone. Pits near Malone and St. Regis Falls were operated to produce sand and gravel for building, paving, and concrete products.

Fulton.—Nine commercial operators produced 268,000 tons of sand and gravel. Most of the output was washed and screened for building and paving. Bank-run material was used principally for fill.

Genesee.—U.S. Gypsum Co. produced gypsum at its underground mine and calcined the material at its nearby Oakfield plant. Limestone was mined and crushed for concrete aggregate, roadstone, railroad ballast, and riprap at LeRoy by General Crushed Stone Co. and LeRoy Lime & Crushed Stone Corp. At Stafford, Genesee Stone Products Corp. mined limestone for concrete aggregate, roadstone, and railroad ballast. The railroad ballast was shipped by railroad. Most of the remainder of the stone was shipped by truck. The quarry of Genesee Stone Products Corp. had been entered in the National Safety Competition and received a citation for having had no disabling work injuries during the year. Sand and gravel was produced from five pits in the county. The principal producers were Batavia Washed Sand & Gravel Co., Inc., Batavia, and Frey Sand & Gravel Corp., Alexander.

Greene.—Alpha Portland Cement Co., Catskill; Lehigh Portland Cement Co., and Marquette Cement Manufacturing Co. produced portland and masonry cements near Alsen. These companies also quarried limestone from nearby deposits for raw material. In addition, Marquette mined clay from its own pit. Other ingredients used in making cement were bauxite, gypsum, iron ore, mill scale, and fly ash. Shipments of finished cement were principally to consumers in New York and New England.

Lehigh Portland Cement Co. entered its Alsen quarry in the National Safety Competition and earned a citation for working through the year without a disabling work injury. Limestone was mined for cement manufacture by Lehigh, Marquette, and Alpha. Crushed limestone for concrete aggregate, roadstone, and riprap was produced by Tri-County Stone Co., Inc., at Windham, and Catskill Mt. Stone Corp. at Catskill. Some of the Catskill Mt. Stone Corp. output was used as asphalt filler. Molding sand was produced by Whitehead Brothers Co. at Coxsackie.

Herkimer.—General Crushed Stone Co., Jordanville, and Eastern Rock Products Inc., Middleville, mined and crushed limestone for concrete aggregate and roadstone. The entire output of both operations was delivered by truck. The Jordanville quarry of the General Crushed Stone Co., was entered in the National Safety Competition and received a citation for having no disabling work injuries during the year. Sand and gravel was produced at Gravesville by Material Sand & Gravel Co., Inc., and at Poland by Nash Sand Co.

Jefferson.—General Crushed Stone Co., produced concrete aggregate, roadstone, railroad ballast, and agstone at its Watertown limestone quarry. The stone was shipped to consumers by truck (66 percent) and by railroad (34 percent). Operations were expanded by installation of additional equipment by new management at the Multicolor Sandstone Co., Redwood quarry. Increased production of sandstone for flagging, cut architectural stone, rubble, and irregular shaped facing stone was reported. The highway department of the Town of Cape Vincent produced crushed limestone for road building and maintenance. Production of 462,000 tons of sand and gravel was reported by 14 commercial producers. Pits were operated chiefly at Watertown, Adams, Alexandria Bay, Belleville, and Antwerp. Most of the processed material was for building and paving; bank-run gravel was used for fill.

Lewis.—The Carbola Chemical Co., Inc., a subsidiary of International Talc Co., Inc., mined and ground limestone at Diana near Natural Bridge. Micronizing equipment was installed for ultrafine grinding. The finely ground limestone was marketed for use as a filler in paint, calcimine, putty, rubber, paper, and other products. The rock was mined underground in open stopes with casual pillars. Limestone for concrete aggregate and roadstone was mined near Boonville by E. G. Delia & Son Construction Corp. The town of Lowville produced limestone for highway maintenance and construction. A quantity of sand and gravel was produced under contract.

Livingston.—The county continued to be the most important salt-producing area in the State. Rock salt recovered from room-and-pillar stopes at the Retsof mine of International Salt Co. was sold for a wide variety of uses. Shipments were made to 26 States, District of Columbia, and Canada. The Retsof mine haulage system was converted from railroad to trackless, and the mine was otherwise modernized to improve efficiency.

Four sand and gravel operations reported total production of 670,000 tons of sand and gravel, mostly processed, from pits near Canawaugus, Dansville, Wadsworth, and Caledonia. General Crushed Stone Co. produced limestone from its Rochester quarry at Honeoye Falls. The output, used for concrete aggregate and roadstone, was delivered by truck.

Madison.—Limestone mined and crushed by Worlock Stone Co., Inc., Perryville, and Warren Brothers Roads Co., Clockville, was used chiefly for concrete aggregate, roadstone, and riprap. Crushed limestone produced by Munnsville Limestone Corp., Munnsville, was used for agstone and railroad ballast as well as concrete aggregate, roadstone, and riprap. All limestone mined in the county was delivered by truck. The Munnsville quarry, participating in the National Safety

Competition received a citation for having had no disabling work injuries during 1964. Cossitt Concrete Products, Inc., produced sand and gravel for building, paving, and fill from a pit near Hamilton.

Monroe.—Dolomite Products Co. operating quarries at Gates and Penfield produced crushed limestone for use as concrete aggregate, roadstone, railroad ballast, and agstone. The company replaced shovels with front-end loaders and otherwise modernized quarry equipment to improve efficiency. Concrete Materials Corp. produced crushed limestone from a quarry near Sweden. The output was used for concrete aggregate and roadstone and was shipped by truck. Sand and gravel production amounting to 1.3 million tons was reported by 17 operators. Processed material was used for building, paving, and ice control and a quantity of bank-run material was used for fill in highway construction. Crude gypsum mined by The Ruberoid Co. at Wheatland was processed at the company's Caledonia plant (Livingston County), where it was converted to finished building products. The Wheatland mine was entered in the National Safety Competition and received a citation for having operated without a disabling work injury during the year.

Montgomery.—Crushed Rock Products, Inc., a subsidiary of Asphalt Stone Products, Inc., mined and crushed limestone for concrete aggregate and roadstone. A quantity of crushed limestone was produced also by Cushing Stone Co., Inc. Both operations were near Amsterdam. Colonial Sand & Stone Co., Inc., Hempstead, Seymour O. Spencer, Fonda, and St. Johnsville Supply Co., Inc., produced mainly processed sand and gravel for building, fill, and ice control.

Nassau.—Nassau County ranked second in the State in tonnage of commercial sand and gravel produced. Three plants each were operated by Colonial Sand & Stone Co., Inc., and Certified Sand & Gravel Corp. Other producers were Penn Industries, Inc., and Pine Hollow Sand & Gravel Co., Inc. All of the output was used for building construction, fill, and paving. Clay produced at a pit near Farmingdale was used by Nassau Brick Co., Inc., for manufacturing building brick.

Niagara.—Union Carbide Olefins Co., Niagara Falls, made quicklime for use in manufacturing calcium carbide and cyanamide. Hydrated lime was sold for metallurgical use and sewage treatment. International Paper Co., North Tonawanda, regenerated lime used in paper manufacture. Royalton Stone Corp. produced limestone for concrete aggregate, roadstone, metallurgical fluxing stone, and agstone at its Gasport quarry. Limestone produced by Frontier Stone Products, Inc., at its Lockport quarry was used for concrete aggregate, roadstone, agstone, and riprap. Niagara Stone Division of McLain Industries, Inc., mined limestone for concrete aggregate, roadstone, and railroad ballast. The entire output was shipped by truck. Synthetic mullite was produced by The Carborundum Corp. at its Niagara Falls plant.

Oneida.—Eastern Rock Products, Inc., produced limestone at its Oriskany Falls quarry. The output was used principally for concrete aggregate and roadstone, but quantities also were sold for agstone and riprap. The entire output was delivered by truck. Eight commercial operations produced 571,000 tons of sand and gravel. The

principal pits were located near Barneveld, Clayville, Verona, and Boonville. Most of the output was processed before shipment.

Onondaga.—Solvay Process Division, Allied Chemical Corp., quarried limestone at its quarry near Jamesville. Most of the limestone was used for the manufacture of quicklime for chemical uses; the remainder of the stone was used for concrete aggregate, roadstone, agstone, railroad ballast, and riprap. A new secondary crushing section was installed. The quarry operation received a citation from National Safety Competition for having worked the year without a disabling work injury. The company operated salt wells at Tully and a plant in Syracuse for producing evaporated salt and brine. Most of the output was brine which was used with the lime in manufacturing soda-ash. A small quantity of salt was produced in vacuum pans. The Rock Cut quarry, also at Jamesville, was mined for limestone by General Crushed Stone Co. A small quantity of irregular-shaped facing stone was produced at Manlius by Brickyard Falls Farm.

Portland and masonry cements were produced at Jamesville by Alpha Portland Cement Co. The company mined shale at a nearby pit and purchased limestone, sand, gypsum, and iron ore. Most of the output was consumed within the State, in ready-mixed concrete. Fifteen commercial operations produced 1.1 million tons of sand and gravel. Most of the output was processed for building and paving; bank-run material was used for fill. Among the principal operators were Consolidated Aggregates Corp., Nedrow; W. F. Saunders & Sons, Inc., Nedrow; and General Crushed Stone Co., Fayetteville. Onondaga Lightweight Aggregate Corp. manufactured fired-clay lightweight aggregate by the sintering process from shale mined at the nearby company's pit. Red clay for manufacturing pottery and flower pots was mined near Camillus by Syracuse Pottery Co., Inc. Minerals Processing Corp., Syracuse, expanded perlite shipped from western States. The expanded material was used principally in soil conditioning, building plaster, and as aggregate in ultralightweight concrete.

Ontario.—Sand and gravel was produced by 12 commercial operators for building, paving, filtration sand, ice control, and fill from pits located near Victor, Oaks Corners, Geneva, Clifton Springs, and Phelps. General Crushed Stone Co. produced crushed limestone for construction and railroad ballast at its Oaks Corners quarry. The operation was entered in the National Safety Competition and received a citation for having had no disabling work injuries during 1964.

Orange.—Commercial production of 589,000 tons of sand and gravel valued at $941,000 was reported by 17 producers. Most of the output was processed for use for building and paving and aggregate. A quantity of sand for filtration and highway ice control also was produced. Among the principal producers were The Windsor Building Supplies Co., Inc., Newburgh; Delaware Valley Sand & Gravel Co., Inc., Port Jervis; A. W. Hollenbeck, Inc., Chester; and Middletown Sand & Gravel Corp., New Hampton. The Jova Brick Works mined clay near Roseton for use in manufacturing building brick. Reed-sedge peat was produced from a bog near Tuxedo by Sterling Forest Peat Co., Inc., for sale in bulk and packages. Mt. Bethel Humus Co., Inc., produced humus from bogs near Middletown for sale in bulk.

Orleans.—Production of sand and gravel was reported by six commercial producers operating pits near Albion, Medina, Ridgeway, Shelby, and Barre.

Oswego.—Sand and gravel for building, paving, and fill was produced from pits located at Lacona, Oswego, and Hastings by four operators. Whitehead Bros. Co. produced molding sand from a pit near Pulaski.

Otsego.—Limestone for concrete aggregate, roadstone, and riprap was produced by Barrett Division, Allied Chemical Corp. at its Springfield quarry. Oneonta Blue Stone Co., Inc., produced dimension sandstone for construction and cut stone for architectural applications at Oneonta. Unadilla Concrete Products Co., Unadilla, produced sand and gravel for ready mix. From a pit near Milford, Seward Gravel Co. produced sand and gravel for building, highway maintenance, and fill.

Putnam.—Leemac Sand & Stone Corp., Cold Spring, produced sand for highway ice control and sand and gravel for building and paving. Harlem Valley Crusher Co., Inc., Patterson, produced sand and gravel for paving.

Rensselaer.—Total commercial sand and gravel production was 685,000 tons. Seventeen operations produced sand and gravel for building, paving, highway ice control, filter sand, and fill. Among the larger producers were Albany Gravel Co., Inc., Albany; Calhoun Bros. and Valente Sand & Gravel, both of Troy; Capitol District Sand & Gravel Co., Inc., Mechanicsville; and Troy Sand & Gravel Co., Inc., West Sand Lake. Fitzgerald Bros. Construction Co., Inc., produced crushed graywacke at the Campbell Mountain quarry, Brunswick, for use as concrete aggregate and roadstone.

Richmond.—U.S. Gypsum Co. calcined gypsum at its New Brighton plant for use in manufacturing building products.

Rockland.—New York Trap Rock Corp. operating basalt quarries at Haverstraw and West Nyack and a limestone quarry at Tomkins Cove, mined and crushed stone for concrete aggregate, roadstone, and stone sand. Crushed basalt was produced by Suffern Stone Co., Inc., for concrete and roadstone. The Tomkins Cove quarry operation of New York Trap Rock Corp. was entered in the National Safety Competition and was awarded a citation for having had no disabling work injuries during the year. Sand and gravel for building and fill were produced at Sparkill by Graney Building Material Corp., and at Congers, by Mt. Ivy Sand & Gravel Co. Sand and gravel for paving was produced by Ward Pavements, Inc., from a pit at Thiells. Gypsum was calcined by U.S. Gypsum at its Stoney Point plant.

St. Lawrence.—Iron ore (magnetite) was mined by open pit at the Benson mine near Star Lake by Jones & Laughlin Steel Corp. Ore was broken on three benches averaging 50 feet in height and concentrated by heavy media, flotation, magnetic separation, and separation in spirals. Most of the concentrates were agglomerated by sintering before shipment for use in the manufacture of pig iron and steel. A quantity of the concentrates and sinter fines was used as a heavy medium in the beneficiation plant.

Zinc was produced at the Edwards mine, and zinc, lead, and silver were recovered at the Balmat mine by St. Joseph Lead Co. Explora-

tion and development to extend ore bodies and to prepare additional stopes for mining were continued at both mines. As part of the program to expand production at the Edwards mine, a new hoist was installed on the 1,300-foot level, and a ball mill and classifier were erected in the mill. Zinc concentrate from both mines was shipped to the St. Joseph Lead Co. smelter at Josephtown, Pa., and lead concentrate from the Balmat mine was shipped to the company-owned Herculaneum (Missouri) smelter for treatment. A quantity of silver was recovered from lead concentrates.

International Talc Co., Inc., recovered talc from two underground mines and one open-pit mine. Underground mining was by sublevel stopes with pillars. Raises and drifts were driven to prepare additional stopes in advance of mining. Development work at the Arnold open-pit mine consisted of stripping. The mill was improved by installation of a new crushing and screening plant. Gouverneur Talc Co., Inc., recovered talc from room and pillar stopes at its Balmat mine near Fowler. Raises, drifts, crosscuts, and sublevel drifts were prepared for additional blocks of ore for stoping. A new building was erected at the mine to house the electrical and timber shops and additional space was added to the laboratory at the mill.

McConville, Inc., Ogdensburg, and Barrett Division of Allied Chemical Corp., Norfolk, mined and crushed limestone for construction, agstone, cement, and riprap. Balducci Crushed Stone Co. mined marble at Gouverneur for roadstone and agricultural purposes. Sand and gravel was produced by 10 commercial operators. Among the largest of these were Putnam-Hawley Building Materials, Inc., Potsdam; George Cooke Sprague ville; and H. W. Gaines, Inc., Potsdam. Most of the output was used for paving and building construction.

Saratoga.—Pallette Stone Corp., Saratoga Springs, quarried and crushed limestone for use as concrete aggregate, roadstone, agstone, and riprap. Glens Falls Portland Cement Co., a division of The Flintkote Co., produced limestone for cement at Glens Falls. A belt conveyor system was installed to transport stone from the quarry to the cement plant. Production of sand and gravel for building, paving, and fill was reported from pits at Waterford, Corinth, and Mechanicville. Engine and molding sand was produced at eight pits located near Milton, Ushers, Clifton Park, Mechanicville, and Jonesville.

Schenectady.—Commercial sand and gravel was produced from 10 pits; 3 near Schenectady, 4 near Rotterdam, 1 at Glenville, and 2 at unspecified localities. Most of the output was used for paving but some was used for building and other purposes.

Schoharie.—Penn-Dixie Cement Corp. purchased the Howes Cave plant of Marquette Cement Manufacturing Co. early in January and operated it throughout the year to produce portland and masonry cement. The company used limestone and shale mined at nearby quarries; gypsum and iron ore were purchased. Shipments were principally to consumers in New York and New England. Penn-Dixie participated in the National Safety Competition and received a citation for having had no disabling work injury in 1964. Crushed limestone for construction was produced by Cobleskill Stone

Products Division of Allied Materials Corp. and Schoharie Stone Corp. Minus 20-mesh limestone for agricultural purposes was prepared by Masick Soil Conservation Co., at Schoharie. Sand and gravel for building and fill was produced from a pit at Jefferson.

Schuyler.—Brine was pumped from salt wells near Watkins Glen by International Salt Co. and Watkins Salt Co., Inc. Salt was recovered from brine in vacuum pans. Some of the salt was sold in pressed blocks. Output was used chiefly by the food and chemical industries. Shipments were made to 34 States, District of Columbia, Puerto Rico, and several foreign countries. Watkins Transit Mix, Inc., produced building sand and gravel and bank-run material for fill from a pit near Watkins Glen.

Seneca.—Limestone was mined for construction purposes at Seneca Falls by Warren Brothers Road Co. Reedsedge peat was produced from bogs near Junius by Finger Lakes Peat Moss Co. The peat was shipped in bulk.

Steuben.—Sand and gravel was produced by Rhinehart Sand & Gravel, Inc., and Dalrymple Gravel & Construction Co., both of Corning and Bath Sand & Gravel Mix, Bath. Output was used for building, paving, and fill. A small quantity of sand and gravel was produced by The Buffalo Slag Co., Inc. at Cohocton.

Suffolk.—Suffolk ranked first among sand-and-gravel producing counties with 6.1 million tons recovered at 22 operations. Output of more than 500,000 tons was reported by five producers. Most (85 percent) of the sand and gravel was processed before shipment; 49 percent was shipped by truck, 1 percent by railroad, and 50 percent by waterway.

Sullivan.—Sullivan Highway Products Co. produced crushed sandstone at the Bridgeville quarry, Monticello, and Fosterdale quarry, Kenoza Lake. Output was used for concrete aggregate and roadstone. Capacity of the Bridgeville operation was improved by installation of a larger primary crusher. Sand and gravel was produced by three operators from pits near Monticello, Mongaup Valley, and Summitville. Most of the output was processed.

Tioga.—Combined production of 272,000 tons of sand and gravel was reported by four operators from pits at Owego, Barton, and Waverly. Output was used for building, paving, highway ice control, railroad ballast, and drainage gravel.

Tompkins.—Cayuga Rock Salt Co., Inc., recovered rock salt from its underground mine near Myers. The product, used mostly for ice control on highways and by the chemical industry, was consumed mainly within the State. Principal out-of-State shipments were to Massachusetts, New Jersey, Pennsylvania, and Vermont. Limestone mined by Cayuga Crushed Stone, Inc., at South Lansing was used mainly for construction, agstone, riprap, and blast-furnace flux. A grinding mill and auxiliary equipment was installed for preparing agricultural limestone. Finger Lakes Stone Co., Inc., Dryden, quarried sandstone and produced sawed and cut architectural stone, as well as irregular shaped stone for facing. Rumsey-Ithaca Corp. and University Sand & Gravel Co., both of Ithaca, produced sand and gravel for building, paving, highway ice control, drainage, and fill.

Ulster.—Ulster County ranked third in value of cement production. Hudson Cement Division, Colonial Sand & Stone Co., Inc., Kingston, produced portland cement at its newly enlarged plant. Limestone from a nearby quarry was the principal cement raw material. Most of the cement output was shipped by barge to New York City for use in ready-mixed concrete. Shipments also were made to other destinations in New York, as well as to Connecticut and New Jersey. Century Cement Mfg. Co., Inc., made natural and masonry cements from cement rock mined underground. Shipments of masonry cement from the Century plant were principally to consumers in New York, New Jersey, eastern Pennsylvania, and Connecticut.

The Callanan Road Improvement Co. mined and crushed limestone for use in construction at its quarry near Kingston. The operation was entered in the National Safety Competition and received a citation for having had no disabling work injuries during 1964. Shale from the Esopus formation was mined for lightweight aggregate by Hudson Lightweight Stone Division, Colonial Sand & Stone Co., Inc., and Nytralite Aggregate, Inc., Division of New York Trap Rock Corp. near Kingston. Also near Kingston, The Hutton Co. and Star Brick Co. mined clay for manufacturing building brick. The Nytralite quarry operation was entered in the National Safety Competition and received a citation for having no disabling work injuries during 1964. Sand and gravel was recovered by Hurley Sand & Gravel Co., High Falls, Inter-County Block Corp., Marlboro, and Orange & Ulster County Shale Co., Inc., Milton.

Warren.—Glens Falls Portland Cement Co., a Division of The Flintkote Co., produced portland and masonry cements by the wet-process in three rotary kilns at its Glens Falls plant. The principal raw material was limestone; other raw materials included gypsum, sand, and iron ore. Shipments were principally in bulk by truck and railroad to consumers in New York and New England. Abrasive garnet, mined by open pit methods, was processed at the North Creek plant of Barton Mines Corp. The carefully-sized garnet was used for sandpaper, grinding and polishing glass, and lapping metal. Garnet gem and mineral specimens were in demand by collectors and amateur lapidarists. Rough specimens and polished garnet from this deposit were marketed commercially. Limestone was mined and crushed for construction purposes at the Glens Falls quarry of the Jointa Lime Co., Inc. Granite produced near Chestertown by Warren Aggregates, Inc., was used for concrete aggregate, roadstone, stone sand, and riprap. Raymond E. Bates Sand & Stone at Glens Falls and Warren Aggregates, Inc., at Chestertown produced sand and gravel for paving and fill.

Washington.—Production of dimension slate was reported by six operators near Granville, three near Middle Granville, two near Hampton, and one at East Whitehall. Products were flagstone, tile, structural slate, and roofing, in decreasing order of tonnage. Western Slate Co., Granville built a new mill building and installed a diamond saw to cut tile. William McCullen, Granville, added a power shovel and dump trucks to improve quarry operations. Williams Bros. Slate Quarry, Middle Granville, installed a diamond saw for cutting slate. Tri-County Stone Co., Inc., mined and crushed limestone at its Hudson

Falls quarry. The output, used principally for concrete aggregate and roadstone, was delivered by truck. Sand and gravel, mostly bank run, was produced from pits at Greenwich, Salem, and Dresden.

Wayne.—General Crushed Stone Co. produced limestone for building and agricultural purposes. Dolomite Products Co. mined and crushed limestone for concrete aggregate and roadstone at its Walworth plant. Sand and gravel for building, paving, fill, and ice control was recovered from pits near Palmyra, Red Creek, and Galen; shipments were made by truck.

Westchester.—Dimension granite was produced from two quarries near Yonkers by Baratta & D'Amato and Di Rienzo Brothers and at East White Plains by Lake Street Granite Quarry, Inc. Output consisted principally of dressed stone for construction work, curbing, and rough construction stone. A small quantity of broken stone for fill was sold by the Lake Street Quarry. Universal Marble Products Corp. mined marble at Thornwood. Crushed marble was used for garden nuggets and terrazzo; ground marble was sold for use as a filler in asphalt and hand soap and for agricultural purposes.

Sand and gravel for building, paving, and fill was recovered from pits near Carmel and Peekskill. Peekskill Emery Co., Di Rubbo American Emery Ore, and De Luca Emery mine recovered emery from open pit mines near Peekskill for use as an aggregate in heavy-duty nonslip floors and pavements and for other abrasive purposes. Shredded humus peat, produced from bogs near Armonk, was shipped in bulk by Stone Age Humus Corp.

Wyoming.—Morton Salt Co. produced evaporated salt in vacuum pans at its Silver Springs plant. Some of the salt was sold in pressed blocks. Sales were chiefly for food processing, chemical, and industrial purposes. American Blue Stone Co. quarried sandstone at its Ambluco quarry near Portageville. The finished stone was sold as cut and sawed architectural stone, flagging, rubble, and irregular shaped facing stone. Production capacity and efficiency were improved by installation of a two-strand wire saw, crane, hoist, and pump.

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 more than $56 million, about $2 million above the previous record year of 1962. Principal minerals mined were stone, sand and gravel, feldspar, lithium minerals, clays, and mica.

North Carolina ranked first among the States in the production of lithium minerals, feldspar, and mica, second in the production of olivine and crushed granite, and third in talc.

Mobil Oil Co. was evaluating 2.4 million acre off-shore leases along the North Carolina coast with two seismic crews and had options on an additional 3.6 million acres.

TABLE 1.—Mineral production in North Carolina [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones (millstones)	(2)	$2		
Clays [3] thousand short tons	2,735	1,761	3,199	$2,064
Feldspar thousand long tons	268	2,821	324	3,085
Gem stones	(2)	14	(2)	15
Gold (recoverable content of ores, etc.) troy ounces	33	1		
Iron ore (usable) long tons, gross weight	730	10		
Lead (recoverable content of ores, etc.) short tons	62	13		
Mica:				
Scrap thousand short tons	62	1,497	64	2,027
Sheet pounds	92,961	13	242,662	58
Phosphate rock thousand long tons			6	41
Sand and gravel thousand short tons	11,028	10,132	11,150	10,404
Silver (recoverable content of ores, etc.) troy ounces	26,754	34		
Stone thousand short tons	15,701	25,683	[4] 17,943	[4] 30,378
Talc and pyrophyllite do	107	446	106	495
Zinc (recoverable content of ores, etc.) short tons	13	3		
Value of items that cannot be disclosed: Asbestos, cement, copper (1963), kaolin, lithium minerals, olivine, stone (marble and slate 1964), and tungsten		r 2,095		7,903
Total		r 44,525		56,470

r Revised.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Excludes kaolin; included with "Value of items that cannot be disclosed."
[4] Excludes certain stone; included with "Value of items that cannot be disclosed."

[1] Geologist, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, North Carolina Geological Survey, Raleigh, N.C.

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

(Thousands)

Year	Value	Year	Value
1955	$44,703	1960	$44,196
1956	41,641	1961	r 50,004
1957	38,066	1962	r 54,352
1958	41,521	1963	r 45,131
1959	40,365	1964	55,478

r Revised.

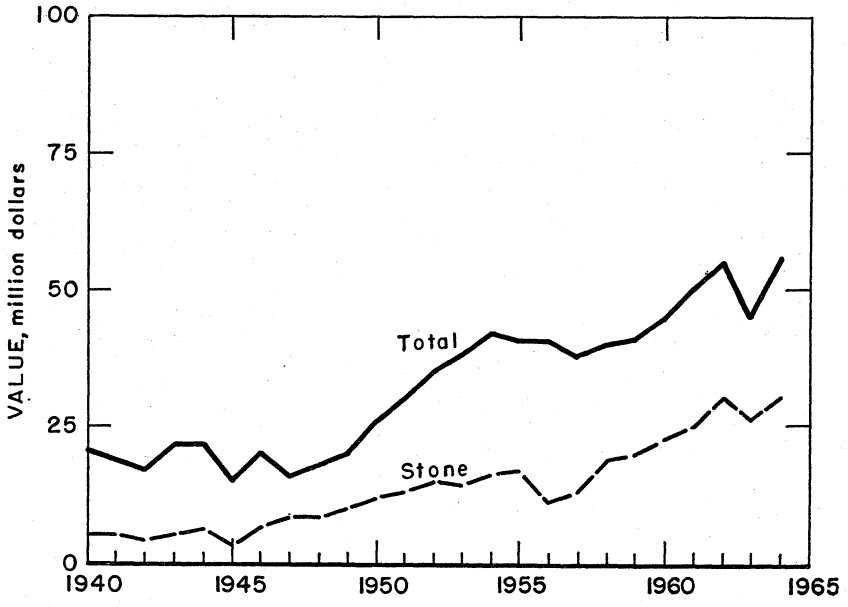


FIGURE 1.—Value of stone and total value of mineral production in North Carolina.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Powhatan Mining Co. mined amphibole asbestos near Burnsville in Yancey County. Production and value increased over 50 percent.

Cement.—Ideal Cement Co. operated a plant at Castle Hayne, Hanover County. Shipments of portland and masonry cement increased substantially during this first full year of production.

Raw materials used in manufacturing were limestone, clays, gypsum, and pyrite cinders. Two 11 by 450 kilns were operated. A wet production process was used in the cement manufacture. A total of 58 million kilowatt-hours of electricity was consumed; all was purchased. Annual capacity of this plant is 3.5 million barrels.

Types I and II, general-use and moderate-heat cements, and Type III, high-early-strength cement were produced. Out-of-State markets for the cement were chiefly in Florida, followed by Alabama, South Carolina, Virginia, Georgia, and Tennessee. The cement was shipped by railroad and truck, chiefly in bulk; no movement by boat was reported. Sales of portland cement were to ready-mixed concrete companies, concrete product manufacturers, highway contractors, building material dealers, and the remainder was sold to other sources.

Clays.—Miscellaneous clay production increased 16 percent in tonnage and 17 percent in value. Kaolin increased slightly in both production and value. Harris Clay Co., Avery County, was the only kaolin producer. Miscellaneous clay was mined by 27 companies from 34 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 & Tile Co., and Pomona Pipe Products Co.

Feldspar.—Mixed and soda feldspar made up the bulk of feldspar production with some potash type produced. Flotation concentrate constituted 93 percent of the total crude production. International Minerals & Chemical Corp. (Hawkins mine), The Feldspar Corp. (Poteat, Wiseman, and Bacchus mines), and Lawson-United Feldspar and Minerals Co. (Minpro mine) mined alaskite and recovered feldspar concentrate in Mitchell and Yancey Counties. Foote Mineral Co. recovery byproduct feldspar at its lithium plant in Cleveland County. Crude lump feldspar from Mitchell and other counties comprised the balance of the production. Sales of ground feldspar totaled 361,000 tons, a 22-percent increase over those of 1963 and setting a new record year. Value was $3,882,000, an increase of 8 percent over that of 1963. The ground feldspar was used mainly for glass and pottery with a small amount for enamel.

Gem Stones.—Among the gem minerals collected were sapphire, beryl, ruby, emerald, smoky quartz, corundum, rhodolite, garnet, and amethyst.

Lithium.—Foote Mineral Co. mined and milled spodumene at Kings Mountain, Cleveland County. A long-term contract was signed with Metallgesellschaft, A.G., of Frankfort, West Germany. Shipments of lithium ore were expected to begin in 1964 and to continue for about 60 years. The company received the Mining Congress Journal Certificate of Merit in recognition of its outstanding achievement in working 1,252,474 man-hours during a 6-year period without a lost-time accident.

Mica.—Production of mica was reported from 17 mines in 4 counties, compared with 16 mines in 5 counties in 1963 and 78 mines in 10 counties in 1962. Mitchell County, with seven mines, accounted for 17 percent of the total value of mica production; Avery, Cleveland, and Yancey accounted for 80 percent; counties of origin could not be identified for the remaining 3 percent. Principal scrap mica producers were Deneen Mica Co., Inc., Southern Mica Co. of North Carolina, Western Mica of North Carolina, Inc., International Minerals & Chemical Corp., and Harris Clay Co. The leading producer of sheet mica was the Mitchell Lumber Co. (Abernathy mine), Mitchell County. Ten mica grinders were active in 1964; both wet and dry processes were used.

TABLE 3.—Ground mica sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Roofing	W	W	W	24,942	$793,600	$31.82
Paint	10,229	$1,090,416	$106.60	6,695	969,569	144.82
Rubber	3,554	491,191	138.21	3,967	603,342	152.09
Wallpaper	324	41,418	127.83	432	55,793	129.15
Plastics	322	43,597	135.39	W	W	W
Other uses [1]	42,497	1,743,975	41.04	19,469	912,418	46.87
Total	56,926	3,410,597	59.91	55,505	3,334,722	60.08

W Withheld to avoid disclosing individual company confidential data.
[1] Includes well drilling, welding rods, pipeline enamel, miscellaneous uses, and uses indicated by symbol W.

Olivine.—Production of olivine increased in both tonnage and value. Mines were operated in Jackson County by Harbison-Walker Refractories Co. and Balsam Gap Co. and in Yancey County by Wiseman Mining Co., Inc. The material was used for refractories, molding sand, and slag conditioner.

Phosphate Rock.—Texas Gulf Sulfur Co. (Lee Creek mine), Beaufort County, mined 80,400 long tons of crude ore which was used in pilot plant tests, and produced 5,800 tons of marketable product.

Perlite.—Carolina Perlite Co. Inc. expanded perlite at Gold Hill, Rowan County, from crude material from Colorado. Quantity and value decreased slightly from 1963 figures.

Sand and Gravel.—Sand and gravel continued to be the second leading mineral commodity produced in the State. Commercial sand accounted for 66 percent of the tonnage and 78 percent of the value in 1964. Overall commercial sales of sand and gravel decreased 3 percent in tonnage, but the value increased 1 percent. Government-and-contractor sand and gravel increased 11 percent in tonnage and 10 percent in value. Overall average unit values increased slightly. Commercial building sand and gravel accounted for 30 percent of the total tonnage and 33 percent of the total value; commercial paving sand and gravel accounted for 53 percent of the total tonnage and 48 percent of the total value, and industrial sand (unground) accounted for less than 1 percent of the total tonnage and value. Sand and gravel was produced in 85 counties. Commercial sand and gravel was produced in 12 counties, sand only was produced in 10 counties, and gravel only was produced in 8 counties. Forty companies operated 46 pits in 29 counties compared with 62 pits in 35 counties in 1963. Government-and-contractor output of sand occurred in 70 counties, gravel only in 1 county, and sand and gravel in 6 counties. Five percent of the commercial sand and gravel production was sold as unprocessed material. Sixty-three percent of the commercially produced sand and gravel was transported by truck, and 37 percent was transported by rail. Leading producers were the North Carolina State Highway and Public Works Commission, Becker County Sand & Gravel Co., W. R. Bonsal Co., Inc., and the lessees of B. V. Hedrick Gravel & Sand Co.

TABLE 4.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Alexander	55	$22	43	$17
Avery	W	W	58	45
Beaufort	92	41	102	42
Bertie	7	2	6	2
Bladen	62	38	68	44
Brunswick	30	18	36	21
Buncombe	791	914	W	W
Burke	92	104	W	W
Cabarrus	241	264	89	132
Camden	24	14	6	3
Carteret	8	3	8	3
Caswell	10	10	10	10
Catawba	46	18	52	21
Cherokee	W	W	46	37
Chowan	90	54	87	50
Clay	32	27	----	----
Cleveland	155	101	W	W
Columbus	72	43	71	46
Currituck	42	25	36	22
Dare	5	3	1	1
Davidson	290	145	320	159
Davie	52	31	158	114
Duplin	28	20	17	11
Edgecombe	170	133	133	104
Forsyth	W	W	117	140
Franklin	11	6	8	4
Gaston	40	16	107	43
Gates	16	9	7	4
Graham	125	100	----	----
Granville	5	6	5	2
Greene	30	14	63	26
Guilford	7	6	5	5
Halifax	W	W	59	23
Hertford	25	15	33	8
Hoke	16	10	47	15
Hyde	3	2	5	1
Iredell	69	27	72	29
Johnston	48	46	44	42
Jones	32	14	48	20
Lee	253	212	291	226
Lincoln	53	21	53	22
Macon	W	W	106	76
Martin	----	----	41	24
Mitchell	27	28	W	W
Montgomery	78	27	58	23
Moore	643	490	599	385
New Hanover	15	9	10	6
Onslow	25	15	21	12
Pamlico	2	1	1	1
Pasquotank	20	12	32	16
Pender	28	16	32	19
Perquimans	19	11	4	2
Person	2	3	5	2
Pitt	115	69	125	74
Polk	98	45	114	54
Richmond	58	35	25	16
Robeson	135	82	135	84
Rockingham	2	2	5	5
Rowan	60	30	70	35
Rutherford	124	50	120	48
Sampson	170	137	190	168
Scotland	28	11	25	14
Stanly	15	9	73	92
Stokes	54	32	65	39
Surry	20	30	7	11
Union	30	23	33	25
Vance	5	3	3	2
Wake	4	3	6	4
Washington	11	7	2	1
Wayne	W	W	40	28
Wilkes	104	78	111	85
Wilson	72	57	87	63
Yadkin	7	11	3	5
Yancey	98	90	25	36
Undistributed [1]	5,829	6,183	6,666	7,455
Total	11,028	10,132	11,150	10,404

W Withheld to avoid disclosing individual company confidential data.

[1] Includes Anson, Ashe, Caldwell, Craven, Cumberland, Harnett, Haywood, Henderson (1963), Lenoir, Madison (1964), McDowell, Mecklenburg, Northampton, Transylvania (1963), and Watauga 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	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Paving	2,484	$1,448	$0.58	3,012	$1,884	$0.63
Structural	2,682	2,142	.80	2,311	1,865	.81
Fill	424	277	.65	453	293	.65
Other sands [1]	539	269	.50	701	326	.47
Total	6,129	4,136	.67	6,477	4,368	.67
Gravel:						
Paving	2,741	2,760	1.01	2,918	3,135	1.07
Structural	1,579	2,194	1.39	1,038	1,661	1.60
Railroad ballast	W	W	W	63	54	.86
Fill	7	6	.81	51	43	.84
Other gravel	[2] 569	[2] 1,037	[2] 1.82	603	1,143	1.90
Total	4,899	5,996	1.22	4,673	6,036	1.30
Total sand and gravel	11,028	10,132	.92	11,150	10,404	.93

W Withheld to avoid disclosing individual company confidential data.
[1] Includes blast, filtration, railroad ballast, and other uses.
[2] Includes railroad ballast gravel.

Stone.—Stone was the principal mineral commodity of the State. Crushed stone made up over 99 percent of the total production.

Crushed traprock production decreased 12 percent in tonnage but increased 1 percent in value; crushed granite increased 15 percent in tonnage and 18 percent in value, and crushed limestone increased 40 percent in tonnage and 46 percent in value. Production of crushed sandstone increased 81 percent in tonnage and 45 percent in value, and crushed marble increased in both tonnage and value. Output of dimension granite decreased 4 percent but showed a 24-percent increase in value; tonnage and value of dimension slate remained the same. Byproduct quartz was recovered from feldspar flotation plants in Mitchell County.

Stone was quarried in 40 counties: Granite in 30, traprock in 9, limestone in 6, slate in Davidson and Montgomery, marble in Cherokee. Commercial stone, excluding quartz, was produced by 30 operators from 78 quarries: 56 granite, 10 traprock, 9 limestone, 2 slate, and 1 marble. The State highway department crushed stone from six granite and three traprock quarries.

Leading producers of crushed granite were Superior Stone Co. (Alamance, Catawba, Gaston, Guilford, Iredell, Mecklenburg, Pitt, Randolph, Rockingham, Rowan, Wake, and Wilson Counties), W. E. Graham & Sons (Buncombe, Caswell, Forsyth, Guilford, Surry, Vance, Wilkes, and Yadkin Counties), and Nello L. Teer Co. (Nash and Wake Counties).

Leading producers of dimension granite were North Carolina Granite Corp. (Surry County), Harris Granite Quarries, and Crystal Pink Granite Co. (Rowan County).

Leading producers of crushed limestone were Superior Stone Co. (Cleveland, Craven, and Onslow Counties), Ideal Cement Co. (New Hanover County), and Fletcher Limestone Co., Inc. (Henderson County).

Leading producers of crushed traprock were Nello L. Teer Co. (Durham and Johnston Counties), Superior Stone Co. (Davidson, Guilford, and Union Counties), and Arrat Products Co. (Surry County).

Columbia Marble Co. quarried crushed and dimension marble. Jacob's Creek Stone Co. quarried dimension slate.

TABLE 6.—Crushed granite sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Cabarrus	86,060	$129,090	86,155	$129,232
Caldwell	W	W	82,000	95,000
Cherokee	13,205	31,111	57,485	86,349
Macon	104,827	104,827	126,000	126,000
Orange	22,483	33,725	33,620	50,430
Undistributed [1]	10,820,836	16,035,099	12,290,275	18,732,504
Total	11,047,411	16,333,852	12,675,535	19,219,515

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Alamance, Buncombe, Caswell, Catawba, Forsyth, Gaston, Guilford, Henderson, Iredell, Jackson, Madison (1963), Mecklenberg, Nash, Northampton (1963), Pitt, Polk, Randolph, Rockingham, Rowan, Rutherford (1963), Stokes (1963), Surry, Swain, Vance, Wake, Wilkes, Wilson, and Yadkin Counties, and counties indicated by symbol W.

Talc and Pyrophyllite.—Ground talc and pyrophyllite increased 2 percent in tonnage and 10 percent in value. Sawed talc (crayons) increased 9 percent in tonnage, and the value remained the same. Ground talc was sold principally for textile use and toilet preparations. Ground prophyllite was used mainly in refractories, ceramics, insecticides, and rubber products. Pyrophyllite was mined in Alamance, Moore, and Orange Counties, and talc was mined in Cherokee County. Leading producers were Piedmont Minerals Co., Inc., and Standard Minerals Co., Inc.

Vermiculite.—Zonolite Co. operated an exfoliating plant at High Point, Guilford County, using crude vermiculite shipped into the State. Principal uses for the finished product were as concrete aggregate, loose-fill insulation, and building plaster.

REVIEW BY COUNTIES

Ninety-four of the 100 counties reported mineral production; New Hanover, Cleveland, Mitchell, Guilford, and Rowan were the leading counties. The North Carolina State Highway and Public Works Commission produced sand and gravel, crushed granite, and crushed traprock in 79 counties for paving, concrete, and roadstone use. Output was obtained both by Commission crews and by contract workers. In addition to the detailed production listed in table 7, substantial quantities of mica, gem stones, and crude feldspar of undetermined county origin were produced. Counties with sand and gravel produc-

tion by the State highway department only are not discussed; see table 4 for additional details.

Alamance.—Superior Stone Co., a division of Martin Marietta Corp. (Burlington quarry), and the State highway department crushed granite for concrete and roads. Boren & Harvey, Inc., mined pyrophyllite at their Snow Camp mine for refractory and ceramic uses. Hanford Brick Co., Inc., mined miscellaneous clay for heavy clay products from their Hanford mine near Burlington.

Anson.—W. R. Bonsal Co., Inc. (Bonsal mine), the lessees of B. V. Hedrick Gravel and Sand Co. (Lilesville mine), and the State highway department mined sand and gravel for building, paving, railroad ballast, blasting, filtration, and other uses.

TABLE 7.—Value of mineral production in North Carolina, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value
Alamance	W	W	Granite, pyrophyllite, miscellaneous clay.
Alexander	$22,235	$17,000	Sand and gravel.
Alleghany	75		
Anson	W	W	Sand and gravel.
Ashe	W	W	Do.
Avery	W	W	Kaolin, mica, sand and gravel.
Beaufort	41,310	83,000	Sand and gravel, phosphate rock.
Bertie	1,795	2,000	Sand and gravel.
Bladen	38,000	44,000	Do.
Brunswick	17,700	21,000	Do.
Buncombe	W	W	Sand and gravel, granite.
Burke	104,925	W	Sand and gravel.
Cabarrus	W	W	Sand and gravel, traprock, granite.
Caldwell	W	W	Granite, sand and gravel.
Camden	13,860	3,000	Sand and gravel.
Carteret	3,375	3,000	Do.
Caswell	W	W	Granite, sand and gravel.
Catawba	W	W	Granite, miscellaneous clay, sand and gravel.
Chatham	481,220	496,624	Miscellaneous clay, traprock.
Cherokee	W	W	Marble, granite, talc, sand and gravel.
Chowan	53,500	50,000	Sand and gravel.
Clay	27,000		
Cleveland	W	W	Limestone, lithium minerals, mica, sand and gravel, feldspar.
Columbus	42,800	46,000	Sand and gravel.
Craven	W	W	Limestone, sand and gravel.
Cumberland	W	W	Sand and gravel, miscellaneous clay.
Currituck	25,000	22,000	Sand and gravel.
Dare	2,700	1,000	Do.
Davidson	W	W	Sand and gravel, traprock, slate, miscellaneous clay.
Davie	31,300	114,000	Sand and gravel.
Duplin	19,895	11,000	Do.
Durham	W	W	Traprock, miscellaneous clay.
Edgecombe	133,400	104,000	Sand and gravel.
Forsyth	W	W	Granite, sand and gravel.
Franklin	5,500	4,000	Sand and gravel.
Gaston	W	W	Granite, sand and gravel.
Gates	9,100	4,000	Sand and gravel.
Graham	100,000		
Granville	5,638	2,000	Sand and gravel.
Greene	13,783	26,000	Do.
Guilford	W	W	Granite, miscellaneous clay, traprock, sand and gravel.
Halifax	W	W	Miscellaneous clay, sand and gravel.
Harnett	W	W	Sand and gravel, miscellaneous clay.
Haywood	W	W	Sand and gravel.
Henderson	574,229	645,588	Limestone, granite, miscellaneous clay.
Hertford	15,000	8,000	Sand and gravel.
Hoke	10,540	15,000	Do.
Hyde	1,500	1,000	Do.
Iredell	W	W	Granite, sand and gravel.
Jackson	W	W	Olivine, granite.
Johnston	W	W	Traprock, sand and gravel, miscellaneous clay.
Jones	14,512	20,000	Sand and gravel.
Lee	W	W	Miscellaneous clay, sand and gravel.
Lenoir	W	W	Sand and gravel.
Lincoln	21,840	22,000	Do.
Macon	W	202,000	Granite, sand and gravel.

See footnotes at end of table.

TABLE 7.—Value of mineral production in North Carolina by counties—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Madison	W	W	Sand and gravel, feldspar.
Martin		24,000	Sand and gravel.
McDowell	W	W	Sand and gravel, feldspar.
Mecklenburg	W	W	Granite, sand and gravel.
Mitchell	3,167,493	3,406,078	Feldspar, mica, sandstone, sand and gravel.
Montgomery	W	W	Sandstone, sand and gravel, slate.
Moore	W	W	Sand and gravel, pyrophyllite, miscellaneous clay.
Nash	W	W	Granite.
New Hanover	W	W	Cement, limestone, miscellaneous clay, sand and gravel.
Northampton	W	W	Sand and gravel.
Onslow	W	W	Limestone, sand and gravel.
Orange	W	233,030	Pyrophyllite, granite.
Pamlico	900	1,000	Sand and gravel.
Pasquotank	11,800	16,000	Do.
Pender	16,500	19,000	Do.
Perquimans	11,200	2,000	Do.
Person	2,500	2,000	Do.
Pitt	W	W	Sand and gravel, granite.
Polk	W	W	Granite, sand and gravel.
Randolph	W	W	Granite.
Richmond	35,100	16,000	Sand and gravel.
Robeson	82,050	84,000	Do.
Rockingham	W	W	Granite, miscellaneous clay, sand and gravel.
Rowan	W	W	Do.
Rutherford	W	48,000	Sand and gravel.
Sampson	151,640	209,880	Sand and gravel, miscellaneous clay.
Scotland	10,868	14,000	Sand and gravel.
Stanly	350,628	457,111	Miscellaneous clay, sand and gravel, traprock.
Stokes	W	W	Miscellaneous clay, sand and gravel.
Surry	W	W	Granite, traprock, sand and gravel.
Swain	W	W	Limestone, granite.
Transylvania	W		
Union	W	W	Traprock, miscellaneous clay, sand and gravel.
Vance	W	W	Granite, sand and gravel, tungsten.
Wake	W	W	Do.
Washington	6,600	1,000	Sand and gravel.
Watauga	W	W	Sand and gravel, granite.
Wayne	W	28,000	Sand and gravel.
Wilkes	78,487	W	Granite, sand and gravel.
Wilson	W	W	Do.
Yadkin	W	W	Do.
Yancey	W	W	Mica, olivine, sand and gravel, feldspar, asbestos.
Undistributed	38,767,502	49,941,689	
Total	44,525,000	56,470,000	

W Withheld to avoid disclosing individual company confidential data.
[1] The following counties are not listed because no production was reported: Tyrrell and Warren.

Avery.—Harris Clay Co. (Gusher Knob and Kaolin mines) mined mica. Harris Clay Co. and English Mica Co. ground mica for paint, rubber, wallpaper, plastics, and other uses. Harris Clay Co. mined kaolin at the Gusher Knob mine for whiteware and refractory uses. Clark, Anderson & Guy (Frank mine) and the State highway department mined sand and gravel for paving use.

Beaufort.—Texas Gulf Sulphur Co. began mining at its Lee Creek mine near Aurora. Initial production was used in pilot plant tests. Plans were revealed for construction of a phosphoric acid and solid phosphate fertilizer material plant at the Lee Creek mine. Magnet Cove Barium Co. and North Carolina Phosphate Corp. (a subsidiary of Kennecott Copper Corp. and American Agricultural Chemical Co.) explored phosphate deposits in the same area as Texas Gulf Sulphur Co. The State highway department mined paving sand.

Buncombe.—Five companies mined sand and gravel for building, paving, fill, and other uses. Leading producers were Grove Stone &

Sand Branch (Grove mine) and Western Stone Co., Inc. (Asheville mine). W. E. Graham & Sons, a division of Vulcan Materials Co. and J. L. Colville Construction Co., Inc., crushed granite for concrete and roads, as well as for riprap. Asheville Mica Co. ground mica for rubber and other uses.

Burke.—Great Lakes Carbon Corp. manufactured carbon and graphite products at the Morgantown plant. A. P. Causby Sand & Stone Co. and the State highway department mined sand for building and paving uses.

Cabarrus.—Young Stone Co. (Gold Hill quarry) crushed traprock for concrete and road use. Coggins Granite Industries, Inc., of Elberton, Georgia started operations at a new quarry near Concord where a coarse-grained brown granite was being quarried. The State highway department mined paving sand and gravel and crushed granite for concrete and roads.

Catawba.—Superior Stone Co. (Hickory quarry) crushed granite for concrete and roads. Statesville Brick Co. (Statesville mine) mined miscellaneous clay for heavy clay products. The State highway department mined paving sand.

Chatham.—Pomona Terra Cotta Co. (Gulf mine), Boren Clay Products Co. (Gulf mine), Sanford Corp., and Cherokee Brick Co. of North Carolina mined miscellaneous clay for heavy clay products. The State highway department crushed traprock for concrete and roads.

Cherokee.—Columbia Marble Co. (Pleasant Valley quarry) crushed marble for terazzo and other uses and quarried dimension marble for rough interior, sawed and cut interior building stone, and cut and dressed monumental stones. Nantahala Talc & Limestone Co. (Valley River quarry) and the State highway department crushed granite for concrete and road use. Hitchcock Corp. (Nancy Jordan mine) mined talc for crayons, toilet preparations, textiles, and other uses. The U.S. Forest Service (North Carolina mine) mined gravel for fill.

Cleveland.—Superior Stone Co. crushed limestone at Kings Mountain quarries Nos. 1 and 2 for concrete, roads, and railroad ballast. Foote Mineral Co. at Kings Mountain mined and milled lithium minerals and also produced a quantity of byproduct feldspar for glass. Kings Mountain Mica Co., Inc. (Moss and Patterson mines), Western Mica of North Carolina (Industrial mine), and Foote Mineral Co. (Kings Mountain mine) produced scrap mica. Shelby Sand & Stone, Inc. (First Broad River mine) and the State highway department mined sand for building, fill, and other uses.

Craven.—Superior Stone Co. (New Bern quarry) and Nello L. Teer Co. crushed limestone for concrete and roads. Southern Sand Co., Inc. (New Bern mine) and State highway department mined sand for building and paving purposes.

Cumberland.—Becker County Sand & Gravel Co. (Fayetteville mine) and the State highway department mined sand and gravel for building and paving use. 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 mill stock and flagging. Cunningham Brick Co. (Thomasville mine) mined miscellane-

ous clay for heavy clay products. The State highway department mined paving sand and gravel.

Davie.—Mount Airy Sand Co. and the State highway department mined structural, paving, and other sand.

Durham.—Nello L. Teer Co. (Durham County quarry) crushed traprock for concrete and roads. Tri-Angle Brick Co. and Borden Brick & Tile Co. mined miscellaneous clay for heavy clay products.

Edgecombe.—Quality Sand & Gravel Co. (Rocky Mount mine), and Tar River Sand & Gravel (Whitehurst mine), and the State highway department mined sand and gravel for building, paving, fill, and other uses.

Forsyth.—W. E. Graham & Sons (North, Piedmont, and 421 quarries) produced granite for riprap, concrete, and roads. Ira Pope & Sons, Inc. (Yadkin River mine) and the State highway department mined sand for building and paving use.

Guilford.—Superior Stone Co. (Pomona, Jamestown, and Buchanan quarries) and W. E. Graham & Sons (Stokesdale quarry) produced granite for concrete, roads, and railroad ballast. Boren Clay Products Co. (Pleasant Garden mine) mined miscellaneous clay for heavy clay products. Superior Stone Co. (Hicone quarry) crushed traprock for concrete and road use. Zonolite Co. exfoliated vermiculite at the High Point plant. The State highway department mined paving sand.

Halifax.—Nash Brick Co., Inc. (Ita and Page mines) mined miscellaneous clay for use in heavy clay products. Albemarle Paper Manufacturing Co. recovered quicklime at the Roanoke Rapids mill. The State highway department mined paving sand and gravel.

Harnett.—Becker County Sand & Gravel Co. (Senter mine), and Nello L. Teer Co. (Erwin mine), and the State highway department mined sand and gravel for building, paving, railroad ballast, and other uses. Norwood Brick Co. (Lillington mine) mined miscellaneous clay for use in heavy clay products.

Henderson.—Fletcher Limestone Co. Inc. (Fletcher quarry) and Cogdill Limestone Co. crushed limestone for concrete and roads. Corn Products, Inc. (Corn quarry) crushed granite for concrete and roads. Moland-Drysdale Corp. (Fletcher mine) mined miscellaneous clay for use in heavy clay products.

Jackson.—Harbison-Walker Refractories Co. (Addie quarry) and Balsam Gap Co. (Balsam Gap mine) mined olivine for refractories, molding sand, and slag conditioners. Rock Products, Inc. (Dillsboro quarry) crushed granite for concrete and roads.

Johnston.—Nello L. Teer Co. (Princeton quarry) produced traprock for concrete and road use. Crumpler Brick & Tile Co. mined miscellaneous clay for use in heavy clay products. The State highway department mined paving sand.

Lee.—Sanford Brick & Tile Co., Inc. (Colon mine), Lee Brick & Tile Co., and Hanford Brick Co. (Colon mine) mined miscellaneous clay for use in heavy clay products. The State highway department mined paving sand and gravel.

Macon.—Franklin Construction Co. (Tubb Mill quarry) produced granite for concrete and roads. Rock Products, Inc. (Dills mine) mined paving gravel. Franklin Mineral Products Co. ground mica for paint, rubber, wallpaper, plastic, pipeline enamel, and other uses

McDowell.—Becker County Sand & Gravel Co. (Marion mine), E. P. Boyd, and the State highway department mined sand and gravel for building and paving uses. Tony Ledford produced crude feldspar from the Honeycutt mine.

Mitchell.—Twenty-three operators produced crude feldspar from 24 mines; the leading producers were International Minerals & Chemical Corp. (Hawkins mine), The Feldspar Corp. (Poteat and Wiseman mines), and Lawson-United Feldspar & Minerals Co. (Minpro mine). Ground feldspar for glass, pottery, enamel, filler, and tile uses was produced by International Minerals & Chemical Corp., Lawson-United Feldspar & Minerals Co., and The Feldspar Corp. Crushed sandstone (quartz) was recovered from these feldspar milling operations. Six operators mined mica from seven mines; the leading producers of scrap mica were Southern Mica Co. of North Carolina (Bailey mine), The Feldspar Corp. (Poteat and Wiseman mines), and International Minerals & Chemical Corp. (Hawkins mine). Four companies ground mica for paint, rubber, wallpaper, plastic, roofing, well drilling, and other uses; the leading producer was Carolina-Southern Mining Co., Inc. Pitman Stone Co., Inc. (Bakersville mine), Crabtree Stone & Gravel Co. (Crabtree mine), and Ellis Construction Co. (Spruce Pine mine) mined paving gravel.

Montgomery.—Thomas & Woody Mining Co. crushed sandstone for concrete and roads. Jacob's Creek Stone Co., Inc. (Edenboro quarry) quarried dimension slate for structural millstock and flagging. The State highway department mined paving sand.

Moore.—Five companies and the State highway department mined sand and gravel for building, paving, and fill. The leading producers were Pleasants Sand & Supply Co. (Pleasants mine) and Aberdeen Sand & Gravel Co. (Aberdeen mine). Standard Mineral Co., Inc. (Underground mine) and General Minerals Co. (Glendon mine) mined pyrophyllite for ceramics, insecticides, paint, rubber, plaster products, 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 their plant near Castle Hayne. Limestone and clay were mined from their Wilmington quarry for use in cement manufacture. The State highway department mined paving sand.

Northampton.—Superior Stone Co. and the State highway department mined sand and gravel for paving use.

Orange.—Piedmont Minerals Co., Inc. (Hillsboro mine) mined pyrophyllite for ceramic and refractory uses. Duke University quarried dimension granite for building stone and rubble purposes. The State highway department crushed granite for concrete and roads.

Pitt.—Concrete Products Co. (Greenville mine), White Concrete Co., Inc. (Munford mine), and the State highway department mined sand for building and paving uses. Superior Stone Co. (Fountain quarry) crushed granite for concrete and roads.

Rockingham.—Superior Stone Co. (Reidsville quarry) mined granite for concrete and road use. Webster Brick Co., Inc. (Draper mine) and Virginia Solite Corp. (Leakesville mine) mined miscellaneous clay for heavy clay products and lightweight aggregate respectively. Pine Hall Brick & Pipe Co., Winston-Salem, announced

plans for increasing brick production by 48 percent by adding a second kiln to the Madison plant. Output would be increased by 100,000 brick a day. The State highway department mined paving sand.

Rowan.—Five companies produced dimension granite from seven quarries for use as rough architectural stone, rough and dressed monumental stone, curbing and flagging, and paving blocks. The leading producer was Harris Granite Quarries Co. (Collins, Balfour, and Shuping quarries). Superior Stone Co. (Woodleaf and Kannapolis quarries) and Harris Granite Quarries Co. (Balfour and Collins quarries) produced granite for concrete and roads, railroad ballast, and riprap. Isenhour Brick & Tile Co. (East Spencer mine) and Carolina Tuff-Lite Corp. mined miscellaneous clay for use in heavy clay products and lightweight aggregate respectively. Carolina Perlite Co., Inc., expanded perlite at the Gold Hill plant. The State highway department mined paving sand.

Sampson.—Williams Sand & Gravel Co. (Williams mine) and the State highway department produced sand and gravel for paving. Sampson Brick Co., Inc. and Patterson Brick Co. mined miscellaneous clay for heavy clay products.

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. Aluminum Company of America began operating its new potline at the Badin aluminum reduction plant. Construction was completed April 9, and the plant was operating at peak capacity of 52,000 tons a year. The unit replaced a 47,500 ton capacity potline. The State highway department crushed traprock and mined sand and gravel for concrete and roads.

Stokes.—Pine Hall Brick & Pipe Co. (No. 1 mine) mined miscellaneous clay for heavy clay products. The State highway department mined paving sand.

Surry.—W. E. Graham & Sons (Elkins, Pilot Mountain, and Mount Airy quarries) and North Carolina Granite Corp. crushed granite for concrete and roads, riprap, railroad ballast, and poultry grit. North Carolina Granite Corp. (Mount Airy quarry) quarried dimension granite for rough dressed monumental stone, paving blocks, and curbing and flagging. Arrat Product Co. (Surry quarry) crushed traprock for concrete and roads. The State highway department mined paving sand.

Swain.—Nantahala Talc & Limestone Co. (Hewitt quarry) crushed limestone for concrete and roads, railroad ballast, and agricultural purposes. J. L. Colville Construction Co. (Colville quarry) crushed granite for concrete and roads.

Union.—Superior Stone Co. (Bakers quarry) and the State highway department crushed traprock for concrete and roads as well as for railroad ballast. Kendrick Brick & Tile Co. (Monroe mine) mined miscellaneous clay for heavy clay products. The State highway department mined paving sand.

Vance.—W. E. Graham & Sons (Greystone quarry) crushed granite for riprap, concrete and roads, and railroad ballast uses. The State highway department mined paving sand.

Wake.—Nello L. Teer Co. (Crabtree and Raleigh quarries) and Superior Stone Co. (Knightdale, Garner, and Rolesville quarries) produced granite for concrete, roads, and railroad ballast. The State highway department mined paving sand.

Watauga.—Maymead Lime Co., Inc. (Maymead mine) and Clark, Anderson & Guy (Boone mine) mined paving gravel. C. M. Shore, Jr., quarried dimension granite for rough architectural use.

Wayne.—Builders Supply Co. (Goldsboro mine) and the State highway department mined sand for building and paving use.

Wilson.—Superior Stone Co. (Neverson and Elm City quarries) produced granite for concrete, roads, and railroad ballast. Gray Concrete Pipe Co., Inc. (Stantonsburg mine), Deans Sand Co. (Wilson mine), and the State highway department mined sand for building, fill, and paving.

Yancey.—Deneen Mica Co. (International mine), Hassett Mining Co. (Simpson mine), Bourne Associates (Green Mountain mine), and Consolidated Mica Co. (Hillard mine) produced scrap mica. Deneen Mica Co. and Hassett Mining Co. ground mica for roofing, well drilling, and other uses. Wiseman Mining Co., Inc. (Wray mine) mined olivine for refractory uses. Yancey Sand & Gravel Co., Inc. (Fox mine) mined sand and gravel for building use. Buchanan & Winters (Winters mine), The Feldspar Corp. (Bacchus mine), J. C. Robinson (Robinson mine), Brad Thomas (Thomas mine), Arthur Boone (Boone mine), Joe Hughes (Green Mountain mine), Ray Street (Street mine), and Jack Buchanan (Briggs mine) mined crude feldspar. The Feldspar Corp. (Burnsville plant) ground feldspar for glass. Powhatan Mining Co. (Burnsville mine) mined amphibole asbestos.

The Mineral Industry of North Dakota

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 North Dakota for collecting information on all minerals except fuels.

By R. G. Raabe [1] and Charles A. Koch [2]

NORTH Dakota mineral production was valued at $92.9 million, 2 percent less than in 1963. Mineral fuels—coal (lignite), natural gas, natural gas liquids, peat, and crude petroleum—accounted for 88 percent of the total value of mineral production. The fuels value was $3 million or 3 percent less than in 1963.

TABLE 1.—Mineral production in North Dakota [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	[2] 5	[2] $10	85	$119
Coal (lignite)—do	2,399	5,250	2,637	5,659
Gem stones	([3])	1	([3])	1
Natural gas—million cubic feet	32,798	6,264	34,700	7,634
Natural gas liquids:				
LP gases—thousand gallons	79,653	3,166	84,338	2,960
Natural gasoline and cycle products—do	20,511	1,339	21,368	1,338
Petroleum (crude)—thousand 42-gallon barrels	25,030	68,332	25,731	63,813
Sand and gravel—thousand short tons	9,529	9,193	10,520	10,142
Stone—do	132	132	31	56
Uranium ore—short tons	5,567	141	W	W
Value of items that cannot be disclosed: Molybdenum (1964), peat, salt, and values indicated by footnote 2 and symbol W	XX	875	XX	1,144
Total	XX	r 94,703	XX	92,866

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] Excludes bentonite and miscellaneous clay, included with "Value of items that cannot be disclosed."

[3] Weight not recorded.

Uranium from the uranium-bearing lignites of southwestern North Dakota increased significantly over that of 1963. All production came from Billings and Stark Counties. The lignite was concentrated by burning at plants and by burning in place at mine sites; for further processing the ash was shipped to mills outside North Dakota.

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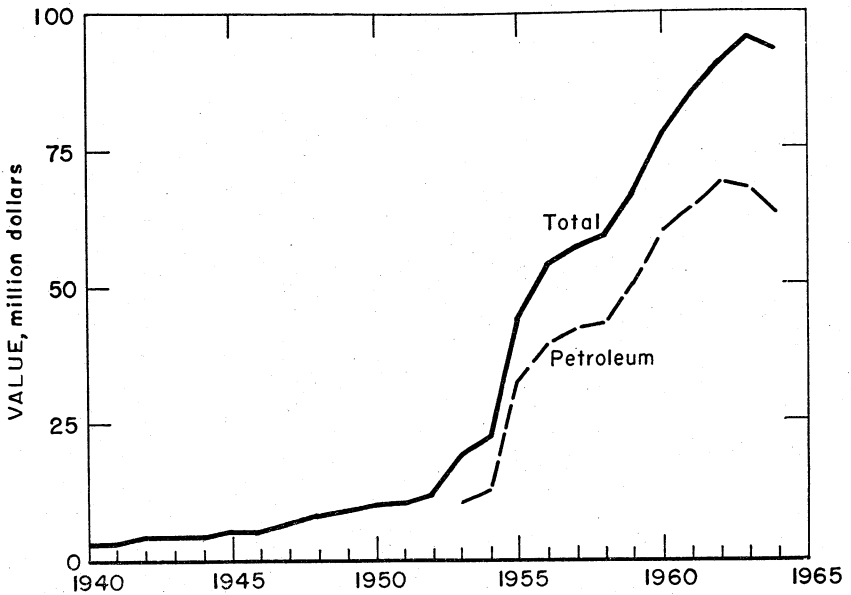


FIGURE 1.—Value of petroleum and total value of mineral production in North Dakota.

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

(Thousands)

Year	Value	Year	Value
1953	$20,736	1959	$68,099
1954	23,510	1960	78,641
1955	47,574	1961	84,485
1956	57,215	1962	r 89,128
1957	56,098	1963	r 93,121
1958	59,456	1964	89,940

r Revised.

Employment and Injuries.—Final statistics on employment and injuries in the mineral industries for 1963 and preliminary data for 1964, compiled by the Bureau of Mines, are given in table 3.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal and peat	320	66	514	1	17	35.02
Metal	12	1	8			
Nonmetal	40	9	73			
Sand and gravel	641	123	1,032		15	14.53
Stone	45	3	27			
Total	1,058	202	1,654	1	32	19.95
1964: p						
Coal and peat	332	67	520	1	15	30.77
Metal	40	11	82		3	36.59
Nonmetal	40	9	74		1	13.51
Sand and gravel	560	122	1,013		19	18.76
Stone	45	3	27			
Total	1,017	212	1,716	1	38	22.73

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Lignite).—A study that could lead to a United States-Canadian power interchange and construction of additional giant power-generating units in North Dakota moved nearer completion as five sponsoring utilities defined their interests at a meeting in Grand Forks.

Baukol-Noonan, Inc.; North American Coal Co.; and Truax-Traer Coal Co. Division, Consolidation Coal Co. were awarded annual coal contracts totaling about $450,000 by the State. Cass County, Cavalier Rural, Kodak Rural, and Sheyenne Valley Electric Cooperatives, and Ottertail Power Co. were awarded contracts to supply energy requirements for the Wing Six Minuteman Missile complex in eastern North Dakota.

Truax-Traer Coal Co. planned to employ a huge bucket-wheel excavator at its large new strip property, the Glenharold mine, near Stanton. The excavation wheel, largest in the world and first of its kind for lignite mining in the U.S., will weigh over 2,000 tons. The Glenharold mine is in the midst of the largest lignite reserve in the Nation and could supply the Basin Electric Power Cooperative powerplant for many years. The Basin Electric plant was under construction and will be the largest lignite-fueled powerplant in the Western Hemisphere. Contingent upon a Rural Electrification Administration (REA) loan, Basin Electric planned to double the size of the new 200-megawatt steam-generating plant. Company officials awarded a $1.1 million contract for constructing a powerline from the plant, at Stanton, to the Federal Bureau of Reclamation line near Washburn.

TABLE 4.—Coal (lignite) production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1963		1964	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Adams	[2] 274,307	[2] $2.42	15,637	$3.33
Bowman	165,112	1.89	139,867	1.8
Burke	283,324	2.31	[3] 535,187	[3] 2.28
Burleigh	(2)	(2)	7,988	3.34
Divide	(2)	(2)		
Dunn	3,714	2.92	2,809	3.00
Grant	19,590	3.05	19,930	2.99
Hettinger	3,487	4.36	2,919	3.16
McLean	61,299	3.28	47,842	3.37
Mercer	1,042,578	2.06	1,237,512	2.02
Morton	12,784	2.60	(3)	(3)
Oliver	7,623	2.50	(3)	(3)
Stark	68,778	1.57	88,848	1.66
Ward	454,512	2.23	536,345	2.24
Williams	1,880	4.60	1,867	4.62
Total	2,398,988	2.19	2,636,751	2.15

[1] Value received or charged f.o.b. mine, including selling cost. (Includes a 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] Production of Burleigh and Divide Counties combined with Adams County to avoid disclosing individual company confidential data.

[3] Production of Morton and Oliver Counties combined with Burke County to avoid disclosing individual company confidential data.

Baukol-Noonan, Inc., announced that its new lignite mine near Larson was in full operation. The new $500,000 tipple, 1 mile west of the mine, had a capacity of 400 tons per hour. Lignite reserves under 35 feet of overburden at the Larson mine were estimated to be 20 million tons.

Research was continuing on a process for producing a gas from lignite which would be similar to natural gas. Although the basic process had been known for years, refinements were needed to make the process economically successful on a large scale. Under a cooperative agreement, the University of North Dakota and the Great Northern Railway Co. (research sponsor) were working to develop a simple, inexpensive, one-step method of converting lignite to a gas containing hydrogen and carbon monoxide. Truax-Traer Coal Co. contracted with the Office of Coal Research, U.S. Department of the Interior, to develop an economical, large-scale process whereby lignites could be converted to a gas similar to natural gas.

To freezeproof shipments by reducing their moisture content, as well as to combat freezing, Truax-Traer Coal Co. installed heat dryers at some of its lignite mines; this process also improved the B.t.u. content.

A new process developed at North Dakota State University gives lignite commercial potential as a soil conditioner-fertilizer.

Investigations by the Federal Bureau of Mines at the Charles R. Robertson Lignite Research Laboratory at Grand Forks continued throughout the year. The program included investigations of lignite as a source of carbon disulfide, the gasification of lump fuel with oxygen, and a survey of the composition and properties of lignite ash and fireside boiler deposits.

Natural Gas.—Dry natural gas was produced only in Bowman County; most of the oil well gas was produced in Burke, McKenzie, and Williams Counties. The oil well gas was processed at three gas plants, one each at Lignite in Burke County and at McGregor and Tioga in Williams County. The residual gas was sold to, and distributed by, Montana-Dakota Utilities Co.

Natural Gas Liquids.—Included in the natural gas liquids were natural gasoline, butane, and propane—products recovered at the three plants. Natural gasoline production increased 5 percent over that of 1963;[3] the combined output of butane and propane increased 4 percent.[4]

Petroleum.—Petroleum production from 126 pools in 13 counties increased 3 percent over that of 1963.[5] The sale price of crude oil by oil-producing companies was reduced by 9 percent, and although production increased, the total value of output declined 7 percent. According to the American Petroleum Institute, oil in recoverable reserves was 377.2 million barrels in 1964 compared with 389.2 million barrels in 1963. Drilling activity increased by 94 wells, from 182 to 276 completions.

TABLE 5.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1963	1964	Principal fields in 1964 in order of production
Billings	650	747	Fryburg, Rocky Ridge.
Bottineau	2,427	2,581	Newburg, South Westhope, Wiley, Haas.
Bowman	1,068	790	Cedar Creek.
Burke	3,481	3,450	North Tioga, Black Slough, Rival, Portal, Lignite.
Divide	352	318	North Tioga, Stoneview.
Dunn	30	28	Lost Bridge.
McHenry	42	56	Pratt.
McKenzie	6,671	7,061	Antelope, Blue Buttes, Charlson, Clear Creek.
Mountrail	1,405	1,418	Tioga, White Earth.
Renville	1,842	2,061	Sherwood, Glenburn.
Stark	38	52	Dickenson.
Ward	14	26	Southwest Aurelia.
Williams	7,010	7,143	Beaver Lodge, Tioga, Capa, Grenora.
Total	25,030	25,731	

Source: North Dakota Geological Survey.

The most significant discovery of the year was the Medora field in Billings County, approximately 7 miles from the nearest production. The discovery well, No. 1 NP–M Tract–1, SE¼SE¼ sec 11, T 139 N, R 102 W, initially produced 863 barrels of oil per day.

Two secondary-recovery operations were begun during the year, one in the Cedar Creek-Ordovician Pool in Bowman County, the other in the Hawkeye-Madison Pool in McKenzie County. The initiation of these recovery operations was to increase the recoverable reserve by 17 million barrels.[6]

[3] Official Oil in North Dakota. North Dakota Geological Survey. First Half 1963. October 1963, pp. 1–123. Second Half 1963. June 1964, pp. 1–131. First Half 1964. September 1964, pp. 1–132. Second Half 1964. May 1965, pp. 1–138.
[4] Work cited in footnote 3.
[5] Work cited in footnote 3.
[6] Folsom, Clarence B., Jr., chief petroleum engineer. North Dakota Crude Oil Inventory as of Jan. 1, 1965. Miscellaneous Series #25, p. 1.

TABLE 6.—Wildcat- and development-well completions in 1964, by counties

County	Oil	Dry	Total	Footage
Wildcat:				
Billings	1	1	2	17,900
Bottineau	5	29	34	132,400
Burke	2	12	14	97,000
Divide		8	8	59,300
Golden Valley		1	1	9,200
Grant		1	1	8,900
La Moure		1	1	1,800
McHenry		4	4	16,100
McKenzie	1	1	2	24,000
Mercer		1	1	10,400
Mountrail		5	5	43,800
Renville	5	27	32	158,100
Slope		1	1	10,100
Stark		1	1	11,800
Ward		5	5	26,400
Wells		1	1	3,400
Williams		10	10	84,300
Total	14	109	123	714,900
Development:				
Billings	7	2	9	80,700
Bottineau	17	14	31	108,500
Bowman	4	1	5	42,300
Burke	23	17	40	266,100
Divide	1		1	8,000
McHenry	2		2	8,500
McKenzie	6		6	63,800
Mountrail		1	1	6,900
Renville	33	16	[1] 50	230,200
Stark	1		1	9,300
Ward	1		1	6,800
Williams	4	2	6	52,900
Total	99	53	[1] 153	884,000
Total all drilling	113	162	[1] 276	1,598,900

[1] Includes 1 service well.

Source: Oil and Gas Journal.

Pipeline expansions during the year included a 112-mile extension by Portal Pipeline Co. and a 33-mile pipeline by Houck Transport Co. To provide service to fields in the Grenora area and to the Dwyer and Goose Lake fields in Montana, Portal Pipeline Co. extended its line from Berthold to Grenora. The Houck Transport Co. constructed a line from Tioga to the refinery at Williston.

Refineries at Mandan and Williston were operated the entire year. Toward the end of the year, a record rate of 48,000 barrels per day was reported at the American Oil Co. Mandan refinery. The Westland Oil Co. Williston refinery was operated at a 50-percent capacity of the 1963 rate. Total throughput for the refineries was 16.5 million barrels; approximately 16.2 million barrels went through the refinery at Mandan and the remainder through the refinery at Williston. The refinery runs were primarily from North Dakota crude, but included 124,000 barrels of Montana crude. Interstate shipments, 9.2 million barrels, were transported primarily by the Portal pipeline to Minnesota; a small amount was shipped to Wyoming refineries.

NONMETALS

The value of nonmetal commodities produced in 1964 was $11 million, 12 percent of the value of all mineral production in the State, and a substantial gain over the value recorded in 1963.

Clays.—Clay production was slightly less than in 1963. Fire clay was produced in one county and miscellaneous clay in three counties. The miscellaneous clay, including shale, was used in manufacturing lightweight aggregate, building brick, and other heavy clay products, and the fire clay for sewer tile. A small quantity of bentonite was produced for manufacturing prepared mortar.

Gem Stones.—Agate, chalcedony, jasper, petrified wood, and other gem stones and mineral specimens valued at $1,000 were collected in the State.

Salt.—Salt production, by solution mining from the Charles formation through 8,500-foot wells in Williams County, was slightly above that of 1963. The salt was used principally for stock and other feeds, oil well drilling, and water softening. Shipments were made to neighboring States, to the upper Midwest, and to Canada.

Sand and Gravel.—Output and value of sand and gravel increased 10 percent over that of 1963, reflecting the continued high degree of preparation and material standards required in constructing Federal-aid highways.

North Dakota planned to award $25.1 million in highway construction contracts in 1965—17 percent less than in 1964.[7] Major construction during 1964 was on U.S. Interstate Highways 94 and 29. Under the Federal-aid program for primary, secondary, and urban highways, 934.1 miles of highway was completed.[8]

The five leading commercial producers accounted for 10 percent of the total production and 13 percent of the total value of sand and gravel in North Dakota.

Production by Government crews and contractors—14 percent and 86 percent, respectively—was used almost entirely for road construction. Rigid specifications for road construction required much of the output to be washed, screened, or otherwise prepared at 356 locations, with portable plants ranging in output from less than 25,000 to 300,000 tons per year. Production was at 424 operations, 28 percent more than in 1963: 67 by commercial operators, 31 by Government crews, and 326 by Government contractors.

Prices ranged from $1.50 per ton for building gravel to $0.62 per ton for railroad ballast. The average value of all sand and gravel produced was $0.96 per ton.

Stone.—Output of stone used for riprap and as concrete and road stone dropped sharply. Most of the production, by contractors for the North Dakota State Highway Department, was used in constructing Federal-aid and State highways.

Sulfur.—Elemental sulfur was recovered at the natural gas processing plants at Lignite in Burke County and at Tioga in Williams County. Production and value of sulfur increased 22 percent and 43 percent, respectively.

Vermiculite.—Crude vermiculite from out-of-State deposits was exfoliated at a plant in Ward County. The processed product was used for insulation, as a lightweight aggregate, in premix plaster, and for soil conditioning and poultry grit.

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[7] Engineering News-Record. State Highway Contract Awards Will Jump to a Record High. V. 174 No. 12, Mar. 25, 1965, pp. 30-32.

[8] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65-10, Feb. 11, 1965.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	411	$492	375	$507
Paving	194	217	225	260
Fill	75	57	52	52
Industrial: Blast	W	W		
Total	680	766	652	819
Gravel:				
Construction:				
Building	414	630	490	735
Paving	928	1,038	972	1,237
Railroad ballast	221	85	468	288
Fill	477	465	244	194
Miscellaneous	49	52	14	7
Total	2,089	2,270	2,188	2,461
Total sand and gravel	2,769	3,036	2,840	3,280
Government-and-contractor operations:				
Sand:				
Paving	2,082	1,908	3,074	2,503
Gravel:				
Building	87	77	1	1
Paving	4,591	4,172	4,605	4,358
Total	4,678	4,249	4,606	4,359
Total sand and gravel	6,760	6,157	7,680	6,862
All operations:				
Sand	2,762	2,674	3,726	3,322
Gravel	6,767	6,519	6,794	6,820
Total	9,529	9,193	10,520	10,142

W Withheld to avoid disclosing individual company confidential data; included with construction sand used as "Fill."

METALS

Uranium Ore.—The quantity and value of uranium oxide contained in ash derived from uraniferous lignite increased substantially in 1964. Three firms—Union Carbide Corp., Susquehanna-Western, Inc., a subsidiary of Susquehanna Corp., and Geo Resources Exploration, Inc.—mined uranium-bearing lignite in Billings and Stark Counties. The uranium ore was recovered by strip mining lignite, which was concentrated into ash by burning, and then shipped to mills in Colorado, New Mexico, and South Dakota for further processing. The lignite also contained a small quantity of molybdenum.

Union Carbide Corp. began operating its new $300,000 burning plant at Belfield in July, and shipped the uranium ash by rail to Rifle, Colo. Susquehanna-Western, Inc., burned its ore at mine sites and shipped the ash to its mill operated by Mines Development, Inc., a subsidiary of Susquehanna Corp., at Edgemont, S. Dak. Geo Resources Exploration, Inc., burned its ore in place and at a plant about 15 miles north of its strip mine; the ash was shipped to

the Mines Development, Inc., plant at Edgemont and to the Kermac Nuclear Fuels Corp. plant at Grants, N. Mex. In June, Kermac Nuclear Fuels Corp. began operating its new $500,000 burning plant at Bowman; the ash was shipped to its uranium mill at Grants, N. Mex.

REVIEW BY COUNTIES

Billings.—Oil production from eight pools in five fields increased 15 percent from 1963 and ranked the county eighth in production in the State. A new field, Medora, was the most significant discovery in the State. The discovery well, the Amerada Petroleum Corp. No. 1 Northern Pacific "M", initially yielded 863 barrels daily from the Heath and Madison formations between 7,815 to 7,828 and 9,044 to 9,082 feet, respectively.

Uranium produced by burning uraniferous lignites increased in 1964.

Bottineau.—Bottineau County was again the fourth largest oil-producing county in the State. Oil production from the 28 pools in 27 fields was slightly above the 1963 production. The county was second in drilling activity during the year; six fields—Lansford, Mohall, East Newburg, South Antler Creek, and two unnamed—resulted from the wildcat drilling. Three of the new fields produced oil from the Mission Canyon formation, two from the Charles formation, and one from the Spearfish formation.

Commercial operators produced building sand and gravel, Government crews produced paving gravel, and Government contractors produced paving sand and gravel, mostly used by the State highway department.

The production of peat, mined and dried for use as a soil conditioner from bog deposits in the Turtle Mountains, declined.

Bowman.—Output of coal (lignite), from the Peerless strip mine operated by Knife River Coal Mining Co., was 15 percent below that of 1963.

Oil production from two pools in two fields decreased 26 percent. Dry gas from two fields increased slightly. No exploratory drilling occurred during 1964, and development drilling dropped sharply.

Burke.—Two oil fields were discovered during 1964, compared with one in 1963. The discoveries may be extensions of nearby existing fields.

Oil well gas from fields in the area was processed at the Texaco Inc. plant at Lignite. The plant recovered natural gasoline, LP gases, and elemental sulfur. The natural gas was marketed through Montana-Dakota Utilities transmission lines.

Sandberg Sand and Gravel Co. at Lignite produced building sand and gravel, and gravel for miscellaneous uses; George Carlson Construction at Powers Lake produced building and paving sand. Contractors produced paving sand and gravel for the State highway department and paving gravel for the county highway department, and State highway crews produced building sand.

Burleigh.—The county, along with Stark County, was ranked fourth in the State in output of sand and gravel. Dakota Sand & Gravel Co. and Northern Improvement Co., both of Bismarck, produced building, fill, and paving sand and gravel. Government crews produced paving gravel and contractors produced paving sand and

TABLE 8.—Value of mineral production in North Dakota, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Adams	$109,713	$52,187	Coal, clays.
Barnes	245,901	248,900	Sand and gravel, stone.
Benson	84,000	233,000	Sand and gravel.
Billings	r 1,958,628	2,276,075	Petroleum, sand and gravel, uranium ore, natural gas, molybdenum.
Bottineau	r 6,852,000	6,595,750	Petroleum, sand and gravel, natural gas, peat.
Bowman	r 3,339,794	2,426,349	Petroleum, coal, sand and gravel, natural gas.
Burke	r 13,586,632	13,004,758	Petroleum, natural gas, coal, LP gases, natural gasoline, sand and gravel.
Burleigh	619,370	619,660	Sand and gravel, coal.
Cass	278,542	38,000	Sand and gravel.
Cavalier	8,000	60,000	Do.
Dickey	109,562	354,000	Do.
Divide	r 1,824,895	1,031,647	Petroleum, natural gas, sand and gravel, LP gases, clays, natural gasoline.
Dunn	r 148,844	107,427	Petroleum, sand and gravel, coal, natural gas, stone.
Eddy	344,000	292,000	Sand and gravel.
Emmons	15,000	94,000	Do.
Foster	31,442	41,000	Do.
Golden Valley		18,000	Do.
Grand Forks	679,000	692,500	Sand and gravel, stone.
Grant	62,789	199,969	Sand and gravel, coal, stone.
Griggs	128,464		
Hettinger	178,200	82,217	Sand and gravel, coal.
Kidder	200	40,000	Sand and gravel.
La Moure	5,000	10,000	Do.
Logan	44,000	198,700	Sand and gravel, stone.
McHenry	r 425,000	286,000	Sand and gravel, petroleum, natural gas.
McIntosh	66,000	90,000	Sand and gravel.
McKenzie	r 21,100,303	20,334,000	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
McLean	369,941	512,580	Sand and gravel, coal, stone.
Mercer	W	W	Coal, sand and gravel.
Morton	631,376	797,872	Sand and gravel, clays, coal, stone.
Mountrail	r 4,480,000	4,214,000	Petroleum, natural gas, sand and gravel.
Nelson	34,000	60,000	Sand and gravel.
Oliver	25,058	W	Sand and gravel, coal.
Pembina	48,000	65,000	Sand and gravel.
Pierce	75,000	75,000	Do.
Ramsey	44,000	231,000	Do.
Ransom	W	48,000	Do.
Renville	r 5,150,000	5,396,000	Petroleum, sand and gravel, natural gas.
Richland	254,219	38,000	Sand and gravel.
Rolette	122,000	313,000	Do.
Sargent	169,000	136,000	Do.
Sheridan	215,000	8,000	Do.
Sioux	W	204,000	Do.
Slope	W	172,000	Do.
Stark	r 471,912	1,098,038	Sand and gravel, uranium ore, coal, petroleum, clays, natural gas, molybdenum, stone.
Steele	218,000	W	Sand and gravel.
Stutsman	348,000	337,000	Do.
Towner	W	W	Sand and gravel, stone.
Traill	238,000	305,000	Sand and gravel.
Walsh	711,000	436,000	Do.
Ward	2,133,397	2,163,971	Coal, sand and gravel, petroleum.
Wells	117,047	121,000	Sand and gravel.
Williams	r 24,083,307	22,509,971	Petroleum, natural gas, LP gases, salt, natural gasoline, sand and gravel, coal.
Undistributed [1]	r 2,519,227	4,198,853	
Total	r 94,703,000	92,866,000	

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.

gravel for the State highway department for use in constructing Interstate Highway 94 in the vicinity of Bismarck. Contractors produced paving sand and gravel for the county highway department and paving gravel for the U.S. Army Corps of Engineers.

Coal output was from the Ecklund strip mine, operated by Ecklund-Taplin Coal Co.

Divide.—The county was ranked second in the production of clays. Miscellaneous clay produced by Baukol-Noonan, Inc., was used in manufacturing lightweight aggregate at its plant at Noonan.

Oil production from five fields in the county decreased 10 percent.

Dunn.—Oil production from the Lost Bridge field decreased 7 percent. No development or exploratory drilling was done.

The county was ranked first in the production of riprap and fifth in the total production of stone.

Grand Forks.—Bradshaw Gravel Supply produced sand and gravel for building and paving and gravel for fill; Davidson Gravel Supply produced sand for building and sand and gravel for paving and fill. Government crews produced paving gravel for the State highway department and contractors produced paving sand and building gravel for the State highway department and the city of Grand Forks, and building gravel for Grand Forks County Highway Department.

McKenzie.—With oil output from 22 pools in 13 fields, increasing 6 percent, the county was ranked second in State production. A wildcat well resulted in the discovery of a new pay zone in the Camel Butte field. The discovery well, Calvert Drilling & Producing Co. No. 1 Brown, NE¼ NE¼ sec 34, T 151 N, R 96 W, initially produced 286 barrels daily from the Duperow formation between 11,358 and 11,386 feet.

Mercer.—Continuing to lead the State in coal (lignite) production, the county had a 19-percent increase and accounted for 47 percent of all coal produced within the State.

Morton.—The county was ranked first in clay production and second in sand and gravel. Hebron Brick Co. produced clay for manufacturing building brick and bentonite for use in manufacturing prepared mortar. Baukol-Noonan, Inc., produced miscellaneous clay for manufacturing lightweight aggregates. Helms Brothers, Inc., produced paving sand and gravel, and Mandan Transfer and Storage, Inc., produced building sand and gravel. Contractors of the State highway department produced paving sand and gravel mostly used in constructing Interstate Highway 94. Crews of the county highway department and contractors of the city of New Salem produced paving gravel.

Toward the end of the year, the American Oil Co. refinery at Mandan was operated at a record rate of 48,000 barrels daily. The approximate throughput for the year was 16.2 million barrels.

Renville.—Ranked fifth in oil output, the county had production from nine pools in nine fields, 12 percent more than in 1963. The county was ranked first in drilling activity with 82 wells.

Stark.—In its first year of activity, Stark County was ranked first in the State in the production of uranium from lignite ash. The leading producer of uranium ore, Union Carbide Corp., began concentrating uranium-bearing lignite at its $300,000 burning plant at Belfield in July.

The county was ranked fifth in coal (lignite) production. Coal (lignite) produced at strip mines by Dickinson Coal Mining Co., Shultz and Lindsay Construction Co., and Walter's Coal mine increased 29 percent over that of 1963.

Fisher Sand and Gravel Co. produced sand and gravel for building, paving, and fill. The county was ranked fourth in the State along with Burleigh County in output of sand and gravel.

The county was ranked third in clay production. Bison Clay Products Co., Inc., produced fire clay for manufacturing heavy clay products.

Ward.—The county again led the State in producing sand and gravel and was second in the output of coal (lignite). Atlas Sand & Gravel, Inc., produced building and paving sand and gravel; Great Northern Railway Co. fill gravel; Minot Sand & Gravel Co. building and paving sand and gravel, and fill gravel; Oberg Construction Co. paving gravel; Shriock Construction, Inc., building sand and paving gravel; and Soo Line Railway Co. paving and railroad gravel.

Coal (lignite) production from Truax-Traer Coal Co., at the Velva strip mine; Sawyer Fuels, Inc., at the Miller strip mine; and Valley Coal Co., at the Valley strip mine, was cumulatively 18 percent over that of 1963.

Crude vermiculite, from out-of-State deposits, was exfoliated by Robinson Insulation Co. at its plant at Minot. The processed material was used for insulation, as lightweight aggregate, in premix plaster, and for soil conditioning and poultry litter.

Coal (lignite) produced by Ben L. Nelson & Jacob Senti at the Black Diamond mine, the only underground coal mine in the State, was slightly below that of 1963.

Borsheim Builders Supply, Inc., produced building sand and gravel and fill sand; Christensen Gravel Co. produced fill and paving gravel; George Mockel produced building sand and gravel.

Oil was produced from the Southwest Aurelia field for the second year of production after being shut-in for several years.

Williams.—The value of mineral output represented 25 percent of the total value in the State; the county continued to lead in crude petroleum production as output from 14 pools in 9 fields increased slightly above that of 1963.

Natural gasoline, butane, and propane were recovered from the natural gas plants at McGregor and Tioga at a slight increase over 1963 production. Operation of the refinery at Williston was 50 percent below that of 1963. The natural gas processing plant at Tioga recovered elemental sulfur. The county produced 15 percent more sulfur than in 1963.

Dakota Salt and Chemical Co. produced salt by solution mining of beds in the Charles formation through 8,500-foot wells.

The Mineral Industry of Ohio

By Joseph Krickich [1]

VALUE of mineral production increased 9 percent over that of 1963 attaining the record high of $454.9 million. The most significant development was the record output of petroleum which more than doubled in value. Other contributing factors were the

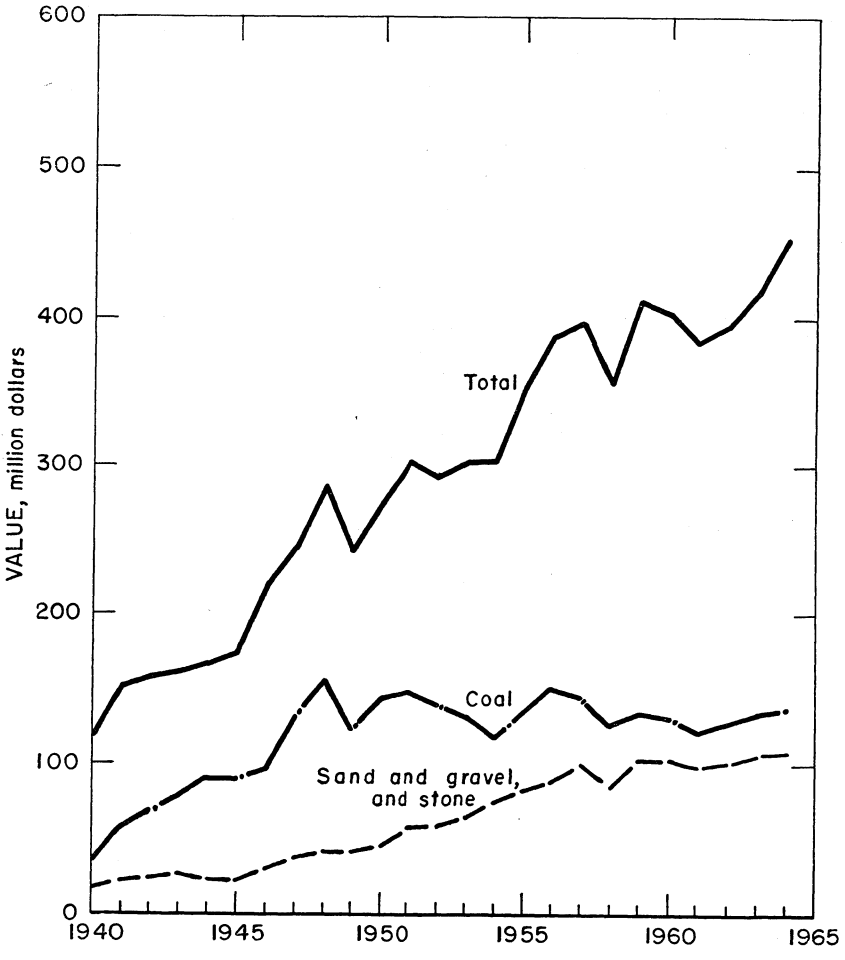


FIGURE 1.—Value of coal, sand and gravel, and stone and total value of mineral production in Ohio.

[1] Minerals specialist, Bureau of Mines, Pittsburgh, Pa.

TABLE 1.—Mineral production in Ohio [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—376-pound barrels	16,217,528	$53,244	15,552,652	$50,647
Masonry—280-pound barrels	1,022,559	3,084	1,067,720	3,127
Clays—thousand short tons	4,841	13,959	5,005	14,426
Coal (bituminous)—do	36,790	136,113	37,310	137,776
Gem stones	(2)	3	(2)	3
Lime—thousand short tons	3,207	45,957	3,664	53,308
Natural gas—million cubic feet	36,817	8,909	37,309	8,880
Peat—short tons	6,910	109	6,363	83
Petroleum (crude)—thousand 42-gallon barrels	6,039	19,023	15,859	46,420
Salt—thousand short tons	4,245	29,682	4,537	31,092
Sand and gravel—do	37,790	44,368	37,771	45,567
Stone—do	37,537	62,787	37,715	61,814
Value of items that cannot be disclosed: Abrasive stones and gypsum	XX	1,742	XX	1,794
Total	XX	r 418,980	XX	454,937

r Revised. XX Not applicable.
[1] Production as measured by mine shipment, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.

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

(Millions)

Year	Value	Year	Value
1940	$295	1953	$311
1941	343	1954	311
1942	344	1955	348
1943	350	1956	381
1944	345	1957	381
1945	297	1958	347
1946	326	1959	398
1947	309	1960	397
1948	309	1961	391
1949	263	1962	r 409
1950	298	1963	r 439
1951	317	1964	473
1952	310		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	7,954	1,815	14,522	6	251	18
Nonmetal	2,480	619	4,969		118	24
Sand and gravel	2,304	505	4,218	3	42	11
Stone	5,659	1,583	12,840	6	150	12
Peat	22	2	15			
Total	18,419	4,524	36,564	15	561	16
1964: p						
Coal	7,600	1,789	14,320	6	325	23
Nonmetal	2,585	646	4,962		123	25
Sand and gravel	2,355	506	4,177	2	70	17
Stone	5,715	1,556	12,675	6	173	14
Peat	19	2	14		1	70
Total	18,274	4,499	36,148	14	692	20

p Preliminary.

record high output of lime and salt and increased demand for Ohio bituminous coal. Demand for construction materials (sand and gravel and stone) remained relatively stable, but portland cement shipments declined.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Production and value of abrasive stones (grindstones) increased, compared with that of 1963. Two producers, one each in Lorain and Washington Counties, were active. Output in Lorain County was a coproduct of sandstone quarrying.

Cement.—Production, shipments, and value of portland cement decreased, as plants operated at 70 percent of capacity, compared with 73 percent in 1963. Production of masonry cement was lower, but a slight increase in shipments was recorded. Average value per barrel of portland cement dropped to $3.26 from $3.28 in 1963; average value of masonry cement decreased by $0.09 to $2.93. Total plant capacity remained at 22.4 million barrels of which 69 percent was by the wet process and 31 percent was by the dry process. Plants were operated in eight counties; Greene, Muskingum, and Lawrence Counties, in decreasing order based on value of sales, continued as the leading areas.

Nearly 4.3 million tons of limestone and cement rock were used by producing companies as the primary cement raw material. Other materials and tonnages used included clay and shale, 678,000; sand, 73,000; gypsum, 134,000; and iron materials, 18,000. Additionally, quantities of alumina, lime, grinding aids, and air-entraining compounds were used. Mostly types I–II (general use) and type III (high-early-strength) cements were produced. A limited quantity of waterproof cement was produced by two companies.

Portland cement shipments were to Ohio (72 percent), Indiana (9 percent), and West Virginia (7 percent). In decreasing order, shipments also were made to consumers in Michigan, Kentucky, Pennsylvania, Illinois, Virginia, New York, and Missouri. Masonry shipments were mostly to Ohio, Indiana, and West Virginia. Portland cement shipments, by type of customer, were as follows: Ready-mixed concrete companies, 9.1 million barrels; highway contractors, 2.6 million barrels; concrete product manufacturers, 2.4 million barrels; and building material dealers, 1.4 million barrels. The remainder went to Federal, State, and local government agencies, other contractors, and miscellaneous customers. Nearly 13.5 million barrels was shipped by truck, and 2.1 million barrels, by rail. Only 8 percent of the portland cement was shipped in containers; most of the cement was delivered in bulk form.

Cement companies used 406.2 million kilowatt-hours of electrical energy. Sixty-five percent of the electricity was purchased from public utilities, and 35 percent was generated by the producing companies.

Clays.—Output of clays (fire clay and miscellaneous clay and shale) increased 3 percent above that of 1963 owing chiefly to increased demand for refractory material. Nationally, the State continued as the foremost producer. In response to increased demand by the steel

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	
1955–59 (average)	10	15,840	15,538	$49,150	1,632
1960	11	16,850	16,752	58,470	1,962
1961	10	15,059	15,303	53,251	1,695
1962	10	15,465	15,353	51,006	1,857
1963	10	16,300	16,218	53,244	[1] 2,064
1964	10	15,606	15,553	50,647	2,079

[1] Stock adjustment.

and foundry industries, clay output for refractory uses increased by 166,000 tons to 993,000 tons. Clays used for manufacturing cement increased 6 percent to 728,000 tons. Output of clay used for heavy clay products (mainly building brick) continued to decline and totaled 2.8 million tons, 2 percent below that of 1963. A slight decline in clay for floor and wall tile also was recorded. For the third consecutive year more miscellaneous clay was used to produce lightweight aggregate (expanded clay). Of the total tonnage produced, 2.7 million tons was classified as miscellaneous clay or shale and 2.3 million tons was fire clay. Other applications for Ohio clay included architectural terra cotta, pottery and stoneware, and rotary-drilling mud. Among the 15 counties with fire clay production, Tuscarawas, Stark, and Columbiana Counties, were the ranking areas. Miscellaneous clay or shale was produced in 38 counties; Cuyahoga, Tuscarawas, and Stark Counties led in output.

Gem Stones.—Value of gem stones (minerals specimens) was the same as in 1963. Abandoned quarries and mine dumps continued to attract collectors, hobbyists, and members of mineralogical and lapidary clubs. As in previous years, specimens collected included calcite, celestite, and flint.

Gypsum.—Production and value of crude gypsum, recovered from two underground mines in Ottawa County, was greater than in 1963. The crude material was calcined at nearby plants for use in manufacturing building products. Calcined gypsum also was produced at a plant in Lorain County from material shipped from outside the State.

Iron Oxide Pigments.—Red iron oxide pigments were produced by Minnestota Mining & Manufacturing Co. at Copley, Summit County. Pyrite cinders recovered as a byproduct of sulphuric acid production in Delaware was used by the company as its primary raw material.

Lime.—For the third consecutive year, lime production increased, establishing a record high output of 3.7 million tons valued at $53.3 million. Greater usage of lime by the chemical and steel industries was the major contributing factor. Lime used in the construction industry also increased, but output of agricultural lime (aglime) decreased for the tenth consecutive year. Average value per ton of refractory lime increased from $16.47 to $17.13, and construction lime increased by $1.21 to $20.20. The average value for chemical lime was virtually unchanged at $12.20 per ton; aglime decreased by $1.20 to $15.32.

Data reported in table 4 excludes regenerated lime and represents only primary lime production. Production and value of regenerated quicklime produced in Montgomery and Ross Counties continued to increase. Of the total primary lime production, 87 percent was quicklime and 13 percent was hydrated lime. Most of the quicklime was used in chemical and other industrial applications; hydrated lime was used chiefly for construction. Sandusky County remained the leading area among the 14 lime-producing areas. The county supplied 31 percent of the total output and 35 percent of the total value, the same percentages as in 1963.

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
1955–59 (average)	36	$495	538	$9,153	1,109	$10,863	1,197	$18,724	2,880	$39,235
1960	30	449	426	8,288	1,604	18,516	1,057	17,150	3,117	44,403
1961	27	381	399	7,400	1,615	17,864	1,007	15,621	3,048	41,266
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

Producers used anthracite and bituminous coal, coke, natural gas, producer gas, and carbon monoxide as fuels. Most operators used shaft-type kilns; hydrators were both batch and continuous type. Nearly 2.2 million tons of the total lime output was used by producers or sold to consumers in Ohio. Shipments to Pennsylvania and Michigan accounted for 11 and 7 percent, respectively. Shipments exceeding 100,000 tons were made to Indiana, New York, and Illinois. In addition, Ohio lime producers made shipments to 39 other States and the District of Columbia. Quantities were exported to Canada, Chile, United Kingdom, and Venezuela.

Perlite (Expanded).—Three plants, one each in Cuyahoga, Hamilton, and Lorain Counties, produced expanded perlite. Most of the material was used for insulation and as a plaster aggregate. Producers were The Cleveland Gypsum Co., Division of Cleveland Builders Supply Co., Cleveland; National Gypsum Co., Lorain; and The Philip Carey Manufacturing Co., Lockland. The companies processed crude perlite shipped from Colorado and Nevada.

Salt.—Production of salt continued its upward trend with a record high output of 4.5 million tons. Total salt tonnage was 7 percent greater than that of 1963; value increased by $1.4 million. Increased output for all categories (rock and evaporated salt and brine) were recorded. Rock salt was recovered from underground mines in Cuyahoga and Lake Counties; sales were chiefly to State and local governmental agencies for use in highway snow and ice removal. Evaporated salt, manufactured mainly by the vacuum pan process, was sold for a wide variety of uses. Quantities were pressed into blocks to meet market requirements. Production was from four operations, two in Summit County and one each in Meigs and Wayne Counties. Virtually the entire output of brine was captive tonnage used for manufacturing

chlorine and soda ash and was centered in Lake and Summit Counties. Limited quantities were sold for use by the rubber industry.

Sand and Gravel.—Output of sand and gravel by commercial producers increased by 700,000 tons, but a corresponding decline in Government-and-contractor output resulted in total production remaining virtually unchanged from that of 1963. However, total value increased by $1.2 million, as higher average unit values were recorded for both construction and industrial material. Sand and gravel used in building and highway construction totaled 32 million tons, 2 percent greater than in 1963. Industrial sand production increased 11 percent to 1.2 million tons valued at $4.9 million. Major uses of industrial sand were for molding, glass manufacturing, and furnace construction and repair.

Commercial producers processed 89 percent of their output by washing, screening, and otherwise preparing their material. Nearly 35.3 million tons of the commercial tonnage was shipped by truck, 1.4 million tons by rail, and 800,000 tons by water transportation. Production by commercial operations was reported in 68 counties: Franklin and Hamilton Counties, each with output exceeding 4 million tons, were the leading areas. Other leading areas, each with production exceeding 1 million tons were Montgomery, Butler, Portage, Stark, Warren, Clark, and Greene Counties.

Slag (Iron-Blast-Furnace).—Production of processed iron-blast-furnace slag increased to nearly 5 million tons, 11 percent greater than that of 1963. Value totaled $9.6 million, an increase of $855,000. The average unit value dropped from $1.97 in 1963 to $1.94 but was still above the national average of $1.73 per ton. Seventy-eight percent of the total processed slag was screened, air-cooled material; the remainder consisted of granulated and lightweight (expanded) slag. Screened air-cooled slag was used mainly as aggregate for concrete and bituminous construction and as railroad ballast. Processing plants were located primarily near steelmaking facilities in Cleveland, Middletown, and Youngstown. As in 1963, the State ranked second in production and accounted for 19 percent of the national output.

Stone.—Total stone production (limestone, sandstone, and calcareous marl) increased, but value was below that of 1963. The tonnage increase was attributed chiefly to greater use of limestone used for manufacturing lime. The decline in value was the result of reclassification of certain dimension sandstone into lower-priced material. Over 98 percent of the stone produced was limestone; the remainder was virtually all sandstone or quartzite. In addition to limestone used for lime manufacture, demand for fluxing stone and railroad ballast increased but most of the other major categories declined. Other miscellaneous uses of crushed limestone included whiting and filler material, stone sand, paper and glass manufacture, mineral food, poultry grit, and for controlling dust in coal mines. Production of dimension limestone used in architectural and construction applications decreased.

Dimension sandstone production increased, but lower unit values were recorded. Most of the dimension sandstone was fabricated for architectural uses, but some was sold for lining steelmaking furnaces. The stone also was marketed for use in construction, curbing, and

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	1933		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	5,820	$6,376	6,419	$6,915
Paving	7,685	7,560	7,651	7,774
Fill	808	606	752	563
Molding	444	1,743	507	2,052
Filtration	23	67	14	47
Other [1]	844	2,805	865	2,975
Total	15,624	19,157	16,208	20,326
Gravel:				
Building	5,556	6,717	5,745	7,009
Paving	12,229	14,467	12,208	14,688
Railroad ballast	38	30	21	16
Fill	1,784	939	1,809	1,023
Other	1,581	2,415	1,530	2,413
Total	21,188	24,568	21,313	25,149
Total sand and gravel	36,812	43,725	37,521	45,475
Government-and-contractor operations:				
Sand:				
Paving	492	370	----------	----------
Fill	2	1	----------	----------
Other	24	8	----------	----------
Total	518	379	----------	----------
Gravel:				
Paving	417	249	250	92
Fill	19	7	----------	----------
Other	24	8	----------	----------
Total	460	264	250	92
Total sand and gravel	978	643	250	92
All operations:				
Sand	16,142	19,536	16,208	20,326
Gravel	21,648	24,832	21,563	25,241
Total	37,790	44,368	37,771	45,567

[1] Includes the following sands: Glass, grinding and polishing (1964), blast, engine, ground, and other.

flagging. Crushed sandstone was sold for refractory (ganister), aggregate, riprap, glass and cement manufacture, abrasive, foundry, and other uses. Total crushed sandstone output was below that of 1963.

Limestone was quarried in 54 counties, 1 less than in the previous year. The ranking areas for production were Sandusky, Erie, Wyandot, and Seneca Counties. Sandstone was quarried in 13 counties; Lorain County led in tonnage and value. Limited quantities of calcareous marl used for agricultural stone (agstone) were produced in Darke County; output and value were below those of 1963.

Seventeen limestone quarries were cited for their safety records in 1964 and were awarded Certificates of Achievement in Safety. The quarries competed in the National Safety Competition and worked without lost-time injuries.

Sulfur (Recovered Elemental).—Sun Oil Co. at its Toledo refinery recovered elemental sulfur by catalytic oxidation of hydrogen sulfide.

Vermiculite (Exfoliated).—The Cleveland Gypsum Co., Division of

TABLE 7.—Crushed and broken limestone sold or used by producers, by uses[1]

(Thousand short tons and thousand dollars)

Uses	1963		1964	
	Quantity	Value	Quantity	Value
Riprap	342	$495	192	$235
Concrete aggregate and roadstone	19,036	24,611	18,993	24,941
Fluxing stone	4,728	7,423	4,952	7,668
Agriculture	2,213	3,880	2,176	3,842
Railroad ballast	924	1,134	942	1,162
Cement	4,084	5,847	3,981	5,563
Lime	4,433	8,159	5,055	9,084
Miscellaneous uses	1,113	2,454	802	2,298
Total	36,872	54,003	37,093	54,794

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

Cleveland Builders Supply Co., Cleveland, produced exfoliated vermiculite from crude material shipped from out of State. The processed material was used in plaster and concrete aggregate, soil conditioning, loose fill insulation, and other industrial uses.

MINERAL FUELS

Coal (Bituminous).—Production of bituminous coal reached the highest level since 1956, increasing 520,000 tons above that of 1963. The average value per ton was $3.69, only $0.01 below that of the previous year. The number of active mines producing 1,000 tons or more dropped from 447 to 420. The number of active strip mines totaled 255, a decrease of 11 compared with 1963. Underground mines decreased by 8 mines to a total of 111; auger mines dropped from 62 to 54. Strip mines supplied 67 percent of the output; the remainder came from underground (29 percent) and auger (4 percent) mines.

Over 24.8 million tons of coal was strip mined; 400,000 tons more than in 1963. Production was reported in 24 counties, 1 less than in 1963. Harrison, Belmont, and Jefferson Counties were the leading areas for strip-mined coal. The average value per ton was slightly below that of 1963. Equipment used by strip mine operators included 44 electric, 21 diesel electric, 483 diesel, and 37 gasoline shovels or draglines. Most of the equipment had dipper capacities of less than 3 cubic yards; 13 shovels and 14 draglines had capacities greater than 12 cubic yards. Other equipment used at strip mines included 35 carryall scrapers, 486 bulldozers, and 106 vertical and 63 horizontal power drills.

Coal was recovered from underground mines in 19 counties, compared with 17 in 1963. Underground output totaled 10.7 million tons, a 2-percent increase. Over 80 percent of the underground tonnage came from Belmont and Harrison Counties. Average value per ton dropped from $4.28 to $4.26. Virtually the entire underground production was cut by machines, less than 1 percent was cut by hand. Of the total cut by machines, 6.2 million tons was by cutting machines and 4.5 million tons was by continuous mining machines. The number of continuous mining machines increased from 41 to 45. Ninety-six percent of the underground tonnage was mechanically loaded.

Other equipment used at underground mines included 163 cutting machines and 65 mobile loading machines.

Output of coal recovered by auger mining decreased 8 percent to 1,750,000 tons. Average value per ton increased from $3.20 to $3.23. Noble, Perry, and Jefferson Counties were the ranking areas for auger-mined coal, supplying 54 percent of the total auger tonnage.

Twenty-two coal cleaning and preparation plants were active, compared with 20 in 1963. Over 14.2 million tons of coal was cleaned, of which 7.8 million tons was by jigs. Nearly 6.1 million tons was by wet-washing other than jigs, and the remainder, by pneumatic methods. At mines having crushing and treatment facilities, 18.2 million tons was crushed and 4.7 million tons was treated by antifreezing and dust-allaying materials.

Coal production by captive operations furnished 14 percent of the total State output. Sixty-one percent of the output was shipped by rail or water; the remainder, by truck and other means.

Three Ohio strip mines, one each in Noble, Stark, and Tuscarawas Counties, were cited for their safety records in 1964. In the National Safety Competition, they were awarded Certificates of Achievement in Safety for working without lost-time injuries. Preliminary employment and injury data for the State's coal mines indicated that an average of 7,600 men worked 14,320,000 man-hours. Six fatal and 325 nonfatal injuries were reported; the same number of fatalities as in 1963. Five of the fatalities were at underground mines, four of which were caused by haulage accidents and one by fall of roof. The rate of 0.16 fatalities per million short tons was well below the national average of 0.45.

TABLE 8.—Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955-59 (average)	36,161	$138,114	1962	34,125	$127,051
1960	33,957	130,877	1963	36,790	136,113
1961	32,226	121,343	1964	37,310	137,776

Coke and Coal Chemicals.—To keep pace with the vigorous steel industry, oven-coke production increased 14 percent above that of 1963. Over 7.2 milion tons valued at $128.9 million was produced. Average value per ton increased from $17.52 to $17.79. Ohio continued to rank third among the 20 oven-coke-producing States. Nearly 10.3 million tons of bituminous coal and 86,000 tons of anthracite coal was carbonized by producers. In contrast with previous years, coke yield reversed its downtrend and increased from 69.76 percent to 69.97 percent.

Twelve plants (10 furnace and 2 merchant) operated 1,836 slot-type ovens, 16 more ovens than at the end of 1963. Detroit Steel Corp. at Portsmouth abandoned 54 of its 108 Semet-Solvay ovens and operated 70 newly constructed Koppers-Becker ovens to account for the increase. In addition to the furnace plant at Portsmouth, steel companies operated plants at Campbell, Cleveland, Hamilton, Massillon, Middleton, Toledo, Warren, and Youngstown. Merchant

TABLE 9.—Coal (bituminous) production, by counties

(Thousand short tons and thousand dollars)

County	1963					1964				
	Number of mines			Total production		Number of mines			Total production	
	Underground	Strip	Auger	Quantity	Value	Underground	Strip	Auger	Quantity	Value
Athens	12	2	1	192	$850	11	2	1	147	$577
Belmont	12	21	7	6,371	25,772	11	20	6	7,835	31,688
Carroll	5	11		311	1,081	3	9	1	272	915
Columbiana	3	33	7	1,312	4,405	3	37	10	1,528	4,849
Coshocton	6	8	3	2,055	8,502	6	8	2	2,302	9,481
Gallia	11	7	2	642	2,105	15	7	3	615	1,855
Guernsey	2	8	1	368	1,225	1	6	3	308	1,033
Harrison	8	13	7	9,691	38,656	8	11	5	7,663	31,273
Hocking	2	4	1	81	328	2	5	1	79	260
Holmes	1	4		299	833	1	3		205	623
Jackson	7	12		412	1,597	6	12		563	1,946
Jefferson	9	33	13	3,942	14,006	7	31	9	4,308	15,571
Lawrence		4		W	W	1	3		W	W
Mahoning		16		913	3,824		14		789	2,894
Meigs	10	4	4	346	1,028	8	4	2	406	1,145
Morgan		3		2,472	7,562	1	4		1,870	5,589
Muskingum	7	5		103	436	7	4	1	116	496
Noble		10	6	1,751	4,637		11	4	2,722	8,148
Perry	9	8	2	2,024	7,588	7	9	2	W	W
Portage		1		80	290		1		W	W
Stark		19		572	1,829		12	1	407	1,297
Tuscarawas	11	33	7	2,397	8,021	9	36	3	2,469	8,298
Vinton	4	2		53	229	4	3		160	605
Washington		3	1	63	216					
Wayne		2		W	W		3		52	144
Undistributed				340	1,093				2,494	9,089
Total	119	266	62	36,790	136,113	111	255	54	37,310	137,776

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

plants were operated at Ironton and Painesville. Over 6.2 million tons of coke was used by producing companies, mostly in blast furnaces. The reminder represented commercial sales to other industrial consumers and for residential heating.

Plants received coking coal from West Virginia (47 percent), Pennsylvania (46 percent), Kentucky (5 percent), and Virginia (2 percent). Over 10.5 million tons of coal was received, 76 percent of which was high-volatile. The remainder consisted of low-volatile (22 percent) and medium-volatile (2 percent).

Coke breeze recovered at plants totaled 471,000 tons valued at $3.1 million. Seventy-four percent of the coke breeze was sold, but producing companies used 54,000 tons in steam generation; 44,000 tons as a binder and reducing agent in iron ore agglomerating plants, and 70,000 tons for other industrial uses. Yearend stocks were 74,000 tons, compared with 119,000 tons the previous year. Other coke coproducts recovered included coke-oven gas, 89.4 billion cubic feet; ammonium sulfate, 91,000 tons; and coke-oven tar, 92.2 million gallons. Of the total coke-oven gas produced, only 7 percent was sold and the remainder was used by producers for heating ovens, boilers, and other industrial uses. Fifty-nine percent of the tar was sold for further refining into tar products; the remainder was used by producers for refining or topping and as fuel.

Ten plants recovered 28.7 million gallons of crude light oil. Derivatives of the oil included 14.3 million gallons of benzene, 3.3. million gallons of toluene, 809,000 gallons of xylene, and 645,000 gallons of solvent naphtha.

Packaged Fuel.—Production and shipments of packaged fuel dropped sharply, as only one plant was active, compared with four plants in 1963. Ralph Coal & Supply Co., Toledo, was the only active producer. Raw material used by the company was mostly low-volatile bituminous coal. Packaged fuel shipments were entirely to consumers in Ohio. Ackerman Coal Co., Toledo, and Pacific Coal & Supply, Inc., Cleveland, abandoned their operations. The Dayton plant of Air City Fuels, Inc., was idle.

Peat.—Shipments of peat continued to decline and were 8 percent below those of 1963. Average value per ton also declined from $15.76 to $12.98. Eight operations were active, two less than in the previous year. Wyandot County led in value of output; Richland County ranked first in tonnage. Most of the State's output was sold in bulk and consisted primarily of the moss variety. Front-end loaders and draglines were the primary equipment used by operators to recover the peat. Reserves at active operations totaled 525,000 tons.

Petroleum and Natural Gas.—Petroleum production increased sharply to more than double that of 1963. Output of natural gas also increased, but value was slightly lower. The number of well completions increased from 1,111 to 2,489. The bulk of the drilling activity was centered in Morrow County, which accounted for over half of the development completions and over one-third of the wildcat completions.

Total footage drilled was 6,815,000, averaging 2,738 feet per well. This compares with 3,033,000 feet averaging 2,730 feet in 1963. Development completions totaled 1,879 (691 oil, 272 gas, 904 dry, and 12 service), compared with 955 in 1963. Morrow County was the foremost area for development completions with 1,086 wells. Other leading areas among the 43 counties with development completions were Ashland (122), Portage (78), and Licking (75) Counties. Of the field wells completed, 568 oil, 99 gas, and 732 dry wells were drilled to depths of 2,500 to 3,750 feet. Only 10 wells were drilled in the 5,000- to 7,500-foot range.

Wildcat completions increased from 156 in 1963 to 610 (6 oil, 16 gas, and 548 dry). Completed wildcat wells were drilled in 47 counties. Morrow County had the greatest activity with 263 completions. Considerable interest also was centered in Delaware and Marion Counties with 101 and 50 completions, respectively. Most of the test wells were drilled between 2,500 and 3,750 feet. Two gas and seven dry wells were drilled between 5,000 and 7,500 feet. One well was drilled in the 7,500- to 10,000-foot range; none was drilled below that depth.[2]

The Ohio Division of Geological Survey reported 3,448 gas wells and 13,752 oil wells (including 3,805 combination oil and gas producers) were in operation at the end of the year. The number of active wells represented a sharp decline from previous years.

[2] Oil and Gas Journal. V. 63, No. 4, Jan. 25, 1965.

According to the American Gas Association and American Petroleum Institute, proved reserves on December 31 were 709,421 million cubic feet of natural gas (14.73 pounds per square inch absolute, at 60° F.) and 100.0 million barrels of petroleum.

Seven companies operated 12 petroleum refineries. Crude oil capacity as of January 1, 1964, was 462,600 barrels per day, 4,500 barrels less than that of 1963. Gasoline output capacity per day was 183,000 barrels, of which 57 percent was catalytic and thermal cracking capacity; the remainder represented reforming capacity. Refineries were operated by American Bitumals & Asphalt Co., Cincinnati; Ashland Oil & Refining Co., Canton and Findlay; Gulf Oil Corp., Cleves and Toledo; Pure Oil Co., Newark and Toledo; Sea-Way Oil Refiining Co., Weston; The Standard Oil Co. (Ohio), Cleveland, Lima, and Toledo; and Sun Oil Co., Toledo.

New rules and regulations governing the issuance of permits for the drilling of wells for the production of petroleum or natural gas became effective May 10. The rules also regulate the spacing and pooling of wells and bonding and safety requirements to promote maximum recovery of petroleum and natural gas.

METALS

Aluminum.—Production and value of primary aluminum increased over those of 1963; higher average value per ton also was reported. The State continued to rank fifth among the 13 aluminum-producing States. Ormet Corp., jointly owned by Olin-Mathieson Chemical Corp. and Revere Copper & Brass, Inc., produced aluminum at its production plant near Hannibal, Monroe County. The company imported bauxite from Surinam and processed the material into alumina at its Burnside, La., plant. Alumina was shipped by river barge to the Hannibal plant for reduction into aluminum. Annual capacity of the reduction plant remained at 180,000 tons. Olin Mathieson Corp. operated a casting and rolling mill adjacent to the reduction plant.

Beryllium.—Brush Beryllium Corp. produced metal, alloys, and compounds at Elmore. The major products were beryllium metal and beryl-copper master alloy. The metal was used in nuclear applications and in aircraft, missiles, and spacecraft.

Ferroalloys.—Ohio continued as the foremost producer of ferroalloys and supplied 31 percent of the total national shipments. Production increased 25 percent over that of 1963, totaling 774,000 tons. Shipments increased 32 percent to 827,000 tons valued at $143.5 million. Value increased only 13 percent, primarily because of lower average unit values for ferromanganese, silicomanganese, ferrosilicon, ferrovanadium, and ferrochromium and chromium briquets, the principal ferroalloys produced. They represented 91 percent of the tonnage and 93 percent of the value of all ferroalloys shipped from plants in Ohio. Shipments of silvery pig iron, another important ferroalloy, also increased. Fourteen principal ferroalloys were produced at 10 plants. Producers were Interlake Steel Corp., Beverly and Toledo; Jackson Iron & Steel Co., Jackson; Ohio Ferro-Alloys Corp., Brilliant, Philo, and Powhatan Point; Union Carbide Corp., Metals Divi-

sion, Marietta and Ashtabula; and Vanadium Corporation of America, Cambridge and Vancoram.

Iron and Steel.—Steel production at Ohio plants was 18 percent greater than in 1963, according to the American Iron and Steel Institute. Nearly 22.2 million tons was produced, of which 17.3 million tons was open hearth steel, and 2.4 million tons was electric steel. The remainder was produced in Bessemer converters and basic oxygen furnaces. Ohio continued to rank second in steel production, accounting for 17 percent of the national output. Production of pig iron totaled 15.3 million tons, 19 percent more than in 1963. Shipments increased 20 percent, totaling 15.4 million tons valued at $925 million. Yearend stocks dropped by 192,000 tons to 277,000 tons. Seventeen plants were active, compared with 15 the previous year. Youngstown Sheet & Tube Co. reactivated one of its two blast furnaces at Youngstown, and Republic Steel Corp. reactivated its Massillon blast furnace. At the 17 active plants, 13 of the 49 blast furnaces were idle. Over 13.1 million tons of basic pig iron was produced, 2.3 million tons more than in 1963.

Over 12 million tons of iron ore was received at steel plants; 6.8 million tons was of domestic origin, and the remainder was imported mainly from Labrador and other parts of Canada. Substantial quantities also were imported from Venezuela, Chile, Brazil, and Liberia. Nearly 6.1 million tons of domestic and 1.7 million tons of foreign iron ore were consumed in blast furnaces. Fluxes consumed included 2.7 million tons of limestone and nearly 1 million tons of dolomite. Tonnages of other materials consumed were pellets (regular), 8 million; sinter (regular), 4.2 million; coke and coke breeze, 10 million; home and purchased scrap, 1.1 million; slag scrap, 400,000; mill cinder and roll scale, 800,000; open-hearth, Bessemer, and basic oxygen slag, 900,000; and flue dust, 84,000. Additionally, quantities of semi-and-self-fluxing sinter, nodules, foreign agglomerates, pig iron, foreign and domestic manganiferous ore, and other materials were used in producing pig iron. At agglomerating plants, 4 million tons of domestic and foreign iron ore was consumed. Mostly imported iron ore was used in steel furnaces. Over 4.9 million tons of slag and 175,000 tons of scrap were produced at blast furnaces; nearly 1 million tons of flue dust was recovered.

Lead and Zinc Pigments.—Black lead oxide pigments were produced at Cleveland by Willard Storage Battery Co. Also at Cleveland, E. I. du Pont de Nemours & Co., Inc., manufactured zinc chloride pigments. American Zinc Oxide Co., Columbus, produced zinc oxide pigments.

Titanium.—Titanium sponge was produced at Ashtabula by Reactive Metals, Inc., jointly owned by United States Steel Corp. and National Distillers and Chemicals Corp. The company was an inactive corporation and was reorganized in 1964. At Niles, the company melted titanium at the former plant of Bridgeport Brass Co., Division of National Distillers and Chemicals Corp. Titanium also was melted by Republic Steel Corp. at Massillon and Canton. Titanium Metals Corp. of America, Toronto, rolled and fabricated titanium from primary metal shipped from its reduction plant at Henderson, Nevada.

Titanium dioxide was produced by the chloride process at Ashtabula by Titania Corp., jointly owned by Cabot Corp. and Ruberoid Co.

Zirconium.—Reactive Metals, Inc., produced zirconium sponge at Ashtabula. The company processed limited quantities of the sponge into chunklets and ingots. However, most of the sponge was shipped to the former Bridgeport Brass Co. plant at Niles for ingot production. Vanadium Corp. of America produced zirconium alloys at Cambridge. Zirconium oxide was produced by Zirconium Corp. of America at Solon. Zircon and zirconia-based refractories were produced by The Chas. Taylor Sons Co., Cincinnati.

REVIEW BY COUNTIES

Value increases were reported in 48 of the State's 86 mineral-producing counties. No mineral production was reported in Clermont and Fulton Counties. In terms of value, Belmont County replaced Harrison County as the foremost mineral-producing area. These two counties and Sandusky County supplied over $88 million of the State's total mineral value. Values in excess of $10 million were recorded in 10 other counties, and 38 additional counties had values exceeding $1 million. County data on petroleum and natural gas operations were not available.

Adams.—Davon, Inc., quarried limestone at its Plum Run Quarry near Peebles. The stone was crushed and sized for sale as concrete aggregate, blast-furnace flux, agstone, railroad ballast, and for coal mine dusting. The Adams County Highway Department produced limestone for road construction and maintenance.

TABLE 10.—Value of mineral production in Ohio, by counties [1 2]

County	1963	1964	Minerals produced in 1964, in order of value
Adams	$1,083,958	$964,186	Stone.
Allen	1,162,581	1,096,512	Stone, sand and gravel.
Ashland	W	W	Sand and gravel, clays.
Ashtabula	W	W	Lime, sand and gravel.
Athens	1,584,169	1,297,164	Coal, stone, clays, sand and gravel.
Auglaize	W	W	Sand and gravel, stone, clays.
Belmont	25,924,414	31,854,079	Coal, stone.
Brown	56,156	58,979	Stone, sand and gravel.
Butler	2,401,113	2,613,000	Sand and gravel.
Carroll	1,287,503	1,088,968	Coal, clays, sand and gravel, stone.
Champaign	257,616	305,000	Sand and gravel.
Clark	W	W	Sand and gravel, lime, stone.
Clermont	168,000		
Clinton	646,700	W	Stone, sand and gravel.
Columbiana	7,185,513	7,855,946	Coal, clays, sand and gravel.
Coshocton	9,887,663	11,019,155	Coal, stone, sand and gravel.
Crawford	W	W	Stone, sand and gravel.
Cuyahoga	5,552,162	6,929,470	Salt, lime, sand and gravel, clays.
Darke	W	W	Sand and gravel, clays, peat, stone.
Defiance	W	W	Sand and gravel.
Delaware	1,299,605	1,462,919	Stone, lime, clays.
Erie	3,007,438	3,168,304	Stone, sand and gravel.
Fairfield	347,563	W	Sand and gravel.
Fayette	907,298	777,686	Stone.
Franklin	9,059,127	9,453,564	Sand and gravel, stone, lime, clays.
Gallia	2,792,228	2,504,351	Coal, stone, sand and gravel, clays.
Geauga	W	W	Sand and gravel, stone.
Greene	W	W	Cement, stone, sand and gravel, clays.
Guernsey	1,417,887	1,143,230	Coal, stone.
Hamilton	4,934,777	5,663,249	Sand and gravel, stone.
Hancock	W	W	Stone, lime, clays, sand and gravel.
Hardin	W	W	Stone.
Harrison	38,937,458	31,490,175	Coal, stone, clays.
Henry	W	W	Sand and gravel, clays.

See footnotes at end of table.

Table 10.—Value of mineral production in Ohio, by counties [1] [2]—Continued

County	1963	1964	Minerals produced in 1964, in order of value
Highland	W	W	Stone, sand and gravel, clays.
Hocking	W	W	Coal, clays.
Holmes	$1,383,684	$1,104,996	Coal, stone, clays, sand and gravel.
Huron	W	29,000	Sand and gravel.
Jackson	2,468,214	2,950,796	Coal, clays, stone.
Jefferson	14,967,854	W	Coal, clays.
Knox	W	W	Sand and gravel, stone.
Lake	W	W	Salt, lime, cement, sand and gravel, clays.
Lawrence	10,378,255	9,746,642	Cement, stone, coal, clays, sand and gravel.
Licking	673,021	W	Sand and gravel, clays.
Logan	550,295	399,505	Stone, sand and gravel.
Lorain	W	W	Stone, sand and gravel, abrasives.
Lucas	W	W	Cement, stone, sand and gravel, clays.
Madison	W	W	Sand and gravel, stone.
Mahoning	W	W	Stone, coal, clays, sand and gravel, peat.
Marion	1,270,543	1,407,782	Stone, clays, sand and gravel.
Medina	W	W	Sand and gravel, clays.
Meigs	W	W	Coal, sand and gravel, salt.
Mercer	W	W	Stone, sand and gravel.
Miami	W	W	Do.
Monroe	W	W	Sand and gravel, stone.
Montgomery	3,581,571	4,152,187	Do.
Morgan	W	W	Coal, stone, sand and gravel.
Morrow	59,250	53,000	Sand and gravel.
Muskingum	W	W	Cement, stone, coal, sand and gravel, clays.
Noble	W	W	Coal, stone, clays.
Ottawa	7,736,895	7,059,299	Lime, gypsum, stone.
Paulding	W	W	Cement, stone, clays.
Perry	W	W	Coal, sand and gravel, clays, stone.
Pickaway	W	W	Sand and gravel.
Pike	W	W	Sand and gravel, stone.
Portage	4,810,357	4,026,550	Sand and gravel, stone, coal, clays, peat.
Preble	W	W	Lime, sand and gravel, stone.
Putnam	441,384	467,599	Stone, lime, clays.
Richland	W	W	Sand and gravel, clays, peat.
Ross	W	W	Sand and gravel, stone.
Sandusky	21,594,400	24,729,735	Lime, stone, sand and gravel.
Scioto	W	W	Stone, clays, sand and gravel.
Seneca	W	W	Lime, stone, clays.
Shelby	290,348	W	Sand and gravel, stone.
Stark	13,368,449	11,768,666	Cement, sand and gravel, clays, stone, coal, peat.
Summit	W	W	Salt, lime, cement, stone, sand and gravel, clays.
Trumbull	182,261	197,000	Sand and gravel.
Tuscarawas	11,678,306	12,441,466	Coal, clays, sand and gravel, stone.
Union	W	W	Stone, sand and gravel.
Van Wert	606,293	634,029	Stone, clays.
Vinton	290,022	682,145	Coal, stone.
Warren	1,207,435	1,604,000	Sand and gravel.
Washington	W	W	Sand and gravel, abrasives.
Wayne	W	W	Salt, sand and gravel, stone, clays, coal.
Williams	W	153,000	Sand and gravel.
Wood	W	1,143,647	Stone.
Wyandot	W	W	Stone, lime, sand and gravel, peat, clays.
Undistributed [3]	r 201,539,582	249,439,735	
Total	r 418,980,000	454,937,000	

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

[1] Fulton County 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.

Allen.—Limestone production decreased 2 percent to 684,000 tons. County output was sold for concrete aggregate, railroad ballast, and agstone. Producers were National Lime & Stone Co. and Western Ohio Stone Co., both near Lima; Suever Stone Co., Delphos; and The Bluffton Stone Co., Bluffton. National Lime & Stone Co. was awarded a Certificate of Achievement in Safety for working over

56,000 man-hours without a disabling work injury in 1964. Western Ohio Stone improved facilities by installing a new mill. The Bluffton Stone Co. added a sand screw to manufacture sand at its plant. Building and paving sand and gravel was produced by Wapak Sand & Gravel Co., Westminster.

Ashland.—Output of commercial sand and gravel was below that of 1963. Producers were Bolin & Son, Ashland; Charles Bucklew, West Salem; and Young's Sand & Gravel Co., Loudonville. Most of the material was processed for construction. Output by Government-and-contractor operations increased. The E. Biglow Co. mined shale used for heavy clay products near New London.

Ashtabula.—Metallurgical quicklime and lime for other chemical and industrial uses were produced at Ashtabula. Construction sand and gravel was produced by Gleason Sand-Gravel, Inc., Conneaut; Northeast Materials, Inc:. and Pinney Dock & Transport Co., both near Kingsville; and Carter Sand & Gravel Co., Ashtabula. Output was slightly above that of 1963. Molding sand was produced by Peerless Mineral Products Co., Conneaut.

Athens.—Total output of coal continued to decline and was 23 percent below that of 1963. Production from all types of mines declined. Underground mining predominated; Karns Coal Co. at mine No. 60 was the leading producer. The Furr Coal Co. and Oak Grove Coal Co. operated strip mines. Gem Coal Co., a leading producer in previous years, did not operate its underground mine or coal cleaning and preparation plant. Diamond Stone Quarries, Inc., operated quarries No. 1 and No. 2 near Albany for the production of limestone used chiefly for concrete aggregate. The No. 2 quarry was formerly operated by Shamrock Quarries, Inc. Plastic fire clay was mined near Nelsonville under contract for Natco Corp. The material was used for manufacturing building brick and heavy clay products. Compared with 1963, sand and gravel output increased slightly. Producers were Athens Sand & Gravel Co., Athens; The F. H. Brewer Co., Chauncey; and Slater Sand & Gravel, The Plains.

Auglaize.—Production of sand and gravel was slightly below that of 1963. Processed sand and gravel was produced by Quality Sand & Gravel & Ready Mix Co., Wapak Sand & Gravel Co., and Western Ohio Stone Co., all near Wapakoneta. Hardin-Coates, Inc., Wapakoneta, produced bank-run material. Jackson Center Gravel Co., Jackson Center, permanently closed its pit. Limestone for concrete aggregate, agstone, and railroad ballast was produced at Buckland by National Lime & Stone Co. Sandkuhl Tile Co., Spencerville, mined clay for manufacturing heavy clay products.

Belmont.—Coal production increased 23 percent above that of 1963; output from underground and strip operations increased, but recovery from auger mines decreased. At underground mines, The North American Coal Corp. and Oglebay Norton Co., with two mines each, were the leading producers. Hanna Coal Co.., Division of Consolidation Coal Co., was the leading producer among the 20 active strip mines. The company operated five electric and two diesel-powered shovels of which two had dipper capacities greater than 12 cubic yards. Coal was cleaned at five plants; all from underground mines. Kish Coal Co. was the leading producer of auger-mined coal. The county

replaced Harrison County as the leading coal-producing area, accounting for 21 percent of the State's total production. Limestone was produced by Thomas E. Ayres Limestone Quarry, Martins Ferry; McCort Bros., Barneville; and Somerton Crushing Co., Somerton.

Brown.—Crews of the Brown County Highway Department produced limestone for aggregate, agstone, and rubble. Howard S. Watson, Georgetown, produced paving gravel.

Butler.—The county ranked fourth (fifth in 1963) in output of sand and gravel. Thirteen operations produced 2.2 million tons valued at $2.6 million. Output was 6 percent greater than in 1963. Major 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. Production was centered near Fairfield, Hamilton, Middletown, and Ross.

Carroll.—Production of coal continued to decline; output was 13 percent below that of 1963. Production from strip mines predominated in the county; James Bros. Coal Co. and Puskarich Mining, Inc., were the leading producers. Clay was recovered from seven pits, three each near Magnolia and Waynesburg, and one near Mineral City. Output was chiefly fire clay used for heavy clay products and refractories. Total output was below that of 1963. Mineral City Sand Co., Mineral City, produced molding and loam sand. Dimension sandstone was produced by Rainbow Stone Co., Sherrodsville. The Carrollton limestone quarry of Alan Stone Co., Inc., was idle.

Champaign.—Sand and gravel was produced by American Aggregates Corp. and Miller's Excavating, Inc., both near Urbana, and Walter Dorsey, Springhill.

Clark.—Production of sand and gravel increased 26 percent above that of 1963 and totaled 1,044,000 tons. Ten operations were active and produced mainly processed construction material. American Aggregates Corp., with plants at Springfield and Fairborn, and Springfield Sand and Gravel Co., Springfield, were the leading producers. Other operations were located at Enon, Medway, New Carlisle, and Springfield. Moores Lime Co., Springfield, quarried limestone for commercial sales and for raw material for manufacturing lime at its nearby plant. Limestone sales were for flux, concrete aggregate, and agstone. The company produced quicklime and hydrate lime for construction, agricultural, chemical, and industrial uses. No dead-burned dolomite was produced as in previous years.

Clermont.—The Point Pleasant limestone quarry of Alan Stone Co. was inactive.

Clinton.—Melvin Stone Co., Melvin, produced limestone for concrete aggregate, agstone, flux, and riprap. Clinton Gravel, Inc., produced processed and unprocessed gravel at Wilmington. Muchmore & Riesenberg produced sand and gravel at the Sligo gravel pit near Clarksville. The pit was formerly operated by Melvin Stone Co.

Columbiana.—Coal production increased 16 percent, and the number of active mines increased by 7 to 50. Nearly 88 percent of the county output was strip-mined coal, 9 percent was auger-mined, and the remainder came from underground mines. Ferris Coal Co. and Industrial Mining & Engineering Co. were the leading producers of strip-

mined coal. Moore Coal Corp. at the Elkton auger mine was the leading producer of auger coal. Total clay production was slightly below that of 1963. Fire clay was produced by McLain Works Refractories Division, H. K. Porter Co., Wellsville, and West Darlington Clay Division, Metropolitan Brick, Inc., Negley. Miscellaneous clay was produced by The Alliance Clay Product Co., Alliance; American Vitrified Products Co., East Liverpool; and Summitville Tiles, Inc., Summitville. Sand and gravel was produced at operations near Hanoverton, Leetonia, and Salem. Most of the material was used in construction.

Coshocton.—Production of coal increased 12 percent, totaling 2.3 million tons. Nearly 79 percent of the output was strip-mined coal. Simco-Peabody Co. and Peabody Coal Co. were the leading strip mine operators. Briar Hill Stone Co. operated six quarries in the county, three near Spring Mount and one each near Cavallo, New Castle, and Stillwell. Output was sawed and fabricated for architectural applications. Nicholl-McBride Stone Holding Co. (formerly Nicholl-McBride Stone Co.) quarried sandstone in Clark Township. The stone was fabricated at the company-owned processing plant at Killbuck, Holmes County. Commercial sand and gravel production totaled 529,000 tons, compared with 628,000 tons in 1963. Most of the output consisted of paving material and came from seven operations. Spring Construction Co., Newcomerstown, and W. P. McCarren Co., with operations near Canal, Lewisville, and Walhonding, were the leading producers.

Crawford.—National Lime & Stone Co. produced limestone at its Spore quarry near Bucyrus. Output was sold mainly for flux and as concrete aggregate. Limestone also was produced under contract for the Crawford County Highway Department. Galion Gravel Co., Galion, produced sand and gravel for building, paving, and fill.

Cuyahoga.—International Salt Co. produced rock salt from its underground mine at Cleveland. The company installed an underground conveyor system at the mine and improved its surface storage facilities and salt reclamation processes. Cuyahoga Lime Co., Cleveland, produced metallurgical quicklime from limestone shipped by boat from Michigan. Most of the quicklime was consumed at nearby steel mills, but some was shipped out of the State. Commercial sand and gravel production decreased 7 percent below that of 1963 and totaled 927,000 tons. Production was reported from 9 operations and consisted chiefly of construction material. No Government-and-contractor production was reported. Terra Vista Sand & Gravel, Valley View, was the leading commercial producer. Clay production totaled 390,000 tons, 6 percent more than in 1963. Output consisted exclusively of miscellaneous clay and shale used for manufacturing heavy clay products and lightweight aggregate. Producers were Cleveland Builders Supply Co., two pits near Cleveland; Hydraulic Press Brick Co. and Cleveland Pottery Co., both near Independence; The Ohio Clay Co., Garfield Heights; and The Berea Brick & Tile Co., Berea.

Darke.—Output of sand and gravel was above that of 1963. Producers were American Aggregates Corp., Foureman's Gravel, Shields Gravel Pit, and Slagle Gravel Co., all near Greenville, and Hollinger Gravel Plant, New Madison. Most of the output was used for paving

and fill. Clay produced for heavy clay products was recovered from pits near Greenville and Versailles. Louie Meyer produced reed-sedge peat at Woodington. Calcareous marl for agricultural purposes was produced at New Madison by Lakeland Valley Organic Products.

Defiance.—Ohio Materials, Ney, produced building sand and paving gravel, and Northwest Materials, Inc., produced bank-run paving gravel at Bryan.

Delaware.—Limestone used principally for aggregate and agstone was produced by National Lime & Stone Co., Delaware; The Owens Stone Co., Ostrander; Marble Cliff Quarries Co., Powell; and Penry Stone Co., Radnor. In the National Safety Competition, Marble Cliff Quarries was awarded a Certificate of Achievement in Safety for its safety record in 1964. The company did not have any lost-time injuries. Scioto Lime & Stone Co., Inc., Delaware, produced quicklime and hydrated lime chiefly for water purification and softening. Quantities of lime for metallurgical applications and for sewage treatment also were produced. Shale for building brick was produced by The Delaware Clay Co., Westerville, and The Galena Shale Tile & Brick Co., Galena.

Erie.—Production of limestone increased slightly above that of 1963. Producers were Castalia Quarries Co., Castalia; Sandusky Crushed Stone Co., Inc., Parkertown; and Wagner Quarries Co., Sandusky. Output was chiefly for concrete aggregate, agstone, and railroad ballast. Wagner Quarries Co. increased its screening capacity during the year. Sandusky Crushed Stone Co. shipped quantities of limestone to Macedonia for stockpiling and resale. Ohio Foundry Sand Co. and The Keener Sand & Clay Co., both near Huron, produced molding sand.

Fairfield.—Output of commercial sand and gravel was virtually the same as in 1963. The F. H. Brewer Co. and Febus Gravel Co., both near Lancaster, were the leading producers. No output was reported by Government-and-contractor operations.

Fayette.—Compared with 1963, limestone production decreased 17 percent to 523,000 tons. The material was sold mainly for concrete aggregate, agstone, and railroad ballast. Producers were Blue Rock, Inc., Greenfield, and Fayette Limestone Co. and Sugar Creek Stone Quarry, Inc., both near Washington Court House.

Franklin.—The county continued as the foremost sand and gravel-producing area; commercial output totaled 5.1 million tons, 5 percent more than in 1963. Output by Government-and-contractor operations also increased. Production was reported from 14 operations; American Aggregates Corp. (three plants) and Miller Sand & Gravel, both of Columbus, and The Olen Corp., Worthington, were the leading producers. Marble Cliff Quarries Co., Columbus, quarried limestone for commercial sales and for manufacturing quicklime and hydrated lime at its nearby plant. The Claycraft Co., Gahanna, and The Columbus Clay Mfg. Co., Blacklick, produced clay for heavy clay products.

Gallia.—Production of coal continued to decrease, declining 4 percent to 615,000 tons. Among the seven strip mines, Ohio River Collieries Co. and Calrite Coals, Inc., were the leading producers. At underground mines, Orville Hogue Coal Co., W. & M. Coal Co., and

Conkle Coal Co., were the foremost producers. James Merry Stone Co. produced limestone at its Flint Rock quarry near Gallipolis. Output was sold for concrete aggregate, agstone, and riprap. M. T. Epling Co., Gallipolis, produced processed building and paving sand and gravel. The Keener Sand & Clay Co., Kerrs, produced molding sand. Clay for floor and wall tile was mined near Waterloo by Jess Brammer.

Geauga.—Commercial sand and gravel production dropped sharply below that of 1963. No output was reported by Government-and-contractor operations. Leading commercial producers were R. W. Sidley, Inc., Thompson, and Northern Ohio Materials, Inc., Newbury. Jefferson Materials Co. abandoned its Boyer plant operations. The deposit was exhausted. Harbison-Walker Refractories Co., Thompson, quarried quartzite for refractory brick.

Greene.—The county continued as the leading cement-producing area. Producers were Southwestern Portland Cement Co. and Universal Atlas Cement Division of United States Steel Corp., both near Fairborn. The companies mined limestone and clay nearby for their principal cement raw materials. Portland and masonry cements produced by the companies were shipped principally to consumers in Ohio, Indiana, and Kentucky. In the National Safety Competition, Universal Atlas was awarded a Certificate of Achievement in Safety for working in 1964 without lost-time injuries. Output of commercial sand and gravel was virtually the same as in 1963. No output by Government-and-contractor operations was reported. Most of the commercial output was processed material used for construction and paving. Leading producers were Hilltop Concrete Corp., Fairborn; Phillips Sand and Gravel Co., Alpha; The Xenia Sand Gravel & Asphalt Paving Co., Xenia; and Bellbrook Gravel, Inc., Bellbrook.

Guernsey.—Coal production was below that of 1963. Output totaled 308,000 tons of which 234,000 tons was strip-mined coal. C. V. & W. Coal Co., Inc., Wells Coal Co., and Virginia Mining Co. were the largest strip mine operators. The only underground mine was operated by Fogle & Son Coal Co. John Gress & Sons, Inc., produced limestone at New Concord.

Hamilton.—The county continued as the second ranking sand- and gravel-producing area. Output increased 4 percent above that of 1963 and totaled 4.3 million tons. Eighty percent of the output was processed mainly for use in construction and paving. Ohio Gravel Division of Dravo Corp. was the leading producer with plants at Camp Dennison, Cleves, Miamitown, and Newton. Other operations were located mainly near Cincinnati. Limestones for agstone was recovered as a byproduct of sand and gravel production at the Newton and Camp Dennison plants of Ohio Gravel Division of Dravo Corp.

Hancock.—Limestone used principally for aggregate was produced by National Lime & Stone Co. and The Tarbox-McCall Stone Co., both near Findlay, and Pifer Stone Co., Williamstown. Northern Ohio Sugar Co., a subsidiary of The Great Western Sugar Co., produced and used quicklime for sugar refining at Findlay. Limestone quarried in Michigan was used by the company. Hancock Brick &

Tile Co., Findlay, mined clay for heavy clay products. Sand and gravel for building, paving, and filtration was produced by H. & M. Sand & Gravel Co., Findlay.

Hardin.—Limestone was produced by The Herzog Lime & Stone Co., Forest, and The Hardin Quarry Co., Dunkirk. Most of the county output was used for aggregate, but sales were made for flux, railroad ballast, agstone, and riprap.

Harrison.—The county was replaced by Belmont County as the State's foremost coal-producing area. However, the county continued to rank first in strip mine production and second in underground output. Total production was 7.7 million tons, 21 percent below that of 1963. In contrast with 1963, where most of the output was strip-mined coal, production in 1964 was mainly from underground mines. At underground mines, Hanna Coal Co., Division of Consolidation Coal Co., with three mines, and The Youghiogheny & Ohio Coal Co., with two mines, were the leading producers. Hanna Coal Co. also was the predominant strip mine producer and produced limestone for aggregate and agstone at Cadiz. The Bowerston Shale Co., Bowerston, mined shale for drain tile.

Henry.—Napoleon Sand & Gravel Co. and Turkey Foot Sand & Gravel, both near Napoleon, produced mainly construction sand. August Honeck & Son, Malinta, and Napoleon Brick & Tile Works, Napoleon, mined clay for drain tile.

Highland.—Output of limestone used chiefly for aggregate and agstone was below that of 1963. Producers were Highland Stone Division, Davon Inc., and Marshall Quarry, both near Hillsboro, and Ohio Asphaltic Limestone Co., New Vienna. The latter company improved its facilities by installing a new secondary crusher and screening plant. Sand and gravel production increased compared with that of 1963. Greenfield Sand & Gravel, Greenfield, was the leading producer. Other production was reported from operations near Hillsboro and Leesburg. The Mowrystown Brick & Tile Co., Mowrystown, mined clay for building brick and drain tile.

Hocking.—Output of coal was slightly below that of the previous year. Most of the output was strip-mined coal; Kencoal, Inc., and Boyle Coal Co., Inc., were the leading strip mine operators. Clay was recovered from pits near Logan and New Straitsville for use in manufacturing building brick.

Holmes.—Production of coal decreased by nearly a third compared with 1963. Total output was virtually all strip-mined coal. Hardy Coal Co. was the leading operator; the only underground mine was operated by Union Coal Co. Holmes Clay Division of Holmes Limestone Co. produced limestone and plastic fire clay at Berlin. Clay also was mined by Belden Brick Co. and Massillon Refractories Co., both near Berlin; The General Clay Products Co., near Baltic; and Clark Clay Co., Millersburg. The latter company acquired a new rubber-tired loader for use in the pits. Briar Hill Stone Co. quarried sandstone at two quarries near Glenmont for architectural uses. Construction sand and gravel was produced by Close Sand & Gravel Co. and Feikert Sand & Gravel, both near Millersburg, and Gallo & Sons, Inc., Holmesville.

Huron.—Structural and paving gravel was produced at New London by Huron Sand & Gravel Co., Inc. Mel-lo Peat Co., Willard, did not operate during the year.

Jackson.—Production of coal increased by more than one-third to 563,000 tons. Over 91 percent of the output was strip-mined coal. Among the 12 active strip mines, Belville Mining Co. and Waterloo Coal Co., Inc., were the primary producers. Fitch Co-Op Coal Co. and Rose Coal Co. were the leading underground coal mine operators. Cedar Heights Clay Co. and Pyro Refractories Division, A. P. Green Fire Brick Co., both near Oak Hill, produced plastic fire clay for refractory and other uses. Waterloo Coal Co., Inc., produced clay and limestone at Oak Hill.

Jefferson.—Production of coal was 4.3 million tons, 366,000 tons more than in 1963. Seventy-six percent of the output was strip-mined coal. The county continued to rank third among the coal-producing areas. Among the 31 active strip operations, Hanna Coal Co., Division of Consolidation Coal Co., The North American Coal Corp., Ohio Edison Co., and Teramana Bros. Coal Mining Co. were the foremost producers. The latter company was awarded a Certificate of Achievement in Safety for its safety record in 1964. The Jensie mine of The North American Coal Corp. was the primary producer of underground-mined coal. Clay production was slightly below that of 1963. Producers were McLain Works Refractory Division, H. K. Porter Co., Inc., and Frederick J. Dando Co., both near Irondale, and Kaul Clay Co., Toronto. Output was mostly plastic fire clay used in refractories.

Knox.—Sand and gravel production was slightly above that of 1963 and totaled 738,000 tons. Construction sand and gravel was produced at operations near Brinkhaven, Gambier, Fredericktown, and Mount Vernon. Fredericktown Sand & Gravel Co., Fredericktown, was the leading producer. The Millwood Sand Co., Howard, produced glass, molding, and ground sand. Briar Hill Stone Co. operated sandstone quarries near Brinkhaven, Cavallo, and New Castle for the production of architectural stone.

Lake.—Rock salt was recovered from the Fairport underground mine of Morton Salt Co., near Painesville. The company improved facilities by installing an underground belt conveyor at the mine. Standard Portland Cement Division, Diamond Alkali Co., mined miscellaneous clay and purchased limestone and gypsum for use in making cement at its Painesville plant. Types I–II, general use portland cement, and masonry cement were produced at the plant. Cement was shipped mainly to consumers in Ohio and western Pennsylvania. Limestone quarried in Michigan was burned into quicklime at the Grand River plant of the Grand River Lime Co. The quicklime was sold for metallurgical and water purification purposes. Diamond Alkali Co. at Painesville produced quicklime and salt brine from nearby wells. The brine and quicklime were used for manufacturing chlorine and alkalies. Output of commercial sand and gravel totaled 223,000 tons, compared with 243,000 tons in 1963. No output by Government-and-contractor operations was reported. Most of the commercial production was near Willoughby.

Lawrence.—Alpha Portland Cement Co., Ironton, and Marquette Cement Manufacturing Co., Superior, produced portland and masonry cements. Marquette mined limestone and shale and Alpha mined limestone (cement rock) and sandstone for use as cement raw materials. In the National Safety Competition, both companies were awarded Centificates of Achievement in Safety for having injury-free operations in 1964. Most of the finished portland and masonry cement was shipped to Ohio, West Virginia, and Kentucky. Alpha Portland Cement Co. purchased three new 20-ton trucks and installed a new automatic skip loading system at its Ironton plant. Limestone also was produced by Engle Stone Co., Division of Benedict, Inc., Pedro, and the Lawrence County Highway Department. Most of the output was used for aggregate.

County output of clay was virtually the same as in 1963. Production was reported from pits near Blackfork, Ironton, Pedro, and South Webster. Most of the output was plastic fire clay used for refractories. Harbison-Walker Refractories Co. at South Webster purchased two new trucks for use in hauling clay from its pits. Jerry Sand & Gravel, Inc., South Point, and Wilson Sand & Gravel Co., Chesapeake, produced construction sand and gravel. Industrial sand was produced near Pedro. Output of coal was below that of 1963, and virtually the entire 1964 output was from three strip mines. Operators were Collins Mining Co., Engle Stone Co., and Cambria Clay Products Co. S. & E. Coal Co. operated the only underground mine.

Licking.—Production of sand and gravel increased to 744,000 tons from 708,000 tons in 1963. Of the 12 active operations, American Aggregates Corp., Alexandria Sand & Gravel Co., and Dry Creek Crushed Gravel Co., all near Newark, were the leading producers. Other operations also were active near Granville, Kirksville, Newark, and Thornville. The Bowerston Shale Co. reactivated its Hanover shale pit which was closed since 1956. Output was used for manufacturing building brick.

Logan.—Production of limestone dropped sharply below that of 1963 and totaled 214,000 tons. Mostly aggregate stone was produced by Connolly Construction Co., East Liberty; C. E. Duff & Son Inc., Huntsville; and Northwood Stone & Asphalt Co., Belle Center. The latter company installed a crusher to meet State specifications. Production of sand and gravel increased and was recovered from four principal operations. Neer's Engineering Laboratories, Bellefontaine, and Weiskille Sand & Gravel, Quincy, were the principal producers.

Lorain.—Cleveland Quarries Co., Amherst, produced dimension and crushed sandstone. Most of the dimension stone was used in architectural work and for lining steel furnaces; the crushed stone was used for riprap. Grindstones were recovered as a byproduct at Amherst quarry. The company acquired the Kipton quarry of The Nicholl-McBride Stone Co. The quarry was idle during the year, but shipments of riprap stone were made from materials mined in previous years. Sand and gravel was produced by Berea Sand & Gravel Co., Columbia Township; Lorain Elyria Sand Co., and National Sand & Gravel Co., both near Lorain; and Stone Equipment Sales, Inc.,

Elyria. Calcined gypsum was produced at the Lorain plant of National Gypsum Co. from crude material shipped from out of State.

Lucas.—Portland cement was produced by Medusa Portland Cement Co. at Toledo from limestone, shale, and sand mined nearby. In addition, quantities of gypsum and iron ore also were used as cement raw materials. The company produced Types I–II, general use portland cement for shipment to Ohio, Michigan, Indiana, and Illinois. The France Stone Co., Waterville; Maumee Stone Co., Maumee; and Toledo Stone & Glass Sand Co., Sylvania; also produced limestone. Most of the stone was used for aggregate, but quantities were sold for riprap, agstone, and railroad ballast. Increased construction activity in the county resulted in greater limestone production; output increased from 1.5 million tons in 1963 to 1.7 million tons. Toledo Stone & Glass Sand Co. and The France Stone Co. were awarded Certificates of Achievement in Safety for working in 1964 without lost-time injuries. Additionally, limestone for rubble was produced at the Toledo House of Correction, Whitehouse. In addition to the output of Medusa Portland Cement Co. at Sylvania, sand production was reported from seven operations near Toledo and Holland. No gravel production was reported. Bellevue Trucking Corp., Holland, was the leading sand producer.

Madison.—Output of sand and gravel by both commercial and Government-and-contractor operations was below that of 1963. Commercial producers were The West Jefferson Sand & Gravel Co., West Jefferson, and McMullen Sand & Gravel Co., Inc., Mount Sterling. Madison Stone Co., Inc., Galloway, and American Aggregates Corp., Plain City, produced limestone for aggregate. American Aggregate built a new plant at the Darby quarry (Plain City) formally operated by Connolly Construction Co.

Mahoning.—Carbon Limestone Co., Lowellville, produced limestone for flux, aggregate, and agstone. The company was awarded a Certificate of Achievement in Safety for working without any disabling injuries in 1964. The company competed in the Quarry Group of the National Safety Competition. Alliance Stone Co., Smith Township, produced limestone aggregate. County clay output was slightly above that of 1963. Natco Corp., Petersburg, and American Fire Clay Co., Canfield, produced fire clay. Alliance Brick Corp. recovered miscellaneous clay from pits near Alliance and Beloit. Sand and gravel was recovered near Salem. Beaver Peat Products Co., Damascus, resumed production of reed-sedge peat. Coal production decreased 14 percent below that of 1963 and was all strip-mined coal. Thompson Bros. Coal Co. and Marshall Mining Co. were the leading operators.

Marion.—Production of limestone increased 21 percent above that of 1963 and totaled 711,000 tons. Most of the output was used for aggregate and agstone. Producers were National Lime & Stone Co. and J. M. Hamilton & Sons Co., both near Marion, and Tri County Limestone Co., LaRue. National Lime & Stone Co. was awarded a Certificate of Achievement in Safety for its 1964 safety record. Marion Brick Corp. mined shale near Iberia. Production of sand and gravel was below that of 1963. Producers were Prospect Sand

Co., Prospect; Penry Stone Co., Radnor; and Green Camp Gravel Co., Green Camp.

Medina.—Sand and gravel production was 579,000 tons, 1 percent below that of 1963. Most of the output was processed material used for construction. Producers were Lodi Sand & Gravel and Quillin Bros. Construction Co., both near Lodi, Seville Sand & Gravel, Inc., Seville, and Ray H. Taylor Trucking & Supply, Medina. Clay for building brick was produced near Wadsworth by Wadsworth Brick & Tile Co.

Meigs.—Coal production increased by 60,000 tons to 406,000 tons. Of the total, 69 percent was strip-mined coal, 24 percent auger-mined, and the remainder came from underground mines. Habet Mining & Construction Co., Inc., and Goeglein Coal Co., with three pits, accounted for all of the strip-mined coal. Production of sand and gravel continued a downward trend begun in 1961, decreasing 6 percent below that of 1963. Producers were Richards & Son, Inc., and Tri-State Materials Corp., both near Apple Grove. Goeglein Gravel Co., Middleport, was idle in 1964. Excelsior Salt Works, Inc., Pomeroy, produced evaporated salt in open pans for use mainly in feed.

Mercer.—The John W. Karch Stone Co., Celina, and Rockford Stone Co., Rockford, produced limestone used mainly for aggregate and agstone. Sand and gravel production was below that of 1963.

Miami.—Limestone used chiefly for metallurgical flux was produced at Piqua by Armco Steel Corp. Compared with 1963, sand and gravel production increased 19 percent to 610,000 tons. Of the eight principal producers, Troy Gravel Co. and Steiner's Sand & Gravel Co., Ludlow Falls, were the principal producers. Production was also reported from Bradford, Covington, Piqua, and Tipp City.

Monroe.—Blaney Sand & Gravel Co., Inc., Clarington, produced mostly processed sand and gravel for building and paving. Watson Piatt produced bank-run paving material from the Witten gravel pit near Fly. Christman Quarry Co., Caldwell, produced limestone for aggregate.

Montgomery.—Production of commercial sand and gravel increased 17 percent above that of 1963 and totaled 3,000,000 tons. No output was reported by Government-and-contractor operations. Twenty-two principal operations were active, and the county ranked third among the producing areas. American Aggregates Corp., with two plants near Dayton, was the leading producer. Other leading producers included Moraine Materials Co., Moraine Village, and Hilltop Concrete Corp., West Carrollton. American Aggregates Corp. produced limestone for aggregate and agstone at quarries near Dayton and Phillipsburg. Carey Brothers Stone Co., Dayton, produced limestone for aggregate and roadstone. The City of Dayton Water Department recovered lime in a rotary kiln from waste sludge and from the recarbonation of water in a purification and softening process. Surplus lime recovered at the plant was sold for water treatment.

Morgan.—Most of the county output of coal was from the Muskingum strip mine of Central Ohio Coal Co.; total county output was below that of 1963. D. & K. Construction, Inc., Reinersville, and Ball & Ball, Amesville, produced limestone. Building and paving

sand and gravel was produced by Stockport Sand & Gravel Co., Stockport.

Morrow.—Chesterville Sand & Gravel Co., Chesterville, produced paving and fill sand.

Muskingum.—Portland and masonry cements were produced at the East Fultonham plant of Columbia Cement Corp. In addition to purchasing sand and gypsum, the company recovered limestone and shale from its underground Jonathan mine near Zanesville. In the National Safety Competition, the company was awarded a Certificate of Achievement in Safety for its Jonathan mine for working without lost-time injuries. Finished cement was shipped principally to consumers in Ohio and West Virginia. Chesterhill Stone Co., East Fultonham, and Sidwell Brothers, Zanesville, produced limestone mainly for aggregate. Decreased highway construction in the county resulted in lower output of sand and gravel. No output was reported by Government-and-contractor operations. The principal commercial producers were Muskingum River Gravel Co., Zanesville, and The Zanesville Gravel Co., Dresden. Ivan L. Hammer produced stoneware clay near East Fultonham. The Frazeysburg shale pit of The Bowerston Shale Co. was idle. Coal production increased 13,000 tons to 116,000 tons. At underground mines, Frank J. Paul & Sons and Monroe Coal Co. were the leading producers. B. & P. Coal Co., Inc., was the primary strip operator.

Noble.—Coal production increased by nearly 1 million tons to 2.7 million tons. Of the total, 87 percent was strip mine production, and the remainder was auger-mined coal. The Cumberland strip mine of Central Ohio Coal Co. was the foremost producer. The company was awarded a Certificate of Achievement in Safety in the National Safety Competition for working without disabling injuries in 1964. Other leading coal producers were Noon Coal Co. and Baker Coal Co. Production of limestone decreased 9 percent and totaled 168,000 tons. Producers were Lawrence King, Cumberland; James Merry Stone Co., Caldwell; Piatt Quarry, Summerfield; and Herman Zerger, Jr., Woodsfield. Ava Brick Corp., Ava, produced shale for manufacturing building brick.

Ottawa.—The United States Gypsum Co., Genoa, produced limestone for making lime at its nearby plant and for sale as concrete aggregate and riprap. Both quicklime and hydrated lime were produced; most of the quicklime was sold for use in glass manufacturing, and the hydrated lime was used primarily for construction and water purification and softening. The Genoa plant was awarded a Certificate of Achievement in Safety for working without lost-time injuries in 1964. Marblehead Stone Division, Standard Slag Co., produced limestone at Marblehead for aggregate and flux. The company made additions to its crushing, blending, and shipping facilities. The plant was idle for over 2 months because of a labor dispute. The Clay Center quarry and plant of Basic Inc. did not operate. Crude gypsum was mined by Celotex Corp., Port Clinton, and United States Gypsum Co., Gypsum. The crude material was calcined at nearby plants for manufacturing finished building products. The gypsum mine of United States Gypsum Co. was awarded a Certificate of Achievement in Safety in 1964 for working without disabling injuries.

Paulding.—Portland and masonry cements were produced by Peninsular Portland Cement Division, General Portland Cement Co., Paulding. The company used limestone and clay mined nearby and purchased sand and gypsum as its principal cement raw materials. Most of the finished cement was sold to customers in Ohio, Indiana, and Michigan, but some was transferred to the company's Cement City, Michigan, plant. Some of the limestone from the Peninsular quarry was shipped to the Michigan plant for processing, and some was sold locally to The France Co. for further processing and sale as aggregate, agstone, railroad ballast, and riprap. Auglaize Stone Co., Oakwood, produced limestone for aggregate, agstone, and flux. The company was cited for its safety record in 1964 and was awarded a Certificate of Achievement in Safety. Clay for drain tile was produced by Baughman Tile Co. and Dangler Drain Tile Co., both near Paulding, and Haviland Clay Works Co., Haviland.

Perry.—Production of coal increased and was mostly strip-mined output. Peabody Coal Co. was the leading producer among the seven underground and nine strip operations.

The Keener Sand & Clay Co., New Lexington, and The Central Silicia Co., Glenford, produced industrial sand. No production was reported by the Ohio State Highway Department. Clay production totaled 247,000 tons, compared with 194,000 tons in 1963. Most of the output was miscellaneous clay used for manufacturing heavy clay products. Production was reported from 10 operations. Logan Clay Products Co., Logan; The Belden Brick Co., Somerset; The Claycraft Co., Shawnee; and Ludowici-Celadon, New Lexington; were principal producers. Maxville Stone Co., Logan, and Morris Bros. Lime & Stone, Rushville, produced limestone mostly for aggregate and agstone. Morris Bros. closed the Rushville quarry in August and planned to open a gravel operation in Fairfield County in 1965.

Pickaway.—Processed sand and gravel was produced by The Sturm & Dillard Co., Circleville. Also at Circleville, McFarland Co. produced bank-run gravel.

Pike.—Mostly processed building and paving sand and gravel was produced by The Standard Slag Co., Sargents, and Seal Builders Supply Corp., Waverly. Leo Vulgarmore, Lucasville, produced bank-run fill gravel. Sharon Silica Co. produced industrial sand and gravel at its Hay Hollow plant near Waverly. Quartzite used chiefly for refractory (ganister) was quarried at Beaver by Durex Division, A. P. Green Firebrick Co., and Cambria Clay Products Co.

Portage.—Sand and gravel production was 2 percent below that of 1963 and totaled 2.1 million tons. Twenty-two operations were active, mainly near Kent, Mantua, Mogadore, Ravenna, and Shalersville. Industrial sands were produced at the Geauga Works near Aurora and at the Portage Works near Garretsville by Industrial Silica Division., Pennsylvania Glass Sand Corp. Construction sand and gravel was produced primarily by Beck Sand & Gravel and Twin Lakes Sand, Inc., both near Streetsboro; The Standard Slag Co. and Solon Sand & Gravel, both near Mantua; Hilltop Sand & Gravel Co., Mogadore; and The Hugo Sand Co., Kent. Harbison-Walker Refractories Co. and General Refractories Co., both near Garrettsville, produced quartzite for refractory (ganister). United States Con-

crete Pipe Co. mined shale for manufacturing vitrified sewer pipe at Diamond. Green Oaks Peat Moss Co., Ravenna, produced moss peat; Portage Peat, Ravenna, was idle. Production of coal was below that of 1963. Peterson Coal Co., operator of the Atwater strip mine, was the only producer.

Preble.—Marble Cliff Quarries Co. produced quicklime and hydrated lime for chemical and other industrial uses at Lewisburg. The company quarried limestone nearby to supply the lime plant and for sale as aggregate, agstone, and other uses. Steiner's Sand & Gravel Co. and Blue Bank Gravel Co., both near West Alexandria, and White Gravel Co., Camden, produced construction sand and gravel.

Putnam.—Production of limestone increased 17 percent above that of 1963 and totaled 305,000 tons. Producers were National Lime & Stone Co., Columbus Grove; Ottawa Stone Co., Inc., Gilboa; and Putnam Stone Co., Ottawa. Ottawa Stone improved its operation by adding a crusher, elevator, and feeder system. Putnam Stone added a sand washer to its facilities. Buckeye Sugars, Inc., Ottawa, produced and used quicklime for sugar refining. The company burned limestone shipped from Michigan. Clay for drain tile was produced by Etter Tile & Coal Co., Dupont; Glandorf Tile Co., Glandorf; and Miller Bros. Clay Works, Inc., Ottoville. The Leipsic clay operation of the Leipsic Clay Products Co. was permanently abandoned.

Richland.—Sand and gravel production totaled 306,000 tons, compared with 341,000 tons in 1963. Producers were D. H. Bowman & Sons, Inc., and Derwacter Sand & Gravel, both near Bellville; Mohican Sand & Gravel Co., Perrysville; and H. W. Fleck & Son, Inc., Lexington. Richland Shale Brick Co. and Ohio Brick & Supply Co., both near Mansfield, produced shale. Moss peat was recovered from a bog near Shelby by Reynolds Farms, Inc. Output was sold in bulk for soil improvement purposes.

Ross.—Production of sand and gravel decreased 3 percent below that of 1963, totaling 657,000 tons. Brewer & Brewer Sons, Inc., and Central States Construction Co., both near Chillicothe, and Miami Gravel Co., Richmond Dale, were the principal producers. Ohio Asphaltic Limestone Co. produced paving sand and limestone for aggregate and agstone at Bainbridge. Chillicothe Sand & Gravel Co., Chillicothe, was idle. Southern Silica, Inc., Richmond Dale, produced sandstone mainly for foundry use and glass manufacture. Some of the material was sold for abrasives and as metallurgical pebble. Ohio Asphaltic Limestone Co. at Bainbridge installed a secondary crusher and conveyors. Quicklime was produced and regenerated for use in manufacturing paper at the Chillicothe plant of The Mead Corp.

Sandusky.—The county remained the leading limestone- and lime-producing area. Lime production, including dead-burned dolomite, totaled 1.1 million tons valued at $18.5 million, 12 percent higher than that of 1963. Over 50 percent of the output was dead-burned dolomite used as refractory material by the steel industries; most of the remainder consisted of quicklime used by the chemical industry and hydrated construction lime. Eight lime plants were active. Output of limestone increased 16 percent above that of 1963 and totaled 4.1 million

tons. Of the total limestone produced, 54 percent was used for manufacturing lime, 17 percent for metallurgical flux, 15 percent for aggregate, and the remainder for various other uses. Nine limestone quarries were active; three each near Gibsonburg and Woodville, and one each near Bellevue, Fremont, and Millersville. Woodville Lime & Chemical Co., Woodville, improved its crushing facilities during the year. Three companies producing limestone and lime had outstanding safety records for the year. National Gypsum Co., Gibsonburg; The J. E. Baker Co., Millersville; and Standard Lime & Cement Co., Division of Martin Marietta Corp., Woodville, were awarded Certificates of Achievement in Safety. Structural sand was recovered by dredging at Fremont by The Home Supply Center, Inc.

Scioto.—Dimension sandstone used primarily in architectural applications was produced by Waller Bros. Stone Co. and The Taylor Stone Co., both near McDermott. General Refractories Co. produced crushed quartzite for silica brick at Minford. Industrial Minerals Division, International Minerals & Chemical Corp., Portsmouth; William and James Belcher, Scioto Furnace; and Myrl C. Ruby, Portsmouth, produced fire clay. The Ruby operation was abandoned at the end of the year. Construction sand and gravel was produced by The Standard Slag Co., Haverhill; Lucasville Sand & Gravel, Lucasville; Earl H. Schilling & Son, Franklin Furance; and Robert L. Rowe, Wheelersburg.

Seneca.—Basic, Inc., quarried dolomite at Maple Grove for commercial sales as well as for raw materials for manufacturing dead-burned dolomite. The refractory material was shipped mostly to steel producers in Ohio, Pennsylvania, and Indiana. Limited quantities were exported. Commerical sales of dolomite were mainly for metallurgical flux, aggregate, and agstone. Limestone used chiefly for aggregate was produced by The France Co. and Webster Stone Co., both near Bloomville, and Northern Ohio Stone Co., Flat Rock. The J. A. Miller Tile Co., Bascom, and St. Stephen Tile Co., St. Stephen, produced clay for manufacture of drain tile.

Shelby.—Output of sand and gravel increased and was used mostly for construction. Producers were The Sidney Sand & Gravel Co., Sidney; The Ernst Gravel Co., Houston; and Spring Creek Gravel Co., Fort Laramie. Miami River Quarries, Inc., Sidney, quarried limestone for aggregate and riprap.

Stark.—Portland and masonry cements were produced at Middle Branch by Diamond Portland Cement Co., Division of The Flintkote Co. The company used limestone, shale, and clay mined nearby and purchased sand and gypsum for cement raw materials. The company had a noteworthy safety record in 1964 and was awarded a Certificate of Achievement in Safety. Finished cement was shipped to Ohio, Pennsylvania, West Virginia, and New York. Limestone was also produced at Canton, East Sparta, and Hartville. East Ohio Limestone Co., Hartville, was in the process of installing a new secondary crusher at its plant. Commercial sand and gravel production totaled 1.9 million tons, 8 percent less than in 1963. No output was reported by Government-and-contractor operations. Twenty commercial operations were active. Major producers were Canton Aggregate Co., with four plants near Canton; The Standard Slag Co., Massillon; Massillon

Washed Gravel Co., Navarre; Ray C. Oster, Canton; and Uniontown Sand & Gravel Supply, Inc., Uniontown. Tuscora Foundry Sand Co. produced industrial sand at Canal Fulton.

Clay production was reported from 17 operations and totaled 647,000 tons, 14 percent less than in 1963. Nearly 402,000 tons was fire clay used primarily for manufacturing heavy clay products. Leading producers were East Ohio Limestone Co., Greentown, and Stark Ceramics, Inc., East Canton. Peat was recovered from bogs near Canton by Gerald R. Hetrick, Lantz Peat Moss, Inc., and Sanders Peat Moss. All of the output was sold in bulk for soil improvement purposes. Lab Nursery & Peat Moss, Canton, did not operate its peat bog. Coal production decreased 29 percent to 407,000 tons. Most of the production was strip-mined coal; Magnolia Mining Co. and Mullet Coal Co. were the primary producers. The Mapleton mine of Magnolia Mining Co. was awarded a Certificate of Achievement in Safety in 1964.

Summit.—Pittsburgh Plate Glass Co., Chemical Division, Barberton, led the county's mineral industry. The company produced portland cement and quicklime and mined evaporated salt and 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. Calcium chloride was recovered as a byproduct of the soda ash process and was sold chiefly for dust control and ice removal. Other important uses of the calcium chloride included concrete curing, oil well drilling, refrigeration, and coal and ore treatment. The company's nearby underground limestone mine supplied the lime plant (six-shaft kilns) and the single rotary cement kiln. Commercial sales for limestone were made for aggregate and riprap. Evaporated salt was marketed for a variety of chemical uses. Output from the company's sandstone quarry was used in glass manufacture and as concrete aggregate.

Diamond Crystal Salt Co. produced salt brine at Akron. Most of the brine was evaporated in both open and vacuum pans and sold for a variety of uses. Some of the evaporated salt was marketed as pressed blocks; the brine was sold for use by the rubber industry. The company started construction of a cooling tower for recirculation of water at its evaporation plant. Output of sand and gravel totaled 817,000 tons, 100,000 tons less than in 1963. Of the 14 active operations, Rubber City Sand & Gravel Co., Akron, and Greenbank Sand & Gravel Co., Barberton, were the leading producers. Camp Brick Co. and The Robinson Clay Products Co., both near Mogadore, mined shale.

Trumbull.—Building, paving, and fill sand and gravel was produced by The Kinsman Sand & Gravel Co., Kinsman.

Tuscarawas.—Although the number of active mines decreased from 51 to 48, coal production increased 3 percent compared with 1963. Strip mining predominated; Eberhart Coal, Inc., Howe Coal, Inc., and J. & M. Mining Co. were the leading producers. At underground mines, Midvale Coal Co., Inc., was the foremost producer. Clay production increased 7 percent and totaled 870,000 tons. The county continued as the leading clay-producing area with 26 active mines. Sixty-nine percent of the total clay output was fire clay used mainly for refractories and heavy clay products. The remainder was miscellaneous clay used chiefly for heavy clay products and floor and wall

tile. Leading producers included The Belden Brick Co., The Evans Pipe Co., Fox Valley Mining Co., and The Stone Creek Brick Co.

Sand and gravel production was 675,000 tons, compared with 649,000 tons in 1963. Industrial sands were produced by Industrial Silica Division, Pennsylvania Glass Sand Corp., at the Coxey Works near Dundee. Construction sand and gravel was produced mainly by Stocker Sand & Gravel Co., Gnadenhutten; Spring Brothers, New Philadelphia; and Edgar Spring, Inc., Sandyville. Limestone was produced by Limestone Division of Wallick Coal Inc., Strasburg; Kimble Coal & Limestone Co., Dover; and Bonum Lime Co., Sugar Creek. Sandstone for architectural work was quarried by Dundee Stone Co., Inc., Dundee.

Union.—Union Limestone, Inc., Ostrander, and L. G. Rockhold & Sons, York Center, produced limestone chiefly for aggregate and agstone. Construction sand and gravel was produced by Marysville Concrete & Materials, Inc., Marysville.

Van Wert.—Production of limestone increased compared with that of 1963. Producers were The Union Quarries Co. and Ridge Township Stone Quarry, both near Van Wert, and Delphos Quarries Co., Delphos. Most of the county output was used for concrete aggregate and roadstone, but some was sold for riprap, railroad ballast, and agstone. Clay for drain tile was produced by Weck Tile Plant, Van Wert.

Vinton.—Production of coal tripled and was mostly strip-mined output. Strip mines were operated by Benedict, Inc., J. A. Crow Coal Co., and Jerald & Everett Eberts. Trace Coal Co. was the leading underground operator. Limestone for aggregate and agstone was produced by McArthur Stone & Coal Co., McArthur. Hope Fire Clay Co., Zaleski, did not operate in 1964.

Warren.—Compared with 1963, output of sand and gravel increased 25 percent and totaled 1.5 million tons. Production was reported from 10 operations; Ohio Gravel Division of Dravo Corp., with plants at Morrow and Waynesville, was the leading producer. Other leading producers included Morrow Gravel Co., Morrow; J. L. Clark Construction Co., Lebanon; Franklin Sand & Gravel Co. and Embro, Inc. (formerly Martz Bros. & Earnhart, Inc.), both near Franklin.

Washington.—Sand and gravel production was below that of 1963. Leading producers were Fred Price Contracting Co., Waterford, and Muskingum River Gravel Co., New Matamoras. Other production was reported from Marietta and Little Hocking. Hall Grindstone Co., Constitution, produced abrasive stone (grindstones). No coal production was reported in the county as in previous years.

Wayne.—Morton Salt Co., Rittman, produced evaporated salt in vacuum and open cans. Some of the salt was sold as pressed blocks. The company started recovery from a new brine field and improved facilities at its plant by installing new sacking equipment, bulk-storage mixing facilities, and a new loading system. For the second consecutive year, sand and gravel production decreased and totaled 396,000 tons. The Rupp Construction, Inc., Marshallville, and Prairie Lane Gravel Co., Wooster, were the leading producers. Mullet Coal Co., Mount Eaton, produced limestone for aggregate. Holmes Clay Division of The Holmes Limestone Co. (formerly Wayne County Quar-

ries, Inc.) produced limestone for aggregate and agstone near Holmesville. Medal Brick & Tile Co. produced shale at Wooster, and Orrville Tile Co. mined clay at Orrville. Mullet Coal Co. mined limestone and plastic fire clay at Mount Eaton. Coal was produced by Holmes Limestone Co., M. & M. Coal Co., and Mullet Coal Co.

Williams.—Output of commercial sand and gravel increased. No production was reported by Government-and-contractor operations. Tri-State Gravel Co., Montpelier, was the leading producer. The Stryker Drain Tile Co., Stryker, was idle in 1964.

Wood.—Production of limestone totaled 854,000 tons, 19 percent more than in 1963. Most of the stone was sold for use as aggregate, but some was used for flux, riprap, agstone, and railroad ballast. Producers were 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. The latter company installed a new agstone crushing mill and a new primary jaw for the crusher. At Portage, Maumee Stone Co. built a new plant 2 miles south of the old plant. The Rossford Brick & Tile Co. was not in production during the year. The plant was sold in July to Rollins Research Industries.

Wyandot.—National Lime & Stone Co. produced limestone for commercial sales and for manufacturing lime at Carey. Most of the commercial sales were for aggregate, flux, glass manufacture, agstone, and railroad ballast. Output at the lime plant consisted chiefly of quicklime for the glass industry and was shipped mainly to consumers in Pennsylvania, Illinois, Indiana, and Michigan. The company had a noteworthy safety record and was awarded a Certificate of Achievement in Safety for 1964. Limestone also was produced by Wyandot Dolomite, Inc., Carey, and Kuenzli Quarries Co., Inc., and J. L. Foucht Quarry, both near Upper Sandusky. The latter company added equipment for producing agstone at its plant. Output of sand and gravel was centered near Upper Sandusky; producers were Corfman Gravel Co., Wilson Sand Co., and Kuenzli Quarries Co., Inc. Production increased compared with 1963. The Humus Co. recovered humus peat from a bog near Carey for sale as seed inoculant and for soil improvement purposes. Shale for building brick was produced by The Claycraft Co., Upper Sandusky.

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 industry of Oklahoma set a record high mineral production value of $881 million, compared with the previous record of $878 million established in 1963. Of 16 minerals produced, bentonite, gypsum, lead, lime, salt, sand and gravel, and zinc increased in value of production. Principal mineral commodities in order of value were petroleum, natural gas, natural gas liquids, cement, and stone. Mineral fuels and related products comprised 94 percent of the total value; nonmetals and mineral commodities 5 percent; and metals 1 percent.

TABLE 1.—Mineral production in Oklahoma [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	898	$911	835	$854
Coal (bituminous) do.	1,008	5,667	1,028	5,474
Gypsum do.	531	1,462	694	1,899
Helium thousand cubic feet	237,201	8,302	230,673	8,073
Lead (recoverable content of ores, etc.) short tons	3,192	689	2,781	729
Natural gas million cubic feet	1,233,883	160,405	1,323,390	166,747
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	555,467	35,131	554,053	34,011
LP gases do.	810,894	28,981	880,804	28,055
Petroleum (crude) thousand 42-gallon barrels	201,962	587,709	202,524	587,320
Salt thousand short tons	4	26	6	41
Sand and gravel do.	5,420	6,116	6,680	7,003
Stone do.	13,817	16,160	13,987	15,087
Zinc (recoverable content of ores, etc.) short tons	13,245	3,046	12,159	3,307
Value of items that cannot be disclosed:				
Bentonite, cement, lime, tripoli, and volcanic ash	XX	22,929	XX	22,670
Total	XX	r 877,534	XX	881,270

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

[1] Geologist, Bureau of Mines, Mineral Resource Office, Bartlesville, Okla.
[2] Geologist, Oklahoma Geological Survey, Norman, Okla.

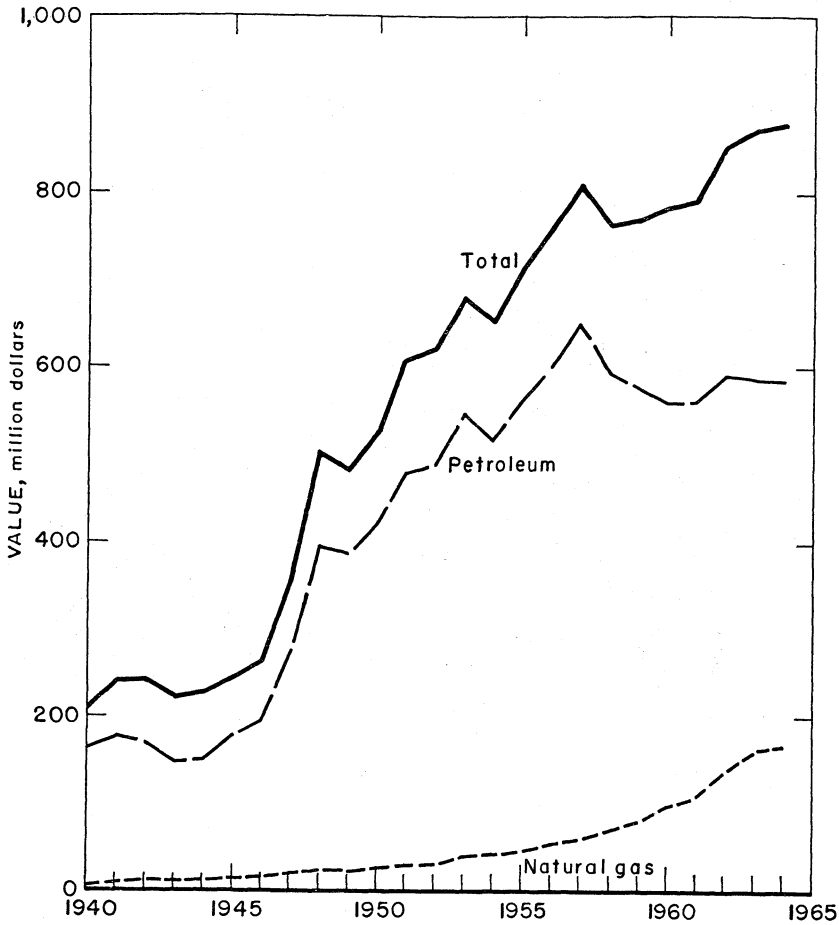


FIGURE 1.—Value of natural gas, petroleum, and total value of mineral production in Oklahoma.

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

(Millions)

Year	Value	Year	Value
1952	$751	1959	$777
1953	770	1960	783
1954	712	1961	783
1955	775	1962	r 822
1956	816	1963	r 854
1957	803	1964	855
1958	762		

r Revised.

Employment and Wages.—As defined by the Oklahoma Employment Security Act, which covers establishments that employ 4 or more persons, the oil and gas industries employed 40,400 persons. Bureau of Mines data for employment in other mineral industries are shown in table 3.

Consumption and Markets.—A significant part of the State mineral output was processed into semifinished and finished products for intrastate use and interstate movement. The industries included oil refineries; gasoline and cycle plants which stripped condensable liquids from natural gas; a helium extraction plant; zinc smelters which reduce zinc ore concentrate; cement, brick, tile, pottery, and glass plants which consumed limestone, gypsum, clay, shale, and silica sand quarried in Oklahoma; building products manufactured from gypsum mined in the State; and lime and calcium carbide manufactured from locally mined limestone. Large quantities of natural gasoline and petroleum products were transported by pipeline to industrial areas in Eastern and North-Central States. Ammonia was produced from natural gas, and carbon black was produced from petroleum distillate.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	369	70	556	----	32	58
Metal	327	82	659	----	35	53
Nonmetal	402	88	702	----	14	20
Sand and gravel	306	82	682	----	5	7
Stone	1,257	343	2,856	1	53	19
Total	2,661	665	5,455	1	139	26
1964: [e]						
Coal	351	72	510	----	48	94
Metal	270	77	617	----	6	10
Nonmetal	330	75	599	----	11	18
Sand and gravel	375	101	840	----	16	19
Stone	1,035	271	2,271	----	59	26
Total	2,361	596	4,837	----	140	29

[e] Preliminary.

Demand for Oklahoma crude petroleum increased over that of 1963 and was over 1.7 million barrels more at yearend. Under State regulatory control, output was maintained in close balance with demand and stocks.

New construction established a record high in 1964; the value reached $1.6 billion, a gain of 8 percent over that of 1963, according to the Bureau of Business Research, University of Oklahoma. Residential building established a high of $1.2 billion, more than a 13 percent increase over the 1963 high; however, the number of housing starts dropped over 4 percent. This phase of the construction industry remained remarkably steady throughout 1964, with greater emphasis being placed on larger homes as well as repairs and modernization of current residences. In other construction industry categories, manufacturing building experienced its best year, nearly 46-percent increase over 1963 figures. Commercial building declined about 50 percent in 1964, although the high volume established at the outset kept the total about 13 percent above the previous high set in 1963. Public utilities construction declined throughout the year, over 7 percent below that of 1963. State highway construction declined

20 percent; other public works declined nearly 3 percent, over 8 percent below the 1963 figure.

Trends and Developments.—The recoverable petroleum reserve declined though less sharply than in 1963; the gas reserve increased. Another successful year for oil and gas discoveries was recorded as the result of widespread drilling; 160 of 484 exploratory wells proved productive, a success ratio of 33 percent. The Anadarko basin in western Oklahoma and the Arkoma basin in the southeast continued to be the site of much drilling activity.

The American Association of Petroleum Geologists annual report indicates that most discoveries by rock units in 1964 were Mississippian and Pennsylvanian in age. The Osage-Meramec groups (Mississippian) were the most productive units, followed by the Des Moines group (Pennsylvanian), Simpson (Ordovician), Morrow and Atoka (Pennsylvanian), and Chester (Mississippian), respectively. Lithology of the producing zones in these units was primarily limestone and sandstone.

Oklahoma ranked fourth in the Nation in exploratory drilling with 484 wells. Test well drilling totaled 2.9 million feet, averaging 5,967 feet per well compared with 5,386 feet in 1963. The 4,032 field development wells drilled totaled 15.6 million feet, averaging 3,863 feet per well, compared with 3,709 feet in 1963.

Humble Oil & Refining Co.'s No. 1 Clark Unit in Grady County was completed in 1964. Gas was produced from the Bromide at 17,224 feet.

Shell Oil Co. began a thermal secondary recovery project in a sector of the Sho-Vel-Tum district in Carter County. Steam and hot water injected through four 1,200-foot-deep wells would drive remaining oil from the Hoxbar sands in the sector. A salt water disposal well was also drilled.

The property and assets of Wilcox Oil Co. were acquired by Tennessee Gas Transmission Co. A prolific oil sand, later known as the Wilcox sand, was discovered several years ago by the company and had become one of the Nation's most important producing sands.

Sunray DX Oil Co. completed a $3.4 million solvent extraction plant at its Tulsa refinery. The final unit in a 6-year, $30 million expansion program, replaced several older units and increased finished lubricating oil capacity to 6,000 barrels per day. The new plant also had a computer system for closed-loop operation of three lubricant-processing units.

On August 14, the No. 1 Frank Paulsen oil well, about 4 miles south of Canton, Blaine County, was drilled for Goff Oil Co. The well blew out under high gas pressure at 8,810 feet and burst into flames as did a water well 140 feet away. A directional relief well, the No. 1–A Paulsen, was drilled in an effort to quench the fire but the attempts were unsuccessful and the fire continued out of control.

John Deere Chemical Co. completed a $3 million expansion program which about doubled urea capacity at its Pryor plant. The new facility employs a process for urea production developed by the Dutch State Mines, Heerland, the Netherlands.

Ground was broken in February for a low-level, continuous casting unit for steel billets by the Sheffield Division of Armco Steel Corp. at its Sand Springs plant. The new unit enabled the plant to cast

reinforcing and merchant-grade bar steel directly into billets, bypassing several long and expensive steps.

Kerr-McGee Oil Industries, Inc., began construction in July of a $1.5 million plant for processing nuclear fuel materials beside the Cimarron River in Logan County north of Oklahoma City. The plant, to be completed in 1965, will process ceramic uranium oxide, produce uranium oxide pellets, and operate a uranium recovery circuit. The nuclear fuel material will be used by reactor builders in the nuclear industry.

Standard Industries, Inc., a crushed stone, sand, and ready-mix concrete firm in Tulsa, was purchased in November by the Murchison Brothers of Dallas, Tex., and an Oklahoma City contractor.

On February 10, construction sluices at Eufaula Dam on the South Canadian River were closed and the passages filled with concrete to close the river and permit filling of the reservoir. The $120 million project was dedicated September 25 by President Lyndon B. Johnson. Temporary construction sluices at the Keystone Dam on the Arkansas River were closed in July and plugged with concrete. On the Little River in McCurtain County, the Broken Bow Dam was about one-third completed at yearend. Upstream from Sallisaw on the Arkansas River, the U.S. Army Corps of Engineers began constructing the Robert S. Kerr Lock and Dam (formerly the Short Mountain Lock and Dam) and at yearend the project was about 9 percent completed. At yearend, the initial contract was let by the U.S. Army Corps of Engineers, Tulsa District, for construction of the Webber Falls Lock and Dam, upstream from Webber Falls on the Arkansas River.

Construction of the $7.3 million Arbuckle Dam and Reservoir on Rock Creek was begun in June by the Bureau of Reclamation, U.S. Department of the Interior. The Norman Dam, under construction on the Little River, neared completion at yearend.

Grand River Dam Authority, a State agency, completed the Markham Ferry project on Grand River 12 miles southeast of Pryor in Mayes County. The project, which includes the Robert S. Kerr Dam (formerly Markham Ferry Dam) and Lake Walsh E. Hudson, was dedicated on October 17.

REVIEW BY COMMODITIES

MINERAL FUELS

Oklahoma remained an important producer of crude petroleum and natural gas as well as refined petroleum products. Low-ash bituminous coal also was produced.

For more than a year, the crude oil price in Oklahoma and several adjoining States has been subject to erosion. Most purchasers had posted a 5-cent-per-barrel price reduction in the midcontinent region by August.

Carbon Black.—Continental Oil Co.'s Ponca City refinery produced carbon black from petroleum distillate; output was 41 percent and value 39 percent more than in 1963.

Coal (Bituminous).—Output of bituminous coal increased 2 percent in quantity but was 3 percent less in value from the previous year.

Coal was produced from 16 mines by 15 operators in 6 counties, compared with 15 mines and 14 operators in 7 counties in 1963. Major producing counties in order of decreasing production were Haskell, Craig, and Rogers. Four companies supplied nearly 86 percent of the total output.

Strip mines furnished almost 99 percent of the total production, the remainder being supplied by underground mines. Output from the underground mines decreased 80 percent from that of 1963, whereas strip mine production increased over 6 percent. Ninety-seven percent of the coal was shipped by railroad and 3 percent was shipped by truck.

Equipment used at 12 strip mines included 10 power shovels, 8 draglines, 1 carryall scraper, 16 bulldozers, 11 power drills, and 46 trucks. An estimated 18.9 million cubic yards of overburden was excavated.

Equipment used at 4 underground mines included 3 cutting machines, 3 power drills, and 17 rail mine cars.

TABLE 4.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	1,904	$12,061	1962	1,048	$6,978
1960	1,342	9,113	1963	1,008	5,667
1961	1,032	6,784	1964	1,028	5,474

Helium.—The Federal Bureau of Mines Keyes helium plant, Cimarron County, produced 298.8 million cubic feet of helium, extracted from natural gas primarily from the Keyes field. Sales of helium totaled almost 231 million cubic feet, valued at $8.1 million, and the remainder of the production was placed in underground storage as part of the national helium conservation program. Federal agencies, principally, the Department of Defense and the Atomic Energy Commission, accounted for more than three-fourths of the helium purchased from the Keyes plant.

Natural Gas.—Oklahoma remained the third largest gas producing State with 64 counties led by Texas, Beaver, Garvin, Harper, Stephens, and Beckham, in descending order, reporting natural gas output.

The proved recoverable reserve of natural gas in Oklahoma at year-end was approximately 110 cubic feet of gas reserve for each cubic foot produced. In 1964 exploratory drilling added 240 billion cubic feet through new discoveries, and extensions and revisions added another 1,586 billion cubic feet to the gas reserve.

TABLE 5.—Marketed production of natural gas[1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1955–59 (average)	704,277	$62,207	1962	1,060,717	$135,772
1960	824,266	98,088	1963	1,233,883	160,405
1961	892,697	108,016	1964	1,323,390	166,747

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

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

	Proved reserves, Dec. 31, 1963	Changes in proved reserves, due to extensions and new discoveries in 1964	Proved reserves, Dec. 31, 1964 (production was deducted)	Changes from 1963, percent
Crude oil—thousand 42-gallon barrels	1,628,138	156,626	1,585,885	−3
Natural gas liquids [1]—do	328,193	43,756	342,902	+4
Natural gas—million cubic feet	19,138,820	1,825,894	19,757,235	+3

[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. V. 19, Dec. 31, 1964, pp. 11–12, 22.

TABLE 7.—Oil and gas wells drilled in 1964, by counties

County	Proved field wells				Exploratory wells			Total
	Oil [1]	Gas	Service	Dry	Oil [1]	Gas	Dry	
Alfalfa	26	3		5	9		2	45
Atoka				3			2	5
Beaver	53	24		38	2		5	122
Beckham		1		4			5	10
Blaine	3	6		4		2	1	16
Bryan		2		1		1	3	7
Caddo	8			4			6	18
Canadian	2	10		1			4	17
Carter	96	5	23	43	1		5	173
Cimarron	11	7		6			5	29
Cleveland	9	2	1	17	2		13	44
Coal	2	9		2			6	19
Comanche	51	1		14			3	69
Cotton	27	1	11	4			5	48
Craig	2	1		2			4	9
Creek	116	5	51	24	1	1	2	200
Custer	9	1					2	12
Dewey	22	13		5	1	1	7	49
Ellis	5	18		9	1	2	7	42
Garfield	145	19	17	16	15	3	5	220
Garvin	69	5	3	55	4		21	157
Grady	6	2	3	6	1	1	6	25
Grant	43	1	1	16	6		7	74
Greer	2			4				6
Harmon							2	2
Harper	6	18		6	1	1	4	36
Haskell		21		4		1	3	29
Hughes	13	24	1	31	2	4	6	81
Jackson	2			4			7	13
Jefferson	23		7	14			18	62
Johnston							1	1
Kay	27	2	1	20	1	1	12	64
Kingfisher	173	8		8	11	1	2	203
Kiowa	4			14	1		3	22
Latimer		19		6		2	2	29
Le Flore		14		4		4	5	27
Lincoln	20	8	2	24	3	1	5	63
Logan	39	3	5	11	8	1	5	72
Love	31	2		2	1		2	38
Major	71	22		10	11	3	3	120
Marshall	7			6		1	3	17
McClain	23	9	2	15	8		8	65
McCurtain				1				1
McIntosh		1				1	4	6
Murray	6	1		17			9	33
Muskogee	53		15	17			1	86
Noble	12	2	2	13	1		5	35
Nowata	51	1	31	17	1			101
Okfuskee	41	9	2	22	1	1	3	79
Oklahoma	9	1	2	4			1	17
Okmulgee	68	9	12	38			1	128
Osage	126	12	97	55	2		15	307
Pawnee	13		6	18		1	8	46

See footnote at end of table.

TABLE 7.—Oil and gas wells drilled in 1964, by counties—Continued

County	Proved field wells				Exploratory wells			Total
	Oil[1]	Gas	Service	Dry	Oil[1]	Gas	Dry	
Payne	43	5	3	28	2		7	88
Pittsburg	1	12		4		2	5	24
Pontotoc	51	2		27	1		5	86
Pottawatomie	37		4	12	2		7	62
Pushmataha							2	2
Roger Mills							2	2
Rogers	59		39	24				122
Seminole	91	2	20	28	2		2	145
Sequoyah							1	1
Stephens	44	9	47	30		2	6	138
Texas	94	33		49	3	3	8	190
Tillman	5			2			1	8
Tulsa	40	1	14	20	2			77
Wagoner	23		4	38				65
Washington	134	1	84	15		1		235
Washita							1	1
Woods		11		14	1	4	7	37
Woodward	1	14		7		6	6	34
Total: 1964	2,148	412	510	962	108	52	324	4,516
1963	2,220	393	529	934	53	37	326	4,492

[1] Includes distillate wells.

Source: Oil and Gas Journal. V. 63, No. 4, Jan. 25, 1965, p. 192.

Eight gas storage fields were in use by the natural gas industry in nine counties. Mustang Fuel Corp. opened its Butler Creek storage in Muskogee County, and Cities Service Gas Co. was developing storage facilities in Webb field of Grant County. Underground storage facilities had a total capacity of 157.3 billion cubic feet of working gas volume (above minimum working pressure) and 124.6 billion cubic feet of cushion gas volume (below minimum working pressure). Available storage capacity permitted continuous production and conservation of casinghead gas from oil wells during periods of low demand.

Natural Gas Liquids.—Recovery of natural gas liquids by 76 natural gasoline plants and 4 cycling plants totaled 1.4 billion gallons, 5 percent greater than in 1963. Natural gasoline and cycle products represented 39 percent of the quantity and 55 percent of the value in 1964; LP gases accounted for the remainder. Increased sales were attributable to the gain in use of LP gas for domestic and commercial purposes and for chemical feedstock. Flame cultivation, a relatively new use for LP gas, made noticeable gains in 1964.

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
1955–59 (average)	468,890	$27,223	602,309	$22,488	1,071,199	$49,711
1960	531,995	33,074	762,258	32,409	1,294,253	65,483
1961	521,237	33,358	817,082	30,141	1,338,319	63,499
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

Four new gasoline plants put on stream in 1964 were Champlin Oil & Refining Co.'s 40-million-cubic-foot-per-day refrigeration absorption Enid plant in the Northeast Enid field, Garfield County; Cities Service Oil Co.'s 50-million-cubic-foot-per-day refrigeration Murdock plant in the Mouser field, Texas County; Humble Oil & Refining Co.'s 15-million-cubic-foot-per-day refrigeration absorption Camargo plant in the Putnam field, Dewey County; and Mobil Oil Co.'s 9-million-cubic-foot-per-day refrigeration Thomas plant for the West Crane and Putnam fields, Dewey County. Phillips Petroleum Co. closed its Reserve plant for the Burbank and Reserve fields in Osage County and its Wewoka plant in the Wewoka field in Seminole County. Sinclair Oil & Gas Co. closed its St. Louis plant which processed gas from the St. Louis and Maud fields in Pottawatomie County. Natural gas from these fields was subsequently processed at the company's Seminole plant. Also closed was Warren Petroleum Corp.'s Kiefer plant in Creek County.

The proved recoverable reserve of natural gas liquids in Oklahoma at yearend was 4 percent more than in 1963 as exploratory drilling added over 3 million barrels and development drilling added nearly 41 million barrels to the reserve.

Underground storage capacity for natural gas liquids was 959,000 barrels at seven sites according to the Oil and Gas Journal. Continental Oil Co. completed a 200,000-barrel propane storage in a salt formation in Grant County. Service Pipe Line Co. was excavating shale to form a 220,000-barrel butane storage in Creek County; completion was scheduled for early in 1965. Shell Oil Co. increased its propane storage capacity to 17,000 barrels in salt layers in Beckham County, and Texaco, Inc., raised its propane storage capacity to 40,000 barrels in salt layers in Beaver County. Humble Oil & Refining Co. withdrew from service its 175,000-barrel storage facility in abandoned oil wells in Pontotoc County.

Petroleum.—Crude oil output totaled nearly 203 million barrels from 80,511 oil wells, compared with 202 million barrels from 81,475 oil wells in 1963. Oklahoma was the fourth largest producing State. Daily average production of crude oil was 553,344 barrels or 6.9 barrels per well. Average indicated demand for crude oil was 559,500 barrels, about 2 percent more than in 1963.

Petroleum output was prorated by the Oklahoma Corporation Commission under the Interstate Oil Compact to maintain a balance between production and indicated demand. The commission reduced the crude oil production allowable for May to 26 percent of the basic depth-acreage formula from 30 percent, which had been in effect the previous 10 months. High inventories of crude and products was cited by the buyers in their request for a reduction to the lowest such rate in history. Under this rate, approximately 540,000 barrels were produced daily, until November when the allowable was raised to 30 percent. The November increase was the first since August 1962 when the allowable was raised from 30 to 34 percent of the basic depth-acreage table.

Petroleum production was reported from 66 counties of which Stephens, Osage, Carter, Garvin, and Creek Counties led in order named. Unallocated fields, including secondary recovery projects and stripper wells, accounted for 50 percent of the total output.

TABLE 9.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	206,426	$597,368	1962	202,732	$591,977
1960	192,913	563,306	1963	201,962	587,709
1961	193,081	561,866	1964	202,524	587,320

TABLE 10.—Crude petroleum production, indicated demand, and stocks, in 1964, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Oklahoma
January	17,222	17,708	18,036
February	16,066	15,597	18,505
March	17,449	16,963	18,991
April	17,233	16,354	19,870
May	17,468	18,237	19,101
June	16,662	15,090	20,673
July	17,158	18,738	19,093
August	16,690	17,549	18,234
September	16,135	16,408	17,961
October	17,244	17,784	17,421
November	16,262	16,728	16,955
December	16,935	17,074	16,816
Total: 1964	202,524	204,230	XX
1963	201,962	202,527	XX

XX Not applicable.

The Interstate Oil Compact Commission, in cooperation with the National Stripper Well Association, reported that on January 1, Oklahoma had 69,161 stripper wells which produced 116.3 million barrels of oil in 1963. Oil reserves of stripper wells totaled 959 million barrels, or 59 percent of overall proved oil reserves in Oklahoma on January 1.

Average wellhead price per barrel of crude petroleum was $2.90—1 cent less than in 1963.

The estimated proved recoverable reserve of crude oil on December 31, 1964, was equivalent to 7.8 barrels of recoverable crude oil underground for each barrel of oil produced in 1964. During the year extensions and revisions added 149.9 million barrels and new discoveries added 6.7 million barrels to reserves. Oklahoma had over 5 percent of the total domestic crude oil reserve and nearly 5 percent of the total liquid fuel reserve, including natural gas liquids.

Thirteen refineries in Oklahoma had a total daily capacity of 415,680 barrels of crude oil and 178,920 barrels of cracked gasoline on January 1, 1964. These refineries processed about 67.5 percent of the State production. Crude oil data for 1963 and 1964 in thousand barrels, were as follows:

Year	Runs to stills	Total receipts	Intrastate receipts	Stocks Dec. 31
1963	135,568	135,799	102,110	2,262
1964	136,659	136,018	106,058	1,592

TABLE 11.—Production of crude petroleum, by fields
(Thousand 42-gallon barrels)

Field [1]	1960	1961	1962	1963	1964
Allen	1,525	1,403	1,390	1,445	2,150
Atlantic	1,111	1,171	1,462	1,450	1,363
Bradley	2,631	3,048	3,273	[2]	
Burbank	15,676	15,275	14,290	13,685	13,417
Camrick	873	1,947	2,175	2,322	2,225
Cement	3,836	4,038	3,533	3,340	3,040
Cumberland	1,219	1,213	1,142	1,133	1,141
Cushing	2,515	2,537	2,629	2,828	3,075
Dover-Hennessey		4,841	8,945	9,010	8,667
Doyle	1,798	1,671	1,313	1,219	1,100
Edmond, West	1,407	1,212	1,179	1,150	1,052
Enid, Northeast	89	64	157	1,460	2,148
Eola-Robberson	3,470	3,624	3,444	3,384	3,433
Glenn Pool	3,200	3,368	3,490	3,303	3,851
Golden Trend	11,071	10,202	10,730	13,427	14,292
Healdton	2,154	2,353	2,513	2,506	2,600
Hewitt	2,938	2,989	2,550	2,461	2,895
Knox	2,206	2,039	1,390	1,838	1,887
Loco	1,309	1,517	1,738	1,848	1,734
Moore, West	1,275	1,294	1,066	685	1,129
Naval Reserve	2,353	2,456	2,367	2,170	1,702
Oklahoma City	2,851	2,617	2,381	2,300	2,112
Payne	1,475	1,392	2,350	2,274	1,969
Postle	90	217	391	470	1,752
Putnam	29	449	900	912	2,076
Ringwood	303	247	268	1,340	1,314
Seminole:					
Bowlegs	905	1,125	1,240	1,110	1,208
St. Louis	1,422	1,449	1,440	1,535	1,470
Sho-Vel-Tum	24,227	24,510	24,350	24,995	26,660
Other fields	98,955	92,813	98,636	96,362	91,062
Total	192,913	193,081	202,732	201,962	202,524

[1] Based on Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Consolidated into Golden Trend.

Pipelines.—Arkansas-Louisiana Gas Co. completed a pipeline system to transport gas from part of the Red Oak Field, Arkoma Basin's largest gasfield, to the new Arkoma pipeline system.

Sinclair Pipe Line Co. replaced an existing 8-inch line with a 16-inch 88-mile crude oil line from its Ringling station to the Panova station near Shawnee.

Humble Oil & Refining Co. utilized a new gas pipeline extension about 7 miles southeast of its Dover-Hennessey gas processing plant. The system includes 53 miles of pipe varying in size from 3½ inches to 14 inches, and 7 miles of 12¾-inch pipe from a central field compressor station to the Dover-Hennessey gas products plant.

Phillips Pipe Line Co. completed a 72-mile pipeline extension to the Balko, Elmwood, Como, and Lakewood fields in Beaver County from its Camrick gathering system in the Texas Panhandle, which delivers crude oil to the Phillips Petroleum Co. refinery at Phillips, Tex. The system comprises 27 miles of 6-inch mainline and 45 miles of 27-inch gathering lines.

NONMETALS

Nine nonmetals produced in 1964 were valued at more than $47.5 million, over 5 percent of Oklahoma's total mineral production value.

Cement.—Shipments of cement by three companies at four locations decreased 3 percent in quantity and value. Dewey Portland Cement Co., a division of Martin Marietta Corp., closed its plant at Dewey in September and placed it on standby status. Plants operated by Ideal Cement Co. at Ada in Pontotoc County; Oklahoma Cement Co.,

southeast of Pryor in Mayes County; and Dewey Portland Cement Co., east of Tulsa in Rogers County, were active throughout 1964.

TABLE 12.—Shipments of portland cement to Oklahoma consumers

Year	Thousand barrels	Year	Thousand barrels
1955–59 (average)	4,999	1962	5,941
1960	4,669	1963	7,105
1961	5,573	1964	6,163

Clays.—Quantity and value of clay sold or used in 1964 declined 7 percent and 6 percent, respectively. Clay produced in 1964 was used primarily in brick and tile, and, to a lesser extent, for portland cement and expanded clay products. Brick and tile were produced in 12 counties; expanded clay aggregate was produced in Oklahoma and Rogers Counties; and pottery was manufactured in Creek County. Bentonite was mined near Vici in Dewey County for filtering and absorbent uses.

Oklahoma Brick Corp.'s new $1 million plant south of El Reno, Canadian County, began operating late in the year and contained one of the region's largest single-tunnel kilns. Capacity of the plant is about 75,000 bricks per day.

TABLE 13.—Clays sold or used by producers[1]

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	723	$724	1962	737	$756
1960	734	739	1963	898	911
1961	792	801	1964	835	854

[1] Excludes bentonite.

Gypsum.—Output of crude gypsum rose nearly 31 percent above that of 1963. U.S. Gypsum Co., an important producer, operated several quarries and a plant at Southard, Blaine County, to manufacture wallboard and other plaster products. Texas Gypsum Co.'s mining affiliate, Castile Mining Co., operated an open pit near Fletcher, Comanche County, to furnish crude gypsum for wallboard at its Irving, Tex., plant. Republic Gypsum Co. completed its new 400,000-square-foot-per-day $4 million wallboard plant at Duke, Jackson County. Gypsum was produced by other operators in Blaine, Caddo, Canadian, and Washita Counties, for agricultural use and as a retarder in portland cement.

Lime.—Output of lime increased about 5 percent over that of 1963. A new $1 million rotary kiln plant capable of producing nearly 220 tons of lime per day was placed on stream by St. Clair Lime Co. at Marble City, Sequoyah County. The lime was used mostly by chemical plants in Pryor and by municipal water plants; other uses were in steel manufacture, carbide manufacture, oil refining, waste disposal, building material, and paper manufacturing.

Salt.—Output of salt increased 52 percent and value nearly 60 percent over that of 1963. In Harmon County, salt was produced by solar evaporation of brine from springs, and in Woods County, from

surface encrustations on the Big Salt Plain of the Cimarron River. Stockfeed and recharging of water softener units were the principal uses; others included herbicides and salinity control of oil well drilling fluid.

Sand and Gravel.—Johnston, McCurtain, Oklahoma, Pushmataha, and Tulsa Counties supplied over 50 percent of the quantity and value of sand and gravel produced in 36 counties during 1964. Truck transportation was used for 83 percent of the sand and gravel shipped by commercial producers, and the remaining 17 percent was moved by rail.

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
1955–59 (average)	3,798	$4,123	2,289	$1,061	6,087	$5,184
1960	4,823	6,544	1,601	924	6,424	7,468
1961	4,029	4,515	1,281	998	5,310	5,513
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

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,067	$1,953	2,418	$2,185
Paving	1,053	977	843	777
Fill	533	316	368	211
Other [1]	528	1,945	549	2,017
Total	4,181	5,191	4,178	5,190
Gravel:				
Building	259	378	164	165
Paving	176	146	650	618
Other [2]	28	41	40	58
Total	463	565	854	841
Total sand and gravel	4,644	5,756	5,032	6,031
Government-and-contractor operations:				
Sand:				
Building	1	2	----	----
Paving	250	118	171	218
Fill	----	----	91	32
Other [3]	5	2	----	----
Total	256	122	262	250
Gravel:				
Building	14	15	----	----
Paving	506	223	502	394
Fill	----	----	884	328
Total	520	238	1,386	722
Total sand and gravel	776	360	1,648	972
Grand total	5,420	6,116	6,680	7,003

[1] Includes other construction sand and industrial sand (unground and ground).
[2] Includes miscellaneous gravel, railroad ballast, and fill.
[3] Other construction sand (1963).

TABLE 16.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Atoka	101	$40	Ottawa	82	$33
Bryan	16	30	Payne	1	1
Cotton	122	95	Pittsburg	14	11
Delaware	11	16	Seminole	251	170
Dewey	81	205	Sequoyah	5	8
Jackson	134	161	Texas	18	17
Kingfisher	158	138	Tulsa	1,282	897
Le Flore	227	227	Woods	1	1
McCurtain	975	360	Woodward	26	21
McIntosh	10	4	Other counties [1]	2,592	3,856
Murray	90	135			
Oklahoma	483	577	Total	6,680	7,003

[1] Includes Alfalfa, Caddo, Grady, Greer, Johnston, Kay, Kiowa, Logan, McClain, Major, Muskogee, Pawnee, Pontotoc, Pushmataha, and Wagoner Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

Stone.—Output of stone, including limestone used to manufacture cement and lime, was slightly higher than in 1963, whereas the value was almost 7 percent below. Comanche, Murray, Pontotoc, Rogers, and Tulsa Counties accounted for 56 percent of all stone produced in the State and 55 percent of the value. Limestone comprised 81 percent of the total stone produced and sandstone 9 percent; the remaining 10 percent was granite and chat. Most of the stone was crushed and used for roadstone, concrete aggregate, cement, and lime. Open-pit methods accounted for all stone produced except that from two underground mines in eastern Oklahoma. Trucks carried 48 percent of the crushed limestone shipments; railroads, 8 percent; and unspecified transportation, 44 percent.

Essentially a chert, chat is the coarse tailing from milling lead and zinc ores in the Tri-State District. Most of the chat was sold for railroad ballast, concrete aggregate, and road surfacing.

Seven granite quarries were operated by four producers in the Wichita Mountains area of Greer and Kiowa Counties, center of the State's dimension granite industry. Two producers operated in Johnston County. The stone was predominantly pink and red granite. Most of the dimension granite was used for monumental stone and was finished in plants within the area; the remainder was shipped to other States for finishing.

Limestone and dolomite were quarried in 36 counties with Comanche, Murray, and Tulsa Counties reporting the largest output. Chem-

TABLE 17.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Granite		Limestone		Sandstone		Other stone		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1960	[1] 5	[1] $620	11,995	$13,852	784	$870	1,270	$756	[1] 14,054	[1] $16,098
1961	22	681	12,531	13,712	1,133	1,529	1,295	639	14,981	16,561
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

[1] Excludes crushed granite.

ical-grade limestone quarried at Marble City, Sequoyah County, was used as a flux in glass manufacture, for making lime, and for agriculture. Dimension limestone was quarried in Caddo, Jackson, Johnston, and Pontotoc Counties for building stone, curbing, and flagging. Limestone for portland and masonry cement was quarried in Mayes, Pontotoc, and Rogers Counties. Dolomite was quarried and crushed for use in agriculture.

Output of sandstone, quarried and crushed in 13 counties, was substantially more than in 1963. The crushed sandstone was used by the Oklahoma State Highway Department and the U.S. Army Corps of Engineers, Tulsa District.

Tripoli.—Output of tripoli in eastern Ottawa County was 2 percent less than in 1963. The crude material was processed at Seneca, Mo., by American Tripoli Division of The Carborundum Co. and sold for buffing compounds and in minor amounts for foundry use.

Vermiculite.—Texas Vermiculite Co. exfoliated vermiculite at its plant in Oklahoma City from crude vermiculite mined in other States. Output of the finished product, used mostly in concrete and plaster, increased 32 percent over that of 1963.

Volcanic Ash.—Produced in Beaver County, volcanic ash output declined 3 percent and the value rose 6 percent from output and value in 1963. Principal use of the volcanic ash was for abrasive-type cleaners. For statistical purposes, the volcanic ash mined in Oklahoma is reported as pumice in the commodity chapter in volume I of the Minerals Yearbook. Pumice is not mined in Oklahoma, and no deposits of pumice or perlite occur in the State.

Water.—Oklahoma's water regulations were brought up to date when water laws passed by the State legislature in 1963 went into effect early in 1964. The rights of farmers, cities, industries, and other water users were clearly defined under these laws. A systematic survey of the State's water resources will be established and appropriations of definite amounts of water will be made.

Construction of the $2.5 million Robert S. Kerr Research Laboratory at Ada began in August and was scheduled to be completed late in 1965. The water supply and pollution control facilities will be operated by Public Health Service of the U.S. Department of Health, Education, and Welfare.

METALS

Copper.—Copper deposits in southwestern Jackson County were described by the Oklahoma Geological Survey.[3] The deposits are in the Flowerpot Shale which extends from north central Texas through western Oklahoma into south central Kansas and consists mainly of reddish-brown shale with thin interbeds of gypsum, dolomite, siltstone, sandstone, and greenish-gray shale. In the upper part of the Flowerpot Shale, two copper-bearing, greenish-gray shale beds occur; the main or "lower copper bed" is 6 inches thick, and the "upper copper bed" is about 4 inches thick. The two beds are separated by about

[3] Ham, William E., and Kenneth S. Johnson. Copper in the Flowerpot Shale (Permian) of the Creta Area, Jackson County, Oklahoma. Okla. Geol. Survey, Circ. 64, 2 pls., 1964, 32 pp.

5 feet of gypsum, dolomite, and shale. Malachite is the dominant mineral in weathered parts of the deposit but chalcocite predominates under moderately thin cover.

The lower bed has the greater economic potential. Its copper content averaged about 3.8 percent for approximately 3 miles in the central part of the outcrop belt. Trenching uncovered the bed 300 feet downdip and samples showed a copper content of 3.41 percent over a width of 7 inches. The Eagle-Picher Co. conducted mining exploration and research on the two copper beds in 1964.

Germanium.—Germanium was recovered from domestic and foreign zinc concentrates and residues 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. germanium processing plant north of Quapaw, Ottawa County.

Lead.—Thirty-one producers reported lead ore output from 57 operations, compared with 24 producers at 47 operations in 1963. Recoverable lead output in Ottawa County in 1964 was nearly 13 percent below the previous year; whereas the value increased almost 6 percent. The price of lead at New York advanced from 12.5 cents per pound on January 1 to 16.00 cents per pound at yearend.

Zinc.—Thirty-four producers reported zinc ore output from 61 operations in 1964 in Ottawa County, compared with 25 producers at 49 operations the previous year. Recoverable zinc output was over 8 percent less than in 1963; however, value increased to nearly 9 percent. The price of zinc at East St. Louis was 13.00 cents per pound until April 14 when it was raised to 13.5 cents. Effective October 14, it increased to 14.5 cents and was unchanged the remainder of the year.

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)
1955–59 (average)	10,768	$1,859	34,260	$2,700	,591	$2,229	18,065	$4,509
1960	1,687	155	4,715	344	936	219	2,332	602
1961	1,333	130	5,936	405	980	202	3,148	724
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
Total, 1891–1964	1,688,378	164,244	9,809,549	488,013	1,294,351	196,530	5,173,061	781,962

[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.

Custom Mills and Smelters.—The Eagle-Picher Co. at Henryetta, Okmulgee County, operated its horizontal retort zinc plant throughout 1964. American Metal Climax, Inc., at Blackwell, Kay County, operated its plant throughout the year. National Zinc Co. at Bartles-

TABLE 19.—Tenor of lead-zinc ore milled and concentrates produced

	1963	1964
Total material milled ..... short tons	479,802	486,545
Recovery of concentrate and metal from quantity milled:		
Galena ..... do	4,317	3,730
Sphalerite ..... do	24,329	22,592
Galena ..... percent	0.90	0.77
Sphalerite ..... do	5.07	4.64
Lead [1] ..... do	0.67	0.57
Zinc [1] ..... do	2.76	2.50
Average lead content of galena concentrate ..... do	75.38	75.95
Average zinc content of sphalerite concentrate ..... do	60.50	59.80
Average value per ton:		
Galena concentrate	$100.09	$135.50
Sphalerite concentrate	$72.20	$86.90

[1] Figures represent metal content of crude ore (dirt) as recovered in concentrate. Data on tailing losses not available.

ville, Washington County, operated its horizontal retort zinc smelter throughout the year. The company announced in July that a $1 million remodeling program to enlarge the furnaces had begun—a move made necessary by the metal price situation in the world and the constant competition.

Kaiser Aluminum & Chemical Corp. acquired Standard Magnesium & Chemical Co., Tulsa, Tulsa County, early in the year. The latter firm operated a secondary magnesium recovery smelter in Tulsa.

The Barbara J. mill of American Zinc, Lead & Smelting Co. near Cardin and the Central mill of The Eagle-Picher Co. near Commerce custom-milled ore from the Tri-State District.

Sulfuric acid was recovered as a byproduct from imported zinc ore processed by National Zinc Co. at its plant in Bartlesville.

TABLE 20.—Mine production of lead and zinc in 1964, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	316	1,209	August	209	1,163
February	288	971	September	218	976
March	239	992	October	220	942
April	276	1,029	November	235	951
May	197	952	December	216	1,049
June	186	860			
July	181	1,065	Total	2,781	12,159

Tri-State District

Output of lead decreased 6 percent in quantity and increased 14 percent in value in the Tri-State District, whereas zinc output increased slightly and value rose 19 percent as a result of higher prices combined with assistance to small miners through the Lead-Zinc Mining Stabilization Program.

Quoted prices on 60 percent zinc concentrates at Joplin, Mo., were $80 per short ton until April 19; effective April 20, the price increased to $84 per ton; and, effective October 19, the price rose to $92 per ton.

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)
1955–59 (average)	16,033	$2,817	63,627	$5,073	11,517	$3,391	33,912	$8,488
1960	3,098	284	8,877	658	1,717	402	4,449	1,148
1961	3,243	352	10,666	716	2,429	500	5,594	1,287
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:								
Kansas	1,603	228	8,636	769	1,185	310	4,665	1,269
Oklahoma	3,730	505	22,592	1,963	2,781	729	12,159	3,307
Total, 1964	5,333	733	31,228	2,732	3,966	1,039	16,824	4,576

TABLE 22.—Tenor of lead and zinc ore milled and concentrates produced in the Tri-State District

	1960 [1]	1961 [1]	1962	1963	1964
Total material milled:					
Crude ore, short tons	51,972	180,331	474,219	612,862	691,798
Recovery of concentrate and metal from material milled:					
Galena, percent	1.85	1.67	1.03	0.93	0.77
Sphalerite, do	7.79	5.64	5.39	5.02	4.51
Lead [2], do	1.18	1.28	0.78	0.69	0.57
Zinc [2], do	4.13	2.98	2.94	2.73	2.43
Average lead content of galena concentrate, do	64.86	78.43	76.75	75.21	75.77
Average zinc content of sphalerite concentrate, do	58.88	58.65	60.64	60.52	59.86
Average value per ton:					
Galena concentrate	$113.62	$111.82	$98.24	$105.68	$137.52
Sphalerite concentrate	$78.40	$67.56	$69.30	$73.82	$87.48

[1] Lead-zinc concentrates from accumulated slimes excluded.
[2] Metal content of the crude ore (dirt) as recovered in concentrate.

REVIEW BY COUNTIES

Minerals were produced in 76 of Oklahoma's 77 counties. Almost 54 percent of the State's total mineral production value was supplied by Stephens, Garvin, Osage, Carter, Texas, Kingfisher, Beaver, Creek, McClain, and Seminole Counties in descending order of value.

Beaver.—Mineral output value declined nearly 2 percent because of decreased sales of natural gas, which offset increased natural gas liquids and volcanic ash production. The Camrick field in Beaver and Texas Counties yielded over 2.2 million barrels of crude oil. Natural gas liquids were recovered by 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. Volcanic ash was mined north of Gate by LaRue-Axtell Co. Texaco, Inc., operated a 40,000-barrel-propane-storage reservoir underground in a salt layer near its processing plant; Warren Petroleum Corp. maintained a 140,000-barrel-LP-gas-underground-storage reservoir in a salt layer near its gas liquids plant. Phillips Pipe Line Co. completed a pipeline to connect the Balko,

TABLE 23.—Value of minerals produced in Oklahoma, by counties[1]

County	1963 r	1964	Minerals produced in 1964 in order of value
Alfalfa	$3,931,063	$3,763,933	Petroleum, natural gas, sand and gravel.
Atoka	331,364	313,303	Stone, sand and gravel, petroleum.
Beaver	36,668,745	36,014,304	Natural gas, petroleum, natural gas liquids, volcanic ash.
Beckham	19,442,372	17,638,699	Natural gas, natural gas liquids, petroleum.
Blaine	3,918,930	4,164,397	Natural gas, gypsum, petroleum, natural gas liquids, stone.
Bryan	2,509,351	2,588,530	Petroleum, natural gas, sand and gravel, stone.
Caddo	11,875,822	11,122,114	Petroleum, natural gas, gypsum, stone, sand and gravel.
Canadian	854,870	873,111	Natural gas, petroleum, gypsum, clays.
Carter	56,370,994	56,993,420	Petroleum, natural gas liquids, natural gas.
Cherokee	W	W	Stone.
Choctaw	280,333	189,725	Do.
Cimarron	11,204,920	10,738,408	Helium, natural gas, petroleum, natural gas liquids.
Cleveland	14,086,824	13,841,534	Petroleum, natural gas liquids, natural gas.
Coal	2,633,410	2,710,876	Petroleum, natural gas, stone.
Comanche	4,282,164	2,962,995	Stone, natural gas, petroleum, gypsum.
Cotton	6,026,223	6,537,999	Petroleum, sand and gravel, natural gas.
Craig	1,018,983	1,111,456	Coal, stone, petroleum, natural gas.
Creek	33,970,166	33,997,116	Petroleum, natural gas liquids, natural gas, stone, clays.
Custer	2,111,102	2,830,618	Natural gas, petroleum, clays.
Delaware	----------	16,000	Sand and gravel.
Dewey	5,963,993	12,274,576	Petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Ellis	676,805	980,268	Natural gas, petroleum.
Garfield	11,855,168	19,390,444	Petroleum, natural gas, natural gas liquids, clays.
Garvin	76,655,719	71,898,660	Petroleum, natural gas liquids, natural gas.
Grady	21,921,259	20,535,226	Petroleum, natural gas, natural gas liquids, sand and gravel.
Grant	7,444,014	7,438,893	Petroleum, natural gas, natural gas liquids.
Greer	342,096	317,009	Stone, petroleum, sand and gravel, natural gas, clays.
Harmon	19,350	44,766	Salt, petroleum.
Harper	19,684,191	19,679,953	Natural gas, natural gas liquids, petroleum.
Haskell	4,080,424	4,952,440	Coal, natural gas, stone.
Hughes	6,403,258	5,871,933	Petroleum, natural gas, stone.
Jackson	768,475	611,925	Petroleum, sand and gravel, gypsum, stone, natural gas.
Jefferson	3,513,786	3,915,129	Petroleum, natural gas.
Johnston	W	W	Sand and gravel, stone.
Kay	13,477,168	12,994,511	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Kingfisher	40,697,509	38,349,109	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	1,519,727	892,332	Stone, petroleum, sand and gravel, natural gas.
Latimer	222,780	4,166,011	Natural gas, stone.
LeFlore	840,382	1,369,536	Natural gas, stone, sand and gravel, coal.
Lincoln	23,921,787	22,430,854	Petroleum, natural gas, natural gas liquids, clays.
Logan	6,258,313	6,571,572	Petroleum, natural gas, sand and gravel, natural gas liquids.
Love	9,455,845	9,547,619	Petroleum, natural gas liquids, natural gas.
Major	12,443,427	14,035,934	Natural gas, petroleum, natural gas liquids, sand and gravel.
Marshall	5,284,683	4,898,114	Petroleum, natural gas liquids, natural gas.
Mayes	6,247,059	6,809,648	Cement, stone, clays, petroleum.
McClain	27,825,679	25,507,173	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain	394,386	583,116	Sand and gravel, stone, petroleum.
McIntosh	628,855	1,036,629	Stone, natural gas, sand and gravel, petroleum.
Murray	3,214,686	3,398,190	Stone, petroleum, sand and gravel, natural gas.
Muskogee	4,569,517	4,035,413	Petroleum, sand and gravel, coal, natural gas, stone.
Noble	8,466,022	7,194,453	Petroleum, natural gas, natural gas liquids.
Nowata	6,047,432	4,785,163	Petroleum, stone, natural gas.
Okfuskee	7,693,731	7,341,896	Petroleum, natural gas, stone, natural gas liquids.
Oklahoma	20,121,831	18,904,383	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.
Okmulgee	5,722,697	5,327,454	Petroleum, natural gas, coal, stone.
Osage	69,290,837	66,060,800	Petroleum, stone, natural gas.
Ottawa	4,399,868	4,826,190	Zinc, lead, stone, tripoli, sand and gravel.
Pawnee	5,351,032	4,808,994	Petroleum, stone, sand and gravel, natural gas.
Payne	7,412,574	7,003,846	Petroleum, natural gas, stone, sand and gravel.
Pittsburg	783,146	401,002	Natural gas, stone, clays, sand and gravel.
Pontotoc	22,012,218	20,582,678	Petroleum, cement, stone, sand and gravel, clays, natural gas liquids, natural gas.
Pottawatomie	11,753,304	10,714,824	Petroleum, natural gas, stone.
Pushmataha	W	W	Sand and gravel, stone.
Roger Mills	2,302	12,083	Petroleum.
Rogers	8,832,611	10,351,958	Cement, petroleum, coal, stone, clays, natural gas.
Seminole	24,954,494	25,426,800	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays.
Sequoyah	1,623,748	1,948,361	Lime, stone, natural gas, sand and gravel.
Stephens	74,994,713	78,221,905	Petroleum, natural gas, natural gas liquids.

See footnotes at end of table.

TABLE 23.—Value of minerals produced in Oklahoma, by counties[1]—Continued

County	1963 r	1964	Minerals produced in 1964 in order of value
Texas	$38,038,469	$41,974,331	Natural gas, petroleum, natural gas liquids, sand and gravel.
Tillman	725,948	280,039	Petroleum.
Tulsa	8,222,074	10,735,917	Petroleum, stone, sand and gravel, clays, natural gas.
Wagoner	500,238	525,491	Petroleum, sand and gravel, natural gas.
Washington	14,365,944	11,062,040	Petroleum, cement, stone, natural gas.
Washita	1,236,165	1,249,303	Natural gas, petroleum, gypsum.
Woods	1,674,035	2,652,513	Natural gas, petroleum, salt, sand and gravel.
Woodward	2,112,616	2,873,843	Natural gas, petroleum, natural gas liquids, sand and gravel.
Undistributed	3,347,974	3,058,212	
Total	877,534,000	881,270,000	

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.

Como, Elmwood, and Logan fields with its Camrick gathering system. Crude oil produced in the fields had been gathered by truck.

Beckham.—Total mineral production value declined more than 9 percent as decreased sales were noted in the mineral fuels. Natural gas and petroleum were produced mainly from the Elk City field. Natural gas liquids were extracted from natural gas at the Elk City cycling plant of Shell Oil Co. Oklahoma Natural Gas Co. maintained an underground natural gas storage reservoir near Sayre. Near Sayre, Shell Oil Co. maintained a 17,000-barrel-propane-underground-storage reservoir in a salt layer.

Blaine.—Mineral production value increased more than 6 percent because of gains in sales of petroleum and gypsum. Universal Atlas Cement Co. quarried gypsum northeast of Watonga, and Walton Gypsum Co. quarried gypsum west of Okeene. United States Gypsum Co. quarried and crushed gypsum and operated a large calcining, sheetrock, and plaster products plant at Southard. Natural gas from fields in Blaine and Major Counties was processed at Pan American Petroleum Corp. Okeene plant.

Caddo.—Losses in petroleum and natural gas accounted for the decline in total mineral output, though the value of gypsum, stone, and sand and gravel output increased. Petroleum and natural gas were produced from several fields of which Cement, being the largest, produced more than 3 million barrels of petroleum. Crude oil was processed at the Cyril refinery of APCO Oil Corp. Harrison Gypsum Co., Inc., obtained gypsum by strip mining near Cement for portland cement and agricultural uses. Dimension and crushed limestone were produced by J. W. McPhearson and Bernard Thiessen. Sand for building purposes was produced by Karlin Sand and Gravel Co. from the Canadian River.

Carter.—The county ranked fourth in total mineral production value, third in production of petroleum, and sixth in natural gas liquids. Petroleum and natural gas were produced from numerous fields; Fox-Graham, Healdton, Hewitt, and Sho-Vel-Tum fields were the largest. Sho-Vel-Tum was the Nation's third largest field, producing more than 26 million barrels of petroleum. Natural gas liquids were extracted from natural gas at plants operated by Apache Gasoline Co. near Ardmore; Harry Ells, Inc., at Healdton; Mack Oil Co. near Wilson; Mobil Oil Co. near Healdton; Pure Oil Co. near Springer;

Shell Oil Co. near Wilson; Signal Oil & Gas Co. near Fox; and Sinclair Oil & Gas Co. at Healdton. Bell Oil & Gas Co. added 250 barrels per day to the catalytic cracking capacity of the Ben Franklin Refining Co. refinery at Ardmore.

Cimarron.—Total mineral production value declined more than 4 percent as losses resulting from decreased sales of helium and natural gas more than offset gains in petroleum and natural gas liquids sales. At the Federal Bureau of Mines Keyes plant, helium was removed from natural gas supplied by Colorado Interstate Gas Co. Several fields in the Keyes area produced natural gas and petroleum. Natural gas liquids were recovered from natural gas at its Keyes plant by Colorado Interstate Gas Co.

Cleveland.—A slight drop in total mineral value resulted when decreased sales of natural gas and natural gas liquids offset an increase in petroleum production value. Natural gas liquids were recovered by Continental Oil Co. at its Short Junction plant and Sunray DX Oil Co. at its Moore plant.

Comanche.—Total mineral output value was 31 percent below 1963 as a result of production losses in stone, natural gas, and petroleum. Limestone was quarried and crushed north of Lawton by Dolese Bros. Co. at its Richards Spur quarry. Gypsum was mined near Fletcher by Castile Mining Co., the mining affiliate of Texas Gypsum Co., Inc., for wallboard manufacture at the latter's Irving, Tex., plant. 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 increased over 9 percent due to increased coal and limestone output. Craig County ranked third among the coal producing counties. Coal was strip-mined by six operators at seven pits.

Creek.—Production gains in petroleum, natural gas, and stone were responsible for a slight gain in total mineral value. Petroleum and natural gas were produced from numerous fields including the prolific Cushing and Glenn Pool fields. Natural gas liquids were recovered by Kerr-McGee Oil Industries, Inc., plant near Milfay and Sinclair Oil & Gas Co. Drumright plant. The Warren Petroleum Corp. natural gas liquids recovery plant at Kiefer closed in 1964. Near Depew, Oklahoma Natural Gas Co. maintained an underground natural gas storage reservoir. Service Pipe Line Co. was mining a cavern in shale capable of storing 220,000 barrels of butane. Completion was expected in early 1965. Clay for manufacturing brick and tile was produced at Sapulpa by Sapulpa Brick & Tile Co. and for pottery by Frankoma Pottery Co.

Dewey.—Mineral production value more than doubled due to large gains in production of petroleum, natural gas, sand and gravel, and clays (bentonite). Putnam, a relatively new field, produced over 2 million barrels of petroleum in 1964. Natural gas liquids were recovered from natural gas by Humble Oil & Refining Co.'s 15-million-cubic-foot-per-day plant near Camargo and Mobil Oil Co.'s 9-million-cubic-foot-per-day plant north of Thomas which were placed on stream in 1964. Bentonite (clay) was produced south of Vici by the Filtrol Corp. for filtering and absorbent uses.

Garfield.—A 64-percent increase in total mineral value resulted from increased production of petroleum, natural gas, and natural gas

liquids. The Northeast Enid field produced over 2 million barrels of petroleum. Natural gas liquids were stripped from natural gas by Champlin Petroleum Co., Enid plant, Livingston Oil Co., Northeast Enid field plant, and Sinclair Oil & Gas Co. Covington plant.

Garvin.—Garvin County dropped to second in the total value of minerals produced, with a 6-percent decrease from 1963 as losses were in petroleum, natural gas liquids, and natural gas. The county ranked fourth in petroleum production value, first in natural gas liquids, and fifth in natural gas. The Golden Trend and Eola-Robberson fields were large producers. Natural gas liquids were recovered at the O. H. Grimes Pauls Valley field plant, Lone Star Gas Co. plant near Katie, Phillips Petroleum Co. plant near Lindsay, Service Gas Products Co. plant near Cumberland in the Hoover field, Sohio Petroleum Co. plant southwest of Elmore City, and Warren Petroleum Corp. plant west of Maysville. Crude oil was processed at the Wynnewood refinery of Kerr-McGee Oil Industries, Inc.

Grady.—A production loss in natural gas liquids was responsible for a 6-percent drop in total mineral value, though gains were made in petroleum and sand and gravel. Natural gas liquids were recovered by British-American Oil Producing Co. at its cycling plant in the Knox-Bromide field and the Mobil Oil Co. cycling plant in the Chitwood field. The Dolese Co. obtained sand for building and paving from pits near Tuttle.

Grant.—Total mineral value declined slightly as output of natural gas offset gains in petroleum and natural gas liquids. Natural gas liquids were removed from natural gas in the Continental Oil Co. Medford plant and CRA, Inc., Lamont field plant. Cities Service Gas Co. was developing an underground reservoir in the Webb field for storing natural gas in times of low demand. The project will have a reported capacity of 54.6 billion cubic feet. Near Medford, Continental Oil Co. maintained a 150,000-barrel butane storage reservoir in a salt layer. A new 200,000-barrel propane storage project near Medford was reported by the company.

Harper.—Total mineral value declined slightly due to losses in the mineral fuels and total stone output. Sun Oil Co. Laverne gasoline plant processed natural gas from the huge Laverne gasfield to recover natural gas liquids.

Haskell.—Haskell was the leading coal producing county. Increased outputs of coal, natural gas, and stone helped to raise the total mineral value more than 21 percent above that of 1963. Garland Coal & Mining Co. and Evans Coal Co., the county's largest producers, produced coal from open pits.

Johnston.—Total mineral value increased nearly 5 percent due to increased output of sand and gravel and stone. Pennsylvania Glass Sand Corp. of Oklahoma produced sand for glass and ground silica from pits north of Mill Creek. Dimension limestone for building was produced near Pontotoc by A–D–A Stone Co. Dimension granite was produced by The Century Granite Co., Inc., and Taylor Granite Co.

Kay.—Total value of mineral production declined over 3 percent from the previous year as losses were noted in petroleum, natural gas liquids, natural gas, sand and gravel, and stone. Petroleum and natural gas were produced from numerous fields; natural gas liquids

were recovered at plants operated by Cities Service Oil Co. and Wunderlich Development Co. A 300,000-barrel-propane-underground-storage cavern in mined limestone was maintained near Ponca City by Continental Oil Co. At Ponca City, crude petroleum was processed at refineries operated by Cities Service Oil Co. and Continental Oil Co. 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 quarry northeast of Ponca City and at another site.

Sand for building, paving, and fill was produced by Sober Brothers Concrete, Inc., at Blackwell, and by Sober Brothers Sand & Gravel Co. at Ponca City. Blackwell Zinc Co., Inc., a division of American Metal Climax, Inc., operated its zinc smelter at Blackwell.

Kingfisher.—A decline of almost 6 percent in total mineral value was noted because of losses in petroleum and stone output. Value of petroleum produced was almost 10 percent less than in 1963. Dover-Hennessey field yielded over 8.6 million barrels of oil. Natural gas liquids were recovered by 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.—Reduced output of stone, petroleum, and natural gas were responsible for a decline of more than 41 percent in mineral value. Dimension granite was quarried near Snyder by Roosevelt Granite Co., Inc., and Wichita Granite Co. Southwest Sand Co. processed sand and gravel from the North Fork Red River west of Snyder for building purposes.

Latimer.—The Red Oak field, said to be the largest unconnected proved gas reserve in the midcontinent area, received its first pipeline outlet. Early in the year, Arkansas-Louisiana Gas Co. completed a gas gathering system in portions of the field to transport gas to its new Arkoma basin pipeline. This was responsible for a substantial increase in total mineral production value. Limestone was quarried and crushed by H. D. Youngman Co. for concrete aggregate and roadstone. Contractors quarried and prepared sandstone for the Oklahoma State Highway Department.

Le Flore.—Increased mineral fuels and mineral output accounted for a 63-percent rise in mineral value. Coal was produced from underground mines by four operators. Three other operators who produce less than 1,000 tons annually were active at two underground mines and a strip mine. Sandstone was quarried and crushed by contractors for use by the Oklahoma State Highway Department as roadstone and as riprap by the U.S. Army Corps of Engineers, Tulsa District. The Oklahoma State Highway Department used gravel for paving highways.

Lincoln.—Total mineral value decreased 6 percent, compared with that of 1963. Petroleum and natural gas were produced from numerous fields, but the respective value was 3 percent and 32 percent below that of 1963. Stroud field, a portion of which extends into Creek County, yielded nearly 1.2 million barrels of oil; and Southwest Mt.

Vernon field produced almost 1.5 million barrels of oil. Natural gas liquids were stripped from natural gas at plants operated by Apache Gas Products Corp. northwest of Kendrick, Highway Gasoline Co. south of Stroud, Sunray DX Oil Co. west of Carney, and Texaco, Inc., east of Davenport. Crude oil was processed at the Stroud refinery of Allied Material Corp. Clay for brick was produced by Stroud Clay Products Co.

Logan.—Increased output of petroleum raised total mineral production value about 5 percent; decreases were reported in natural gas, natural gas liquids, and sand and gravel output. Petroleum and natural gas were produced from numerous fields and natural gas liquids were stripped from natural gas at the No. 3 plant of Eason Oil Co. south of Crescent. Sand for building and paving was produced by The Dolese Co. near Guthrie and for paving by the Oklahoma State Highway Department.

Love.—A slight increase in total mineral production value resulted from a gain in petroleum production which offset declines in value of natural gas and natural gas liquids. Natural gas liquids were recovered by the California Oil Co. cycling plant in Southeast Marietta field, Greenville Gasoline Co., Inc., plant north of Marietta, and by Texaco, Inc., at its Enville plant.

Major.—Total mineral production value increased 13 percent, though natural gas liquids value declined. Ringwood field yielded over 1.3 million barrels of petroleum. Natural gas liquids were recovered from natural gas by National Fuels, Inc., at its Ringwood plant.

Marshall.—A decrease of over 7 percent in total mineral production value was the result of declines in value of mineral fuels produced. Petroleum and natural gas were produced from several fields of which the most notable was the Cumberland field. Natural gas liquids were stripped from natural gas by National Fuels, Inc., plant east of Madill and Service Gas Products Co. Aylesworth field plant near Cumberland.

Mayes.—Total mineral production value increased 9 percent due largely to increased output of cement and petroleum. Limestone and clay were produced for cement by Oklahoma Cement Co. at its plant southeast of Pryor. Limestone was quarried and crushed for roadstone, concrete aggregate, and agricultural uses by Standard Industries, Inc., northeast of Pryor. Construction of the Markham Ferry project on Grand River, 12 miles southeast of Pryor, by Grand River Dam Authority was completed. On October 17, the project was dedicated.

McClain.—Value of minerals produced was 8 percent less than in 1963 due to production losses in petroleum, natural gas, and natural gas liquids. Petroleum and natural gas were produced from numerous fields; Payne field yielded almost 2 million barrels of petroleum. Natural gas liquids were recovered by Sohio Petroleum Co. Norman plant, Sunray DX Oil Co. Criner plant, and Universoil, Inc., Dibble field plant near Blanchard. The Dolese Co. and Lamar Lawson produced sand and gravel for building and paving; the Oklahoma State Highway Department used gravel for paving highways.

McIntosh.—Mineral value rose about 65 percent; increased output of stone, natural gas, and petroleum offset a decline in sand and gravel production. Limestone and sandstone were quarried and crushed

for concrete aggregate and roadstone. U.S. Army Corps of Engineers, Tulsa District, used stone and sand on the Eufaula Dam project. The dam was completed, except for work in the public use areas, and was officially dedicated on September 25. Natural gas and petroleum were produced, mostly from Coalton and Stidham fields. A small quantity of coal was obtained by strip mining by an operator not subject to the Bureau of Mines coal producers canvass.

Murray.—Mineral production value increased about 6 percent because of an increase in stone and sand and gravel. Limestone was quarried and crushed at Rayford and Big Canyon quarries by Dolese Bros. Co. and Sooner Rock & Sand Co. Sand and gravel for building was produced by Joe Brown Sand & Gravel Co. Two fields produced petroleum and natural gas.

Muskogee.—Value of minerals produced was about 12 percent less than in 1963; lower production of petroleum was responsible for most of the decline. Petroleum and natural gas were produced from several fields; Muskogee field, the largest, yielded over 1 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. Two operators obtained coal by strip mining. Sand for building, paving, and fill was dredged from the Arkansas River by Yahola Sand Co. Gravel for paving was produced by the city of Muskogee. Fansteel Metallurgical Corp. operated its columbium-tantalum plant at Muskogee.

Noble.—The 15-percent decline in mineral value resulted from losses in petroleum, natural gas, natural gas liquids, and stone. Petroleum and natural gas were produced from numerous fields. Natural gas liquids were stripped from natural gas at Sinclair Oil & Gas Co. Lucien plant and Wunderlich Development Co. Billings plant.

Okfuskee.—Overall mineral production value decreased 5 percent as lower output of crude oil and natural gas liquids outweighed increased natural gas and stone. Petroleum and natural gas were produced from numerous fields; Olympic, the largest, yielded 417,000 barrels of petroleum—21 percent less than in 1963. Natural gas liquids were recovered from natural gas at Grimes Gasoline Co. Okemah and Weleetka plants. Limestone and sandstone were quarried and crushed by contractors for use as concrete aggregate, roadstone, and riprap by the Oklahoma State Highway Department.

Oklahoma.—The 6-percent decline in total mineral value resulted from losses in petroleum, natural gas, and clays. Largest of numerous fields, Oklahoma City field yielded 2.1 million barrels of petroleum. Natural gas liquids were recovered at Champlin Petroleum Co. Witcher field plant; Cities Service Oil Co. Bodine plant in Oklahoma City field; Patton & Swab, Inc., Edmond field plant; Phillips Petroleum Co., Edmond field plant and Oklahoma City field plant. Sand for building and paving was produced by The Dolese Co., Sizemore Sand & Gravel, Sand Products, Inc., and Shoffner Sand & Gravel Co. The latter firm also produced gravel for paving purposes. Clay for brick and tile products was obtained from pits in the western part of Oklahoma County by Acme Brick Co. Near Choctaw, clay for lightweight aggregate was mined and expanded by Chandler Materials Co.

Okmulgee.—The 7-percent drop in mineral value was the result of losses in crude oil and natural gas which offset increased coal and stone values. Petroleum and natural gas were produced from numerous fields. Crude oil was processed at Phillips Petroleum Co. refinery in Okmulgee. Carbon Hill Coal Co. obtained coal by strip mining near Henryetta. Sandstone quarried and crushed by contractors was used by U.S. Army Corps of Engineers, Tulsa District, for riprap. The Eagle-Picher Co. operated its horizontal-retort zinc plant at Henryetta.

Osage.—Osage County ranked third in total mineral production value and second in petroleum. Mineral value declined 5 percent because of production losses in all segments of the industry. Numerous fields produced petroleum and natural gas. Burbank field was under an extensive waterflooding program. Naval Reserve field yielded 1.7 million barrels of crude oil. Domes-Pond Creek field, also under an extensive waterflood program, yielded over 1 million barrels of petroleum. The Phillips Petroleum Co. natural gas liquids Reserve plant which processed natural gas from Burbank and Naval Reserve fields was shut down. Limestone was quarried and prepared by Sedan Limestone Co., Standard Industries, Inc., and others for concrete aggregate and roadstone. Contractors also quarried and prepared limestone for Oklahoma State Highway Department.

Ottawa.—All of the Oklahoma lead and zinc output and a major part of the Tri-State District was supplied from mines in Ottawa County. Output in terms of recoverable content of ores decreased 13 percent and 8 percent, respectively, but value rose nearly 6 percent for lead and 9 percent for zinc, because of higher prices and payments made to producers under the Lead-Zinc Stabilization Program. The Eagle-Picher Co.'s Rare Metals plant was operated north of Miami. Chat, a waste product of lead and zinc milling, was supplied by four 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.

Pawnee.—Petroleum and natural gas were produced from numerous fields. Limestone was quarried and prepared by W. O. Cox and Standard Industries, Inc., for concrete aggregate and roadstone. Five contractors mined limestone for U.S. Army Corps of Engineers, Tulsa District, for riprap, concrete aggregate, and roadstone. Construction, paving, and fill sand were produced by Tulsa Sand Co., Inc., from the Arkansas River. Paving sand was produced by a contractor for Oklahoma State Highway Department.

Payne.—Numerous fields produced petroleum and natural gas; Yale-Quay was the largest. Crude oil was processed at the Cushing refineries of Kerr-McGee Oil Industries, Inc., and Midland Cooperative, Inc. Limestone was quarried and crushed for concrete aggregate and roadstone. Unprocessed gravel was used by Payne County Highway Department.

Pontotoc.—Value of mineral production declined 6 percent because of losses in natural gas, natural gas liquids, cement, stone, and sand and gravel. Allen oilfield, parts of which are in Hughes and Seminole Counties, yielded nearly 2.2 million barrels of oil; Fitts field yielded almost 800,000 barrels of oil. Natural gas liquids were stripped from natural gas at the Fitts field plant of Humble Oil & Refining Co.

Arkansas-Louisiana Gas Co. maintained an underground natural gas storage reservoir in North Ada field. 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. At its quarry near Roff, Mid-Continent Glass Sand Co. produced sand for glass and molding purposes.

Pottawatomie.—Reduced production of petroleum and natural gas accounted for part of the 9-percent drop in mineral value. Biggest loss in value was in natural gas liquids caused by closing the Sinclair Oil & Gas Co. St. Louis plant. Natural gas from St. Louis and Maud fields was processed at the company's Seminole plant in Seminole County. Petroleum and natural gas were produced from many fields; St. Louis, the largest, yielded nearly 1.5 million barrels of crude oil. Limestone was quarried and prepared by two producers for riprap, concrete aggregate, and roadstone.

Rogers.—Increased production of cement, clay, stone, and coal offset losses in petroleum and natural gas. Petroleum and natural gas were produced from three fields; Chelsea district produced most of the crude petroleum. The quantity of coal, obtained by strip mining 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 at its plant northeast of Tulsa. Limestone was quarried and prepared by one contractor for use as riprap by the U.S. Army Corps of Engineers, Tulsa District.

Seminole.—A 2-percent increase in total mineral value was noted as increases in natural gas liquids, sand and gravel, and stone compensated for losses in petroleum, natural gas, and clays. Petroleum and natural gas were produced from many fields; most notable was Seminole City field which produced 968,000 barrels of petroleum. Natural gas liquids were extracted from natural gas by Redco Corp. at its Seminole plant and Sinclair Oil & Gas Co. Seminole plant. Phillips Petroleum Co. gas liquids plant in Wewoka field was closed. Limestone was quarried and crushed by Standard Industries, Inc., and others for concrete aggregate and roadstone and for use by Oklahoma State Highway Department. Sandstone was quarried and prepared by one contractor for Oklahoma State Highway Department. Shale for brick and tile was obtained west of Wewoka for Wewoka Brick & Tile Co.

Sequoyah.—Output of minerals was 20 percent more than in 1963. Limestone was mined and crushed at underground mines 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 the new kiln near the mine. The remainder was used for agricultural purposes, glass manufacturing, paper mills, 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. St. Clair Lime Co. placed on stream in 1964 a new lime kiln capable of producing 220 tons per day near the mines. Crushed limestone was supplied by a contractor to U.S. Army Corps of Engineers, Tulsa District. Gravel for Oklahoma State Highway Department was produced by one operator. Several small fields produced natural gas.

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Stephens.—Production of petroleum, natural gas, and natural gas liquids had a combined value which placed the county first in the State for 1964 and 4 percent above that for 1963. The county was first in petroleum, sixth in natural gas, and third in natural gas liquids values. It shared in production of crude oil from the giant Sho-Vel-Tum field, as did Carter and Garvin Counties. Loco field produced over 1.7 million barrels of crude oil; Knox field in part in Grady County yielded nearly 1.9 million barrels of oil under a pressure maintenance and cycling program. Natural gas liquids were stripped from natural gas at Cyprus Mines Corp. Marlow plant; Mobil Oil Co. plant in the Sholem-Alechem field; Service Gas Products Co. Doyle field plant; Skelly Oil Co. Velma plant; and Warren Petroleum Corp. Duncan plant. Crude oil was processed at Sunray DX Oil Co. Duncan refinery.

Texas.—The county ranked fifth in the State in total mineral value, first in natural gas, and seventh in natural gas liquids; production of all minerals, except stone, increased significantly raising the mineral value for the county 10 percent above that of 1963. Natural gas liquids were recovered by Anadarko Production Co. North Richland Center plant; Cities Service Oil Co. Guymon and Murdock plants; Dorchester Gas Producing Co. Hooker plant; Excelsior Oil Corp. Tyrone plant; Hugoton Plains Oil & Gas Co. Hugoton plant; and Mobil Oil Co. Postle-Hough plant. Stewart Brothers Sand & Gravel Co. and two other producers processed sand for building and fill.

Tulsa.—A 31-percent rise in total mineral value was due to substantial gains in petroleum and sand and gravel which offset losses in natural gas, stone, and clays. Crude oil was processed at Sunray DX Oil Co. and The Texas Co. refineries in west Tulsa. Sunray DX Oil Co. concluded a $30 million, 6-year modernization program with completion of a $3.4 million solvent extraction plant. The unit replaced several older units and increased finished lubricating oil capacity to 6,000 barrels per day. Limestone was quarried and crushed by plants operated by Anchor Stone Co., Standard Industries, Inc., at two locations, and Tulsa Rock Co. for concrete aggregate, roadstone, agriculture, and other uses. Sand for building, paving, fill, and other uses and gravel for fill was processed by 10 producers; the largest were Bagby-Harris Sand Co.; Chandler Materials Co.; McMichael Sand Co.; Mohawk Rock and Sand Co.; and Standard Industries, Inc. Brick and tile products were made in Tulsa by Acme Brick Co. U.S. Army Corps of Engineers, Tulsa District, continued work on Keystone Dam on the Arkansas River; at yearend the dam was nearly complete.

Washington.—Mineral value declined 23 percent as losses were registered in all segments of the industry; most significant losses occurred in petroleum and cement manufacture. Petroleum and natural gas were produced from five districts. Portland cement was manufactured by Dewey Portland Cement Division, Martin-Marietta Corp., part of the year. Limestone was quarried and crushed by M. E. Stewart & Sons Rock Products Co. east of Bartlesville. Sulfuric acid, a byproduct from imported zinc ores, was produced at National Zinc Co.'s Bartlesville smelter. In July, the company began a $1 million remodeling program at the smelter.

Washita.—Natural gas and petroleum were produced from several fields and part of the prolific Elk City field. Gypsum was stripped

from a surface deposit south of Colony by Agricultural Gypsum Corp.

Woods.—Mineral output value showed gains of more than 58 percent as natural gas and petroleum output increased. Natural gas and petroleum were produced from several small fields. Ezra S. Blackmon recovered salt by solar evaporation from water basins adjacent to the Cimarron River west of Freedom.

Woodward.—Increases in crude oil, natural gas, and natural gas liquids production resulted in a 36-percent increase in overall mineral value. Natural gas liquids were recovered from natural gas at Pan American Petroleum Corp. 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 Jerry J. Gray [1] and Gary A. Kingston [1]

MINERAL production value in Oregon reached a record high of $64.3 million, a 3-percent gain over the $62.7-million total in 1963. A large portion of the gain was attributed to the 33-percent increase in the value of sand and gravel output. Lime, nickel, and pumiceous materials values also were appreciably higher. Major mineral commodities which recorded decreases were cement, clays, and stone. Small values in copper, diatomite, gold, mercury, perlite, silver, and lead also were produced.

Petroleum was the mineral commodity that caused the greatest interest and excitement. The excitement resulted from the Bureau of Land Management (BLM) opening a million acres of Federal land off the Washington and Oregon coasts for oil leasing. Oregon offered smaller amounts of State-owned land for bidding. Nine major companies were engaged in offshore exploration. The interest climaxed October 1, when BLM opened bids from 11 oil companies or coalitions of companies. For the 580,000 acres leased off the Oregon and Washington coasts, successful bids totaled $35.5 million. Successful bids for Federal lands off Oregon were $27.8 million.

A higher average price for mercury ($315 per flask in 1964 compared with $189 in 1963) encouraged mining activity and production. Production of silver and gold from the Oregon King mine (Jefferson County) declined sharply.

Although Oregon's output of cement declined, combined shipments from nine plants in Oregon and Washington rose to 8.3 million barrels (376 pounds each) of finished portland cement. Shipments totaled 7.8 million barrels from the same plants in 1963.

Improved market conditions for aluminum and nickel were reflected by Bonneville Power Administration (BPA) increased power sales. Power used in production of these metals increased 29 percent and 15 percent, respectively.

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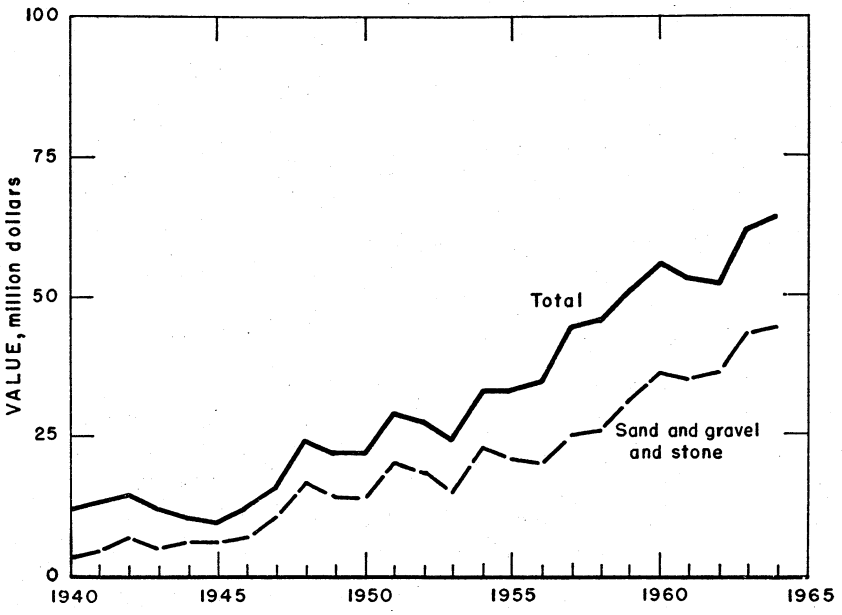


FIGURE 1.—Value of sand and gravel and stone, and total value of mineral production in Oregon.

TABLE 1.—Mineral production in Oregon [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	279	$330	196	$262
Copper (recoverable content of ores, etc.) short tons	W	W	15	10
Diatomite do	150	3	W	W
Gold (recoverable content of ores, etc.) troy ounces	1,809	63	661	23
Lime thousand short tons	87	1,835	95	1,918
Mercury 76-pound flasks	W	W	126	40
Nickel (content of ore and concentrate) short tons	13,394	W	15,420	W
Perlite do			5	(2)
Pumice and volcanic cinder thousand short tons	422	664	566	909
Sand and gravel do	15,715	18,850	18,253	25,158
Silver (recoverable content of ores, etc.) troy ounces	58,234	74	14,372	19
Stone thousand short tons	19,692	24,197	16,120	19,296
Tungsten concentrate (60 percent WO_3 basis) short tons			1	1
Uranium ore do	1,763	45	27	2
Zinc (recoverable content of ores, etc.) do	3	1	W	W
Value of items that cannot be disclosed: Cement, gemstones, iron ore (pigment material) (1963), lead, and values indicated by symbol W	XX	16,630	XX	16,631
Total	XX	62,692	XX	64,269

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.

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

(Thousands)

Year	Value	Year	Value
1955	$34,059	1960	$55,483
1956	34,865	1961	r 53,277
1957	44,078	1962	r 52,828
1958	46,987	1963	r 63,336
1959	50,044	1964	63,937

r Revised.

Consumption, Trade, and Markets.—The business climate proved favorable for growth during 1964. Factory payrolls advanced $83 million over those of the 1963 total, and total personal income and per capita personal income increased 7 and 6 percent, respectively. Cement shipments to and within the State decreased 5 percent; but the value of building permits issued rose. Future construction indicators—heavy engineering awards and highway contracts awarded—decreased 49 and 34 percent, respectively. The U.S. Army Corps of Engineers awarded the year's highest value single contract for $9.9 million to Paul Hardeman, Inc., for construction of the Foster Dam, Linn County.

TABLE 3.—Indicators of Oregon business activity

	1963	1964 p	Change, percent
Personal income:			
Total—millions	$4,568.0	$4,868.0	+6.6
Per capita	$2,467.0	$2,602.0	+5.5
Construction activity:			
Building permits—millions	$215.3	$252.4	+17.2
Heavy engineering awards—do	$274.7	$140.0	−49.0
Value of highway contracts awarded—do	$107.7	$70.6	−34.4
Expenditures on highway contract work—do	$73.5	$90.2	+22.7
Cement shipments to and within Oregon, thousand 376-pound barrels	3,189.4	3,024.0	−5.2
Cash receipts from farm marketings—millions	$418.8	$427.8	+2.1
Factory payrolls—do	$851.0	$933.6	+9.7
Annual average labor force and employment:			
Total labor force—thousands	750.0	765.6	+2.1
Unemployment—do	35.3	35.4	+0.3
Employment:			
Construction—do	29.2	31.1	+6.5
Lumber and wood products—do	69.2	72.2	+4.3
Food products—do	20.7	20.3	−1.9
All manufacturing—do	145.1	149.5	+3.0
All industries—do	712.7	730.0	+2.4

p Preliminary.

Sources: Survey of Current Business, Construction Review, Pacific Builder & Engineer, State Highway Commission, State Employment Department, and Bureau of Mines.

Legislation and Government Programs.—The Wilderness Act of 1964 placed 750,000 acres of Oregon's public domain into a National Wilderness Preservation System. Under the Act, prospecting, exploration, and mining will be allowed until January 1, 1984, at which time only existing mining claims may be developed further. Before any new acreage can be added to the system, the Bureau of Mines and the U.S. Geological Survey must examine such lands and report their mineral potential to the Congress.

TABLE 4.—Employment and payrolls in mineral-industry establishments subject to Oregon unemployment-compensation law, by industries

Industry	1963		1964	
	Employment	Payrolls (thousand)	Employment	Payrolls (thousand)
Mining	1,335	$8,667	1,478	$10,226
Stone, clay, and glass products:				
Glass and pottery	421	2,746	376	2,565
Hydraulic cement	420	2,959	401	2,902
Structural clay products	145	743	141	726
Concrete, gypsum, and plaster products	1,970	13,132	2,024	13,957
Cut-stone, stone, and pottery products	41	[1] 230	72	342
Miscellaneous	83	458	62	364
Total	3,080	20,268	3,076	20,856
Primary metals:				
Blast furnaces, steelworks, rolling and finishing mills	1,404	10,562	1,505	12,201
Primary smelting and refining of nonferrous metals	1,496	10,196	1,674	12,212
Iron and steel foundries	1,923	13,033	1,910	13,221
Nonferrous foundries	358	2,114	409	2,580
Secondary smelting and refining of nonferrous metals and miscellaneous industries	167	1,074	172	1,192
Total	5,348	36,979	5,670	41,406
Industrial chemicals	422	3,124	445	3,332
Petroleum refining and related products	407	2,316	372	2,308
Grand total	10,592	71,354	11,041	78,128

[1] Pottery products were combined with cut stone, etc., in 1964.
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	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	148	26	212	----------	11	52
Nonmetal and coal	217	35	282	----------	8	28
Sand and gravel	1,340	296	2,377	----------	74	31
Stone	1,893	389	3,136	----------	102	33
Total	3,598	746	6,007	----------	195	32
1964: [p]						
Metal	190	31	243	----------	16	66
Nonmetal and coal	184	27	219	----------	6	27
Sand and gravel	1,485	341	2,711	----------	52	19
Stone	1,945	375	3,045	----------	92	30
Total	3,804	774	6,218	----------	166	27

[p] Preliminary.

Two contracts were in effect under the program of the Office of Minerals Exploration (OME). The Pacific Mineral & Chemical Co., Inc., $63,000 contract, initiated in 1962 for mercury (Crook County), was recessed during the year. A $55,000 contract was signed with Oregon King Consolidated, Inc., for gold and silver exploration in Jefferson County. Government participation in the two contracts was 50 percent.

The natural resources of Oregon and the programs of various Federal agencies concerned with these resources were described in an illustrated booklet published by the U.S. Department of the Interior.[2]

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives and Roofing Granules (Processed).—Material from the Hanna Nickel Smelting Co. slag pile at Riddle was screened and kilned by Mining-Mineral Manufacturing Co. for use as a sandblasting abrasive. Flintkote Co., Pioneer Division, shipments of processed roofing granules decreased 58 percent compared with the 1963 total. The source of raw material for the Portland plant was purchased crushed river gravel.

Cement.—Cement production and shipments were 10 percent less than in 1963 as a result of less shipments to Washington State destinations. As in previous years, output was from three plants—one each in Baker, Clackamas, and Jackson Counties. Although out-of-State shipments were made to Washington, Idaho, northern California, and Alaska, the major destinations were within the State. Shipments were 90 percent by truck, 9 percent by rail, and 1 percent by water. The distribution of portland cement shipments was 67 percent to ready-mixed concrete companies, 14 percent to concrete-product manufacturers, 8 percent to general contractors, 8 percent to building-materials dealers, 2 percent to highway contractors, and 1 percent to Federal, State, and local government agencies. The ratio of bulk to bagged shipments was about 7:1.

Production and shipments from nine cement plants in Oregon and Washington totaled 8.2 million barrels (376 pounds each) of finished portland cement. Shipments from the same plants totaled 7.7 million barrels in 1963. The average value of portland cement shipped by Oregon and Washington producers was $3.59 per barrel, f.o.b. plant, compared with $3.57 in 1963.

Clays and Shale.—Clays production declined 30 percent from the 1963 level primarily because less was used in making cement. The production of miscellaneous clay (used for making heavy-clay products) and shale (used for making expanded aggregate) remained about the same as in 1963, but bentonite output increased 73 percent. Miscellaneous clay was produced in Benton, Clackamas, Klamath, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. Bentonitic clay was dug from a deposit in Crook County. Shale used at cement plants came from Baker and Jackson Counties. Shale for bloating and subsequent use as lightweight-concrete aggregate was produced at two quarries in Washington County.

Diatomite.—Production and shipments of prepared diatomite were lower than in 1963. The only producer, Pacific Diatomite Corp., mined crude diatomaceous earth from a deposit near Silver Lake in Lake County and trucked it to Eugene for processing into pet litter.

[2] U.S. Department of the Interior, Office of the Secretary. Natural Resources of Oregon, 1964, 68 pp.

Gems and Gem Materials.—Oregon's recreation mining industry continued to attract rock collectors to all parts of the State from the ocean beaches to the State line at the southeast corner. Output of gems and gem materials was in small amounts by a large number of amateur collectors. The industry was served by 52 gem and mineral clubs and 43 commercial dealers. An estimated 75,000 people visited the Prineville area to collect cryptocrystalline varieties of quartz, including thunder eggs, moss agate, plume agate, jasper, and petrified wood. The majority of the collecting was on private land open to digging at a fee and on the Prineville Chamber of Commerce mining claims open to free digging.

Lime.—Production of lime increased slightly compared with that of 1963. Limestone from Texada Island, British Columbia, Canada, was used by Ash Grove Lime & Portland Cement Co. at its new Portland plant. The major markets for quicklime and hydrated lime produced by this firm and Chemical Lime Co., Baker, continued to be the electroprocessing, metallurgical, and paper industries in the Pacific Northwest. Limestone barged from Texada Island also was used by Pacific Carbide & Alloys Co., Portland, to make quicklime for making calcium carbide. Amalgamated Sugar Co., Nyssa, burned limestone to quicklime for use in its sugar refinery.

Lime regenerated from recycled calcium-carbonate sludge at four pulp mills for use in pulp manufacturing was not included in the State total as primary production.

Perlite.—Crude perlite from Nevada and Idaho 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.

Five tons of perlite was shipped from the Paisley operation in Lake County.

Pumice and Pumiceous Materials.—Pumice and pumiceous materials (volcanic cinder, scoria, and volcanic ash) output was mainly for county, State, and Federal road construction. Central Oregon Pumice Co. and Graystone Corp., Cascade Pumice Division (formerly Boise Cascade Pumice) produced pumice and volcanic cinder at quarries near Bend (Deschutes County). Processed material was sold to concrete-products plants throughout the Northwest, California, and Canada. Kaiser Cement & Gypsum Corp. mined and processed volcanic ash for its pozzolanic properties from a deposit near Shutler, Gilliam County. The finished material was shipped by truck and rail to the John Day and Green Peter dam projects.

Sand and Gravel.—The principal reason for the increased sand and gravel output was greater requirements at projects of the State highway department (3.4 million tons in 1963 to 5.8 million tons in 1964).

Sand and gravel production was reported from 35 of the 36 counties. Both Multnomah and Lane County operations produced over 2.5 million tons of sand and gravel; output exceeding 1 million tons each was reported from Douglas, Morrow, and Gilliam Counties.

Stone.—A decline in stone production resulted from the State highway department using less crushed stone, 3.0 million tons in 1963, compared with 0.9 million tons in 1964. Commercial stone production was 4.5 million tons, and output of Government-and-contractor stone

(largely contractor production for Federal, State, county, and municipal agencies) was 11.7 million tons, compared with 5.5 and 14.1 million tons, respectively, in 1963. Output of basalt, the principal stone quarried, was used for roadstone, ballast, aggregate, and riprap. During 1961, initial barge shipments of limestone from Texada Island, British Columbia, Canada, were received by limestone users. From that time, the quantity of limestone quarried in the State continued to decline; 1.2 million tons (1960), 952,000 tons (1961), 901,000 tons (1962), 824,000 tons (1963), and 623,000 tons (1964). The largest market for limestone output continued to be the cement industry, followed by the sugar, lime, paper, metallurgical, and agricultural industries. Limestone was quarried in Baker, Josephine, and Polk Counties.

TABLE 6.—Sand and gravel sold or used by producers, by class of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	3,365	$4,415	3,285	$4,333
Railroad ballast	51	54	117	94
Road material	4,500	5,413	4,874	6,070
Other [1]	1,014	1,143	1,079	1,163
Total	8,929	11,026	9,355	11,660
Government-contractor operations:				
Building	6	6	193	287
Road material	6,699	7,774	8,628	13,166
Other [1]	81	44	77	45
Total	6,786	7,824	8,898	13,498
All operations:				
Building	3,371	4,421	3,478	4,620
Railroad ballast	51	54	117	94
Road material	11,199	13,188	13,502	19,236
Other [1]	1,095	1,188	1,156	1,208
Grand total [2]	15,715	18,850	18,253	25,158

[1] Includes fill material, special sands, and sand and gravel used for miscellaneous purposes.
[2] Because of rounding, individual items may not add to totals shown.

TABLE 7.—Stone sold or used by producers by uses

(Thousand short tons and thousand dollars)

Use	1963		1964	
	Quantity	Value	Quantity	Value
Building (dimension stone)	3	$19	1	$12
Concrete and roadstone	13,656	17,161	11,822	14,052
Railroad ballast	446	585	220	307
Riprap	4,661	4,981	2,550	2,552
Other [1]	927	1,451	1,527	2,373
Total [2]	19,692	24,197	16,120	19,296

[1] Used at cement, paper, metallurgical, and chemical plants; at sugar refineries; and for miscellaneous unspecified purposes.
[2] Because of rounding, individual items may not add to totals shown.

Quartz (silica) was produced and marketed by Bristol Silica Co., Jackson County, for use in making silicon metal, silicon carbide abrasives, cement, and roofing granules.

Stone was produced from operations in 34 of the 36 counties; output exceeded 2 million tons in Lane County and 1 million tons each in Gilliam and Sherman Counties.

Talc and Soapstone.—Soapstone for use as a carrier material in insecticides was ground at the Portland plants of Miller Products Co. and Stauffer Chemical Co. The crude material was obtained from mines in Skagit County, Wash.

Vermiculite (Exfoliated).—Crude vermiculite obtained from producers in Montana and South Africa was expanded at Portland plants of Vermiculite Northwest, Inc., and Supreme Perlite Co. The expanded product was used principally as loose-fill insulation; smaller quantities were utilized as aggregate (plaster and concrete), as a fertilizer conditioner, and for soil conditioning.

A report describing an occurrence of vermiculitized biotite in northeastern Oregon was published.[3]

METALS

Aluminum.—Primary aluminum ingot output from two plants—Harvey Aluminum, Inc., The Dalles, and Reynolds Metals Co., Troutdale—increased 24 percent over that of 1963.

A significant rise in production by the Reynolds company was indicated by Bonneville Power Administration (BPA) electric-energy sales statistics. The Bonneville agency reported that 889.4 million kilowatt-hours of noninterruptible (firm) energy was delivered to the Troutdale plant. This was 145 percent more than was sold to the company during 1963. Six of eight potlines in operation at Troutdale from May through December represented 75 percent of the plant's 91,500-ton annual capacity. The plant was working at 50 percent of rated capacity before May.

Harvey Aluminum, Inc., purchased 1.6 billion kilowatt-hours of electric power from BPA, which was slightly more than in 1963. Process improvements at the Harvey plant accounted for a 2,000-ton improvement in annual capacity over the previous rating of 80,000 tons. The plant was operated at capacity.

Antimony.—An improved market and price for antimony prompted exploration and development at the Gray Eagle mine (Baker County), the Coyote mine (Malheur County), and the Jay Bird mine (Jackson County).

Copper.—Most of the 15 tons of copper produced in the State was mined at the Standard property, Grant County, operated by Jim Kinsella. Oregon King mine (Jefferson County) silver ore and Buffalo mine (Grant County) gold ore yielded minor amounts of the metal.

Gold.—Production of gold declined 64 percent compared with that of the previous year. The drop was attributable mainly to a sharp dip in lode-gold output. There also was smaller recovery of placer gold.

[3] Staples, Lloyd W., and Howard C. Brooks. An Occurrence of Vermiculitized Biotite in Northeastern Oregon. Ore Bin, v. 26, No. 10, 1964, pp. 169–175.

The Oregon King silver mine (Jefferson County) and the Buffalo gold mine (Grant County) were the principal lode-gold sources. The most productive of 14 placer properties was the Davis in Josephine County. Although only 49,000 cubic yards of alluvial materials was washed by placer gold operators in the State, less than half of which was processed in Jackson and Josephine Counties, concern was voiced by recreation interests, about excessive stream pollution from placer operations, particularly concerning operations on the Rogue River.

Of the 14 active placer mines 9 were operated by small-scale hand methods. At these mines 12,000 cubic yards of gravel was washed and 204 ounces of gold recovered, compared with 236 ounces of gold recovered from 36,000 yards at 10 mines in 1963. There also were 2 hydraulic mines, 2 dragline dredges, and 1 skid mounted washing plant active. Output from these 5 mines was 118 ounces compared with 292 ounces from mechanized operations in 1963. The quantity of gravel treated was 38,000 cubic yards, as against 27,000 yards in the previous year.

Iron Ore.—The Bunker Hill Co., Kellogg, Idaho, completed exploration initiated during 1963 to evaluate the economic potential of Oregon iron-bearing coastal sands. The company concluded that there was insufficient iron indicated in the Clatsop Spit area sands (Clatsop County) to justify proposed mining and processing. Leases acquired by the Bunker Hill firm on about 4,000 acres of land were surrendered.

TABLE 8.—Mine production of gold, silver, and other metals, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Other metals [1] (pounds)
1963:					
Lode ore:					
Dry gold	11	273	53	20	200
Dry silver, gold-silver, and gold old tailings [2]	5	4,278	1,193	58,113	5,800
Copper	1	48	35	39	----------
Total lode	16	4,599	1,281	58,172	6,000
Placer	14	(3)	528	62	----------
Grand total	30	4,599	1,809	58,234	6,000
1964:					
Lode ore:					
Dry gold, gold-silver, and silver [2]	4	1,725	311	14,256	20,200
Copper	1	57	28	71	23,800
Total lode	5	1,782	339	14,327	44,000
Placer	14	(3)	322	45	----------
Grand total	19	1,782	661	14,372	44,000

[1] For 1963 excludes copper and lead; 1964 includes copper, lead, and zinc.
[2] Combined to avoid disclosing individual company confidential data.
[3] For 1963, 63,259 cubic yards of placer gravel washed (does not include gravel washed at commercial gravel plants to produce byproduct gold); 1964, 49,000 cubic yards of placer gravel washed.

Lead.—A minor quantity of lead was recovered from ore mined at the Buffalo and the Oregon King mines.

Federal Resources Corp., Salt Lake City, Utah, leased a group of properties in the Bohemia mining district (Lane County) and began exploration to determine if there was a continuance of metal values

at depth. Core drilling on the Helena property was contracted to Boyles Bros. Drilling Co., Spokane, Wash., and tunneling in the Musick mine was contracted to Brown Bros. Construction Co., Inc., Hailey, Idaho.

Mercury.—The nearly dormant quicksilver mining industry of the State was rejuvenated by a sharp price increase for mercury. Caution was shown by idled producers toward the expensive task of reopening mines that could be closed again by a rapid return of the metal to an unprofitable price. As a result, only 126 flasks (76 pounds of mercury per flask) had been produced by the end of the year. The larger companies had sales contracts with consumers before readying their mines and processing plants for production.

The Williams ranch (Canyon Creek) property, Grant County, operated during the year by Canyon Creek Mercury Mines, was taken over in December by Cordero Mining Co., Palo Alto, Calif. The Cordero company was to begin immediate exploration and development.

American Mercury Corp., Montreal, Canada, leased the Black Butte mine (Lane County) from Quicksilver Syndicate, Inc. Mine development and surface plant rehabilitation were started.

In Malheur County, the Bretz mine was reopened by Bretz Mining Co., Salt Lake City, Utah. Projected production was to be 4,000 flasks annually.

Work was begun at properties in Jackson County (War Eagle, Bonita, and Palmer Creek) and Douglas County (Red Cloud). No activity was reported at the Pacific Minerals & Chemical Co. Mother Lode, Cobar, and Lookout Mountain groups, Jefferson County. Pacific Minerals had been doing exploration under an OME contract.

Nickel.—The Hanna Mining Co. at Nickel Mountain (Douglas County), produced 1,071,000 dry tons of nickel ore, containing 1.44 percent (15,420 tons) nickel.

Hanna Nickel Smelting Co., receiving ore from the mine via an 8,300-foot aerial tramway, produced 23,187 tons of ferronickel containing 11,236 tons of nickel. The Hanna company canceled a contract providing for Federal purchase of 17.3 million pounds of nickel contained in ferronickel. The cancellation was based on an oversupply of nickel in the Government stockpile. The company's entire smelter output was in demand by commercial markets. Continued interest was shown in potentially minable nickel deposits, including resources in the Curry County Red Flats area.

Bonneville Power Administration electric-energy market statistics revealed that the Hanna smelter required 679 million kilowatt-hours of electricity valued at $1.5 million. This was a 14.7-percent increase in energy consumption over that in 1963.

Silver.—Production of silver fell 75 percent from the highest production level in 20 years attained in 1963.

The Oregon King silver mine (Jefferson County) yielded most of the State total, supplemented by smaller quantities recovered from ores mined at gold and base-metal properties. Depletion of ore in old workings of the Oregon King and concentration of activity on development accounted for the decline.

Tungsten.—A shipment of less than 1 short ton of tungsten concentrate was made from Baker County. The concentrate containing 570 pounds of tungsten trioxide (WO_3) was from ore mined previously by Joseph Fitzpatrick at the Chicken Creek property near Durkee.

Uranium.—The O'Keefe Co. mined and shipped 27 tons of ore containing 465 pounds of uranium oxide (U_3O_8) from the White King mine in Lake County. Kermac Nuclear Fuels Corp. sold the idle Lakeview uranium plant to Oregon Pacific Industries Corp., a local industrial development organization.

Zinc.—Zinc was recovered at a Utah smelter from gold ore mined in Grant County.

Other Metals.—The complex of metallurgy research and production operations at Albany (Linn County) was concerned with many metals, including titanium, columbium, zirconium, tungsten, and molybdenum. Research at the Federal Bureau of Mines Albany Metallurgy Research Center provided the nucleus of activity that had led to the location of three processing plants in the Albany area, Wah Chang Corp., Oregon Metallurgical Corp., and Northwest Industries, Inc.

Bonneville Power Administration released a report on titanium in the Pacific Northwest prepared by the Bureau of Mines Albany Office of Mineral Resources.[4]

One steel ingot company (Oregon Steel Mills, Inc.) and numerous steel casting companies in Portland (Multnomah County) operated at favorable rates of capacity in what was a record-setting production year nationally for the steel industry. Oregon Steel Mills produced rolled structural and merchant steel products from steel ingot produced at the plant from scrap steel, including salvaged automobiles. Foundry plants, such as Esco Corp., Columbia Steel Castings Co., and Precision Castparts Co., were notable producers of high-value alloy steel castings marketed throughout the world.

MINERAL FUELS

Petroleum.[5]—Twelve companies were active exploring, by seismic and other geophysical methods, the Continental Shelf off the Oregon coast. The oil companies were striving to evaluate the area in advance of a Federal lease offering on October 1 of 836,000 acres on the Outer Continental Shelf (beyond the 3-mile limit) and an Oregon State Land Board leasing offer on December 3 of 136,000 acres of submerged lands (inside the 3-mile limit) off Coos Bay.

When the Bureau of Land Management opened bids for Continental-Shelf land bordering Oregon on October 1, 11 companies or coalitions of companies had submitted a total of 165 bids for 74 tracts. The agency had set a minimum bonus bid of $5.00 per acre and a yearly rental fee of $3.00 per acre. Winning bonus bids totaled $27.8 million for 425,430 acres. The highest single bid and the highest bid per acre was a Union Oil Company of California $2.2-million bid for a tract of 5,760 acres, located 20 miles offshore in the Coos Bay area. Standard

[4] Fulkerson, Frank B., and Jerry J. Gray. The Titanium Industries and Their Relation to the Pacific Northwest. Report for the Bonneville Power Administration, Portland, Oreg. BuMines Mineral Resource Office, Albany, Oreg., 1964, 46 pp.

[5] Petroleum leasing data were obtained from the Ore Bin, a monthly publication of the Oregon Department of Geology and Mineral Industries.

Oil Co. and Shell Oil Co. were the only companies to enter bids in Oregon's December 3 land offer, and they were successful in leasing 14,000 acres for $29,000.

The construction of an 8- to 16-inch, 267-mile pipeline by the Olympic Pipeline Co. from refineries in the Ferndale-Anacortes, Wash., area to Portland, Oreg., was started in September from the Portland end. The line was scheduled to be finished by October 1965.

REVIEW BY COUNTIES

Mineral production was reported from all 36 counties in 1964. With certain important exceptions, output was from nonmetallic deposits. Only selected counties with significant metal and nonmetal developments are discussed in the review that follows.

Baker.—The Oregon Portland Cement Co. plant at Lime continued, in terms of value, to be the principal mineral industry activity. The cement operation utilized limestone from the company Limerock quarry and shale from the company-owned Gales Creek quarry. Limestone for industrial and agricultural uses was quarried near Durkee by the cement company.

Chemical Lime Co. produced quicklime and hydrated lime at a plant north of Baker. Limestone for the plant was produced from a new quarry on Baboon Creek 2½ miles west of the idle Marble Creek quarry. Mining equipment was moved from Marble Creek and a power line was constructed across the summit of the Elkhorn range to the new quarry. The power line had the longest tower-to-tower span, 3,380 feet, of any electric distribution line in the State.

Production of both cement and lime was less.

Clackamas.—Mineral production value fell 14 percent, principally because of less demand for sand and gravel. Oregon Portland Cement Co. cement production was 3 percent less than in 1963. Limestone for the cement operation was transported by barge from Texada Island, British Columbia, Canada.

Clatsop.—The Bunker Hill Co., Kellogg, Idaho, dropped leases on iron-bearing beach sands in the Clatsop Spit area after drilling 34 test holes, each to a depth of approximately 80 feet. The drill holes were put down by Janssen Drilling Co., Aloha. It had been estimated that 66 pounds of iron per ton of sand was the minimum content that could be considered for exploitation of the area. The exploration disclosed an iron content less than 50 percent of the minimum requirement. Exploration was undertaken on the possibility that the iron content would increase with depth, whereas it was found to diminish.

Crook.—Central Oregon Bentonite Co. increased production from its Silver Wells pit because of greater demand for bentonite, used 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.

Exploration at the Pacific Minerals & Chemical Co., Inc., Mother Lode mercury property under an OME contract was recessed during the year.

TABLE 9.—Value of mineral production in Oregon, by counties

(Thousand dollars)

County	1963	1964	Minerals produced in 1964 in order of value
Baker	$5,822	$4,080	Cement, stone, lime, sand and gravel, gold, tungsten, silver.
Benton	423	543	Sand and gravel, stone, clays.
Clackamas	7,488	6,406	Cement, sand and gravel, stone, clays.
Clatsop	211	323	Stone, sand and gravel.
Columbia	366	341	Stone, sand and gravel, pumice.
Coos	808	341	Sand and gravel, stone.
Crook	107	104	Sand and gravel, clays.
Curry	2	210	Sand and gravel, stone.
Deschutes	819	653	Pumice, sand and gravel.
Douglas	9,531	9,804	Nickel, sand and gravel, stone, mercury, gold, silver.
Gilliam	1,180	4,295	Stone, sand and gravel, pumice.
Grant	428	358	Stone, sand and gravel, mercury, copper, gold, silver, zinc, lead,
Harney	284	112	Stone, sand and gravel.
Hood River	886	236	Do.
Jackson	4,949	4,049	Cement, stone, sand and gravel, clays, pumice, gold, silver.
Jefferson	974	1,253	Stone, sand and gravel, pumice, silver, gold, copper, lead.
Josephine	237	1,217	Sand and gravel, stone, gold, silver.
Klamath	1,379	1,245	Stone, sand and gravel, pumice, clays.
Lake	90	210	Sand and gravel, stone, uranium, diatomite, perlite
Lane	7,310	5,696	Sand and gravel, stone, mercury.
Lincoln	692	878	Stone, sand and gravel.
Linn	1,458	1,182	Sand and gravel, stone.
Malheur	796	1,091	Lime, sand and gravel, stone, mercury.
Marion	688	1,181	Sand and gravel, stone.
Marrow	W	1,821	Do.
Multnomah	5,043	5,998	Sand and gravel, lime, stone, clays.
Polk	489	231	Sand and gravel, stone, clays.
Sherman	2,058	3,102	Stone, sand and gravel.
Tillamook	522	227	Stone, sand and gravel, clays.
Umatilla	1,332	516	Stone, sand and gravel.
Union	378	360	Do.
Wallowa	W	W	Do.
Wasco	1,087	560	Sand and gravel, stone.
Washington	689	1,477	Stone, sand and gravel, clays.
Wheeler	126	59	Stone.
Yamhill	706	429	Stone, sand and gravel, clays.
Undistributed [1]	3,334	3,681	
Total	62,692	64,269	

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.

Curry.—Value of mineral output gained significantly because of sand and gravel and stone requirements at State highway department and U.S. Army Corps of Engineers highway projects.

Deschutes.—Increased production of pumice did not offset lower yields of sand and gravel and lack of stone output.

Douglas.—The Hanna Mining Co. and Hanna Nickel Smelting Co., 5 miles west of Riddle, operated their nickel mine and smelter, respectively, the entire year. The multiple bench mine consisted of 30 faces, 5 more than the previous year. Over 2 million tons of ore and waste was moved at the mine.

Gilliam.—A 264-percent gain for mineral production value was recorded because of sand and gravel and stone needs at the John Day dam project.

Grant.—Approximately 60 tons of copper ore was shipped from the Standard mine near Prairie City to the Tacoma smelter.

The mill capacity at the Buffalo gold property, near Granite, was enlarged. Exploration and development accounted for a moderate output of gold and silver. Work at the mine showed that a downward continuation of the vein existed to the 600 level and that there was an increase in silver values with depth.

Hood River.—Decreased requirements for stone by the State highway department caused mineral output value to fall to $236,000 from $866,000 in 1963.

Jackson.—Ideal Cement Co. production of cement at Gold Hill was about the same as in 1963. Limestone used at the 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 was trucked 4 miles to a screening plant at Gold Hill. The sized material was sold for industrial uses.

Josephine.—The yield of sand and gravel and stone caused a 414-percent increase in mineral production value.

Lane.—National Metallurgical Co., Springfield, a subsidiary of American Metal Climax, Inc., reduced silica rock to silicon metal in two electric furnaces. Plant capacity was expanded 40 percent by rebuilding the original furnace and by installing a new transformer and larger electrode holders. Silica rock was used from a deposit in Jackson County and from a source in northern California.

The Black Butte mercury mine, 17 miles southeast of Cottage Grove, was being reopened. The mine had yielded over 16,000 flasks of mercury since it was discovered in 1890.

Federal Resources Corp. was exploring the Musick and Helena properties in the Bohemia district.

Linn.—Wah Chang Corp., Albany, imported nearly 5 million pounds of Australian zircon sand (zirconium ore), about 16,000 pounds of Malayan columbite (columbium ore), and approximately 161,000 pounds of tantalite (tantalum ore) from various areas of Africa and from Portugal and Brazil.

Oregon Metallurgical Corp., Albany, imported titanium sponge that was melted and poured into ingots and castings.

Malheur.—The Bretz mine in the Opalite district near McDermitt was being reopened by the Bretz Mining Co. Production was to go exclusively to Minerals & Chemicals Phillip Corp., the principal owner of the mine. About 14,000 flasks of mercury had been recovered previously from the mine.

Multnomah.—Sand and gravel, stone, clay, and lime were the mineral commodities produced. Output of sand and gravel rose to 2.9 million tons, an increase of 8 percent over that of 1963. A rise in Government-and-contractor production for use as road material accounted for the increase. Stone production increased 32 percent over that of 1963 because of more Government-and-contractor output used for road construction. Clay, used in manufacturing building brick, was mined by Columbia Brick Works from a pit southeast of Gresham for firing at the Portland plant.

Limestone barged from Texada Island, British Columbia, Canada, was calcined to lime by Pacific Carbide & Alloys Co. and Ash Grove Lime & Portland Cement Co. The former firm utilized the quicklime to manufacture calcium carbide, and the latter firm sold quicklime and hydrated lime to the chemical and construction industries. Limestone from Texada Island also was used in manufacturing cement by Oregon Portland Cement Co. at Oswego.

The Ash Grove Lime & Portland Cement Co. Portland lime plant, which was placed into operation in April, utilized two vertical axis rotary hearths. Each hearth had a capacity of 125 tons per day, and uniform quality was obtained by automatic controls for adjusting the speed of rotation, depth of bed, and heat from the gas burners.

Crude nonmetals, such as perlite (Nevada and Idaho), soapstone (Washington), and vermiculite (Montana), were produced in other States and shipped to processing plants in the county.

Union Carbide Corp., Portland, purchased 144.9 million kilowatt-hours of electric energy from the Bonneville Power Administration. The energy was consumed in the production of silicon and manganese alloys as well as calcium carbide.

Sherman.—Increased demand for sand and gravel caused mineral output value to rise 51 percent compared with that of 1963.

Umatilla.—Decreased demand for sand and gravel and stone resulted in a 61-percent drop in the value of mineral production compared with that of 1963.

Wasco.—Curtailment of use of stone by the U.S. Forest Service and the State highway department caused a 48-percent fall in mineral output value compared with that of 1963.

Washington.—Sand and gravel and stone required for highway projects provided the impetus for a 114-percent gain in the value of mineral production compared with that of 1963.

Shale for processing to expanded lightweight aggregate was quarried near Vernonia and Banks by Cloverleaf Mines, Ltd., and Empire Lite-Rock, Inc., respectively. The quarry near Vernonia, formerly owned by Smithwick Concrete Products Co., was sold to a community organization, Vernonia Industrial Development Corp. (VIDCO), which had been formed to purchase and expand both the shale-bloating plant and the quarry. VIDCO was able to complete the purchase through a $120,000 local development loan granted by the Small Business Administration. The quarry was to be operated by Cloverleaf Mines, Ltd., under a lease-purchase arrangement with VIDCO.

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 James R. Kerr [1]

THE VALUE of the mineral industry of Pennsylvania increased to $902 million, the highest level since 1957, and 5 percent greater than that of 1963. The bituminous coal industry, responding to greater demand by the metallurgical and electric utility markets, increased production by 5 million tons. Value of bituminous coal production was 11 percent ($38.1 million) more than that of 1963. This was attributed to increases in both tonnage and prices. The average price f.o.b. mine rose $0.17 to $5.07 per ton.

The healthy National economy, which spurred the iron and steel industry also stimulated those mineral industries providing raw material for iron and steel manufacture. For example, limestone for blast-furnace flux; lime for open-hearth and oxygen furnace flux; clay for refractory products; and iron ore, the major ingredient, were produced in greater quantities than in 1963. In addition, the iron ore-associated byproducts, such as cobalt, pyrite, and gold and silver were produced in greater quantities because of processing of larger tonnages of crude iron ore.

Output of zinc ore increased in response to higher prices and a firm market for zinc metal. Increased roadbuilding programs and increased construction of private and public buildings required larger quantities of sand and gravel and crushed stone for aggregate uses.

The greatest declines in value among the State mineral industries were $4.9 million in anthracite production and $3.8 million in cement production. The drop in anthracite output was due to significant decreases in exports, principally to Western Europe. The cement industry in the eastern half of the State continued to operate with capacities in excess of available East Coast markets. These cement companies were fighting to retain the old markets and to share in the new in a highly competitive, price-conscious area.

Petroleum and natural gas industries shared a loss in value of $2.8 million. Petroleum average prices decreased $0.24 per barrel, and natural gas output was 11 percent (10.5 billion cubic feet) less than that of 1963 because of reduced pressure and flow at many of the old wells.

Leading producing counties, with primary commodities in parentheses, were Washington and Greene (bituminous coal), Northampton

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TABLE 1.—Mineral production in Pennsylvania [1]

Mineral		1963		1964	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Portland	376-pound barrels	38,316,209	$118,203	37,662,763	$113,409
Masonry	280-pound barrels	2,509,948	6,611	2,817,796	7,594
Clays [2]	short tons	3,190,605	14,717	3,187,100	15,814
Coal:					
Anthracite	do	18,267,384	153,503	17,184,251	148,648
Bituminous	do	71,500,953	350,085	76,530,758	388,218
Copper	do	4,434	2,731	3,614	2,356
Gem stones		[3]	4	[3]	4
Lime	short tons	1,188,217	17,548	1,440,285	20,656
Natural gas	million cubic feet	92,657	24,091	82,166	22,349
Natural gas liquids:					
Natural gasoline	thousand gallons	1,311	78	1,138	64
LP gases	do	1,721	118	1,481	100
Peat	short tons	33,952	339	29,500	397
Petroleum (crude)	thousand 42-gallon barrels	5,083	23,178	5,113	22,088
Sand and gravel	short tons	14,065,816	23,539	16,199,000	26,414
Stone	do	49,535,776	83,450	52,829,268	91,075
Zinc [4] (recoverable content of ores, etc.)	short tons	27,389	6,572	30,754	8,345
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, iron ore, mica, pyrites, sericite schist, silver, and tripoli		XX	32,644	XX	34,519
Total		XX	r 857,411	XX	902,050

r Revised. 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] Weight not recorded.
[4] 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 the mine.

(cement), Luzerne (anthracite), Schuylkill (anthracite), and Cambria (bituminous coal).

Legislation and Government Programs.—Most governmental activity was with the bituminous and anthracite coal industries; the following items were mostly taken from local press sources.

Satisfactory compliance with its new strip mining law was reported by State officials. The greatest area of violation was in not taking proper measures to handle the difficult drainage problem. State officials reported that costs of soil restoration under the new law were averaging $250 to $350 per acre or 9 cents to 17 cents per ton of coal.

A four-man task force was designated by the Governor to unify State programs aimed at combating and relieving problems created by coal mining. Such problems included surface subsidence from underground mines, stream pollution, strip mine reclamation, elimination of culm piles, and control of underground fires.

The State Land Reclamation Board has approved plans to convert two Mercer County strip pits into lakes. The regulation about converting old strip mines to lakes stipulated that the water impounded be pure. If the impounded water was acid, a sudden outwash could result in a serious pollution problem.

The State Department of Mines was reportedly taking steps to reseal several abandoned underground mines where floods had broken the old seals early in 1964.

Steel companies with captive coal mining operations in southwestern Pennsylvania have contributed to State sponsored research programs

designed to combat the problem of stream pollution from acid mine water. Representatives of the Western Pennsylvania Coal Operators Association also contributed to the State program to control stream pollution. The State awarded a contract for construction of a portable pilot plant for mine drainage be put into operation in an effort to provide technical and economic data on processing mine drainage to abate pollution.

The State Secretary of Health announced plans for a thorough study of the disease anthracosilicosis, a progressive lung disease affecting both bituminous and anthracite miners.

The State Air Pollution Commission refused a request for permission to operate a coal refuse pile in Western Pennsylvania because applicant refused to meet certain requirements stipulated by the Commission.

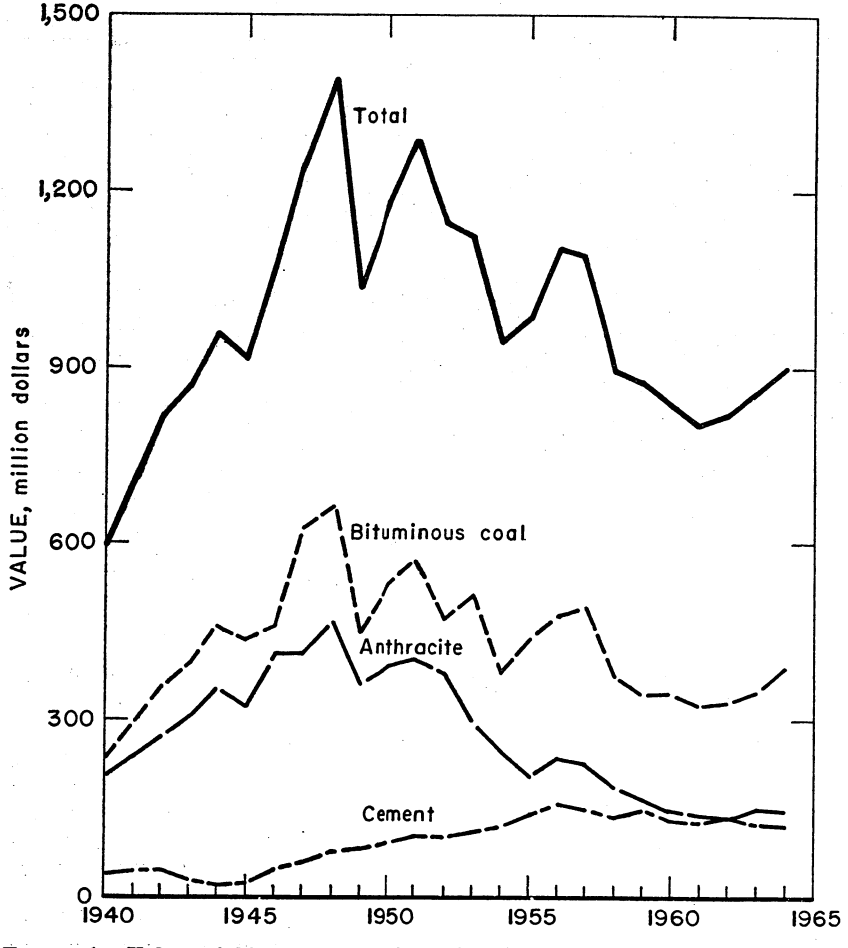


FIGURE 1.—Value of bituminous coal, anthracite, cement, and total value of mineral production in Pennsylvania.

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

(Millions)

Year	Value	Year	Value
1940	$1,523	1953	$1,135
1941	1,619	1954	991
1942	1,735	1955	982
1943	1,662	1956	1,105
1944	1,719	1957	1,058
1945	1,512	1958	889
1946	1,576	1959	891
1947	1,532	1960	862
1948	1,438	1961	839
1949	1,092	1962	r 869
1950	1,249	1963	r 917
1951	1,319	1964	965
1952	1,179		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Bituminous coal	25,414	5,334	42,761	22	959	23
Anthracite	13,498	2,912	21,048	32	1,295	63
Metal and nonmetal	3,016	737	6,200	1	132	21
Sand and gravel	1,162	245	2,068	1	43	21
Stone	8,957	2,340	19,154	4	249	13
Peat	49	10	81		2	25
Total	52,096	11,578	91,312	60	2,680	30
1964: p						
Bituminous coal	27,000	5,939	48,070	18	1,035	22
Anthracite	13,144	2,812	20,368	24	1,342	67
Metal and nonmetal	3,000	778	6,415	2	156	25
Sand and gravel	1,185	272	2,290		45	20
Stone	8,920	2,391	19,946	3	321	16
Peat	52	12	95		2	21
Total	53,301	12,204	97,184	47	2,901	30

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Anthracite).—The quantity of anthracite coal exported was less than half that in 1963, dropping from 3.4 to 1.6 million tons. This was the principal factor in the 6-percent decrease in anthracite production in 1964. Retail deliveries were 18 percent less than in 1963, and stocks in retail dealers yards increased by 9 percent. Increased consumption of anthracite by electric utilities and by coke plants, 5 percent and 9 percent, respectively, did not overcome the loss in exports. The more significant reductions in anthracite exports were those to the Netherlands, France, and Belgium.

Of total anthracite production, 7.2 million tons was recovered from strip mines; 5.9 million tons from underground mines; 3.4 million tons from culm banks, and 705,000 tons from dredges. Of underground

production, 3.5 million tons was loaded mechanically; 64 percent was loaded by 495 conveyors (including duckbills) and pit-car loaders, 22 percent by 139 scraper loaders, and 14 percent by 31 mobile loaders. Dredges on the Susquehanna River accounted for 86 percent of output by dredging; the balance was dredged from the Schuylkill River. Culm bank production was reported in three regions, 46 percent in Schuylkill, and 27 percent each in the Lehigh and Wyoming regions.

The leading counties in anthracite production were Luzerne, Schuylkill, Northumberland, Lackawanna, and Columbia. Men employed in these counties totaled 12,586, about three-fourths were in Luzerne and Schuylkill. All told, 13,144 men were employed by the anthracite industry, a decrease of 354 men from 1963. Most of the lost employment was due to reduced employment at underground mines. The men employed worked an average of 214 days, totaling 2.8 million man-days. This included employment at all fresh mining operations, (underground and strip), dredging operations, and at culm banks. Mining employment was centered in the Schuylkill and Wyoming regions. There were 24 fatal injuries at the anthracite mines, 8 less than in 1963. Although there were 47 more nonfatal injuries, the nonfatal injury rate increased by 4.36 to 65.89 injuries per million man-hours of exposure. The fatal injury rate decreased from 1.52 to 1.18 per million man-hours. Of the fatal injuries, 22 occurred underground and 2 on the surface. Falls of roof, rib, or face killed nine men; haulage accidents, five men; explosives and gas explosions, three each; falls through walkways at breakers two; and inrush of water or of material, one each.

A project was planned to determine whether large-scale culm processing plants could be economically operated by private industry. A coal refuse processing plant built on the Eureka culm pile in the Green Ridge section of Scranton would be designed to process 50 tons of material per hour. Coal recovered at the plant would be sold to a nearby utility company. In addition, a fill material would be recovered as a byproduct for use in mine-flushing programs in the Scranton area. The State project was planned for at least 1 year of operation.

Plans were announced for installation of a new water filtration plant at Erie, where two of four filters of the city were to be rebuilt, utilizing layers of finely ground anthracite coal and sand and gravel as filtration medium. A coagulant aid would be used with the coal and sand.

Coal (Bituminous).—An increase of 6.4 million tons in captive coal production was the major reason for the 7-percent increase in coal production. Both the utility and metallurgical markets were strong. Open-market coal comprised 61 percent of total output; captive coal, 39 percent. Average value of total production was $5.07 per ton, $0.17 per ton more than in 1963. Of total production, 68 percent was mined at 537 underground mines; 31 percent, at 510 strip mines; and 1 percent, at 76 auger mines. There were 59 fewer mines in operation in 1964 (1,123). Of total output, 67 percent was mechanically cleaned, 66 percent of this was by wet washing other than jigs, 19 percent by jigs, and 15 percent by pneumatic methods. Ninety-seven preparation plants were in operation, eight more than in 1963. At 15 of these

plants, 6.9 million tons of coal fines were thermally dried. Of total output, 51 percent was crushed, and 9 percent was treated chiefly with oil, salt, or combinations of the two, for dust allaying or anti-freezing. Shipments were 79 percent by rail or water, 19 percent by truck, and the balance by other means.

Mechanical loading was practiced at 233 of the underground mines, and of underground output 97 percent was loaded by mechanical means. Continuous miners accounted for 75 percent of this total and mobile loading machines accounted for 21 percent. Mechanical loading was accomplished by 270 mobile loaders (7 less than in 1963); 188 loaded cut and blasted coal into shuttle cars, 9 loaded into mine cars, and 8 loaded onto conveyors. Sixty-five mobile loaders operated behind continuous mining machines loading the miner-cut coal. In addition, 12 duckbills (1 less than in 1963) and 168 hand-loaded face conveyors (28 less than in 1963) were in use.

Strip-mining equipment included 839 power shovels (81 less) and 402 draglines (18 less); most were diesel-powered and had less than 3 cubic yards in capacity. However, 13 of these were large plus-12-cubic-yard units. Other equipment included 814 bulldozers, 102 horizontal and 146 vertical overburden drills, 19 carryall scrapers, and 1,654 trucks which averaged 14 tons in capacity. At the 76 auger mines, 79 augers were in use, serviced by 84 trucks that averaged 14 tons in capacity.

Of underground production, 75 percent was mined and loaded by 373 continuous mining machines, 36 machines more than in 1963. In addition, 24 percent of the underground output was cut by 588 cutting machines, 77 less than in 1963. Coal drilling was by 528 hand-held or post-mounted and 54 mobile drills. Roof bolting was accomplished by 296 rotary and 241 percussion drills. Miscellaneous drilling functions were performed with 129 other drills.

Underground haulage was by 1,351 trolley locomotives, 91 battery-powered locomotives and 20 other locomotives. There were 657.9 miles of main-line track and 333.6 miles of working-section track. In addition, 477 mother conveyors (74 more than in 1963), each averaging 1,468 feet, carried large tonnages. Not included with the 477 mother conveyors was the large number of room and gathering conveyors in use. Intermediate underground haulage in addition to the room and gathering conveyors, was by 970 cable-reel and 12 battery shuttle cars, plus 32 small shuttle buggies.

There were 18 fatal and 1,035 nonfatal injuries in the bituminous coal industry, compared with 22 fatal and 959 nonfatal in 1963. Injury rates were 0.37 fatal and 21.53 nonfatal per million man-hours of exposure and 0.23 fatal and 13.29 nonfatal per million short tons mined. Even with 45 more nonfatal injuries in 1964, the injury rate decreased because of increased production and employment. In 1964 an average of 27,000 men worked an average of 220.0 days, totalling 48.1 million man-hours. This was an increase of 600 men, working an additional 11.3 days and 3.8 million man-hours more than in 1963. These injury rates are well below the national average of 0.90 fatal and 41.86 nonfatal per million man-hours, and 0.45 fatal and 20.93 nonfatal per million tons mined. Of the fatal injuries, 14 occurred underground, 2 at surface facilities associated with underground

mines, and 2 at strip mines. Of the underground fatalities, eight were caused by falling roof; one was caused by falling face or rib; three died in haulage accidents; and two were killed in accidents involving machinery. The two strip fatalities were caused by haulage equipment and other machinery.

Washington County was the leading coal producing area followed by Greene, Cambria, and Clearfield.

Issuance of contracts for construction of the power-generating station at the Keystone mine mouth initiated the beginning of a building program which was expected to stimulate mining employment in the Johnstown-Indiana area. Coal from the Keystone mine will be consumed at the powerplant at the rate of 5.5 million tons annually when full operation is reached in 1968.[2] Power will be sent through extra-high voltage transmission lines to major power markets in the East. Aerial photography was being used to plot the best route for the transmission lines. Duquesne Light Co. and the Allegheny Power System jointly plan a giant mine-mouth powerplant on the Monongahela River in Pennsylvania and West Virginia. Five of the seven utility companies sponsoring the Keystone complex are planning a similar facility, called the Conemaugh plant, northwest of Johnstown and 27 miles from the Keystone mine.

A new concept in railroading has been started, using equipment owned by an investor-owned electric utility to transport fuel from origin to destination on a rigid schedule. Pennsylvania Power and Light Co., the owner of the unit train, loads at the Marion mine of the Tunneltown Mining Co., Tunneltown. The train of 74 cars, having a capacity of 7,000 tons, can be loaded in less than 3 hours and unloaded in one 8-hour shift. Empty cars can be returned to their point of origin in 2 days, compared with the former 12 to 20 days. Ultimate plans of the company included four such trains.[3] The Robinson mine of North American Coal Corp. at Seward was being expanded to accommodate a unit tram, having facilities capable of loading 8,000 tons in 4 hours. PBS Coals, Inc., also announced plans to develop a mine for unit-train shipment of utility coal from the mine in Somerset County, to Washington, D.C., and Syracuse, N.Y.

Power industry experts agreed that the cost differentials among the alternate methods for generating and supplying energy for Eastern markets have narrowed considerably since 1960. The economic advantages of (1) mine-mouth power generation and long distance extra high voltage transmission, (2) unit-train coal transportation to powerplants in the market areas, and (3) nuclear power generation in the load centers have become more difficult to assess.

Coke and Coal Chemicals.—The continued high level of activity in the iron and steel industry required larger quantities of coke, and the coke industry responded with output of 17.6 million tons of oven coke—15 percent more than in 1963. Twelve plants continued in operation, but only 3,662 ovens were in use; 58 ovens less than in 1963. Beehive coke output increased 46 percent to 562,000 tons. Eighteen beehive coke plants with 3,800 ovens were in operation, the same number of

[2] Mining Congress Journal. V. 50, No. 4, April 1964, p. 125.
[3] Skillings Mining Review. V. 53, No. 29, July 18, 1964, pp. 1, 6–7.

TABLE 4.—Coal (bituminous) production by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Allegheny	4,436	$23,876	4,833	$26,170
Armstrong	4,150	16,420	4,320	18,280
Beaver	452	1,476	494	1,685
Bedford	317	1,099	285	994
Blair	13	59	11	54
Bradford	W	W	W	W
Butler	1,902	6,964	1,827	6,745
Cambria	6,955	37,575	8,741	48,202
Cameron	68	265	W	W
Centre	759	2,547	601	2,199
Clarion	3,711	12,717	3,175	11,052
Clearfield	6,890	25,080	7,288	26,681
Clinton	481	1,588	482	1,695
Elk	673	2,443	440	1,530
Fayette	1,500	7,410	1,834	10,562
Greene	9,615	59,373	11,588	71,620
Huntingdon	53	180	68	223
Indiana	5,588	25,968	5,509	24,657
Jefferson	1,802	6,326	1,891	6,683
Lawrence	897	2,772	841	2,529
Lycoming	29	115	W	W
Mercer	982	3,719	587	2,271
McKean	W	W	22	78
Somerset	3,120	11,873	3,168	14,184
Tioga	386	1,727	W	W
Venango	678	2,332	491	1,977
Washington	12,153	76,836	13,460	85,064
Westmoreland	3,857	19,164	4,081	20,971
Undistributed	34	181	494	2,112
Total	71,501	350,085	76,531	388,218

W Withheld to avoid disclosing individual company confidential data.

plants, but 164 more ovens; 136 ovens were abandoned, but 300 new or rebuilt ovens were put into operation. Oven-coke production comprised 29 percent of the National total and the State was ranked first in coke output, having production more than twice that of the next ranked State (Indiana). More than 95 percent of the coke produced, was consumed by the producing company in blast furnaces, and a much smaller quantity was consumed in foundries. The balance was sold chiefly to blast-furnace plants.

Value of oven-coke production was $299.4 million, an average value at the plant of $17.02—reflecting an increase of $2.11 per ton over that of 1963. Value of beehive-coke production was $7.6 million, an average of $13.48 per ton at the plant.

Total coal receipts for oven-coke production was 26.1 million tons, of which 73 percent was high volatile, 21 percent was low volatile, and 6 percent was medium volatile. Average value of the coal carbonized, was $8.09 per ton, a decrease of $0.36 per ton from that of 1963.

To produce 1 ton of coke, 1.44 tons of coal was carbonized, the same as in 1963. At the beehive ovens, 1.63 tons of coal was required to produce 1 ton of coke. Of the 25.3 million tons of bituminous coal carbonized at slot-oven plants, all but 363,000 tons was washed; and at the beehive plants, 165,000 tons was unwashed (18 percent of the total). Of the coal received at oven-coke plants, 14.2 million tons

originated in Pennsylvania; 10.3 million tons, in West Virginia; 1.2 million tons, in Virginia; and 441,000 tons, in Kentucky.

Coke-breeze production in 1964 was 863,000 tons, 17 percent more than in 1963. Of total coke breeze produced, 71 percent was consumed by the producer, mostly in agglomerating and steam plants, and the balance was sold.

More than 272.5 billion cubic feet of coke-oven gas was produced—10,770 cubic feet per ton of coal coked. Of this total, 107.0 billion cubic feet was used in heating ovens; 163.8 billion cubic feet was sold; and the balance was wasted.

Recovered products at the oven-coke plants, in addition to the coke breeze and coke-oven gas, included 246,309 tons of ammonium sulfate equivalent; 241.1 million gallons of coke-oven tar; 75.6 million gallons of crude light oil, from which were derived 40.7 million gallons of benzene; 10.6 million gallons of toluene; 3.6 million gallons of xylene, and 2.9 million gallons of solvent naphtha.

Natural Gas Liquids.—Output of natural gas liquids was 62,357 barrels; a 14 percent reduction from that of 1963. Of the total, 43 percent was natural gasoline; the balance was other liquefied petroleum gases. The value of natural gas liquids produced was $164,000, 16 percent less than that of 1963. Prices of natural gasoline and liquefied petroleum gases were 5.6 cents and 6.8 cents per gallon, respectively.

As of January 1, 1964, five natural gas processing plants were in operation of which three were absorption and two were compression. Daily capacity of these plants was 17,450 gallons, of which 3,000 gallons was liquefied petroleum-gas mixtures, and 14,450 gallons was natural gasoline and other products. Most of this capacity was recovered by the absorption (16,500 gallons) and the balance by the compression process.

Reserves of natural gas liquids were estimated to be 1.38 million barrels, 4 percent less than the estimate made at the end of 1963.

Peat.—Sales of peat were 16 percent greater than in 1963. Ten producers were active in six counties. Average price per ton increased by $0.08 to $10.05. Luzerne County yielded the largest peat output, followed by Wayne County. Of total output, 42 percent was humus peat; the balance was almost evenly divided between moss and reed-sedge peat. Peat-mining activity involved 428 acres, 96 acres more than in 1963.

Petroleum and Natural Gas.—Production of crude oil was 5.1 million barrels valued at $22.1 million, a slight increase from that of 1963. However, because of decreased prices for petroleum at the wellhead, total value decreased 5 percent. According to the Oil and Gas Section, Pennsylvania Bureau Topographic and Geologic Survey, the wellhead price of Pennsylvania crude from the Bradford district, which comprised 60 percent of total petroleum production, was $4.48 per barrel. The balance of output, which is comprised of Pennsylvania crude from the Middle and Southwest districts, averaged $4.10 per barrel. Total natural gas production was 82.7 billion cubic feet of which 82.2 billion cubic feet was marketed for $22,349,000, an 11-percent decline in marketed production, causing a loss of $1.7 million in natural gas

revenues from that of 1963. The average price of natural gas was $0.27 per thousand cubic feet.

Drilling in proven areas resulted in 619 development wells, compared with 489 in 1963. This new drilling resulted in 242 oil wells, 274 gas wells, and 103 dry holes. Secondary recovery projects resulted in drilling 278 wells. Thirteen additional wells were drilled for gas storage, and one was drilled for waste disposal. Of the 27 wildcat tests, 6 resulted in gas discoveries; a success rate of 22 percent, compared with 29 percent in 1963. The grand total of 911 development wells, 27 wildcats, and 27 old wells drilled deeper resulted in 2.2 million feet of drilling. The average depth of the wildcat holes was 6,478 feet or 536 feet deeper than that of 1963. At the end of 1964, it was estimated that there were 53,065 producing oil wells and 13,520 producing gas wells, yielding a daily average of 0.27 barrel of oil and slightly less than 17,000 cubic feet of gas per day, per well, respectively.

The trend to hydraulic stimulation of both oil and gas wells continued. Both primary producing wells and wells in secondary recovery projects benefited from this technique. The success of notching and selective fracturing was a major factor in the recent increase in drilling shallow sand wells. In the Youngsville-Sugar Grove Field in Warren County, 114 new oil wells were completed. In the New Bethlehem area of Clarion County and the Pleasantville area in Venango and Forest Counties, daily production increased significantly. Three secondary recovery projects using steam injection were under way in the Tidioute and Bradford areas, and a feasibility test was under way for the area near Franklin.

One of the outstanding exploratory developments during 1964 was the discovery of commercial quantities of natural gas in the Cambrian Gatesburg formation in Crawford County. A discovery well drilled in Fayette County in 1937 to the Summit field was deepened to the Silurian Tuscarora Sandstone, and at total depth of 11,571 feet was the deepest producing well in the State. The Kastle pool in the Conneaut field, Crawford County, discovered in 1962, has 48 shut-in gas wells. Upon completion of a gathering pipeline system (expected in 1965), production likely will develop.

An interesting but noncommercial gas strike was made near Prosperity. At a depth of 500 feet, drillers encountered a flow of gas estimated from 10 to 15 million cubic feet per day. Because of the shallow depth it was believed the reserve would prove to be inadequate to justify a completion and the well was capped.[4]

Ten companies operated natural gas storage facilities in more than 30 fields in 14 counties in Pennsylvania and in contiguous areas in the adjacent States of New York and West Virginia. Some of the larger operating companies were Equitable Gas Co., Manufacturers Light & Heat, and People's Natural Gas Co., all having large storage capacity mainly in southwestern Pennsylvania. Others were Consolidated Gas Supply Corp. (formerly New York State Natural Gas Corp.), Tennessee Gas, Texas Eastern, Transcontinental Gas Pipe Line Corp., and United Natural Gas Co. having most of their storage capacity in the northwestern and west central part of the State. Total gas storage

[4] Bulletin of the American Association of Petroleum Geologists. V. 49, No. 6, June 965, pp. 666–672.

capacity of the State was estimated to be 666.7 billion cubic feet.[5] The American Gas Association estimated that 521.5 billion cubic feet were in storage at yearend, compared with 491.2 billion cubic feet in storage at the end of 1963.

Thirteen petroleum refineries were in operation in 1964. Total operating capacities in barrels per day included 619,000 barrels of crude oil, a catalytic cracking capacity charge of 253,000 barrels, a thermal cracking capacity charge of 68,000 barrels, and a reforming capacity charge of 137,000 barrels.

The reserve of crude oil as of December 31 was estimated by the American Petroleum Institute to be 86.6 million barrels, 5.1 million barrels less than in 1963. The American Gas Association estimated the reserve of natural gas to be 1,243.6 billion cubic feet, 29.1 billion cubic feet more than on December 31, 1963, based on standard conditions of 14.73 pounds per square inch absolute pressure and 60° F.

NONMETALS

Cement.—Portland cement production was 2 percent less than that of 1963, but masonry cement output increased 12 percent. Average price per barrel for portland cement continued to decline, dropping $0.07 per barrel to $3.01. Average price for masonry cement, however, increased $0.07 to $2.70 per barrel. The downward trend in shipments of portland cement, particularly in eastern Pennsylvania, reflected the continuing highly competitive market along the Atlantic seaboard.

Portland cement capacity was 52.4 million barrels, almost 1.5 million barrels less than in 1963. Twenty-one plants were in operation, of which 16 were in eastern and 5 were in western Pennsylvania. Of total capacity 63 percent was of the dry process and 37 percent of the wet process. Electrical energy used by the cement industry totaled 967.4 million kilowatt-hours of which 84 percent was purchased. The balance was generated by the companies. Cement stocks as of December 31 were 5.7 million barrels, compared with 5.8 million barrels in 1963 and 6.0 million barrels at the end of 1962.

Portland cement shipments were to ready-mixed concrete companies (58 percent), concrete product manufacturers (20 percent), building-material dealers (12 percent), and highway contractors (7 percent). The balance was shipped to other contractors, Government agencies, and miscellaneous consumers. Pennsylvania cement was shipped to consumers in 45 States and several foreign countries.

Lost markets for the State cement output were mostly in the New England area. Other decreased markets were noted in New Jersey, New York, Delaware, and along the Atlantic seacoast into South Carolina. Consumption within the State increased significantly, and new markets were developed in the adjoining States of Ohio, Maryland, and West Virginia. Of total shipments 39 percent was consumed in Pennsylvania, 21 percent in New Jersey, 14 percent in New York, 8 percent in Ohio.

Tons of raw materials consumed in producing portland cement included cement rock, 7.6 million tons; limestone, 3.3 million; shale,

[5] Oil and Gas Journal. V. 63, No. 18, May 3, 1965, pp. 138–144.

128,000; clay, 99,000; sand, 219,000; slag, 180,000; gypsum, 326,000; and iron ore, 37,000. Air-entraining compounds included Vinsol resin and Airalon.

Of total shipments 62 percent was shipped by truck and 37 percent by rail. The balance was shipped by boat or used at the plant.

Most of the shipments were in bulk form (83 percent). Of the remainder, 16 percent was shipped in paper bags and 1 percent in other containers.

TABLE 5.—Portland cement shipments, by counties

County	Number of plants in 1964	1963		1964	
		376-pound barrels	Value	376-pound barrels	Value
Lehigh	4	6,566,840	$18,954,773	6,030,959	$16,027,656
Northampton	9	18,816,439	56,104,232	17,857,155	51,362,025
Allegheny	2	6,714,204	21,995,863	7,633,528	25,046,654
Lawrence	2				
Berks	1	6,218,726	21,147,992	6,141,121	20,972,499
Butler	1				
Montgomery	1				
York	1				
Total	21	38,316,209	118,202,860	37,662,763	113,408,834

Clays.—Output of clay was at virtually the same rate as that of 1963. Value of output, however, increased by $1.1 million mainly because of higher values per ton assigned to miscellaneous clay. Clay output (excluding kaolin) was distributed roughly one-half fire clay and one-half miscellenous clay. Production of clay refractories was the highest since 1960. Output of firebrick and fireblock was less than that of 1963, but a tenfold increase in production of high-alumina brick offset this loss. In addition, output for refractory mortar, for bulk use in foundries and steelworks, and miscellaneous refractory uses all increased. Clay consumption in production of building brick and other heavy clay products—mostly miscellenous clay (68 percent)—increased 5 percent from 1963. Diminished lightweight aggregate production resulted in consumption of less than half as much clay as was used for this purpose in 1963. Clay consumption in the manufacture of portland cement and the production of pottery and flowerpots was at virtually the same rate as that of 1963.

Clay was produced in 32 counties; the leading areas were Lawrence, Clearfield, Armstrong, Berks, and Jefferson. Lower production in Clearfield County (the former leading area for clay production) brought about a change in first ranking as Lawrence County assumed this position. However, the value of Clearfield County's clay output was over four times greater than that of Lawrence County because of the higher priced fireclay produced in that county. Because of the low value assigned to the miscellaneous clay produced in Lawrence County, it was ranked 11th in value of output.

Gem Stones.—Mineral specimens were collected chiefly by hobbyists and amateur lapidarists at scattered locations in the eastern part of the State but centered chiefly in Chester and Montgomery Counties. Gem stones collected in Chester County at the Cornog quarry, included black quartz (containing red garnet), pink calcite, and zoisite in

TABLE 6.—Clays sold or used by producers, by kinds and uses [1]

(Short tons)

Use	Fire clay		Miscellaneous clay	
	1963	1964	1963	1964
Refractories:				
Firebrick and block	783,272	735,106	----------	----------
Fire clay mortar	20,672	43,306	----------	----------
Heavy clay products	557,945	605,062	1,267,538	1,308,816
Portland and other hydraulic cements	----------	----------	199,275	198,358
Undistributed	[2] 142,681	[2] 200,639	[3] 219,222	[3] 95,813
Total	1,504,570	1,584,113	1,686,035	1,602,987

[1] Excludes Kaolin.
[2] Includes rubber (1963), paint (1963), exports (1964), floor and wall tile, high-alumina brick, clay crucibles, foundries, steelworks (bulk), other refractories, insecticides and fungicides, other filler, absorbent uses, and other uses.
[3] Includes art pottery, flowerpots, and glaze slip; foundries, and steelworks (bulk); lightweight aggregate; linoleum and oilcloth; and other uses (1963).

TABLE 7.—Clays sold or used by producers in 1964, by counties

County	Short tons	Value	Types of clay
Adams	79,900	$39,950	Miscellaneous clay.
Armstrong	255,970	1,963,285	Fire clay, miscellaneous clay.
Beaver	117,483	929,290	Do.
Bucks	59,900	59,900	Miscellaneous clay.
Butler	9,028	13,500	Do.
Cambria	32,818	163,955	Fire clay, miscellaneous clay.
Chester	97,153	121,500	Miscellaneous clay.
Clarion	73,743	309,470	Fire clay, miscellaneous clay.
Clearfield	435,177	2,784,784	Do.
Clinton	W	44,717	Do.
Columbia	15,868	28,500	Miscellaneous clay.
Fayette	102,836	W	Fire clay, miscellaneous clay.
Greene	1,500	1,900	Miscellaneous clay.
Lawrence	460,925	642,340	Fire clay, miscellaneous clay.
Montgomery	57,629	103,286	Miscellaneous clay.
Somerset	110,630	878,242	Fire clay.
Undistributed [1]	1,276,540	7,729,324	
Total [2]	3,187,100	15,813,943	

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Allegheny, Berks, Blair, Centre, Cumberland, Dauphin, Huntingdon, Indiana, Jefferson, Lancaster, Luzerne, McKean, Monroe, Northumberland, Schuylkill, and York Counties, and counties indicated by symbol W.
[2] Incomplete total; excludes Kaolin produced in Blair and Cumberland Counties.

quartz. Gems collected at the Bessemer quarry included zeolites, stilbite, hevlandite, and pyrite. At the Kibblehouse quarry specimens collected included calcite (fluorescing red, blue white, and cream), calcite crystals, garnet, epidote; at the Audubon mine sphalerite, barite chalcopyrite, and mulfenite were collected.

Graphite.—Manufactured (artificial) graphite was produced in an electric graphetizing plant near St. Marys in Elk County. Output in the form of graphite electrodes and anodes were sold to the iron and steel and the chemical industries.

Gypsum.—A gypsum calcining plant was operated at Philadelphia using both domestic and imported crude gypsum.

Iodine.—Two companies consumed out-of-State crude iodine in the production of both inorganic and organic sulfur compounds. One plant was at Pittsburgh in Allegheny County and one at Myerstown in Lebanon County.

Iron Oxide Pigments.—A small quantity of crude iron oxide pigment materials (red iron oxide and yellow sulfur mud) was mined.

The State continued to rank first in output of finished iron oxide pigments. Output was 4 percent more than in 1963. The leading type of pigment produced was the manufactured pure red iron oxides. Large quantities of natural brown iron oxides also were finished. Other types included the manufactured and natural yellows, manufactured browns, and manufactured and natural magnetic blacks. One plant in Carbon County and two in Northampton were in operation in 1964.

Lime.—The market for chemical and industrial lime was very active as consumption by these industries was more than 250,000 tons greater than in 1963. A major portion of this increase was attributed to a strong demand for lime in steel furnaces. Most of the other major markets remained at virtually the same rate as that of 1963. Most of the output (81 percent) was quicklime. Eighteen plants were operated in 15 counties. Centre County with three large lime-producing companies was, by far, the first ranking area followed by Lebanon, York, Butler, and Chester Counties. State lime-burning capacity was more than 1.8 million tons. Kilns in use included 17 rotary, 25 pot, and 11 shaft. Regenerated lime was recycled at one paper plant. Almost two-thirds of the lime output was consumed within the State, but shipments were made to 22 States, Canada, Chile, and Venezuela. Maryland, New York, New Jersey, and Ohio were leading States of destination.

TABLE 8.—Lime sold by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Armstrong	327	$4,905	310	$4,371
Centre	576,346	7,577,065	767,948	9,716,998
Dauphin	7,500	120,000	7,800	132,600
Lancaster	W	W	560	5,066
Lebanon	150,000	2,182,000	204,000	2,812,000
Mifflin	W	W	4,023	36,705
Northumberland	325	2,925	355	3,200
Undistributed [1]	453,719	7,661,045	455,289	7,945,084
Total	1,188,217	17,547,940	1,440,285	20,656,024

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Bedford, Butler, Chester, Juniata, Montgomery, Snyder, Westmoreland, and York Counties, and counties indicated by symbol W.

Mica.—Flake mica was produced by General Mining Associates at the Hoke mine, near Glenville. Output, which increased over that of 1963, was sold to manufacturers of paint, welding rods, and rubber products.

Perlite (Expanded).—Crude perlite shipped from Colorado was exexpanded at six plants in five counties. Allegheny County led in perlite output. Sales of the expanded product were slightly less than in 1963. The leading use was for lightweight aggregate in building plaster. Other uses included concrete aggregate and filler. Average price increased by $2.00 to $62.00 per ton.

Pyrites.—Pyrite was recovered by flotation in the milling process for

magnetite iron ore at the Grace and Cornwall concentrators. Output increased 15 percent from 1963. The concentrate was shipped for consumption at the company sulfuric acid plant in the iron and steel complex at Sparrows Point, Md.

Sand and Gravel.—Production of sand and gravel resumed its upward climb after a year of decreased output, increasing by more than 2.1 million tons (15 percent) from 1963. Of total commercial output, 60 percent was sand, and 40 percent was gravel. The aggregate market consumed 85 percent of total commercial tonnage of which building aggregate comprised 7.8 million tons and paving aggregate 5.8 million tons. Almost all the markets for sand and gravel increased, but the major tonnage increases were in paving (1.3 million tons) and building (0.6 million tons). Industrial sands played a prominent role in that the value of the State sand and gravel industry because of its high unit value, usually about twice that of aggregate production. Leading among the industrial sand uses were glass, grinding and polishing, fire or furnace, and engine. Ground sand production increased significantly but the average price per ton decreased more than 10 percent.

Bucks was the leading county for sand and gravel output followed by Erie, Westmoreland, Beaver, Huntingdon, and Mercer. Huntingdon County was the leading area for ground and industrial sand. All told, 108 commercial companies operated 115 pits in 47 counties. A dredge which had operated on the Allegheny River in Armstrong County moved down river into Westmoreland County and caused a sudden shift in source of a major tonnage. Of total output 98 percent was washed, screened, or otherwise prepared. Transportation was mostly by truck (67 percent) and waterway (26 percent); the balance by railroad and other disposition. A small amount of Government-and-contractor sand and gravel also was produced.

Stone.—Production of stone increased 7 percent and value of production increased 9 percent from that of 1963. Principal factors contributing to the stimulated mineral activity were increased limestone production for flux, increased sales of sawed and dressed dimension sandstone, a firm market for crushed basalt and crushed miscellaneous stone for aggregate and roadstone, new output of crushed slate for lightweight aggregate, and increased slate output for roofing material.

Increased production was reported for all types of crushed stone except granite. The greatest amount of increase was for dimension sandstone but output of dimension basalt and dimension slate also was greater than that of 1963.

The leading type of stone produced was limestone, comprising 83 percent of tonnage and 72 percent of value. The stone types produced, showing respective tonnage and value rankings in parentheses, were limestone (first in both), basalt (second and third), sandstone (third and second), miscellaneous stone (fourth and fifth), granite (fifth and sixth), and slate (sixth and fourth).

The major crushed stone markets were for concrete aggregate and roadstone (55 percent), cement manufacture (21 percent), and blast-and-open-hearth flux (11 percent). Other uses for crushed stone included agstone, railroad ballast, refractory products, and roofing granules. To summarize, the leading crushed stone markets for limestone were aggregate, cement manufacture, and flux; for sandstone, aggre-

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Molding	122	$378	124	$396
Building	4,261	6,301	4,697	6,648
Paving	2,298	3,188	2,859	4,109
Fire or furnace	168	382	108	326
Fill	39	29	24	25
Undistributed [1]	1,533	4,914	1,818	5,382
Total	8,421	15,192	9,630	16,886
Gravel:				
Building	2,931	4,313	3,137	4,550
Paving	2,278	3,666	2,978	4,507
Fill	153	89	207	138
Undistributed [2]	206	228	217	276
Total	5,568	8,296	6,539	9,471
Total sand and gravel	13,989	23,488	16,169	26,357
Government-and-contractor operations:				
Sand: Other	27	33	26	33
Gravel:				
Paving	50	18	----	----
Other	----	----	4	24
Total sand and gravel	77	51	30	57
Total all operations:				
Sand	8,448	15,225	9,656	16,919
Gravel	5,618	8,314	6,543	9,495
Grand total	14,066	23,539	16,199	26,414

[1] Includes glass, grinding and polishing, blast, engine, filter (1963), railroad ballast (1963), ground, and other sand.
[2] Includes railroad ballast, miscellaneous, and other gravel.

gate and roofing granules; for basalt, granite and miscellaneous stone and aggregate; and for slate, roofing granules, and flour.

The leading dimension stone industries, in terms of value were slate (66 percent) and sandstone (23 percent). Leading market for dimension stone (excluding slate) were the various types of building stone. A significant quantity of curbing and flagging also was produced. The larger markets for dimension slate were for structural and sanitary ware, blackboards, and roofing material.

Crushed stone was produced at 223 quarries of which 157 were limestone, 37 sandstone, 17 basalt, 5 slate, 5 miscellaneous stone, and 2 granite. Dimension stone was quarried at 65 quarries of which 41 were sandstone, 10 slate, 5 miscellaneous stone, 4 basalt, 4 granite, and 1 limestone. These quarries will not add to a grand total for the State since dimension and crushed stone were sometimes obtained from the same quarry.

The leading stone-producing counties listing the principal types of stone in parentheses, were Northampton (limestone and slate); Montgomery (limestone and miscellaneous stone); Adams (limestone and sandstone); Berks (limestone and basalt); Lawrence (limestone); Bucks (limestone, basalt, and miscellaneous stone); and York (limestone).

Roofing granules were produced at three plants, one each in Adams, York, and Beaver Counties.

TABLE 10.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Allegheny	234	$399	W	W
Armstrong	1,416	3,103	477	$787
Beaver	775	1,065	854	1,170
Bedford	7	18		
Berks	59	86	W	W
Bradford	113	140	W	W
Butler	149	202	164	219
Clearfield	27	33	W	W
Clinton			4	24
Crawford	114	133	92	108
Cumberland	212	309	250	376
Erie	1,401	1,988	1,613	2,086
Fayette	60	131	51	114
Lackawanna	234	237	261	288
Lancaster	205	384	229	446
Luzerne	465	548	631	754
McKean	10	10	10	10
Mercer	323	449	735	889
Montgomery	1	14	6	12
Northampton	449	551	486	602
Schuylkill	122	258	124	257
Snyder	128	134	162	185
Warren	210	319	261	412
Wayne	17	23	132	178
Undistributed [1]	7,338	13,007	9,657	17,497
Total	14,066	23,539	16,199	26,414

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Blair, Bucks, Cambria, Carbon, Clarion, Columbia, Dauphin, Elk, Forest, Franklin, Fulton, Huntingdon, Jefferson, Lawrence, Lycoming, Mifflin, Monroe, Montour, Philadelphia, Somerset, Tioga (1964), Venango, Westmoreland (1964), Wyoming, and York Counties, and counties indicated by symbol W.

TABLE 11.—Stone sold or used by producers, by uses

Use	1963		1964	
	Short tons	Value	Short tons	Value
Dimension stone:				
Building stone	132,623	$1,324,393	121,921	$1,340,151
Curbing and flagging	38,604	884,090	43,964	1,163,893
Other uses [1]	29,152	3,548,153	31,086	3,654,579
Total	200,379	5,756,636	196,971	6,158,623
Crushed and broken stone:				
Riprap	W	W	9,463	20,039
Concrete and roadstone	28,425,086	41,027,731	28,983,140	42,279,571
Furnace flux (limestone)	4,788,866	8,791,840	5,885,117	10,375,887
Railroad ballast	483,395	733,264	486,989	742,077
Refractory	131,214	1,445,489	W	W
Agricultural	1,089,748	3,255,974	1,000,054	3,104,776
Other uses [2]	14,417,088	22,439,139	16,267,534	28,393,707
Total	49,335,397	77,693,437	52,632,297	84,916,057
Grand total	49,535,776	83,450,073	52,829,268	91,074,680

W Withheld to avoid disclosing individual company confidential data.
[1] Includes roofing slate and millstock.
[2] Includes riprap (1963) and refractory (1964).

TABLE 12.—Stone sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Adams, Cumberland	3,692,006	$7,452,253	4,137,126	$10,847,874
Armstrong	W	W	185,813	431,532
Berks	3,192,310	4,083,477	3,396,066	4,578,911
Blair, Huntingdon	1,383,193	2,373,561	1,489,990	2,567,420
Bucks	2,859,489	5,117,736	3,160,124	4,223,338
Butler	1,082,807	2,087,679	1,289,182	2,467,851
Cambria	2,700	8,100	W	W
Carbon, Monroe, Schuylkill	708,597	1,854,051	928,550	2,364,168
Centre	2,068,603	3,770,312	2,432,183	4,259,858
Chester	2,133,717	3,888,616	2,449,119	5,073,218
Dauphin	1,026,014	1,499,608	988,084	1,616,504
Erie	140	225		
Fayette, Somerset	1,529,179	2,937,153	935,980	1,832,068
Franklin	1,042,780	1,360,517	W	W
Juniata, Mifflin, Snyder	691,999	1,102,674	888,606	1,249,631
Lackawanna	136,986	272,114	W	W
Lancaster	3,094,198	4,380,148	2,948,392	4,181,751
Lawrence	2,601,792	4,348,166	3,199,749	4,345,289
Lebanon	1,436,793	2,444,595	1,698,035	2,867,643
Lehigh	2,297,556	2,154,027	2,533,795	2,624,085
Montgomery	4,189,420	6,694,731	4,679,418	7,671,742
Northampton	4,885,758	8,396,007	5,341,525	8,427,109
Northumberland	56,150	99,600	55,410	97,810
Potter	8,702	254,751	W	W
Susquehanna	W	W	170,896	745,587
Wayne	117,607	185,807	157,408	330,176
Westmoreland	741,910	1,289,389	667,021	1,167,469
York	3,108,776	6,268,751	3,074,191	6,617,425
Undistributed [1]	5,446,594	9,126,025	6,022,605	10,486,221
Total	49,535,776	83,450,073	52,829,268	91,074,680

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Allegheny, Bedford, Clarion, Clinton, Delaware, Elk (1964), Fulton, Jefferson, Luzerne, Lycoming, McKean (1964), Mercer, Montour, Perry, Tioga, Union, Washington, and Wyoming Counties, and counties indicated by symbol W.

Sulfur.—Sulfur and hydrogen sulfide were recovered in liquid purification of oil refinery gases. Sulfur was recovered at three refineries in the eastern part of the State at virtually the same rate as that of 1963. Hydrogen sulfide, recovered at another refinery, was converted directly into sulfuric acid.

Talc.—Sericite schist, resembling talc mineralogically and suitable for many of the same uses because of similar chemical and physical properties, was mined by three companies in Adams County. Crude production was almost one-third greater than that of 1963. One of the companies, Mauna Mining Co., went out of business in November 1964, reportedly for economic reasons. The entire output was ground at company mills and sold. The largest market by far was for asphalt filler. Other uses included joint cement, insecticides, and roofing.

Tripoli.—Total sales of tripoli (rottenstone) were at virtually the same rate as that of 1963. Two companies in Lycoming County mined and processed the material for use as an abrasive compound and as a filler material.

Vermiculite (Exfoliated).—Production of exfoliated vermiculite was almost identical with that of 1963. Two plants were in operation, one in Bucks County and one in Lawrence County. The largest use by far was for insulation. Other uses included agriculture, as a lightweight aggregate in concrete and plaster, and as a packing medium.

METALS

Beryllium.—Beryllium metal, alloys, and compounds were produced from beryl by the Beryllium Corp. at plants at Reading and Hazleton. Litigation against the company by residents near the America plant near Reading, began because of lung infection believed to have been caused by the emission of toxic beryllium dust into the atmosphere, resulted in a decision against the company and the awarding of a significant cash settlement to the litigants.

Cadmium.—St. Joseph Lead Co. recovered cadmium from sintering machine fume at its Josephtown plant in Beaver County. Equipment designed for recovery of cadmium had been installed in 1937. Cadmium also was recovered at the Palmerton plant of New Jersey Zinc Co.

Cesium-Rubidium.—Penn Rare Metals, Division of Kawecki Chemical Co., processed pollucite to cesium metal and compounds at Revere. This firm also produced rubidium compounds. Rare Metals Derivatives, Inc., processed pollucite to cesium compounds at Ambler.

Cobalt.—Pyrite concentrate from Pennsylvania magnetite iron ore was processed at plants at Sparrows Point, Md., and Wilmington, Del., to recover its cobalt metal content. Cobalt production increased significantly from that of 1963.

Copper.—The recovery of copper from flotation concentrate decreased from that of 1963. More concentrate was produced, but the copper content was significantly lower than that of 1963.

Ferroalloys.—Both production and shipment of ferroalloys increased from 1963. Shipments amounted to 586,000 tons valued at $100.9 million. Thirteen types of ferroalloys were produced, however, ferromanganese comprised a major portion (92 percent) of this total. Of the balance, spiegeleisen and ferromolybdenum were the more important types.

United States Steel Corp. was transforming its Clairton pig-iron blast furnace to produce ferromanganese. Output was to be shipped to the company Duquesne Works for use in open-hearth furnaces to produce various alloy steels.

Germanium.—Kawecki Chemical Co., Boyerstown, acquired the Penn Rare Metals, Inc., Revere, and will operate the firm as a wholly owned subsidiary. Products of the plant will be germanium, cesium, rubidium, tellurium, and other high-purity metals.[6]

Gold and Silver.—Production of gold and silver was virtually the same as in 1963. Output was recovered from the copper concentrates prepared in the milling of iron ore.

Iron Ore.—Responding to the firm demand for iron and steel, shipments of iron ore were 10 percent greater than in 1963. Magnetite, produced from the Cornwall and Grace underground mines, was crushed, concentrated by magnetic separation, and pelletized at agglomerating plants at the mine sites. Most of the agglomerates were shipped to company-owned iron and steel plants and were consumed in blast furnaces.

Iron and Steel.—The continuing vigorous economy was reflected

[6] Chemical and Engineering News. V. 42, No. 7, Feb. 17, 1964, p. 30.

in increased production of pig iron and steel. Pig iron output increased from 17.3 to 21.0 million tons, and according to the American Iron and Steel Institute, steel production increased from 25.2 to 30.5 million tons. For the first time, tonnages of steel produced by the basic oxygen method were published; 3.6 million tons was produced by basic oxygen furnaces in 1964. Most of the steel production (79 percent) was from open hearth furnaces, 24.0 million tons in 1964 total. The balance of steel output was from Bessemer and electric furnaces.

Most of the pig iron produced was classed as basic. In order of production, the other classes were Bessemer, malleable, foundry, and low phosphorous. A small tonnage was made directly into castings. Receipts of U.S.-produced and foreign-produced iron ore were 42 percent and 28 percent, respectively, more than in 1963. Total closing stocks of iron ore were 11.3 million tons; a 286,000 ton increase over opening stocks. Of the total iron ore consumed, 50 percent was prepared by agglomeration, 45 percent was consumed directly in blast furnaces, and 5 percent directly in steel furnaces. Fluxes consumed by the iron and steel industry, included 3.7 million tons of limestone and 2.9 million tons of dolomite.

Other materials consumed included 1.4 million tons of mill cinder and roll scale, 1.0 million tons of raw flue dust, 1.8 million tons of steel furnace slag, 14.2 million tons of coke and coke breeze, more than 0.3 million tons of anthracite, 19.9 million tons of pig iron and hot metal, 11.1 million tons of home and purchased scrap, and 0.3 million tons of slag scrap.

Agglomerate consumption and transshipment to other plants totaled 25.5 million tons, of which more than half was U.S. sinter (regular); more than one-quarter was semi- and self-fluxing sinter. The balance of agglomerate consumption was comprised mostly of regular pellets, plus a smaller quantity of foreign agglomerates.

In operation of the iron and steel furnaces, 6.8 million tons of slag was produced; 0.9 million tons of flue dust was recovered; and more than 155,000 tons of scrap was produced. Nine companies operated 20 plants, 1 plant less than in 1963. The Birdsboro plant of Colorado Fuel and Iron, was closed indefinitely. Fifty blast furnaces were active, 13 more than in 1963.

Confidence in the growth of the national economy and in the role of steel in that growth, was reflected in construction of new steel plants and renovation and modernization of existing plants. Illustrating this optimism were the numerous reports of construction activity. Allegheny Ludlum was planning a major new steel-melting plant at Natrona. Equipment at the plant would include two oxygen converters for producing alloy steel, a hot-blast cupola, and the required auxiliary equipment. Jones & Laughlin Steel Corp. announced plans for future expansion of its Aliquippa works onto Corn Island. The area of the Ohio River between the island and the existing plant is to be filled, resulting in a 50-percent increase in acreage for future expansion of the plant. The channel on the other side of the island would be widened to permit barge traffic and to handle the extensive docking requirements of the company when the present docking area is lost in the filling operation. The company also announced plans

to build a new blast furnace, having a 2,500 ton capacity, at its Hazelwood works. Pittsburgh Steel Co. was planning the construction of a $3.5 million iron ore sintering plant with capacity of 500,000 tons of sinter per year. Armco Steel Corp. announced acquisition of 474 acres adjacent to its present plant site at Butler on which a new low-level continuous-casting unit likely will be built. The increased property holdings will provide the space needed for any additional expansion. The largest vacuum degassing unit in the world will be installed at the Pittsburgh (Hazelwood) works of Jones & Laughlin Steel Corp. Expectations were that the new furnace would improve the yield of steel ingots and lead to development of new steels. Lukens Steel Co. announced plans to add a new 145-ton electric furnace to its two 100-ton capacity furnace plants at Coatesville and eventually plans to retire all its open-hearth furnaces. Sharon Steel Co. will virtually double its steel production capacity with the planned addition of a third Kaldo oxygen furnace and pressure-casting equipment for producing stainless and high-alloy steels. These furnaces, scaled-up from a Swedish prototype, are the only rotating-oxygen furnaces in the Nation. Because of problems in finding a long-lived refractory lining, a specially designed high-temperature brick was developed and was performing satisfactorily. Capacity for basic-oxygen steelmaking in Pennsylvania was more than 4 million tons annually.

Iron and Steel Scrap.—To meet the requirements of accelerated steel products, significantly more iron and steel scrap was consumed than in 1963. Ferrous scrap was collected and prepared at scattered locations throughout the State but was centered in metropolitan areas, such as Pittsburgh, Philadelphia, and Harrisburg. The leading varieties of scrap consumed were No. 1 heavy-melting steel, No. 2 and all other bundles, cast-iron scrap and other borings, and No. 1 electric-furnace bundles.

Slag (Iron-Blast-Furnace).—Production of iron-blast-furnace slag was 6 percent more than that of 1963—6.2 million tons valued at $11.1 million. The State led in production of slag. Average price per ton of slag was $1.78, compared with the national average of $1.73. Of the total State slag output, 77 percent was screened air-cooled. Markets were for aggregate used in most types of construction activity.

Smelters.—The Josephtown and Palmerton smelters continued operation in 1964. The Josephtown plant of St. Joseph Lead Co., near Aliquippa in Beaver County, smelted zinc concentrates from its New York and Missouri operations and from other domestic and foreign sources. Output of the plant was zinc metal and oxide, cadmium, and sulfuric acid. The Palmerton complex of New Jersey Zinc Co. produced zinc and metal and oxide, cadmium, sulfuric acid, and anhydrous ammonia. Zinc concentrates and zinc crude from company-owned facilities plus other domestic and foreign material were processed.

Zinc.—Mine output of zinc was 12 percent more than that of 1963. Value of production increased 27 percent because of the higher price per pound commanded by zinc metal on the world market. The zinc ore concentrates were shipped to the company smelter at Palmerton.

REVIEW BY COUNTIES

Adams.—Output of crushed limestone at three quarries was nearly 500,000 tons more than that of 1963. Greater production of flux for blast-and-open hearth furnaces by Bethlehem Steel Co. at its new Hanover quarry was the leading factor in increased county production. Teeter Stone, Inc., and Gettysburg Limestone Products, Inc., produced crushed limestone for aggregate. Bethlehem Steel Co. installed a new stone-sand classifier and new screening equipment at the Hanover plant. Crushed basalt and quartzite was produced by the Ruberoid Co., mostly for roofing granules. The Hanover quarry of Bethlehem Steel Co. received a Certificate of Achievement in Safety for working throughout 1964 without a disabling work injury.

Sericite schist was produced by Summit Industries, Inc., at two open-pit mines near Mt. Hope and Bendersville. The crude material was trucked to the company mill at Aspers. After grinding, it was shipped for consumption as asphalt filler and in joint cement. The company reported increased orders. Mauna Mining Corp. mined sericite schist near Gardner for processing at the company mill at Carlisle in Cumberland County. The company went out of business in November 1964, reportedly for economic reasons.

TABLE 13.—Value of mineral production in Pennsylvania by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value [2]
Adams	W	W	Stone, sericite schist, clays.
Allegheny	$35,348,049	[3] $27,192,462	Coal, cement, clays, sand and gravel, stone, iron ore (pigment material).
Armstrong	W	21,465,940	Coal, clays, sand and gravel, stone, lime.
Beaver	3,535,030	3,784,588	Coal, sand and gravel, clays.
Bedford	W	W	Stone, coal, lime.
Berks	32,397,801	W	Iron ore, cement, stone, clays, cobalt, coal, pyrites, sand and gravel.
Blair	1,903,668	1,924,474	Stone, coal, clays, sand and gravel.
Bradford	W	341,185	Sand and gravel, coal.
Bucks	W	W	Sand and gravel, stone, clays.
Butler	14,486,841	[4] 9,445,729	Coal, cement, stone, lime, sand and gravel, clays.
Cambria	37,754,195	48,488,015	Coal, clays, stone, sand and gravel, iron ore (pigment material).
Cameron	264,698	W	Coal.
Carbon	6,774,955	5,906,595	Coal, stone, sand and gravel.
Centre	W	W	Lime, stone, coal, clays.
Chester [5]	4,012,246	5,194,718	Stone, lime, clays.
Clarion	13,844,560	12,329,169	Coal, stone, clays, sand and gravel.
Clearfield	28,418,087	W	Coal, clays, sand and gravel.
Clinton	1,871,537	W	Coal, clays, stone, sand and gravel.
Columbia	3,269,045	W	Coal, sand and gravel, clays, peat.
Crawford	132,924	108,000	Sand and gravel.
Cumberland	W	W	Stone, sand and gravel, clays.
Dauphin	3,559,293	W	Stone, coal, clays, sand and gravel, lime.
Delaware	W	W	Stone.
Elk	W	W	Coal, sand and gravel, stone.
Erie	W	W	Sand and gravel, peat.
Fayette	W	12,824,818	Coal, stone, clays, sand and gravel.
Forest	W	W	Sand and gravel.
Franklin	W	1,534,184	Stone, sand and gravel.
Fulton	W	W	Stone, sand and gravel.
Greene	59,373,257	71,621,786	Coal, clays.
Huntingdon	W	W	Sand and gravel, stone, coal, clays.
Indiana	W	W	Coal, clays.
Jefferson	W	W	Coal, clays, stone, sand and gravel.
Juniata	W	W	Stone, lime.
Lackawanna	10,272,932	W	Coal, sand and gravel, stone, peat.
Lancaster	W	6,856,245	Stone, coal, sand and gravel, clays, lime.
Lawrence [5]	8,048,756	7,792,359	Cement, stone, coal, clays, sand and gravel, peat.
Lebanon	W	W	Iron ore, stone, lime, copper, cobalt, coal, pyrites, gold, silver.
Lehigh [6]	27,680,588	26,997,146	Zinc, stone, cement.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Pennsylvania by counties—Continued

County	1963	1964	Minerals produced in 1964 in order of value [2]
Luzerne	W	$58,439,697	Coal, sand and gravel, stone, peat, clays.
Lycoming	$1,519,666	W	Stone, sand and gravel, coal, tripoli.
McKean	W	W	Clays, coal, stone, sand and gravel.
Mercer	W	W	Coal, sand and gravel, stone.
Mifflin	1,979,023	W	Sand and gravel, stone, lime.
Monroe	562,571	535,407	Stone, sand and gravel, clays.
Montgomery	13,097,487	[4] 7,787,028	Stone, cement, lime, clays, sand and gravel.
Montour	W	W	Stone, sand and gravel.
Northampton	66,800,123	62,486,684	Cement, stone, sand and gravel.
Northumberland	W	W	Coal, clays, stone, lime.
Perry	W	W	Stone.
Philadelphia	W	W	Sand and gravel.
Potter	254,751	W	Stone.
Schuylkill	W	W	Coal, stone, sand and gravel, clays.
Snyder	424,159	431,676	Sand and gravel, stone, coal, lime.
Somerset	13,333,376	15,682,072	Coal, clays, stone, sand and gravel.
Sullivan	66,717	82,377	Coal.
Susquehanna	W	745,587	Stone.
Tioga	W	1,603,429	Coal, sand and gravel, stone.
Union	W	W	Stone.
Venango	W	W	Coal, sand and gravel.
Warren	318,767	412,000	Sand and gravel.
Washington	W	W	Coal, stone.
Wayne	W	W	Stone, sand and gravel, peat, coal.
Westmoreland	W	W	Coal, sand and gravel, stone, lime.
Wyoming	W	593,267	Sand and gravel, stone.
York	17,146,330	[4] 7,421,637	Cement, stone, lime, clays, sand and gravel, mica.
Undistributed [7]	[r] 448,960,011	482,021,681	
Total	[r] 857,411,000	902,050,000	

[r] Revised.
W Withheld to avoid disclosing individual company confidential data.
[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] Excludes masonry cement; included with "Undistributed."
[7] Includes values indicated by symbol W.

Alwine Brick Co. mined shale at New Oxford for building brick manufacture. The company installed new grinding equipment in 1964. Gettysburg Drain Tile Works did not operate.

Allegheny.—Bituminous coal production, most of which (81 percent) was from underground mines was greater than that of 1963. The county ranked sixth among the coal-producing areas in the State. All told, 36 mines were in operation, 17 of which were underground, 17 strip, and 2 auger. Underground production was mostly from the Double Freeport coal group. Almost all the underground production was loaded mechanically. Sixteen continuous mining machines were in use. Harman Coal Co. and Republic Steel Corp. both with two active mines were the leading underground producers. Wm. Aloe Coal Co., Pittsburgh Coal Co., and Mac Coal Co. (two mines) were the leading strip-mining companies. The latter two companies also operated the only auger mines in the county. Strip and auger mining were mostly in the Pittsburgh seam. Most of the output was mechanically cleaned at five preparation plants. The Russell No. 2 strip mine of Aloe Coal Co. received a Certificate of Achievement in Safety for working throughout 1964 without a disabling work injury.

Portland and masonry cements were produced by Universal Atlas Cement Division, United States Steel Corp. at Universal and by

Green Bag Cement Co., Division of Marquette Cement Manufacturing Co. at Neville Island, Pittsburgh. County portland cement output was almost evenly divided between air-entrained and non-air-entrained. Significant quantities of locally available slag were used to produce portland slag. Portland and masonry cement shipments were mainly by truck in bulk to consumers chiefly in Western Pennsylvania. Primary customers were ready-mixed concrete companies. Two 360-foot kilns and one 500-foot kiln were in operation.

Sand and gravel production was less than one-half of that in 1963. The Harry Zubik Company suction dredge sunk in a flood in March 1964. Completion of a highway project in the area also contributed to the drop in sand and gravel production. McGrady, Inc., was the leading producer.

Clay output was entirely for manufacturing building brick. Milliken Brick Co., Inc., the leading producer, mined shale near Wilkinsburg and Pitcairn. Boston Brick Company, Inc., was taken over by Glenn Lumber and Supply Co., Inc., North Bessemer.

A small quantity of dimension sandstone was quarried near Elizabeth and in Jefferson Boro. Pennsalt Chemicals Corp. recovered crude red iron oxide pigments from the red mud residue of a former aluminum reduction plant at Natrona. Perlite Manufacturing Co. (Carnegie) and the Panacalite Perlite Co. (Pittsburgh) produced expanded perlite from crude Colorado perlite, mainly for use in lightweight plaster and concrete. Clover Chemical Co. produced organic and inorganic iodine compounds from out-of-State crude iodine at a plant near Pittsburgh.

Armstrong.—Bituminous coal production increased mostly because of increased underground mining. The county remained seventh ranked in coal production in the State. Auger mining was significantly reduced; only 7 auger mines were active, compared with 13 in 1963. Of total output, 63 percent was from 43 underground mines, 34 percent was from 47 strip mines, and the balance was from 7 auger mines. Most of the underground output was mechanically loaded; four additional continuous mining machines were in use. Leading underground mining companies were Leechburg Mining Co., Canterbury Coal Co., and Allegheny River Mining Co. (both strip and underground). Strip producers were P. & L. Coal Co., West Freedom Mining Co. (two mines), and Snyder Coal Co. (auger and strip). Carpentertown Coal and Coke Co. was one of the larger auger-mining companies. Eight coal preparation plants cleaned about half of total output.

Production of sand and gravel was only about one-third of that produced in 1963. Output was mostly for building and paving aggregate. Universal Sand and Loam Co., Leechburg permanently closed its operation in 1964. Davison Sand & Gravel Co., the leading producer in 1963, moved its floating dredge on the Allegheny River to Westmoreland County.

Clay output, mostly fire clay for manufacturing firebrick and block, was greater than that of 1963. Eight clay mines were in operation in 1964. Freeport Brick Co. reported greatly increased output from its mine near Freeport. Howe Sound Co., Kittanning, and Kittanning Brick Co., Adrian, also produced fire clay. The latter company

installed a new mechanical loading machine in its underground mine.

Crushed limestone production was more than double that of 1963. Manor Minerals, Inc., a new producer, quarried and crushed limestone near Kittanning for concrete aggregate and roadstone. Four other limestone quarries were active; two were operated by Mowrey & Good near McWilliams and Girty. In addition to road building aggregate, crushed limestone for agricultural use (agstone) also was produced. C. D. McCanna produced hydrated agricultural lime at a plant near Kittanning.

Beaver.—Increased production of strip-mined coal offset sharply decreased output by auger mines and lower underground production. Most of the county coal output was from 12 strip mines producing mostly from the Lower and Middle Kittanning seams. Dodd's Coal Co. with two strip mines was the leading producer. The Ambrose strip mine of the Ambrosia Coal and Construction Co. received a Certificate of Achievement in Safety for working throughout 1964 without a disabling work injury.

Increased output of sand and gravel was reported to meet the demand of increased building activity. More than two-thirds of total output was building sand and gravel, most of the balance was consumed as paving aggregate. Iron City Sand and Gravel, the leading producer, operated a dredge on the Ohio River. Shippingport Sand & Gravel Co. also produced large tonnages at stationary plants near Georgetown and Shippingport.

Clay production was virtually the same as that of 1963. Four clay pits and three underground mines were in operation, producing mostly fire clay for building brick manufacture. Leading producers were Standard Clay Manufacturing Co. and Colonial Clay Products Co. operators of underground clay mines at New Brighton and Fallston, respectively. Another large producer was Darlington Brick Division, General Dynamics Corp., operators of an open-pit mine near Darlington, with output used for roofing granules.

Bedford.—Detwilers Industries, Inc., produced crushed sandstone for concrete aggregate and roadstone near New Enterprise. Leap Ganister Rock Co. did not quarry in 1964, but shipped sandstone for ganister from stockpile. New Enterprise Stone and Lime Co. produced crushed limestone chiefly for roadstone and coal mine rock dust at its Ashcom quarry near Everett. The company also produced a small quantity of hydrated lime.

Production of bituminous coal decreased 10 percent from that of 1963 because of reduced output from strip mines. Underground coal production increased slightly. The leading strip-mining companies were PBS Coals, Inc., and L. & B. Coal Co. The leading underground producer was G. M. & W. Coal Co. Feight Brothers produced a small quantity of building sand near Everett.

Berks.—Bethlehem Cornwall Corp. mined crude magnetite at its Grace mine near Morgantown. A concentrating plant at the mine recovered the iron ore by crushing, grinding, magnetic separation, and pelletizing of the fine-sized material. Pyrites (containing cobalt and copper) was recovered by flotation. The pyrite from this mine and the company's Cornwall mine in Lebanon County was shipped to a new sulfuric acid plant at Sparrows Point, Md. After roasting, the pyrite

cinder was leached to recover a concentrate containing cobalt and copper. This concentrate was shipped to Pyrites Co., Inc., at Wilmington, Del., for refining. Copper and cobalt metal and cobalt compounds were produced. This was the only cobalt metal production from a domestic primary source.

Allentown Portland Cement Co. produced portland and masonry cements at a plant near Evansville. Most of the output was non-air-entrained, general-use cement for sale mainly to ready-mixed concrete companies. Shipments were mostly by truck and railroad in bulk. Primary consuming States for the portland and masonry cement produced by the company were Eastern Pennsylvania, New Jersey, New York, and Connecticut. The company mined the cement rock and limestone needed for raw material. The cement mill had five kilns in operation, of which four were 160 feet, and one was 127 feet in length.

Crushed limestone produced by four companies remained virtually the same rate as in 1963. Allentown Portland Cement Co. operated quarries near Evansville and Oley; Eastern Lime Corp. quarried near Oley and Kutztown, producing limestone mostly for use in cement manufacture. The latter company also produced roadstone. E. J. Breneman, Inc., Sinking Spring, and Berks Products Corp., Temple, produced crushed limestone mainly for aggregate. Crushed oystershell was produced by Reading Poultry Food Co. for use as poultry grit and mineral food. The Oley No. 1 and No. 2 and Evans quarries received a Certificate of Achievement in Safety for operating through 1964 without a disabling work injury.

Three companies produced crushed basalt for sale mainly to the roadstone and railroad ballast markets. Producers were the John T. Dyer Quarry Co., Birdsboro; Bradford Hills Quarry, Inc., Morgantown; and Pottstown Trap Rock Quarries, Inc., Douglassville. Martin Quarries produced sandstone (crushed) for concrete aggregate and stone sand at a quarry near Bechtelsville.

Anthracite coal was mined at a higher rate than that of 1963.

Sand and gravel production decreased sharply. Refractory Sand Co., Inc., the leading producer in 1963, closed its plant in March 1964 because of reported unfavorable economic conditions. Schildt Brothers also closed its pit in 1964. Grings Quarry produced building and paving aggregate at a stationary plant near Sinking Springs. Glen-Gery Shale Brick Corp. mined shale at open-cut mines near Wyomissing and Shoemakersville for manufacturing building brick.

Blair.—Eight companies operated nine limestone quarries producing mostly concrete aggregate and roadstone. New Enterprise Stone & Lime Co. quarried and crushed limestone at its Roaring Springs and Canoe Creek stationary plants. Narehood Brothers, Inc., produced crushed limestone for concrete aggregate and agstone near Tyrone. Roadstone and asphalt filler were the markets of the crushed limestone produced by Grannas Brothers Stone & Asphalt Co., Inc., at Hollidaysburg. General Refractories Co. and J. L. Hartman produced crushed quartzite for ganister at Hollidaysburg and Sproul. C. E. Powell produced crushed quartzite, mostly for aggregate at Williamsburg.

Firebrick and fireblock was produced by Harbison-Walker Refrac-

tories Co. at Williamsburg from both purchased and mined clay. Four other clay mines in the county were idle in 1964. Four underground coal mines and one strip mine produced at a slightly lower rate than that of 1963. Frankstown Sand Supply produced building sand at a stationary plant near Hollidaysburg. West Virginia Pulp & Paper Co. regenerated lime at its pulp-and-paper plant for reuse in its manufacturing process.

Bradford.—Sand and gravel output almost doubled that of 1963. State Aggregates, Inc., assumed operation of J. A. Eck & Sons, Inc., in April. Towanda Sand & Gravel Co., Inc., reported increased production of building and paving sand and gravel at a stationary plant near Towanda.

Reduced bituminous coal production was reported by Paul Percival from his Sands Run strip mine.

Bucks.—Crushed limestone, entirely for paving aggregate and roadstone use, was quarried at four locations. Reduced prices for county output indicated increased competition. Leading producers were Eureka Stone Quarry, Inc., and New Hope Crushed Stone & Lime Co. with quarries at Eureka and New Hope, respectively. Crushed basalt was quarried at five locations at a rate more than one-fifth greater than that of 1963. Output was entirely for concrete aggregate and roadstone. Leading producers were General Crushed Stone Co., Quakertown; and Tohickon Quarry Co., Weisel. A small quantity of dimension basalt was quarried for rough construction uses. Dressed building dimension sandstone and flagging was quarried by Delaware Quarries at Lumberville. The company reported purchase of new trucks, improving its transportation facilities. George Wiley produced crushed sandstone (bluestone) near Point Pleasant for construction aggregate. Miscellaneous stone (argillite) was quarried and crushed by Better Materials Corp., Penns Park, and Gill Quarries, Inc., Trevose, for sale as roadstone. Better Materials Corp. installed new crushing equipment. Vernon Horn produced crushed granite near Chalfont for concrete aggregate and roadstone.

The county continued as the first ranked area in sand and gravel production in the State. Output was marketed almost equally for building and paving. Most of the production originated in Tullytown and Upper Black Eddy. The leading producer, by far, was the Warner Co. at the largest plant in the State, the Van Sciver plant near Tullytown. Other large producers were Penn Valley Crushed Stone Co., Levittown; and Durnan & Good, Upper Black Eddy.

Quakertown Brick & Tile Co., Inc., mined shale near Quakertown for manufacturing building brick. Hyzer and Lewellen produced exfoliated vermiculite near Southampton for use mainly in home insulation and as a lightweight aggregate.

Butler.—Bituminous coal production decreased because of reduced production from the 33 strip mines in the county, output from which comprised 82 percent of the total in 1964. Fourteen underground and 14 auger mines were in operation. Of total underground production about four-fifths was loaded mechanically. Equipment in use at the strip mine included 46 power shovels and 27 draglines. Seven of the draglines and two of the power shovels had dipper capacities ranging from 6 to 12 cubic yards. Most of the strip pro-

duction was in the Brookville and Middle Kittanning Coal seams. Sunbeam Coal Co. & Kerry Coal Co. (three mines) were the leading strip-mining companies; both also operated auger mines. Eagal Coal Co. was the leading underground mining company. Three cleaning plants prepared about one-fourth of total county output.

Portland and masonry cements were manufactured by Penn-Dixie Cement Corp. at a plant near West Winfield. Most of the output was typed for general use and moderate heat, with large quantities of both air-entrained and non-air-entrained. Ready-mixed concrete companies were the major consumers. The majority of shipments was in bulk by truck to consumers in the Western Pennsylvania area. The company produced the limestone and sand portions of its raw material requirements. Two 250-foot kilns, 10.5 feet in diameter, were in use.

Limestone production in the county in excess of 1 million tons was quarried by five companies. Road building and cement manufacture were the principal markets. Some agstone, riprap, and flux was sold. The three larger quarries were operated by Allegheny Mineral Corp., Harrisville; Penn-Dixie Cement Co., West Winfield; and Sechan Limestone Co., Portersville. Secondary crushing facilities were improved by Winfield Lime & Stone Co., Inc. Annandale Sandstone Co. produced sandstone riprap and architectural dimension stone near Boyers. The West Winfield mine of Penn-Dixie Cement Corp. received a Certificate of Achievement in Safety in the nonmetal group for working throughout 1964 without a disabling work injury.

Sand and gravel mainly for building and paving aggregate was produced at three stationary plants. H. W. Cooper and Highway Sand & Gravel Co., Inc., both operated plants near Slippery Rock. Mercer Lime & Stone Co. produced mainly quicklime near Branchton, mostly for consumption in steel furnaces. A significant tonnage also was sold for water purification. Shale was mined at an open cut near Mars by Scott Borland Brick Yard for building brick manufacture.

Cambria.—The county ranked third in bituminous coal production, having an output of 8.7 million tons, 1.8 million tons more than that of 1963. Of total output, 87 percent was mined at 87 underground operations; 12 percent at 20 strip mines; the balance at 6 auger mines. At the underground mines, 92 continuous miners were in use, 6 more than in 1963. The county tied with Greene County in number of active continuous mining machines. Most of the underground output was mechanically loaded. Of total output, more than three-fourths was cleaned at 11 preparation plants. Most of the county production was from the Upper and Lower Kittanning and Freeport coal seams. Leading underground coal producers were Bethlehem Mines Corp. (five mines), Barnes & Tucker (three mines), and Eastern Associated Coal Co. Major strip mining companies were North Cambria Fuel Co., C. E. Powell Coal Co., and Ace Drilling Co. (also a leading auger-mining company).

Triangle Clay Products Co. mined miscellaneous clay at an open cut near Johnstown for building brick. North Cambria Fuel Co. recovered fire clay from coal strip pits, and George P. Gates operated an underground mine at Patton to produce fire clay for sale to Patton Clay Manufacturing Co. chiefly for manufacturing vitrified sewer

pipe. Triangle Clay Products Co. purchased new equipment and paved its stocking areas. Crushed sandstone for construction aggregate was produced by the Appalachian Stone Division, Martin Marietta Corp. and sand and gravel was produced by Parry Sand & Gravel Co. for construction uses; both operations were near Johnstown.

Lanzendorfer Minerals Co. produced sulfur mud for yellow iron oxide pigments at an operation near Nanty Glo.

Cameron.—Rydesky Mines, the only bituminous coal mining company in the county in 1964, operated a strip mine in the Lower Kittanning seam.

Carbon.—Anthracite coal production decreased from 645,000 tons in 1963 to 501,000 tons in 1964. The leading producers were Lehigh Valley Anthracite, Inc., and Greenwood Stripping Corp.

North American Refractories Co. produced captive crushed quartzite near Palmerton for ganister. Fauzio Bros. produced crushed sandstone near Nesquehoning for aggregate and for sale to cement companies. Alliance Sand Co., subsidiary of Martin Marietta Corp., produced building and paving sand and sand for sale to cement manufacturers at a stationary plant near Palmerton. Building sand and gravel was produced near Hazleton. The Prince Manufacturing Co. finished mostly natural red iron oxides and pyrite cinder near Bowmanstown for use as iron oxide pigments.

Centre.—The county continued as the leading lime producing area. High calcium lime was produced mostly for chemical and industrial uses, chief among which was use in steel furnaces. Other large chemical and industrial uses were for pulp and paper, water purification, tanning, and chromium chemical manufacture. Producers were Warner Co. and National Gypsum Co., both of Bellefonte and Standard Lime & Cement Co., Division Martin Marietta Corp., Pleasant Gap. A large portion of the lime output was consumed within the State.

Crushed limestone for captive use in lime manufacture was the leading use in 1964. However, significant quantities also were produced for concrete aggregate and roadstone. Other uses included glass manufacture, rock dust for coal mines, flux, and stone sand. Total output was almost 2.5 million tons. Leading producers were Warner Co. and National Gypsum Co., both at Bellefonte; and Appalachian Stone Division, and Standard Lime & Cement Co., both divisions of Martin Marietta Corp. at Pleasant Gap. For the fourth consecutive year the Bellefonte mine of National Gypsum Co. won the famed Sentinel of Safety trophy granted to that company among all the quarrying companies having the lowest lost-time injury rate (based on the most man-hours).

The Pleasant Gap Mine of Standard Lime & Cement Co. received a Certificate of Achievement in Safety for working throughout 1964 without a disabling work injury. The Warner Co. and National Gypsum Co. both performed exploration and development work and improved mining systems at their underground mines.

Coal production dropped 21 percent because of significantly reduced strip-mined tonnage, which comprised 91 percent of total output. Leading producers were Elliott Coal Mining Co. and Wasson, Inc., at strip mines; Holden, Finberg and Finberg, at underground mines;

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and R. S. Carlin, Inc., at auger mines. The Carlin No. 6 strip mine of R. S. Carlin, Inc., received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury. Plastic fire clay for manufacturing firebrick and block was mined by Harbison-Walker Refractories Co. at its Blair opencut mine near Stormstown. A new fire-clay pit was put into production by Reese Brothers Coal Co. near Osceola Mills. Output was sold for firebrick and block.

Chester.—Crushed limestone production was slightly more than that of 1963, but total value increased significantly as sharply increased prices in certain stone markets were reported. Most of the output was for concrete aggregate and roadstone. Other uses included blast- and open-hearth furnace flux, lime manufacture, and magnesium metal manufacture. Limestone producers were Bradford Hills Quarry, Inc., Downington; Warner Co., Paoli and Devault; and Appalachian Stone Division, Martin Marietta Corp., Malvern. Warner Co. reported installation of new screening equipment. Basalt was quarried and crushed for roadstone by V. Di Francesco & Sons, Devault; and Keystone Trappe Rock Co., Cornog. The latter company also produced railroad ballast. French Creek Granite Co. quarried dimension basalt near St. Peters, mostly rough blocks for architectural use. Dimension sandstone (bluestone) mostly for rough construction and rubble was quarried, mostly in the Avondale vicinity. Valley Forge Building Stone Co. (formerly Frank Rarick) was the leading producer.

The Warner Co. produced high-magnesium lime at its Cedar Hollow Plant near Devault for mason's lime, sewage treatment, and agricultural uses. Clay and shale was mined by McAvoy Vitrified Brick Co. at an opencut mine near Phoenixville for building brick manufacture.

Clarion.—Coal production was 14 percent less than that of 1963, but the county retained its second ranking in strip mining among the coal-producing counties. Most of the production loss was attributed to a 500,000 ton reduction in strip output, which comprised 96 percent of output. Twenty-seven strip mines, five less than in 1963, were in operation, mostly in the Clarion and Lower Kittanning seams. Two continuous mining machines loaded most of the underground production, and 61 power shovels and 38 draglines were in use at the strip mines. Of the draglines in use, 18 had dipper capacities of 6 to 12 cubic yards, and 3 had capacities greater than 12 cubic yards. Leading strip and auger producers were C. & K. Coal Co., Allison Engineering Co., and Mac Coal Co. The largest underground mine was operated by D. & J. Coal Co. Six cleaning plants prepared 82 percent of total output.

Plastic and flint fireclay was mined underground by Climax Division, A. P. Green Fire Brick Co. for its own use in producing firebrick and block. New Bethlehem Tile Co. mined both fire clay and miscellaneous clay for building brick at an opencut mine near New Bethlehem. Kaiser Refractories and Chemicals Division, Kaiser Aluminum and Chemical Corp. was idle in 1964.

Allegheny Mineral Corp. (Parker) and Emlenton Limestone Co. (Turkey City) produced crushed limestone mostly for aggregate.

Increased sand and gravel output was reported by the Glacial Sand & Gravel Co. from a stationary plant near Parker. Fill and antiskid material also was produced.

Clearfield.—The county ranked fourth in total coal production and first in both strip and auger mining. There were 169 mines in operation of which 92 were strip, 60 were underground, and 17 were auger. Six fewer underground mines were active, and underground tonnage dropped 12 percent. Auger-mining activity sharply increased with nine new operations contributing to output more than 2½ times greater than that of 1963. Strip production of 6.1 million tons comprised 84 percent of total output. At the strip mines, 176 power shovels and 96 draglines removed overburden or loaded coal, almost three times more equipment than in the next ranking county. Most of the output was from the Kittanning and Freeport seams. Twenty of the strip mines produced more than 100,000 tons. Benjamin Coal Co. was the leading strip and auger mining company. The leading underground mine was operated by Lady Jane Collieries, Inc. Twelve cleaning plants prepared 40 percent of total output. The Last Run No. 1 mine of the Diamond T. Strip Mining Corp. received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

The county dropped to second place in clay production with output of 435,000 tons of clays. There were 21 mines in operation producing mostly fire clay for firebrick and fireblock and other refractory products. Harbison-Walker Refractories Co. consumed both purchased fire clay and fire clay of its own production to produce firebrick and fireblock. Augenbaugh Coal Co., Inc., Curwensville, and Bartell Excavating, Inc., Boardman, sold large quantities of fire clay to refractory product manufacturers. Falls Creek Refractories Co. and Blair Clay Products, Inc., both of Curwensville, produced and consumed significant quantities of fire clay.

Applachian Stone Division, Martin Marietta Corp. operated a stationary sand and gravel plant near Curwensville, output being used for building and paving aggregate.

Clinton.—Bituminous coal production was virtually the same as that of 1963. Almost all the output was from seven strip mines, three more than in 1963. Only two small hand-loading underground mines were active. The leading strip producer was D. G. Wertz Coal Co. Strip output was mostly from the Lower and Middle Kittanning seams. The Garden Coal Co. received a Certificate of Achievement in Safety for operating its strip-coal mine throughout 1964 without a disabling work injury.

Lycoming Silica Sand Co. produced crushed limestone at Salona for road construction. Mill Hall Clay Products, Inc., produced heavy clay products from shale mined by Lee Bowman, contractor. Flint fire clay mined at two small pits, was sold mainly to high-alumina brick manufacturers.

Columbia.—Anthracite coal production was more than twice that produced in 1963. The leading producer was Jeddo-Highland Coal Co.

Building brick was manufactured by The Alliance Clay Product Co. from shale mined near Mifflinville. Building and paving sand pro-

duced by Bloomsburg Sand & Gravel Co., Inc., was processed at a stationary plant near Bloomsburg. Benton Peat, Inc., produced moss and humus peat from a bog near Benton for sale mostly for general soil improvement.

Crawford.—Sand and gravel production, mostly for paving aggregate was produced at a reduced rate from three stationary plants. Producers were Hasbrouck Sand & Gravel Co., Titusville; W. L. Dunn, Cochranton; and Conneaut Lake Sand & Gravel, Inc., Conneaut Lake.

Cumberland.—Slackened construction activity in 1964 was reflected by a significant drop in crushed limestone production, particularly in the area near Shippensburg. Five quarries were in operation producing mostly concrete aggregate and roadstone. Hempt Bros., Inc., Camp Hill, the leading producer also was the leading producer of sand and gravel. Both commodities were for the paving aggregate market. C. & L. Goodhart produced masonry sand near Walnut Bottom. Philadelphia Clay Co. mined kaolin near Mt. Holly Springs for sale to manufacturers of white cement.

Dauphin.—Crushed limestone was produced mainly for aggregate and for blast-and-open-hearth furnace flux. Hempt Bros., Inc., took over operation of the Bethlehem Steel Co. Steelton plant. Other producers were H. E. Millard Lime & Stone Co., Palmyra, and George E. Ebersole & Sons, Hummelstown. Faylor Lime & Stone Co. quarried and crushed increased tonnages of basalt for concrete aggregate and roadstone. Gangloff Bros. was the leading anthracite producer in the county.

Anthracite was produced at virtually the same rate as in 1963. H. E. Millard Lime & Stone Co. produced high-magnesium lime at its Swatara plant near Annville, mostly for agricultural use. Output of sand and gravel by Pennsy Supply, Inc., at its Amity Hill plant, was almost three times that of 1963. New roadbuilding activity in the area was the principal reason for the large increase in production. Glen-Gery Shale Brick Corp. mined captive shale at opencuts near Middletown and Harrisburg for building brick manufacture.

Delaware.—Media Quarry Co. quarried dimension sandstone near Media for rough construction and architectural uses and for rubble. V. Di Francesco & Sons quarried and crushed basalt at the Llanerch and Freeboro quarries for sale mostly to roadbuilding contractors. General Crushed Stone Co. quarried basalt mostly for the aggregate market at the Glen Mills quarry. The county was the leading basalt-producing area in the State. Mica schist for a rough building stone was quarried by Carl Galantino, Inc., Marple; F. Cantano & Sons, Broomall; and Di Bonaventura Quarries Inc., Springfield. Dimension granite was quarried by Joseph F. Faccenda and The Lima Building Stone Quarry, Inc., near Swarthmore and Lima, respectively. The Llanerch quarry of V. Di Francesco & Sons Co. received a Certificate of Achievement in Safety for working throughout 1964 without a disabling work injury.

Perlite Products Co. processed crude Colorado perlite at a plant near Primos and produced expanded perlite for sale chiefly as lightweight plaster aggregate. Sinclair Refining Co. and Sun Oil Co.

recovered sulfur in the liquid purification of oil refinery gas at Marcus Hook.

Elk.—Bituminous coal production was more than 200,000 tons less than that of 1963. The loss was attributed to sharply reduced strip- and auger-mined tonnage. The leading underground-mining company was the Blue Valley Coal Co. The larger strip-mining companies were P. & N. Coal Co., Inc.; Smith & Rogus Coal Co.; and Blusea Coal Co. Output was mostly from the Lower Kittanning and Lower Freeport seams.

Clark Construction Co. produced crushed sandstone near Johnsonburg for construction aggregate. Paving gravel was produced by Stone Haven Mix from a portable plant near Johnsonburg. Artificial graphite was produced by Speer Carbon Co., Division of Air Reduction Co., Inc., at a plant near St. Mary's for shipment to Niagara Falls, N.Y., for further processing. The processed material was sold to steel and chemical companies for use as graphite electrodes and anodes.

Erie.—The county advanced from third to second rank among State sand and gravel producing counties. Erie Sand Steamship Co. was the leading producer with output of more than 1 million tons. The company operated a dredge on Lake Erie and produced mostly building sand. Nickel Plate Sand & Gravel Co. produced a wide variety of specialized sand and gravel products and also bank-run fill gravel. All told, seven companies were active in 1964.

Donald L. Wenner did not operate his sandstone quarry in 1964. Corry Peat Products Co. produced mostly reed-sedge peat for general soil improvement.

Fayette.—Bituminous coal production increased 22 percent from that of 1963. Of total output, 71 percent was from 24 underground mines; the balance was from 26 strip mines. There was no auger production in 1964. In use at the underground mines were 14 continuous mining machines (3 more than 1963). Ninety-four percent of the underground production was loaded mechanically. Four cleaning plants were in operation. Underground output was mostly from the Pittsburgh and Lower Kittanning seams, and strip production was from the Pittsburgh Redstone and Sewickley seams. Leading underground mining companies were National Mines Corp. and Eastern Associated Coal Co. Leading strip mine operators were Bridgeview Coal Co. and Purco Coal Co.

Connellsville Blue Stone Co. produced crushed sandstone (bluestone) near Connellsville for sale as construction aggregate. General Refractories Co. produced ganister from quartzite quarried near Layton. A small quantity of sandstone rubble also was produced. Appalachia Stone Division, Martin Marietta Corp. produced crushed limestone at quarries near Uniontown and Lake Lynn. Output was significantly less than that of 1963.

Harbison-Walker Refractories Co. and Kaiser Refractories and Chemicals Division, Kaiser Aluminum & Chemical Corp., mined fire clay at the Smith and Ohiopyle opencut mines near Ohiopyle for firebrick and fireblock manufacture. Layton Fire Clay Co. mined miscellaneous clay for building brick and purchased fire clay from Robert N. Matthews for firebrick and fireblock manufacture.

McClain Sand Co., Inc., continued operating a dredge on the Monongahela River near Point Marion and produced sand and gravel for building and paving aggregate.

Forest.—Tionesta Sand & Gravel, Inc., produced building and paving sand and gravel from a stationary plant near Tionesta at virtually the same rate as that of 1963.

Franklin.—Crushed limestone production by three companies at five quarries was less than that of 1963, because of reduced consumption of roadbuilding aggregate. Valley Quarries, Inc., quarried limestone at two locations, Chambersburg and at Shippensburg; the latter site was formerly owned by Pinola Lime & Stone Corp. Other producers were Appalachia Stone Division, Martin Marietta Corp. with quarries near Zullinger and Williamson, and New Enterprise Lime & Stone Co., at Dry Run.

Building sand was produced at stationary plants near Fayettesville by Mt. Cydonia Sand Co., Inc., and Caledonia Sand Co. Output was virtually at the same rate as that of 1963.

Fulton.—H. B. Mellot Estate, Inc., installed additional equipment and sharply increased production of crushed limestone mainly for aggregate at its Morton and Charlton quarries and also produced building and paving sand near Warfordsburg.

Greene.—The county with 11.6 million tons of output ranked second among the 29 bituminous coal producing counties in the State. Virtually the entire output was from 26 underground mines operating in the Pittsburgh coal seam. Output was almost 2 million tons greater than that of 1963. Nine strip mines also were active. Underground production which increased 20 percent was to a great extent loaded by 92 continuous mining machines. United States Steel Corp. had 48 continuous miners in operation. Most of the total coal output was mechanically cleaned, a significant portion in Fayette County. Leading producers (all underground mines) were United States Steel Corp. (four mines), Gateway Coal Co., Jones & Laughlin Steel Corp., Duquesne Light Co., and the Buckeye Coal Co.

Clay and shale were mined by Greene County Clay Products Co., Inc., at an opencut mine near Waynesburg for its own use in manufacturing building brick.

Huntingdon.—Pennsylvania Glass Sand Corp. produced a wide range of industrial and ground sands at its Keystone Works near Mapleton Depot. Glass sand was the leading market. The high value of the company product ranked the county second in value of production, even though it ranked fifth in tonnage output.

Crushed limestone was produced at virtually the same rate as that of 1963. Warner Co. quarried and crushed limestone at its Union Furnace facility near Tyrone, and New Enterprise Stone & Lime Co. did the same at its McConnellstown operation. Output was mostly for concrete aggregate and roadstone. North American Refractories Co. produced mostly refractory stone from quartzite quarried near Three Springs. Alexandria Fire Clay Co. mined plastic fire clay near Alexandria for sale to refractory mortar producers. A small quantity of bituminous coal was mined at two strip mines and five small underground mines operating mostly in the Kelly and Fulton seams.

Indiana.—Production of bituminous coal decreased slightly but the

county remained fifth ranking in output. Of the 5.5 million tons produced, 86 percent was mined at 71 underground operations; the balance at 26 strip and 2 auger mines. Seven more continuous miners were in operation making a total of 47. Of underground production, 95 percent was loaded mechanically, and of total production, 72 percent was mechanically cleaned at 12 cleaning plants—3 more than in 1963. Most of the coal production was from the three Kittanning and two Freeport seams. Leading underground mining companies were Rochester & Pittsburgh Coal Co. (two mines) and Crichton Coal & Coke Co. The larger strip mining companies were Taylor Bros. and Mears Coal Co. (two mines)

Plastic fire clay was mined by Hiram Swank's Sons, Inc., and by L. H. Foehrenbach, near Clymer (sold to Hiram Swank's) for use in manufacturing a variety of clay refractory products.

Jefferson.—Bituminous coal production increased slightly from that of 1963. Of the 1.9 million tons produced, 58 percent was mined at 25 strip mines; 37 percent, at 25 underground mines; the balance, at 8 auger mines. Strip-coal production decreased, but both underground and auger production increased. The county ranked third in auger mining. Of underground production, 96 percent was mined mechanically. Five continuous miners were in use; one less than in 1963. Equipment used at strip mines included 48 power shovels and 17 draglines; four had bucket capacities between 6 and 12 cubic yards. Leading underground producers were Doverspike Bros. Coal Co. and United Industries, Inc.; strip producers were R. D. Baughman Coal Co., Inc. (three mines). The latter company and P. & N. Coal Co. operated the largest auger mines. Coal seams mined were the Lower and Middle Kittanning and the Lower Freeport. The Cherryhill No. 1 underground mine of Imperial Coal Corp. received a Certificate of Achievement in Safety for working throughout 1964 without a disabling work injury.

Plastic fire clay was mined near Summerville by Hanley Co. for building brick manufacture. The Brockway Clay Co. produced fire clay from one underground and strip mines near Brockway for manufacturing vitrified sewer pipe. Flint fire clay was mined and sold by Henry O'Neill & Co. to firebrick and fireblock manufacturers. Sugar Hill Limestone Co. produced crushed limestone at Brockway chiefly for sale as agstone. Bank-run paving gravel was produced near Brockway.

Juniata.—Increased highway construction in the area brought about a large increase in output of crushed limestone by Juniata Limestone Co., McAlisterville. Agricultural quicklime was produced by Fulkroad Lime Quarry near McAlisterville.

Lackawanna.—Moffat Coal Co., Inc., and Carbondale Coal Co., Inc., were among the larger anthracite producers in the county. Output in 1964 was 920,000 tons, almost 40,000 tons less than that of 1963. Stabler Construction Co. produced sandstone aggregate from a quarry near Scranton. Contractors Sand & Gravel, Inc., operated an open pit and a stationary plant near Moscow, and produced building and paving sand and gravel, much of which was used in ready-mixed concrete. Two other pits were active, yielding mostly paving sand

and gravel. Packaged reed-sedge peat was sold by Lake Linda Peat Co., Inc., from crude peat mined at a bog near Dalton.

Lancaster.—The county was fifth ranked in the State in limestone production with large crushed limestone output mostly for concrete aggregate and roadstone. Significant tonnage of agstone also was produced. Seventeen quarries were active in 1964; 13 produced more than 100,000 tons. The leading producers were Ivan M. Martin, Inc., Blue Ball; D. M. Stoltzfus and Son, Inc., Talmage and Quarryville; and A. G. Kurtz & Sons, Inc., Denver. Total output was slightly less than that of 1963. Equipment installations during the year included new conveying, screening, and storage facilities by David M. Burkholder, Inc., and a new primary crusher by A. G. Kurtz & Sons, Inc.

Anthracite was dredged from the Susquehanna River. Output was at virtually the same rate as in 1963. Building or paving sand and a small quantity of fire or furnace sand was produced. Four pits were in operation; the largest was Milton Grove Sand, Inc., operators of a stationary plant near Milton Grove.

Building brick was produced by Glen-Gery Shale Brick Corp. and Lancaster Brick Co. from shale or clay mined near Ephrata and Lancaster, respectively. Narvon Mines, Ltd., operated an opencut mine near Narvon, producing plastic fire clay for sale mostly as a mineral filler. The company reported a major plant renovation in 1964. Amos K. Stoltzfus produced agricultural quicklime near Elverson.

Lawrence.—Bessemer Cement Co., Division of Diamond Alkali Co. and Medusa Portland Cement Co. produced portland and masonry cement at plants at Bessemer and Wampum, respectively. Air-entrained for general use was the principal cement type produced. Most of the shipments were made in bulk by truck chiefly to ready-mix concrete companies. The leading consumers were located in Eastern Ohio and Western Pennsylvania. Both companies quarried the shale and stone raw material. Six kilns were in operation in 1964, of which two were 390 feet in length, one was 450 feet, and three were 235 feet. Bessemer Cement Co. replaced a mill in its slurry grinding department and a finished mill in its cement grinding department. Bessemer Cement Co. and Medusa Portland Cement Co. received Certificates of Achievement in Safety for operating throughout 1964 without a disabling work injury.

The county was third ranked in limestone production, having an output of almost 3.2 million tons. United States Steel Corp. was the largest producer, reporting output of crushed stone for blast-furnace flux greatly exceeding that of 1963. In addition to the limestone produced by the cement companies, New Castle Lime & Stone Co. produced rock dust, filler, and aggregate.

The county replaced Clearfield County as the leading producer of clays. Ralph A. Veon, Inc. (Enon Valley) produced the largest amount of clay, with output of plastic fire clay for sale to building-brick and vitrified-sewer-pipe manufacturers and to foundries. The company acquired new mining equipment in 1964. Metropolitan Brick, Inc., mined plastic fire clay and shale near Bessemer for building brick. The Negley Fire Clay Co. mined plastic fire clay for refractories and building brick near New Galilee.

Bituminous coal production dropped 6 percent, compared with that

of 1963. Most of the output was from 19 strip mines, 2 less than 1963. Output mainly was from the Lower and Middle Kittanning seams. Ambrosia Coal and Construction Co. (four mines) and R. A. Veon, Inc., were leading strip-coal producers. Only one small underground and two small auger mines were in operation in 1964.

Production of sand and gravel, most of which was sold as building and paving aggregate, was less than that of 1963. Mahoning Valley Sand Co. was the leading of three producers, operating a stationary plant near West Pittsburg. General declining construction activity was reported in this area. Reed-sedge and humus peat was recovered by D. M. Boyd and Moores Humus and Nursery from bogs near New Wilmington and Washington, respectively. Output was sold entirely in bulk form for soil conditioning. Zonolite Co. produced exfoliated vermiculite at its Ellwood City plant for use chiefly as loose-fill insulation.

Lebanon.—Bethlehem Cornwall Corp. mined magnetite iron ore at Cornwall and processed the crude ore at its Cornwall concentrator. The magnetite was recovered by crushing, grinding, magnetic separation, and agglomeration. Valuable byproducts recovered by flotation were gold and silver, copper, pyrite, and cobalt. The No. 3 mine of Bethlehem Cornwall Corp. received a Certificate of Achievement in Safety in the metal group for operating throughout 1964 without a disabling work injury.

Increased production of crushed limestone was reported in the county. Most of this increase was attributed to increased sales of blast- and open-hearth furnace flux. Larger limestone consumption by cement companies, both purchased and captive, was reported. Leading limestone producers were H. E. Millard Lime & Stone Co. and Calcite Quarry Corp., both of Lebanon; and Fiala, Inc., Annville. The former company reported installation of additional limestone grinding and screening facilities. The company also produced high calcium lime near Annville mostly for sale to steel companies. Other uses were for water purification, mason's lime, and agriculture. The company did not operate its Palmyra plant in 1964. The leading anthracite mining company was Talbot Realty Co., Inc. County anthracite production was 31,000 tons, compared with 44,000 tons in 1963. Whitmoyer Laboratories, Inc., consumed crude iodine in manufacturing iodine compounds at a Myerstown plant.

Lehigh.—Sphalerite (zinc sulfide), mined and concentrated at the Friedensville mine, was shipped to a smelter at Palmerton for recovery of zinc metal.

Four cement companies were in operation in 1964, and all shipped more than 1 million barrels of portland cement. Producers were Whitehall Cement Manufacturing Co., Cementon; Giant Portland Cement Co., Egypt; Lehigh Portland Cement Co., Fogelsville; and Coplay Cement Manufacturing Co., Coplay. Shipments were largely in bulk by truck to ready-mixed concrete companies and concrete product manufacturers. The major portion of shipments was of the general use, non-air-entrained type to consumers in New Jersey, eastern Pennsylvania, New York, and Connecticut. Twenty-eight kilns were in operation. The Whitehall Cement Mfg. Co. put a new large kiln in operation and discontinued operating six smaller kilns

late in 1964. The company made large-scale improvements to its plant, replacing equipment and increasing capacity. Cement manufacturing companies produced captive limestone. Concrete aggregate and roadstone were the chief markets for the limestone produced by Eastern Lime Corp., Stiles; Lehigh Stone Co., Armrod; and Roy J. Kern, Schnecksville. New Jersey Zinc Co. processed waste limestone rock from its Friedensville mine for sales chiefly as agstone. Total limestone production was 2.5 million tons, an increase of 200,000 tons from that of 1963. Roy J. Kern increased crushing facilities and Lehigh Stone Co. installed a classifier at its washing-screening plant. The Reliance "B" quarry of Giant Portland Cement Co. and Quarry No. 8 of Coplay Cement Manufacturing Co. received a Certificate of Achievement in Safety for operating throughout the year without a disabling work injury.

Penn Big Bed Slate Co., Inc., quarried dimension slate near Slatedale mostly for structural and sanitary use, and for blackboards. The company had fire damage to its plant in 1964, but replaced the burned building and equipment and was back in operation without a great loss of operating time. Pennsylvania Perlite Corp. produced expanded perlite at its Allentown plant for use in lightweight plaster and in cryogenics.

Luzerne.—The county continued as first ranking area in anthracite production with output of 6 million tons, a significant reduction from the 6.8 millioin tons produced in 1963. Leading producers were Glen Alden Corp., Susquehanna Coal Co., Jeddo-Highland Coal Co., George Rancho, and Hudson Realty Co., Inc.

Crushed sandstone, chiefly for construction aggregate, was produced by Coolbaugh Sand & Stone, Inc., Dupont; General Crushed Stone Co., White Haven; and American Asphalt Paving Co., Shavertown. Output was less than that of 1963. Significantly increased production of sand and gravel was reported. Both sand and gravel shared in the increase. All six producers operated stationary plants, and 100 percent of output was processed. Leading producers were J. A. & W. A. Hess, Inc., Nescopeck; Airport Sand & Gravel Co., Inc., Wyoming; Frank B. Sgarlat Sand & Gravel Co., Forty Fort; and Honeyhole Sand & Stone Co., Hazleton.

The county was the leading peat-producing area in the State. Four producers mined and sold peat, mostly humus and reed-sedge in bulk, for general soil improvement. Producers were Bald Mountain Peat Corp., Wilkes-Barre; and Blue Ridge Soil Pep Co., Inc.; Pennsylvania Peat Moss, Inc.; and Stillers Blue Ridge Peat Co., all near White Haven.

Hazleton Brick Co. mined shale for building brick at an opencut mine near Hazleton. Bylite Corp. reclaimed shale from a coal refuse bank for lightweight aggregate production. Hazleton Brick Co. reported increasing its manufacturing facilities.

Lycoming.—Lycoming Silica Sand Co., operator of limestone quarries near Jersey Shore and Muncy, in 1964 purchased the Susquehanna Quarry Co. Jersey Shore Limestone quarry but did not operate the plant. Output of these quarries was chiefly for road construction. Some agstone also was sold. The company also operated a stationary sand and gravel plant near Montoursville producing building and

paving aggregate, railroad ballast, sub-base fill, and smaller quantities of engine and molding sand.

Strip-mined coal production showed a sharp increase from that of 1963. Industry in the county, however, was small; only three strip operations and one small underground mine were active. The larger strip mines were operated by Fisher Mining Co. and Paul Percival. Small quantities of sandstone rubble and flagging were quarried.

Keystone Filler & Manufacturing Co. and Penn Paint & Filler Co. mined tripoli (rottenstone) near Muncy and Antes Fort, respectively, for sale as a filler and abrasive material. The former company also produced crushed slate flour near Muncy.

McKean.—Wetmore Coal Co., the only coal producer, stripped the Lower and Middle Kittanning seams. Kane Stone Co. produced mostly aggregate material at a sandstone quarry near Kane and C. L. McGavern, Jr., produced bank-run fire or furnace sand from a pit near Eldred. Shale for building brick was produced at an opencut mine near Lewis Run by Hanley Co.

Mercer.—Bituminous coal production by 11 strip mining companies was 40 percent less than that of 1963. No underground or auger mines were in operation. The entire coal output was from the Brookville seam. One mechanical cleaning plant was in operation. The larger strip-mining companies were Buckeye Coal Co., Miller & McKnight, and Pengrove Coal Co. Equipment at strip mines included 11 power shovels and 8 drag lines, 4 of which had dipper capacities between 6 and 12 yards.

Sand and gravel production was more than twice that of 1963. Atlas Sand & Gravel, Inc., reported production for the first time. The product was used mainly for building and paving material. Other producers were Seidle Sand & Gravel Co., Mercer; Transfer Sand & Gravel Co., South Pymatuning Township; and Taylor Sand & Gravel Co., Big Bend. Sandstone for a variety of uses was produced by White Rock Silica Sand Co. at its Greenville quarry. Arthur J. Cobbie quarried dimension sandstone near Leesburg.

Mifflin.—Pennsylvania Glass Sand Corp. produced valuable industrial sand at its Hatfield works near McVeytown. Grinding and polishing, glass, and engine sands were the principal products. Two other sand and gravel pits were in operation producing construction sand and paving gravel.

Crushed limestone production in the county served the road construction and the iron and steel industries. Bethlehem Limestone Co. quarried limestone at its Naginey quarry, mostly for use as fluxing stone but also for aggregate use. Burkeholder & Burkeholder, acting as subcontractor for Wright Construction Co., produced crushed limestone for road construction from a large limestone cut at Milroy. Six limestone quarries were active in 1964; two more than in 1963. Agriculture was the chief use for the lime produced by Honey Creek Lime Co., Reedsville, and Ehrenzeller Lime Co., McVeytown. Haws Refractories Co. produced crushed quartzite for ganister near Hawstone.

Monroe.—Hamilton Stone Co., Inc., produced crushed limestone for roadstone and for sale to cement companies at a quarry and stationary plant near Bossardsville. Building sand and gravel, mainly for use

in ready-mixed concrete, was produced at stationary plants by Javelyn Mobile Mix, Inc., Stroudsburg, and Sheesley Minerals, Inc., Kunkletown. White clay was produced for cement manufacture at Kunkletown by Universal Atlas Cement Division, United States Steel Corp.

Montgomery.—Crushed limestone production increased to 3.3 million tons, 13 percent more than that of 1963. The county was second ranked in production of limestone. Increased consumption of flux for the iron and steel industry brought about increased captive output by Bethlehem Limestone Co., Bridgeport, and greater sales by G. & W. H. Corson, Inc., at Plymouth Meeting. These companies also produced construction aggregate, and the latter sold some of its production for magnesium metal manufacture and a variety of chemical uses. The Plymouth Meeting quarry of G. & W. H. Corson, Inc., received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Allentown Portland Cement Co. manufactured portland and masonry cement at a plant in West Conshohocken. Output was entirely for general use and moderate heat cement. Eastern Pennsylvania and New Jersey were recipients of the major portion of company cement shipments. Three kilns were operated. The company quarried its limestone requirements. A production shutdown of 60 days was reported during 1964. Mignatti Construction Co., Inc., produced mostly crushed granite for construction aggregate and a small quantity of dimension granite near Bethayres. Montgomery Stone Co., Inc., produced both dimension and crushed basalt at its quarry near Montgomeryville. R. K. Kibblehouse and Pottstown Trap Rock Quarries, Inc., produced crushed basalt for aggregate at Perkiomenville and Sanatoga, respectively. Crushed argillite was produced by Gill Quarries, Inc., at quarries near Spring House and Norristown and by M & M Stone Co., Inc., Harleysville. A small quantity of rough construction dimension mica schist also was produced. Firestone Products Co., Inc., quarried dimension quartzite near Glenside for refractory uses (furnace linings), rubble, and a small tonnage of crushed sandstone. The Harleysville quarry of M & M Stone Co. received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Mason's lime was by far the leading market for the output of the G. and W. H. Corson lime plant at Plymouth Meeting. Shale was mined near Trappe by the Philadelphia Brick Co. for heavy clay products and by The Robinson Clay Product Co. near Pottstown for vitrified sewer pipe. Common clay for flowerpots was produced by The Keller Pottery Co., North Wales. Refractory and Insulation Corp. produced expanded perlite at its Port Kennedy plant for a variety of filler and insulation uses. A small quantity of building sand was produced at a stationary plant near Norristown.

Montour.—Mausdale Quarry Co. produced crushed limestone for roadstone near Danville, and Lycoming Silica Sand Co. produced roadstone and agstone at a quarry near Milton. Sand and gravel for construction was produced by Thomas Sand & Gravel Co. at a stationary plant near Danville.

Northampton.—The county remained as first ranked in cement production with 10 plants in operation, shipping almost 18 million bar-

rels of portland cement. All but three of the companies also produced masonry cement. More than 900,000 barrels of masonry cement were shipped. The larger of the producing companies in order of shipments were Keystone Portland Cement Co., Bath; Universal Atlas Cement Division, United States Steel Corp., Northampton; Hercules Cement Co., Division of American Cement Corp., Stockertown; Nazareth Cement Co. and Lone Star Cement Corp., Pennsylvania Division, both of Nazareth. Ready-mixed concrete companies consumed the greatest portion of cement shipments and concrete product manufacturers also consumed significant quantities. Shipments were concentrated in the eastern Pennsylvania area but most of the Eastern States received cement shipments from the county. A total of 43 cement kilns were in operation. Keystone Portland Cement Co. closed the No. 6 Bath plant in late 1963, and the Bath No. 5 plant was used for cement regrinding only. The Alpha Portland Cement Co. closed its Martins Creek plant in October 1964. Competition for markets along the Atlantic seaboard continued to be intense. Wages were raised as second stage of a 2-year contract, and companies reported reduced profit margins.

Limestone production increased by 400,000 tons to 5.2 million tons, and the county continued as first ranked among the limestone producing companies. Cement manufacturing companies produced large quantities of captive limestone or cement rock in the Nazareth, Northampton, and Bath areas. Crushed limestone for concrete aggregate and roadstone was produced by Bethlehem Steel Co., Bethlehem, and The Trumbower Co., Inc., Nazareth. The Bethlehem quarry of Bethlehem Steel Co., the Keystone Quarry of the Keystone Portland Cement Co., The Fogelsville Quarry of Lehigh Cement Co., the No. 4 quarry of Penn-Dixie Cement Corp., the Nazareth Quarry of Nazareth Cement Co., and the Northampton quarry of Universal Atlas Cement Division, United States Steel Corp. received a certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Ten slate quarries were in operation in 1964. Leading dimension slate uses were for flagging, structural and sanitary ware, blackboards, bulletin boards, and roofing. Most dimension slate markets were virtually unchanged from that of 1963. One exception was for billiard table tops, which increased significantly. Nine of the slate-producing companies had value of output of more than $200,000. Leading dimension slate producers were Anthony Dally & Sons, Inc., Stephens-Jackson Co., D. Stoddard & Sons, Inc., Diamond Slate Co., and Doney Slate Corp., all of Pen Argyl. Crushed slate was produced by three operators, two of which also produced dimension slate. The leading crushed slate producer was Pennsylvania Lightweight Aggregate, Inc., Bangor, with output mostly for lightweight aggregate plus smaller quantities for roofing granules. Capitol Slate Co. purchased additional machinery, and Pennsylvania Lightweight Aggregate, Inc., installed new equipment and constructed a maintenance building.

Building and paving sand and gravel was produced at virtually the same rate as that of 1963. Companies active were Houdaille Construction Materials, Inc., Portland; W. J. Lowe & Sons, Inc., Bangor; and Lehigh Valley Sand & Gravel Co., Inc., Easton. Mineral Pig-

ments and Metals Division, Charles Pfizer and Co., Inc., Easton, and Reichard-Coulston, Inc., Bethlehem, produced finished (natural and manufactured) iron oxide pigments. Of total manufactured pigment production, the leading types were pure red calcined copperas and yellow iron oxide. The leading natural pigment product was mixtures of red and brown iron oxides.

Northumberland.—Anthracite production increased slightly to 2.1 million tons. The leading producers were the Susquehanna Coal Co., Reading Anthracite Co., and Rosini Coal Co.

The entire clay production was from mines in the Watsontown area. Glen Gery Shale Brick Corp. and Watsontown Brick Co. mined shale for building brick. Watsontown Mineral Products Co. mined shale for use as linoleum filler. Limestone for roadstone and agstone was produced by Eugene Meckley at a stationary plant near Herndon. Clyde Starook produced small quantities of agstone and aglime.

Perry.—Crushed limestone for roadstone was produced by Bradford Hills Quarry, Inc., at its Newport quarry.

Philadelphia.—The Liberty Corp. dredged large quantities of sand and gravel from the Delaware River near Philadelphia. Output was greater than that of 1963. The Atlantic Refining Co. recovered hydrogen sulfide (burned for sulfuric acid manufacture) and molten sulfur, and Gulf Oil Co. recovered sulfur by the Claus process, both at Philadelphia refineries. Calcined gypsum (stucco) was produced by U.S. Gypsum Co. at a plant in Philadelphia.

Potter.—Nine dimension sandstone quarries centered near Austin were in operation, producing mostly flagging. Penn Kress Flagstone Co., Inc., and Wright & Hoffman (formerly Rummings & Wright) were leading producers.

Schuylkill.—The county was the second-ranked anthracite producing area. Leading producers were Reading Anthracite Co., Greenwood Stripping Co., Mammoth Coal Co., Honeybrook Mines, Inc., and Gilberton Coal Co. Output was 5.8 million tons, a significant drop in production from the 6.5 million tons in 1963.

Summit Quarries produced construction quartzite aggregate near Summit Station, and Harbison-Walker Refractories Co. quarried and crushed quartzite for ganister near Andreas. Paving and fire or furnace sand was produced by Refractory Sand Co., Inc., at a stationary plant near Andreas. Auburn Brick Co. mined shale near Auburn for building brick. Lightweight aggregate was produced by Lehigh Materials Co. from shale supplied by various producers. Huss Contracting Co. operated a limestone quarry and stationary plant near Andreas producing aggregate and roadstone. Pennsylvania Aggregates, Inc., was idle in 1964. The peat bog of Frank Gozjalk located near Tamaqua was idle in 1964.

Somerset.—Bituminous coal production increased slightly to 3.2 million tons. Of this total, 57 percent was mined at 49 strip and 43 percent at 63 underground mines. The county was the third ranking strip-mining area. Stripping equipment included 75 power shovels and 46 draglines. Four power shovels and eight draglines had dipper capacities between 6 and 12 cubic yards. Coal seams stripped included all the Kittanning and Freeport beds. Underground mining was mostly in the Upper Kittanning seam. Of the underground output,

69 percent was mechanically loaded. Nine continuous miners were in use; two more than in 1963. Leading underground mines were operated by Bird Coal Co. and Solar Fuel Co. (three mines). Leading strip-mining companies were Svonavec Coal Co., Sanner Brothers Coal Co. (four mines), and Ponfeigh Smokeless Coal Co. (two mines).

Clay production was at virtually the same rate as that of 1963. General Refractories Co. was the leading producer, mining flint fire clay at three locations for its own use in manufacturing firebrick and block. A new overburden-stripping dragline was put into operation at the company Fort Hill opencut mine. Hiram Swank's Sons, Inc., operated an underground clay mine near Holsopple, producing plastic fire clay for manufacturing refractory products. Somerset Limestone Co., Inc., and Keystone Lime Co. produced crushed limestone for roadstone at Barkersville and Springs, respectively. The latter company also sold agstone.

Crushed sandstone for concrete and roadstone was produced by Detwiler Industries, Inc., Central City and Clarence Rodamer, Springs. Small quantities of sand and gravel aggregate were produced near Berlin and Boswell.

Snyder.—Crushed limestone for roadstone and agstone was produced by National Limestone Quarry at Middleburg. The company reported rewiring the plant for 440 volts in a conversion from diesel to electric power. Anthracite production increased slightly from that of 1963. Increased output of building and paving sand and gravel was reported by Central Builders Supply Co., from a stationary plant near Selinsgrove. Carton Comfort produced a small tonnage of aglime near Mount Pleasant Mills.

Susquehanna.—The Keller Supply Co., Inc., and Susquehanna Quarry Co. sold crushed sandstone (bluestone) from quarries near Clifford and Montrose, respectively. Seven dimension sandstone quarries were in operation producing mainly flagging. The leading producer was Mitchell Stone Co., Springville. Bennett's Quarry of Keeler Supply Co., Inc., received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Tioga.—Bituminous coal production was less than that of 1963. Most of the output was strip mined by five companies. Only one small underground mine was active. Most of the output was from the Seymour seam. Leading strip-mining companies were Jones & Brague Mining Co. and Liberty Valley Construction Co. Fred Gee Gravel Co., a new producer, operated a portable plant near Middleburg Center and produced paving sand and gravel. A small quantity of sandstone rubble was quarried in Elk Township.

Union.—Faylor Lime and Stone Co. produced crushed limestone for roadstone and agstone at a quarry and stationary plant near Winfield, and John L. Iddings produced limestone for roadstone near Mifflinburg.

Venango.—Most of the county bituminous coal output was from 14 strip mines. Output was significantly less than that of 1963 even though 3 more strip mines (14) were in operation. Two auger mines and one small underground mine also were active. Equipment at strip mines included 24 power shovels and 14 draglines. Leading in production were the strip mines operated by Tasa Coal Co. and Testa

Brothers, Inc., and the auger mine operated by Black Diamond Coal Mining Co. Output was from the Clarion and Brookville coal seams.

Oil City Sand & Gravel Co., the leading producer, operated a dredge on the Allegheny River near Oil City producing building and paving sand and gravel. Industrial Silica Division, Pennsylvania Glass Sand Corp., produced molding and fire or furnace sand at its Venango Works near Utica. Paving and other gravel was produced by two additional companies in 1964.

Warren.—The first full year of production of a dredge operated by Warren Sand & Gravel Co., Inc., on the Allegheny River near Warren was the leading factor in the large increase in sand and gravel production. Other producers were General Concrete Products Corp. and Nelson & Ellberg, both of Warren.

Washington.—The county was first ranked in coal production. Output increased 1.3 million tons to 13.5 million tons. Underground mining increased 11 percent and compensated for decreased output in both strip and auger production. Of total output, 94 percent was mined at 21 underground operations; the balance was from 13 strip and 3 auger mines. In use at underground mines were 65 continuous miners, 2 more than in 1963. Virtually the entire underground production was loaded mechanically. Eight cleaning plants prepared 11.9 million tons. The entire county output was from the Pittsburgh coal seam. Leading underground producers were Bethlehem Mines Corp. (three mines); United States Steel Corp. (two mines); Pittsburgh Coal Co. (two mines); Mathies Coal Co.; and Jones & Laughlin Steel Corp. (two mines). Leading strip mines were Harman Creek Coal Corp. (also auger) and National Steel Corp.

Crushed limestone for roadstone was produced by Washington Stone Co. at a stationary plant near Washington. No clay was recovered at this quarry in 1964. The Appalachian Stone Division, Martin Marietta Corp. quarry was abandoned in 1964 following completion of Interstate Highway 70 in the area.

Wayne.—Sand and gravel production increased sharply over that of 1963. Keystone Pavement & Construction Co., Inc., produced paving sand and gravel near Lake Ariel. Wayne Concrete & Sand Works, Inc., produced crushed sandstone chiefly for concrete aggregate at a quarry near Lake Ariel. Anthracite coal production dropped from 7,500 tons in 1963 to 1,775 tons. Dimension sandstone (bluestone), chiefly for flagging, was quarried by three companies; the largest was the Paul Tompkins Estate. Wayne Peat Humus Co. mined moss and humus peat from a bog near Gouldsboro and sold the product both in packaged form and in bulk for general soil improvement uses.

Westmoreland.—Of the total coal production of 4.1 million tons, 95 percent was mined at 34 underground operations; the balance, from 1 auger and 25 strip mines. Most of the production came from the Pittsburgh and Upper Freeport coal seams. Of the underground output, 98 percent was loaded mechanically. Three more continuous miners (17) were used than in 1963. Six cleaning plants prepared 82 percent of total output. Leading underground mining companies were Republic Steel Corp., Delmont Fuel Co., Jamison Coal Co., Pittsburgh Coal Co., and Allegheny-Pittsburgh Coal Co. The leading strip producer was C. W. Brown. The Hutchison mine of Pittsburgh

Coal Co. received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work in jury.

Crushed sandstone entirely for use as concrete aggregate and roadstone, was produced by five companies at a lower rate than that of 1963. The leading producers were Latrobe Construction Co., Ligonier; Eidenmiller Enterprises, Inc., Lycippus; and J. M. Hall & J. M. Hall, Jr., Inc., Baggaley. Dimension sandstone for flagging was quarried by Lynn's Quarry near Belle Vernon. Latrobe Construction Co. added new ventilating equipment and increased the dust control facilities at its Longbridge underground mine. A small quantity of limestone was quarried mostly for use as aggregate by Paul W. Kendi & Sons, Inc., near Mt. Pleasant. The Whitney quarry of Eidenmiller Enterprises, Inc., received a Certificate of Achievement in Safety for operating throughout the year without a disabling work injury.

Davison Sand & Gravel Co. moved its marine dredge on the Allegheny River from Armstrong County and produced large quantities of building and paving sand and gravel. Aglime was produced by Agricultural Lime & Stone Co. at a plant near Derry.

Wyoming.—Increased sand and gravel production was reported by East Falls Sand & Gravel and Wyoming Sand & Stone Co., both at Falls. Output was mostly for building and paving aggregate. J. G. Robinson, Inc., quarried dimension sandstone (bluestone) for flagging.

York.—Medusa Portland Cement Co. produced both portland and masonry cement at its York plant. Portland cement output was mostly the general use, non-air-entrained type. Shipments were almost evenly divided between rail and truck. Most shipments were in bulk but significant quantities were shipped in paper bags. The company completed construction of its white cement plant in 1963 and has dismantled its gray cement plant. Capacity of the new plant is practically double that of the old one. Portland cement shipments were to 35 States and to foreign countries. Leading customers were ready-mixed concrete companies and concrete product manufacturers.

In terms of value, the county ranked first in limestone production. National Gypsum Co. with a large high-priced market in whiting for floor covering and White Pigment Corp., producing for a wide variety of whiting markets, contributed significantly to the high-county valuation. Both companies had quarries near York. In terms of tonnage, Thomasville Stone & Lime Co. and Lincoln Stone Co., both of Thomasville, and J. E. Baker Co., York, were the leading producers. Metallurgical flux, dead-burned dolomite, aggregate uses, and cement manufacture were leading markets. J. E. Baker produced dead-burned dolomite at its York plant. Ten quarries were in operation, and production was at virtually the same rate as that of 1963. The Ruberoid Co. produced crushed slate for roofing granules and for slate flour at a quarry and plant near Delta.

The York quarry of The J. E. Baker Co. and the Delta quarry of The Ruberoid Co. received Certificates of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Pennsy Supply, Inc., produced building and paving sand and gravel at a stationary plant near York Haven. Neuman Sand & Supply Co. produced building sand near York. County sand and gravel output was greater than that of 1963.

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Glen Gery Shale Brick Corp., York Colonial Division, operated an opencut shale mine near Dover producing shale for captive use in building brick manufacture. Medusa Portland Cement Co. mined miscellaneous clay near York for use in its cement plant. General Mining Associates recovered flake mica from sericite near Glenville and sold the product to paint and welding rod manufacturers and for use as mold lubricant (rubber). Pennsylvania Perlite Corp. produced expanded perlite for use mainly as lightweight aggregate in building plaster.

The Mineral Industry of Puerto Rico, The Panama Canal Zone, The Virgin Islands, and Pacific Island Possessions

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

THE Puerto Rican economy continued its growth, as evidenced by a 10-percent increase in net income and 9-percent increase in value of mineral output. The construction industry was dominated by private residential and public plant activity. Value of construction projects for 1964 reached $376 million, or 17 percent more than the 1963 total value. Government construction activity, mainly schools, roads, and other public works, also increased.

TABLE 1.—Mineral production in Puerto Rico [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement---thousand 376-pound barrels	7,217	$22,090	7,926	$23,879
Clays---thousand short tons	200	158	341	271
Lime---do	4	103	18	574
Salt---do	8	131	5	74
Sand and gravel---do	7,616	10,407	7,816	11,492
Stone---do	5,334	8,237	5,504	8,586
Total		41,126		44,876

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

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Exports totaled $918 million, a 9-percent gain over the value in 1963. About 94 percent of the exported goods went to the United States. Value of imports into Puerto Rico totaled about $1,400 million, a 17 percent gain compared with the value in 1963. Mineral fuels, metals, and other mineral products comprised about 25 percent of the total value.

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

(Thousands)

Year	Value	Year	Value
1955	$16,604	1960	$30,851
1956	16,870	1961	34,812
1957	22,269	1962	38,818
1958	19,248	1963	41,965
1959	20,714	1964	45,466

Investigation of metallic mineral deposits on concessions granted by the Puerto Rico Mining Commission continued. Companies involved in projects which began 3 to 5 years ago were Bear Creek Mining Co. and Ponce Mining Co. Both have been exploring potential copper deposits in the Lares-Utuado region. Annual reports of the two companies reported that extensive deposits of low-grade copper ore had been delineated.

The Puerto Rico Water Resources Authority and the U.S. Atomic Energy Commission (AEC) continued work on a nuclear power plant near Rincón, Aguadilla District, designed to generate 16,300 kilowatts. The boiling nuclear superheat (BONUS) plant uses uranium dioxide fuel to produce dry, high-temperature steam for operating a turbine generator. The first self-sustaining nuclear chain reaction in the plant occurred on April 13, 1964. The first operating test was conducted in August and full electrical power production on a test basis was scheduled for early 1965.

Feasibility of building a full-scale atomic power plant by 1970 was studied by the Puerto Rico Water Resources Authority. The new plant would have a capacity of 200,000 kilowatts. Sites near San Juan and near Rincón were considered for the new plant.

The Federal Geological Survey, working under a cooperative agreement with Puerto Rico Economic Development Administration, was mapping quadrangles at various locations on the island during 1964. A provisional geologic map of Puerto Rico and adjacent islands was published, along with a hydrogeologic map showing yield of water in the different geologic formations.[4]

The Water Resources Division of the Geological Survey, in cooperation with the Commonwealth of Puerto Rico, prepared two water resources bulletins and a flood map.[5]

[4] Briggs, R. P. Provisional Geologic Map of Puerto Rico and Adjacent Islands. U.S. Geol. Survey. Map I–392, 1964. Briggs, R. P., and J. P. Akers. Hydrogeologic Map of Puerto Rico and Adjacent Islands. U.S. Geol. Survey. Hydrologic Investigations Atlas HA–197 (prepared in cooperation with the Commonwealth of Puerto Rico), 1964.

[5] Bogart, D. B., T. Arnow, and J. W. Crooks. Water Resources of Puerto Rico, A Progress Report. U.S. Geol. Survey and the Commonwealth of Puerto Rico, 1964. López, M. A. Floods at Toa Alta, Toa Baja, and Dorado, Puerto Rico. U.S. Geol. Survey. Hydrologic Investigations Altas HA–128, 1964. Ward, P. E., and L. S. Truxes. Water Wells in Puerto Rico. U.S. Geol. Survey and the Commonwealth of Puerto Rico, 1964.

The Puerto Rican Department of Public Works, in cooperation with the Federal Bureau of Public Roads, continued a comprehensive and systematic survey of construction materials of Puerto Rico. Publication was scheduled for reports on the Bayamón, San Juan, and Juncos quadrangles; similar reports on other quadrangles were being prepared.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Heightened activity in the construction industry led to an increase of 21 percent in domestic demand for cement. Accordingly, exports of Puerto Rican cement dropped 18 percent, and imports gained 20 percent. Most of the imported cement was shipped from Colombia. Total stocks of cement at the two Puerto Rico plants was 164,400 barrels, a decrease of 9 percent from that of 1963. Plant production averaged 106 percent of rated capacity.

Clays.—Domestic production of clay followed the rising trend of cement output and increased substantially. Clay used in making heavy clay products and other ceramics was mined from deposits near Carolina in the San Juan District, principally by Puerto Rico Clay Products Corp. A substantial quantity of sandy clay used for fill and for various construction projects was not included as mineral production. The extremely high value of land in Puerto Rico permits usage of pit-run fill costing as much as 75 cents per cubic meter.

TABLE 3.—Portland cement production and shipments

Year	Production (376-pound barrels)	Shipments		Unit value
		376-pound barrels	Value (thousands)	
1955–59 (average)	4,822,896	4,812,817	$15,192	$3.16
1960	5,415,086	5,441,497	14,546	2.67
1961	6,070,140	5,931,420	16,946	2.86
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

Diazlite, Inc., Puerto Rico's first lightweight aggregate plant, continued work at its plant near San Juan. The plant was closed down part of the year to permit addition of new machinery. The new equipment consisted of a modified extruder to pelletize the clay, and a small kiln to surface dry the pellets for stockpiling. The pellets are expanded in the main rotary kiln, dropped into a cooling kiln, and are then screened into three different sizes—coarse, medium, and fine. No crushing is required.

Lime.—The Puerto Rican Cement Co., Inc., lime plant at Ponce produced throughout the year, but not at its full annual capacity of 33,000 tons. The hydrated lime output was principally used for mason's lime. Lesser amounts were used for sugar refining, leather tanning, water purification and softening, and sanitation.

Salt.—Salt ponds were operated by Ponce Salt Industries, Inc., Puerto Rico Salt Works, Inc., and other smaller producers in the extreme southwestern part of the island. The locally produced salt was used in the petrochemical industry and operations related to fishing and fish canning. Crude salt imported from Gran Inagua was refined to table salt for domestic use.

Sand and Gravel.—Production of sand and gravel increased about 3 percent, paralleling the increased construction activity. Most of the sand and gravel was used as concrete aggregate. An intensive search for new sources of suitable grades of sand was conducted in the San Juan area, but no large deposits were discovered. Silica sand from inland beds west of San Juan was produced primarily for use in the nearby cement and glass plants. Lesser amounts were used in foundries, as abrasives, in commercial sandblasting, and in marble polishing operations. Puerto Rico Glass Corp. was the principal user of the white, high-grade sands. Feldspar and other raw materials used in making the glass were imported.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,856	$2,916	2,012	$3,456
Paving	1,699	1,713	1,539	1,904
Fill	419	262	500	453
Other	29	54	25	35
Total sand	4,003	4,945	4,076	5,848
Gravel:				
Building	1,312	2,457	1,379	2,578
Paving	1,018	1,981	957	1,789
Fill	361	241	589	482
Other	138	119	----	----
Total gravel	2,829	4,798	2,925	4,849
Total sand and gravel	6,832	9,743	7,001	10,697
Government-and-contractor operations:				
Sand:				
Building	----	----	----	----
Paving	196	186	201	256
Fill	453	344	472	409
Total sand	649	530	673	665
Gravel:				
Building	----	----	----	----
Paving	18	30	18	22
Fill	117	104	124	108
Total gravel	135	134	142	130
Total sand and gravel	784	664	815	795
Grand total	7,616	10,407	7,816	11,492

Dredging operations were completed in San Juan Harbor. Completion of the project left the channel at new depths of 36 to 46 feet to facilitate movement of larger, oceangoing vessels

Stone.—Limestone, classified as marble in many deposits, was produced in all seven districts. Andesite, tuffaceous siltstone, and

miscellaneous volcanic stone were produced in all districts except Arecibo. Granite was produced in Humacao and Guayama Districts. Stone output was 79 percent crushed limestone, 2 percent crushed granite, and 16 percent crushed miscellaneous stone. The remaining 3 percent was rough dimension stone and crushed marble. Crushed marble was used in making terrazzo. Crushed limestone output of the two cement plants was 2.2 million tons, about 16 percent more than that of 1963.

TABLE 5.—Stone sold or used by producers

(Thousand short tons and thousand dollars)

Year	Dimension limestone		Crushed limestone [1]		Miscellaneous stone		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1955–59 (average)	100	$198	1,936	$2,574	36	$72	2,072	$2,844
1960	37	87	3,474	5,938	708	1,636	4,219	7,661
1961	[2] 77	[2] 213	3,718	4,546	1,254	2,525	5,049	7,284
1962	61	130	4,270	5,829	1,258	2,592	5,589	8,551
1963	65	152	3,918	5,306	1,351	2,779	5,334	8,237
1964	75	191	4,347	6,009	1,082	2,386	5,504	8,586

[1] Includes limestone for cement and lime.
[2] Includes dimension marble.

MINERAL FUELS

The quantity of crude oil imported from Venezuela gained 9 percent; imported unfinished oil from Venezuela decreased 29 percent. The oils were refined at the Cataño plant of Caribbean Refining Co. and the Guaynilla plant of Commonwealth Oil Refining Co.

Commonwealth Petrochemicals, Inc., a subsidiary of Commonwealth Oil Refining Co., began constructing a $25-million aromatics plant near Ponce. Completion was scheduled for mid-1965. The plant was designed to convert naphtha feedstock into 66-million gallons of benzene a year, as well as 10-million gallons of toluene, 10-million gallons of otho-xylene, 45-million gallons of mixed xylenes, and 10-million gallons of aromatic solvents.

Puerto Rico Chemical Co., an affiliate of Hooker Chemical Co., began work on a $6-million petrochemical plant at Arecibo. Completion was scheduled for late 1965. The plant will produce phthalic anhydride.

TABLE 6.—Value of mineral production in Puerto Rico, by districts

Senatorial district	1963	1964	Mineral products produced in order of value
Aguadilla	$1,371,600	$1,436,900	Stone, sand and gravel.
Arecibo	1,130,155	1,415,200	Do.
Guayama	1,184,525	1,270,250	Sand and gravel, stone.
Humacao	777,259	778,200	Stone, sand and gravel.
Mayaguez	2,497,058	2,600,400	Sand and gravel, stone, salt.
Ponce	13,466,927	16,021,748	Cement, sand and gravel, stone, lime, clay.
San Juan	20,698,476	21,353,302	Cement, sand and gravel, stone, clay.
Total	41,126,000	44,876,000	

Industrial Siderurgica, Inc., produced concrete reinforcing bars from domestic and imported iron and steel scrap. Its plant expansion program progressed during the year. The 500-ton-capacity scrap shear was completed and used most of the year. Buildings and foundations for the two 20-ton electric furnaces were in place, and purchase of the furnaces was negotiated. Operation of the two furnaces was scheduled for June 1965.

Mining, concentrating, and smelting of Puerto Rican copper ores were the subjects of several meetings among the Mining Commission and various mining companies. Exploration activities near Utuado and Lares resulted in a favorable outlook for a major copper industry in Puerto Rico.

PANAMA CANAL ZONE [6]

The value of mineral production in the Panama Canal Zone gained about 17 percent over that of 1963. A higher unit value for miscellaneous stone and basalt accounted for the increase. Sand and gravel was produced by Panama Sand Co., Inc. Basalt was quarried by Panama Canal Co.; andesite by the U.S. Army—Carribbean.

The Federal Geological Survey published results of its work on geology and paleontology of the Canal Zone.[7]

VIRGIN ISLANDS [8]

Basalt quarrying in the Virgin Islands remained at about the 1963 level. Caribbean Material Supply Co. was the major stone producer. Principal use of the crushed stone was for concrete aggregate, roadstone, and riprap.

Harvey Aluminum, Inc., progressed in constructing its alumina plant on St. Croix. Contracts were awarded for all phases of construction, including power, water, air and steam services, foundations, structures, tankage, and installation of operational and processing facilities. Initial operations are scheduled for the latter part of 1965. The plant will utilize a data acquisition system with a digital computer to monitor process measurements and operating data. The plant's sea-water conversion facility successfully passed its testing program and was being shipped to St. Croix.

Dredging the deep-water channel and harbor to serve the alumina plant was nearing completion.

The Virgin Islands Government contracted for a second sea-water conversion and electric turbogenerating plant. Capacity of the new plant will be 1-million gallons per day of fresh water and 7,500 kilowatts of electricity. The process is flash evaporation. Completion of the plant was scheduled for late 1965.

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[6] Prepared by Harry F. Robertson.

[7] Woodring, W. P. Geology and Paleontology of the Canal Zone and Adjoining Parts of Panama. U.S. Geol. Survey Prof. Paper 306-C, 1964.

[8] Prepared by Harry F. Robertson.

TABLE 7.—Mineral production in the Panama Canal Zone and Virgin Islands[1]

Mineral	1963		1964	
	Short tons	Value	Short tons	Value
Canal Zone:				
Sand and gravel	83,633	$87,057	84,000	$82,000
Stone[2]	161,501	281,021	152,708	348,540
Total		368,078		430,540
Virgin Islands:				
Stone (basalt)	65,973	328,919	68,550	341,720

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

The Puerto Rican Cement Co. completed arrangements for constructing a plant in St. Thomas to store, package, and distribute Ponce portland cement. Main components of the plant will be a steel storage silo, a warehouse, a truck-weighing scale, a packing machine, and assorted conveying equipment.

The cement will be shipped to the Virgin Islands in bulk by special vessel and, upon arrival in St. Thomas, will be blown through steel piping from the vessel's hold into the silo. Completion was scheduled for March 1965.

PACIFIC ISLAND POSSESSIONS[9]

American Samoa.—Basalt rock and dredged coral limestone and sand were processed by crews of the Government of American Samoa. The material was used for riprap, concrete aggregate, roadstone, and fill in maintenance jobs; in public works projects administered by the Federal Aviation Agency; and for projects contracted by the District Public Works Office, 14th Naval District, in behalf of the local government. Construction of American Samoa's first luxury hotel, a $1.3-million 100-room complex of hotel rooms and thatched fales (cottages), was begun late in 1964 near Pago Pago.

TABLE 8.—Mineral production in the Pacific Island possessions

Area and mineral	1963		1964	
	Short tons	Value	Short tons	Value
American Samoa:				
Sand	76,680	$192,720	22,000	$20,000
Stone (crushed)	944,372	2,351,112	157,180	233,500
Total		2,543,832		253,500
Canton: Stone (crushed)	1,560	6,000		
Guam: Stone: Dimension	373	1,400		
Crushed	306,995	438,146	469,206	868,126
Wake: Stone (crushed)	8,585	50,500	1,755	5,400

Guam.—A large volume of coral limestone was quarried and processed by government crews and contractors and commercial producers on Guam, which in 1964 was still rebuilding from the

destruction wrought by typhoons in November 1962 and April 1963. Reconstruction included roads, utilities, schools, airfields, terminals, and other government structures, and the building of typhoon-resistant concrete family housing and commercial establishments with concrete roofs. Hawaiian Rock Products, Inc., at Barrigada, supplied specification aggregate materials for asphalt and portland cement concrete to the military and civilian public works agencies, as well as for local commercial projects. Guam Coral Co., Tamuning, and Perez Bros., Inc., Agana, sold or used appreciable quantities of coral for concrete and concrete building products during 1964.

Wake.—Federal Aviation Agency crews produced a small quantity of coral limestone for use in repair of island facilities. Most all other mineral materials used by contractors for rehabilitation of the marine railway and for paving and construction purposes were withdrawn from stockpiles of coral quarried in 1963 or brought to the island by the contractors from Hawaii and Guam.

Other Pacific Island Possessions.—No mineral production was reported on the Islands of Canton, Enderbury, Jarvis, Johnston, Midway, and Palmyra. Virtually all of the mineral materials required for construction of the National Aeronautics and Space Administration tracking station on Canton Island, for building waterfront facilities and foundations for communications and navigational aids on Johnston Island, and for maintenance purposes on Midway Island, were supplied by contractors from Hawaii or the U.S. mainland.

Pacific Trust Territories.—Mineral production data are not available for the Pacific Trust Territory, but local sand and gravel, and stone were used for construction. Both basalt and coral were used for crushed stone. As a result of increased appropriations since 1962 by the U.S. Congress, construction of roads, schools, and other public buildings, and airfields has been accelerated. Increased commercial activity and development of tourist facilities also has supported new construction. Work was in progress on the Palau airfield on Babelthuap Island. When complete, this will represent the fifth link in the airfield chain serving the district centers of the Trust Territory. A sixth and last airfield was planned on Ponape Island.

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[9] Prepared by Roy Y. Ashizawa.

The Mineral Industry of Rhode Island

By Harold F. York [1]



MINERAL production in Rhode Island declined again in 1964 for the fourth consecutive year after reaching an alltime high in 1960. The value of production was $2.5 million, 9 percent less than that of 1963. Sand and gravel production comprised 63 percent of the total mineral valuation. Miscellaneous stone and crushed limestone also contributed significantly to the total. Providence County again was the leading producing area, accounting for about two-thirds of the State total, followed in order of value by Kent, Washington, and Newport Counties.

TABLE 1.—Value of mineral production in Rhode Island, by counties [1]

(Thousands)

County	1963	1964	Minerals produced in 1964 in order of value
Kent	W	W	Sand and gravel.
Newport	$31	$36	Sand and gravel, stone.
Providence	1,733	1,666	Do.
Washington	380	198	Do.
Undistributed [2]	663	649	
Total	2,807	2,549	

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

[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
1940	$1,843	1953	$1,537
1941	2,038	1954	1,524
1942	1,350	1955	1,914
1943	1,319	1956	1,647
1944	1,018	1957	1,391
1945	803	1958	2,269
1946	799	1959	2,281
1947	1,018	1960	5,687
1948	1,793	1961	3,085
1949	1,088	1962	r 3,018
1950	1,644	1963	r 2,864
1951	1,398	1964	2,582
1952	1,386		

r Revised.

[1] Geologist, Bureau of Mines, Pittsburgh, Pa.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal						
Metal						
Nonmetal						
Sand and gravel	91	18	148		4	27
Stone	48	9	73		1	14
Total	139	27	221		5	23
1964: p						
Coal						
Metal						
Nonmetal						
Sand and gravel	85	17	139		5	36
Stone	45	9	73	1	2	41
Total	130	26	212	1	7	38

p Preliminary.

REVIEW BY MINERAL COMMODITIES

Gem Stones.—Miscellaneous mineral specimens were collected from mine dumps and quarries at unspecified localities, mostly in the northern part of the State. Gem stones recovered in past years included actinolite, agate, fluorescent calcite, and pegmatite minerals.

Sand and Gravel.—Production of sand and gravel decreased 6 percent in quantity and 12 percent in value compared with the 1963 figures. Seventeen operations were active in four counties. Providence County accounted for one-half of the production, followed by Kent, Washington, and Newport Counties. Eighty percent of the sand and gravel was processed by washing or screening. Total production was 1.65 million short tons, most of which was used for construction. The balance was molding sand and sand for miscellaneous uses, including beach nourishment and ice control. The markets for sand and gravel follow: Building, 49 percent; paving, 21 percent; fill, 18 percent; and other purposes, 12 percent. The average value per short ton decreased from $1.05 in 1963 to $0.98 in 1964. Transportation was mainly by truck; a small tonnage was shipped by railroad. There was no output by Government-and-contractor operators in 1964.

Stone.—The output of stone increased 2 percent in quantity and decreased 3 percent in value, compared with the 1963 figures, and accounted for 37 percent of the value of the State's mineral production. Production of dimension granite for monumental stone increased. Gencarelli, Inc., quarried and stockpiled a large quantity of riprap at the quarry. The company purchased granite riprap from the Iafolla Crushed Stone Co., Inc., Portsmouth, N.H., to complete a breakwater project. The only crushed granite produced in the State was a small amount by Westerly Granite Corp.

Crushed limestone production increased over that of 1963. Most of the output was used for agricultural purposes, roofing gravel, conklinite (white marble pebbles), flux, filler for fertilizer, and aggregate. Miscellaneous stone from quarries in Newport and Providence Coun-

ties was used for concrete aggregate, roadstone, riprap, and railroad ballast. Of the total stone value, miscellaneous stone accounted for 63 percent, limestone for 28 percent, and granite for 9 percent. No granite was produced by Government-and-contractor operators in 1964.

REVIEW BY COUNTIES

Kent.—Even though only sand and gravel was produced in 1964, Kent County maintained second place in value of mineral production, producing slightly less than one-half of the State's sand and gravel output. Sand production for paving and fill purposes was greater than in 1963, but building sand output decreased. The production of molding sand declined, but the value remained virtually the same as in 1963. All markets for gravel increased except that for paving, which declined 61 percent from the 1963 value. Most of the sand and gravel was washed and screened. Transportation was mostly by truck. Whitehead Brothers Co., Washington, produced molding sand. Luigi Vallone, Inc., and the Rhode Island Sand & Gravel Co., Inc., both near Warwick, produced sand and gravel for building, paving, fill, and other construction purposes. Overall, production of sand and gravel increased 10 percent in tonnage, but decreased 2 percent in value, compared with the 1963 figures.

Newport.—Peckham Bros. Co., Inc., Middletown, was the only commercial producer of sand and gravel and stone in 1964. Paving gravel increased 52 percent in value, while the production of paving sand decreased 11 percent compared with that of 1963. The entire production was washed and screened. Production of crushed conglomerate for concrete aggregate and roadstone increased by almost one-half during the year but declined in value, reflecting significantly reduced prices.

Providence.—The county ranked first in mineral production among the State's four mineral-producing counties. Eleven sand and gravel producers and two stone producers operated in 1964. The output was valued at $1.67 million, a decrease of 3 percent from the 1963 value; the decline in sand and gravel production more than offset increases in stone output. The value of sand and gravel production declined 16 percent. The output was used for building, paving, fill, and other purposes, including ice control, and was valued at about $1.03 per ton. Seventy-nine percent of the production was washed and screened. Transportation was by truck. Principal producers were Andrews Sand & Gravel Co. and Del Bonis Sand & Gravel Co., both near Cranston; A. Cardi Construction Co., Inc., Coventry; Tasca Sand & Gravel Co., and J. Santoro, Inc., near Smithfield; Town Line Sand & Gravel, Slatersville; Forte Bros. Inc., and Mack Sand & Gravel Co., Cumberland; and Silvestri Bros., Inc., Johnston.

The output of crushed limestone from the Lincoln quarry of the Conklin Limestone Co., Inc., increased over that of 1963. Most of the stone was used for agricultural purposes; lesser amounts were used for roofing gravel, blast furnace flux, aggregate, and other purposes. Miscellaneous stone for riprap, concrete, roadstone, and railroad ballast was produced by M. A. Gammino Construction Co. at its Cranston quarry. Transportation was all by truck.

Washington.—Output of sand and gravel declined 15 percent in tonnage and 31 percent in value. Stone production declined 97 percent by volume and 61 percent in value. Production of sand and gravel for paving purposes increased but not sufficiently to overcome the losses in other markets. Louis B. Schaeffer at Peace Dale produced paving gravel. The South County Sand & Gravel Co. at South Kingston produced sand and gravel for building, paving, and fill. Most of the production was processed by washing and screening. Sand and gravel accounted for more than one-half of the mineral value of the County.

Westerly Granite Corp., Bradford, quarried granite for riprap and dressed monumental stone. Gencarelli, Inc., Westerly, produced rough dimension granite. The value of unfinished dimension granite was virtually the same as in 1963. Only a small amount of broken granite was sold for riprap. Part of the lost riprap market was offset by increased production of both rough and dressed monumental stone.

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 Lawrence E. Shirley [1] and Henry S. Johnson, Jr.[2]

SOUTH CAROLINA'S mineral production in 1964 established a record high with a total value of $39 million. More than $2 million of the total increase was due to increased output of masonry and portland cement, miscellaneous clay, and sand and gravel. Leading commodities in order of total value were cement (masonry and portland), stone (crushed and dimension granite), clays (kaolin, fire, and miscellaneous), sand and gravel, vermiculite, and kyanite. These six leading commodities accounted for 93 percent of the total mineral production value and each had values of over $1 million. Substantial value increases were recorded for crushed granite, kyanite, scrap mica, vermiculite, barite and pyrite.

TABLE 1.—Mineral production in South Carolina [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,491	$7,589	1,743	$8,309
Gem stones	(2)	(3)		
Sand and gravel—thousand short tons	4,051	4,750	4,622	5,262
Stone—do	7,262	10,926	[4] 6,109	[4] 9,176
Value of items that cannot be disclosed: Barite, cement, feldspar, kyanite, scrap mica, peat, pyrites, stone (crushed limestone, 1964), and vermiculite	XX	13,214	XX	15,966
Total	XX	36,479	XX	38,713

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than ½ unit.
[4] Excludes certain stone; included with "Value of items that cannot be disclosed."

Commodities establishing record highs were barite, masonry and portland cement, miscellaneous clay, kyanite, peat, pyrites, sand and gravel, and vermiculite. Leading companies mining and processing

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, South Carolina Geological Survey, Columbia, S.C.

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

(Thousands)

Year	Value	Year	Value
1955	$22,793	1960	30,426
1956	20,917	1961	30,336
1957	22,513	1962	r 33,941
1958	22,360	1963	r 36,456
1959	30,033	1964	38,652

r Revised.

minerals were Giant Portland Cement Co. (masonry and portland cement, miscellaneous clay and crushed limestone), J. M. Huber Corp. (kaolin), Becker County Sand & Gravel Co. (sand and gravel), Campbell Limestone Co. (crushed granite and crushed limestone), and W. R. Grace & Co. (vermiculite).

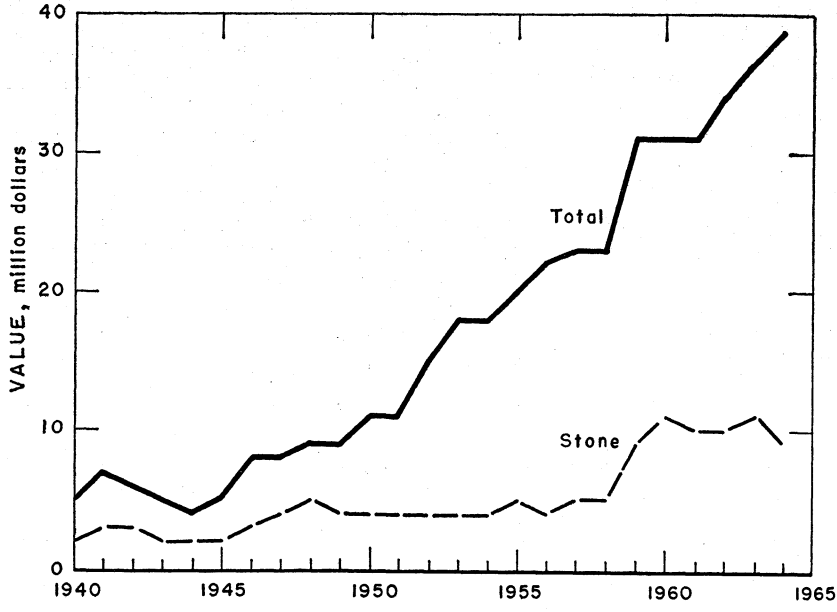


FIGURE 1.—Value of stone, and total value of mineral production in South Carolina.

Trends and Developments.—South Carolina experienced a record year of industrial development. The highest level of industrial expansion in the history of the State was experienced with $277 million in new or expanded plants compared with $264 million in 1963. Commercial and industrial construction increased 33 percent over 1963 figures and an additional increase in construction was anticipated for 1965, though at a slower rate. The high levels of industrial development and construction gains were reflected in the increased sales and use of construction materials.

The Division of Geology, State Development Board,[3] continued studies throughout the year concerning mineral resources and geology of the State. At yearend, mineral resource studies were in progress for Newberry, Pickens, Orangeburg, Edgefield, York, Oconee, Horry, and Anderson Counties. Shorter investigations included work on gold, phosphate, clays, granite, mica, iron ore, limestone, and sand and gravel. Reports published during the year included "Corundum Resources," "Gem Stone Resources," and "Geology in South Carolina." "Gold Mining in South Carolina," with special reference to York County, was published in Geologic Notes, a periodic publication of the Division.

South Carolina passed the halfway mark in completing and opening to traffic the Interstate System highway-mileage programed for the State. The 16-year program passed its 8th year with 342 of the 680 miles completed. A total of 117 miles was under construction and another 170 miles under survey or plans. Interstates 26 and 85 were essentially complete; Interstates 20 and 95 were under construction.

Electric power expansion and improvements to existing facilities were made to supply industrial centers throughout the State. Late in the year, four major power companies, in the Carolinas-Virginia area, signed an agreement to pool $4.4 billion of generation and transmission facilities to be constructed over the next 17 years. The program called for joint long-range construction of 44 million kilowatts of electricity generating capacity and 3,100 miles of high-voltage transmission lines. South Carolina Electric & Gas Co., Carolina Power & Light Co., Duke Power Co., and Virginia Electric & Power Co. were the participants in the agreement which covers a 100,000-square-mile area and some 2.3 million electric customers in South Carolina, North Carolina, Virginia, and West Virginia.

Port activities continued at a high level. The South Carolina Ports Authority estimated that direct and indirect benefits from the ports were worth over $200 million annnually to the State. The Authority announced plans for four new projects at its North Charleston terminal.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Nonmetal and peat	1,241	296	2,465	--------	46	19
Sand and gravel	343	90	725	--------	17	23
Stone	796	193	1,610	1	35	22
Total	2,380	579	4,800	1	98	21
1964: p						
Nonmetal and peat	1,027	266	2,142	--------	45	21
Sand and gravel	370	93	745	1	17	24
Stone	785	199	1,638	--------	22	13
Total	2,182	558	4,525	1	84	19

p Preliminary.

[3] Johnson, H. S., Jr. Geologic Activities in South Carolina During 1964. Geologic Notes. Division of Geology, State Development Board, v. 8, Nos. 5 and 6, September-December, 1964, pp. 51–55.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Industrial Minerals, Inc., the only barite producer in the State, increased output considerably, establishing a record year. The crude barite was ground for use as a rubber filler and shipped out of the State.

Cement.—Carolina Giant Division of Giant Portland Cement Co., near Harleyville, Dorchester County, increased shipments of both masonry and portland cement, establishing a record year for both types. Masonry cement increased 27 percent in output and 29 percent in value, continuing a growth trend extending back to 1957, the first year of production; substantial gains have been made each year in both output and value, although unit value has shown declines during this period. Portland cement output increased 10 percent over that of 1963 and value 5 percent over that of 1963. Growth in output also reflected increases in the mining of limestone and miscellaneous clay by the company for use in the manufacture of cement. Shipments of the finished products were made within the State and to surrounding marketing areas in nearby States.

Clays.—South Carolina continued to rank as the second leading State in the production of kaolin. Kaolin was produced in Aiken County by 6 companies operating 11 mines, and in Richland County by 4 companies from 4 mines. Producers in Aiken County, listed in order of output were J. M. Huber Corp., Dixie Clay Co., National Kaolin Products Corp., Southeastern Clay Co., United Clay Mines Corp., and Bell Kaolin Co. Producers in Richland County were Columbia Pipe Co., Carolina Ceramics, Inc., D. T. Duncan, and Eastern Brick & Tile Co. Principal uses of kaolin were as a filler in rubber and other fillers, in refractories, in the manufacture of whiteware and in fertilizer; other minor uses were insecticides and fungicides, plaster and plaster products, paper filling, paint, and other uses.

Miscellaneous clay output increased 21 percent in tonnage and 17 percent in value over 1963, to a record level. Output was 1.2 million tons valued at $1.1 million. Fifteen companies in 12 counties produced miscellaneous clay from 17 mines. Leading counties were Dorchester, Richland, and Greenwood; leading individual producers in the State were Carolina Giant Division of Giant Portland Cement Co. (Dorchester County), Southern Brick & Tile Co. (Greenwood County), and Columbia Brick & Tile Co. (Richland County). Miscellaneous clay was used in manufacturing masonry and portland cement as well as in heavy clay products such as building brick, paving brick, draintile, and sewer pipe.

Southern Brick Co., Ninety-Six mine, installed a new grinding and blending plant, two new 325-foot kilns, and new clay storage facilities, bringing its capacity to 90 million brick annually.

A new corporation, Pee Dee Ceramics, Inc., announced purchase of the J. D. Murchison brick plant in Marion County. The company planned to market its products in the coastal area.

TABLE 4.—Kaolin sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Rubber	330,296	$4,690,269	$14.20	361,974	$5,236,761	$14.47
Fertilizers	4,909	60,428	12.31	W	W	W
Insecticides and fungicides	24,398	310,911	12.74	9,011	112,561	12.49
Firebrick and block	10,868	93,988	8.65	54,759	394,321	7.20
Plaster and plaster products	W	W	W	3,800	66,366	17.46
Architectural terra cotta	3,420	51,300	15.00	3,450	69,000	20.00
Other uses [1]	110,866	1,415,860	12.77	88,107	1,287,920	14.62
Total	484,757	6,622,756	13.66	521,101	7,166,929	13.75

W Withheld to avoid disclosing individual company confidential data.
[1] Includes whiteware; foundries and steelworks; paper filling; linoleum and oilcloth; paint; mortar; other fillers; other refractories (1963); saggers, pins, stilts, and wads; exports (1963); other uses, and uses indicated by symbol W.

Feldspar.—Spartan Minerals Co., Pacolet, produced a feldspar-silica product from granite screenings from the Campbell Limestone Co. Pacolet granite quarry. The material was ground and shipped out of the State for various uses.

Kyanite.—Kyanite output in York County continued to climb and reached a record level as in 1963. The material was ground and shipped out of the State, principally for use in the refractory industry.

Lime.—Several companies, principally paper manufacturers and processors of wood products, produced regenerated or recirculated lime. Total output was 278,000 tons valued at $3.5 million compared with 1963 production of 289,000 tons valued at $2.9 million.

Mica.—Mineral Mining Corp., Kershaw, Lancaster County, recovered scrap mica from an open-cut mica schist deposit; output and value increased over 1963 figures but did not exceed the record year established in 1962. The mica was dry-ground and shipped for use in enamel for pipelines, paint, plastics, welding rods, and electrical products.

Pyrite.—Commercialores, Inc., York County, produced pyrite as a byproduct of milling kyanite ore. Both production and value increased markedly over 1963. The pyrite was shipped out-of-State.

Sand and Gravel.—Sand and gravel output and value established another record year. Twenty-four companies in 18 counties produced commercial sand and/or gravel from 29 mines, 4 mines less than in 1963. Seventy percent of the total was sand and the remaining 30 percent gravel; all of the material was classified as commercial since no Government-and-contractor producers reported production. Of the 29 mines reporting, 11 produced over 100,000 tons and 18 produced less than 100,000 tons. Fifty-six percent of the material was transported by truck and the remaining 44 percent by rail; 70 percent of the material was processed or prepared before shipment and the remaining 30 percent was unprocessed. Of the 29 plants in operation during the year, 26 were stationary and the remainder portable; stationary plants accounted for 94 percent of the total sand and gravel output. Leading

counties, listed in order of tonnage produced, were Marlboro, Lexington, Sumter, Lancaster, and Chesterfield; these five counties accounted for 72 percent of the total sand and gravel produced in the State. Leading individual producers, listed in order of output, were Becker County Sand & Gravel Co., with operations in Marlboro, Sumter, Chesterfield, and Dorchester Counties; Brewer Sand Co., Lancaster County; and Columbia Silica Sand Co., Lexington County. Construction sand was used for building, paving, fill, and other uses. Industrial sand was used for glass (melting only), molding, blast, fire, furnace, engine, filtration, and other purposes. Ground sand was used for glass, filler, pottery, and other purposes. Construction gravel was used for building, paving, railroad, and other purposes.

The Becker County Sand & Gravel Co. Marlboro mine and equipment was described; excellent illustrations were shown of the plant layout, loading facilities, and other interesting features of the operation.[4]

Owens-Corning Fiberglass Co. announced early in the year the expansion of its Aiken plant. To meet increased production demands, the company installed another glass melting furnace and other equipment. The concern was a large consumer of high-grade silica sand.

Stone.—In 1963, crushed limestone was included in the total stone figures but was concealed this year to prevent disclosure of individual producers' data. Crushed granite output continued to gain. A record was established for value of output, but the quantity was slightly less than that in 1959.

Dimension granite continued to decrease as in 1963; output declined only slightly below 1963 figures, but value decreased 21 percent. Crushed limestone, showing an increase in 1963 over the previous year, decreased in tonnage and value below 1963 figures.

TABLE 5.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Aiken	268	$227	228	$203
Anderson	8	4		
Chesterfield	453	532	W	W
Greenville	50	31	61	34
Greenwood	55	65	110	73
Lancaster	2	1	533	198
Lexington	828	886	751	1,065
Marion	5	5	W	W
Oconee	3	2		
Pickens			11	13
Richland	95	44	88	39
Spartanburg	92	84	W	W
York	2	1		
Undistributed [1]	2,190	2,869	2,840	3,637
Total	4,051	4,751	4,622	5,262

W Withheld to avoid disclosing company confidential data.

[1] Includes the following counties for which figures are withheld to avoid disclosing individual company confidential data: Charleston (1963), Cherokee, Dorchester, Florence, Horry, Jasper, Kershaw, Marlboro, and Sumter Counties, and counties indicated by symbol W.

[4] The Dixie Contractor. Becker County Sand & Gravel Uses New Loader for Improved Plant Operation. V. 39, No. 28, December 1964, pp. 88–89.

TABLE 6.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,888	$1,202	$0.64	2,015	$1,221	$0.61
Paving	375	156	.42	823	380	.46
Fill	16	8	.49	39	25	.64
Engine	30	95	3.23	W	W	W
Blast	W	W	W	9	41	4.56
Other uses [1]	312	995	3.19	W	W	W
Total	2,621	2,456	.94	W	W	W
Gravel:						
Fill	1	1	.69			
Other uses [2]	1,429	2,294	1.61	W	W	W
Total	1,430	2,295	1.60	W	W	W
Total sand and gravel	4,051	4,751	1.17	4,622	5,262	1.14

W Withheld to avoid disclosing individual company confidential data.
[1] Includes railroad ballast (1963), glass, molding, fire or furnace, filtration, and other sands.
[2] Includes structural, paving, railroad ballast, and other gravel.

Crushed granite was produced from 11 quaries in 10 counties by 6 companies, 1 quarry more than in 1963. A new quarry was operated in York County by Superior Stone Co. Leading producing counties were Pickens, Greenville, and Lexington; these three counties accounted for 47 percent of the total output. Leading individual producing quarries, listed in order of output, were Campbell Limestone Co.'s Beverly quarry, Pickens County; Weston & Brooker's Cayce quarry, Lexington County; and Campbell Limestone Co.'s Lakeside quarry, Greenville County. Campbell Limestone Co. again operated 3 quarries and Palmetto Quarries Co. operated 4 quarries in 4 counties. Trucks transported 73 percent of the crushed granite, and railroads transported the remainder.

Dimension granite production decreased slightly. Three companies quarried dimension granite from five quarries in two counties, Fairfield and Kershaw. Winnsboro Granite Co., the leading producer, operated one quarry in Fairfield County. Kershaw Granite Co. and Comolli Granite Co. both operated two quarries, each, in Kershaw County. All of the dimension granite quarried was rough and used as monumental stone.

Crushed limestone was produced by three companies from three quarries in two counties. Carolina Giant Division of Giant Portland Cement Co., the leading producer, crushed limestone in Dorchester County for use in its Harleyville plant in the manufacture of masonry and portland cement. Ideal Cement Co., also of Harleyville, with properties adjacent to Carolina Giant, crushed limestone for concrete and roadstone, and agricultural uses. Campbell Limestone Co. crushed limestone at its Cherokee County quarry; the material was used for concrete and roadstone, agricultural purposes, and as flux

for foundries. Trucks transported 90 percent of the crushed limestone, and railroads the remainder.

The use of high-pressure air drilling at the Campbell Limestone Co. Beverly quarry near Liberty was described.[5] Primary costs at the quarry were reduced by one-half; drilling penetration rates were increased by essentially doubling the air pressure on the drills. When compared with churn drilling, the drilling cost per ton is less than one-half the cost of churn drilling. Drills and air compressors are electrically-powered and were modified to meet the company specifications. The rock drilled is a contorted biotite granite gneiss, and crushed granite is the ultimate product.

TABLE 7.—Crushed granite sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	5,126,446	$7,511,792	$1.47	5,242,496	$7,651,578	$1.46
Railroad ballast	284,322	359,135	1.26	367,242	447,952	1.22
Riprap	85,771	96,061	1.12	W	W	W
Other uses [1]	381,547	813,351	2.13	491,803	871,785	1.77
Total	5,878,086	8,780,339	1.49	6,101,541	8,971,315	1.47

W Withheld to avoid disclosing individual company confidential data.
[1] Includes stone sand, poultry grit, and uses indicated by symbol W.

Vermiculite.—The State ranked second to Montana in vermiculite production for the sixth consecutive year. Output surpassed the previous record established in 1960. Zonolite Division of W. R. Grace & Co., again the leading producer in the State, mined crude ore in Laurens County, processed the crude ore at its Kearney plant and shipped the ore to its own exfoliating plant near Travelers Rest and to out-of-State exfoliating plants. Patterson Vermiculite Co., the second leading producer, mined, processed, and exfoliated vermiculite from its Laurens County properties. American Vermiculite Co., Roan Mountain, Tenn., mined crude ore from two mines in Laurens County and exfoliated the crude at its own plant in the county. Material exfoliated in the State increased 25 percent in tonnage and 32 percent in value; principal uses were for concrete aggregate, loose-fill insulation, building plaster, and other uses.

METALS

Ferroalloys.—Pittsburgh Metallurgical Co., Charleston, operated an electric arc-furnace and produced ferrosilicon, ferrochromium, and ferrochromium silicon. V-C Chemical Co., a division of Socony-Mobil Oil Co., Inc., Charleston, produced ferrophosphorus as a byproduct of elemental phosphorus furnace operations.

[5] Alfred, Robert C. High-Pressure Drilling. Pit and Quarry, v. 56, No. 10, April 1964, 6 pp.

Zirconium.—Orefraction Minerals, Inc., near Andrews, Georgetown County, continued operating its zircon processing plant; the plant completed 49 years of operation. The company installed a highly automated plant to manufacture zirconium silicate ceramic opacifiers. Orefraction produces dry-milled and granular zircon for the foundry, refractory, ceramic, and glass industries.

MINERAL FUELS

Peat.—Peat established a record year in both output and value; tonnage increased 7 percent and value 11 percent over 1963 figures. Ti-Ti Peat Humas Co., Colleton County, produced reed-sedge peat for use as a soil conditioner.

REVIEW BY COUNTIES

Mineral production was recorded in 24 of the 46 counties, 6 counties fewer than in 1963. Dorchester, Aiken, and Lexington, the three leading counties in the State, furnished 57 percent of the total mineral production value, the same as in 1963. The leading 10 counties, all with output of over $1 million, furnished 84 percent of the total value, compared with 82 percent in 1963; the other 7 leading counties, listed

TABLE 8.—Value of mineral production in South Carolina, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Abbeville	$95		
Aiken	6,604,569	$6,905,049	Kaolin, sand and gravel.
Anderson	W	W	Granite.
Charleston	W		
Cherokee	1,101,075	963,935	Limestone, sand and gravel, barite, miscellaneous clay.
Chester	W		
Chesterfield	531,748	W	Sand and gravel.
Colleton	W	W	Peat.
Dorchester	W	W	Cement, limestone, miscellaneous clay, sand and gravel.
Edgefield	22,210	W	Granite, miscellaneous clay.
Fairfield	W	W	Granite, miscellaneous clay, fire 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	W	Sand and gravel, granite, miscellaneous clay.
Lancaster	W	W	Mica, sand and gravel, miscellaneous clay.
Laurens	W	W	Vermiculite.
Lexington	W	W	Granite, sand and gravel, miscellaneous clay.
Marion	W	W	Miscellaneous clay, sand and gravel.
Marlboro	W	W	Sand and gravel, miscellaneous clay.
Newberry	10		
Oconee	1,762		
Pickens	W	W	Granite, sand and gravel.
Richland	W	1,765,330	Granite, kaolin, miscellaneous clay, sand and gravel.
Spartanburg	W	W	Granite, feldspar, sand and gravel.
Sumter	W	W	Sand and gravel, miscellaneous clay.
Union	100		
York	W	W	Kyanite, granite, pyrites.
Undistributed	28,217,431	29,078,686	
Total	36,479,000	38,713,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] The following counties are not listed because no production was reported: Allendale, Bamberg, Barnwell, Beaufort, Berkeley, Calhoun, Clarendon, Darlington, Dillon, Georgetown, Hampton, Lee, McCormick, Orangeburg, Saluda, and Williamsburg.

in order of output were Richland, Fairfield, Marlboro, York, Spartanburg, Pickens, and Laurens. Twenty-two counties reported no mineral production compared with 16 in 1963.

Aiken.—For the ninth consecutive year Aiken ranked second in mineral production value, surpassed only by Dorchester County. Aiken was one of two counties producing kaolin. Producing companies and mines, lited in order of output, were J. M. Huber Corp. (Barden, Ideal, and Paragon mines), Dixie Clay Co. (McNamee mine), National Kaolin Products Co. (Aiken County mine), Southeastern Clay Co. (Johnson, Seigler, Rodgers, and Toole mines), United Clay Mines Corp. (No. 7 mine), and Bell Kaolin Co. (Batesburg mine). The Southeastern Clay Co. Seigler mine was operated for the first year.

Leading sand and gravel producers listed in order of output were Perry Minerals Co. (Clearwater mine), Augusta Sand & Gravel Co. (Clearwater mine), and Carolina Sand Co. (Aiken mine). Most of the sand and gravel was used for building and paving; trucks transported most of the material, with railroads handling a small percentage.

Anderson.—Interstate Materials Co. (Anderson quarry) crushed granite for concrete, roadstone, and riprap; output and value decreased considerably. The mine was closed late in the year and the equipment was sold.

Charleston.—West Virginia Pulp & Paper Co. (Charleston limekiln) produced regenerated industrial quicklime for use in the manufacture of pulp and paper; output decreased but value increased over 1963 figures; the company also reported consumption of crude iodine. Pittsburgh Metallurgical Co. Inc. and V–C Chemical Corp., a division of Socony-Mobil Oil Co., Inc., both in the Charleston area, produced ferroalloys from electric furnace operations.

Cherokee.—Campbell Limestone Co. (Blacksburg quarry) again led the county in mineral production but output and value decreased. Jobe Sand Co. (Blacksburg mine) produced industrial sand; output and value remained about the same. Industrial Minerals, Inc. (Kings Creek mine), was the only barite producer in the State. Broad River Brick Co. produced miscellaneous clay for building brick.

Chesterfield.—Becker County Sand & Gravel Co. (Cash mine) produced building and paving sand and gravel; output and value increased. F. T. Williams Co. (Pageland mine) produced building sand; tonnage and value showed a considerable increase.

Colleton.—Ti-Ti Peat Humus Co., the only peat producer in the State, had record output in both quantity and value; tonnage increased 7 percent and value 11 percent. Reed sedge peat was produced by the company and sold for use as a soil conditioner.

Dorchester.—Dorchester County led the State in mineral production value for the ninth consecutive year and was first in miscellaneous clay production. Carolina Giant Division of Giant Portland Cement Co. was the principal producer in the county with outputs of masonry and portland cement, crushed limestone, and miscellaneous clay; production of both types of cement established a record requiring increased production of crushed limestone and miscellaneous clay. Ideal Cement Co. (Carolina quarry) crushed limestone for use as asphalt filler. and for agricultural purposes. Salisbury Brick Co. (Salisbury mine)

and Dorchester Ceramics, Inc. mined miscellaneous clay for building brick. Becker County Sand & Gravel Co. (Summerville mine) and Murray Mines Co. (Murray mine) produced building and paving sand; output by both companies was about the same as in 1963.

Edgefield.—Palmetto Quarries Co. (McCormick quarry) a crushed granite operation reported production for the first year. Merry Bros. Brick & Tile Co. produced miscellaneous clay for use in building brick.

Fairfield.—Crushed granite output showed a substantial gain, miscellaneous clay output decreased, dimension granite remained about the same, and fire clay was reported for the first year, previously having been reported under miscellaneous clay. Palmetto Quarries Co. (Blair quarry) and Rion Crushed Stone Co. (Rion quarry) crushed granite for concrete and roadstone as well as for other uses. Carolina Ceramics, Inc. (Fairfield mine), produced a small tonnage of fire clay for refractories. Richland Shale Products Co. (Richtex mine) produced miscellaneous clay for building brick. Winnsboro Granite Co. (Winnsboro quarry) quarried rough dimension granite for the monument industry; output and value remained about the same as in 1963.

Florence.—Coastal Sand Co. (Johnsonville mine) produced building, paving, and fill sand; output and value increased. Lanford Sand Co. (Florence mine) produced building sand; all of the sand was transported by truck.

Georgetown.—International Paper Co. (Georgetown limekiln) produced regenerated quicklime for use in the manufacture of pulp and paper; output and value decreased.

Greenville.—The county ranked third in crushed granite production. Campbell Limestone Co. (Lakeside quarry) crushed grante for concrete, roadstone, and railroad ballast; output and value increased. Zupan Sand Co. (Greenville mine) produced sand for building, paving, and fill purposes. W. M. Barber Sand Co. (Greenville mine) produced building sand. Zonolite Co. division of W. R. Grace & Co. exfoliated vermiculite at its plant near Travelers Rest.

Greenwood.—Palmetto Quarries Co. (Stoney Point quarry) crushed granite for concrete and roadstone; output and value increased. Southern Brick Co. (Ninety-Six mine) mined miscellaneous clay for building brick; output more than doubled. Perry Minerals Co. (Ware Shoals mine) mined building sand. Wilson Bros. Sand Co. (Hodges mine) mined paving sand and reported for the first year.

Horry.—E. P. Pitts Sand Corp. (Pitts mine) mined industrial sand for use in glass manufacture.

Jasper.—Deerfield Sand & Mining Co. (Deerfield mine) produced sand for building and paving uses; output and value increased.

Kershaw.—Mineral Mining Corp. (Kershaw grinding plant) ground mica mined from its mica schist deposit in Lancaster County; output and value increased. Kershaw Granite Co. (Kershaw and Coral Gray quarries) and Comolli Granite Co. (Carolina Mahogany and Carolina Diamond Grey quarries) quarried dimension granite for rough monument uses; output of the four quarries decreased slightly. Whitehead Bros. Co. (Lugoff mine) mined industrial sand for use as molding sand; Kershaw County Sand Co. (Camden mine) produced sand for building and fill purposes. Carolina Ceramics, Inc. (Kershaw mine), produced a small tonnage of miscellaneous clay for building brick.

Lancaster.—Mineral Mining Corp. (Kershaw mine) recovered scrap mica from a mica schist deposit, and for the third year was the only mica producer in the State; output and value of the crude material increased. Brewer Sand Co. (Brewer mine), in its first year of operation, mined paving sand. Ashe Brick Co. (Van Wyck mine) produced miscellaneous clay for building brick.

Laurens.—Vermiculite was mined, processed, and exfoliated in the Enoree Area. The county ranked 10th in value of mineral production. Total production by three companies increased considerably over that of 1963. Zonolite Division of W. R. Grace & Co., as in 1963, was the principal producer and processor; the company mined and shipped processed ore to its plant near Travelers Rest and to a number of Southeastern States' plants for exfoliating. Patterson Vermiculite Co. (Laurens County mine) mined crude ore and exfoliated the material at its plant in the Enoree area. American Vermiculite Co. mined crude ore at its Courtney and Donnon mines and exfoliated the crude at its Enoree plant.

Lexington.—Lexington County, for the second consecutive year, ranked third in value of mineral production; the county also ranked second in crushed granite output and sand and gravel production. Weston & Brooker (Cayce quarry) crushed limestone for concrete, roadstone, and railroad ballast; output and value increased. Pennsylvania Glass Sand Corp. (Columbia mine), in its third year of operation in the county, continued to increase output of industrial sand for glass, molding, blasting, and chemical uses; the company also produced ground sand for a number of uses. Columbia Silica Sand Co. (Edmund mine) produced building and industrial sand; output and value showed a substantial increase. Foster Bros. Dixiana Sand Co. (Dixiana mine) mined building and industrial sands; output increased but value declined. Strickland Sand Co. (Strickland mine) completed its second year of operation in the county and produced paving sand; output remained about the same, but value increased. Guignard Brick Co. (Columbia mine) mined miscellaneous clay for building brick; output and value increased considerably.

Marion.—J. D. Murchison (Pee Dee mine) mined miscellaneous clay for building brick; output increased considerably over that of 1963. At yearend, Pee Dee Ceramics, Inc., announced it had purchased the operation of J. D. Murchison and would begin modernization of the plant in the coming year; plans call for production to be doubled within 5 years, with initial production goals set at 10 million brick annually. Sandy Bluff Sand Co. (Snipes mine) mined a small tonnage of building sand.

Marlboro.—Marlboro County again ranked sixth in value of mineral production and was first in output of sand and gravel. Becker County Sand & Gravel Co. (Marlboro mine) mined building and paving sand and gravel; output and value increased. Palmetto Brick Co. (Irby mine) and Cheraw Brick Works, Inc. (Cheraw mine), produced miscellaneous clay for building bricks; combined output of the two plants increased.

Pickens.—Pickens County ranked first in granite production and was ninth in value of mineral production. Campbell Limestone Co.

(Beverly quarry) crushed granite; output and value decreased. The Beverly quarry continued to lead the State in crushed granite output; the material was used for concrete, roadstone, and riprap. Horton and Holliday (Pickens mine) produced building sand and reported for the first year.

Richland.—Richland County moved up to fourth ranking county in value of mineral production and ranked second in miscellaneous clay output. Palmetto Quarries Co. (Columbia quarry) crushed granite for concrete, roadstone, and riprap; output and value increased. Kaolin was produced by four companies, principally for fire brick; the companies, listed in order of output, were Eastern Brick & Tile Co. (601 mine), Carolina Ceramics, Inc. (Pontiac mine), Columbia Pipe Co. (Ridgewood mine), and D. T. Duncan (Duncan Kaolin mine). Miscellaneous clay was produced by two mines for use in building brick; Columbia Brick & Tile Co. (Columbia mine) and Carolina Ceramics, Inc. (Richland mine), both reported increases. Harrison Sand Corp. (Harrison mine) mined building and industrial sand; output and value remained about the same as in 1963. Columbia Organic Chemical Co., Inc., reported crude iodine consumption.

Spartanburg.—Campbell Limestone Co. (Pacolet and Pelham quarries) crushed granite for concrete, roadstone, and riprap; both quarries increased output and value. Spartan Minerals Co. (Pacolet mine) recovered a feldspar-quartz material from granite screenings obtained from Campbell Limestone Co.'s Pacolet quarry; most of the material was used by the glass and pottery industries, and was shipped both locally and to out-of-State consumers. L. G. Chapman Sand Pit, Inc. (Chapman mine), mined sand and gravel; output and value decreased. The sand was used for building and paving purposes, and the gravel was used for paving.

Sumter.—Sumter County, for the fifth consecutive year, ranked third in sand and gravel output. Becker County Sand & Gravel Co. (Camden mine) continued to mine sand and gravel at an increased rate; output and value increased, establishing a record year. The sand and gravel was used for building and paving purposes. Eastern Brick & Tile Co. (Wedgefield mine) produced miscellaneous clay for building brick; output and value decreased considerably.

York.—York County ranked seventh in value of mineral production, making its first appearance in the top 10 counties in the State. Commercialores, Inc. (Henry Knob mine), mined kyanite and recovered pyrite from the milling of the ore; output and value of both commodities increased. Superior Stone Co. (Pineville quarry) crushed granite and reported for the first year. Bowater-Carolina Corp. (Catawba limekiln) produced regenerated quicklime for the manufacture of pulp and paper.

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 R. B. Stotelmeyer,[1] C. A. Koch,[2] and Duncan J. McGregor [3]

MINERAL production in South Dakota for 1964 was valued at $53 million. Metals as a group increased 5 percent and fuels 14 percent in value of production; nonmetals declined 8 percent, or more than $2 million. The first production of molybdenum in South Dakota, as a byproduct in processing uranium-bearing lignite ash, was reported in 1963; however, no shipments were made until 1964. For the 16th consecutive year, the State was the leading gold producer in the Nation.

TABLE 1.—Mineral production in South Dakota [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand 376-pound barrels	1,914	$6,107	2,044	$7,073
Clays—thousand short tons	r 240	r 960	245	1,076
Coal (lignite)—do	16	62	13	63
Copper (recoverable content of ores, etc.)—short tons	1	(2)		
Feldspar—long tons	25,590	157	26,980	180
Gem stones	(3)	20	(3)	20
Gold (recoverable content of ores, etc.)—troy ounces	576,726	20,185	616,913	21,592
Gypsum—thousand short tons	24	97	19	76
Lead (recoverable content of ores, etc.)—short tons	4	1		
Mica: Scrap—do	W	W	996	32
Sheet—pounds	10,000	(2)		
Petroleum (crude)—thousand 42-gallon barrels	215	428	247	495
Sand and gravel—thousand short tons	20,806	16,313	13,770	13,641
Silver (recoverable content of ores, etc.) thousand troy ounces	117	150	133	172
Stone—thousand short tons	2,794	7,339	2,118	6,245
Uranium ore—short tons	72,088	1,931	110,147	1,551
Value of items that cannot be disclosed: Beryllium concentrate, lime, lithium minerals, molybdenum (1964), vanadium, and values indicated by symbol W.	XX	r 366	XX	608
Total	XX	r 54,116	XX	52,824

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 $500.

[3] Weight not recorded.

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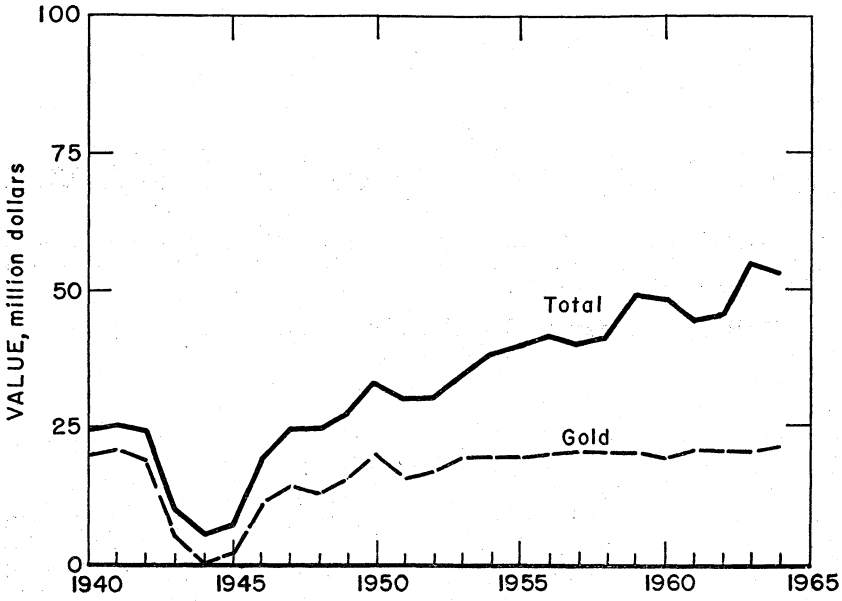


FIGURE 1.—Value of gold and total value of mineral production in South Dakota.

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

(Thousands)

Year	Value	Year	Value
1953	$35,157	1959	$48,009
1954	38,970	1960	46,638
1955	41,387	1961	r 43,785
1956	41,836	1962	r 44,387
1957	40,241	1963	r 51,285
1958	41,733	1964	49,482

r Revised.

Employment and Injuries.—Final statistics for 1963 of employment and injuries in the mineral industries, excluding the petroleum industry, and preliminary data for 1964, compiled by the Bureau of Mines, are given in table 3.

Government Programs.—The Federal Bureau of Mines was engaged in studies to determine whether lignite coal from extensive deposits in the State could be used successfully as a soil conditioner and fertilizer. An investigation of iron occurrences was completed. Other projects under way included a study of the petroleum and natural gas resources in the State and a mineral industry survey of the State.

At Sioux Falls, the Pathfinder atomic reactor operated by Northern States Power Co. achieved criticality in the boiler region on March 24. Loading of the boiler core was completed in September, superheater fuel was loaded during November.

The 1964 South Dakota Legislature voted a reduction in the State severance tax from 2.5 to 1 percent.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	8	1	11		1	89
Metal	2,088	612	4,894	3	72	15
Nonmetal	177	39	325		10	31
Sand and gravel	1,615	283	2,321		41	18
Stone	593	134	1,087		30	28
Total	4,481	1,069	8,638	3	154	18
1964: p						
Coal	8	1	11		1	91
Metal	2,085	624	5,000	1	73	15
Nonmetal	235	57	469		8	17
Sand and gravel	1,070	187	1,536		42	27
Stone	725	160	1,317		32	24
Total	4,123	1,029	8,333	1	156	19

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of cement from the State-owned plant at Rapid City consisted of approximately 2 million barrels of portland cement and 43,000 barrels of masonry cement. The average price of portland cement in 1964 was $3.43 per barrel, compared with $3.16 in 1963; the price of masonry cement increased from $4.43 to $4.70 per barrel. Out-of-State shipments were made to Iowa, Minnesota, Montana, Nebraska, North Dakota, and Wyoming.

Cement-plant profits of $2.5 million were allocated to the State general fund, $500,000 to the State highway fund, and $500,000 allocated to counties and cities according to a formula established by the State Legislature in 1963. One-third of the $500,000 was distributed in equal shares to all counties. The remaining two-thirds was allocated to counties and cities, on the basis of assessed valuation.

Clays.—Bentonite was mined on State-owned land west of Belle Fourche and processed for use mainly as a refractory in foundries and in preparing well-drilling muds; bentonite also was used in adhesives, animal feed, briquette binding, enameling, filters, insecticides, manufacturing paper, plaster, and reservoir sealants. Processing plants continued to be supplied with crude material from deposits in Wyoming.

Miscellaneous clay was mined near Belle Fourche and was used for manufacturing building brick; shale produced near Rapid City was used as a raw material for cement and in manufacturing lightweight aggregate.

Feldspar.—Output of feldspar increased 5 percent over that of 1963, although five fewer mines were operated. There were 17 mines in Custer County and 7 in Pennington County. Most of the feldspar, purchased by International Minerals & Chemical Corp. (IMC), was

ground at the company plant near Custer for shipment to out-of-State markets. The feldspar section of the Northwest Beryllium Co. plant, at Keystone, was destroyed by fire on March 30. The section was rebuilt and the entire plant was enlarged.

The ground feldspar was shipped to manufacturers of brick and tile, enamel, glass, porcelain, and pottery in Canada and Mexico in addition to domestic consumers.

Gypsum.—Gypsum, used as a retarder in portland cement, was mined by the South Dakota Cement Commission from deposits in Pennington County.

Lime.—Late in 1964, Pete Lien & Sons began lime production at a new $500,000 plant situated at the company-owned limestone quarry near Rapid City. The quantity produced was four times that originally projected. The company planned to market its product in western North Dakota and Nebraska, eastern Wyoming and Montana, and all of South Dakota. Much of the lime was used for soil stabilization in highway construction.

Production of metallurgical lime was continued by Black Hills Lime Co. at Pringle, in Custer County. Utah-Idaho Sugar Co. produced lime for use in manufacturing beet sugar at its Belle Fourche plant. Late in the year, the company announced that the plant, which was opened in 1927, was to be closed permanently.

Lithium.—Production of lithium (hand-sorted amblygonite) was recorded at the Hugo mine, operated by L. W. Judson, and at the Ingersoll mine, operated by Keystone Chemical Corp. Both mines are near Keystone, in Pennington County. Only two other States, California and North Carolina, reported lithium production.

Mica.—Scrap mica was produced at the Ingersoll mine of Keystone Chemical Co. and at the Peerless mine of Northwest Beryllium Co. Both mines are near Keystone. The mica was sold to manufacturers of paint and roofing materials.

No production of sheet mica was reported, thus ending 12 consecutive years of production.

Sand and Gravel.—Production of sand and gravel was reported in 63 of the 67 counties: Jackson, Jones, Stanley, and Ziebach Counties had no production. Large production was reported for those counties where major road construction was under way.

There were 109 commercial operations in 39 counties and 261 Government-and-contractor operations in 61 counties. Seven of the commercial operators reported production of over 100,000 tons of sand and gravel.

Ten million tons of gravel and 3 million tons of sand—94 percent of the output—was used for paving. The remainder was used mostly in building construction and as fill and railroad ballast. Of the total production, 97 percent was processed by being washed, sized, or otherwise prepared. Except for 164,000 tons moved by rail, all sand and gravel was transported by truck.

The State Highway Commission awarded 177 construction contracts totaling $34 million. There was 925.6 miles of Federal-Aid projects: 65.2 miles in the National System of Interstate and Defense Highways and 860.4 miles in the Federal-Aid Primary and Secondary Highway Systems (ABC programs). As of December 31, 1964, 311.9 miles or 46 percent of the designated 679.2 miles of the interstate

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	598	$597	381	$395
Paving	317	304	301	293
Railroad ballast	W	W		
Fill	44	29	20	16
Industrial:				
Other	3	2	35	35
Total	962	932	737	739
Gravel:				
Construction:				
Building	390	421	276	354
Paving	1,898	1,813	1,468	1,326
Railroad ballast	52	40	24	21
Fill	58	34	54	34
Miscellaneous	139	79		
Total	2,537	2,387	1,822	1,735
Total sand and gravel	3,499	3,319	2,559	2,474
Government-and-contractor operations:				
Sand:				
Building			12	12
Paving	1,352	1,294	2,423	2,423
Total	1,352	1,294	2,435	2,435
Gravel:				
Building	9	9	46	46
Paving	15,944	11,689	8,730	8,686
Fill	2	2		
Total	15,955	11,700	8,776	8,732
Total sand and gravel	17,307	12,994	11,211	11,167
All operations:				
Sand	2,314	2,226	3,172	3,174
Gravel	18,492	14,087	10,598	10,467
Total	20,806	16,313	13,770	13,641

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

system was open to traffic; in addition, engineering planning and right-of-way acquisitions were under way on 302.1 miles and 65.2 miles was under construction. South Dakota was one of nine States where work was either in progress or completed on 100 percent of the designated interstate mileage.[4]

Planned State highway department contracts for 1965 totaled $55.3 million, compared with $34 million in 1964[5] and $60.4 million in 1963.

Stone.—Granite, all mined at seven quarries in Grant County, accounted for 45 percent of the value of stone produced. Most of the granite was finished at plants in Minnesota for use in building construction and as monumental stone. Crushed and broken limestone was mined in Custer, Fall River, Lawrence, and Pennington Counties

[4] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65–10, Feb. 11, 1965.
[5] Engineering News-Record. State Highway Contract Awards Jump to a Record High. V. 174, No. 12, Mar. 25, 1965, pp. 30–32.

for asphalt filler, in manufacturing cement and lime, as railroad ballast and riprap, and in road construction. Noncommercial uses were by the U.S. Army Corps of Engineers, the Federal Bureau of Reclamation, the Federal Forest Service, and the South Dakota and Wyoming State Highway Departments. Crushed and broken sandstone was produced in Hanson, Minnehaha, Pennington, and Tripp Counties for concrete and road aggregates, filters, railroad ballast, refractory stone, riprap, and roofing granules.

TABLE 5.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Aurora	205	$205	Hyde	198	$198
Beadle	404	404	Jerauld	89	89
Bennett	187	187	Kingsbury	174	174
Bon Homme	191	191	Lake	171	172
Brookings	233	247	Lawrence	307	307
Brown	579	580	Lincoln	161	160
Brule	1,036	1,036	Lyman	151	151
Buffalo	117	116	Marshall	232	228
Butte	59	83	McCook	138	138
Campbell	3	2	McPherson	114	114
Charles Mix	533	533	Meade	315	310
Clark	229	220	Mellette	15	15
Clay	76	75	Miner	105	105
Codington	135	124	Minnehaha	1,206	1,181
Corson	450	450	Moody	609	615
Custer	82	82	Pennington	434	459
Davison	93	93	Perkins	189	200
Day	329	328	Potter	116	116
Deuel	69	70	Roberts	399	391
Dewey	99	99	Sanborn	45	50
Douglas	231	237	Shannon	37	37
Edmunds	412	414	Spink	269	269
Fall River	97	103	Sully	47	47
Faulk	89	89	Todd	78	78
Grant	56	56	Tripp	84	52
Gregory	84	75	Turner	422	418
Haakon	50	50	Union	95	95
Hamlin	12	13	Walworth	270	150
Hand	25	25	Washabaugh	74	74
Hanson	48	48	Yankton	181	181
Harding	390	390			
Hughes	89	89	Total	13,770	13,641
Hutchinson	353	353			

TABLE 6.—Stone sold or used by producers, by kinds

Year	Granite		Limestone		Sandstone [1]	
	Short tons	Value	Short tons	Value	Short tons	Value
1960	17,915	$3,002,488	1,578,618	$2,501,216	1,031,524	$1,855,179
1961	26,476	2,823,441	1,378,062	1,939,293	984,512	1,493,464
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

Year	Other stone		Total	
	Short tons	Value	Short tons	Value
1960	520,945	$550,469	3,149,002	$7,909,352
1961	417,391	385,953	2,806,441	6,642,151
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

[1] Includes quartz and quartzite.
[2] Includes slate.

TABLE 7.—Stone sold or used by producers, by uses

Use		1963		1964	
		Quantity	Value	Quantity	Value
Dimension stone:					
Rough construction and rubble	short tons	W	W		
Rough architectural	cubic feet	W	W	4,000	$15,810
Dressed architectural	do.	22,518	$167,714	16,410	110,136
Rough monumental	do.	W	W	23,000	77,190
Dressed monumental	do.	170,511	2,482,407	176,382	2,604,715
Flagging	do.	W	W		
Other	do.	71,900	134,652		
Total (approximate, in short tons)		25,430	2,784,773	17,803	2,807,851
Crushed and broken stone:					
Riprap	short tons	184,140	238,984	258,242	529,044
Railroad ballast	do.	W	W	220,958	330,974
Concrete and roadstone	do.	1,929,070	3,325,693	1,108,020	1,778,340
Cement	do.	416,642	624,963	W	W
Other	do.	[1] 238,286	[1] 364,296	[2] 512,692	[2] 798,803
Total	do.	2,768,138	4,553,936	2,099,912	3,437,161
Total stone (approximate, in short tons)		2,793,568	7,338,709	2,117,715	6,245,012

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes stone used in asphalt, filler, lightweight aggregate, lime, and refractory.
[2] Includes stone used in asphalt filler, filter, lime, refractory, and roofing granules.

METALS

Beryllium.—Production of beryl increased substantially. Beryllium concentrate (beryl) production was purchased by Beryl Ores Co., Golden, Colo., from independent producers including Keystone Chemical Co., operator of the Ingersoll mine, in Pennington County.

Copper.—No production of copper was reported in 1964; a small amount had been produced in Pennington County in 1963.

Gold and Silver.—Gold production increased 7 percent and silver 14 percent. Except for a small amount of gold recovered from a placer operation in Pennington County, all of the gold and silver was produced by Homestake Mining Co. at its Homestake mine at Lead, Lawrence County. The quantity of ore mined and milled and the value of gold and silver recovered in 1964 were the largest in the history of the company.

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)
1955–59 (average)	2	----	1,758	563,016	$19,706	140	$127
1960	2	----	1,767	554,771	19,417	108	98
1961	2	----	1,781	557,855	19,525	127	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
1876–1964	NA	NA	NA	30,579,633	851,884	12,008	9,120

NA Not available.
[1] Excludes placer gravel.

Iron Ore.—Magnetic highs, often indicative of iron occurrences, were discovered near Bristol and near Crandall, in Day County, and Langford, in Marshall County. The discoveries were the result of surveys made in 1963 by the South Dakota Geological Survey and the University of South Dakota. American Metal Climax, Inc., leased approximately 4,500 acres in the area.

Iron ore mined in prior years from deposits near Nemo and stockpiled was used in manufacturing cement at Rapid City. None was produced in 1964.

Lead.—No production of lead was reported in 1964; a small amount had been produced in Lawrence and Pennington Counties in 1963.

Molybdenum.—Molybdenum was recovered as a byproduct in the treatment of uranium-bearing lignite ash at the mines Development mill at Edgemont and at the Kermac Nuclear mill in New Mexico. This was the first known shipment of molybdenum from the State.

Uranium.—The quantity of uranium ore mined increased 53 percent over that of 1963; however, the value of the contained uranium declined 20 percent because of a drop in the average grade of ore mined. The greatest increase was in the sandstone ores mined in Custer and Fall River Counties. Output of uranium ores from Harding County declined.

Kermac Nuclear Fuels Corp. began burning uranium-bearing lignite ore, mined in South Dakota, at the company burning plant at Bowman, N. Dak. The lignite was burned under controlled conditions to yield an ash amenable to treatment. The ash was processed at the company uranium mill near Grants, N. Mex.

At the Edgemont, Fall River County, uranium mill of Mines Development, Inc., a subsidiary of Susquehanna-Western, Inc., lignite ash and sandstone ores were treated for recovery of uranium, vanadium, and molybdenum. The sandstone ores were from South Dakota and Wyoming and included both company-mined and custom ores. The ash was produced at the company burner near Buffalo, in Harding County. The plant also processed lignite ash from deposits in Billings County, N. Dak. Operation of the mill was to continue until the 1966 Atomic Energy Commission (AEC) contract expires.

Vanadium.—Production of vanadium oxide (V_2O_5) was continued at the Mines Development, Inc., uranium mill at Edgemont. The vanadium was contained in sandstone ores from Custer and Fall River Counties, S. Dak., and from Wyoming.

MINERAL FUELS

Coal (Lignite).—Output of coal (lignite), other than uraniferous lignite, was from the Dewey County Coal Co. strip mine near Firesteel. The coal, under 27 feet of overburden, was mined with a power shovel and dragline for stripping and loading.

Petroleum.—Production of crude petroleum in 1964 was 247,422 barrels. Of this 195,551 barrels was from 20 wells in the Buffalo field in Harding County, and the remainder from 4 wells in the Barker Dome field in Custer County. Some oil was recovered from a remote well in Dewey County. The showing was with a large amount of water, produced in a well drilled to the Red River formation.

Leasing was a highlight of petroleum activity marked by the largest lease sale in South Dakota history in December when 369,355 acres was leased.

Drilling activity increased with the drilling of 26 wells, 8 more than in 1963. The well in Dewey County was not considered completed in 1964.

TABLE 9.—Wildcat and development well completions in 1964, by counties

County	Oil	Dry	Total	Footage
Wildcat:				
Fall River		11	11	30,300
Gregory		1	1	2,200
Harding		2	2	18,000
Jones		1	1	2,500
Mellette		1	1	2,600
Spink		2	2	2,000
Stanley		1	1	3,300
Tripp		1	1	3,200
Total		20	20	64,100
Development:				
Custer	2	3	5	7,700
Harding	1		1	8,800
Total	3	3	6	16,500
Total all drilling	3	23	26	80,600

Source: Oil and Gas Journal.

Exploration and development drilling in the Minnelusa formation in eastern Wyoming prompted the drilling of wildcat wells in southwestern South Dakota. A series of Minnelusa tests were started in Meade and Butte Counties.

Kaneb Pipe Line Co. expanded its system by laying 120 miles of 6-inch products pipeline from Yankton to Wolsey.

REVIEW BY COUNTIES

Mineral production was reported from all but 4 of the 67 counties in the State. Jackson, Jones, Stanley, and Ziebach Counties reported no mineral production.

Butte.—American Colloid Co. produced bentonite and operated its processing plant at Belle Fourche. IMC processed bentonite at its Belle Fourche plant from the raw material mined in Wyoming. Bentonite was used as refractories in foundries and steel plants, in rotary-drilling mud, and in many other uses.

Black Hills Clay Products Co. produced clay for manufacturing building brick.

Sand and gravel was produced by three commercial and two Government-and-contractor operators. Sand was used in paving; gravel was used in building construction and in paving.

Utah-Idaho Sugar Co., a producer of lime used in manufacturing beet sugar, announced that the Belle Fourche plant was to be closed early in 1965.

TABLE 10.—Value of mineral production in South Dakota, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Aurora	$145,000	$205,000	Sand and gravel.
Beadle	265,973	404,000	Do.
Bennett	13,000	187,000	Do.
Bon Homme	180,537	191,000	Do.
Brookings	W	247,000	Do.
Brown	304,836	580,000	Do.
Brule	356,000	1,036,000	Do.
Buffalo	166,000	116,000	Do.
Butte	W	W	Clays, sand and gravel, lime.
Campbell	17,000	2,000	Sand and gravel.
Charles Mix	95,773	533,000	Do.
Clark	118,000	220,000	Do.
Clay	70,000	75,000	Do.
Codington	410,000	124,000	Do.
Corson	321,081	450,000	Do.
Custer	r 1,039,798	614,380	Feldspar, stone, petroleum, sand and gravel, uranium ore, vanadium, lime.
Davison	97,000	93,000	Sand and gravel.
Day	253,000	328,000	Do.
Deuel	111,331	70,000	Do.
Dewey	107,872	162,050	Sand and gravel, coal.
Douglas	338,309	237,000	Sand and gravel.
Edmunds	70,000	414,000	Do.
Fall River	312,816	474,893	Uranium ore, vanadium, sand and gravel, stone.
Faulk	157,000	89,000	Sand and gravel.
Grant	3,692,773	2,863,851	Stone, sand and gravel.
Gregory	124,000	75,000	Sand and gravel.
Haakon	284,000	524,575	Stone, sand and gravel.
Hamlin	134,000	13,000	Sand and gravel.
Hand	285,000	25,000	Do.
Hanson	617,204	48,000	Do.
Harding	r 2,266,875	2,117,697	Uranium ore, petroleum, sand and gravel, molybdenum.
Hughes	251,000	89,000	Sand and gravel.
Hutchinson	403,203	353,000	Do.
Hyde	54,000	198,000	Do.
Jackson	69,005	----	
Jerauld	414,000	89,000	Sand and gravel.
Kingsbury	189,000	174,000	Do.
Lake	242,000	172,000	Do.
Lawrence	20,767,795	22,122,992	Gold, sand and gravel, silver, stone.
Lincoln	257,000	160,000	Sand and gravel.
Lyman	417,000	151,000	Do.
Marshall	162,000	228,000	Do.
McCook	182,194	138,000	Do.
McPherson	122,542	114,000	Do.
Meade	504,649	310,000	Do.
Mellette	70,000	15,000	Do.
Miner	225,000	105,000	Do.
Minnehaha	2,734,878	2,192,098	Sand and gravel, stone.
Moody	234,000	615,000	Sand and gravel.
Pennington	9,351,442	9,622,948	Cement, stone, sand and gravel, lime, clays, gypsum, mica (scrap), feldspar, lithium, beryllium concentrates, gold.
Perkins	180,000	200,000	Sand and gravel.
Potter	191,000	116,000	Do.
Roberts	255,240	391,000	Do.
Sanborn	39,000	50,000	Do.
Shannon	5,000	37,000	Do.
Spink	205,000	269,000	Do.
Stanley	37,452	----	
Sully	63,000	47,000	Sand and gravel.
Todd	14,000	78,000	Do.
Tripp	1,000	W	Stone, sand and gravel.
Turner	940,218	418,000	Sand and gravel.
Union	95,000	95,000	Do.
Walworth	303,000	150,000	Do.
Washabaugh	----	74,000	Do.
Yankton	134,000	181,000	Do.
Ziebach	37,000	----	
Undistributed[2]	r 2,611,158	1,349,866	
Total	r 54,116,000	52,824,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] Jones County is not listed because no production was reported.

[2] Includes production of some sand and gravel (1963), gem stones, and beryllium concentrates (1964) that cannot be assigned to specific counties, and values indicated by symbol W.

Custer.—A decline in the value of mineral production of 41 percent compared with that of 1963 resulted chiefly because stone production dropped sharply. Increases in value of production were noted for feldspar and petroleum; decreases were registered for sand and gravel, stone, uranium, and vanadium. Beryllium and sheet mica had been produced in 1963, but were not reported in 1964.

Feldspar was produced at 17 mines, of which 5 yielded in excess of 1,000 long tons. IMC purchased feldspar in addition to operating its own mines. The feldspar was ground at the company plant near Custer before shipment to out-of-State markets.

Sand and gravel was produced for use in paving. Limestone was mined for manufacturing lime at Black Hills Lime Co. near Pringle. Although uranium ore production increased, the lower average grade of the ore resulted in a decreased value of production. Byproduct vanadium was recovered from the treatment of the uranium ores.

At the Barker Dome field, four producing oil wells, two more than in 1963, increased output from 4,000 barrels in 1963 to 52,000 in 1964. Oil well exploration was continued: five wells were drilled to completion, and two became producers.

Fall River.—Sandstone uranium ore from 20 mines in the county was processed at Mines Development, Inc., mill at Edgemont. The mill-feed also included sandstone ores from three mines in Custer County; lignite ash from mines in Harding County and from Billings County, N. Dak.; and approximately 122,000 tons of ore from mines in Campbell, Converse, and Crook Counties, Wyo. Vanadium oxide from sandstone ores and molybdenum from lignite ash were recovered as byproducts.

Value of sand and gravel production was $103,000, a 102-percent increase. All production by commercial operators, Flyte Sand & Gravel Co. and Oral Sand Co., was used for building construction. There were also two Government-and-contractor operators.

Oil well exploration activity was greater than any other county as 11 wildcat wells were drilled to completion; all were dry.

Grant.—Grant County was ranked third in the value of minerals produced due to output of granite at seven quarries near Milbank and Big Stone City. Although the value of stone production increased, a sharp decline in sand and gravel output resulted in an $829,000 drop in overall value of minerals produced.

Harding.—Petroleum production from 20 producing wells at the Buffalo field declined slightly. Three wells were completed.

Kermac Nuclear Fuels Corp. mined uranium-bearing lignite ore. Susquehanna-Western, Inc., burned lignite at the company burner near Buffalo.

Lawrence.—All of the gold and silver produced in Lawrence County was mined by Homestake Mining Co. According to the company annual report to stockholders, both tonnage and revenue, increasing by 7 percent, established new annual alltime highs for the mine. Metallurgical recovery was 96.24 percent, compared with 96.92 percent in 1963.

According to the annual report to stockholders the measured ore reserve as of December 31, 1964, was 16.8 million tons, with an esti-

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	
1960	1,767	$19,465	$11.02	$4,021
1961	1,781	19,590	11.00	4,030
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

[1] From 1876 to 1964, inclusive, this mine yielded bullion and concentrates that brought a net return of $779.9 million and paid $224.7 million in dividends

Source: Homestake Mining Co. annual report to stockholders.

mated grade of $11.01 (0.315 ounces) of gold per ton, a decline of 31 cents per ton. For the first time, the measured reserve included ore in Eleven Ledge, from the 3,950-foot level to the 4,400-foot level, and from the 5,000-foot level to the 6,050-foot level.

Progress was made in preparation for mining below the 4,850-foot level. The planned rate of 800 tons per day from the lower levels was achieved late in the year. In the lower levels, ore shoots, though numerous, were small and irregular; and rock pressures were higher.

As depth of mining increased, ventilation and air conditioning continued to be major factors.[6] Rock temperature at the surface of the Homestake mine was 44° Fahrenheit. The temperature and latent humidity increased about 1.5° Fahrenheit with each 100 feet of depth. At the lowest point in the mine, 6,800 feet below the surface, air temperature reaches 120° Fahrenheit. In addition to an extensive ventilation system, Homestake used portable refrigeration units. The units were specially designed and custom built, patterned on similar units in use in South Africa, by Yale Inc., Minneapolis, Minn. The air conditioners are operated from 100 to 1,000 feet from the working face.

Pennington.—Eleven minerals were produced, more than in any other county, and all of the State production of cement, gypsum, lithium, and mica came from the county.

Shipments of portland and masonry cements from the State-owned cement plant at Rapid City were valued at more than $7 million, a 16-percent increase. Limestone, shale, gypsum, and sand used at the plant were mined near Rapid City. Iron ore, used in manufacturing specialty cements, was obtained from stockpiles. Cement shipments were made to all of the States bordering South Dakota.

Crushed and broken limestone also was produced by Hills Materials Co., L. G. Everist, Inc., and Pete Lien & Sons, for use in manufacturing lime, as railroad ballast and riprap, and in road construction. Crushed sandstone, produced by Newlon & Cordes, was used as roofing granules.

Sand and gravel for use in building and paving was produced by commercial and Government-and-contractor operators. The commercial operators were Birdsall Sand & Gravel Co., and L. G. Everist,

[6] Engineering and Mining Journal. Homestake Spot Cools Hot Work Levels. V. 166, No. 4, April 1965, p. 91.

Inc. Government operators were the South Dakota Cement Commission, the Federal Forest Service, and the South Dakota Department of Highways.

Feldspar production was reported from seven mines and five producers: Hough & Judson, IMC, Keystone Chemical Co., Northwest Beryllium Co., and Robert Stilen. Mica also was produced by Keystone Chemical Co. and Northwest Beryllium Co.

Northwest Beryllium Co. continued to operate its flotation mill at Keystone. In March, fire destroyed the building housing the feldspar section. A new building was constructed containing feldspar-concentrating equipment, filter, magnetic separators, and a shop. Reportedly, a modification of a flotation process developed by the Federal Bureau of Mines was used to recover pegmatite minerals. The process was adopted after considerable research and laboratory work by the company. The mill was equipped to recover scrap mica, soda feldspar, high-purity silica sand, beryl, columbite-tantalite, and cassiterite. The company also planned to recover potash feldspar, which was to be selectively mined, dry crushed, and hand sorted. Metallurgical steps were to include crushing and screening to produce a scrap mica product and to provide rodmill feed; grinding followed by gravity concentration to produce a concentrate of columbite-tantalite and cassiterite; flotation to recover fine mica, feldspar, and beryl; magnetic concentration to remove impurities; and acid digestion and magnetic separation to produce silica sand. Planning was designed to increase daily mill capacity to 200 tons of ore.[7]

Production was begun at the lime plant operated by Pete Lien & Sons of Rapid City. The 175-ton-per-day calcining and hydrating plant used a rotary kiln with continuous hydrator and automatic mill to treat the raw material obtained from the 40-foot-thick Minnekahta limestone formation near the plant. Most of the product was to be used as a soil stabilizer in road construction. The firm had been awarded a contract by Northwestern Engineering Co. of Denver (Colo.) and Rapid City, to provide 8,035 tons of hydrated lime for highway construction. About 50 men were to be employed at the plant.[8]

Miscellaneous clay, in addition to that used for cement, was produced from deposits near Rapid City for manufacturing lightweight aggregate. Lithium was produced at the Hugo and Ingersoll mines near Keystone. Virgil Williams, of Keystone, produced a small amount of gold from a stream-gravel placer deposit.

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[7] Thom, Clarence. Mineral Recovery at Northwest Beryllium Corp. Deco Trefoil, v. 29, No. 1, January–February 1965, pp. 9–16.

[8] Simpson, Jack R., New Rotary-Kiln Lime Plant in South Dakota. Pit and Quarry, v. 56, No. 11, May 1964, pp. 92–97.

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 masonry cement, ball clay, phosphate rock, sand and gravel, and zinc highlighted the mineral industry of Tennessee in 1964. Tennessee led the Nation in production of ball clay, pyrite, and zinc; it ranked second in output of phosphate rock, third in output of dimension marble; and fourth in production of fuller's earth and dimension sandstone. The total value of mineral production was 8 percent greater than in 1963, the previous record year. Increased zinc production accounted for 72 percent of the increased value.

Leading industries which together furnished 93 percent of the total value of production, follow: Copper and zinc mining, stone quarrying, cement manufacturing, coal mining, phosphate rock mining and processing, and sand and gravel mining. Leading companies were Tennessee Copper Co. (copper, gold, pyrite, silver, and zinc), American Zinc Co. of Tennessee (limestone and zinc), Monsanto Co. (phosphate rock), Penn-Dixie Cement Corp. (cement, clay, and limestone), Marquette Cement Manufacturing Co. (cement, clay, and limestone), New Jersey Zinc Co. (limestone and zinc), Ideal Cement Co. (cement, clay, and limestone), and Signal Mountain Division of General Portland Cement Co. (cement and limestone).

Trends and Developments.—American Zinc Co. continued development of the Immel mine in Knox County. Initial production was expected by the end of 1965, with an output of 2,000 tons per day by 1967. Primary crushing will be done underground, and the ore will be shipped to the Mascot mill by truck.

American Smelting & Refining Co., after obtaining options on substantial acreage, initiated a drilling program late in 1964. The acreage, in a belt parallel to the Mascot-Jefferson City zinc belt, is northeast of Knoxville and extends to a point southwest of Jefferson City. Initial cost of the project, including options and preliminary drilling, is estimated at $250,000 for 1964.

[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	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	24,082	$404	39,188	$519
Cement:				
Masonry—thousand 280-pound barrels	1,161	3,079	1,212	3,228
Portland—thousand 376-pound barrels	8,283	26,760	8,343	26,791
Clays [2]—thousand short tons	1,238	5,248	1,310	5,576
Coal (bituminous)—do	6,121	22,689	5,990	22,674
Copper (recoverable content of ores, etc.)—short tons	13,717	8,450	13,889	9,056
Gold (recoverable content of ores, etc.)—troy ounces	137	5	133	5
Natural gas—million cubic feet	90	17	77	15
Petroleum (crude)—thousand 42-gallon barrels	16	W	10	W
Phosphate rock—thousand long tons	2,352	17,876	2,441	18,971
Sand and gravel—thousand short tons	7,613	9,443	7,972	10,245
Silver (recoverable content of ores, etc.)—troy ounces	107,913	138	90,539	117
Stone—thousand short tons	26,825	38,113	[3] 26,497	[3] 38,239
Zinc (recoverable content of ores, etc.)—short tons	95,847	22,045	115,943	31,536
Value of items that cannot be disclosed: Fuller's earth, iron ore (1963), lime, pyrite, and values indicated by symbol W	XX	r 6,458	XX	6,993
Total	XX	r 160,725	XX	173,965

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] Excludes fuller's earth: included with "Value of items that cannot be disclosed."
[3] Excludes crushed sandstone, included with "Value of items that cannot be disclosed."

The Tennessee Valley Authority (TVA) Bull Run Steam Plant, being built on the shore of the Melton Hill reservoir in Anderson County, was scheduled to begin operation early in 1966. The plant with one unit of 900,000-kilowatt capacity, will consume an estimated 2.2 million tons of coal annually. TVA started construction of the Nickajack Dam to replace Hales Bar Dam on the Tennessee River below Chattanooga. Cost of the project was estimated at $70 million, and the dam, including powerhouse and locks, was scheduled for completion in 1968. Contracts for the Nickajack Dam project were awarded as follows: Penn-Dixie Cement Corp. will furnish the cement and Lambert Bros. will furnish the sand and crushed stone.

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

(Millions)

Year	Value	Year	Value
1955	$122	1960	$143
1956	136	1961	151
1957	130	1962	154
1958	130	1963	r 163
1959	142	1964	173

r Revised.

Tennessee Copper Co.'s $5 million contact-process sulfuric acid plant began production in mid-1964. The metallurgical gas plant, with a rated capacity of 850 tons per day, produces acid from sulfur dioxide (SO_2). The copper smelter and iron or pyrite roasters provide the SO_2.

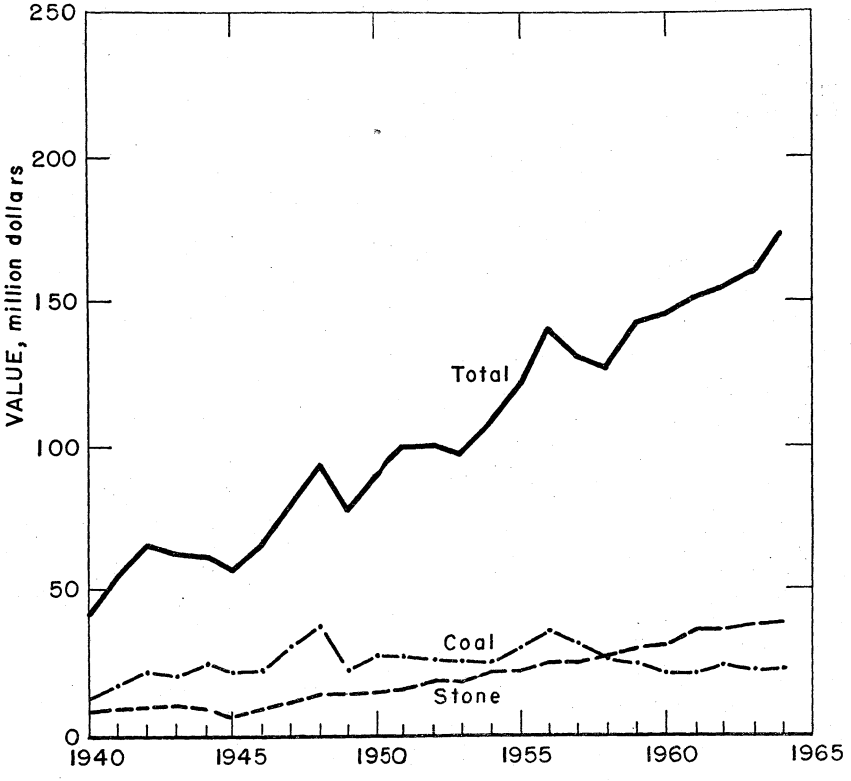


FIGURE 1.—Value of stone, coal, and total value of mineral production in Tennessee.

Victor Chemical Div. of Stauffer Chemical Co. awarded a contract to Allis-Chalmers Manufacturing Co. to build and equip a phosphate rock processing plant at Mt. Pleasant. Allis-Chalmers' Grate-Kiln system, used in producing cement clinker, sintered lime, and iron ore pellets, will be used for the first time in the phosphorus industry. The plant, to be completed in late 1965, will compact phosphate rock into flakes; these will be preheated on the grate as they travel into the kiln where they will be fused into lumps. This material will then go into electric furnaces for the production of elemental phosphorus.

Consolidated Coal Co. planned to open a new $15 million coal mine in Claiborne County. The mine will supply coal to Georgia Power Co.'s Harllee Branch power station. Initial production is expected in 1967, with an annual rate of 1.5 million tons by 1968.

Government Programs.—The Federal Bureau of Mines—with a Mineral Resource Office at Knoxville, a Metallurgy Research Laboratory at Norris, and a Mineral Resource Field Office at Tuscaloosa, Ala.—continued its widespread and comprehensive study of the mineral

industry in Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina, and Tennessee.

The Norris Metallurgy Research Laboratory continued its examination and testing of clays and other ceramic materials. Research also continued on synthetic minerals, synthetic refractory hard materials, and horizontal zinc retorts.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	2,767	475	3,825	1	90	24
Metal	1,088	266	2,132	2	34	17
Nonmetal	1,341	342	2,777		59	21
Sand and gravel	694	174	1,475		33	22
Stone	2,911	747	6,143	2	113	19
Total	8,801	2,004	16,352	5	329	20
1964: p						
Coal	2,972	535	4,300	3	115	27
Metal	1,260	326	2,592	3	83	33
Nonmetal	1,290	339	2,764		48	17
Sand and gravel	725	182	1,545	1	37	25
Stone	3,085	809	6,756	3	99	15
Total	9,332	2,191	17,957	10	382	22

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Production of nonmetals accounted for 64 percent of the total value of mineral production, compared with 67 percent in 1963.

Barite.—Three operators mined crude barite from six mines in three counties for oil-well-drilling muds, chemicals, and other uses. The leading producer was National Lead Co., Ballard mine. Production increased 63 percent but was 63 percent below the record total of 1941.

Cement.—Four companies produced masonry cement at five plants in five counties; the leading producer was Marquette Cement Manufacturing Co. Shipments increased 4 percent above the previous record set in 1963. Consumption in Tennessee was 56 percent, and shipments were made to North Carolina (16 percent), Georgia (13 percent), South Carolina (4 percent), Alabama (4 percent), Kentucky (3 percent), Virginia (3 percent), 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 increased 1 percent, but were 2 percent below those of 1962, the record year. Consumption in Tennessee was 50 percent, and shipments were made to North Carolina (19 percent), Georgia (18 percent), Alabama (5 percent), Virginia (3 percent), Kentucky (2 percent), South Carolina (2 percent), and other States (1 percent). Raw materials used in cement included limestone (86 percent), clays and shale (9 percent), gypsum (3 percent), and other (2 percent). All limestone was produced from captive operations.

Portland cement was used as follows: In ready-mixed concrete (60 percent), in concrete products (17 percent), by highway contractors (11 percent), by building-materials dealers (6 percent), and in other ways (6 percent).

Clays.—Tennessee led the Nation in the production of ball clay. Five companies operated six mines in Henry and Weakley Counties; leading producers were H. C. Spinks Clay Co., Inc., and United Clay Mines Corp. Production was 4 percent greater than in 1963, the previous record year.

Southern Clay Co., Inc., and Tennessee Absorbent Clay Co. mined fuller's earth in Henry County for absorbent uses. Production increased 11 percent. Tennessee ranked fourth in the Nation in production of fuller's earth.

Miscellaneous clay was mined by 10 companies at 13 mines in 9 counties for building brick, heavy clay products, lightweight aggregate, and cement. Leading counties were Knox, Davidson, and Sullivan; leading producers were General Shale Products Corp. and W. G. Bush & Co., Inc. Production increased 6 percent, but was 10 percent below the record set in 1956.

TABLE 4.—Ball clay sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Whiteware, etc.	211,738	$2,985,339	$14.10	220,490	$3,156,177	$14.31
Floor and wall tile	55,300	772,829	13.98	W	W	W
Firebrick and block	W	W	W	28,750	433,000	15.06
Other uses [1]	88,324	918,802	10.40	121,375	1,343,500	11.07
Total	355,362	4,676,970	13.16	370,615	4,932,677	13.31

W. Withheld to avoid disclosing individual company confidential data.
[1] Includes heavy clay products; enameling; saggers, pins, stilts, and wads; art pottery; exports (1963); other uses; and uses indicated by symbol W.

Lime.—Foote Mineral Co., Knoxville; Williams Lime Manufacturing Co., Knoxville; and Stauffer Chemical Co., Nashville, produced quicklime and hydrated lime for building and chemical uses. Production decreased 2 percent. Consumption in Tennessee was 39 percent, and shipments were made to North Carolina (33 percent), Kentucky (15 percent), South Carolina (6 percent), Virginia (3 percent), and other States (4 percent).

Mica.—Carolina Southern Mining Co., Inc., in Unicoi County produced ground mica for welding rods and joint cement from scrap mica shipped from North Carolina. The plant closed in mid-1964.

Perlite.—Chemrock Corp. expanded crude perlite from Colorado at the Nashville plant for filter aids, concrete aggregate, building plaster, loose fill insulation, and soil conditioning.

Phosphate Rock.—Seven companies mined and processed phosphate rock in Giles, Hickman, Maury, Sumner, and Williamson Counties. Leading producers were Monsanto Co. and Hooker Chemical Co. Marketable production increased 4 percent over that of 1963 and 1 per-

cent over the record set in 1962. Tennessee ranked second in the Nation in the production of phosphate rock.

V-C Corp. completed and started operating its new electric elemental-phosphorus furnace at Mt. Pleasant.

TABLE 5.—Phosphate rock sold or used by producers, by uses

Use	1963			1964		
	Long tons	Value		Long tons	Value	
		Total	Average per ton		Total	Average per ton
Elemental phosphorus	2,257,567	$16,848,592	$7.46	2,372,698	$18,227,988	$7.68
Ordinary superphosphate [1]	137,831	1,453,976	10.54	86,130	845,705	9.82
Total	2,395,398	18,302,568	7.64	2,458,828	19,073,693	7.76

[1] Includes triple superphosphate (1963), pig-iron blast furnace (1963), fertilizer filler (1963), and direct application to the soil.

Pyrite.—Tennessee Copper Co. recovered pyrite concentrate from sufide ore mined in Polk County. Production increased 2 percent, but was 4 percent below the record total of 1957. Tennessee continued to lead the Nation in output of pyrite.

Sand and Gravel.—Sand and gravel was mined by 38 commercial operators at 42 locations in 27 counties. Government-and-contractor production amounted to 9 percent of the total mined. There were six Government-and-contractor operators at six locations in six counties. Leading counties were Shelby, Benton, and Davidson. Leading commercial producers were Hadley Contracting Co., Inc., Ingram Materials, Inc. and Cordova Sand and Gravel Co., Inc. Total production increased 5 percent over the 1963 record figure. Of the total production, 90 percent was washed. Transportation was as follows: 80 percent was hauled by truck, 16 percent by rail, and 4 percent by water.

Stone.—Limestone was crushed by 56 commercial operators at 81 quarries in 51 counties. Government-and-contractor production amounted to 7 percent of the total crushed limestone and was produced at 23 quarries in 17 counties. Leading commercial producers were Lambert Bros. (Blount, Claiborne, Davidson, Hawkins, Humphreys, Knox, Roane, Sevier, Sullivan, and Williamson Counties) and Chattanooga Rock Products (Hamilton and Marion Counties). Production decreased 1 percent below the record of 1963. Of the total commercial production, 89 percent was hauled by truck, 8 percent by rail, and 3 percent by waterway.

John J. Craig Co., Knoxville Crushed Stone Co., and Appalachian Marble Co. crushed marble for terrazzo and other uses. Production decreased 10 percent below that of 1963 and was 43 percent below the record of 1948. John J. Craig Co. (Hamil, Marmor, Crisp, and Lee quarries), Tennessee Marble Co. (Endsley, Eagle, and Luttrell quarries), Gray Knox Marble Co. (Brown and Gray Knox quarries), Appalachian Marble Co. (Bond and Appalachian quarries), and Imperial Black Marble Corp. (Thornhill quarry) quarried dimension

TABLE 6.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Benton	817	$1,282	774	$1,387
Cumberland	63	87	53	83
Davidson	W	W	633	1,100
Fayette	107	107	97	85
Giles	200	200	175	142
Greene			28	42
Grundy	84	134	135	169
Hardeman	58	68	58	72
Haywood	59	46	84	68
Lauderdale	77	60	56	45
Loudon	15	22	W	W
Monroe	22	34	23	34
Obion	W	W	129	104
Polk	8	16	W	W
Shelby	1,525	1,394	1,427	1,390
Unicoi	280	450	W	W
Undistributed [1]	4,298	5,543	4,300	5,524
Total	7,613	9,443	7,972	10,245

W. Withheld to avoid disclosing individual company confidential data.

[1] Includes Bradley, Carroll, Decatur, Franklin, Gibson, Hamilton, Henderson, Humphreys, Knox, McNairy, Putnam, Sevier, Stewart, Tipton, and Wayne 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	1963			1964		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,832	$2,735	$1.49	1,922	$2,858	$1.49
Paving	857	1,252	1.46	1,096	1,576	1.44
Molding	246	738	3.00	285	853	2.99
Fire or furnace	7	13	2.00	20	40	2.00
Engine	1	2	1.50	2	3	1.50
Other sand [1]	457	860	1.88	465	908	1.95
Total	3,400	5,600	1.65	3,790	6,238	1.65
Gravel:						
Paving	2,875	2,368	.82	2,810	2,378	.85
Structural	1,141	1,325	1.16	1,038	1,286	1.24
Railroad ballast	50	67	1.35	W	W	W
Other gravel [2]	147	83	.56	334	343	1.03
Total	4,213	3,843	.91	4,182	4,007	.96
Total sand and gravel	7,613	9,443	1.24	7,972	10,245	1.29

W. Withheld to avoid disclosing individual company confidential data.

[1] Includes grinding and polishing, other construction, fill, glass sand, and other sands.

[2] Includes fill, other construction, and miscellaneous gravel; and other gravel as indicated by symbol W.

marble in Blount, Grainger, Knox, and Union Counties. Production increased 5 percent over that of 1963, but was 46 percent below the record of 1957. Tennessee ranked second in the Nation in production of dimension marble.

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Sewanee Silica Co., White Silica Sand Co., and Turner Bros. Stone Co., Inc., crushed sandstone. Production increased 6 percent over that of 1963, but was 9 percent below the record of 1962. Fifteen companies quarried dimension sandstone at 16 quarries in Cumberland and Fentress Counties for rough architectural, sawed and dressed building stone, and flagging. Leading producers were Tennessee Stone Co., Inc., and Crab Orchard Stone Co., Inc. Production increased slightly but was 48 percent below the record of 1955. Tennessee ranked fourth in the Nation in production of dimension sandstone.

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Blount	455,117	$627,749	343,841	$491,113
Claiborne	162,724	214,761	212,660	285,815
Clay	87,333	131,000	84,000	126,000
Cocke	58,418	87,627	91,369	95,023
Davidson	2,938,181	3,197,578	3,192,814	3,729,291
Decatur	W	W	976,291	1,127,851
Fentress	127,493	169,926	198,700	271,200
Franklin	745,398	1,001,125	766,045	1,037,107
Grainger	29,544	25,100		
Grundy	55,650	71,675	W	W
Hamblen	344,396	462,144	433,863	592,430
Hawkins	144,100	198,941	136,274	195,847
Humphreys	685,237	833,287	552,252	697,697
Knox	2,716,986	4,397,159	2,150,655	3,075,200
Loudon	500	600		
Macon	80,000	100,000	W	W
Marion	1,051,392	1,304,096	1,151,863	1,493,081
Pickett	16,625	36,250		
Roane	386,375	454,244	W	W
Sevier	256,335	364,878	238,606	346,519
Sullivan	W	W	650,544	894,242
Unicoi	132,000	165,000	130,000	160,000
Union	23,500	29,375	28,628	34,600
Washington	194,702	242,064	258,867	323,943
White	281,865	317,537	124,389	124,389
Williamson	468,280	593,757	420,474	521,401
Undistributed [1]	15,099,368	19,016,501	14,264,913	19,173,163
Total	26,541,519	34,042,374	26,407,048	34,795,912

W Withheld to avoid disclosing individual company confidential data.

[1] Includes Anderson, Bedford, Bradley, Campbell, Cannon, Carter, Coffee, Cumberland, Dickson (1963), Giles, Greene, Hamilton, Hancock (1964), Hardin, Hickman (1963), Jefferson, Johnson, Lincoln, Marshall, Maury, McMinn, Meigs, Monroe, Montgomery, Overton, Putnam, Rhea, Robertson, Rutherford, Sequatchie, Sumner, Warren, Wayne, and Wilson Counties, and counties indicated by symbol W.

TABLE 9.—Crushed limestone sold or used by producers, by uses

Use	1963			1964		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	21,740,841	$26,707,845	$1.23	21,660,276	$28,111,532	$1.30
Cement and lime	2,214,884	3,433,844	1.55	2,265,306	2,797,722	1.24
Agstone	1,631,928	1,873,686	1.15	1,551,103	2,181,411	1.41
Stone sand	274,912	406,822	1.48	246,519	378,867	1.54
Riprap	12,985	14,184	1.09	W	W	W
Other uses [1]	665,969	1,605,993	2.41	683,844	1,326,380	1.94
Total	26,541,519	34,042,374	1.28	26,407,048	34,795,912	1.32

W. Withheld to avoid disclosing individual company confidential data.
[1] Includes railroad ballast, glass, paper (1963), asphalt filler, fertlizer filler, other fillers, filter beds (1963), mineral food, fluxing stone, rock dust for coal mines, other uses, and uses indicated by symbol W.

TABLE 10.—Dimension marble sold or used by producers, by uses

Use	1963			1964		
	Cubic feet	Value		Cubic feet	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Building stone:						
Rough	130,187	$475,688	$3.65	118,271	$388,058	$3.28
Sawed, dressed	194,714	711,700	3.66	182,780	752,214	4.12
Cut, dressed	[1] 38,215	[1] 644,662	[1] 16.87	W	W	W
Total	363,116	1,832,050	5.05	[2] 340,757	[2] 2,135,672	[2] 6.27

W. Withheld to avoid disclosing individual company confidential data.
[1] Includes a small quantity of monumental stone.
[2] Includes monumental stone and uses indicated by symbol W.

METALS

Production of metals accounted for 23 percent of the total value of mineral production, compared with 19 percent in 1963.

Copper.—Tennessee Copper Co. recovered copper concentrate from sulfide ore mined in Polk County. Production of recoverable copper was 1 percent greater than in 1963, but was 3 percent less than the record figure of 1962. The company has extended its development of the mine to the 28 level. Previous core drilling had encountered ore at the 30 level, the deepest ore in the basin.

Ferroalloys.—Shipments of ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, ferrochrome silicon, and ferrophosphorus totaled 306,026 tons, valued at $28,223,000, an increase of 75 percent in tonnage and 30 percent in value from the 1963 figures.

Gold.—Tennessee Copper Co. recovered gold as a byproduct from smelting copper concentrate. Production decreased 3 percent below that of 1963 and was 81 percent below the record set in 1930.

Iron Ore.—There was no recorded production of iron ore. The survey, "The Brown Iron Ores of East Tennessee," was published.[3]

Pig Iron.—Tennessee Products & Chemical Corp. shipped foundry, basic, low phosphorus, malleable, and chromium-bearing pig iron from stocks at its Rockwood plant. The furnace did not operate during 1964, and the plant was sold in mid-1964 to Woodward Iron Co., Woodward, Ala.

Silver.—Tennessee Copper Co. recovered silver as a byproduct from smelting copper concentrate. Production decreased 16 percent from the 1963 figure and was 19 percent below the record set in 1962.

Zinc.—Tennessee zinc production set a record for the fifth time in the last 7 years. Tennessee continued to be the leading zinc producing State.

American Zinc Co. of Tennessee operated the Young, Coy, Grasselli, and North Friends Station mines in Jefferson County and the Mascot No. 2 mine in Knox County. The North Friends Station mine, closed since 1957, was reopened late in 1964 with a planned production of 500 tons per day. New Jersey Zinc Co. operated the Jefferson City mine in Jefferson County and the Flat Gap mine in Hancock County. The Flat Gap mine, closed since 1961, reopened early in 1964 with a planned production of 2,000 tons per day. Tennessee Coal & Iron 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. started production from its New Market mine in Jefferson County in mid-1964. Planned production is 2,400 tons per day. The New Market concentrator continues to treat ores from the American Zinc Co. Young mine.

Total crude ore milled in the State was 5,102,448 tons. Zinc concentrates were shipped to Illinois, Montana, Ohio, Oklahoma, Pennsylvania, and Texas. American Zinc Co. continued sinking a shaft to develop its Immel mine in Knox County.

Exploration and development at zinc and copper mines included the following: Diamond drilling, 66,676 feet; percussion drilling, 97,928 feet; drifting, 44,772 feet; raising, 7,482 feet; shaft sinking, 1,269 feet; inclining, 2,881 feet; and long-hole drilling, 19,707 feet.

TABLE 11.—Mine production of recoverable gold, silver, copper, lead, and zinc

Commodity	1963		1964		Earliest record to date	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gold.....troy ounces..	137	$5	133	$5	24,452	$599
Silver.....do....	107,913	138	90,539	117	4,169,135	3,232
Copper.....short tons..	13,717	8,450	13,889	9,056	560,984	211,980
Lead.....do....					27,143	3,185
Zinc.....do....	95,847	22,045	115,943	31,536	1,808,804	375,962
Total.....	XX	30,638	XX	40,714	XX	594,958

XX. Not applicable.

[3] Maher, Stuart W. The Brown Iron Ores of East Tennessee. State of Tennessee, Dept. of Conservation, Div. of Geol. Rept. of Inv., No. 19, 1964, 63 pp.

MINERAL FUELS

Production of mineral fuels accounted for 13 percent of the total value of mineral production compared with 14 percent in 1963.

Coal (Bituminous).—Bituminous coal was mined at 253 mines in 16 counties, compared with 266 mines in 17 counties in 1963. Leading producing counties were Anderson, Campbell, and Scott. Leading producers were Pocahontas Fuel Co. (Morco mine), Clinchfield Coal Co. (Meadow Creek mine), and Tennco Inc. (No. 1 strip mine). Production was 2 percent less than that of 1963 and 32 percent below the record of 1956. Average production per mine increased from 23,000 to 23,700 tons.

TVA purchased 68 percent of the coal mined in Tennessee, which amounted to 18 percent of TVA coal purchases.

In the northern part of the State (District 8), 177 mines in 9 counties produced 4,704,000 tons of coal, compared with 195 mines in 10 counties that produced 5,210,000 tons in 1963. Average production per mine decreased from 26,700 to 26,600 tons. Underground mines produced 64 percent of the total; strip mines, 31 percent; and auger mines, 5 percent. Shipments were 68 percent by rail or water and 32 percent by truck. Captive tonnage was 1 percent of the total.

Equipment used at 134 underground mines included 118 cutting machines that cut 82 percent of the total tonnage; 130 power drills that drilled 79 percent; 85 locomotives; 50 shuttle cars; 1 mother conveyor; 32 mobile leading machines that loaded 56 percent; 7 continuous mining machines that loaded 13 percent; and 29 face conveyors that loaded 5 percent. Equipment used at 36 strip mines included 72 power shovels, 53 bulldozers, 13 power drills, and 42 trucks. Equipment used at seven auger mines included seven coal recovery augers, three power shovels, and four bulldozers. Twenty-eight percent of the coal was crushed.

In the southern part of the State (District 13), 76 mines in 7 counties produced 1,286,000 tons, compared with 71 mines in 7 counties that produced 911,000 tons in 1963. Average production per mine increased from 12,800 to 16,900 tons. Underground mines produced 52 percent of the total; strip mines produced 48 percent. Shipments were 73 percent by rail or water and 27 percent by truck. The coal was sold in the open market, mainly to TVA.

Equipment used in 65 underground mines included 31 cutting machines that cut 78 percent of the total tonnage; 48 power drills that drilled 59 percent; 14 locomotives; 4 shuttle cars; 1 mother conveyor; and 2 mobile loading machines that loaded 26 percent. Equipment used at 11 strip mines included 17 power shovels, 5 draglines, 14 bulldozers, 11 power drills, and 42 trucks. Of the total tonnage, 17 percent was crushed.

Natural Gas.—Marketable production of natural gas decreased 14 percent. At the end of the year, 35 gas wells were producing. Cumulative production of natural gas since 1916 was 3,596 million cubic feet.

Petroleum.—Production of crude petroleum decreased 38 percent below that of 1963. At the end of the year 38 oil wells were producing. Cumulative production since 1916 was 671,000 barrels. According to

TABLE 12.—Coal (bituminous) production, by counties

County	1963		1964	
	Short tons	Value	Short tons	Value
Anderson	1,971,334	$7,546,290	1,782,390	$6,886,655
Bledsoe	52,555	188,197	9,719	32,157
Campbell	1,384,810	4,963,898	1,008,060	3,462,421
Claiborne	351,433	1,216,722	364,189	1,292,967
Cumberland	34,613	97,608	16,635	52,400
Fentress	87,176	315,577	50,328	188,730
Grundy	213,220	991,600	332,424	1,303,102
Hamilton	48,090	198,443	29,618	114,249
Marion	249,791	1,040,277	538,244	2,495,758
Morgan	366,452	1,176,010	366,052	1,288,270
Overton	52,140	208,560	38,423	119,495
Pickett	1,200	4,476		
Putnam	462,594	1,696,054	477,776	1,783,914
Rhea	13,386	45,378	24,400	95,160
Scott	497,937	1,737,291	600,654	2,276,420
Sequatchie	104,954	376,536	67,141	229,622
Van Buren	229,379	886,246	284,352	1,052,996
Total	6,121,064	22,689,163	5,990,405	22,674,316
Earliest record to date	412,600,000	NA	418,600,000	NA

NA. Not available.

"Oil and Gas Journal," exploratory drilling continued in Tennessee; completions were reported from six counties. Nineteen holes were completed, with a total footage drilled of 14,020; all holes were dry. This compares with 29 completions with a total footage of 21,929 in 1963, in which crude oil was hit in three holes.

REVIEW BY COUNTIES

Mineral production was reported from 78 counties; leading producers were Jefferson, Polk, Maury, Knox, and Davidson. In addition to the commodities listed in table 12, small quantities of oil and gas were produced; the county origin of these was undetermined.

Anderson.—Pocahontas Fuel Co. (Morco Colliery), Tennco Inc. (No. 1 strip mine), and Tennessee Auger Co., Inc. (Walnut Mountain Deep mine), were the leading producers of the 40 active coal mines. Of these coal mines, there were 30 underground, 9 strip, and 1 auger. Ralph Rogers & Co., Inc. (Oak Ridge quarry) and Anderson County Highway Department (Taylor's quarry No. 1) crushed limestone for concrete, roads, and stone sand. Lalite Corp. (Briceville mine) mined miscellaneous clay for lightweight aggregates.

Bedford.—A & R Stone Co., Inc. (Shelbyville quarry) crushed limestone for concrete, roads, and agricultural stone (agstone).

Benton.—Four mines produced sand for glass and molding; the leading producer was Hardy Sand Co. (Camden and Silica mines). Camden Gravel Co. and Memphis Stone & Gravel Co. mined gravel for paving.

Bledsoe.—Peacock Coal Co. (No. 1 mine) and State Vocational Training School (No. 4 mine) were the leading producers of the four active coal mines, all underground.

TABLE 13.—Value of mineral production in Tennessee, by counties[1]

County	1963	1964	Minerals produced in 1964 in order of value
Anderson	W	W	Coal, limestone, miscellaneous clay.
Bedford	W	W	Limestone.
Benton	$1,282,008	$1,387,000	Sand and gravel.
Bledsoe	188,197	32,157	Coal.
Blount	W	W	Marble, limestone.
Bradley	W	W	Limestone, sand and gravel.
Campbell	W	W	Coal, limestone, sandstone.
Cannon	W	W	Limestone.
Carroll	W	W	Sand and gravel.
Carter	W	W	Limestone.
Claiborne	1,431,483	1,578,782	Coal, limestone.
Clay	131,000	126,000	Limestone.
Cocke	87,627	95,023	Do.
Coffee	W	W	Do.
Cumberland	W	W	Sandstone, limestone, sand and gravel, coal.
Davidson	9,400,339	9,671,876	Cement, limestone, sand and gravel, miscellaneous clay, lime.
Decatur	W	W	Limestone, sand and gravel.
Dickson	W		
Fayette	107,000	85,000	Sand and gravel.
Fentress	488,903	461,530	Limestone, coal, sandstone.
Franklin	W	W	Cement, limestone, sandstone, sand and gravel, miscellaneous clay.
Gibson	W	W	Sand and gravel.
Giles	W	W	Limestone, phosphate rock, sand and gravel.
Grainger	W	40,000	Marble.
Greene	W	W	Limestone, sand and gravel.
Grundy	1,197,725	W	Coal, sand and gravel, limestone.
Hamblen	462,144	592,430	Limestone.
Hamilton	8,085,219	9,426,057	Cement, limestone, sand and gravel, coal, miscelleneous clay.
Hancock		W	zinc, limestone.
Hardeman	67,500	72,000	Sand and gravel.
Hardin	W	W	Limestone.
Hawkins	198,941	195,847	Do.
Haywood	45,900	68,000	Sand and gravel.
Henderson	W	W	Do.
Henry	W	W	Ball clay, fuller's earth.
Hickman	W	W	Phosphate rock.
Humphreys	W	W	Limestone, sand and gravel.
Jefferson	W	W	Zinc, limestone.
Johnson	W	W	Limestone.
Knox	17,351,374	16,377,951	Cement, zinc, limestone, marble, lime, sand and gravel, miscellaneous clay.
Lauderdale	60,300	45,000	Sand and gravel.
Lincoln	W	W	Limestone.
Loudon	W	W	Barite, sand and gravel, miscellaneous clay.
Macon	100,000	W	Limestone.
Marion	W	W	Cement, coal, limestone.
Marshall	W	W	Limestone.
Maury	W	W	Phosphate rock, limestone.
McMinn	W	W	Barite, limestone.
McNairy	W	W	Sand and gravel
Meigs	W	W	Limestone.
Monroe	W	W	Limestone, sand and gravel, barite.
Montgomery	W	W	Limestone.
Morgan	1,176,010	1,288,270	Coal.
Obion	W	104,000	Sand and gravel.
Overton	W	W	Limestone, coal.
Pickett	40,726		
Polk	W	W	Copper, pyrites, zinc, silver, sand and gravel, gold.
Putnam	W	W	Coal, limestone, sand and gravel.
Rhea	W	W	Limestone, coal.
Roane	454,244	W	Limestone.
Robertson	W	W	Do.
Rutherford	W	W	Do.
Scott	1,737,291	2,276,420	Coal.
Sequatchie	W	W	Limestone, coal.
Sevier	W	W	Limestone, sand and gravel.
Shelby	W	W	Sand and gravel, miscellaneous clay.
Stewart	W	W	Sand and gravel.
Sullivan	W	W	Cement, limestone, miscellaneous clay.
Sumner	W	W	Limestone, phosphate rock.
Tipton	W	W	Sand and gravel.
Unicoi	614,567	W	Sand and gravel, limestone.
Union	W	W	Marble, limestone.
Van Buren	886,246	1,052,996	Coal.
Warren	W	W	Limestone.
Washington	W	W	Limestone, miscellaneous clay.

See footnotes at end of table.

TABLE 13.—Value of mineral production in Tennessee, by counties[1]—Continued

County	1963	1964[2]	Minerals produced in 1964 in order of value
Wayne	W	W	Limestone, sand and gravel.
Weakley	$2,336,956	$2,488,500	Ball clay.
White	317,537	124,389	Limestone.
Williamson	W	W	Phosphate rock, limestone.
Wilson	W	W	Limestone.
Undistributed[2]	r 112,475,763	126,375,772	
Total	r 160,725,000	173,965,000	

r Revised.
W. Withheld to avoid disclosing individual company confidential data.

[1] The following counties are not listed because no production was reported: Cheatham, Chester, Crockett, DeKalb, Dyer, Houston, Jackson, Lake, Lawrence, Lewis, Madison, Moore, Perry, Smith and Trousdale.
[2] Includes value of petroleum, natural gas, and values indicated by symbol W.

Blount.—Gray Knox Marble Co. (Brown quarry), John J. Craig Co. (Crisp, Lee, Marmor, and Hamil quarries), and Tennesse Marble Co. (Endsley quarry) quarried dimension marble for rough and dressed building stone and dressed monumental stone. John J. Craig Co. crushed marble for terrazzo and other uses. Lambert Bros. Division of Vulcan Materials Co. (Maryville quarry) crushed limestone for concrete and roads.

Bradley.—Bradley Limestone Co., Inc. (Welch quarry) and Bradley County Highway Department crushed limestone for concrete, roads, and agstone. Hiwassee Sand Co., Inc., mined sand for structural and paving uses.

Campbell.—Coal was produced at 45 mines—33 underground, 11 strip, and 1 auger. Leading producers were Dixie Pine Coal Co., Inc. (No. 1 Strip mine), Hurricane Mountain Coal Co. (No. 2 mine), and Dean Coal Co., Inc. (No. 2A Strip mine). Claiborne Construction & Supply Co. (LaFollette quarry) and Jellico Stone Co., Inc. (Jellico quarry) crushed limestone for concrete, roads, agstone, and stone sand. White Silica Sand Co. (Silica quarry) crushed sandstone for concrete, roads, abrasives, and other uses.

Carroll.—Hardy Sand Co. (Bruceton mine) mined sand for grinding and polishing and for fertilizer filler.

Claiborne.—Coal was produced at 24 mines—18 underground, 4 strip, and 2 auger. Leading producers were Acorn Coal Co. (No. 3 auger mine), Harris Branch Coal Co. (No. 1 mine), and Tackett Coal Co. (No. 3 strip mine). Lambert Bros. (Tazewell quarry) crushed limestone for concrete and roads.

Clay.—Dixie Limestone Co. (Celina quarry) crushed limestone for concrete, roads, and agstone. Two oil wells totaling 1,048 feet were drilled.

Cumberland.—Fifteen companies quarried dimension sandstone for rough architectural, sawed and dressed building stone, and flagging. Leading producers were Tennessee Stone Co., Inc. (McGuire quarry), Crab Orchard Stone Co., Inc. (Peck quarry), and Turner Bros. Stone Co., Inc., crushed sandstone for refractory use. Southern States Lime Corp. (Crab Orchard mine) and Cumberland County Highway Department (County quarry) produced limestone for fluxing stone, concrete, roads, railroad ballast, agstone, glass, rock dust

for coal mines, mineral food, lime, and other uses. Three mines, all underground, produced coal; the leading producer was Clear Creek Coal Co. (No. 1–A mine). Potter Sand & Gravel Co. (Crossville mine) mined sand and gravel for structural and paving uses.

Davidson.—Davidson County ranked fifth in the State in total value of mineral production. Marquette Cement Manufacturing Co. produced masonry and portland cements at the Nashville mill throughout the year. Lambert Bros. (Danley, Hermitage, and River Road quarries), Eller & Olson Crushed Stone Co., Inc. (E & O quarry), Menefee Crushed Stone Co. (Nashville quarry), and Hoover, Inc. (Nashville quarry) crushed limestone for concrete, roads, agstone, asphalt filler, and fertilizer filler.

Ingram Materials, Inc. (Nashville mine) mined sand and gravel for structural and paving uses. W. G. Bush & Co., Inc. (Nashville mine) mined miscellaneous clay for use in heavy clay products and cement. Stauffer Chemical Co. produced lime for industrial uses. Tennessee Products & Chemical Corp. expanded crude perlite from Western States at the Nashville processing plant.

Decatur.—Western Materials, Inc. (Parsons quarry) produced limestone for concrete, roads, and agstone. Teague Bros. Sand & Gravel Co. and Tinker Sand & Gravel Co. (Perryville mine) mined sand and gravel for structural use.

Fayette.—Fayette County Highway Department (County mine) mined paving sand and gravel.

Fentress.—Sells & Gibson Coal Co. (P. No. 2 mine), Hollis Miller Coal Co. (No. 4 mine), and Layton P. Hood Coal Co. (No. 2 mine) were the leading producers of the eight active coal mines, all underground operations. Frogge & Williams, Inc. (Wright quarry) crushed limestone for concrete, roads, and agstone. Crossville Stone Co. (Jamestown quarry) quarried dimension sandstone for rough architectural stone and flagging. One oil well totaling 950 feet was drilled.

Franklin.—Marquette Cement Mfg. Co. produced masonry and portland cements at the Cowan mill throughout the year. Cowan Stone Co. (Anderson mine and Cowan quarry), Marquette Cement Mfg. Co. (Cowan quarry), and Franklin County Highway Department (Bostick quarry) crushed limestone for concrete, roads, fluxing stone, agstone, glass, lime, cement, and other uses. Sewanee Silica Co. (Monteagle quarry) crushed sandstone for concrete, roads, abrasives, 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.

Giles.—Cedar Grove Lime Co. (Cedar Grove quarry) crushed limestone for concrete, roads, and agstone. Victor Chemical Works mined phosphate rock. Giles County Highway Department mined paving gravel.

Grainger.—Imperial Black Marble Corp. quarried dimension marble for rough building stone at the Thornhill quarry.

Greene.—Malone Bros. Quarry, Inc. (Malone Bros. quarry), Greene County Highway Department (Midway, Dog Walk, and Cove Creek quarries), and Agricultural Lime Co., Inc., produced limestone for

concrete, roads, and agstone. Busler Sand Co. (Greenville mine) mined sand for structural uses.

Grundy.—Cone Ridge Coal Co. (No. 1–B strip mine) and Ramsey Coal Co. (No. 1 strip mine) were the leading producers of the four active coal mines, all strip mines. Cumberland Mountain Sand Co. (McMinnville mine) mined structural and paving sand. Viola White Lime Co. (Old State quarry) crushed limestone for concrete, roads, and agstone.

Hamblen.—White Pine Stone Co. (Hamblen quarry) crushed limestone for concrete and roads.

Hamilton.—Signal Mountain Portland Cement produced masonry and portland cements at the Chattanooga mill throughout the year. Chattanooga Rock Products (Chattanooga quarry) crushed limestone for concrete, roads, and agstone. Dixie Sand & Gravel Corp. (Dixie mine) mined sand and gravel for structural, paving, fill, and other uses. Seven mines—six underground and one strip—produced coal. Leading producers were Russell Mining Co. (No. 7 strip mine) and Oak Hill Coal Co. (No. 2 mine). General Shale Products Co. (Chattanooga mine) and Federal Ceramic Corp. (Daisy mine) mined miscellaneous clay for heavy clay products.

Hancock.—New Jersey Zinc Co. (Flat Gap mine) mined zinc ore and recovered limestone as a byproduct.

Hardeman.—Marcel Baudre (Saulsbury mine), Bolivar Sand Co. (Bolivar mine), and Tri-State Sand Co. (Saulsbury mine) mined structural sand.

Hardin.—Hardin Limestone Co. crushed limestone for concrete, roads, and agstone. Tennessee River Pulp & Paper Co. reclaimed lime for industrial uses.

Hawkins.—Lambert Bros. (McCloud quarry) crushed limestone for concrete and roads.

Henderson.—Ayers Mineral Co. (Zane mine) mined molding sand.

Henry.—H. C. Spinks Clay Co., Inc., Kentucky-Tennessee Clay Co., and Laird Brick Co. mined ball clay for whiteware, floor and wall tile, refractories, heavy clay products, and exports. Southern Clay Co., Inc., and Tennessee Absorbent Clay Co. mined fuller's earth for absorbent uses.

Hickman.—M. C. Boyle Phosphate Co. (Bratton mine) mined phosphate rock for agricultural uses.

Humphreys.—Lambert Bros. (Rock Hill quarry) crushed limestone for concrete and roads. Sangravel Co., Inc. (Johnsonville mine) mined sand and gravel for structural and paving uses.

Jefferson.—Jefferson County ranked first in the State in total value of mineral production. American Zinc Co. of Tennessee (Young, Coy, Grasselli, and North Friends Station mines), New Jersey Zinc Co. (Jefferson City mine), Tennessee Coal & Iron (Zinc mine works), and New Market Zinc Co. (New Market mine) recovered zinc ores. Limestone was produced by the Jefferson County Highway Department and also recovered as a byproduct from zinc mines; this material was used for concrete, roads, railroad ballast, agstone, and stone sand.

Knox.—Knox County ranked fourth in the State in total value of mineral production. Ideal Cement Co. produced masonry and port-

land cements at the Knoxville mill throughout the year. American Zinc Co. of Tennessee (Mascot No. 2 mine) mined zinc ore and recovered limestone as a byproduct. Seven quarries and one mine produced limestone for concrete, roads, cement, lime, glass, and other uses; leading producers were Lambert Bros. (City, Halls, and Dixie Lee quarries) and Ideal Cement Co. (Knoxville quarry). Foote Mineral Co. and Williams Lime Manufacturing Co. produced lime for construction, chemical, and industrial uses.

Appalachian Marble Co. (Appalachian and Bond quarries), Gray Knox Marble Co. (Gray Knox quarry), and Tennessee Marble Co. (Eagle quarry) quarried dimension marble for rough and 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. Knoxville Sand & Gravel Co. (Knoxville mine) and Oliver King Sand & Lime Co., Inc. (King mine) mined sand and gravel for structural, paving, grinding and polishing, and engine uses. Shalite Corp., General Shale Products Corp., and Ideal Cement Co. mined miscellaneous clay for lightweight aggregates, heavy clay products, and cement.

Lauderdale.—Lauderdale County Highway Department (County mine) mined paving gravel.

Loudon.—B. C. Wood mined barite at the Cedar Fork mine. Lambert Bros. (Lenoir City mine) and West Knoxville Sand Co. (Concord mine) mined sand for paving, grinding and polishing, and structural uses. Old Hickory Brick Co., Inc. (Greenback mine) mined miscellaneous clay for heavy clay products.

Marion.—Penn-Dixie Cement Corp. produced portland cement at the Richard City mill throughout the year. Signal Mountain Portland Cement (Bennetts Lake quarry), Penn-Dixie Cement Corp. (Richard City quarry), and Chattanooga Rock Products (Marion quarry) crushed limestone for concrete, roads, agstone, and cement. Coal was produced by 30 mines—29 underground and 1 strip. Leading producers were Grundy Mining Co. (Grays Creek No. 11 mine), Spruce Coal Co. (Spruce No. 4 mine), and Maple Mining Co. (Maple No. 3 mine).

Maury.—Maury County ranked third in the State in total value of mineral production. Six operators produced phosphate rock; leading producers were Monsanto Co. (Monsanto mine) and Stauffer Chemical Co. (Globe mine). Columbia Rock Products Corp. (Theta Pike mine) crushed limestone for concrete, roads, agstone, stone sand, and other uses. National Carbon Co. manufactured carbon and graphite products at the Columbia plant.

McMinn.—National Lead Co. (Ballard mine) and Godsey Mines, Inc. (Athens, Niota, and Calhoun mines) mined barite. Floyd D. Webb Stone Co. (Webb quarry) and McMinn County Highway Department (Athens quarry) crushed limestone for concrete and roads. Bowaters Southern Paper Corp, reclaimed lime for industrial uses.

Monroe.—Creighead Limestone Co. (Creighead quarry) and Monroe County Highway Department (Madisonville quarry) crushed limestone for concrete, roads, and agstone. Vonore Sand Co. and Tennessee River Sand Co. mined structural and paving sand. National Lead Co. shipped barite from stocks at the Roy mine.

Morgan.—Coal was produced at 22 mines—15 underground, 6 strip, and 1 auger. Leading producers were G & F coal Co., Inc. (G & F strip mine), Tennessee Auger Co. (Twin auger mine), and Brushy Mountain Coal Mines (No. 7 mine).

Obion.—Obion County Highway Department (County mine) and Reelfoot Materials, Inc. (Troy mine) mined paving sand and gravel.

Overton.—Livingston Limestone Co. (East and South quarries) crushed limestone for concrete, roads, and agstone. Nine mines, all underground operations, produced coal; leading producers were Holly John Coal Co. (No. 1 mine) and Mountain Land Coal Co. (No. 1 mine) Two oil wells totaling 3,010 feet were drilled.

Pickett.—Four oil wells totaling 3,732 feet were 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 the copper concentrates. 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) and R. O. Davis (Ducktown mine) mined sand for structural and fire or furnace use and gravel for paving and miscellaneous uses.

Putnam.—Clinchfield Coal Co. (Meadow Creek mine) was the only active coal producer. R. E. Poteet (Poteet quarry) crushed limestone for concrete, roads, and agstone. Sand, Inc. (Monterey mine) mined structural and paving sand.

Rhea.—Rhea County Limestone Co. (Dayton quarry) crushed limestone for concrete and roads. Rocky Creek Coal Co. (RC No. 1 and RC No. 6 mines) and Norris Coal Co. (No. 1–A mine), all underground operations, were the active coal producers.

Roane.—A. B. Long Quarries, Inc. (Swan Pond quarry), Lambert Bros. (Rockwood quarry), and Roane Limestone Co. (Rockwood quarry) crushed limestone for concrete, roads, agstone, and stone sand. Tennessee Products & Chemical Corp. produced pig iron and sinter at the Rockwood plant.

Robertson.—Porter Brown Limestone Co. (Springfield No. 1 quarry) crushed limestone for concrete, roads, and agstone. Six oil wells totaling 3,204 feet were drilled.

Scott.—Coal was produced at 25 mines—17 underground, 6 strip, and 2 auger. Leading producers were Pee Wee Mining Co. (Pee Wee mine), Cox-Jellico Coal Corp. (Roberts No. 1 strip mine), and C. R. Lewis Coal Co. (Shock Creek auger mine).

Sequatchie.—Seventeen mines, all underground, produced coal; leading producers were Seals Coal Co. (No. 1 mine), Scott Coal Co. (No. B–4 mine), and Nunley Coal Co. (No. 1–A mine). Dunlap Stone Co. (Sequatchie quarry) crushed limestone for concrete, roads, and agstone.

Shelby.—Four mines produced sand and gravel for structural, paving, fill, and other uses; leading producers were Cordova Sand & Gravel Co. and W. S. Jordan Gravel Co. John A. Denies Sons Co.

mined miscellaneous clay for heavy clay products and lightweight aggregate.

Sullivan.—Penn-Dixie Cement Corp. produced masonry and portland cements at the Kingston mill throughout the year. Lambert Bros. (New Kingsport quarry) and Limestone Products Corp. (Rockway quarry) crushed limestone for concrete and roads. 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.—Ralph Rogers & Co., Inc. (Pilot Knob mine) and Sumner County Highway Department crushed limestone for concrete, roads, and agstone. Monsanto Co. mined phosphate rock. Four oil wells totaling 2,076 feet were drilled.

Tipton.—Tipton County Highway Department (Tipton County mine) and Clyde W. Owens Sand & Gravel Co. (Covington mine) mined sand and gravel for structural, paving, fill, and other uses.

Unicoi.—Brooks Sand-Gravel (Erwin mine) mined structural sand and paving and railroad-ballast gravel. Unicoi County Highway Department (Rex Lewis quarry) crushed limestone for concrete and roads. Carolina-Southern Mining Co. ground mica for welding rods and joint cement at the Kingsport mica grinding plant.

Union.—Union County Highway Department (Welch and Luttrell quarries) and George Bros. crushed limestone for concrete and roads. Tennessee Marble Co. (Luttrell No. 3 quarry) quarried dimension marble for rough and dressed building stone.

Van Buren.—Coal was produced at 11 mines—6 underground and 5 strip; leading producers were Walden Ridge Coal Co. (Walden Ridge No. 1 strip mine), C R & B Coal Co. (No. 11 strip mine), and Waters Coal & Construction Co. (No. 5 strip mine).

Washington.—Washington County Highway Department (Dillow, Taylor Bridge, Gray, and Boones Creek quarries) crushed limestone for concrete and roads. General Shale Products Corp. (Johnson City mine) mined miscellaneous clay for use in heavy clay products.

Wayne.—Universal Limestone Co. (Waynesboro quarry) crushed limestone for concrete, roads, and agstone. Hassell & Dowdy (Baker mine) mined structural sand and gravel.

Weakley.—United Clay 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.

Williamson.—Monsanto Co. mined phosphate rock. Lambert Bros. (Franklin quarry) and Williamson County Highway Department (Globe quarry) crushed limestone for concrete and roads.

Wilson.—Marquette Cement Manufacturing Co. (Martha quarry) and Wilson County Rock Products, Inc. (Lebanon and No. 2 quarries) 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 Bureau of Economic Geology, The University of Texas, for collecting information on all minerals except fuels.

By F. F. Netzeband,[1] Harold F. Pierce,[2] and Roselle Girard[3]

TEXAS retained its position as the Nation's leader in mineral production value for the 30th consecutive year. A large varied mineral processing industry converted the raw materials into marketable products for State, national, and internatinonal markets.

A mineral production record of $4.5 billion was established as all sectors of the State's economy expanded. Growth was indicated by the number of new plants and expansions to existing plants, especially in the petroleum, chemical, fabricated metals, and transportation industries.

TABLE 1.—Mineral production in Texas[1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	29,104	$92,734	30,030	$94,492
Masonry—thousand 280-pound barrels	930	2,858	930	2,805
Clays[2]—thousand short tons	4,199	6,849	4,156	6,695
Gem stones	(3)	150	(3)	140
Gypsum—thousand short tons	1,099	3,999	1,131	4,049
Helium—thousand cubic feet	[4] 264,342	[4] 9,252	[5] 304,909	[5] 10,672
Lime—thousand short tons	1,131	13,026	1,350	17,201
Natural gas—million cubic feet	6,205,034	775,629	6,525,649	809,180
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	3,320,416	218,975	3,512,460	232,245
LP gases—do	5,366,831	169,695	5,521,236	167,492
Perlite (crude)—short tons			300	3
Petroleum (crude)—thousand 42-gallon barrels	977,835	2,908,380	989,525	2,928,994
Salt—thousand short tons	5,965	22,355	6,410	28,797
Sand and gravel—do	33,256	36,311	29,155	33,394
Stone—do	43,142	54,007	40,240	52,070
Sulfur (Frasch process)—thousand long tons	2,550	50,109	3,126	62,232
Talc and soapstone—short tons	72,658	368	89,334	395
Value of items that cannot be disclosed: Asphalt (native), barite, bromine, clay (kaolin (1964) and fuller's earth), coal (lignite), graphite, iron ore (usable), magnesium chloride (for metal), magnesium compounds (except for metal), pumice, sodium sulfate, and uranium ore	xx	62,777	xx	82,222
Total	xx	r 4,427,474	xx	4,533,078

r Revised. xx Not applicable.

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

[2] Excludes certain clays, included with "Value of items that cannot be disclosed."

[3] Weight not recorded.

[4] Excludes 668,938,000 cubic feet of crude helium valued at $6,858,000 shipped to underground storage at Amarillo, Tex.

[5] Excludes 1,022,569,000 cubic feet of crude helium valued at $10,340,805 shipped to underground storage at Amarillo, Tex.

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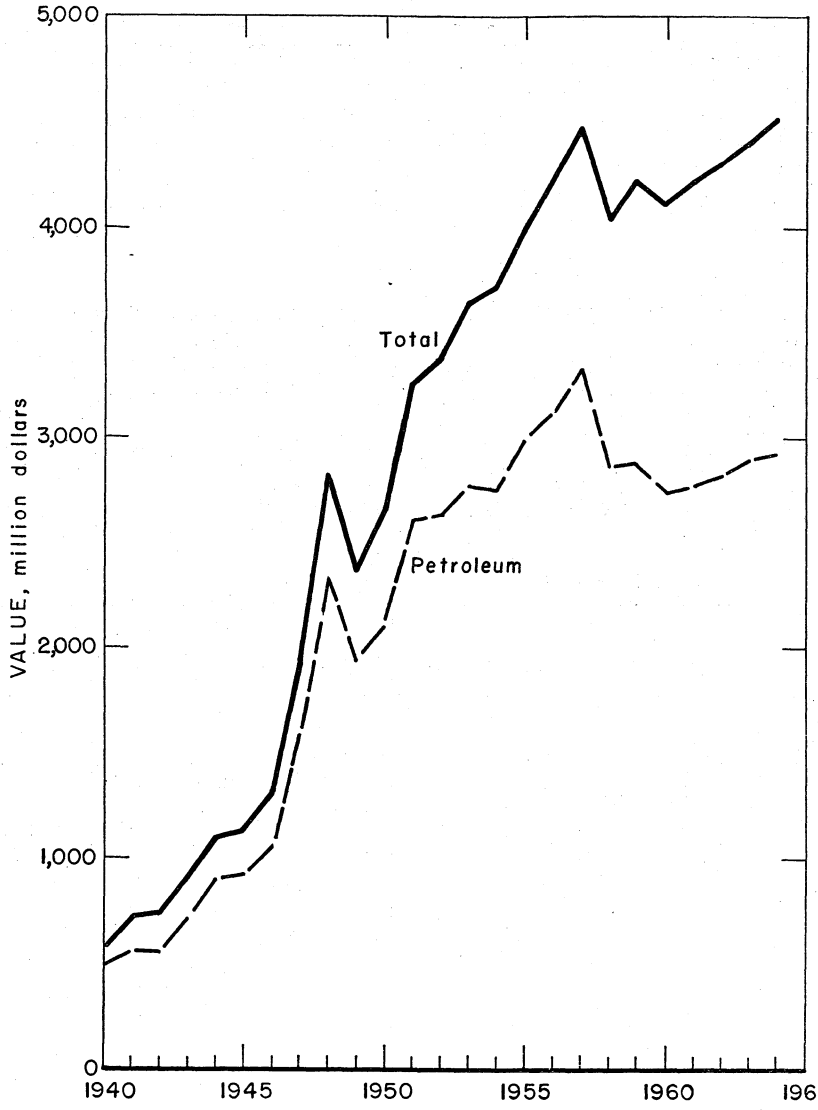


FIGURE 1.—Value of petroleum and total value of mineral production in Texas.

Texas oilfields produced 989.5 million barrels of oil in 1964, 1 percent more than in 1963, and its gasfields yielded a record of 6,526 billion cubic feet of natural gas, 5 percent greater than the previous 1963 record production. To supply the flow of oil, the industry drilled 16,273 wells, 2 percent more than the number drilled in 1963 and raised the State's total number of producing oil wells to 199,119—an increase of 883 wells over the total in 1963. Proved recoverable crude oil reserves were estimated to total 14.3 billion barrels according to the American Petroleum Institute. This reserve represented 46 percent of the Nation's total crude oil reserve. Discoveries added 70.3

million barrels; extensions and revisions added 585.1 million barrels. The oil industry maintained its proved reserve about equal to what it produced for the past decade.

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

(Millions)

Year	Value	Year	Value
1953	$4,160	1959	$4,279
1954	4,092	1960	4,126
1955	4,374	1961	r 4,186
1956	4,593	1962	r 4,212
1957	4,448	1963	r 4,300
1958	4,038	1964	4,393

r Revised.

Natural gas production continued its steady advance to a new record in 1964. Primary markets for natural gas—feedstock for the petrochemical industry and power and space-heating of industrial plants and homes—remained unchanged from 1963. Expansion of the ethylene, propylene, and butadiene industries of Texas was largely responsible for the 5-percent rise in gas marketed in the State.

Markets for total natural gas liquids remained strong but those for LP gases softened during the latter part of the year owing to a mild winter. Net results of this circumstance were increased stocks and lower prices. Natural gas liquid output advanced 4 percent, but the value rose less than 3 percent owing to a 1.3 percent decline in LP gases prices. LP gases accounted for 61 percent of the 1964 output, natural gasoline and other cycle products for the remainder.

The output of nonmetals was influenced by conflicting trends in the construction industry. Modest gains in number of industrial, commercial, and public works construction awards were offset by a significant decline in the number of new starts in home building in 1964. The result of the residential construction decline was lower demand for clay, sand and gravel, and stone. Substantial increases were registered in the chemical commodities—lime, salt, and sulfur.

The metal mining and processing industry maintained its firm position in the State and national economy. The State's 18 metallurgical plants contributed significantly to the Nation's metal supply with aluminum, antimony, copper, lead, tin, and zinc. A major portion of the country's magnesium requirements was recovered from sea water at the Freeport plants of the Dow Chemical Co. Brown iron ores of Cherokee and Morris Counties supplied part of the pig iron used by Texas metal manufacturing and fabricating industries. The State's lone uranium mill recovered "yellow cake" from ores in Karnes County.

Consumption, Trade, and Markets.—The mineral producing and processing industries of Texas supplied national and international markets, as well as local markets, because of their great capacities to produce and the State's abundant natural resources. The industries include petroleum production and refining; natural gas and natural gas liquid recovery; ferrous, nonferrous, and light metal extractive industries; and bromine, graphite, natural salines, and sulfur production.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	108	28	223		3	13
Metal	1,387	422	3,376	1	25	8
Nonmetal and native asphalt	2,836	819	6,630	3	164	25
Sand and gravel	2,566	682	5,854	3	132	23
Stone	5,049	1,507	12,646	1	225	18
Total	11,946	3,458	28,729	8	549	19
1964: p						
Coal	102	29	200		5	25
Metal	1,105	331	2,649	1	22	9
Nonmetal and native asphalt	2,817	808	6,632	3	157	24
Sand and gravel	2,305	618	5,547		122	22
Stone	5,200	1,570	12,921	4	316	25
Total	11,529	3,356	27,949	8	622	23

p Preliminary.

TABLE 4.—Employment data in mining and related industries

Industry	Employment		Weekly hours worked		Weekly earnings	
	1963	1964	1963	1964	1963	1964 p
Manufacturing	518,700	537,900	41.4	41.7	$97.29	$100.91
Primary metals	25,800	27,700	40.4	41.6	115.54	120.64
Stone, clay, and glass products	25,400	26,500	44.5	44.1	85.89	88.20
Chemicals	49,300	50,400	41.6	42.1	133.12	138.51
Petroleum and related industries	37,300	36,300	41.7	41.4	138.44	140.76
Transportation equipment	49,800	54,200	41.5	42.0	123.26	130.20
Nonmanufacturing	2,181,700	2,251,700				
Mining	113,200	112,200	42.6	42.8	118.00	120.70
Crude petroleum	[1] 106,900	[1] 105,800	42.5	42.6	119.85	122.69
Other mining	6,300	6,400	39.4	40.4	117.81	122.01
Construction	172,000	179,600				

p Preliminary.
[1] Includes natural gas.

Source: Texas Employment Commission in cooperation with the Federal Bureau of Labor Statistics.

Water.—Water supply, demand, conservation, and quality and pollution control remained pressing problems. Industry, State and Federal agencies, and university and private research groups continued studies on many of the problems. In addition, reservoirs to augment present supplies were being built or planned by the U.S. Army Corps of Engineers, Bureau of Reclamation, and a number of State water commissions.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

New records for production and value were established by the mineral fuels industries. Combined output, which included crude oil, natural gas, natural gas liquids, helium, and lignite, represented nearly 92 percent of the total mineral value.

Refining capacity of Texas dropped 1 percent to 2,852,315 barrels per stream day as five small refineries with a combined capacity of 26,500 barrels were shut down.

TABLE 5.—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
1940	493	190	16	699	70.5	27.1	2.4				
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	−0.4
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	0.4	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	1,165	157	2,312	42.8	50.4	6.8	1.2	5.1	4.0	3.4

[1] One barrel of crude oil equivalent to 5,600 cubic feet of natural gas or 57.4 gallons of natural gas liquids, a composite of 52.7 gallons of natural gasoline and 60.8 gallons of LP gases.

Crude oil stocks at refineries, pipelines, tank farms, and in lease tanks declined 6 percent during the year. Stocks of refined products, however, increased. Gasoline and distillate stocks proved most troublesome to the refining industry, notwithstanding a 3-percent gain in demand. Crude runs to stills in 1964 exceeded 1963 runs throughout most of the year. The oversupply of refined products resulted in continued erosion of product prices. Prices for most Texas crudes have declined from 1963 prices.

Coryell County became Texas' 205th oil producing county with completion of Johnston Oil Co. No. 1 W. D. Bowlin, 17 miles southwest of Gatesville.

Oil allowables of Texas operators were to be increased after January 1, 1965, by drilling on wider spacing. The new allowable schedule of the Texas Railroad Commission provided lower allowables for wells under 40-acre spacing and raised it for wells on spacings of more than 40 acres.

Two of the world's largest electronically controlled inline gasoline blenders are in service at the Beaumont refinery of Mobil Oil Co. The blenders automatically and simultaneously measure, control, and record flow of seven gasoline base stocks and seven additives.

TABLE 6.—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 1963	
	Texas		United States		Texas		United States					
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	Texas	United States
Crude oil	978	990	2,753	2,787	43.7	42.8	48.5	47.5	35.5	35.5	+1.2	+1.2
Natural gas	1,108	1,165	2,633	2,776	49.5	50.4	46.4	47.3	42.1	42.0	+5.1	+5.4
Natural gas liquids	151	157	293	309	6.8	6.8	5.1	5.2	51.5	50.8	+4.0	+5.5
Total equivalent	2,237	2,312	5,679	5,872	100	100	100	100	39.4	39.4	+3.4	+3.4

[1] Million barrels of oil equivalent, derived by gas and liquids factors reported in table 5.

TABLE 7.—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 1963		Texas		United States	
	1963	1964	1963	1964	1963	1964	Texas	United States	1963	1964	1963	1964
Crude oil	14,573	14,300	30,970	30,991	47.1	46.1	−1.9	+0.1	14.9	14.4	11.2	11.1
Natural gas	21,037	21,224	49,313	50,223	42.7	42.3	+0.9	+1.8	19.0	18.2	18.7	18.1
Natural gas liquids	2,958	2,897	5,615	5,668	52.7	51.1	−2.1	+0.9	19.6	18.5	19.2	18.3
Total oil equivalent	38,568	38,421	85,898	86,882	44.9	44.2	−0.4	+1.1	17.2	16.6	15.1	14.8

[1] Million barrels of oil equivalent, derived by gas and liquids factors reported in table 5.

TABLE 8.—Production and value of mineral fuels

Year	Crude petroleum		Natural gas[1]	
	Thousand barrels	Value (thousands)	Million cubic feet	Value (thousands)
1955–59 (average)	1,029,423	$3,044,842	5,156,794	$489,813
1960	927,479	2,748,735	5,892,704	665,876
1961	939,191	2,791,377	5,963,605	733,523
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	6,525,649	809,180

Year	Natural gas liquids					
	Natural gasoline and cycle products		LP gas		Total	
	Thousand gallons	Value (thousands)	Thousand gallons	Value (thousands)	Thousand gallons	Value (thousands)
1955–59 (average)	2,911,708	$207,609	3,830,617	$147,164	6,742,325	$354,773
1960	2,880,906	207,583	4,476,142	200,478	7,357,048	408,061
1961	3,111,427	214,279	4,768,222	185,558	7,879,649	399,837
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

[1] Marketed production, gas either sold or consumed by producers including losses in transmission, amounts added to storage, and increases in gas pipelines.

Humble Oil and Refining Co. planned a 13,500-barrel hydrocracker unit at its Baytown refinery. The new unit will provide higher yields of gasoline but not materially raise the 302,000-barrel capacity of the refinery. California Oil Co. planned replacement and modernization of its El Paso refinery and two additional gasoline distillation and catalytic hydrogenation facilities. American Oil Co. added an Ultrafiner unit to its Texas City refinery to desulfurize naphtha fed to an Ultraformer.

Asphalt, Native.—Two companies produced asphalt-bearing Anacacho limestone in Uvalde County. Production was about 15 percent over that of 1963, reflecting increased highway construction and maintenance operations.

Carbon Black.—The carbon black industry recovered 1,166 million pounds valued at $86.5 million in 1964, a 5 percent increase in value over that of 1963, and representing 52 percent of the U.S. domestic carbon black production. The industry consumed about 65,438 million cubic feet of natural gas for an average yield of 2.88 pounds of material per 1,000 cubic feet of gas, and 205.9 million gallons of gas liquids for an average yield of 4.75 pounds of material per 1,000 gallons of natural gas liquids. There were 20 carbon black plants active in 1964 compared with 21 plants in 1963. Plants in the Panhandle counties—Carson, Grey, Hutchinson, Moore, and Wheeler—supplied 43 percent of the State's entire output.

Helium.—Helium production from the two Government recovery plants at Amarillo and Exell increased 15 percent in 1964 compared with production in 1963. Production from the Dumas and Sherman plants of Phillips Petroleum Co. increased over 50 percent. The bulk

of the present helium reserve was in four gasfields lying in the Panhandle of Texas, Oklahoma, and Kansas.

The U.S. Government remained the largest consumer of helium through its defense, space exploration, and nuclear energy programs. Other important uses included production of titanium and zirconium, production of transistors, and as a shield in the welding of some metals. The Federal Bureau of Mines, as the Government agent, purchased 3.2 billion cubic feet of crude helium (over 60 percent helium) from private plants for storage in the Cliffside gasfield near Amarillo.

Linde Division of Union Carbide produced liquid helium at its 125-liter-per-hour plant at Amarillo. Three new liquid helium plants were built in 1964.

Lignite.—Lignite, used as fuel to generate electric power and as a raw material for manufacturing activated carbon, was mined from open pits in Milam and Harrison Counties.

Natural Gas.—Marketed production of natural gas in Texas in 1964 was a record 6,525,649 million cubic feet, an increase of 5 percent compared with 1963 production. Gas wells produced more than 77 percent of the marketed gas; oil wells accounted for the remaining 23 percent. According to the Railroad Commission of Texas, an average of 22,334 gas wells were producing in 1964 compared with 22,016 gas wells in 1963. Of 16,273 wells drilled in Texas during 1964, 1,934 were gas wells.

Estimated proved natural gas reserves at yearend totaled 118,855 billion cubic feet or 42 percent of the national reserve, according to American Gas Association statistics.

The natural gas industry increased storage capacity for liquefied natural gas (LNG), both above and below ground. By storing the liquid natural gas during the off season, the peak demands of the larger markets can be more easily served.

Natural Gas Liquids.—During 1964, the total output of natural gas liquids was 9,034 million gallons valued at $400 million. As in 1963, LP gases accounted for nearly 61 percent of the recovered liquids. Principal industrial consumers were the State's expanding petrochemical industry and the synthetic rubber industry.

There were 288 gasoline plants, 78 pressure-maintenance plants, and 35 cycling plants recovering natural gas liquids in the State at yearend. Thirteen new gasoline plants were built during the year, and numerous plants were remodeled to increase daily capacities. Fourteen gasoline plants were shut down during the year.

According to the American Gas Association, the proved recoverable reserve of natural gas liquids exceeded 3.9 billion barrels and amounted to 51 percent of the Nation's total reserve.

Petroleum.—Despite curtailed production in 1964, Texas retained leadership in petroleum. It had the major share of the Nation's petroleum reserve, produced the greatest volume of crude oil, processed the largest volume of crude oil at its refineries, provided a major source of feedstock to the petrochemical industry, operated more drilling rigs and exploratory and developmental drilling projects, and invested more capital in discovery of its oil reserves than any other State in the Nation.

TABLE 9.—Crude petroleum production, indicated demand, and stocks, in 1964, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Texas
January	83,118	84,011	98,556
February	78,162	79,937	96,781
March	85,107	80,792	101,096
April	82,067	78,607	104,556
May	84,114	82,943	105,727
June	81,138	79,455	107,410
July	82,175	86,470	103,115
August	82,127	88,688	96,554
September	80,160	81,794	94,920
October	84,095	85,696	93,319
November	81,166	78,534	95,951
December	86,096	87,835	94,212
Total:			
1964	989,525	994,762	xx
1963	977,835	980,692	xx

xx Not applicable.

TABLE 10.—Petroleum daily average production and runs to stills

(Thousand 42-gallon barrels)

Month	1963		1964	
	Crude production	Runs to stills	Crude production	Runs to stills
January	2,540	2,410	2,706	2,452
February	2,688	2,493	2,729	2,453
March	2,641	2,357	2,759	2,410
April	2,667	2,352	2,755	2,451
May	2,664	2,426	2,727	2,465
June	2,669	2,406	2,714	2,465
July	2,696	2,370	2,675	2,537
August	2,708	2,432	2,660	2,499
September	2,684	2,260	2,720	2,417
October	2,697	2,421	2,741	2,438
November	2,660	2,477	2,727	2,371
December	2,680	2,419	2,794	2,482

Because of excessive stocks of crude oil and certain refined products and continued weakness in demand for domestic crudes, which prevailed through most of 1964, total crude oil production rose only 1 percent to 989.5 million barrels. Stocks of gasoline and distillate fuels remained substantially above normal requirements, resulting in general weakening of wholesale prices and gasoline price wars at the retail level. The continued imbalance of supply and demand resulted in strict proration of Texas crude oil production.

Crude oil was produced in 205 of the 254 counties in Texas. Twenty-seven counties produced over 10 million barrels each, and an additional 96 counties reported production in excess of 1 million barrels each in 1964. The five leading counties in order of value of output were Andrews, Ector, Crane, Gaines, and Gregg.

Texas had 199,119 producing oil wells at the end of 1964, an increase of 883 over 1963. Average daily production amounted to 13.6 barrels per well compared with that of 13.5 barrels per well in 1963.

Proved recoverable reserves of crude oil in Texas declined 273 million barrels to 14.3 billion barrels as of January 1, 1965, according to the American Petroleum Institute. Exploratory drilling added 70.3 million barrels to proved reserves, development drilling in the form of extensions and revisions added 585.1 million barrels. Texas had 46 percent of total U.S. oil reserves.

Average indicated daily demand for crude oil in Texas in 1964 amounted to 2,717,929 barrels, 1 percent more than that in 1963.

An unusual project in the petroleum industry was the construction of a big-inch waterflood pipeline. Shell Pipe Line Corp. expected to spend up to $10 million to construct a 160-mile system to deliver up to 600,000 barrels of brackish water per day. The water will be drawn from some 20 wells completed in the Capitan Reef area near Kermit and delivered to operators conducting waterflood operations in Ector County.

Mobil Oil Co.'s gas cycling plant in the Coyanosa multipay field in Pecos County is expected to recover approximately 50 million barrels of liquid from the reservoir over and above that which would have been obtained by primary depletion.

Atlantic Refining Co., operating a secondary project for the 39-well, 17,000-acre Mustang Island Sand 6 unit in Corpus Christi Bay, is expected to recover some 2 million barrels of additional oil. From the unitized Goldsmith field Adobe unit in Ector County, Phillips Petroleum Co., through a secondary project, is expected to recover an additional 13.5 million barrels of crude oil. In a "fireflood project," Continental Oil Co. planned to recover an additional 400,000 barrels of oil from its East Arnim field in Fayette County.

Crude oil stocks in Texas as of December 31, 1964, amounted to 89.1 million barrels of which 21.1 million barrels were in pipelines, 13.6 million barrels in lease tanks, 12.9 million barrels in refineries, and 41.5 million barrels in gathering systems, pipelines, tank farms, and terminals.

Texas had 59 oil refineries in 1964 with a total maximum daily capacity of 2.7 million barrels. More than 85 percent of the capacity was on the gulf coast adjacent to the Beaumont, Corpus Christi, and Houston areas. Texas refineries charged 908.9 million barrels of crude oil to stills during the year, up 26 million barrels from 1963. Refinery output increased from 1,027 million barrels in 1963 to 1,044 million barrels in 1964, the greatest increase being gasoline—up 125 million barrels. During 1964, five refineries with a total daily capacity of 26,500 barrels were shut down.

Petrochemicals.—The petrochemical industry maintained its dominant national position through new products, installations, and expansions. There were 137 petrochemical plants operating, most of which were along the gulf coast. More than half of all the plastic materials and resins produced in the Nation and more than half its output of synthetic rubber was from this area. Approximately 80 percent of the Nation's output of ethylene was produced in the Houston area.

Underground chemical pipelines tied together more than 65 plants and 6 subterranean salt domes, which can be used for storage as well as a low cost source of salt brine. The underground pipelines may be

TABLE 11.—Runs to stills and output of refineries in 1964, by months

(Thousand 42-gallon barrels)

Month	Runs			Output					
	Crude	Products	Rerun	Gasoline	Kerosine	Fuel oil		Jet fuel	Miscellaneous
						Distillate	Residual		
January	76,019	7,563	−2,917	38,648	5,998	19,132	3,020	1,884	11,983
February	71,149	7,240	−1,932	35,370	4,937	19,288	3,270	2,207	11,385
March	74,701	7,556	−1,567	38,397	4,834	18,946	3,446	2,676	12,391
April	73,532	7,699	−3,531	37,600	4,315	17,624	3,279	2,375	12,507
May	76,418	7,839	−3,951	39,788	4,098	18,026	2,719	3,000	12,675
June	73,951	7,162	−1,454	37,987	3,684	18,733	2,924	3,091	13,240
July	78,633	7,934	−2,018	41,402	3,587	19,320	3,254	3,512	13,474
August	77,463	8,180	−2,742	41,049	4,635	18,286	2,840	3,285	12,806
September	72,523	8,346	−2,205	37,907	5,160	17,007	3,134	2,923	12,533
October	75,563	8,202	−2,461	39,983	5,706	17,452	2,798	2,903	12,462
November	71,144	8,246	−1,547	38,099	4,985	17,443	2,848	2,659	11,809
December	76,927	8,138	−2,825	39,585	6,347	18,863	3,059	2,512	11,874
Total:									
1964	898,023	94,105	−29,150	465,815	58,286	220,120	36,591	33,027	149,139
1963	876,529	95,430	−20,417	456,151	57,871	228,134	40,386	28,635	140,365

TABLE 12.—Stocks of crude petroleum at refineries, tank farms, and gathering systems in 1964, by months

(Thousand 42-gallon barrels)

Month	Refineries	Tank farms and pipelines	Lease tanks	Total
January	13,736	64,848	7,473	86,057
February	15,372	63,900	7,502	86,774
March	15,805	66,583	7,453	89,841
April	16,240	70,198	7,200	93,638
May	16,125	70,613	7,543	94,281
June	16,142	71,114	7,307	94,563
July	15,044	68,033	7,290	90,367
August	15,031	61,741	7,548	84,320
September	14,075	60,061	7,311	81,447
October	14,936	58,301	7,451	80,688
November	14,519	59,933	7,628	82,080
December	13,449	60,182	7,133	80,764

TABLE 13.—Stocks of refined products by refineries with plants and pipelines in 1964, by months

(Thousand 42-gallon barrels)

Month	Gasoline [1]	Kerosene	Fuel oil		Jet fuel	Natural gas liquids	Miscellaneous products
			Distillate	Residual			
January	35,042	4,127	13,438	5,539	1,578	1,662	30,195
February	36,739	3,939	12,282	5,538	2,016	1,580	30,443
March	36,620	4,718	13,569	5,454	2,466	1,643	30,320
April	34,549	5,066	15,221	6,274	2,138	1,498	31,335
May	32,497	5,172	16,561	6,058	2,182	1,544	32,768
June	28,919	5,117	21,075	6,187	1,709	1,447	31,550
July	31,402	4,368	22,586	6,603	2,409	1,547	30,209
August	30,910	4,839	26,087	6,331	2,867	1,462	30,182
September	31,111	5,452	26,692	6,258	2,343	1,379	30,644
October	31,591	5,770	26,912	6,008	2,547	1,415	30,049
November	32,091	4,467	23,891	5,285	2,327	1,454	29,845
December	33,894	4,973	18,091	5,278	2,863	1,590	30,435

[1] Includes naphtha.

utilized to allow one plant to use the products of another, and then pass on products of its own.

The Texas petrochemical industry expanded as new facilities were built and producing capacities were enlarged. Some of the larger expansions are as follows: Celanese Chemical Co. installed a 100-million-pound-per-year acetic acid unit at its Pampa complex and a 100-million-pound-per-year vinyl acetate facility at its Bay City plant. Suntide Refining Co., with Amoco Chemicals Corp., added a 50-million-pound-per-year paraxylene plant to its Corpus Christi refinery. Helmerich and Payne, Inc., built a 10-million-pound-per-year mercaptan blending plant adjacent to the Humble Oil & Refining Co., Baytown refinery. Texas Eastman Co. was building a multimillion-dollar high-purity ethylene unit and an acetaldehyde unit at its Longview chemical complex. Gulf Oil Co. was adding a 100-million-pound-per-year high-purity alpha olefin facility to its Cedar Bayou complex outside of Houston and its Baytown facility. Amoco Chemical Corp. added a 200-million-pound-per-year styrene monomer plant to its Texas City refinery. Jefferson Chemical Co. completed a 5-million-pound-per-year high-purity cyclohexylamine (the principal ingredient in artificial sweeteners) unit at its Austin research center. The company completed a large ethylene oxide unit at its Port Neches plant. Texaco, Inc., planned a large cyclohexane unit for its Port Arthur refinery; cyclohexane is used as a base for various plasticizers and synthetic fibers such as nylon. Sinclair Refining Co. completed a 40-million-pound-per-year methyl ethyl ketone unit at its Houston refinery and planned addition of a 45-million-pound-per-year paraxylene unit to the one now in operation. E. I. du Pont de Nemours & Co., Inc., will add a 750-million-pound-per-year ethylene plant to its Sabine River works at Orange. Monsanto Chemical Co. began constructing a 115-million-pound-per-year acrylonitrile facility and a 30-million-pound-per-year phenobic and urea resin unit at its Chocolate Bayou complex south of Houston.

In the West Texas area, Cosden Oil & Chemical Co., Big Spring, expanded its present petrochemical facilities. El Paso Natural Gas Products and Rexall Drug & Chemical Co., Odessa, constructed plants to produce 50 million pounds of propylene and 30 million pounds of polypropylene annually. Odessa Natural Gasoline Co. completed construction of a 25,000-ton ammonia plant. Rexall Drug & Chemical Co. completed an olefin copolymer plant with an annual capacity of 30 million pounds.

NONMETALS

The 1964 value of nonmetal production was $329 million, an 8-percent increase over 1963 value, and was responsible for over 7 percent of the total mineral value. Seventeen nonmetal commodities were reported in 1964; in 1963 there were 16. The five principal commodities in order of value were cement, sulfur, stone, sand and gravel, and salt. Production increases were reported for 11 of these nonmetal commodities, declines were noted for 3, and 3 remained unchanged.

Most of the nonmetal minerals were produced for local markets because of their bulk weight and low unit price, the major exceptions being sulfur and bromine.

Liquid sulfur shipments to gulf and east coast ports were begun by Texas Gulf Sulphur Co. in its new 23,760-ton seagoing tanker—the SS *Marine Texan.*

Marshall Brick Co. completed installation of a 1-million-brick-per-month tunnel kiln at its Marshall plant. Southwestern Brick & Tile Co. completed a modified tunnel kiln which operates on a semiperiodic base. The kiln was built in three sections to provide drying, firing, and cooling periods.

Water quality and water resources were studied by Federal, State, and local agencies. The U.S. Army Corps of Engineers had reservoir sites under consideration in Trinity, Neches, Sabine, Sulphur, and Red River Watersheds. Some of the reservoir sites being evaluated by the U.S. Army Corps of Engineers included the upper and lower branches of Lake Fork Creek; upper and lower Big Sandy Creeks in the Mineola, Hawkins, and Big Sandy areas; Rabbit Creek, Cherokee Bayou Lake No. 2, Martins Creek, and Eight Mile Creek in the Longview-Kilgore area; and the Socagee, State Line, Bon Wier, Bayou Toro, Newton, and Lower Anacoco in the lower reaches of the Sabine River.

Most of the civil works projects by the U.S. Army Corps of Engineers were in the Houston and adjacent gulf area. The $61 million Sam Rayburn Dam and Reservoir on the Angelina River was on schedule in 1964 with completion planned for 1965.

Barite.—Crude barite was obtained from an open-pit mine in the Seven Heart Gap area of Culberson County by Continental Minerals Co. and processed at the company mill near Van Horn. Crude barite from other States and from foreign countries was processed at grinding plants in Brownsville (Cameron County), Houston (Harris County), and Corpus Christi (Nueces County). Most of the material was used as an additive in drilling mud.

Bromine.—Production of ethylene dibromide increased 58 percent in quantity and 24 percent in value over 1963. Ethylene dibromide, used chiefly as an additive in motor fuel antiknock fluids, was extracted from sea water at the Freeport plant of Ethyl-Dow Chemical Co. in Brazoria County.

Cement.—The cement industry expanded production, storage, and handling facilities in 1964. Ten companies, with 17 plants, operated during the year with total production capacity of 43.2 million barrels of cement, compared with 10 companies, 16 plants, and a total capacity of 42.3 million barrels in 1963.

TABLE 14.—Portland cement production, shipments, and consumption

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments		Consumption (quantity)
		Quantity	Value	
1955–59 (average)	24,863	24,649	$73,260	21,367
1960	23,190	22,721	73,964	20,195
1961	24,889	25,101	80,808	21,566
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

The new 1.25-million-barrel-per-year Amarillo plant of Southwestern Portland Cement Co. in Potter County began regular production in 1964. Halliburton Portland Cement Co. of Corpus Christi was purchased by the Centex Construction Co. of Dallas. A major producer of construction materials, Gifford-Hill & Co., Inc., announced plans to construct and operate a new portland cement plant north of Midlothian in Ellis County.

Cement plants were in 12 counties compared with 11 counties in 1963. Portland cement shipments increased 3 percent with a 2-percent increase in value over 1963. Six plants, comprising about 34 percent of total capacity, were along the gulf coast and used over 2.5 million tons of shell in producing cement; 11 cement plants, in 9 inland counties, used more than 5 million tons of crushed limestone.

At four of the cement plants accounting for 19 percent of total installed capacity a dry process was used. The wet process was used at 13 plants with 81 percent of the capacity. Intrastate markets consumed nearly 83 percent of portland cement and 76 percent of masonry cement shipped in 1964.

Clays.—The clay industry remained an important segment of the State's economy, although a slight decline was reported in clay production during 1964. The total clay production decreased about 1 percent; the value decreased about 2 percent.

Miscellaneous clay provided 81 percent of total clay production; approximately 34 percent was used in cement. Other important uses included building brick, heavy clay products, and lightweight aggregate. Most of the fire clay was used in building brick, with lesser amounts in refractories, vitrified pipe, pottery, stoneware, and other uses. Bentonitic clay, including fuller's earth, was used as an additive in rotary drilling muds, as a filtering and decolorizing agent, as a carrier for insecticides and fungicides, as an absorbent, and as a soil conditioner.

Clay production was reported from 48 counties by 88 producers; 38 of the counties reported miscellaneous clay, 13 reported fire clay, 4 reported bentonite, 1 reported fuller's earth, and 1 reported kaolin production. The five leading counties in order of output were Galveston, Eastland, Bexar, Dallas, and Harris. The five principal producing companies were, in alphabetical order, Dallas Lightweight Aggregate Division of Texas Industries, Inc., Featherlite Corp. and its subsidiary Featherlite Co. of San Antonio, Henderson Clay Products Co., and Ideal Cement Co.

TABLE 15.—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
1955–59 (average)	139	$1,089	520	$1,173	2,706	$2,923	3,365	$5,185
1960	116	873	715	1,668	2,471	2,517	3,302	5,058
1961	122	900	676	1,660	2,988	3,177	3,786	5,737
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

[1] Incomplete total, excludes kaolin (1964) and fuller's earth.

Magnet Cove Barium Corp. completed a plant near Kosse in Limestone County to process kaolin and glass sand obtained from strip mines in the Simsboro formation. Marshall Brick Co. of Marshall installed a new tunnel kiln, which increased production capacity to 3 million brick per month. Expansion also was underway at Martin Brick Co. in Coleman, Marshall Pottery Co. in Marshall, and Hereford Tile & Brick Co., Inc., in Hereford. The new tri-zone firing system of Southwestern Brick and Tile Co. of Snyder was described in the November issue of "Brick & Clay Record." The new ceramic plant of Texas Clay Tile, Inc., was completed at Malakoff.

Fluorspar.—No Texas production was reported. Fluorspar mined outside the State (chiefly in Mexico) was processed at mills in Alpine (Brewster County), Brownsville (Cameron County), Flatonia (Fayette County), Houston (Harris County), and Eagle Pass (Maverick County) for chemical and metallurgical uses.

Gem Stones.—Collection, preparation, and sale of gem stones and mineral specimens by dealers, hobbyists, and amateurs continued. The gem stones and specimens included agate, jasper, cinnabar, fluorite, topaz, calcite, opal, petrified wood, and others.

Graphite.—Crystalline flake graphite in Precambrian metamorphic rocks was mined from open pits in Burnet County by Southwestern Graphite Co. and processed at the company mill. Graphitic schist (classified as miscellaneous stone) was produced near Llano in Llano County by Graphilter Corp. for use as filter material. Pure Oil Co. acquired the Garland plant of Ling-Temco-Vought, Inc., for production of high-temperature graphite; the new corporation is known as Poco Graphite, Inc.

Gypsum.—Production of crude gypsum increased about 3 percent in volume and slightly more than 1 percent in value. Seven producers reported production from the following five counties: Fisher, Hardeman, Hudspeth, Nolan, and Ward. All production was from open-pit mines. Most of the gypsum was used in wallboard, plaster, and other building materials; lesser amounts were used as retarder in portland cement. In Hamlin, Celotex Corp. announced plans to build a 12,000-square-foot warehouse addition.

TABLE 16.—Crude gypsum mined

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	1,228	$4,015	1962	1,120	$3,956
1960	1,131	3,960	1963	1,099	3,999
1961	1,074	3,832	1964	1,131	4,049

Lime.—Expansion of the lime industry of Texas continued as demand remained at high levels. Consumption by chemical and other industrial users amounted to 71 percent of total output in 1964. The remainder was used in construction (including soil stabilization), in agriculture, and as refractory lime. Production of primary quicklime and hydrated lime was reported from 13 plants in 9 counties. In order of output, the three leading counties were Brazoria, Nueces, and Wil-

liamson. Limestone comprised about 57 percent of the basic raw material used in preparing lime; the remaining percentage was shell.

Most of the lime output, 56 percent, was consumed within the State; the major part of the production was for captive use. Most of the out-of-State shipments were sent to adjoining States.

The industry utilized 23 shaft kilns and 20 rotary kilns (total annual rated capacity was 1,490,000 tons). Principal chemical and other industrial uses were in alkalies, paper, and petrochemicals, and as metallurgical lime in open-hearth and electric furnaces. Large quantities were used for water purification and softening.

TABLE 17.—Lime sold or used by producers

Year	Quicklime (short tons)	Hydrated lime (short tons)	Total	
			Short tons	Value (thousands)
1955–59 (average)	408,959	285,606	694,565	$7,130
1960	433,405	388,037	821,442	9,087
1961	412,063	377,475	789,538	8,703
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

Brazos Lime Co., a new lime producer, began operating its recently constructed 400-ton-per-day plant near Blum in Hill County; Edwards limestone quarried near the plant is used as raw material. Texas Lime Co., which operates a 300-ton-per-day lime plant south of Cleburne, announced plans to build an additional 220-ton-per-day plant about 12 miles west of Cleburne at the company's Edwards limestone quarry. In Houston, U.S. Gypsum Co. began producing hydrated lime that was used primarily for road stabilization in the gulf coast area. With the installation of a new rotary lime kiln, Austin White Lime Co. increased calcining capacity by 220 tons per day.

Magnesium Compounds.—Magnesium compounds were derived from sea water at the Freeport plant of Dow Chemical Co. A significant quantity of magnesium hydroxide was processed to obtain periclase, a basic refractory material, at the Freeport plant of E. J. Lavino & Co.

Natural Salines.—Sodium sulfate was recovered from salt brines in Terry and Ward Counties by Ozark-Mahoning Co. Production increased over that in 1963.

Perlite.—The first commercial perlite mining in Texas was reported by Perlite Producers, Inc., of Midland. In addition to the crude production, seven plants in five counties expanded crude material from New Mexico and Colorado. The bulk of the expanded material was used as a lightweight aggregate for roof decks and as an aggregate in building plaster. All plants were close to markets in or near large metropolitan and industrial areas.

Pumicite (volcanic ash).—Pumicite produced from open pits in Starr County was prepared as an insulating medium, as an absorbent for oils and greases, and as a filler in floor tile and acoustical plaster.

Salt.—Salt, derived from salt domes of the gulf coast and salt beds of the West Texas Permian basin, was a vital ingredient of the State's expanding chemical industry. Production increased 7 percent over 1963 production. Over 93 percent of the production was brine from wells drilled to subsurface salt domes and salt beds. Production was reported from 10 counties by 11 producers. The three principal producing counties were Brazoria, Chambers, and Duval. Most of the brine was used in producing caustic soda, soda ash, and chlorine. Other uses included pulp and paper manufacture, water softening, feed mixes, and manufacture of other chemicals.

TABLE 18.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	4,104	$15,391	1962	5,553	$19,485
1960	4,756	18,222	1963	5,965	22,355
1961	4,695	17,682	1964	6,410	28,797

Sand and Gravel.—Output of sand and gravel declined over 12 percent and the value 8 percent despite near record activities of the State's building and highway construction programs.

Production was reported from 106 of the State's 254 counties with commercial production supplying almost 87 percent of the output and noncommercial the remainder. Building and paving uses consumed 93 percent of the output. Some of the remaining output was used as railroad ballast, engine and molding sands, filtering and grinding media, and raw material for glass manufacture. Ninety-four percent of all the sand and gravel produced was washed or otherwise prepared. Trucks hauled 74 percent of the shipments, railroads 25 percent, and barges 1 percent. The average value of commercial sand and gravel in 1964 was $1.22 per ton; prepared material averaged $1.25 per ton, and pit-run material averaged $0.40 per ton. In 1963 prepared material averaged $1.21 per ton and pit-run material $0.41 per ton. The bulk of the Government-and-contractor material was produced for the Texas Highway Department.

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
1955–59 (average)	24,795	$26,919	5,746	$2,012	30,541	$28,931
1960	26,918	29,857	2,926	897	29,844	30,754
1961	23,272	27,975	4,126	2,716	27,398	30,691
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

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	9,585	$9,245	8,645	$8,650
Paving	2,045	2,002	2,423	2,639
Fill	594	249	817	384
Other [1]	722	1,935	580	2,478
Total	12,946	13,431	12,465	14,151
Gravel:				
Building	9,814	13,192	8,258	11,080
Paving	4,340	5,174	4,055	5,146
Fill	198	94	157	85
Other [2]	213	194	314	434
Total	14,565	18,654	12,784	16,745
Total sand and gravel	27,511	32,085	25,249	30,896
Government-and-contractor operations:				
Sand:				
Building	76	191	1	2
Paving	352	160	411	173
Fill	82	33	11	4
Total	510	384	423	179
Gravel:				
Building	8	17		
Paving	5,227	3,825	3,297	2,245
Fill			186	74
Total	5,235	3,842	3,483	2,319
Total sand and gravel	5,745	4,226	3,906	2,498
Grand total	33,256	36,311	29,155	33,394

[1] Includes railroad (1963), other construction sand, and industrial sand (unground and ground).
[2] Includes railroad ballast, miscellaneous, and other construction gravel.

Stone.—The stone industry of Texas reduced its output nearly 7 percent and its value 4 percent as residential construction awards declined. Seven kinds of stone were produced in 1964—basalt, caliche, granite, marble, limestone, rhyolite, and sandstone. Stone was produced in 76 counties; the 5 leading counties were Wise, Bexar, Comal, Burnet, and Williamson.

Stone accounted for 75 percent of the output and shell the remaining 25 percent. Limestone was responsible for 93 percent of stone production, sandstone for 4 percent, and the remaining 3 percent was comprised of basalt, caliche, granite, marble, and rhyolite. Crushed stone accounted for 99 percent of total stone production; crushed limestone was responsible for 94 percent of the total. Principal uses for crushed stone were for roadstone, concrete aggregate, railroad ballast, cement, and lime.

Shell, dredged from shallow bays along the gulf coast, totaled about 10 million tons in 1964. The three leading counties producing shell were Chambers, Galveston, and Matagorda. Principal uses included the manufacture of cement, chemicals and lime, for concrete aggregate, and poultry grits.

TABLE 21.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Limestone		Sandstone		Shell		Miscellaneous		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1960	26,620	$26,208	1,816	$1,036	10,304	$15,798	159	$212	39,029	$45,088
1961	24,439	25,718	2,266	1,511	10,531	15,373	905	695	38,316	45,874
1962	25,717	27,851	1,266	2,045	10,073	14,701	584	499	38,067	48,988
1963	31,375	34,682	1,412	1,756	9,804	14,026	271	252	43,142	54,007
1964	28,263	31,950	1,304	1,753	9,990	15,077	W	W	40,240	52,070

W Withheld to avoid disclosing individual company confidential data. Included in total.
[1] Includes other stone to avoid disclosing individual company confidential data.

Sulfur.—Output of Frasch elemental sulfur was reported from four gulf coast and Coastal Plain counties by three producers. Production of sulfur recovered from crude oil and sour gas was reported from 17 counties by 31 plants. Output of Frasch sulfur (84 percent of total sulfur produced in the State in 1964) increased 3 percent to 2.5 million long tons. Shipments, however, increased nearly 23 percent to 3.1 million long tons and value increased 24 percent. The domestic price of sulfur gained slightly; however, sulfur producers rescinded some of the earlier bonuses and services to the consumer to implement the improved value. The sulfuric acid industry consumed more than 80 percent of the production, nonacid uses the remainder. Principal uses for sulfuric acid were in fertilizers, chemicals and organic pigments; petroleum refining; and production of iron and steel. Principal nonacid uses included carbon disulfide, wood pulp, dyes, and other chemicals.

TABLE 22.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1955–59 (average)	3,225	3,134	$79,400
1960	2,679	2,747	62,855
1961	2,778	2,730	62,720
1962	2,622	2,655	57,297
1963	2,413	2,550	50,109
1964	2,489	3,126	62,232

Talc and Soapstone.—Production of talc was reported by six producers in Hudspeth County; soapstone was mined by one producer in Gillespie County. Output was nearly 23 percent greater than in 1963. Principal uses included dinnerware and other ceramic bodies, filler for roofing, carrier for insecticides and pesticides, and dusting material for rubber and other type molds. Most of the talc markets were Mexican and intrastate.

Vermiculite (Exfoliated).—Crude vermiculite from other States and from foreign countries was processed at four plants in three counties. Principal uses of the exfoliated material were for loose fill insulation and as lightweight aggregate in plaster and concrete.

Water.—Water was an important factor in the industrial growth of Texas and the Southwest; the State's ability to meet the increasing water requirements will influence much of the industrial future of Texas.

Surface and ground water supplies were adequate for industrial, municipal, and irrigation requirements prior to World War II. However, burgeoning water requirements of the State's growing population and economy, as well as several years of near drought conditions in certain areas, have impeded recharging of underground and surface reservoirs. Fortunately, the north, east, and gulf coast regions of Texas have surface water from rivers and lakes as a major source of supply. The west, southwest, and Panhandle regions have only the Canadian River to bolster their underground water supply.

State and Federal agencies have built and are building more dams to provide surface reservoirs to augment and conserve this most valuable resource. Five dam projects on the Brazos River watershed were authorized by the Texas Water Commission during 1964. More than 1 million acre-feet of reservoir will result from these projects. The projects included a new reservoir on the Brazos between Possum Kingdom and Lake Whitney, the Belton Dam on the Leon River in Bell County, the Somerville Reservoir on Yegua Creek in Washington County, the Stillhouse Hollow Reservoir on the Lampasas River in Bell County, and the Proctor Reservoir on the Leon River in Comanche County.

The $18.8 million Somerville Dam and Reservoir project included the relocation and construction of roads and utility lines and work on the main embankment and spillway. The Forney Lake Dam, to provide water for the Dallas area, also was under construction in 1964.

The Sanford Dam on the Canadian River was 95 percent complete and the aqueduct project was 52 percent complete at yearend according to the Bureau of Reclamation. The dam, a 15-million-cubic-yard earthfill structure that is 200 feet high and 6,390 feet long, will create a 1,408,000-acre-foot reservoir.

Construction of the $60 million Toledo Bend Dam and hydroelectric complex on the Sabine River was authorized by the Texas Water Commission and the State of Louisiana. Texas and Louisiana each subscribed $15 million of the project costs with three power companies underwriting the remaining $30 million. The 8,600-foot-long dam across the Sabine River, 75 miles north of Orange, will impound 4.5 million acre-feet of water in Texas and Louisiana. Two turbines will generate 80,000 kilowatts of energy. Tentative completion date was May 1968. The Texas Highway Department will build 237.9 miles of new roads in the area at a cost of $7.7 million and relocate roads and build new bridges at a cost of $5.3 million.

Waterways improvement projects included a $19 million project to deepen the Houston Ship Channel from Galveston Bay to a turning basin at Houston; a $5.4 million project for a 36-foot-deep channel from deep gulf water across Matagorda and Lavaca Bays to Point Comfort; a $24.2 million project to deepen the Port Aransas-Corpus Christi Channel from 36 feet to 40 feet from gulf deep water through Corpus Christi Bay via Corpus Christi to a turning basin at Viola; and a $5.8 million Sabine-Neches Waterway project to provide a

36-foot-deep channel from the Sabine Pass outer bar via Port Arthur and Beaumont and via a 30-foot channel to Orange.

The U.S. Department of the Interior continued operating the $1.2 million saline water demonstration plant at Freeport. The 1-million-gallon-per-day long tube vertical 12 effect distillation plant is part of the Demonstration Plant Act of Public Law 448, 1952, for the production of potable from sea water or brackish water to increase the water resources of the Nation.

METALS

Iron ore and uranium were the only metals mined in Texas—magnesium metal was recovered from sea water. There was an imposing array of mineral processing and metallurgical plants, however, at which ores and minerals from other States and from foreign countries were processed.

Metals recovered at Texas plants included aluminum, antimony, cadmium, copper, germanium, gold, silver, iron, lead, magnesium, tin, tungsten, and zinc. National and international markets remained the major outlets for the metals, other than iron, but the metals fabricating industry was rapidly expanding.

Aluminum and Bauxite.—The aluminum industry of Texas, which began production in 1950 with an annual capacity of 57,000 tons, progressed to an annual capacity of 385,000 tons in 1964. Expansion programs of the Aluminum Company of America included a 187,000-ton increase in the alumina plant adjacent to the Point Comfort reduction works, and improved cells and electrodes in the Point Comfort plant. Reynolds Metals Co. planned to enlarge its La Quinta alumina plant near Corpus Christi with a fifth digester train, a lime hydrator, and accessory facilities such as bauxite grinding mills, a new boiler, and turbo generators to replace the present gas-fired ones. When this phase is completed in 1965, the company planned to modernize the four existing digester trains and related equipment. The combined program will increase the La Quinta capacity from the current 2,500 tons of alumina daily to 3,000 tons.

Antimony.—Antimony from ores and concentrates imported from Mexico and Bolivia was recovered at the Laredo smelter of National Lead Co. Smelter output was greater than in 1963, commensurate with a significant rise in consumption. The principal uses for the metal were in antimonial lead for batteries, bearing metals, and frits; and as pigment in ceramic enamels, paints, and lacquers.

Copper.—Blister copper was produced at the El Paso copper smelter of the American Smelting and Refining Co. from ores and concentrates of Western States and foreign countries. Fire-refined copper and electrolytic-grade copper were produced at the Nichols refinery of Phelps Dodge Refining Corp. No appreciable change occurred at either operation during 1964.

Iron and Iron Ore.—The 1964 output of iron ore from open pits in Cherokee and Morris Counties was 90 percent larger than that in 1963. The ore was shipped to one blast furnace near Daingerfield and to another in Houston. Both blast furnaces were basic units of integrated steel mills operated by Lone Star Steel Co. and Armco Steel

Corp. Ore from Mexico and from South America supplemented domestic ore as blast furnace feed. The blast furnaces and steel mills operated at near capacity as demands for steel products remained high.

New facilities of Lone Star Steel Co. included four new soaking pits, a 100-foot addition to the stripper building where ingots are removed from molds, an enclosed control room with separate automatic temperature controls for the gas-fired furnaces and other auxiliary equipment. The soaking pits are 9 by 24 by 16 feet deep and will hold about 150 tons of ingot steel. These new units will increase ingot heating capacity of the Lone Star plant 50 percent and will permit more efficient and flexible use of the rolling mill.

Armco Steel Corp. added production facilities to its cold-rolled and galvanized sheet mills, installed a vacuum degassing unit, and expanded basic steel production and the range of its structural products. The Houston plant has 1 blast furnace, 8 open hearth furnaces, 2 coke batteries, 2 electric-arc furnaces, 10 soaking pits, a blooming mill, a combination slab and plate mill, and an iron ore smelter.

Lead.—Lead ores and concentrates from Western States and from Mexico were processed into base bullion at the El Paso lead smelter of American Smelting & Refining Co. Precious metals were recovered from smelter residues and other materials at the El Paso smelter. Seven secondary lead smelters in Texas also treated scrap material. Demand for antimonial lead for storage batteries was decreased slightly compared with that of 1963.

Magnesium.—Magnesium was produced from sea water at the Dow Chemical Co. electrolytic plants at Freeport. Magnesium capacity was being raised from the present 92,000 tons per year to 100,000 tons through improved cell design, efficiency, and feed capacity.

The use of magnesium as an alloying constituent with aluminum and as a reducing agent to produce titanium increased during 1964. Appreciable quantities of the metal were used for automobile parts, business machines, and hand tools where light weight is important; and for cathodic protection of iron and steel in ships and marine equipment, industrial boilers, and pipelines.

Manganese.—Imported manganese ore was smelted at the Houston plant of Tenn-Tex Alloy & Chemical Corp. to produce ferromanganese. Most of the alloy was used as an additive for the growing Texas steel industry; the remaining minor quantity was shipped outside the State for similar uses.

Mercury.—Exploration and development programs for mercury in the Terlingua District continued dormant during 1964, notwithstanding a significant rise in the price.

Tin.—Output of the Wah Chang Corp. tin smelter at Texas City increased in 1964 compared with that of 1963. The smelter continued as the only source of primary refined tin in the United States.

Uranium.—Stockpiled uranium ore from Karnes and Live Oak Counties was processed at the 200-ton-per-day solvent extraction mill of Susquehanna-Western, Inc.

Zinc.—Three primary zinc plants (two horizontal retort and one electrolytic) processed foreign and Western States ores and concentrates. Secondary smelters in the Fort Worth-Dallas and in the Houston-Beaumont areas treated scrap material. Texas zinc smelters operated at near capacity as domestic demand continued at high levels.

Secondary Metals.—*Iron and Steel Scrap.*—Scrap was an important raw material for the Texas iron and steel industry which consumed 2.4 percent of the Nation's scrap. The major part of the 2 million tons of ferrous scrap consumed within the State was purchased by the users from scrap dealers.

Lead Scrap.—Texas had an appreciable secondary lead smelting capacity. These plants processed lead scrap, battery plates, bearing metal, and other alloys into refined and antimonial lead and alloys such as babbitt and solder. Secondary lead smelters in Texas were Houston Fishing Tackle Co., Magnus Metal Division of National Lead Co., and Houston Lead Co., at Houston; Southern Lead Co. and National Lead Co. at Dallas; National Metal and Smelting Co. at Fort Worth; Standard Electric Co. at San Antonio; and Wilkinson Brothers Smelting Co. at Laredo.

REVIEW BY COUNTIES

Anderson.—There were 717 million barrels of crude oil produced in 1964. Fourteen exploratory wells totaling 94,796 feet resulted in one oil discovery and one new gas pay. Development drilling totaling 203,479 feet proved 29 oil wells. Natural gas liquids were recovered at gas processing plants of Tidewater Oil Co., Texaco Inc., and Slocum Gas Co., having a combined capacity of 68.3 million cubic feet per day. Gasoline, kerosine, diesel oil, and fuel oil were recovered at the 2,200-barrel-per-day Tucker refinery of Anderson Refining Corp. Glazed wall and floor tile were produced at the Clayburn Tile Factory. Glass containers were produced at the Palestine plant of Knox Glass, Inc.

TABLE 23.—Value of mineral production in Texas, by counties [1]

County	1963 r	1964	Minerals produced in 1964 in order of value
Anderson	$24,106,334	$25,717,570	Petroleum, natural gas, natural gas liquids.
Andrews	241,925,933	252,841,850	Petroleum, natural gas liquids, natural gas.
Angelina	625,661	555,871	Clays, natural gas, petroleum.
Aransas	11,182,383	12,023,684	Natural gas, petroleum, natural gas liquids, shell.
Archer	30,367,894	30,508,001	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Atascosa	15,768,998	17,594,650	Petroleum, natural gas, natural gas liquids, sand and gravel.
Austin	6,574,665	6,638,460	Do.
Bandera	2,800		
Bastrop	1,013,964	967,843	Clays, petroleum, natural gas.
Baylor	6,513,993	5,968,664	Petroleum, natural gas, stone.
Bee	15,102,160	15,011,461	Natural gas, petroleum, natural gas liquids, stone.
Bell	W	W	Sand and gravel, stone.
Bexar	19,405,273	21,075,568	Cement, stone, sand and gravel, natural gas liquids, petroleum, clays, natural gas.
Blanco	3,437	25,000	Sand and gravel.
Borden	26,483,536	25,435,990	Petroleum, natural gas, sand and gravel.
Bosque	7,834	111,679	Stone, sand and gravel.
Bowie	427,550	193,200	Sand and gravel, petroleum, natural gas.
Brazoria	161,448,280	177,973,572	Petroleum, natural gas, magnesium chloride, bromine, natural gas liquids, salt, lime, magnesium compounds, sand and gravel.
Brazos	167,990	156,230	Natural gas, petroleum.
Brewster	W	W	Clays.
Briscoe	W	W	Do.
Brooks	22,226,991	24,245,740	Natural gas, petroleum, natural gas liquids.
Brown	2,174,519	2,049,979	Stone, petroleum, natural gas, clays.
Burleson	104,554	267,880	Stone, petroleum, sand and gravel.
Burnet	3,892,919	3,548,208	Stone, graphite, sand and gravel.
Caldwell	9,715,390	10,121,970	Petroleum.
Calhoun	21,681,564	22,280,033	Natural gas, petroleum, natural gas liquids, lime, shell, sand and gravel.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1963 r	1964	Minerals produced in 1964 in order of value
Callahan	$7,547,254	$7,195,690	Petroleum, natural gas, natural gas liquids.
Cameron	977,360	1,019,860	Natural gas, petroleum.
Camp	1,705,560	2,326,110	Petroleum, natural gas.
Carson	28,694,676	27,662,600	Natural gas, petroleum, natural gas liquids.
Cass	10,654,674	8,001,630	Petroleum, natural gas, natural gas liquids.
Chambers	66,154,103	67,812,323	Petroleum, natural gas, shell, salt, natural gas liquids.
Cherokee	7,579,334	8,162,307	Petroleum, iron ore, natural gas, natural gas liquids, clays.
Childress	378,035	253,890	Petroleum, sand and gravel, stone.
Clay	11,463,186	11,463,757	Petroleum, natural gas, stone.
Cochran	27,402,650	29,369,460	Petroleum, natural gas, natural gas liquids.
Coke	27,864,176	26,369,280	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coleman	9,756,873	8,756,029	Petroleum, natural gas, sand and gravel, natural gas liquids, stone, clays.
Collin	100,690	168,990	Petroleum, stone.
Collingsworth	1,434,680	1,663,380	Natural gas, petroleum.
Colorado	24,974,464	23,398,520	Natural gas, natural gas liquids, sand and gravel, petroleum.
Comal	3,948,214	3,884,838	Stone, lime, sand and gravel.
Comanche	403,759	604,220	Stone, petroleum, natural gas.
Concho	1,059,430	1,040,620	Petroleum, natural gas.
Cooke	31,234,500	31,809,650	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Coryell	30,335	88,727	Stone, petroleum.
Cottle	386,170	223,680	Petroleum, natural gas.
Crane	142,835,215	142,403,690	Petroleum, natural gas liquids, natural gas.
Crockett	22,516,191	24,026,120	Petroleum, natural gas, natural gas liquids.
Crosby	1,288,604	1,338,520	Sand and gravel, petroleum, natural gas.
Culberson	4,214,308	4,129,555	Petroleum, natural gas, barite.
Dallam	28,560	29,800	Natural gas.
Dallas	21,089,030	18,351,466	Cement, sand and gravel, stone, clays.
Dawson	23,333,207	25,017,531	Petroleum, natural gas liquids, natural gas, stone.
Denton	575,235	502,294	Natural gas, petroleum, clays, sand and gravel.
De Witt	10,092,523	11,090,130	Petroleum, natural gas, natural gas liquids, sand and gravel.
Dickens	122,300	111,520	Petroleum, natural gas.
Dimmit	947,810	904,450	Do.
Donley	40,000		
Duval	36,352,548	36,383,881	Petroleum, natural gas, salt, natural gas liquids, stone.
Eastland	4,671,894	5,011,111	Natural gas liquids, petroleum, natural gas, clays, stone.
Ector	225,865,877	236,607,268	Petroleum, natural gas liquids, natural gas, cement, stone.
Edwards	1,460	20,700	Petroleum.
Ellis	8,117,078	11,144,950	Cement, stone, clays, sand and gravel.
El Paso	4,935,648	4,687,475	Cement, stone, sand and gravel.
Erath	2,117,337	2,342,810	Natural gas, natural gas liquids, petroleum.
Falls	63,117	1,110	Petroleum.
Fayette	1,828,176	1,951,116	Sand and gravel, petroleum, clays, stone, natural gas.
Fisher	17,771,609	18,017,174	Petroleum, gypsum, natural gas, natural gas liquids, clays.
Floyd	W	13,680	Petroleum.
Foard	3,245,680	3,216,670	Petroleum, natural gas.
Fort Bend	34,130,616	35,930,714	Petroleum, sulfur, natural gas, salt, natural gas liquids, clays, sand and gravel.
Franklin	11,716,854	12,451,440	Petroleum, natural gas liquids, natural gas.
Freestone	3,809,237	4,388,556	Natural gas, petroleum, stone, natural gas liquids, clays.
Frio	4,731,850	4,787,050	Petroleum, natural gas, natural gas liquids.
Gaines	99,595,169	99,605,760	Petroleum, natural gas, natural gas liquids, stone.
Galveston	51,592,641	53,525,323	Petroleum, natural gas, shell, natural gas liquids, clays, sand and gravel.
Garza	16,881,580	14,381,850	Petroleum, sand and gravel, natural gas.
Gillespie	100,952	2,019,693	Petroleum, sand and gravel, stone, soapstone.
Glasscock	5,179,310	5,200,830	Petroleum, natural gas.
Goliad	10,273,168	10,129,870	Natural gas, petroleum, natural gas liquids.
Gonzales	596,356	457,417	Clays, petroleum, sand and gravel, natural gas.
Gray	56,397,662	59,900,070	Petroleum, natural gas liquids, natural gas.
Grayson	28,094,902	26,821,632	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Gregg	89,922,241	94,584,730	Petroleum, natural gas liquids, natural gas.
Grimes	485,640	130,860	Natural gas, stone.
Guadalupe	10,861,558	11,071,140	Petroleum, clays, natural gas.
Hale	1,491,600	1,787,110	Petroleum, natural gas liquids, natural gas.
Hall		72,000	Stone, sand and gravel.
Hamilton	128,882	99,483	Natural gas, stone, petroleum.
Hansford	24,208,904	25,225,850	Natural gas, natural gas liquids, petroleum.
Hardeman	4,864,078	5,060,765	Petroleum, gypsum, natural gas liquids, natural gas, sand and gravel.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1963[r]	1964	Minerals produced in 1964 in order of value
Hardin	$21,304,082	$21,306,800	Petroleum, natural gas, natural gas liquids.
Harris	115,588,442	100,472,762	Petroleum, cement, natural gas, natural gas liquids, salt, lime, sand and gravel, clays.
Harrison	20,414,810	22,482,466	Natural gas, petroleum, natural gas liquids, coal, clays.
Hartley	1,992,030	2,069,630	Natural gas, petroleum.
Haskell	13,332,580	12,422,080	Petroleum, natural gas.
Hays	19,572	504,000	Sand and gravel.
Hemphill	1,545,650	1,612,840	Petroleum, natural gas.
Henderson	14,682,094	17,240,229	Petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Hidalgo	33,771,131	35,743,381	Natural gas, natural gas liquids, petroleum, sand and gravel, stone, clays.
Hill	3,660	143,796	Stone, sand and gravel, petroleum.
Hockley	34,118,528	36,475,830	Petroleum, natural gas liquids, natural gas.
Hood	----------	52,503	Sand and gravel, stone.
Hopkins	4,840,319	4,670,557	Petroleum, natural gas natural gas liquids, clays.
Houston	5,468,977	4,277,243	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Howard	44,649,488	42,365,010	Petroleum, natural gas liquids, sand and gravel, natural gas.
Hudspeth	1,414,420	571,424	Talc, stone, gypsum.
Hunt	185,670	211,829	Natural gas, stone, petroleum.
Hutchinson	54,741,348	54,290,544	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, salt.
Irion	4,433,275	4,865,050	Petroleum, natural gas liquids, natural gas.
Jack	16,145,162	15,314,450	Petroleum, natural gas, natural gas liquids, sand and gravel.
Jackson	48,770,588	50,778,760	Do.
Jasper	2,741,945	2,614,357	Petroleum, natural gas, clays, lime.
Jefferson	68,965,790	65,920,227	Petroleum, natural gas, sulfur, natural gas liquids, salt, shell, sand and gravel, clays.
Jim Hogg	18,550,759	19,614,440	Petroleum, natural gas, natural gas liquids.
Jim Wells	56,246,390	58,599,790	Do.
Johnson	1,721,633	3,168,429	Lime, stone, sand and gravel, petroleum.
Jones	15,933,990	13,974,110	Petroleum, natural gas liquids, natural gas, sand and gravel.
Karnes	15,060,386	16,951,355	Petroleum, natural gas, uranium, natural gas liquids.
Kaufman	2,418,365	2,137,091	Petroleum, stone, natural gas.
Kendall	3,550	17,982	Stone.
Kenedy	5,743,480	7,326,210	Petroleum, natural gas.
Kent	32,637,840	33,358,550	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kerr	W	W	Sand and gravel.
Kimble	42,569	24,810	Sand and gravel, natural gas, petroleum.
King	2,589,890	2,755,180	Petroleum, natural gas.
Kleberg	82,644,198	84,462,842	Petroleum, natural gas, natural gas liquids, stone.
Knox	6,753,120	6,338,930	Petroleum, natural gas.
Lamb	5,440,192	2,399,468	Petroleum, stone, natural gas.
Lampasas	126,618	357,237	Sand and gravel, stone.
La Salle	1,255,350	1,269,200	Petroleum, natural gas.
Lavaca	13,252,034	12,029,997	Natural gas liquids, natural gas, petroleum, stone, sand and gravel.
Lee	49,970	47,160	Petroleum.
Leon	6,728,457	7,582,740	Petroleum, natural gas, natural gas liquids.
Liberty	42,433,025	41,306,162	Petroleum, sulfur, natural gas, sand and gravel, natural gas liquids.
Limestone	1,991,315	1,969,405	Natural gas, petroleum, clays, stone, sand and gravel.
Lipscomb	5,625,410	7,771,400	Petroleum, natural gas.
Live Oak	21,662,272	18,493,070	Natural gas, petroleum, natural gas liquids.
Llano	1,583,114	2,279,858	Stone.
Loving	12,361,880	11,591,470	Petroleum, natural gas.
Lubbock	1,281,832	1,043,950	Petroleum, sand and gravel, natural gas.
Lynn	1,675,290	1,676,810	Do.
McCulloch	565,957	1,422,528	Sand and gravel, stone.
McLennan	6,983,898	7,392,423	Cement, sand and gravel, stone, clays, petroleum.
McMullen	9,350,637	9,970,790	Natural gas, petroleum, natural gas liquids.
Madison	2,419,500	2,146,700	Petroleum, natural gas, natural gas liquids.
Marion	4,877,369	4,297,070	Natural gas, petroleum, natural gas liquids.
Martin	7,717,450	10,382,040	Petroleum, natural gas.
Mason	11,219	14,000	Sand and gravel.
Matagorda	54,433,351	57,076,499	Natural gas, petroleum, natural gas liquids, shell, sand and gravel, clays.
Maverick	2,361,022	2,174,280	Petroleum, natural gas liquids, natural gas.
Medina	1,429,360	1,380,528	Petroleum, clays, natural gas.
Menard	649,676	594,310	Petroleum, natural gas.
Midland	49,619,508	49,490,959	Petroleum, natural gas liquids, natural gas, stone.
Milam	W	W	Coal, petroleum.
Mills	20,510	6,430	Stone.
Mitchell	6,758,944	9,020,400	Petroleum, sand and gravel, natural gas.
Montague	21,255,879	22,211,761	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1963[r]	1964	Minerals produced in 1964 in order of value
Montgomery	$26,486,662	$26,201,410	Petroleum, natural gas, natural gas liquids, sand and gravel.
Moore	52,134,059	56,562,165	Natural gas, natural gas liquids, helium, petroleum.
Morris	W	W	Iron ore.
Motley	1,384,598	1,153,960	Petroleum, sand and gravel, natural gas.
Nacogdoches	3,608,671	3,772,380	Natural gas, natural gas liquids, clays, petroleum.
Navarro	6,871,720	7,240,100	Petroleum, stone, natural gas, sand and gravel, clays.
Newton	6,634,562	5,544,010	Petroleum, natural gas, natural gas liquids.
Nolan	25,826,232	26,026,100	Petroleum, cement, natural gas liquids, gypsum, natural gas, stone, sand and gravel.
Nueces	77,184,278	80,577,465	Natural gas, petroleum, natural gas liquids, cement, lime, shell, sand and gravel.
Ochiltree	25,499,751	27,702,210	Petroleum, natural gas, natural gas liquids.
Oldham	503,449	W	Sand and gravel, clays.
Orange	11,368,107	11,631,705	Petroleum, natural gas, cement, natural gas liquids, clays, sand and gravel.
Palo Pinto	3,200,956	3,504,615	Natural gas liquids, natural gas, petroleum, clays, sand and gravel.
Panola	44,069,746	43,259,710	Natural gas, petroleum, natural gas liquids.
Parker	2,553,832	3,012,822	Natural gas liquids, natural gas, stone, clays, petroleum, sand and gravel.
Parmer	237,970	188,950	Petroleum.
Pecos	62,775,343	62,806,120	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Polk	4,713,351	4,808,384	Petroleum, natural gas, stone, sand and gravel.
Potter	14,349,939	17,338,975	Natural gas, helium, natural gas liquids, cement, sand and gravel, stone, clays.
Presidio	24,476	26,700	Sand and gravel, perlite.
Randall	62,582	----------	
Reagan	22,375,481	23,691,020	Petroleum, natural gas liquids, natural gas.
Real	----------	59	Stone.
Red River	79,710	77,190	Petroleum.
Reeves	9,955,630	10,666,200	Petroleum, natural gas liquids, natural gas, sand and gravel.
Refugio	74,867,971	77,443,320	Petroleum, natural gas, natural gas liquids.
Roberts	5,786,890	5,335,820	Petroleum, natural gas.
Robertson	502,873	490,910	Sand and gravel, petroleum.
Runnels	13,899,508	14,120,630	Petroleum, natural gas liquids, natural gas.
Rusk	60,258,264	57,760,700	Petroleum, natural gas, natural gas liquids, clays.
Sabine	472	18,000	Sand and gravel.
San Augustine	2,050	23,070	Sand and gravel, petroleum.
San Jacinto	1,865,746	1,950,780	Petroleum, natural gas, sand and gravel.
San Patricio	46,912,737	47,565,061	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays.
San Saba	----------	W	Stone.
Schleicher	11,429,919	11,174,240	Petroleum, natural gas, natural gas liquids.
Scurry	101,509,187	98,941,545	Petroleum, natural gas liquids, natural gas, stone clays, sand and gravel.
Shackelford	11,538,389	10,720,620	Petroleum, natural gas, natural gas liquids.
Shelby	1,059,569	971,700	Natural gas, petroleum.
Sherman	15,806,970	16,518,980	Do.
Smith	9,220,897	8,540,170	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Somervell	87,728	46,500	Sand and gravel, stone.
Starr	28,418,248	29,591,520	Petroleum, natural gas, natural gas liquids, pumicite, clays.
Stephens	8,650,758	8,390,211	Petroleum, natural gas, natural gas liquids, stone.
Sterling	2,255,020	4,451,380	Petroleum, natural gas.
Stonewall	19,543,397	20,170,290	Petroleum, natural gas liquids, natural gas, sand and gravel.
Sutton	600,740	625,250	Natural gas, petroleum.
Tarrant	11,584,482	9,839,518	Cement, sand and gravel, stone.
Taylor	15,291,326	16,197,280	Petroleum, natural gas, natural gas liquids, stone, sand and gravel, clays.
Terrell	4,733,402	4,938,330	Natural gas, stone, sand and gravel.
Terry	24,153,841	19,950,151	Petroleum, sodium sulfate, natural gas, natural gas liquids.
Throckmorton	8,113,131	8,123,910	Petroleum, natural gas, sand and gravel.
Titus	13,932,280	14,754,220	Petroleum, natural gas.
Tom Green	5,996,912	7,056,420	Petroleum, natural gas, natural gas liquids, sand and gravel.
Travis	4,774,964	3,804,115	Lime, sand and gravel, stone, petroleum.
Trinity	54,735	11,853	Petroleum, stone.
Tyler	2,646,880	2,732,960	Petroleum, natural gas, natural gas liquids.
Upshur	5,562,136	5,897,140	Petroleum, natural gas, sand and gravel.
Upton	55,048,799	59,416,220	Petroleum, natural gas liquids, natural gas.
Uvalde	W	3,050,240	Asphalt, stone, sand and gravel, natural gas.
Val Verde	661,050	556,100	Natural gas, petroleum, sand and gravel.
Van Zandt	20,872,028	22,522,905	Petroleum, salt, natural gas liquids, natural gas.
Victoria	26,567,706	26,232,240	Petroleum, natural gas, sand and gravel.
Walker	968,455	368,458	Stones, clays, petroleum, sand and gravel.
Waller	33,527,803	29,826,410	Natural gas, natural gas liquids, petroleum, sand and gravel.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1963 r	1964	Minerals produced in 1964 in order of value
Ward	$66,760,040	$78,587,864	Petroleum, natural gas, natural gas liquids, sodium sulfate, salt, sand and gravel, gypsum.
Washington	934,960	672,310	Petroleum, stone, natural gas.
Webb	10,728,317	12,422,542	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Wharton	48,348,198	59,568,374	Sulfur, petroleum, natural gas, natural gas liquids, sand and gravel.
Wheeler	8,559,030	10,199,870	Petroleum, natural gas, natural gas liquids.
Wichita	35,328,976	37,044,932	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Wilbarger	19,168,492	18,315,380	Petroleum, natural gas, natural gas liquids, sand and gravel.
Willacy	6,843,980	7,111,260	Petroleum, natural gas.
Williamson	4,427,428	4,877,561	Lime, stone, petroleum.
Wilson	2,001,790	1,773,488	Petroleum, natural gas, clays.
Winkler	92,924,124	89,649,320	Petroleum, natural gas, natural gas liquids.
Wise	32,807,051	33,734,811	Natural gas, petroleum, natural gas liquids, stone, sand and gravel, clays.
Wood	52,099,548	48,557,980	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Yoakum	47,533,626	51,277,183	Petroleum, natural gas liquids, natural gas, salt.
Young	16,694,714	15,317,390	Petroleum, natural gas, natural gas liquids, sand and gravel.
Zapata	5,260,350	5,568,060	Natural gas, petroleum.
Zavala	1,208,590	970,960	Petroleum, natural gas.
Undistributed	20,048,296	27,449,338	
Total	4,427,474,000	4,533,078,000	

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

[1] The following counties were not listed because no actual production was reported in 1963 or 1964: Armstrong, Bailey, Castro, Deaf Smith, Delta, Fannin, Jeff Davis, Kinney, Lamar, Rains, Rockwell Swisher.

Andrews.—Andrews County ranked first in the State with a total mineral production value of $253 million. Natural gas liquids were recovered at seven gas processing plants with a combined daily throughput of 379.5 million cubic feet, a 7.5-million-cubic-foot increase over 1963 total capacity. Pan American Petroleum Corp. increased its Three Bar plant from 18.5 to 22 million cubic feet and Pure Oil Co. increased the Bakke plant from 6 to 10 million cubic feet daily. Exploratory and development drilling totaling 1.5 million feet proved 142 oil wells and 6 gas wells; 31 holes were dry. Sulfur was recovered from sour natural gas at the Midland Farms plant of Pan American Petroleum Corp. and at the Andrews plant of J. L. Parker Co.

Aransas.—The oil and gas industry recovered 1.8 million barrels of crude oil and 43.9 billion cubic feet of natural gas in 1964. Total mineral value increased 8 percent. Carbon black was recovered at the Aransas Pass plant of United Carbon Co., Div. of Ashland Oil & Refining Co. Shell was dredged by Heldenfels Bros. Development wells drilled by the oil and gas industry totaled seven and resulted in one oil well and one gas well. Exploratory drilling totaled 45,949 feet and resulted in two gas discoveries.

Archer.—Natural gas liquids were recovered at the Holliday gasoline plant of Warren Petroleum Corp. and the McGregor plant of Progress Petroleum Products. Exploratory drilling, totaling 102,148 feet, proved three oil wells. Development drilling proved 216 oil wells. Contractors prepared sandstone and sand and gravel for Texas Highway Department.

Atascosa.—During the year, 3.8 million barrels of crude oil and 39.6 billion cubic feet of gas were produced. The Jourdanton gasoline

plant of Humble Oil & Refining Co. recovered natural gas liquids. Exploratory and development drilling proved 21 oil wells and 1 gas well. Sulfur was recovered at the Fashing plants of Gillring Oil Co. and National Sulphur Co.

Austin.—Development drilling totaling 54,380 feet proved 12 oil wells and 2 gas wells. Shell Oil Co. recovered natural gas liquids at its 20-million-cubic-foot Sealy gas processing plant.

Bee.—Natural gas liquids were recovered at the Burnell-North Pettus recycling plant of Pan American Petroleum Corp., the cycle plant of Houston Natural Gas Production Co., and the gas processing plant of Tidewater Oil Co. Crude oil was processed at the Pettus refinery of Danaho Refining Co. Bee County's oilfields yielded 1.3 million barrels of crude oil. Natural gas production was 7.9 billion cubic feet. Exploratory drilling totaled 263,560 feet and proved one oilfield and five gas discoveries. Of 75 development wells, 22 were completed as oil wells and 22 as gas wells.

Bexar.—Portland and masonry cements were produced at the San Antonio plant of Longhorn Portland Cement Co. and at the Cementville plant of San Antonio Portland Cement Co. Both companies quarried limestone and recovered clay from open pits for manufacturing cement products. Other limestone was quarried from open pits, crushed, and processed for use as concrete aggregate, roadstone, and railroad ballast by Allied Materials Co., Bexar Concrete Co., McDonough Bros., Inc., Olmos Rock Products Corp., H. B. Zachry Aggregates Plant, and by contractors for Division 15 of Texas Highway Department.

Fire clay, used for building brick and heavy clay products, was mined from open pits by Alamo Clay Products Co. near Elmendorf and by Southern Co. near Losoya. Miscellaneous clay, used to produce lightweight aggregate, was mined from open pits by Barrett Industries and by Featherlite Corp. of San Antonio. Sand and gravel used principally in building and paving, was processed at 15 stationary plants by 13 companies. Lavaca Gathering Co. recovered natural gas liquids at its new 130 million cubic foot Junction gasoline plant.

Crude oil was processed at three San Antonio refineries having a combined daily capacity of 8,700 barrels. Sixty-three development wells totaling 65,082 feet resulted in 41 oil completions and 22 dry holes.

Brazoria.—The mineral industries of Brazoria County were third in total value and first in natural gas output in 1964. Natural gas liquids were recovered at Bayou gasoline plant of Phillips Petroleum Co., Pledger plant of Humble Oil & Refining Co., Old Ocean plant of Pan American Petroleum Corp., and the new 10-million-cubic-foot-per-day gasoline plant of H. L. Hunt. Refined products and ethylene were recovered at Sweeny refinery of Phillips Petroleum Co. Exploratory drilling of 250,988 feet proved 1 oil and 2 gas wells; development drilling totaling 372,566 feet proved 14 oil and 12 gas wells.

Bromine, used to manufacture ethylene dibromide, was recovered from sea water at the Freeport plant of Ethyl-Dow Chemical Co. Magnesium chloride, used to produce magnesium ingots, cast anodes and alloys, and magnesium chemicals, was recovered from sea water at the Freeport plants of the Dow Chemical Co. The company also produced lime from shell and salt in brine for industrial and chemical uses.

Dow's huge chemical complex produced chlorine, sodium chemicals, HCl, ammonia, acetylene, benzene, ethylene, propylene, butadiene, polyethylene and epoxy resins, and numerous other chemical derivatives and intermediates. Dow Badische Chemical Co. produced caprolactam, cyclohexanone, acrylic acid, and numerous acrylate derivatives. E. J. Lavino & Co. produced periclase from magnesium hydroxide slurry piped from the Dow plant. Tetramethyl and tetraethyl lead were produced at the Freeport plant of Nalco Chemical Co. Paving sand and gravel was produced for District 12 of Texas Highway Department.

Brooks.—Humble Oil & Refining Co. recovered cycle condensate and derived liquids at its 42-million-cubic-foot-per-day cycle plant in the Kelsey field. Carbon black was recovered from natural gas at the Falfurrias channel plant of United Carbon Co., Inc. Exploratory drilling totaled 129,139 feet and proved 5 oil pays; development drilling of 353,355 feet proved 19 oil and 18 gas wells.

Brown.—The oil and gas industry completed 22 oil and 5 gas wells through 96,245 feet of development drilling. Limestone was quarried and crushed for riprap, concrete aggregate, railroad ballast, and other purposes by White's Mines, Inc., Carson Quarrying, and various contractors of Texas Highway Department. Clay, used in building brick and floor and wall tile, was produced from open pits by Texas Brick Co.

Burnet.—Gravel for paving and railroad ballast was produced by Texas Granite Gravel Co. Crushed limestone for concrete aggregate, roadstone, and railroad ballast was produced by Texas Construction Materials Co. and Carson Quarrying. Pure Stone Co. prepared limestone for glass, whiting, and other fillers. Crushed and dimension granite were quarried in Marble Falls for riprap and rough construction and finished architectural stone by Texas Granite Corp., Texas Construction Materials Co., and Texas Crushed Stone Co. The Southwestern Graphite Co. mined graphite ore from open pits and recovered concentrate at its mill near Burnet.

Calhoun.—The oil and gas industry completed four gas discoveries with 255,970 feet of exploratory drilling and five oil and seven gas wells with 156,524 feet of development drilling. The industry produced 1.6 million barrels of crude oil and 112.3 billion cubic feet of natural gas. Natural gas liquids were recovered at the 42.8-million-cubic-foot-per-day Kellers Bay cycle plant of Humble Oil & Refining Co. and at five natural gasoline plants with a combined daily throughput of 221 million cubic feet. Union Carbide Corp., Chemicals Division, produced ethylene, propylene, butadiene, styrene, acetylene, and numerous petrochemical intermediates and derivates at its Seadrift plant.

Bauxite ores from Surinam and Dominican Republic were refined to alumina at the Point Comfort refinery of Aluminum Company of America. The alumina was reduced to aluminum ingots at adjacent reduction works or shipped to the company's Rockdale reduction plant. The U.S. Army Corps of Engineers was building a 36-foot-deep channel across Matagorda Peninsula to Point Comfort. Shell was dredged from the shallow bays of Port Lavaca by Bauer Dredging Co. Lime was produced from shell for use in refining operations of Alcoa's Point Comfort works; excess production was sold on the open market. Sand

and gravel was produced by contractors for District 13 of Texas Highway Department.

Callahan.—The oil and gas industry produced 2.3 million barrels of crude oil and 2.7 billion cubic feet of natural gas. Natural gas liquids were recovered at the 1.8-million-cubic-foot-per-day gasoline plant of Gulf Central Oil & Gas Co. The oil and gas industry drilled 42 exploratory wells totaling 94,956 feet to complete 8 oil and 3 gas discoveries, and 182 development wells for 238,803 feet to complete 69 oil and 5 gas wells.

Cameron.—Development drilling totaling 27,186 feet proved three gas wells. Union Carbide Corp., Chemicals Division, produced methyl ethyl ketone and acetic acid and some derivatives at its Brownsville complex. Crude barite, mostly from foreign sources, was ground at the Brownsville plant of Magcobar, Inc., and Victoria Gin Co., Inc. Amtex Milling Co. was adding a second vertical kiln to produce lime from limestone. Fertilizers, insecticides, and fungicides were prepared at plants of Swift & Co., Agricultural Chemicals, Kipfer Chemical Co., and Niagara Chemical Division of FMC Corp. (2 plants).

Carson.—Natural gas liquids were recovered at the Cargray gasoline plant of the Dorchester Gas Producing Co., the Bryan No. 17 plant of Shell Oil Co., and the Schafer plant of Skelly Oil Co. The oil and gas industry produced 3.9 million barrels of crude oil and 99 billion cubic feet of natural gas. The industry drilled 134 development wells totaling 446,134 feet to complete 101 oil and 2 gas wells. Carbon black was recovered at the Schafer plant of Cabot Corp.

Cass.—Natural gas liquids were recovered at the 30-million-cubic-foot-per-day Lodi gasoline plant of Breckenridge Gasoline Co. and the Bryans Mill plant of Shell Oil Co. which increased daily throughput from 30 to 45 million cubic feet. Sulfur was recovered at the Bryans Mill gasoline plant of Shell Oil Co. Miscellaneous synthetic organic chemicals and cyclic intermediates were produced at the Linden petrochemical plant of Texas Chemical Intermediates Co. Local brown iron ore was milled and sintered at the mill of Lone Star Steel Co.

Chambers.—The oil and gas industry produced 15 million barrels of crude oil and 99 billion cubic feet of natural gas. Natural gas liquids were recovered at the Anahuac gasoline plant of Humble Oil & Refining Co. and at the Mont Belvieu plant of Warren Petroleum Corp. Completion of 27 wells resulted in 2 oil discoveries and 76 oil and 19 gas extensions. Shell was dredged from bays of Chambers County by W. D. Haden Co. and Parker Bros. Co. and used principally in preparing lime, cement, and concrete. Salt in brine was obtained from wells at Barbers Hill salt dome by Diamond Alkali Co. and used in industrial chemicals.

Cherokee.—Exploratory drilling, totaling 101,566 feet proved two oil and one gas discovery; development drilling proved four oil wells and one gas well. Brown iron ore was mined from open pits near Jacksonville by L. B. Haberle and Jennings & Halbert for use by the cement industry and from open pits near Rusk by Armco Steel Corp. for its blast furnace at Houston. Fire clay was mined from open pits by A. P. Green Fire Brick Co. and General Refractories Co.

Cochran.—Mineral output included 8.9 million barrels of crude oil and 21.2 billion cubic feet of natural gas. Natural gas liquids and

sulfur were recovered at the Lehman gasoline plant of Cities Service Oil Co. The oil and gas industry drilled 13 exploratory and development wells totaling 69,631 feet resulting in 1 oil discovery and 10 oil extensions.

Coke.—Natural gasoline and LP gases were recovered at gasoline plants of Sun Oil Co. and Union Texas Petroleum, Division of Allied Chemical Corp. Daily throughput of the Jameson plant of Sun Oil Co. was raised from 50 million cubic feet to 56 million cubic feet. Twelve development wells totaling 64,468 feet proved 7 oil wells. Montgomery Sand & Gravel, Inc., prepared paving and building sand and gravel.

Coleman.—The oil and gas industry produced 2 million barrels of crude oil and 12 billion cubic feet of natural gas. Natural gas liquids were recovered at Coker gasoline plant of Coker Gasoline Co., Glen Cove plant of Luling Oil & Gas Co., Inc., and Duncan plant of Valera Oil Co. Exploratory drilling proved 6 oil and 1 gas discovery; development drilling proved 32 oil and 9 gas wells. Silica sand, used as molding sand and in glass manufacture, was produced at a stationary plant near Santa Anna by Santa Anna Silica Sand Co., Inc., which ceased operations and closed its facilities in late 1964. Miscellaneous clay, used for face brick and heavy clay products, was mined from open pits near Coleman by the Martin Brick Co. Unglazed floor tile was produced by Flooramic Tile Co.

Colorado.—Natural gas liquids were recovered at the Sheridan cycling plant of Shell Oil Co., and at the Chesterville gasoline plant of Tenneco Oil Co. Development drilling totaling 215,191 feet resulted in 3 oil completions and 19 gas completions. Building and paving sand and gravel were produced from pits near Columbus, Eagle Lake, Alleyton, Altair, and Glidden by Horton & Horton, Parker Bros. & Co., Inc., Texas Construction Material Co., and Thorstenberg Materials Co.

Comal.—Limestone, quarried and crushed from open pits near New Braunfels, was used in lime by U.S. Gypsum Co. Limestone, quarried from pits near Ogden, was prepared by Servtex Materials Co. for use as railroad ballast, riprap, concrete aggregate, and agricultural lime. Building and paving sand and gravel was prepared by Erhardt Kraft.

Cooke.—Mineral output included 9.9 million barrels of crude oil and 6.5 billion cubic feet of natural gas. Natural gas liquids were recovered at Walnut Bend gasoline plant of Union Texas Petroleum and Sivells Bend gasoline plant of Standard Oil Co. of Texas. Crude oil was processed at the Gainesville refinery of Tydal Co. Exploratory drilling totaling 32 holes and 169,790 feet proved 5 oil discoveries; of 180 development wells totaling 455,588 feet, 116 were completed as oil wells. Building and paving sand and gravel were prepared by Nelson Bros., Inc.; various producers prepared crushed stone and sand and gravel for Texas Highway Department.

Crane.—Mineral value totaling $142.4 million was the fourth largest in the State. Production of 39.7 million barrels of crude oil and 88 billion cubic feet of natural gas was reported. Natural gas liquids were recovered at five gasoline plants with a combined daily throughput of 373 million cubic feet. Warren Petroleum Corp. increased the Waddell plant capacity from 44 to 105 million cubic feet. Exploratory drilling of 196,046 feet proved 5 oil discoveries; development

drilling of 955,991 feet completed 188 oil and 12 gas wells. Sulfur was recovered at Crane plant of Phillips Petroleum Co. and at Waddell and Sand Hills plants of Warren Petroleum Corp.

Crockett.—Natural gasoline and LP gases were recovered at the new Ozona plant of Delta Drilling Co. and at gasoline plants of Cities Service Oil Co. and Shell Oil Co. Exploratory drilling by the oil and gas industry totaled 203,948 feet proving 7 oil and 3 gas discoveries with development drilling of 496,699 feet proving 57 oil and 25 gas wells.

Culberson.—The mineral industry produced 1.3 million barrels of crude oil and 2.9 billion cubic feet of natural gas. Continental Oil Co. raised daily capacity of its Ramsey plant from 5 to 12 million cubic feet. Continental Minerals recovered barite at the MJ mine and processed it as a drilling mud additive at Van Horn.

Dallas.—Mineral production declined 13 percent in 1964. Limestone was quarried and crushed for use in cement by Lone Star Cement Corp. and Trinity Cement Division of General Portland Cement Co.; crushed limestone for concrete aggregate and roadstone was prepared under contract for Division 18 of Texas Highway Department. Portland and masonry cements were produced at the Dallas plant of Lone Star Cement Corp. and at the Eagle Ford plant of General Portland Cement Co. The cement companies produced clay for use in cement. Miscellaneous clay or shale was used in heavy clay products and lightweight aggregate at the Ferris and Mesquite plants of Ferris Brick Co. and the Dallas plant of Dallas Lightweight Aggregate Co.

Dawson.—Combined liquids were recovered at the Lamesa plant of Texaco, Inc. The oil and gas industry drilled 16 exploratory wells for a total of 156,635 feet, completing 5 discoveries, and also drilled 93 development wells totaling 707,403 feet, completing 78 as oil wells. Calcareous sandstone was quarried and crushed from an open pit near O'Donnell for concrete aggregate and roadstone by Lone Star Materials, Inc.

De Witt.—Production of crude oil, natural gas, natural gas liquids, and sand and gravel was about 10 percent over the 1963 value. Natural gas liquids were recovered at the new 100-million-cubic-foot-per-day Gohlke gasoline plant of Lavaca Gathering Co. Exploratory and development drilling, totaling 535,126 feet, proved 1 oil well and 14 gas wells; 1 new oilfield and 8 new gasfields were discovered. Sand and gravel was prepared for concrete aggregate and roadstone by various producers and by contractors for District 13 of Texas Highway Department.

Dimmit.—Mineral fuel production was 5 percent less than in 1963, due primarily to the drop in crude oil output. Exploratory and development drilling, totaling 65,920 feet, resulted in one new gasfield and five oil pays. Crude oil was processed at the 3,000-barrel-per-day Carrizo Springs refinery of Texstar Petroleum Co.

Duval.—Mineral production was substantially the same as that in 1963. Exploratory drilling resulted in discovery of 2 new gasfields; development drilling proved 36 oil and 21 gas wells. Natural gas liquids were recovered at gasoline plants of Socony Mobil Oil Co. and Humble Oil & Refining Co., and at the cycle plant of Trinity Gas Corp. Pittsburgh Plate Glass Co. recovered salt in brine from wells at Palagana salt dome near San Diego for use in manufacturing

chlorine, soda ash, caustic soda, and industrial chemicals. Duval Quarry Co., Inc., quarried and prepared stone for riprap and concrete aggregate.

Eastland.—Natural gas liquids were recovered at three gasoline plants with daily combined capacity of 17.5 million cubic feet per day. Exploratory and development drilling, totaling 26 wells and 61,556 feet, resulted in 3 oil wells and 3 gas wells. Fire clay and miscellaneous clay used in lightweight aggregate, floor and wall tile, brick, and pottery were mined from open pits near Ranger by Featherlite Corp.; near Eastland, by Texas Lightweight Aggregate Co.; and near Cisco, by Texeramics Co. and N. D. Gallagher Clay Products Corp. Contractors quarried and prepared limestone for concrete aggregate and roadstone for Texas Highway Department.

Ector.—Ector County ranked first in natural gas liquid output and second in both crude oil production and total mineral value. Exploratory and development drilling, totaling 307 wells and 1,876,465 feet, proved 262 oil and 13 gas wells. Natural gas liquids were recovered at six gasoline plants with combined daily throughput of 604 million cubic feet and at the 30-million-cubic-foot-per-day Headlee cycle plant of Tidewater Oil Co. Crude oil was processed at the 13,500-barrel Odessa refinery of Shell Oil Co.

A signficant petrochemical complex was in the Odessa metropolitan area. El Paso Natural Gas Products Co. operated its olefin (ethylene, propylene), butadiene, and styrene plants. Rexall Chemical Co. produced polyethylene resins and polypropylene. Polyethylene and polypropylene glycols, naphthenic acid salts and tall oil salts were produced by Magma Corp. General Tire & Rubber Co. prepared chemical plastics and polybutadiene-styrene type rubbers. Corrosion and scale inhibitors were prepared by Western Chemical Co. and by Nocor Chemical, Inc. Carbon black was recovered at the channel plant of Sid Richardson Carbon & Gasoline Co. Southwest Fertilizer & Chemical Co. prepared insecticides and ground talc, sulfur, and other soft materials on a custom basis. Salt brine for oilfield use was recovered by Morton Salt Co.

Portland and masonry cements were prepared from limestone and clay by Southwestern Portland Cement Co. Sulfur was recovered at the Odessa plant of Odessa Natural Gasoline Co., the Penwell plant of J. L. Parker Co., the North Cowden plant of Pan American Petroleum Corp., the Goldsmith plant of Phillips Petroleum Co., and the Foster plant of Sid Richardson Carbon & Gasoline Co. Limestone was quarried and prepared for concrete aggregate and roadstone by Permian Sand & Gravel Co., Inc., and White's Mines, Inc.

Ellis.—Value of minerals produced was 37 percent more than that in 1963. Limestone was quarried and crushed for cement at the Midlothian plant of Texas Industries, Inc., and by various contractors for concrete aggregate and roadstone for Texas Highway Department. Miscellaneous clay, used in brick and heavy clay products, was mined from open pits near Ferris by Acme Brick Co. and Ferris Brick Co., and from pits near Palmer by Barron Brick Co. Paving gravel was prepared by various contractors for Texas Highway Department.

El Paso.—Mineral value was 5 percent under 1963 value. Southwestern Portland Cement Co. quarried limestone and shale from open pits for portland and masonry cements at its El Paso plant. El Paso refineries of California Oil Co. and Texaco, Inc., processed crude oil.

Limestone was quarried and crushed for concrete aggregate and roadstone by McMillan Quarries, Inc. and Vowell Material Co. Industrial sand and building sand and gravel were prepared by El Paso Sand Products, Inc., and by General Redi-Mix, Inc. Structural and paving sand and gravel were prepared on contract for the U.S. Army Corps of Engineers. Face and common brick were made from Mexican clays by the International Brick Co., Inc. Southwest Fertilizer & Chemical Co. prepared fertilizers, insecticides, and fungicides. American Smelting & Refining Co. produced copper and lead bullion; electrolytically refined copper was recovered at the El Paso refinery of Phelps-Dodge Refining Corp. American Minerals, Inc., prepared and ground manganese ores from Mexico for ferroalloys and for coloring in face brick. Border Steel Mills, Inc., increased its products line to include structural shapes and reinforcing bars.

Fayette.—Value of minerals produced was nearly 7 percent more than that in 1963. Building and paving sand and gravel were recovered from pits near LaGrange by Thorstenberg Materials Co., Inc. District 13 of Texas Highway Department contracted for crushed sandstone and building and paving sand and gravel. Bentonitic clay, used principally in preparing drilling mud, and fullers earth were recovered from open pits near Flatonia by Milwhite Co., Inc., Baroid Div. of National Lead Co., Balcones Minerals Corp., and Flatonia Fullers Earth Co.

Fisher.—Three new oilfields were discovered through exploratory drilling; development drilling proved 23 oil wells. Natural gas liquids were recovered at the new Hamlin plant of Graridge Corp. and at three other gas processing plants. Clay for cement was recovered from open pits by Lone Star Cement Corp. Crude gypsum, used in wallboard, plaster, and other building products, was mined from open pits near Longworth by Celotex Corp. and from pits near Rotan by National Gypsum Co.

Fort Bend.—Improvement in all commodities, except clay, resulted in a 5-percent increase in mineral value. Natural gas liquids were recovered at the Needville gasoline plant of the Industrial Gas Supply Corp. Exploratory and development drilling amounted to 47 wells and 256,303 feet of hole, resulting in 1 gas discovery and 14 oil and 4 gas wells. Native sulfur was recovered by the Frasch method from Orchard Dome by Duval Corp. and from Long Point Dome by Jefferson Lake Sulphur Co. Texas Lightweight Aggregate Co. mined miscellaneous clay from pits near Missouri City for use in lightweight aggregate. Calag Co., Inc., prepared shale for miscellaneous uses. Salt in brine and evaporated salt were prepared at the Blue Ridge plant of United Salt Corp. Paving sand and gravel was produced under contract for District 12 of Texas Highway Department.

Franklin.—Value of mineral fuels was 6 percent greater than that in 1963 due to increased production of petroleum, natural gas, and natural gas liquids. Exploratory and development wells, totaling 107,926 feet, resulted in one oil discovery and eight oil and two gas completions. Natural gas liquids were recovered at the New Hope cycling plant of Tidewater Oil Co.; sulfur was also recovered from sour gas at the plant.

Freestone.—The 15-percent increase in value of mineral production, as compared with value in 1963, was due to production increases in

crude oil and natural gas. Exploratory and development drilling, totaling 152,048 feet, proved one gas discovery and resulted in one oil and seven gas completions. Miscellaneous clay, used in brick and heavy clay products, was mined from open pits near Teague by Teague Brick & Tile Co. Calcareous sandstone was quarried and crushed for concrete aggregate and roadstone by East Texas Stone Co. and by various contractors for Texas Highway Department.

Gaines.—Mineral value of Gaines County approximated the 1963 value. Drilling of 158 exploratory and development wells proved 8 oil and 2 gas discoveries and 102 oil and 4 gas wells. Natural gas liquids were recovered at the Seminole plant of Phillips Petroleum Co. and West Seminole plant of Cities Service Oil Co. Sulfur was recovered from sour natural gas at the Seminole No. 67 plant of Columbian Fuel Corp. and carbon black was produced at the Seminole No. 66 plant of Columbian Carbon Co. Calcareous sandstone was quarried and crushed for concrete aggregate and roadstone by Pioneer Pavers, Inc.

Galveston.—Value of mineral production in Galveston County was 4 percent greater than that of 1963 as production gains were reported for both natural gas and crude oil. Exploratory and development drilling of 72 wells proved 2 gas discoveries and completed 33 oil and 11 gas wells. Offshore drilling, totaling 180,912 feet, resulted in two oil and four gas discoveries. Natural gas liquids were recovered at the Alta Loma gasoline plant of Margaret Hunt Trust Estate. Crude oil was processed at three refineries having a combined daily capacity of 240,000 barrels.

Clay was recovered from open pits by Ideal Cement Co. and Gulf Coast Portland Cement Co. Shell was dredged from shallow bays at Galveston by Horton & Horton for use principally as roadstone and in cement. Paving sand was prepared by City of Galveston construction crews and by contractors for Texas Highway Department.

Gillespie.—Mineral value rose significantly due to new petroleum production. Soapstone was strip mined on contract for Southwestern Talc Corp. Five operators produced a total of 94,000 tons of building and paving sand and gravel. Bear Mountain Quarries, Inc., mined and prepared rough monumental granite. Dimension limestone was produced for sawed building stone by Doebbler's Quarry.

Gray.—Increases in oil and gas production were responsible for the 6 percent rise in total mineral value. Development drilling, totaling 115 wells and 345,739 feet, resulted in 101 oil wells and 4 gas wells. Natural gas liquids were recovered in six gas processing plants having a combined daily capacity of 279 million cubic feet. Carbon black was recovered at the Pampa plant of Cabot Corp. and at plants 201 and 203 of Peerless Carbon Black Co., Div. of Columbian Carbon Co.

Grayson.—There was a 5-percent decline in 1964 total mineral value as declines in crude oil and natural gas liquid output exceeded an increase in natural gas production. Natural gas liquids were recovered at New Mag cycle plant and Sherman gasoline plant of Standard Oil Co. of Texas. Exploratory and development drilling proved 3 oil discoveries and 10 oil extensions. Crushers, Inc., and S. E. Evans, Inc., quarried and prepared limestone for concrete aggregate, riprap, and roadstone. M & K Sand & Gravel Co. produced building and paving sand.

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Gregg.—Improved activities in the county's oil and gas industry were responsible for the 5-percent rise in 1964 mineral value. Natural gas liquids were recovered at four gasoline plants with a combined daily capacity of 100 million cubic feet. Eight exploratory and development wells, totaling 60,718 feet, proved one oil discovery and one oil and four gas completions. Crude oil was processed at the Longview refinery of Premier Oil Refining Co. of Texas and refineries of Dallawax Co. and Petrolite Corp. at Kilgore.

Hardeman.—Value of mineral production was over 4 percent greater than in 1963. Exploratory and development drilling accounted for 31 wells which resulted in 8 oil wells. Shell Oil Co. operated a gasoline plant in the Conley field. Bestwall Gypsum Co. mined gypsum from open pits near Acme for wallboard, plaster, and other building products. Limestone was quarried and prepared as concrete aggregate and roadstone for District 25 of Texas Highway Department.

Hardin.—Mineral production approximated that of 1963. Exploratory and development drilling of 111 wells totaling 403,184 feet, proved 65 oil wells and 22 gas wells. Natural gas liquids were recovered at Nos. 25 and 26 cycling plants of Sinclair Oil & Gas Co. and at the Amata Gas Corp. plant. A 2,500-barrel refinery at Silsbee was operated by South Hampton Co.

Harris.—Value of mineral production decreased 13 percent compared with that of 1963. Natural gas liquids were recovered at five gasoline plants having a total daily capacity of 280 million cubic feet and at two cycling plants with combined capacity of 90 million cubic feet daily. Crude oil was processed at six refineries with combined per-calendar-day capacity of 549,500 barrels. Sulfur was recovered from hydrocarbons by Shell Chemical Co., Signal Oil & Gas Co., Sinclair Refining Co., and Stauffer Chemical Co. Exploration and development of new sources of hydrocarbons continued at a brisk rate; a total of 132 wells were drilled with combined footage of 563,947 feet. Of 132 wells drilled, 76 were completed as oil wells and 21 were completed as gas wells.

Olin Mathieson Chemical Corp. was constructing a phosphoric acid plant at Pasadena which would have a capacity of 500 tons per day. Stauffer Chemical Co. and Phillips Petroleum Co. formed the jointly owned Phosphate Chemicals, Inc., for producing fertilizer. In addition, they expect to make sulfuric acid, phosphoric acid, and superphosphoric acid. Sinclair Petrochemicals, Inc., was producing 40 million pounds per year of methyl ethyl ketone (MEK), a solvent used basically in artificial leather and protective coatings. Sinclair Refining Co. placed on stream a plant with an annual capacity of 45 million pounds of paraxylene, a raw material for synthetic fibers and films.

Salt was mined underground and prepared as rock salt and block salt at the Hockley plant of United Salt Co. and was obtained as salt in brine from wells at Pierce Junction salt dome near Houston by Texas Brine Co.

Crude perlite was processed by two companies, Perlite of Houston, Inc., and Filter-Media, Inc., for use primarily in insulation, concrete aggregate, filter aid, and building plaster.

There are 1,508 manufacturing plants in Harris County. A partial breakdown is as follows: 162 petrochemical and allied industries plants; 25 petroleum and related industries plants; 77 rubber and

miscellaneous plastic plants; 91 stone, shell, clay, and glass plants and 65 metal plants.

The Nation's greatest concentration of petrochemical plants is found along the gulf coast and the center of the activity is Harris County. Numerous additions and plant expansions within the growing petrochemical industry were located in this county. Gulf Oil Corp. was building a multimillion-dollar plant to produce in excess of 100 million pounds of normal alpha olefins annually.

Helmerich & Payne, Inc., planned a refinery to produce specialized sulfur compounds; principal output would be mercaptan blends. Ethyl Corp. commenced constructing a plant to make synthetic alcohols that will be used in detergents and plastics. Humble Oil & Refining Co. began work on a multi-million-dollar hydrocracking unit at its Baytown refinery. The new unit is expected to provide higher yields of motor gasoline from certain fractions than was possible with the fluid catalytic cracking process.

Brown iron ores from Texas and ores from Minnesota and Labrador were processed by Houston Steel Division of Armco Steel Corp. Imported ferromanganese and manganese alloy ores were processed by Tenn-Tex Alloy & Chemical Corp.

Barite from foreign countries and from other States was crushed and ground for use in drilling mud at the Houston plants of the Milwhite Co., Inc., and Baroid Division of National Lead Co.

Portland and masonry cements were manufactured by Gulf Coast Portland Cement Co., Ideal Cement Co., Lone Star Cement Corp., and Trinity Portland Cement Division of General Portland Cement Co. Two cement producers also recovered clay from open pits. In addition, clay was processed for building brick by J. M. Cordell & Sons, Inc., Houston Brick & Tile Co., and Acme Brick Co.

Construction lime was made from oyster shell by United States Gypsum Co. Building and paving sand and gravel were produced by numerous companies for use in the building trade and District 12 of Texas Highway Department.

Harrison.—The 10-percent increase in mineral value was due essentially to increased natural gas and petroleum output. Exploratory and development drilling accounted for 111 wells totaling 403,317 feet which resulted in 88 oil and 11 gas completions. Natural gas liquids were recovered at three gasoline plants. Brick, heavy clay products, stoneware, and pottery were manufactured from miscellaneous clay and fire clay mined from open pits by Marshall Brick Co. and Marshall Pottery Co. Lignite mined from open pits was used in manufacturing several grades of activated carbon by Darco Activated Carbons Division of Atlas Chemical Industries, Inc. Crude oil was refined at the Harleton refinery of Hunt Oil Co.

Henderson.—Mineral value increased 17 percent because of modest increases in crude oil and natural gas production. Exploratory and development drilling completed five oil and eight gas wells. Total footage drilled for all wells was 224,888 feet. Natural gas liquids were recovered at three gasoline plants. Ida Gasoline Co., Inc., operated a 500-barrel-per-day refinery. Brick, heavy clay products, fire brick, and refractory shapes were manufactured from clay mined near Athens by Anderson County Mining Enterprises, Inc., Athens Brick

Co., Inc., Harbison-Walker Refractories Co., Texas Clay Products Co., and Athens Tile & Pottery Co.

Hidalgo.—There was a 6-percent increase in total value of minerals produced in Hidalgo County as crude oil and natural gas outputs increased. Natural gas liquids were recovered at the plants of Delhi-Taylor Oil Corp., Shell Oil Co., Sinclair Oil & Gas Co., Tenneco Oil Co., and Anchor Gasoline Corp. Crude oil was processed at the refineries of Delta Refineries, Permian Corp., and Rado Refining Co. Clay for building brick was processed by Valley Brick & Tile Co., sand and gravel for building by The Fordyce Co., and stone for concrete aggregate by Heldenfels Bros.

Howard.—The 5-percent decline in mineral value was due to curtailed crude oil production. Cosden Petroleum Corp. processed crude oil at its Big Spring refinery. Carbon black was recovered from hydrocarbon liquids by the Sid Richardson Carbon & Gasoline Co. Natural gas liquids were recovered from the E. Vealmoor field by Reef Corp. West Texas Sand & Gravel Co. and R. E. Janes Gravel Co., Inc., prepared building and paving sand and gravel. A total of 105 exploration and development wells were drilled; 80 were completed as oil wells.

Hudspeth.—Talc used in ceramics, insecticides, paint, roofing granules, rubber, and joint cement was recovered from open pits near Allamoore by seven producers. Pioneer Talc Co. operated its grinding mill at increased capacity. Crude gypsum, used as a retarder in cement by Southwestern Portland Cement Co., was mined from open pits near Sierra Blanca. Rhyolite was quarried and crushed by Gifford-Hill & Co., Inc., at a quarry near Van Horn.

Hutchinson.—Production increases in both natural gas and natural gas liquids failed to compensate for decreased crude oil production, resulting in a 1-percent decrease in total mineral value. Drilling activity accounted for 72 development wells; 56 were completed as oil wells and 14 completed as gas wells. Carbon black was recovered at three furnace plants and one channel plant. Natural gas liquids were recovered at eight gasoline plants. Phillips Petroleum Co. operated a butadiene plant adjacent to its Borger refinery; the refinery had a per-calendar-day capacity of 85,000 barrels. Tri-City Sand & Gravel Co. and Borger Redi-Mix Co. produced building and paving sand and gravel. Salt in brine was recovered from underground salt beds by Phillips Petroleum Co. for use in its petrochemical complex at Borger. Limestone was crushed by H. B. Zachry Co. and various other operators for the building trade.

Jack.—Exploratory and development drilling resulted in 6 oil discoveries and 1 gas discovery and 43 oil and 9 gas completions. Bryson Pipeline & Refining Co. processed crude oil at its Bryson refinery. Natural gas liquids were recovered at the gasoline plants of Black Hawk Gasoline Corp., CM & M Gas Products, Inc., Cities Service Oil Co. and Maynard Oil Co.

Jackson.—Exploratory and development drilling accounted for 109 wells totaling 800,489 feet and proved 23 oil wells and 21 gas wells. Gasoline plants of Sunray DX Oil Co. and Socony Mobil Oil Co., Inc., recovered natural gas liquids. Contractors recovered and prepared paving sand and gravel from open pits for district 13 of Texas Highway Department.

Jasper.—Exploratory and development drilling of 12 wells totaling 87,845 feet proved 3 oil discoveries and 1 gas discovery and 1 oil and 1 gas extension. Alpha Portland Cement Co. recovered clay for cement. Lime was produced by East Texas Pulp & Paper Co.

Jefferson.—Decreased production of most minerals resulted in a 4-percent decrease in total mineral value as compared with that of 1963. Natural gas liquids were recovered at gasoline plants of San Jacinto Gas Processing Co. and Union Texas Petroleum. Exploratory and development drilling of 82 wells proved 2 oil discoveries and 42 oil and 2 gas extensions. Six oil refineries with a daily throughput of 950,000 barrels processed domestic and foreign crudes.

An imposing array of petrochemical plants was in Jefferson County. In Beaumont, E. I. du Pont de Nemours & Co., Inc., produced cyclohexylamine, acrylonitrile, caprolactam, tetraethyl lead, and polyethylene rubber; Goodyear Tire & Rubber Co. produced isoprene, polybutadiene, and polyisoprene type synthetic rubbers; Houston Chemical Corp. produced ethylene, diethylene and triethylene glycols, ethylene oxide, and tetraethyl and tetramethyl leads; Mobil Chemical Co. produced ethylene and benzene; and Olin Mathieson Chemical Corp. produced sulfuric acid. At Port Arthur, Great Lakes Carbon Corp. produced and calcined petroleum coke; Gulf Oil Corp. produced aromatic distillates, benzene, butylenes, ethylene, toluene, tripropylene, cyclohexane, and other intermediates; Koppers Co., Inc., produced ethylbenzene and polyethylene resins; and Olin Mathieson Chemical Corp. produced sulfuric acid. At Port Neches, Goodrich-Gulf Chemicals, Inc., produced polyethylene resins and polybutadiene and polybutadiene-styrene type rubbers; Jefferson Chemical Co., Inc., produced sodium hydroxide, aromatic distillate, ethylene, propylene, and numerous ethylene and propylene glycols, oxides, carbonates and other derivatives; Neches Butane Products Co. produced butadiene; Sonford Chemical Co. produced hydrogen chloride and chlorinated organic compounds; and Texas-U.S. Chemical Co. produced butadiene and other types of synthetic rubber. Six refineries, with a total daily throughput capacity of 986,000 barrels, processed crude oil in the county.

Native sulfur was recovered by the Frasch process from Spindletop Dome and Fannett Dome by Texas Gulf Sulphur Co. and from refinery gases by Atlantic Refining Co. and Gulf Oil Corp. Texas Brine Corp. recovered salt in brine from wells near Gladys. Common and roman bricks were produced from miscellaneous clay mined by Beaumont Brick Co., Inc. C. A. McKinley Sons, Inc., produced building sand and gravel. William T. Burton Industries, Inc., recovered shell from shallow bays in the county.

Jim Wells.—Crude oil and natural gas production contributed to the 4-percent increase in mineral value. The industry drilled 72 wells totaling 420,694 feet proving 2 oil and 1 gas discovery and 14 oil and 14 gas extensions. Natural gas liquids were recovered at the La Gloria cycle plant of La Gloria Oil & Gas Co., the Seeligson cycle plant of Socony Mobil Oil Co., Inc., and new Falfurrias gasoline plant of Central States Gas Producing Co., and the Orange Grove plant of Gas Processors, Inc.

Johnson.—Increases in lime, sand and gravel, and stone production resulted in an 84-percent increase in total mineral value. Lime for

chemical and industrial uses and for building materials was produced from limestone quarried by Texas Lime Co. The company also quarried and crushed limestone for riprap, concrete aggregate, roadstone, mineral food, and soil conditioner. Various contractors quarried and crushed limestone for concrete aggregate and roadstone for District 2 of Texas Highway Department. Building and paving sand and gravel was prepared by W. O. Pelphry and by various contractors for Texas Highway Department.

Karnes.—Production of uranium oxide (U_3O_8), crude oil, natural gas, and natural gas liquids accounted for the 13-percent increase in mineral value. Uranium ores recovered from open pits in the Falls City area were treated at the mill of Susquehanna-Western, Inc. Natural gas liquids were recovered at the Cabeza Creek gasoline plant of United Gas Pipeline Co., the Fashing plant of Warren Petroleum Corp., and the Person plant of Shell Oil Co. Exploratory and development drilling of 50 wells totaling 454,052 feet proved 1 oil discovery and 19 oil and 6 gas wells. Sulfur was recovered from sour gas at the Fashing plant of Warren Petroleum Corp. and the Person plant of Shell Oil Co.

Kleberg.—Total mineral value increased 2 percent. Exploratory and development drilling of 223 wells totaling 1,586,470 feet proved 3 oil and 4 gas discoveries and 127 oil and 40 gas extensions. Natural gas liquids were recovered at the May gasoline plant of Cities Service Oil Corp., at the King Ranch, and at the new 175-million-cubic-foot-per-day cycling plant of Humble Oil & Refining Co. Heldenfels Bros. quarried and prepared aggregate for concrete.

Lavaca.—Reduction in natural gas liquids and crude oil recovery offset a production increase in natural gas resulting in a 9-percent decrease in mineral value from that of 1963. New facilities at the Provident City gasoline plant of Shell Oil Co. increased throughput from 60 to 75 million cubic feet per day. Exploratory and development drilling of 17 wells totaling 134,875 feet resulted in 2 oil wells and 3 gas wells. Natural gas liquids were recovered at the gasoline plants of Mobil Oil Co., Shell Oil Co., George Mitchell & Associates, and San Jacinto Gas Processing Corp. Sandstone was quarried and prepared as concrete aggregate and roadstone by contractors for District 13 of Texas Highway Department.

Liberty.—Fuels accounted for over 85 percent of county mineral value. Gasoline plants of Southwest Industries, Inc., Humble Oil & Refining Co., and the new refrigeration-absorption plant of Sinclair Oil & Gas Co. recovered natural gas liquids. The 153 wells drilled by the industry proved 106 oil wells and 7 gas wells. Texas Gulf Sulphur Co. mined native sulfur by the Frasch process at Moss Bluff dome. Building and paving sand and gravel, as well as industrial sand used for blast, engine, and hydrofrac, were prepared by Texas Construction Materials Co. Paving sand and gravel was prepared by numerous contractors for Texas Highway Department.

Llano.—Marble was quarried and prepared as roofing material, terrazzo, and paint filler by Bilbrough Marble Co.; monumental granite was quarried and prepared by Premier Granite Quarries and Texas Crushed Stone Co. A graphitic schist was quarried and prepared as a filter medium by Graphilter Corp.

McLennan.—Universal Atlas Cement Co. mined limestone and clay from open pits near its Waco Plant for portland and masonry cements. Limestone was quarried and crushed for concrete aggregate and roadstone by various contractors for Texas Highway Department. Building and paving sand and gravel were prepared by four producers. Waco Aggregate Co. produced clay from open pits for lightweight aggregate and building brick.

McMullen.—Mineral value increased 7 percent compared with that of 1963. Of 55 wells drilled, totaling 316,825 feet, 10 proved to be oil wells and 7 proved to be gas wells. Amata Gas Corp. completed a small gas processing plant in the Rhode Ranch field. Trans-Jeff Chemical Corp. operated a sulfur recovery plant near Tilden. Paving sand and gravel was prepared for Texas Highway Department by various producers.

Matagorda.—The value of mineral production increased 5 percent due to increased oil, natural gas, sand and gravel, and shell production which offset moderate declines in natural gas liquids and clay production. Exploratory and development drilling of 116 wells, totaling 1,096,695 feet, proved 50 oil wells and 22 gas wells. Natural gas liquids were recovered at two cycle plants and five gasoline plants. Pal-Port Brick Manufacturing Div. of Sunset Brick & Tile, Inc., mined miscellaneous clay from open pits for brick and heavy clay products. Contractors produced paving sand and gravel for District 12 of Texas Highway Department. Matagorda Shell Co. dredged shell from adjoining bays. Stone was quarried and crushed for concrete aggregate and roadstone by one producer.

Medina.—Fifty-three wells were drilled; 30 were completed as oil producers. D'Hanis Brick & Tile Co. mined miscellaneous clays from open pits for building brick and heavy clay products. Medina Perlite Co. began expanding perlite during 1964; the raw material was not produced in the county. A refinery with a 1,500 barrel daily capacity was operated by Braytex, Inc.

Midland.—Exploratory and development drilling accounted for 30 wells totaling 299,517 feet of which 16 were oil wells and 11 were gas wells. Natural gas liquids were recovered at four gasoline plants. Three cycling plants were in operation during 1964. Perlite from other States was expanded at the plant of Perlite Industries, Inc., for use in plaster, acoustical walls, and loose fill insulation. Limestone was quarried and crushed for concrete aggregate and roadstone.

Milam.—Lignite, used as a fuel in generating electric power for Rockdale reduction works of Aluminum Company of America, was mined from open pits by Industrial Generating Co. Alumina from the company's Point Comfort refinery was used in the operation. Development drilling proved 22 oil wells out of 33 drilled. Three exploratory wells were drilled and abandoned as dry holes.

Montague.—Exploratory and development drilling accounted for 140 wells totaling 753,310 feet, resulting in 103 oil wells. Natural gas liquids were recovered at the Bowie gasoline plant of Bowie Gasoline Corp. of Texas. Building and paving sand and gravel were prepared by one operator. Contractors prepared paving gravel and crushed sandstone for concrete aggregate and roadstone for District 3 of Texas Highway Department.

Montgomery.—The oil and gas industry drilled 14 wells totaling 135,120 feet, which resulted in 6 gas completions. The slight decline in mineral value was due to the drop in natural gas liquids and sand and gravel output. Natural gas liquids were recovered at two cycling plants and five gasoline plants during the year. Carbon black was recovered from hydrocarbon liquid at Conroe No. 63 furnace plant of Columbian Carbon Co. Contractors produced paving sand and gravel for District 12 of Texas Highway Department.

Moore.—Mineral production increased 8 percent in value compared with that of 1963. A total of 53 development wells were drilled; 25 were completed as oil wells and 18 as gas wells. Significant production gains were reported for all commodities. Underground LPG storage amounted to 1.3 million barrels by Shamrock Oil & Gas Corp.; the company also operated a sulfur recovery plant at its McKee gasoline plant. Phillips Petroleum Co. used natural gas in producing anhydrous ammonia, nitric acid, and nitrogen solutions. The Machovec zinc retort smelter of American Zinc Co. of Illinois operated during 1964, treating ores and concentrates from other States and foreign countries. Natural gas liquids were recovered at eight gasoline plants; crude oil was processed at the McKee plant of Shamrock Oil & Gas Corp. Carbon black was produced from hydrocarbon liquids at the Sunray furnace plant of Continental Carbon Co.

Navarro.—There was a 5-percent increase in mineral value compared with 1963, due to increases in all minerals except sand and gravel. Miscellaneous clay, used in building brick and heavy clay products, was mined from open pits by Whiteselle Brick & Lumber Co. Exploratory and development drilling accounted for five holes, totaling 29,730 feet, and proved one gas well. Building and paving sand and gravel were prepared by two producers. Lone Star Producing Co. began operating its Trinity River complex which produced various types of fertilizers. Contractors quarried and prepared limestone for concrete aggregate for Texas Highway Department.

Nolan.—A total of 31 exploratory and development wells were drilled, of which 11 were completed as oil producers. Natural gas liquids were recovered at six plants. Lone Star Cement Corp. quarried and prepared limestone for portland and masonry cement at the Maryneal plant. U.S. Gypsum Co. and Flintkote Co. mined gypsum from open pits near Sweetwater for use as portland cement retarder, for agricultural uses, and for manufacturing plaster, wallboard, lath, and other gypsum products for the building industry. Building and paving sand and gravel were prepared by Hillsdale Gravel Co.

Nueces.—The value of mineral production increased by 4 percent compared with that of 1963. A total of 230 exploratory and development wells were drilled and resulted in 105 oil producers and 57 gas wells; total footage was 1,233,456. Four cycling plants operated. Eight gasoline plants were on stream and had a total daily throughput capacity in excess of 378 million cubic feet. In Luby field, a 36-million-cubic-foot plant was completed by Pan American Petroleum Corp. and a 10-million-cubic-foot plant was activated by Sun Oil Co. Seven oil refineries operated with maximum total daily capacity exceeding 248,000 barrels. The Celanese Chemical Co. of Bishop continued to be a leader in production of acetyl chemicals. American Smelting & Refining Co. continued electrolytic zinc refining and alloy-

ing operations at its Corpus Christi refinery; zinc concentrates were obtained from Western States and foreign markets.

Building and paving sand and gravel were prepared by Heldenfels Bros. and M. P. Wright, Jr. Shell, used for concrete aggregate and manufacture of lime and cement, was dredged from shallow bays in the county by Corpus Christi Shell Co., Inc., Heldenfels Bros., and General Dredging Corp. Portland and masonry cement were manufactured from shell and local clays at the Corpus Christi plant of Halliburton Portland Cement Co. Lime for industrial, chemical, and building purposes was manufactured from shell by Pittsburgh Plate Glass Co.

Ochiltree.—Mineral production value increased 9 percent over that of 1963. This increase reflected the continued development of petroleum and natural gasfields. A total of 83 exploratory and development wells were drilled which resulted in 55 new oil wells and 14 new gas wells. Natural gas liquids were recovered at the Spearman gasoline plants of Northern Natural Gas Co. and Skelly Oil Co.

Orange.—The county produced approximately 27 billion cubic feet of natural gas and over 2 million barrels of crude oil. Of 40 exploration and development wells drilled, 17 were completed as oil producers and 4 were completed as gas producers. Total footage drilled was 286,226 feet. Phillips Petroleum Co. recovered carbon black from natural gas liquids at its Echo Philblack plant. Firestone Synthetic Rubber & Latex Co., Division of Firestone Tire & Rubber Co., produced polybutadiene at its Orange facility. Marathon Oil Co. and Union Texas Petroleum Division of Allied Chemical Corp. recovered natural gas liquids. Portland cement was manufactured from shell and clay at the plant of Texas Portland Cement Co. Division of Alpha Portland Cement Co. Texas Sand Pit produced sand and gravel for the paving industry.

Palo Pinto.—Natural gas liquids were recovered by Lone Star Gas Co. and Southwestern Gas Pipeline, Inc. Of 39 exploration and development wells drilled, 6 were completed as oil wells and 17 as gas wells. Miscellaneous clay, used in brick and heavy clay products, was mined from open pits near Mineral Wells by Texeramics, Inc., Texas Vitrified Pipe Co., and Reliance Clay Products Co. Mineral Wells Sand & Gravel Co. and various contractors recovered building and paving sand and gravel from pits near Mineral Wells. Much of the material was used by Texas Highway Department, District No. 2.

Panola.—Development drilling proved 138 oil and 13 gas wells. With a combined daily capacity of 778 million cubic feet, gasoline plants of Arkla Chemical Corp., Champlin Petroleum Co., Cities Service Oil Co., San Jacinto Gas Processing Corp., and United Gas Pipeline Co. recovered natural gasoline and LP gases.

Pecos.—Of a total of 194 exploratory and development wells drilled, 77 were completed as oil wells and 28 were completed as gas wells. Natural gas liquids were recovered at gasoline plants of Phillips Petroleum Co., Marathon Oil Co., and Pecos Co. Mobil Oil Co. commenced operating a cycling plant in the Coyanosa field. Paving gravel was prepared by Portable Aggregates, Inc.

Potter.—Helium was produced and refined at the Government-owned plant near Amarillo. Natural gas liquids were recovered at the Fain and Turkey Creek gasoline plants of Amarillo Oil Co. Building and

paving sand and gravel were recovered and processed from pits near Amarillo by Panhandle Gravel, Inc., and Texas Sand & Gravel Co., Ltd. The Texaco, Inc., refinery at Amarillo processed crude oil. Of 20 exploration and development wells drilled, 15 were completed as gas wells. American Smelting & Refining Co. operated its zinc retort smelter at a reduced rate. Zinc concentrates were obtained from Western States and foreign imports.

Reagan.—Total value of mineral production increased 6 percent to $23.7 million. Big Lake plant of Northwest Production Corp. utilized the modified Claus process to recover sulfur from sour gas. Natural gas liquids were recovered at three plants. Of 87 holes drilled, 78 were completed as oil wells and 1 as a gas well.

Reeves.—Increased production of mineral fuels was responsible for a 7-percent increase in value of mineral production. A total of 49 oil wells and 3 gas wells was completed out of the 90 wells drilled. Phillips Petroleum Co. processed natural gas from Tunstill, Mason, and North Mason fields at the Tunstill gasoline plant near Orla. Natural gas liquids were also processed at Ramsey gasoline plant of Continental Oil Co. Five-Fifty Land Co. and Permian Sand & Gravel Co., Inc., prepared building and paving sand and gravel.

Refugio.—Drilling activity in the county remained remarkably stable during the year; 75 exploratory and development wells were drilled, of which only 27 were dry holes. Humble Oil & Refining Co. recovered natural gas liquids at its Tom O'Connor gas plant. Hunt Industries and Pan American Petroleum Corp. also operated liquid recovery plants.

San Patricio.—Production of about 11 million barrels of crude oil and 98 billion cubic feet of natural gas accounted for over 89 percent of the mineral value. Exploratory and development drilling of 87 holes resulted in completion of 36 oil wells and 18 gas wells. Natural gas liquids were recovered at Red Fish Bay gasoline plant of Sunray DX Oil Co., Taft No. 20 plant of Sinclair Oil & Gas Co., Portilla gasoline plant of Superior Oil Co., and Welder plant of Marathon Oil Co. Claude Hughes and Heldenfels Bros. quarried and prepared crushed stone for concrete aggregate and roadstone. Building and paving sand and gravel were prepared by Fordyce Gravel Co. and Thorstenberg Material Co. Sherwin alumina plant and San Patricio reduction plant of Reynolds Metals Co. operated at about the same rate as last year. Miscellaneous clay was processed by Halliburton Portland Cement Co. for cement.

Scurry.—Scurry County ranked fifth in crude oil production and seventh in total mineral value in the State. Of the 59 exploratory and development wells drilled, 35 were completed as oil producers. Four gasoline plants recovered natural gas liquids. Miscellaneous clay was mined from open pits for brick and heavy clay products by Southwestern Brick & Tile Co.

Shackelford.—Mineral fuels output decreased 7 percent from that of 1963. From a total of 310 wells drilled, with a cumulative footage of 446,746 feet, 156 were completed as oil wells and 5 as gas wells. Natural gas liquids were recovered at the No. 1 gasoline plant of Marshall Young Drilling Co.

Smith.—A 7-percent decrease in mineral production value was reported. Over 2 million barrels of crude oil and 10 billion cubic feet

of natural gas were produced. Thirty-nine exploratory and development wells were drilled, 6 produced oil and 1 produced gas. Natural gas liquids were recovered by Chapel Hill gasoline plant of Etexas Producers Gas Co. Crude oils were processed at the Tyler refinery of LaGloria Oil & Gas Co. Miscellaneous clay, used for brick and heavy clay products, was mined from open pits by Reliance Clay Products Co. Industrial sands for foundry use were processed by H. J. Ellis Sand Co.

Starr.—Mineral output was 4 percent greater than that in 1963 reflecting a major increase in production of natural gas and a slight increase in production of petroleum and sand and gravel. In addition, exploratory development drilling discovered 25 gas and 35 oil wells. Both plants of Sun Oil Co., the Rincon gasoline plant of Continental Oil Co., and the North Rincon plant of Shell Oil Co. recovered natural gas liquids. Rio Clay Products Co., a division of Pozzolana, Inc., mined miscellaneous clay from open pits for brick and heavy clay products. Pumicite to be used as carrier for insecticides and concrete admixture was processed by Pozzolana, Inc.

Tarrant.—Trinity Portland Cement Division of General Portland Cement Co. quarried and prepared limestone for portland and masonry cements. Carruthers Cut Stone Co. quarried dimension limestone and numerous producers processed crushed limestone for District 2 of Texas Highway Department. Building and paving sand and gravel were prepared by 10 producers. Mica that was produced outside of Texas was ground and prepared by Western Mica Co. Sil-Flo Corp. expanded perlite for filters.

Taylor.—Petroleum accounted for over 90 percent of the total mineral value, and 171 development and exploratory wells were drilled during the year. Clay, used in building brick, was mined from open pits by Abilene Brick Co. H. B. Zachry & Co. quarried and prepared crushed limestone for concrete aggregate and roadstone. Building and paving sand and gravel were prepared by Caton Sand & Gravel Co. and R. E. Janes Gravel Co., Inc. Debco Corp. of Texas processed crude oil at its Abilene refinery. Natural gas liquids were recovered by Gulf Central Oil & Gas Co., McWood Corp., and Valera Oil Co.

Terry.—Mineral production value was a 17-percent reduction from that in 1963. Adair gasoline plant of Amerada Petroleum Corp. and Wellman plant of Chillgas Corp. recovered natural gas liquids. Carbon black was recovered from natural gas and natural gas liquids at Seagraves No. 64 furnace plant of Columbian Carbon Co. Sodium sulfate was recovered from brine at the Brownfield plant of Ozark-Mahoning Co. Paving sand and gravel for Texas Highway Department was processed by various producers.

Travis.—Value of mineral production decreased 20 percent from that of 1963. Austin White Lime Co. quarried and prepared limestone for lime, which was used by building, agricultural, and chemical industries. In addition, limestone was quarried and crushed for riprap, metallurgic flux, railroad ballast, soil conditioner, concrete aggregate, and roadstone by Austin White Lime Co. and Texas Crushed Stone Co. Building and paving sand and gravel were prepared by Capital Aggregates, Inc., and Travis Materials, Inc. Contractors produced crushed limestone for Districts 2 and 14 of Texas Highway Department.

Uvalde.—Asphaltic limestone was quarried and prepared for road surfacing materials from pits near Dabney by White's Uvalde Mine and from pits near Blewett by Uvalde Rock Asphalt Co. Basalt for concrete aggregate, roadstone, filter material, and rock wool was quarried and prepared by Southwest Stone Co. The D & D Gravel Co. and Weirich Bros., Inc., prepared building and paving sand and gravel. Limestone was processed by various operators.

Van Zandt.—The oil and gas industry produced 2.9 billion cubic feet of natural gas and 5.2 million barrels of crude oil. Pure Oil Co. recovered natural gas liquids at its Van gasoline plant. Morton Salt Co. recovered rock salt from underground mines and salt in brine from wells near Grand Saline. Pan American Petroleum Corp. recovered sulfur and liquids from gas produced from the Edgewood and NE Edgewood fields. This sulfur recovery plant is the largest such facility in the Nation and has a daily output of 578 long tons of sulfur. Anderson County Mining Enterprises, Inc., produced floor and wall tile from fire clay.

Ward.—Ward County mineral production value increased 18 percent over that of 1963, principally due to increased petroleum production. Approximately 24.6 million barrels of crude oil and 24.8 billion cubic feet of natural gas were produced. Natural gas liquids were recovered at three plants. Salt was obtained from brine by Montex Chemical Co. Sodium sulfate was recovered from salt wells and dry lake brines at the Monahans plant of Ozark-Mahoning Co. Permian Sand & Gravel Co., Inc., prepared building and paving sand and gravel from Anderson pit near Grand Falls and mined gypsum from Johnson pit near Pyote.

Webb.—A 16-percent increase in value of mineral production resulted from increased natural gas and crude oil production. Of 79 exploration and development wells drilled, 12 were completed as oil producers and 16 as gas producers. Antimony ore imported from Mexico was processed at the Texas Mining & Smelting Division of National Lead Co. in Laredo. Miscellaneous clay used in brick and heavy clay products was mined from open pits by Laredo Brick and Tile Co., Inc. Building sand and gravel was prepared by Aldape Sand & Gravel Co. and Solis Sand & Gravel Co.

Wharton.—Increased demand for sulfur resulted in a 23 percent increase in total mineral value as compared with 1963. Texas Gulf Sulphur Co. continued mining sulfur by the Frasch process at Boling Dome. In exploration and development drilling, a total of 146 wells were drilled; 45 were completed as oil producers and 43 as gas producers.

Wheeler.—Mineral fuel production was 19 percent more than that in 1963. McLean-28 gasoline plant of Warren Petroleum Co. recovered natural gas liquids. Carbon black was recovered from natural gas and natural gas liquids at the Shamrock furnace plant of United Carbon Co., Division of Ashland Oil & Refining Co.

Wichita.—Production of petroleum was responsible for over 93 percent of mineral production value. Wichita Falls refinery of American Petrofina Co. of Texas refined crude oil. Natural gas liquids were recovered at two gasoline plants. Sandstone was quarried and crushed for concrete aggregate and roadstone. Paving sand and gravel was prepared by contractors for District 3 of Texas Highway

Department. Northwest Materials Co. and Wichita Sand & Gravel Co., subsidiary of Gifford-Hill & Co., Inc., prepared building and paving sand and gravel.

Williamson.—Williamson County, one of the State's leading stone and lime producers, increased its value of mineral production 10 percent. Limestone was quarried and prepared for lime by Round Rock White Lime Co., Southwestern Superior Products Corp., and White Stone Lime Co. Rough, architectural, and dressed building stone were quarried and prepared by Leander Limestone Corp., Texas Quarries, Inc., and San-Tex Stone Quarry, Inc. Limestone was quarried and crushed by various producers for concrete aggregate, roadstone, fertilizer, filler, and other industrial uses.

Wise.—Mineral production value increased 3 percent over that of 1963. Production of petroleum, natural gas, natural gas liquids, and limestone dominated the mineral picture of the county. Acme Brick Co. mined miscellaneous clay from pits near Bridgeport for use in heavy clay products. Limestone was quarried and prepared for concrete aggregate and roadstone by Bridgeport Stone Co., Gifford-Hill & Co., Inc., Crushers, Inc., Southwest Stone Co., and Wesco Stone Corp.

Yoakum.—An 8-percent increase in mineral production resulted from increased natural gas and petroleum production. Wasson gasoline plant of Shell Oil Co. and Prentice plant of Pan American Petroleum Corp. recovered natural gas liquids. Frontier Chemical Co. recovered salt in brine from wells near Denver City.

Young.—The oil and gas industry completed 67 oil wells and 6 gas wells during the year. Over 4.8 million barrels of crude oil were recovered from the county's oilfields. Natural gas liquids were processed at three plants. Pitcock Bros. prepared building and paving sand and gravel. Contractors quarried and crushed limestone for concrete aggregate and roadstone for District 2 of Texas Highway Department.

The Mineral Industry of Utah

This chapter was 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 Merwin H. Howes,[1] R. B. Stotelmeyer,[1] and Joseph M. Harstead [2]



MINERAL-output value for Utah in 1964 of $391.4 million was comprised of metals valued at $222.7 million, mineral fuels at $128.2 million, and nonmetals at $40.5 million. Increases in values of metals and nonmetals of $11.2 million and $2.8 million, respectively, offset a decrease in value of $8 million for mineral fuels.

A 4-percent gain in production value of copper (the leading mineral product in Utah, accounting for 33 percent of the total mineral production value in the State), with gains in values of all other metals except beryllium, silver, and vanadium, resulted in a 5-percent gain for metals values.

TABLE 1.—Mineral production in Utah [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide (natural)—thousand cubic feet	100,895	$7	96,432	$7
Clays [2]—thousand short tons	125	470	127	330
Coal (bituminous)—do	4,360	22,755	4,720	33,184
Copper (recoverable content of ores, etc.)—short tons	203,095	125,107	199,588	130,131
Fluorspar—do	247	7	W	W
Gem stones	(3)	75	(3)	75
Gold (recoverable content of ores, etc.)—troy ounces	285,907	10,007	287,674	10,069
Iron ore (usable)—thousand long tons, gross weight	1,881	12,900	2,082	14,306
Lead (recoverable content of ores, etc.)—short tons	45,028	9,726	40,249	10,545
Lime—thousand short tons	156	2,668	163	2,917
Natural gas (marketed)—million cubic feet	77,122	14,036	80,175	10,904
Perlite—short tons	1,313	7	2,003	12
Petroleum (crude)—thousand 42-gallon barrels	33,435	90,943	28,575	74,867
Pumice—thousand short tons	28	46	W	W
Salt—do	325	3,462	371	3,848
Sand and gravel—do	11,709	10,408	10,218	10,405
Silver (recoverable content of ores, etc.)—thousand troy ounces	4,791	6,128	4,552	5,886
Stone—thousand short tons	2,346	4,040	3,105	6,930
Uranium ore—short tons	743,792	23,852	761,180	26,385
Vanadium—do	382	W	405	1,214
Zinc (recoverable content of ores, etc.)—do	36,179	8,321	31,428	8,548
Value of items that cannot be disclosed: Asphalt and related bitumens, beryllium concentrate (1963), cement, gypsum, molybdenum, natural gas liquids, phosphate rock, potassium salts, and values indicated by footnote 2 and symbol W	xx	[4] 40,458	xx	[5] 40,867
Total	xx	r 385,423	xx	391,430

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] Excludes fire clay and halloysite; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Value of metals and mineral fuels, $23,894,000; value of nonmetals, $16,564,000.
[5] Value of metals and mineral fuels, $24,848,000; value of nonmetals, $16,019,000.

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

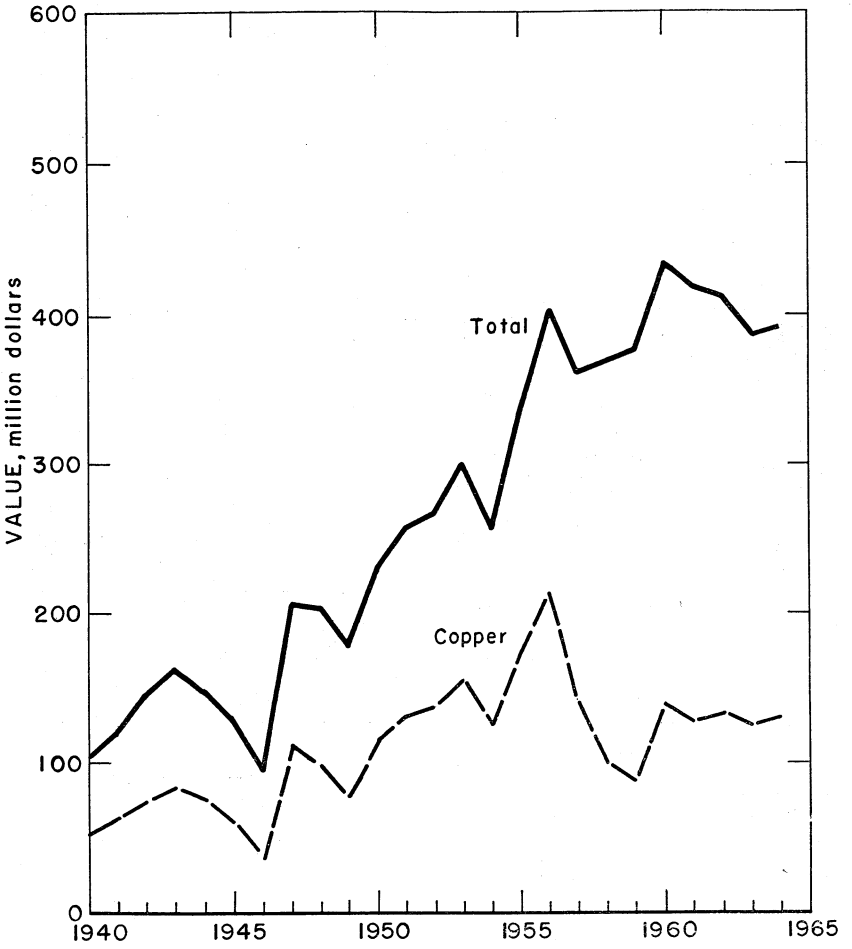


FIGURE 1.—Value of copper and total value of mineral production in Utah.

The total value of mineral fuels dropped 6 percent because of decreases in production values of petroleum, natural gas, and natural gas liquids; these decreases countered substantial gains in values of coal and gilsonite.

The rise in nonmetals output value was mainly the result of an increase in value of stone production. Values of cement, fluorspar, lime, perlite, phosphate rock, and salt also increased. Clays, gypsum, potassium salts, pumice, and sand and gravel values decreased.

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

Year	Value	Year	Value
1953	$312	1959	$372
1954	265	1960	417
1955	301	1961	r 412
1956	337	1962	r 397
1957	350	1963	r 357
1958	380	1964	364

r Revised.

Employment and Injuries.—Final employment and injuries data for 1963 and preliminary data for 1964 (excluding all mineral fuels industries except the coal and asphalt (gilsonite) industries) compiled by the Federal Bureau of Mines are shown in table 3.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	1,631	306	2,402	10	101	46
Metal	5,075	1,377	11,017	3	244	22
Nonmetal	662	174	1,391	20	113	96
Sand and gravel	575	119	959		37	39
Stone	505	135	1,086	1	21	20
Asphalt	250	65	517		23	45
Total	8,698	2,176	17,372	34	539	33
1964: p						
Coal	1,692	312	2,430	6	95	42
Metal	5,505	1,406	11,412	3	380	34
Nonmetal	640	146	1,166	1	70	61
Sand and gravel	500	104	837		26	31
Stone	440	114	910		20	22
Asphalt	195	47	374		15	40
Total	8,972	2,129	17,129	10	606	36

p Preliminary.

Legislation and Government Programs.—No Office of Minerals Exploration contracts were executed in 1964. All previously awarded contracts either had been terminated or completed before January 1, 1964.

A report [3] showed that from July 1, 1956, to December 31, 1964, Utah completed to full or acceptable interstate highway standards 123.3 miles of road plus 28.1 miles of highways adequate for present travel, for a total of 151.4 miles open to traffic. The State was ranked 42d in total miles open to traffic and 14th in total miles (423.8) of highway in progress.

[3] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program. Dec. 31, 1964; press release BPR 65–10, Feb. 11, 1965.

A total $57.3 million was awarded for Utah highway construction[4] in 1964: $41.9 million for interstate contracts, $13.9 million for Federal-Aid Primary and Secondary (ABC) contracts, and $1.5 million for State-financed contracts. The 1965 plans called for $49.3 million for interstate contracts, $10.2 million for ABC contracts, and $400,000 for State-financed contracts.

The Kennecott Copper Corp. and the State of Utah agreed to make a joint study of the feasibility of building a test jetty in Great Salt Lake with Utah Copper Division tailings; the study was to determine the potential use of tailings for dikes, land fills, and roads in a long-range plan to develop the lake area. The project was planned to start early in 1965.

Thirteen mines continued to participate in the Federal Lead and Zinc Stabilization Program. Public Law 87–347, which established the program, was amended on July 25, 1963, by Public Law 88–75 which provided that the dollar value of lead or zinc or a combination of lead and zinc sold must equal or exceed 50 percent of the total dollar value of all minerals in the ore in order to qualify for stabilization payments. To implement the amendment, all previously qualified producers were required to reapply for participation in the program and were re-certified on the basis of amended rules and regulations, which were published in the Federal Register on December 4, 1963.

Rising prices of lead and zinc progressively reduced payments to participants for the lead and zinc produced. Average monthly prices for lead reached 14.5 cents per pound in October and for zinc in November; payments ceased for lead delivered after October 1 and for zinc after November 1. Stabilization payments in 1964 were $46,177 for 1,530.5 tons of lead and 792.7 tons of zinc.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—There was no production of beryllium from the State, although The Anaconda Company made a test shipment from its Spor Mountain property to its new beryllium plant at Anaconda, Mont.

Copper.—Utah again was ranked second only to Arizona in the output of copper. Although copper production was 2-percent less, the increase of 1.8 cents per pound in the weighted average price in 1964—to 32.6 cents—resulted in a 4-percent gain in the output value. By far the largest production in the State came from the open-pit mine of the Utah Copper Division of Kennecott Copper Corp. Other producers were: American Mining Co. at Bawana mine, United States Smelting Refining and Mining Co. (USSR&M Co.) at U.S. and Lark mine, and Hecla Mining Co. at Mayflower mine.

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[4] Engineering News-Record. State Highway Contract Awards Will Jump to a Record High. V. 174, No. 12, Mar. 25, 1965, pp. 30–32.

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)
1955–59 (average)	64	1	27,729	356,603	$12,481	5,607	$5,074
1960	37		28,832	368,255	12,889	4,783	4,329
1961	34		28,542	342,988	12,005	4,798	4,435
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
1864–1964	NA	NA	[3] 1,077,652	17,338,989	507,091	827,801	626,885

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1955–59 (average)	211,062	$143,670	44,293	$12,236	41,396	$9,816	$183,277
1960	218,049	139,987	39,398	9,219	35,476	9,153	175,577
1961	213,534	128,120	40,894	8,424	37,239	8,565	161,549
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
1864–1964	9,012,760	3,700,273	5,234,899	715,404	1,652,617	307,710	5,857,363

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.

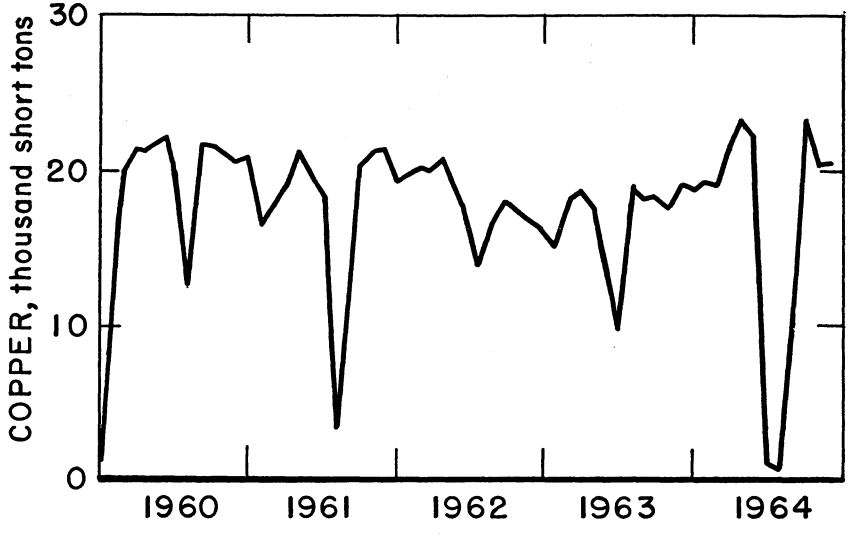


FIGURE 2.—Mine production of copper in Utah, by months, in terms of recoverable metals.

TABLE 5.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	[3] 7	[3] [4] 139,152	[3] 1,337	[3] $46,795	[3] 259,802	[3] $335,924
Juab	2	34,826	306	10,710	18,749	24,242
Millard	1	21	3	105	428	553
Piute	(3)	(3)	(3)	(3)	(3)	(3)
Salt Lake	7	24,793,426	251,635	8,807,225	3,139,953	4,059,959
San Juan	(3)	(3)	(3)	(3)	(3)	(3)
Summit	3	171,753	1,620	56,700	466,685	603,424
Tooele	5	27,770	120	4,200	220,826	285,528
Utah	(3)	(3)	(3)	(3)	(3)	(3)
Wasatch	2	109,377	32,653	1,142,855	441,767	571,205
Washington	1	2,545	----	----	3,750	4,849
Total:						
1964	28	25,278,870	287,674	10,068,590	4,551,960	5,885,684
1963	31	r 27,034,721	285,907	10,006,745	4,790,511	6,127,638

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Beaver	[3] 3,563	[3] $2,322,978	[3] 1,155	[3] $302,388	[3] 775	[3] $210,827	[3] $3,218,912
Juab	12	7,824	----	----	----	----	42,776
Millard	1	359	2	576	2	585	2,178
Piute	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Salt Lake	194,996	127,137,359	26,812	7,024,809	18,415	5,008,744	152,038,096
San Juan	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Summit	130	84,467	5,169	1,354,226	5,804	1,578,729	3,677,546
Tooele	216	141,191	2,300	602,705	1,628	442,789	1,476,413
Utah	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Wasatch	661	431,298	4,811	1,260,534	4,803	1,306,443	4,712,335
Washington	9	5,900	----	----	1	299	11,048
Total:							
1964	199,588	130,131,376	40,249	10,545,238	31,428	8,548,416	165,179,304
1963	203,095	125,106,520	45,028	9,726,048	36,179	8,321,170	159,288,121

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[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.

[3] Production of Beaver, Piute, San Juan, and Utah Counties combined to avoid disclosing individual company confidential data.

[4] Excludes tonnage of uranium ore milled.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc in 1964, 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	3	44,392	343	19,170	60,300	----------	----------
Dry silver	5	87,657	574	125,807	86,100	61,200	62,200
Total	8	132,049	917	144,977	146,400	61,200	62,200
Copper	4	24,581,312	243,277	2,116,401	351,687,400	300	300
Copper-lead-zinc and uranium [2]	[3] 3	[4] 1,207	20	32,516	929,000	402,700	156,000
Lead	8	6,588	249	78,566	52,100	1,842,300	455,700
Lead-zinc	8	514,038	43,201	2,170,141	4,251,100	77,260,700	57,179,700
Zinc	1	9	----------	35	400	700	2,600
Total	22	25,103,154	286,747	4,397,659	356,920,000	79,506,700	57,794,300
Other lode material:							
Copper precipitates	1	28,723	----------	----------	42,080,300	----------	----------
Copper-lead cleanup	[5]	1	----------	55	400	100	----------
Lead cleanup and zinc slag [2]	[5]	43,666	10	9,269	28,900	930,000	4,999,500
Total	1	72,390	10	9,324	42,109,600	930,100	4,999,500
Total lode material	29	25,307,593	287,674	4,551,960	399,176,000	80,498,000	62,856,000

[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] Copper-lead-zinc mines only; 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 1964, 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]	286,419	4,256,376	356,721,300	76,689,700	56,895,000
Direct-smelting:					
Ore	1,245	286,260	345,100	2,878,200	961,500
Copper precipitates	----------	----------	42,080,300	----------	----------
Cleanings and old slag	10	9,324	29,300	930,100	4,999,500
Total	1,255	295,584	42,454,700	3,808,300	5,961,000
Grand total	287,674	4,551,960	399,176,000	80,498,000	62,856,000

[1] Includes uranium-ore concentrate.

Approximately $20 million of the $100 million Utah program of Kennecott to expand copper production by 100,000 tons annually had already been spent, principally for converting the upper levels of the open-pit mine to truck haulage.

Gold.—Gold increased 1 percent in quantity and in value of production. Decreases in gold output at the Kennecott Utah Copper pit (principal producer in the State), the USSR&M Co. U.S. and Lark mine, and the United Park City Mines Co. United Park City mines were more than offset by increased output at the Hecla Mining Co. Mayflower mine.

Iron Ore.—Shipments of iron ore (including direct shipping ores and concentrates) increased 201,517 long tons in quantity and $1.4 million in value (11 percent each). The production came from seven mines, one in Beaver County, the Bawana mine, operated by Majestic Oil & Mining Co., later acquired by American Mining Co., and six in Iron County, the Blowout and Comstock mines, operated by The Colorado Fuel and Iron Corp. (CF&I); the Desert Mound and Iron Mountain mines, operated by United States Steel Corp. (USS), Western Ore Operations; and the Comstock Alluvial and Iron Springs mines, operated by Utah Construction & Mining Co. USS was the leading iron ore producer in the State. Ore from the Blowout and Comstock mines, owned by CF&I, was mined by Utah Construction & Mining Co. and shipped to the CF&I plant at Pueblo, Colo. All other iron ore from Iron County was shipped to the USS Geneva plant.

At one of its iron properties near Comstock Hill, Utah Construction & Mining Co. used a portable dry-type placer unit as an iron-mining innovation. Excavation was performed with a standard dragline which dumped the magnetite-bearing alluvium into a feed hopper of the separating unit. The ore was crushed, screened, and magnetically separated. Tailings were disposed of by means of a belt stacker; concentrates were fed directly into dump trucks.

TABLE 8.—Usable iron ore shipments

(Thousand long tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	3,672	$25,552	1963	1,881	$12,900
1960	3,334	23,862	1964	2,082	14,306
1961	3,533	25,493	1906–64	70,624	327,716
1962	2,630	18,242			

Lead.—Despite the 11-percent drop in quantity of lead produced, the value was 8 percent higher—the weighted average price was 13.1 cents per pound, 2.3 cents more than in 1963. The five leading lead producers were USSR&M Co. at the U.S. and Lark mine; United Park City Mines Co. at the United Park City mines; Hecla Mining Co. at the Mayflower mine; McFarland & Hullinger, lessees, at the USSR&M Co. Ophir mine; and Kennecott Copper Corp., Tintic Division, at the Burgin mine. The lead output decreased at all of these mines.

According to the company annual report, preparatory work (to establish two additional working levels) was commenced late in 1964 on the extension of the USSR&M Co. U.S. and Lark main operating incline shaft in the lower section of the mine. At the Ophir mine a new level was opened by extending the interior incline shaft 357 feet for a total incline length of 2,091 feet. This activity was the result of a search for additional ore.

Considerable progress was made in developing the Burgin mine by Kennecott Copper Corp., Tintic Division. The 1,500-foot production shaft was nearing completion and surface plant facilities were essentially completed. Production, at a minimum rate of 500 tons per day, was expected early in 1965.

Molybdenum.—Molybdenum was recovered as a byproduct of copper ore mined from the Kennecott Copper Corp. Utah Copper pit. Output decreased 0.5 percent.

Silver.—Silver decreased 5 percent in quantity and 4 percent in value. The weighted average price of silver in 1964 was $1.293 per ounce, 1.4 cents higher than in 1963. Silver producers in order of output were Kennecott Copper Corp. at Utah Copper pit; USSR&M Co. at U.S. and Lark mine; Hecla Mining Co. at Mayflower mine; United Park City Mines Co. at United Park City mines; McFarland & Hullinger, lessees, at USSR&M Co. Ophir mine; American Mining Co. at Bawana mine; McFarland & Hullinger at Ontario dump; Kennecott Copper Corp. at Burgin mine; Wortley Co. at Daly West mine and dump; Deer Trail Mines & Arundel Mining Co. at Deer Trail mine; and Beeson Exploration at Cardiff and Wasatch mines.

Uranium Ore.—Output of uranium ore, increasing 2 percent in tonnage, was 11 percent greater in value because the average grade rose from 0.37 percent (7.4 pounds per ton) in 1963 to 0.40 percent (7.9 pounds per ton) in 1964. The ore was produced at 215 operations (8 more than in 1963) in 7 counties. San Juan County had 95 percent of the uranium output value of the State.

Plants processing Utah uranium ore were American Metal Climax, Inc., Climax Division, Climax Uranium Co., Grand Junction, Colo.; Atlas Corp., Atlas Minerals Division, Mexican Hat and Moab; Mines Development, Inc., a subsidiary of Susquehanna Corp., Edgemont, S. Dak.; Union Carbide Corp., Mining and Metals Division, Rifle and Uravan, Colo.; Vanadium Corporation of American (VCA), Shiprock, N. Mex.; and Vitro Chemical Co., Salt Lake City.

TABLE 9.—Mine production of uranium ore, by counties [1]

County	1963				1964			
	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	1	W	W	W	3	W	W	W
Emery	29	37,320	170,013	$682,232	24	38,648	176,325	$715,468
Garfield	24	2,441	19,346	84,813	34	1,587	13,087	56,707
Grand	36	21,927	109,125	448,706	30	15,578	77,712	318,254
Juab	1	W	W	W	1	W	W	W
Piute	6	W	W	W	5	W	W	W
San Juan	110	663,833	5,160,459	22,392,045	118	686,998	5,687,362	25,003,423
Undistributed	----------	18,271	66,756	244,020	----------	18,369	74,758	291,464
Total	207	743,792	5,525,699	23,851,816	215	761,180	6,029,244	26,385,316

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.

Vanadium.—The quantity of vanadium metal in vanadium oxide recovered from uranium ores was less than in 1963. These ores—produced in Emery, Garfield, Grand, and San Juan Counties—were processed by Climax Uranium Co. Grand Junction, Colo.; Union Carbide Corp., Mining and Metals Division, Rifle and Uravan, Colo.; and VCA, Shiprock, N. Mex. Utah mineral production was credited with the value of the vanadium recovered.

Zinc.—Zinc production decreased 13 percent in tonnage, but increased 3 percent in value; the weighted average price rose to 13.6 cents per pound, an increase of 2.1 cents. Zinc was produced at U.S. and Lark mine by USSR&M Co. (leading producer in the State); at United Park City mines by United Park City Mines Co.; at Mayflower mine by Hecla Mining Co.; at Murray slag dump by International Smelting and Refining Co.; at USSR&M Co. Ophir mine by McFarland & Hullinger, lessees; and at Deer Trail mine by Deer Trail Mines & Arundel Mining Co.

MINERAL FUELS

Asphalt and Related Bitumens.—Value of gilsonite production increased 22 percent. Producers were American Gilsonite Co., Standard Gilsonite Co., and Ziegler Chemical & Mineral Corp., in Uintah County; Ziegler Chemical & Mineral Corp. also mined gilsonite at the Castle Peak mine in Duchesne County. The product was used, principally, for manufacturing metallurgical coke, gasoline, and diesel fuel by American Gilsonite Co. at its refinery at Fruita, Colo. Other uses included inks, japans, manufacturing varnishes, molded articles, roofing, and stains.

Carbon Dioxide.—Carbon dioxide output declined 4 percent. Production, from one well was by Equity Oil Co. at the Farnham Dome field in Carbon County. Transported by pipeline, the gas was converted to dry ice and liquid carbon dioxide at a plant in Wellington.

Coal (Bituminous).—Value of coal production increased 46 percent, or more than $10 million; the tonnage produced increased 8 percent. Coal not sold on the open market, representing 51 percent of the total production, was used for manufacturing coke for steel plants. The largest production was by Kaiser Steel Corp. at the Sunnyside group mines, Carbon County.

TABLE 10.—Coal (bituminous) production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1963		1964	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Carbon	3,492,950	$5.38	3,752,354	$7.43
Emery	751,628	4.47	847,521	5.53
Iron	48,261	4.74	53,747	4.65
Kane	1,260	5.05	1,883	5.34
Sevier	47,495	6.08	47,000	6.08
Summit	17,937	4.55	17,338	4.68
Total	4,359,531	5.22	4,719,843	7.03

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes value for coal not sold but used by producers, 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.)

All the production was from underground mines. Thickness of the coal seams ranged from 54 to 240 inches. Eighty-nine percent of the coal was shipped by rail.

At a hearing convened by the Utah State Engineer, in December, plans were outlined for developing a $600 million coal mine and power

facility. The proposed development in southern Utah would require an estimated 14.6 million tons of coal per year. The hearing was held to consider the request of Resources Co., a subsidiary of Arizona Public Service Co., for diversion of water from Lake Powell for use at a powerplant having an ultimate capacity of 5,000 megawatts.

Arizona Public Service Co. announced that exploration on the Kaiparowits Plateau in Kane County indicated extensive coal deposits.

Natural Gas.—Total gas production, including dry gas and oil well gas, increased 4 percent. Counties leading in output were San Juan and Uintah contributing 39 percent, and 32 percent, respectively.

The remainder was from Carbon, Daggett, Duchesne, Emery, and Grand Counties. Wildcat drilling resulted in two dry-gas discoveries, one in Grand County and the other in Uintah County. Development-well drilling resulted in 17 gas wells in 5 counties.

Natural Gas Liquids.—Natural gas liquids were recovered at four plants in three fields: Aneth in San Juan County, Clay Basin in Daggett County, and Red Wash in Uintah County. The plants were operated by El Paso Natural Gas Co. (Aneth); Mountain Fuel Supply Co. (Clay Basin); California Oil Co., Western Division (Red Wash); and Warren Petroleum Corp. (Red Wash Extension). Output of natural gasoline and LP gases (butane and propane) decreased 10 percent and 8 percent, respectively. The combined value of natural gasoline and LP gases declined 11 percent.

Petroleum.—Crude petroleum production, 28.6 million barrels, decreased 15 percent. The production came from 851 wells in 9 counties. The largest decrease was in San Juan County where secondary-recovery operations were expanded in the Greater Aneth area. The five most productive fields during the year were Red Wash, McElmo Creek, Aneth, Lisbon, and Ratherford; all but one—Red Wash in Uintah County—are in San Juan County.

Wildcat and development drilling decreased 3 percent and 24 percent, respectively. A well drilled by Tenneco Oil Co. in Garfield County was completed as the first commercial oil well in the Kaiparowits basin of southern Utah. A dry hole drilled to 16,237 feet in Grand County by Pan American Petroleum Corp. and Sinclair Oil & Gas Co. set a new depth record for Utah.

TABLE 11.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1963	1964	Principal fields in 1964 in order of production
Box Elder	----	(1)	Undesignated.
Carbon	6	2	Peters Point.
Daggett	1	1	Clay Basin.
Duchesne	35	70	Monument Butte, Duchesne.
Emery	21	24	Grassy Trail.
Garfield	----	50	Upper Valley.
Grand	371	267	Salt Wash, Long Canyon.
San Juan	26,242	20,554	McElmo Creek, Aneth, Lisbon, Ratherford.
Uintah	6,759	7,607	Red Wash, Ashley Valley.
Total	33,435	28,575	

[1] Less than ½ unit.

Source: Utah Oil & Gas Conservation Commission.

TABLE 12.—Wildcat- and development-well completions in 1964, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Box Elder			2	2	6,900
Carbon			2	2	18,600
Duchesne	1		9	10	59,500
Emery	1		7	8	45,400
Garfield	1		1	2	16,300
Grand	1	1	18	20	47,600
San Juan	2		21	23	145,100
Summit			1	1	12,200
Uintah	5	1	10	16	90,200
Wasatch			1	1	7,500
Washington			1	1	7,300
Wayne			1	1	6,700
Total	11	2	74	87	463,300
Development:					
Daggett		2		2	11,100
Duchesne	6	1	2	9	45,000
Garfield	1			1	6,800
Grand	3	7	16	26	91,900
San Juan	2	1	10	13	53,000
Uintah	27	6	7	40	232,800
Total	39	17	35	91	440,600
Total all drilling	50	19	109	178	903,900

Source: Oil and Gas Journal.

TABLE 13.—Oil and gas discoveries in 1964

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		
Carbon County:												
Wildcat	No. 1 North Springs Unit.	Pacific Natural Gas Exploration Co.	27	15 S.	9 E.	Redwall	10,345–11,445	12,737		3,440	Dec. 12	SIGW.
Daggett County:												
Wildcat (Clay Basin).	No. 7 R. D. Murphy.	Mountain Fuel Supply Co.	22	3 N.	24 E.	Mowry	5,533–5,562	5,678		4,800–5,450	June 7	SIGW.
Duchesne County:												
Monument Butte	No. 1 Walton-Federal.	Shamrock Oil & Gas Corp.	11	9 S.	16 E.	Green River	4,735–5,020	6,300	1,073		May 11	OW. Old well workover.
Emery County:												
Ferron	No. 3 Ferron Unit.	Pan American Petroleum Corp.	21	20 S.	7 E.	Kaibab	7,070–7,220	10,022	43	1,107	Sept. 15	New pay.
Garfield County:												
Wildcat	No. 2 Upper Valley Unit.	Tenneco Oil Co.	13	36 S.	1 E.	Timpoweap-Kaibab.	6,660–6,733	9,424	300		Apr. 1	OW.
Grand County:												
Wildcat	No. 13 Federal	United Technical Industries, Inc.	13	20 S.	23 E.	Mancos	1,312–1,576	1,617	30		July 10	OW.
Do	No. 1 Seiber Nose St.	Promontory Oil Co.	2	20 S.	24 E.	Brushy Basin	1,443–1,452	1,500	2		May 18	OW.
Do	No. 8–1 Capansky-Phillips Fee.	William G. Bush	8	20 S.	24 E.	Morrison	1,678–1,690	1,853		2,800	Nov. 9	SIGW.
Do	No. 5 Federal	U-Tex Oil Co	10	20 S.	24 E.	Brushy Basin	1,295–1,302	1,302		2,956	Feb. 6	SIGW.
Do	No. 1-X Federal	United Technical Industries, Inc.	19	20 S.	24 E.	Salt Wash	1,044–1,054	1,076	35		Dec. 4	OW.
Do	No. 30–81 Pumpelly-Stava.	Pumpelly-Stava Operator.	30	20 S.	24 E.	do	842½–848½	1,058		750	Feb. 12	SIGW.
Do	No. 2 Murray Fee.	Vanco Oil Co	24	21 S.	23 E.	Morrison	558–573	610	3		Aug.	OW. Old well workover.
San Juan County:												
Wildcat	No. 1 South Ismay.	Zoller & Danneberg	5	41 S.	26 E.	Lower Ismay	5,540–5,545	5,553	271	162	Nov. 16	OW.
Do	No. 1 Navajo 'K'.	Phillips Petroleum Co.	32	42 S.	26 E.	Desert Creek	5,764–5,766	5,962	155		May 15	OW.

See footnotes at end of table.

TABLE 13.—Oil and gas discoveries in 1964—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		
Uintah County:												
Wildcat	No. 1 Horseshoe Bend Federal.	California Oil Co.	34	6 S.	21 E.	Green River "L."	6,904–6,993	7,250	221		Nov. 2	OW.
Do	No. 1 Pan Am State.	H. P. McLish (Pan American Petroleum Corp.).	32	6 S.	22 E.	Uinta	3,170–3,175	6,705		1,800	June 3	SIGW.
Do	No. 2 McLish Unit.	Shamrock Oil & Gas Corp.	1	7 S.	21 E.	Green River	6,584–6,592	7,190	30	30	Oct. 5	OW.
Do	No. 2 Horseshoe Bend.	do	3	7 S.	21 E.	Wasatch Tongue.	6,816–7,026	7,402	237		Aug. 16	OW.
Do	No. 1 Morgan Federal.	do	15	8 S.	20 E.	Green River	4,542–5,158	6,379	24		July 12	OW.
Do	No. 1 Wash Estate.	do	27	8 S.	20 E.	Wasatch	4,238–5,286	6,185	86	72	Mar. 10	OW.
Do	No. 6 Bench Unit.	Pan American Petroleum Corp.	5	9 S.	19 E.	do	5,046–5,056	5,930	18		June 1	SIOW.
Do	No. 1 East Red Wash.	do	4	8 S.	25 E.	Green River	4,202–4,211	4,754	81		Dec. 4	OW.
Do	No. 4 Oil Springs Unit State.	D. J. Stone	2	12 S.	24 E.	Wasatch	2,302–2,320	3,320		522	Mar. 8	SIGW.
Do	No. 5 Oil Springs Unit.	do	5	12 S.	24 E.	do	(Gas) 2,777–2,787 (Oil) 3,713–3,721				Mar. 26	SIGW.
								3,829	50	550		
Do	No. 1 State	do	16	12 S.	24 E.	do	2,671–2,675	3,303		733	Dec. 1	SIGW.
Do	No. 23–2–1 Evacuation Creek.	Pacific Natural Gas Exploration Co.	2	12 S.	25 E.	Morrison	8,035–8,208	8,300		1,250	Aug. 6	SIGW.

[1] SIOW—Shut-in oil well; SIGW—Shut-in gas well; OW—oil well.

Source: State of Utah, Oil & Gas Conservation Commission. Yearly Well Completion Report Wells Completed or Abandoned. January–December 1964. Petroleum Information Corp. 1964 Résumé, Oil and Gas Operations in the Rocky Mountain Region.

Five refineries, all in the Salt Lake City area, processed 32.9 million barrels of crude petroleum, an increase of 9.3 percent. The refineries were operated by American Oil Co. and California Oil Co., Western Division, Salt Lake City; Beeline Refining Co. Division, Frontier Refining Co., North Salt Lake; Caribou-Four Corners Oil Co., and Phillips Petroleum Co., Woods Cross.

NONMETALS

Barite.—No barite was produced in Utah in 1964. Crude barite from mines in Nevada was ground at the Yuba Minerals & Milling Co. plant in Salt Lake City for use in well drilling.

Cement.—Output of cement gained 2 percent in quantity and value. Portland cement was produced by Ideal Cement Co. (major producer) at Devil's Slide, Morgan County, and by Portland Cement Co. of Utah at Salt Lake City, Salt Lake County. A small quantity of masonry cement also was produced by Ideal Cement Co.

Clays.—A decline in output value of halloysite, the leading clay produced in the State, was the principal cause of a drop in total clay output value. Halloysite, produced exclusively by Filtrol Corp. at the Dragon mine in Juab County, was used as a catalyst in oil refining. Fire clay for use in manufacturing building brick was produced by International Pipe and Ceramics Corp. and Shirlef L. Powell; miscellaneous clay for manufacturing building brick was produced by International Pipe and Ceramics Corp., Interstate Brick Co., and Loyd R. Stubbs. Cedarstrom Fire Clay Co. and R. D. Wadley Clay Co. produced fire clay used for refractories. Miscellaneous clay was mined by Azome Utah Mining Co. for use as a soil conditioner, by International Pipe and Ceramics Corp. for manufacturing vitrified sewer pipe, and by Utelite Corp. for making lightweight aggregate. Bentonite was produced by Redmond Clay & Salt Co.; bentonite and fuller's earth were produced by Western Clay & Metals Co. near Redmond.

Fluorspar.—Fluorspar production, sold for use in steel plants and iron foundries, increased tenfold in quantity and value. The output came from the Lost Sheep mine of Willden Bros. (major producer) and the Fluorine Queen mine of Chesley & Black, both mines situated in the Spor Mountain area in Juab County.

Gypsum.—The output of gypsum, by Bestwall Gypsum Co. and United States Gypsum Co., from open-pit mines near Sigurd, in Sevier County, declined. Wallboard plants near Sigurd were operated by both companies.

Lime.—Production of lime gained 4 percent in quantity and 9 percent in value. Major producers were The Flintkote Co., Utah Operations, U.S. Lime Division, and Utah Marblehead Lime Co. in Tooele County. Other producers were Utah-Idaho Sugar Co. in Box Elder and Salt Lake Counties; The Amalgamated Sugar Co. in Cache County; Kennecott Copper Corp., Utah Copper Division, in Salt Lake County; and Lakeside Lime & Stone Co. in Utah County. Most of the lime was used in Utah for chemical, industrial, refractory, and construction purposes. Approximately one-third of the production was shipped to Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Washington, Wyoming, and Canada.

Perlite.—Crude perlite from the North Pearl Queen quarry of Henry Shoo in Beaver County (only producer in Utah) advanced 53 percent in tonnage and 71 percent in value. It was produced for expansion by Acme Lite-Wate Products, Inc., Salt Lake City, and Bestwall Gypsum Co., near Sigurd (Bestwall also processed crude perlite from Caselton, Nev.). Expanded perlite was used as a lightweight ingredient in building plaster.

Phosphate Rock.—Production of phosphate rock increased 1 percent in quantity and 2 percent in value. Four properties were operated: Three by San Francisco Chemical Co.—the Benjamin and Cherokee mines, near Randolph in Rich County, and the Vernal mine, north of Vernal in Uintah County; and one by FMC Corp.—the Jeffs mine, also near Randolph in Rich County. The San Francisco Chemical Co. rock from Rich County was processed and sold at the company Leefe plant at Sage, Wyo.; the FMC Corp. rock from Rich County and the San Francisco Chemical Co. rock from Uintah County were processed and sold for agricultural and industrial uses in Utah.

Potash.—Potassium salts production dropped 35 percent in quantity and 27 percent in value. The entire output was made by Kaiser Aluminum & Chemical Corp., Bonneville, Ltd., Division, at its Wendover plant. This plant and the extensive mineral reserves were acquired from Standard Magnesium & Chemical Corp.

Start of production operations at the Cane Creek potash mine of Texas Gulf Sulphur Co. (TGS) were delayed until early 1965. Initial annual production capacity was to be 600,000 short tons of muriate of potash.

Ore was to be extracted by the room-and-pillar mining method (pillar size and spacing were to be determined by experience). Several types of mining equipment—including ripper miners, boring machines, undercutters, drill jumbos, and loaders—were being tried. Ore was to be transported 3,000 feet from the deposit to the shaft by 42-inch-wide belt conveyors. Initially, ore was to be moved from working faces to the conveyors by means of diesel shuttle cars; as mining progressed, the main-line conveyors were to be extended, and panel conveyors, equipped with double roll crushers set at 5 inches, were to be added. Shuttle cars were to operate at the faces.

The 22-foot-diameter, 2,789-foot-depth, concrete-lined shaft was divided into two compartments by a reinforced-concrete ventilation curtain. One compartment was equipped with a service hoist and a counterweight-balanced 80-man cage; the other was equipped with two 20-ton-ore skips in balance. Rope guides were used instead of the usual timber guides. Speeds were 800 feet per minute for the cage and 2,160 feet per minute for the skips. Ventilation was at the rate of 250,000 cubic feet per minute.

Muriate of potash was to be recovered in three grades at the flotation processing plant: standard, coarse, and granular.

The mine was served by a new 19-mile paved highway and a 36-mile railroad connecting the mine with the Denver and Rio Grande Western Railroad Co. at Brendel.

Pumice.—Melvin Bradshaw produced pumice near Milford in Beaver County for use as concrete aggregate.

Salt.—Salt production increased 14 percent in quantity and 11 percent in value. Solar evaporation of Great Salt Lake brine was the

means of recovering 97 percent of the total salt production in the State. Producers of evaporated salt, in order of output value, were Morton Salt Co. in Salt Lake County; Leslie Salt Co., Solar Salt Co., and Utah Salt Co. in Tooele County; and Lake Crystal Salt Co. in Box Elder County. Rock salt mines north of Redmond were operated by Albert Poulson and Redmond Clay & Salt Co. in Sanpete County and by Poulson Brothers Salt Co. in Sevier County.

About one-third of the evaporated salt was used in manufacturing chlorine and other chemicals and as livestock feed. Other major uses were by casing manufacturers, cold storage companies, food processors, ice manufacturers, meat packers, tanners, and for water softening. Rock salt was used mainly as livestock feed. Salt shipments were made to 15 other States and Canada.

Sand and Gravel.—The quantity of sand and gravel produced was 13 percent lower, but the value declined only .03 percent. Sand and gravel was produced in all 29 counties. The smaller output was caused by reduced road and building construction. Total pit operations decreased from 161 to 149—3 fewer for commercial and 9 fewer for Government-and-contractor pits. The five largest producing counties, in order of output, were Salt Lake, Utah, Davis, Box Elder, and Washington; cumulatively producing 77 percent of the State total. Leading producers, in order of production, were Utah Sand & Gravel Products Corp. from its Cottonwood Heights and Stauffer plants, Gibbon & Reed Concrete Products Co. in Salt Lake County, Gibbons and Reed Co. from its Whitehall pit in Davis County, and Harper Johnson Sand & Gravel Co. and South East Sand & Gravel, Salt Lake County.

TABLE 14.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Beaver	38	$37	Rich	4	$2
Box Elder	669	757	Salt Lake	4,625	4,841
Cache	290	335	San Juan	121	116
Carbon	W	W	Sanpete	W	W
Daggett	85	79	Sevier	W	W
Davis	938	698	Summit	3	2
Duchesne	5	5	Tooele	207	223
Emery	29	29	Uintah	328	298
Garfield	25	25	Utah	982	1,057
Grand	35	29	Wasatch	14	13
Iron	342	337	Washington	631	631
Juab	14	14	Wayne	2	2
Kane	36	41	Weber	253	287
Millard	357	343	Undistributed	183	202
Morgan	W	W			
Puite	2	2	Total	10,218	10,405

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	1,164	$1,224	1,265	$1,428
Paving	166	173	488	529
Fill	76	31	91	49
Other			15	23
Industrial:				
Molding	9	27	4	12
Blast	(1)	(1)	(1)	1
Fire or furnace	20	20	W	W
Engine	5	14	6	14
Other			25	43
Total	1,440	1,489	1,894	2,099
Gravel:				
Construction:				
Building	1,484	1,587	1,574	1,859
Paving	1,608	1,440	1,637	1,740
Railroad ballast	11	5	23	7
Fill	1,176	492	378	146
Other			16	16
Miscellaneous	59	48	377	471
Total	4,338	3,572	4,005	4,239
Total sand and gravel	5,778	5,061	5,899	6,338
Government-and-contractor operations:				
Sand:				
Building	282	282	9	10
Paving	149	149	191	142
Fill	68	34	84	42
Total	499	465	284	194
Gravel:				
Building	1,009	951	67	57
Paving	4,057	3,746	3,792	3,724
Fill	366	185	176	92
Total	5,432	4,882	4,035	3,873
Total sand and gravel	5,931	5,347	4,319	4,067
All operations:				
Sand	1,939	1,954	2,178	2,293
Gravel	9,770	8,454	8,040	8,112
Total	11,709	10,408	10,218	10,405

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Less than ½ unit.

About 60 percent of the sand and gravel, 679,000 tons of sand and 5.4 million tons of gravel, was used for paving. Gravel was also used in building construction, as fill, and as railroad ballast. Sand also was used in building construction and as fill and for industrial uses.

Only Salt Lake County had production in excess of 1 million tons. Commercial output was 58 percent of the total tonnage. Only 34,000 tons of commercially produced sand and gravel was transported by rail; all other was transported by truck. Ninety percent of the commercial sand and gravel was washed, sized, or otherwise prepared.

Stone.—Stone production increased 72 percent in value—nearly $3 million—from 47 operations in 17 counties. Among the three counties reporting a value of production in excess of $1 million, Cache County was the leader. Thirty-one commercial operations accounted for about 60 percent of the tonnage and 57 percent of the value of stone produced, mainly granite, limestone, marble, and sandstone. Granite produced by Wilford H. Hanson Stone Quarries, Inc., of Salt Lake County was used for architectural building stone.

Crushed and broken limestone, produced in six counties, was used as asphalt filler, flux, poultry grit, railroad ballast, riprap, as a refractory, and for miscellaneous uses. It was also used in manufacturing cement and lime, in controlling coal dust, and in road construction. Dimension limestone was used as architectural stone.

TABLE 16.—Stone production in 1964, by counties

County	Short tons	Value	County	Short tons	Value
Box Elder	364,064	$938,845	Summit	2,601	$42,533
Cache	695,973	1,794,375	Tooele	270,287	943,516
Davis	668	6,715	Uintah	240	600
Emery	11,348	28,370	Utah	842,054	1,228,309
Iron	W	W	Wasatch	70,327	186,572
Juab	W	W	Washington	191	2,339
Morgan	W	W	Weber	5,117	12,544
Salt Lake	W	W	Undistributed	841,961	1,741,285
San Juan	200	4,000			
Sevier	W	W	Total	3,105,031	6,930,003

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

TABLE 17.—Stone sold or used by producers, by kinds

Year	Granite		Limestone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value
1960	1,200	$1,200	1,702,021	$2,921,737	----------	----------
1961	----------	----------	1,621,128	2,815,852	639	$3,703
1962	159,724	336,207	[1] 1,608,466	[1] 2,862,366	W	W
1963	15,704	253,225	[1] 1,716,450	[1] 3,219,167	W	W
1964	800	160,000	[1] 2,003,925	[1] 3,860,409	626	17,255

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1960	76,158	$118,615	57,500	$45,312	1,836,879	$3,086,864
1961	126,470	329,405	59,681	69,774	1,807,918	3,218,734
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

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

TABLE 18.—Stone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction, short tons	479	$11,687	168	$2,250
Rubble, do	75	1,875	28	125
Rough architectural, cubic feet	W	W	22,642	187,375
Sawed stone, do	9,909	55,882	5,346	34,482
Dressed stone, do	15,064	208,000	3,526	5,800
Flagging, do	W	W	6,474	12,425
Other, do	5,494	13,575	----------	----------
Total (approximate, in short tons)	3,000	291,019	3,200	242,457
Crushed and broken stone:				
Riprap, short tons	608,884	351,666	1,093,623	2,730,943
Metallurgical, do	721,693	1,000,445	810,592	1,244,774
Concrete and roadstone, do	26,552	90,468	165,240	312,052
Other, do	[1] 985,787	[1] 2,306,707	[2] 1,032,331	[2] 2,399,777
Total, do	2,342,916	3,749,286	3,101,786	6,687,546
Total stone (approximate, in short tons)	2,345,900	4,040,305	3,105,000	6,930,003

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes stone used in aggregates, asphalt filler, cement, coal dust, lime, mosaic, poultry grit, precast products, railroad ballast, roofing granules, stone sand, and terrazzo.
[2] Includes stone used in asphalt filler, cast stone products, cement, coal dust, concrete aggregates, filter, foundry, landscaping, lime, poultry grit, railroad ballast, roofing granules, and terrazzo.

Marble produced in Box Elder, Tooele, and Utah Counties was crushed and used for cast-stone products and terrazzo. Producers were Aggregate Supply, Inc., and Utah Quartz & Rock, Inc.

The increase in value of crushed and broken sandstone, $2 million more than in 1963, was the major factor for the increase in value of total stone production. There were six commercial operators. The crushed and broken sandstone was used as concrete aggregate, refractory stone, riprap, and terrazzo and in cast-stone products, filters, foundries, and roofing. Principal Government-and-contractor users were the Federal Bureau of Reclamation (Willard Dam) and the Cache County Road Department. The stone was used for riprap. Dimension sandstone produced by six operators was used for building stone and flagging.

Crushed and broken miscellaneous stone, produced by commercial and Government-and-contractor operators, was used as concrete and roadstone and as riprap.

Talc.—Tri-State Minerals Co. ground crude talc at its mill in Ogden. The crude ore came from the company mine at Dillon, Mont.

Vermiculite.—Vermiculite, exfoliated at the Salt Lake City plant of Vermiculite-Intermountain, Inc., was used as an aggregate and in insulation and acoustical material.

REVIEW BY COUNTIES

Mineral output, reported for all 29 counties, ranged in value of production from $2,000 in Wayne County to $177.7 million in Salt Lake County. Five counties—Carbon, Iron, Salt Lake, San Juan, and Uintah—had production valued in excess of $10 million: Salt Lake County had output of the largest variety of minerals and mineral products, 12 in number. Ten counties had declines in value of mineral production compared with that of 1963.

Beaver.—Mineral production value increased 80 percent as a result of greater output of gold, silver, copper, lead, zinc, perlite, and uranium ore. Value of production declined for iron ore, pumice, and sand and gravel. Copper output accounted for most of the mineral production value. The Bawana mine of American Mining Co. was a major source of most of the gold, silver, and copper; some lead also was produced. The same metals, and zinc, were produced at the Horn Silver mine of Bellevue Mines. Uranium ore was produced at three operations, two more than in 1963. All of the perlite and pumice mined in the State came from the county. The perlite was used as building plaster; pumice was used as concrete aggregate.

TABLE 19.—Value of mineral production in Utah, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Beaver	$1,343,093	$2,421,769	Copper, silver, uranium ore, sand and gravel, pumice, gold, perlite, lead, zinc, iron ore.
Box Elder	1,137,122	1,938,430	Stone, sand and gravel, lime, salt, clays, petroleum.
Cache	W	W	Stone, sand and gravel, lime.
Carbon	20,251,867	29,686,619	Coal, natural gas, sand and gravel, carbon dioxide, petroleum.
Daggett	442,600	589,500	Natural gas, sand and gravel, natural gasoline, petroleum.
Davis	865,450	704,715	Sand and gravel, stone.
Duchesne	108,200	W	Gilsonite, petroleum, sand and gravel, natural gas.
Emery	4,421,634	5,655,399	Coal, uranium ore, vanadium, petroleum, sand and gravel, natural gas, stone.
Garfield	159,292	W	Petroleum, uranium ore, vanadium, sand and gravel.
Grand	3,968,491	3,549,023	Natural gas, petroleum, uranium ore, vanadium, sand and gravel.
Iron	13,430,736	14,900,549	Iron ore, sand and gravel, coal, stone,
Juab	1,395,624	1,135,630	Clays, stone, fluorspar, silver, sand and gravel, gold, copper, uranium ore.
Kane	1,188,440	51,047	Sand and gravel, coal.
Millard	116,314	345,178	Sand and gravel, zinc, lead, silver, copper, gold.
Morgan	W	W	Cement, stone, sand and gravel.
Piute	W	506,341	Uranium ore, zinc, lead, silver, gold, copper, sand and gravel.
Rich	W	W	Phosphate rock, sand and gravel.
Salt Lake	170,992,785	177,714,520	Copper, molybdenum, gold, lead, zinc, sand and gravel, silver, cement, salt, stone, lime, clays.
San Juan	r 104,531,095	89,097,925	Petroleum, uranium ore, natural gas, LP gases, natural gasoline, vanadium, copper, sand and gravel, silver, stone.
Sanpete	W	130,400	Clays, salt, sand and gravel.
Sevier	1,259,561	1,222,888	Gypsum, coal, clays, sand and gravel, salt, stone.
Summit	4,186,780	3,890,340	Zinc, lead, silver, clays, copper, coal, gold, stone, sand and gravel.
Tooele	7,962,874	8,192,701	Lime, salt, potassium salts, stone, lead, zinc, silver, sand and gravel, copper, clays, gold.
Uintah	29,317,835	30,832,141	Petroleum, gilsonite, natural gas, phosphate rock, sand and gravel, LP gases, natural gasoline, stone.
Utah	2,544,088	2,775,745	Stone, sand and gravel, lead, clays, zinc, silver, lime, copper, gold.
Wasatch	3,652,258	4,911,907	Zinc, lead, gold, silver, copper, stone, sand and gravel.
Washington	192,741	644,387	Sand and gravel, copper, silver, stone, zinc.
Wayne	W	2,000	Sand and gravel.
Weber	624,465	299,544	Sand and gravel, stone.
Undistributed[1]	11,329,650	10,230,808	
Total	r 385,423,000	391,430,000	

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.

Box Elder.—Value of mineral production increased 70 percent. Increases were noted for lime, salt, sand and gravel, and stone. The increases in value for sand and gravel and stone accounted for most of the rise in the total value of mineral production. However, tonnages of sand and gravel and stone were less than in 1963. Clay was

produced by International Pipe and Ceramics Corp. for use in building brick. Lime produced by Utah-Idaho Sugar Co. was used in the refining of beet sugar.

Low-gravity (1° API) crude oil was discovered at 150 feet in a shallow well drilled at Rozel Point on the shore of Great Salt Lake. The initial production was 5 barrels daily.

Cache.—The county was first in the output of stone, used mostly for riprap. The value of stone production was $1.8 million. Lime was produced by The Amalgamated Sugar Co. for use in sugar refining. Sand and gravel commercial output was used in building and road construction; Government-and-contractor operators produced gravel for use in paving.

Carbon.—Carbon County was ranked fourth in the value of mineral production ($29.7 million). Bituminous coal, valued at $27.9 million, was the major mineral commodity. Increasing 48 percent, the value of coal production was 84 percent of the State total coal-output value. Production came from 20 underground mines, 1 less than in 1963. The major producers were Independent Coal & Coke Co., Kaiser Steel Corp., and USS.

Total natural gas output from the Clear Creek, Nine Mile Canyon, Peters Point, and Stone Cabin fields increased by $398,000. Decreases were noted in production values for patroleum from Peters Point field and for carbon dioxide from Farnham Dome field.

Daggett.—Declines in natural gasoline, sand and gravel, and petroleum production values were offset by an increase in natural gas from the Clay Basin field. Natural gasoline was recovered at the Mountain Fuel Supply Co. Clay Basin plant. Value of petroleum production was slightly below that of 1963. Sand and gravel, valued at $79,000, was produced by Government-and-contractor operators for use in paving.

Davis.—Sand and gravel output from six operators in the county—four commercial plants plus the State and county highway departments—accounted for 99 percent of the value of mineral production. With the exception of 113,000 tons of gravel and 95,000 tons of sand used in building construction, the sand and gravel output was used for paving or fill. Crushed sandstone produced by Utah Quartz & Rock, Inc., was used at foundries and for filters, roofing, and terrazzo.

Duchesne.—Gilsonite shipped from the Ziegler Chemical & Mineral Corp. Castle Peak mine accounted for a large share of the value of production. Petroleum production doubled, and natural gas output declined. The increase in petroleum output resulted from the discovery of the Monument Butte field. Production from the older oilfields—Castle Peak, Duchesne, and Eight Mile Flat (Wells Draw Unit)—decreased 41, 27, and 40 percent, respectively. Gas production from the one-well Blue Bell field decreased 77 percent.

Emery.—Value of mineral output increased by $1.2 million. Bituminous coal represented 83 percent of the county mineral production value. Nine coal mines were operated. The major producers were United States Fuel Co., USS, and Minerals Development Corp. Uranium ore production, from 24 mines, increased 4 percent. Vanadium, contained in uranium ores and recovered at processing plants, also increased in value of output.

Production of petroleum, from the Ferron and Grassy Trail fields, and natural gas, from the Flat Canyon field, increased. (Output

from the Carbon County area of the Grassy Trail field is included in Emery County production figures.)

Production of sand and gravel declined. Output was used for road construction. The output of stone (limestone) mined by a contractor, for the Federal Bureau of Reclamation, was used as riprap.

Garfield.—Petroleum, the leading mineral in value of output, was produced from the Tenneco Oil Co. Upper Valley field.

Output of uranium ore and associated vanadium declined. Among the 34 uranium operations, 24 contained recoverable vanadium. Sand and gravel produced by the State highway department increased.

Grand.—Mineral production was valued at $3.5 million, a decline of 11 percent. The decline was caused by reduced output of petroleum, sand and gravel, stone, uranium ore, and vanadium. Production of natural gas, the leading mineral, increased; over half of the gas which was from the San Arroyo field. The principal petroleum fields were the Salt Wash and Long Canyon.

Uranium ore production from 30 operations declined 29 percent in value. Vanadium contained in the ore and recovered at uranium mills also declined. Continuing operation of the Atlas Corp. uranium mill at Moab was assured after extension of its purchase contract with the Atomic Energy Commission (AEC) was approved. Sand and gravel output, 35,000 tons, was used for paving.

The official opening of the TGS Cane Creek potash mine and refinery, originally scheduled for December 12, was delayed; the new opening date was to be early in January 1965.

Iron.—The county was ranked fifth in the State in value of mineral production. Iron ore accounted for most of the mineral value. Other minerals produced were coal, sand and gravel, and stone.

Iron ore was produced at six mines. Shipments were made to the CF&I plant at Pueblo, Colo., and to the USS plant at Geneva. Ore for the Colorado plant was magnetite; that for the Utah plants was principally hematite.

Coal output was from three operations. Sand and gravel was used in paving. A small amount of crushed limestone was produced by two operators, and sandstone was produced by one operator.

Juab.—Output of fluorspar, sand and gravel, stone, gold, silver, and copper increased. The declines in clay, uranium ore, and lead production resulted in an overall drop in the value of mineral output. Clay (halloysite), produced by Filtrol Corp., was used as an oil-refining catalyst. Fluorspar, mined by Chesley & Black and Willden Bros., was used in the iron and steel industries. All of the State production of fluorspar came from the county. Stone output consisted of crushed limestone for flux and in manufacturing lime and crushed sandstone used as a refractory (ganister). Sand and gravel was used for paving.

Gold, silver, and copper were mined at the Godiva mine, operated by Stanley Ryan, and at the Sunbeam mine dump, operated by Wortley Co. Uranium ore came from the Yellow Chief mine of Black Rock Mining Co. A diamond-drilling program was conducted at the Spor Mountain beryllium property of The Brush Beryllium Co. to determine the configuration of the ore body, so that open pit mining could be planned efficiently. Exploration was continued by rotary drilling at The Anaconda Company Spor Mountain property where a large beryllium ore reserve had been developed.

Kane.—Commercial sand and gravel was produced by Boyds' Rock, Sand & Gravel. Sand and gravel was produced by contractors for the Federal Bureau of Reclamation and sand was produced by maintenance crews of the State highway department. The coal was produced by Alton Coal Mine Co. Arizona Public Service Co. announced the exploration and future development of a large coal deposit in the Kaiparowits Plateau area.

Morgan.—Portland and masonry cements were produced by Ideal Cement Co. at approximately the same rate as in 1963. Stone (limestone) production was used in manufacturing cement. Sand and gravel was produced for use in paving and for fill.

Piute.—Gold, silver, copper, lead, and zinc were produced at the Bully Boy mine of T. & R. Corp. and the Deer Trail mine of Deer Trail Mines & Arundel Mining Co. Uranium ore was from five operations of VCA.

Rich.—The San Francisco Chemical Co. phosphate rock operations were to be expanded from 2,000 to 3,000 tons per day; the expansion was to cost more than $1 million. At the Cherokee mine ore beds "A" and "B" were to be mined; the company also operated the Benjamin mine. Ore from both mines was processed at the company plant at Sage, Wyo. Production of phosphate rock from the Jeffs mine of FMC Corp. was used by the company.

Salt Lake.—Mineral production, representing 45 percent of the State total, increased by approximately 4 percent. Although copper output decreased 5,686 tons, the value increased by $3.5 million. Copper output was primarily from operations of the Kennecott Copper Corp., Utah Copper mine. The remainder was from nine other operations, principally the U.S. and Lark mine of USSR&M Co. Molybdenum was recovered from copper ore as a byproduct at the Arthur and Magna mills, Kennecott Copper Corp., Utah Copper Division. The corporation was also the leading producer of gold and silver. The U.S. and Lark mine, a major producer of gold and silver, also led in the output of lead and zinc. Other sources of gold, silver, copper, lead, and zinc were the Butterfield mine of USSR&M Co., the Cardiff and Wasatch mines of Beeson Exploration, and the Grizzly mine operated by Page E. Blakemore. Zinc was recovered from the Murray slag dump by International Smelting and Refining Co.

Contracts were awarded during the year as part of the Kennecott $100-million-expansion program for the Utah Copper Division. Plans were to increase ore production from 90,000 to 108,000 tons per day and to increase copper precipitate recovery to 6,000 tons per month.

Sand and gravel from 43 operations was the major nonmetal commodity produced in the county. Commercial output, 79 percent of the total, was for building construction (50 percent), paving (33 percent), fill (4 percent), and the remainder for railroad ballast and miscellaneous uses. Government-and-contractor production was for highway construction. Portland Cement Co. of Utah operated its Salt Lake City plant at approximately the same rate as in 1963. The company quarried limestone for use in the plant. Limestone was produced by Kennecott Copper Corp. for use as a flux and for the manufacture of lime for use in concentrating copper ores. Wilford H. Hansen Stone Quarries, Inc., quarried architectural granite, and Aggregate Supply, Inc., produced quartzite used in manufacturing cast-stone products. Utah-Idaho Sugar Co. manufactured quicklime for use in sugar re-

fining. Output of evaporated salt, by Morton Salt Co. at Saltair, increased slightly. International Pipe and Ceramics Corp. produced clay for building brick.

San Juan.—San Juan County was ranked second in the State in the value of mineral production. The county led in the output of natural gas, natural gas liquids, petroleum, uranium ore, and vanadium. Petroleum production decreased 22 percent; waterflood operations were expanded in the Greater Aneth area (Aneth, McElmo Creek, Ratherford, and White Mesa fields). Oil well gas production decreased 14 percent; dry gas output decreased 17 percent. El Paso Natural Gas Co. recovered natural gas liquids and natural gasoline at its Aneth plant.

Uranium ore produced from 118 operations increased 12 percent in value and represented 95 percent of the State total. Vanadium, contained in some uranium ores and recovered at uranium processing mills, declined in value. Operation of the Atlas Corp. uranium mill at Mexican Hat continued. The contract for purchase of uranium oxide from Atlas Corp. by AEC was extended to December 31, 1970, under the stretchout program and included the Mexican Hat mill. The corporation planned to operate the plants at Moab and Mexican Hat in accordance with delivery schedules for uranium oxide and availability of crude ore. Copper and silver were recovered by Lee A. Hyde at the Four Aces mine and as byproducts of uranium operations; no zinc was recovered.

Sand and gravel output was used in building and road construction. Harris Shumway produced dressed sandstone for building construction.

Sanpete.—Redmond Clay & Salt Co. produced bentonite for use as a reservoir lining and as roofing material. Miscellaneous clay mined by Azome Utah Mining Co. was used in fertilizers. Rock salt, mainly used for livestock feed, was mined by Albert Poulson and Redmond Clay & Salt Co. Sand and gravel output was by Hales Sand & Gravel Co. and the State highway department.

Sevier.—Mineral production was comprised principally of gypsum mined by Bestwall Gypsum Co. and United States Gypsum Co. Gypsum, mined from open pits near Sigurd, was used in manufacturing wallboard. Coal production was by Southern Utah Fuel Co. Output of clays increased as a group. Bentonite mined by Western Clay & Metals Co., at Redmond, was used for filtering and clarifying and for refractories, in rotary-drilling muds, and as a water sealant. The company also produced fuller's earth at the Aurora mine for use in filtering mineral oils and for export. International Pipe and Ceramics Corp. and Interstate Brick Co. produced clay for manufacturing building brick. Sand and gravel was produced by Hales Sand & Gravel Co. for building and road construction and by a contractor and crews of the Utah State Department of Highways for road construction. Rock-salt production was from the Poulson Brothers Salt Co. operation. Hales Sand & Gravel Co. produced miscellaneous stone for use in concrete and as roadstone.

Summit.—Metals cumulatively accounted for 95 percent of the value of the mineral production. United Park City Mines Co. produced gold, silver, copper, lead, and zinc at the United Park City mines. These metals also were produced at the Keystone mine by Keystone

Mining Co. in a joint venture with United Park City Mines Co. Fluxing ore containing gold, silver, and copper was shipped from the Daly West dump by Wortley Co. and from the Ontario dump by McFarland & Hullinger. The values of the gold, silver, copper, and zinc were less than in 1963; lead production was higher.

Among the nonmetals, clay (all miscellaneous) output declined. Production was by International Pipe and Ceramics Corp. for manufacturing vitrified sewer tile, Interstate Brick Co. for manufacturing building brick, and Utelite Corp. for making lightweight aggregate. Production of the other nonmetals, sand and gravel and stone, also declined. The sand and gravel, produced by Wortley Co., was used in paving. Sawed sandstone was quarried by Rocky Mountain Quarries and miscellaneous stone was produced by a contractor of the State highway department.

Tooele.—Increases in the value of nonmetals output resulted in a 3-percent rise in the value of mineral production. Lime, the major mineral commodity in value of production, increased. Quicklime and hydrated lime, manufactured by U.S. Lime, were used in construction, chemical, and other industries. Utah Marblehead Lime Co. produced dead-burned dolomite for use as refractory lime. Leslie Salt Co., Solar Salt Co., and Utah Salt Co. produced solar-evaporated salt from Great Salt Lake brine. Output was valued at $1.9 million compared with $1.5 million in 1963. Bonneville, Ltd., produced potassium salts at its evaporation plant in Wendover.

Six commercial operators produced limestone, marble, and sandstone. Crushed limestone was used for asphalt filler, coal-dust control, flux, and riprap, for manufacturing cement and dead-burned dolomite. Dimension limestone for architectural use also was produced. Marble was used in cast-stone products, as was some of the crushed sandstone. The sandstone also was used for terrazzo.

Sand and gravel output was by two commercial operators, by crews of the county highway department, and by three Government contractors; it was used in building and road construction. Shirlef L. Powell and Interstate Brick Co. produced clay for building brick.

Output of gold, silver, and copper decreased; lead production increased, and zinc output was the same. All five of the metals were produced at the Ophir mine owned by USSR&M Co. and leased to McFarland & Hullinger. These metals were also produced at the Lion Hill mine operated by E. A. St. Clair & V. E. Stearns. Silver, copper, lead, and zinc were also produced at the Treasure Hill mine by Madison Mining Co. and at the Wandering Jew mine by Century Silver Corp. Small amounts of silver, lead, and zinc were produced by John D. Reid, lessee, at the Combined Metals Reduction Co. Calumet mine.

Uintah.—The county was ranked third in the State in the value of mineral output. Mineral fuels (gilsonite, LP gases, natural gas, natural gasoline, and petroleum) represented 97 percent of the county mineral output value.

Petroleum production increased 13 percent, largely from the Wonsits Valley unit, an extension of the Red Wash field. Value of natural gas output declined. A 20-percent increase in oil-well gas production did not offset a 23-percent decrease in dry gas production. Warren Petroleum Corp. installed a gas-processing plant in the Wonsits Valley unit. (California Oil Co. operated a plant at Jensen.) Pro-

duction of LP gases and natural gasoline decreased. Drilling activity decreased 6 percent for wildcat wells and 11 percent for development wells. There were five oil discoveries and one gas discovery.

Output of gilsonite increased. Producers were American Gilsonite Co., Standard Gilsonite Co., and Ziegler Chemical & Mineral Corp. At the American Gilsonite Co. operations hydraulic mining with extremely high pressures was successful. The ore was pumped from the mine and transported through a 72-mile pipeline to the refinery at Fruita, Colo.[5]

Phosphate rock production declined. All of the output, from the Vernal unit of San Francisco Chemical Co., was used for manufacturing phosphoric acid and triplesuperphosphate.

Sand and gravel was produced by Intermountain Concrete Co. and the State and county highway departments. Crushed limestone was produced by a contractor for the Federal Bureau of Reclamation.

Utah.—Output of stone constituted 44 percent of the value of mineral production; sand and gravel accounted for 38 percent. Crushed limestone from three commercial producers was used for coal-dust control, concrete and roadstone, flux, manufacturing lime, railroad ballast, and roofing granules. Limestone also was produced for the State highway department. Crushed marble, at the Creme Travertine quarry, was prepared for use as terrazzo by Aggregate Supply, Inc. Sand and gravel output from 17 commercial and Government-and-contractor operations was used mostly in building and road construction.

Clay production from eight operations was used for manufacturing building brick, in foundries, and in open-hearth refractories. Lakeside Lime & Stone Co. manufactured lime for agricultural use, masonry cement, petroleum refining, soil stabilization, and steel production.

Gold, silver, copper, lead, and zinc were produced from development ore at the Burgin Shaft mine, by Kennecott Copper Corp., Tintic Division, which leases the area from Chief Consolidated Mining Co. and Tintic Standard Mining Co. Production was from ores mined above and below the 1,050-foot level.

The 14-foot diameter, concrete-lined Burgin No. 2 production shaft was deepened 1,019 feet to a depth of 1,296 feet, 170 feet below the permanent water table. Shaft stations were cut and concreted at the 1,050- and 1,200-foot levels. Loading and skip pockets were cut 60 feet below each of the levels. Because of water inflows, pregrouting around the shaft was done from the 1,050-foot level. A 16-inch cased churndrill hole was completed near the shaft from the 1,050-foot level to a depth of 450 feet. Pumping from the drill hole established a drainage cone around the shaft area and greatly facilitated shaft-sinking operations.

Shaft sinking above the 1,050-foot level was delayed by a perched water table in the volcanic rocks to a depth of 700 feet. Four ring dams and water collection drifts were driven at the 700-foot level to control the water and to provide a water supply for mining operations.

[5] Dewey, Richard F. Recent Developments in American Gilsonite Operations (Including a Report on) Tunnel Boring and Large Diameter Shaft Drilling. Pres. at Nat. West. Min. Conf., Colo. Min. Assoc., Denver, Colo., Feb. 4, 1965, 8 pp.

Surface plant facilities—office, changehouse, shop-warehouse-compressor building, hoist house, and assay office—were completed. The installation of the surface electrical substation, double drum hoist, and a 500-horsepower compressor were essentially completed.

Production at a rate of 500 tons per day was scheduled for early 1965.

Wasatch.—Metals comprised 96 percent of the county mineral production value. Gold, silver, copper, lead, and zinc were produced at the Mayflower mine operated by Hecla Mining Co. and at the United Park City mines of United Park City Mines Co. Development of recreational facilities continued at the United Park City property. The 10,000-acre mining area was to be converted into a recreational complex costing nearly $2 million.

Sand and gravel production was for county highway construction. Dimension sandstone was quarried by Eugene Tuckett Flagstone Co. and Wilford H. Hansen Stone Quarries, Inc. Products were used for building stone and flagging.

Washington.—Sand and gravel represented 98 percent of the total value of mineral production. The sand and gravel was used in highway construction by contractors for the Utah State Department of Highways. Crushed limestone also was produced for the State highway department. Sawed sandstone, used in building construction, was quarried by Utah Scenic Stone Corp.

Weber.—Sand and gravel was produced by commercial and Government-and-contractor operators. Most of the commercial output (65 percent) was used in building construction. The remainder was used for paving, as was all of the noncommercial output. Miscellaneous stone, used as riprap and aggregate, was produced by a contractor for the State highway department.

The Mineral Industry of Vermont

By James R. Kerr [1]

THE value of mineral production in Vermont increased 7 percent to a record high in 1964 due largely to sharply increased demand for cut and dressed exterior dimension marble and a rapid expansion of the slate-tile market. A firm demand was reported for ground talc, particularly for roofing and plastics manufacture. A small peat industry was established, with the first recorded production occurring in 1964. A new lightweight aggregate plant began operations at midyear near Castleton using crushed slate as raw material. Another activity drawing more than casual attention was the wildcat oil and gas well being drilled in the Champlain basin in Grand Isle County, 3 miles south of Centre Alburg. Plans were to drill to 6,500 feet.

TABLE 1.—Mineral production in Vermont [1]

Mineral	1963		1964	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Peat			286	$4
Sand and gravel	2,374,575	$1,410	1,764,000	1,494
Stone	2,158,603	19,193	2,069,704	20,652
Value of items that cannot be disclosed: Asbestos, clays, gem stones, lime and talc	XX	3,788	XX	3,977
Total	XX	24,391	XX	26,127

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
1940	$13,434	1953	$21,945
1941	15,440	1954	21,705
1942	12,826	1955	24,346
1943	10,721	1956	22,069
1944	12,891	1957	22,065
1945	13,222	1958	21,583
1946	17,321	1959	22,886
1947	19,546	1960	22,656
1948	19,948	1961	24,096
1949	21,443	1962	r 24,917
1950	22,643	1963	r 24,341
1951	21,073	1964	25,776
1952	20,350		

r Revised.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Nonmetal and peat	276	72	583	----	18	31
Sand and gravel	236	54	450	----	9	20
Stone	2,087	538	4,344	3	155	36
Total	2,599	664	5,377	3	182	34
1964: p						
Nonmetal and peat	305	84	675	----	17	25
Sand and gravel	250	45	369	1	9	27
Stone	2,050	530	4,302	1	178	42
Total	2,605	659	5,346	2	204	39

p Preliminary.

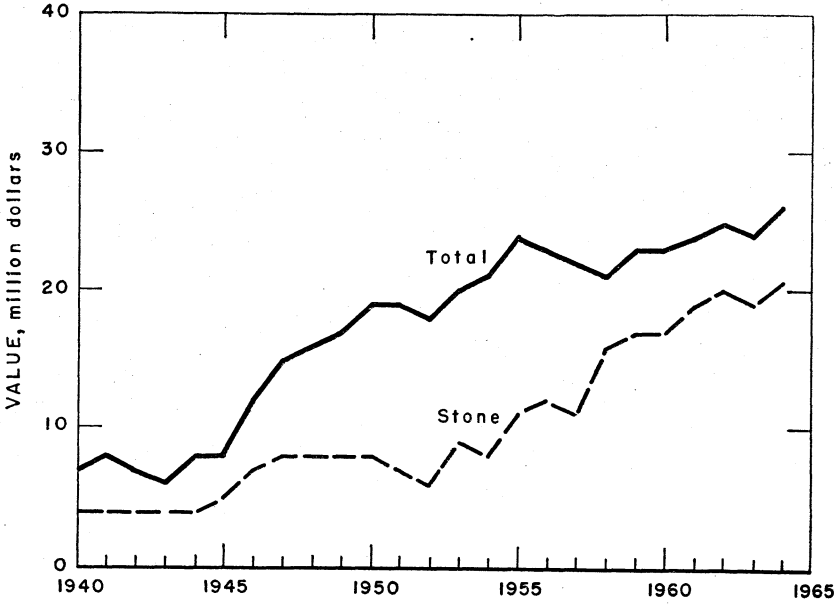


FIGURE 1.—Value of stone and total value of mineral production in Vermont.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Production of chrysotile asbestos decreased 3 percent, but value of production increased because of greater sales of higher priced grades. Average selling prices per ton varied from $30.75 to $376.08, the latter price being for a special grade. Twenty-seven grades of asbestos were produced compared with 26 in 1963 and 18 in 1962. The asbestos deposit, considered to be a southward extension of the Quebec,

Canada, deposits, occurs in massive serpentine and is principally of the slip-fiber type.

Clays.—Miscellaneous clay for building brick was produced at one operation in Chittenden County at virtually the same rate as in 1963. Increased quantities of kaolin were produced from a pit near Bristol in Addison County. Expanded kaolin markets were reported.

Gem Stones.—Garnet, jasper, magnetite, pyrite, and other mineral specimens were collected by hobbyists at scattered locations throughout the State.

Lime.—Both quicklime and hydrated lime, chiefly for consumption by the paper industry, were produced at a lower rate than in 1963. Decreased production of hydrated building lime also was reported. One company had operations in Addison and Chittenden Counties.

Mica, Reconstituted.—Specially delaminated mica scrap was used to prepare reconstituted sheet material utilizing papermaking procedures at a plant in Rutland.

Peat.—A small quantity of humus and reed-sedge peat was produced at two operations in Windsor County, the first recorded production in Vermont. Output was sold in bulk and packaged mostly for general soil improvement.

Sand and Gravel.—Total production of commercial sand and gravel increased 11 percent over that of 1963, owing to a 42-percent increase in output of gravel. All gravel markets increased, particularly the building and fill outlets. Sand production decreased 21 percent with the greatest loss in the paving and fill sand markets. Building sand output increased. Twelve counties produced commercial sand and gravel. Average value per ton increased from $0.86 to $1.08. The quantity of processed sand and gravel increased 5 percent to comprise 70 percent of commercial output. Leading counties in production of commercial sand and gravel were Bennington, Washington, Caledonia, and Addison. Total output, however, decreased 26 percent because of a sharp drop in Government-and-contractor production, the decline from 1963 amounting to almost 730,000 tons. The State highway commission reported work on fewer projects in 1964, as many of the road construction programs were completed in 1963. However, many new projects were in a development stage or have been advertised for bids so that the coming year should see a renewal of roadbuilding activity.

TABLE 4.—Sand and gravel production by Government-and-contractor operations, by counties

(Thousand short tons)

County	1963	1964	County	1963	1964
Addison	153	224	Orleans	52	43
Bennington	122	--	Rutland	29	50
Caledonia	4	--	Washington	69	62
Chittenden	386	1	Windham	311	25
Essex	78	7	Windsor	52	86
Franklin	8	5	Unspecified	--	--
Grand Isle	--	--			
Lamoille	6	51	Total	1,283	554
Orange	13	--			

Stone.—Despite a significant loss in production of crushed granite and a cessation of crushed sandstone output, the value of the stone industry output increased almost $1.5 million in 1964. Value of dimension marble sales increased 13 percent, as an excellent market for cut and dressed exterior marble offset depressed markets for most other uses. Output of rough building marble decreased sharply from that of 1963. Activity in the dimension granite industry was at virtually the same rate as in 1963. Increased production of rough monumental granite offset losses in output for dressed monumental, dressed architectural, and rubble. Crushed granite production at Government-and-contractor operations was only about one-third that of 1963. Dimension slate production decreased 10 percent, but value increased 14 percent because of a significantly increased market for high-value slate tile. Twenty slate quarries were in operation—two less than in 1963. A lightweight aggregate plant using crushed slate as raw material was put into operation at midyear in Rutland County on the site of an abandoned slate roofing granule plant. Large quantities of slate fines in tailings may be used as raw material, or, if necessary, the slate quarry may be reopened. Crushed limestone production increased 18 percent as most major markets, except for agricultural stone (agstone), were more active than in 1963. Output of miscellaneous stone increased 70 percent over that of 1963.

Talc.—Talc production was about one-fourth greater than in 1963. Significantly increased sales were made to the roofing, paper, plastics, and toiletry or cosmetic industries. Much of the talc production was from deposits in north-central Vermont near Johnson in Lamoille County, where talc is associated with serpentine. Other production came from Windham and Windsor Counties.

REVIEW BY COUNTIES

Addison.—Sand and gravel, for building, paving, and fill, was produced near Middlebury by J. P. Carrara & Sons, Inc., and Champlain Construction Co. Roy P. Shackett sold bank-run gravel for fill and paving near Leicester. Total output more than doubled that of 1963. Expanded markets for kaolin, chiefly in the floor- and wall-tile industries, caused a significant increase in output at the Vermont Kaolin Corp. Bristol pit. Vermont Associated Lime Industry continued to produce hydrated lime at New Haven.

Bennington.—Sand and gravel production was more than double that of 1963. William E. Daily, Inc., and Burgess Brothers operated pits near Bennington, producing chiefly paving aggregate. G & H Sand & Gravel Co., Inc., produced bank-run sand and gravel near Manchester for building and fill.

Caledonia.—Caledonia Sand & Gravel Co., Inc., and Lawrence Sangravco, Inc., operated portable plants near St. Johnsburg and sold processed sand and gravel for paving and building and paving, respectively. The former company also quarried and crushed miscellaneous stone near Waterford for aggregate.

Chittenden.—Significantly increased production of crushed limestone by L. A. Demers Crushed Rock Co. at Colchester was mostly sold to the highway commission for road construction. Vermont Associated

TABLE 5.—Value of mineral production in Vermont, by counties

County	1963	1964	Minerals produced in 1964 in order of value
Addison	W	$171,778	Sand and gravel, clay, lime.
Bennington	$164,381	W	Sand and gravel.
Caledonia	W	W	Sand and gravel, stone.
Chittenden	1,627,877	1,329,790	Stone, sand and gravel, lime, clay.
Essex	27,229	4,000	Sand and gravel.
Franklin	W	W	Stone, sand and gravel.
Grand Isle	W	W	Stone.
Lamoille	W	W	Talc, sand and gravel.
Orange	W	W	Stone, sand and gravel.
Orleans	W	W	Asbestos, sand and gravel, stone.
Rutland	10,708,552	12,096,732	Stone, sand and gravel.
Washington	W	W	Do.
Windham	707,058	272,500	Stone, sand and gravel, talc.
Windsor	558,188	571,164	Stone, talc, sand and gravel, peat.
Undistributed	10,597,728	11,680,361	
Total	24,391,000	26,127,000	

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

Lime Industry, Inc., quarried limestone at Winooski for sale as agstone and for captive use in lime manufacture. Lime was sold chiefly to the paper industry. The State highway department quarried less limestone in 1964. Sand and gravel for building, paving, and fill was produced by W. C. Kirby, contractor, at Burlington, and paving sand and gravel was produced by Hinesburg Sand & Gravel Co. at Hinesburg. Campbell Construction, Inc., produced bank-run sand near Williston. Sharply increased competition was reported to be cutting profit margins. Kleen-Moss Co., Inc., was draining parts of a 30-acre peat bog near Williston preparatory to production of humus peat. This was the first recorded activity in peat in the area.

Franklin.—High calcium crushed limestone was produced by Swanton Lime Works, Inc., near Swanton. The major portion of output was for roadbuilding aggregate, but significant quantities were sold for agricultural uses, to paper mills, and for mineral food. A. G. Anderson produced building, paving, and fill sand at a stationary plant and Ray DuBois produced bank-run paving sand, both at Swanton.

Grand Isle.—Vermont Marble Co. produced dimension and crushed marble at its Isle La Motte Quarry.

Lamoille.—Talc was mined by Eastern Magnesia Talc Co., Inc., at its No. 4 mine near Johnson. Virtually all the crude output was ground and beneficiated by flotation. Building sand and gravel was produced at a portable plant near Johnson by Albert S. Nadeau. Kenneth Farr produced bank-run gravel near Morrisville for building and paving.

Orange.—Rough dimension granite was quarried by The Rock of Ages Corp. at its Pirie quarry near Williamstown. Most of the stone prepared was for monuments and mausoleums. A small quantity of rubble also was sold. Willard B. Martin produced bank-run paving gravel near East Corinth. Levi Lemieux reported output of bank-run sand and gravel near Williamstown, and Caledonia Sand & Gravel Co., Inc., produced processed paving gravel at a portable plant at Ryegate.

Orleans.—Vermont Asbestos Mines, Division of the Ruberoid Co., continued production of chrysotile asbestos at its Lowell mine for processing at its mill in Lamoille County. The company also recovered miscellaneous stone at the Lowell mine for sale as roadbuilding aggregate. Howard G. Calkins produced and processed sand and gravel for paving and other miscellaneous uses at a stationary plant near Danville.

Rutland.—Marble production increased 8 percent over that of 1963 and continued its top ranking among the State's mineral industries. Vermont Marble Co. operated five quarries and five finishing plants producing dimension marble for a wide variety of markets. The leading use in terms of value was cut and dressed exterior marble. Cut and dressed interior marble, cut and dressed monumental marble, and sawed and dressed exterior marble also were produced in significant quantities. Green Mountain Marble Division of Georgia Marble Co. operated an underground quarry and finishing plant at West Rutland. Cut and dressed monumental marble was the leading product sold. The company has contracted to sink a 120-foot mine shaft in preparation for opening a new underground marble quarry at West Rutland. This will be the second shaft-access underground marble quarry in North America; the first is Georgia Marble's original quarry at West Rutland. The new shaft will reach a 40-foot-thick layer of white marble buried beneath 75 feet of glacial till and 35 feet of limestone. Opening of the new mine became necessary because the company's other mine at West Rutland, which is mining a different layer of marble, will be substantially depleted in the next few years. The two mines will not be connected.[2]

Twenty slate quarries, two less than in 1963, were in operation. Production of slate decreased, but significant increases in output of slate tile, a high-priced product, resulted in increased value of sales. Dimension slate also was sold for flagging, structural and sanitary uses, and for roofing. Leading producers were Vermont Structural Slate Co. (four quarries), Fair Haven Slate Co., Tatko Brothers Slate Co., and Hilltop Slate Co. Production of crushed slate resumed in the State in 1964 as Vermont Light Aggregate Corp. began operation of a lightweight aggregate plant near Castleton which used crushed slate as raw material. White Pigment Corp. quarried limestone near South Wallingford for processing into whiting at its Florence plant. Vermarco Lime Co. produced concrete aggregate, stone sand, and agstone from its Loveland quarry near Florence.

J. P. Carrara & Sons, Inc., produced chiefly building and paving sand and gravel at a stationary plant near Rutland.

Washington.—The Rock of Ages Corp. operated its Rock of Ages and E. L. Smith granite quarries near Graniteville and its Wetmore and Morse quarry near Websterville. Most of this output was processed for sale as monuments and in mausoleums. Small quantities of rubble and curbing also were sold. Wells-Lamson Quarry Co., Inc., produced rough blocks for architectural work and sold crushed granite for aggregate. Garand-Teed Quarries, Inc., quarried dimension granite chiefly for monuments near Adamant. Woodbury Quarries,

[2] Rock Products. V. 67, No. 1, January 1964, p. 106.

Inc., quarried rough blocks near Woodbury for fabrication at Barre, by The Rock of Ages Corp.

Paving sand and gravel was produced by Caledonia Sand & Gravel Co., Inc., at a portable plant near Plainfield. King's Pit near South Barre yielded bank-run paving sand and gravel for building, paving, and fill. Le Page's gravel pit produced bank-run paving and fill sand and gravel at Barre.

Windham.—Brattleboro Sand & Gravel Co. produced and processed sand and gravel for building and paving at a stationary plant near Brattleboro.

Vermont Talc Co. mined talc in Windham County for processing at a plant in Chester (Windsor County). Much of the ground output was shipped to manufacturers of plastics, roofing, paper and insecticides.

Windsor.—Vermont Marble Co. quarried dimension marble and a small quantity of crushed marble at its Rochester quarry. The Rock of Ages Corp. quarried granite at its Bethel quarry near Bethel, producing rough blocks for architectural uses and rubble. Crude talc mined by Eastern Magnesia Talc Co., Inc., at its Hammondsville No. 3 mine near Reading was shipped to a company mill at Chester for processing. The company was erecting a new talc processing plant in West Windsor. The new facilities will include 12 storage bins, 78 feet in height.[3]

Building and paving sand and gravel was produced at a stationary plant near Sharon by Sharon Sand & Gravel, Inc. Hume Pipe of N. E. Inc. (formerly Martin Marietta Corp., Concrete Products Division) produced processed sand and gravel for use in the production of concrete pipe.

The first recorded production of peat in the State was reported. Kirk's Green Mountain Peat produced reed-sedge peat and Jack Comstock produced humus peat.

[3] New Englander. February 1964, p. 18.

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] James L. Calver,[2] and Harold F. York [3]

VALUE of mineral output in Virginia in 1964 was $237 million, 4-percent more than in 1963, and a new high. More than one-half of the mineral commodities produced gained in both output and value. Slight-to-substantial gains were made, or new records set, in output for commodities supplying the construction industries, with the exception of gypsum and masonry cement. Production and value of stone and kyanite rose to new highs. Records were also established in tonnage of coal and sand and gravel mined and in value of clay produced. Accelerated highway and other construction was a

TABLE 1.—Mineral production in Virginia [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays---thousand short tons	1,410	$1,558	1,440	$1,614
Coal (bituminous)---do	30,531	120,972	31,654	123,123
Gem stones	(2)	6	(2)	6
Lead (recoverable content of ores, etc.)---short tons	3,500	756	3,857	1,010
Lime---thousand short tons	639	8,058	780	9,781
Natural gas---million cubic feet	2,085	488	1,609	479
Petroleum (crude)---thousand 42-gallon barrels	3	W	6	W
Sand and gravel---thousand short tons	10,400	17,752	10,588	13,722
Soapstone---short tons	3,696	9	3,775	9
Stone---thousand short tons	27,653	45,529	30,407	52,153
Zinc (recoverable content of ores, etc.) [3]---short tons	23,988	5,725	21,004	5,700
Value of items that cannot be disclosed: Aplite, portland cement, masonry cement, feldspar, gypsum, iron ore (pigment material), kyanite, petroleum (crude), salt, titanium concentrate (ilmenite and rutile), and values indicated by symbol W	XX	r 28,211	XX	29,818
Total	XX	r 229,064	XX	237,415

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] Weight not recorded.

[3] 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.

[1] Chemist, Bureau of Mines, Pittsburgh, Pa.
[2] State geologist, Virginia Division of Mineral Resources, Charlottesville, Va.
[3] Geologist, Bureau of Mines, Pittsburgh, Pa.

prime influence in increases in quantity of stone, sand and gravel, portland cement, and clays. Fifty-two percent of the total value of mineral production in Virginia was contributed by fuels (53 percent in 1963), 45 percent by nonmetals (44 percent in 1963) and 3 percent by metals, the same as in 1963.

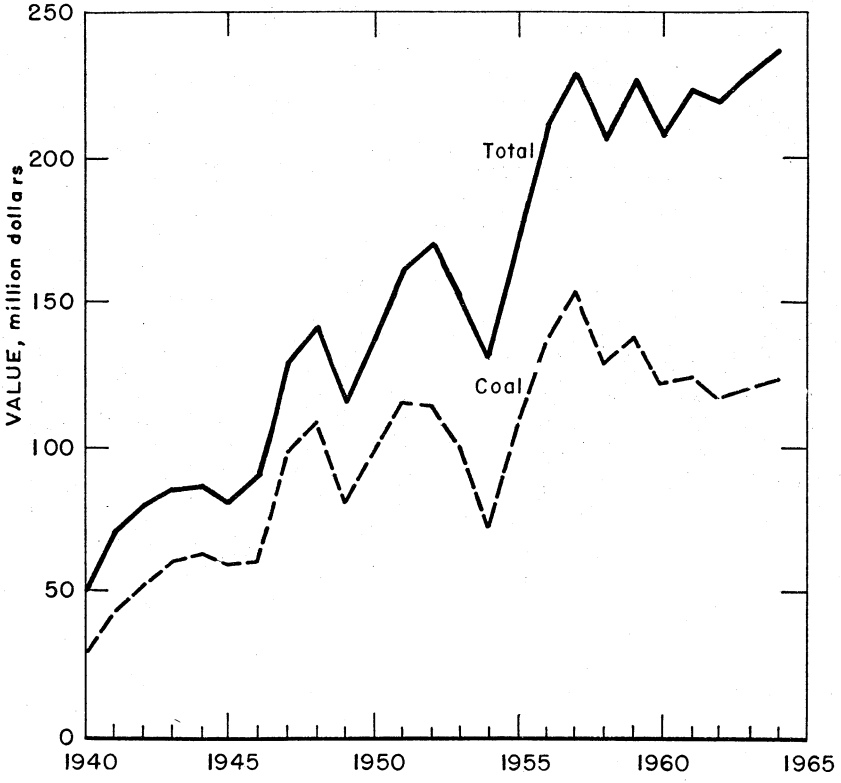


FIGURE 1.—Value of coal and total value of mineral production in Virginia.

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

(Millions)

Year	Value	Year	Value
1940	$114	1953	$155
1941	148	1954	138
1942	156	1955	175
1943	152	1956	210
1944	162	1957	223
1945	131	1958	205
1946	129	1959	231
1947	159	1960	214
1948	150	1961	234
1949	123	1962	234
1950	145	1963	r 244
1951	164	1964	252
1952	169		

r Revised

Trends and Developments.—A summary of the progress of topographic mapping in Virginia through June 1964 was published, listing the number and types of maps available and the areas covered.[4] A discussion of the Everona Formation, North Central Virginia, appeared in a later issue of the same publication.[5] Included in the discussion was a table listing chemical analyses of samples of calcium and magnesium-bearing-carbonate materials obtained in the area. This issue also contains an index listing the volume and number and pages of subjects reported in the publication (Virginia Minerals) from volume 1, No. 1, to volume 10, No. 4.

As a part of the Bureau of Mines comprehensive investigation of all U.S. titanium resources, an appraisal of nelsonite occurrences in Nelson and Amherst Counties and their titanium potential has been published.[6] Although nelsonite deposits are considered to be of secondary importance compared with much larger deposits (an estimated 20 million tons) of lower grade saprolite ores,[7] the report indicates that the nelsonite deposits are of high grade and that further investigation is warranted.

The building of the Chesapeake Bay Bridge-Tunnel, which contributed significantly to the demand for mineral commodities supplied to the construction industries, has been interestingly described in a recent publication;[8] the Bridge-Tunnel complex was opened in 1964.

An addition to the recently passed multimillion-dollar Aid-to-Appalachia Program was a plan for promoting new uses of coal, improvement of mining practices and restoration of areas disfigured by strip mining operations.[9] The economically depressed Appalachian Area included counties in the States of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Construction of 1,500 coal-carrying hopper cars of 95-ton-capacity costing over $15 million was planned by Norfolk and Western Railway. Fabrication of the cars at its Roanoke Shop reportedly was scheduled to begin in January 1965. Over 3,400 such cars have already been built under a program that began in November 1963.

In keeping with continuing efforts to improve the competitive position of coal by improving mining practices, the Office of Coal Research awarded the Virginia Polytechnic Institute (VPI) a $285,000 contract to investigate and propose techniques for minimizing the costs of underground coal production.[10] The study will include longwall mining, haulage, ventilation, power distribution, and drainage. A contract awarded to VPI several years ago involved an investigation of face operations.

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[4] Virginia Minerals. Progress of Topographic Mapping. V. 10, No. 3, August 1964, pp. 6–10.
[5] Mack, Tinsely. Everona Formation in the Northern Piedmont, Virginia. Virginia Minerals, v. 10, No. 4, November 1964, pp. 1–4.
[6] Fish, George E., and Vernon F. Swanson. Titanium Resources of Nelson and Amherst Counties, Va. (In Two Parts.) 2. Nelsonits. BuMines Rept. of Inv. 6429, 1964, 25 pp.
[7] Fish, George E. Titanium Resources of Nelson and Amherst Counties, Va. (In Two Parts.) 1. Saprolite Ores. BuMines Rept. of Inv. 6094, 1962, 44 pp.
[8] Sullivan, Frank. Down to the Sea—In Cars. The Commonwealth, v. 31, No. 4, April 1964, pp. 25–31, 66.
[9] Coal Age. Johnson Outlines Program for Appalachia. V. 69, No. 6, June 1964. P. 26.
[10] Coal Age. V. 69, No. 8, August 1964, pp. 46, 52.

Indicating the increasing importance of Virginia in research and development was the announcement by Allied Chemical Corp. that it will build a multimillion-dollar technical center near Hopewell for increasing research and development capability of its fiber division,[11] and also the announcement of plans by V–C Chemical Co. (formerly Virginia-Carolina Chemical Co.) to erect a $750,000-research-and-development center in Hanover County.[12]

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	12,483	2,501	19,867	25	844	44
Metal	333	83	665	----------	29	44
Nonmetal	668	177	1,405	----------	28	20
Sand and gravel	719	165	1,510	----------	31	21
Stone	3,865	1,016	8,431	4	171	21
Total	18,068	3,942	31,878	29	1,103	36
1964: p						
Coal	12,118	2,486	19,620	23	895	47
Metal	330	83	671	----------	30	45
Nonmetal	850	225	1,792	----------	46	26
Sand and gravel	730	168	1,537	----------	43	28
Stone	4,005	1,087	9,014	3	211	24
Total	18,033	4,049	32,634	26	1,225	38

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Bituminous-coal output in 1964 set a new production record of 31.7 million tons, a 4-percent increase over the former record year of 1963.

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 in this volume published by the Federal Bureau of Mines may differ somewhat from that published by the State. The value of the output increased 2 percent over that of 1963 and was only 2 percent below the record high value ($126 million) of 1961. The average value per ton, however, continued to decline, and was $3.89 compared with $3.96 in 1963, $3.99 in 1962, and $4.16 in 1961, reflecting the continuous trend toward modernization and cost reduction in the bituminous coal industry.

A wide variety of coals were produced, including high-and-low-volatile types for domestic and industrial heating, industrial power, coke feedstock, and a small quantity of semianthracite for domestic heating. Coal was also exported in sizable tonnage. Over two-fifths

[11] Chemical and Engineering News. V. 42, No. 29, July 20, 1964, p. 27.
[12] The Commonwealth. V. 31, No. 9, September 1964, pp. 44, 46.

of the Virginia coal tonnage was produced by one county—Buchanan; four of the eight southwestern counties in which coal was mined—Buchanan, Dickenson, Wise, and Russell—accounted for 98 percent of the total output, compared with 97 percent in 1963. Underground production comprised 88.7 percent of the total; strip-mine output, 7.7 percent; and auger-mine production, 3.6 percent.

The number of mines in Virginia totaled 1,398, 6 percent fewer than in 1963. Underground mines declined 7 percent to 1,298, while the number of strip and auger mines rose to 44 and 56, respectively, compared with 38 and 51 in 1963. Mechanically loaded coal amounted to 45 percent of the total underground output; 73 percent of the mechanically loaded tonnage was by 127 mobile loading machines, 6 more than in 1963. Thirty-one continuous mining machines were also used. Of the total coal mined, 42 percent was mechanically cleaned in 28 cleaning plants. Wet washing other than with jigs was the principal method of cleaning, accounting for 79 percent of the cleaned coal. Thirty-six percent of the total coal mined was crushed. Seven percent of the total coal produced was treated with dust-allaying and antifreezing preparations, of which oil predominated (98 percent).

TABLE 4.—Coal (bituminous) production and value, by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value [1]	Quantity	Value [1]
Buchanan	13,141	$50,435	14,503	$57,379
Dickenson	8,257	32,741	7,728	28,510
Lee	502	2,065	471	1,826
Montgomery	13	45	8	29
Russell	1,904	8,807	1,899	7,317
Scott	3	11	4	17
Tazewell	469	1,530	237	787
Wise	6,242	25,338	6,804	27,258
Total	30,531	120,972	31,654	123,123

[1] Value received or charged for coal, f.o.b. mine, including selling cost. (Includes value for coal not sold but used by producers, 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 commerically.)

Coke.—Beehive-coke was produced in six plants in 1964, four in Wise County, one in Buchanan County, and one in the city of Norton. As in 1963, there were 877 beehive ovens operational, of which 390 were rectangular- or horizontal-bed internal-combustion ovens. Machine-drawn ovens numbered 756, and the number of hand-drawn ovens was 121. There were no slot ovens operated and no byproduct recovery was made. Production of coke was about 25 percent greater than in 1963, and average value per ton increased $0.62 to $14.99.

Petroleum and Natural Gas.—Total gas production was 1,882 million cubic feet, including both marketed gas and that used for miscellaneous purposes. This is a decline of 23 percent from 1963. Buchanan County led in output, producing 1,285,626 thousand cubic feet of gas. Dickenson and Tazewell Counties produced 584,030 and 12,124 thousand cubic feet of gas, respectively.

The output from Buchanan and Tazewell Counties was delivered to the pipelines of Hope Natural Gas Co. and the Atlantic Seaboard Corp.; production from Dickenson County was delivered to the lines of the Kentucky-West Virginia Gas Co. There were no natural-gas-processing plants operating in Virginia as of January 1, 1964.

Natural-gas reserves were estimated by the American Gas Association to total 32,180 million cubic feet, an increase of 877 million cubic feet, or almost 3 percent more than the estimated reserve at the end of 1963. As of December 31, 1964, there were 103 producing gas wells in Virginia. Of interest was the drilling of seven successful gas wells in Tazewell County. The wells were drilled through Mississippian Berea sandstone to an average depth of 5,250 feet. The combined open flow after fracture was 41 million cubic feet.[13]

Oil production in Lee County (Rose Hill and Ben Hur fields) increased from 3,466 barrels in 1963 to 5,828 barrels in 1964, a gain of 68 percent. Eight wells were oil productive at yearend.

A development oil well was drilled in Lee County, offsetting the well in which there had been a small amount of oil discovered in 1963. It has been reported that this well was shut down at 2,000 feet. The Shell Oil Co. drilled a wildcat test on the farm of L. S. Bales in Lee County, which was spudded December 7, 1964. The well was drilled to a total depth of 8,020 feet before being plugged and abandoned in January 1965. It has been reported that oil and gas leases on 575,000 acres were held by the major oil companies.

The American Oil Co. operated a skimming, cracking, and coking plant at Goodwin Neck, York County. The plant had a crude-oil capacity of 38,000 barrels, a catalytic-cracking capacity of 22,800 barrels, a thermal-cracking capacity of 13,700 barrels, and a reforming capacity of 6,800 barrels, all per day.

NONMETALS

Aplite.—Output and value of aplite for glass manufacture increased in 1964. Aplite was also quarried and crushed for highway use. Production was from Hanover and Nelson Counties.

Cement.—Shipments of portland cement increased moderately in 1964 (9 percent), and total value increased 6 percent, but unit value decreased slightly. Masonry-cement shipments decreased slightly (1 percent) in both quantity and total value; unit value increased slightly. Plant capacity for producing portland cement remained essentially unchanged during the year. Two plants used the dry process of manufacturing portland cement, and one used the wet process. Three plants made both portland and masonry cement, and one plant produced only masonry cement. Cement was manufactured in Augusta, Botetourt, and Warren Counties and the city of Chesapeake.

The cement producers mined limestone, shale, clay and calcareous marl for their own use. Materials purchased for use in cement manufacture included sand, gypsum, oyster shells, mill scale, various air-entraining compounds, and various grinding aids.

[13] American Association of Petroleum Geologists. Bull. V. 49, No. 6, June 1965, pp. 684–685.

Types 1–11 (general-use and moderate-heat cements) comprised the bulk of portland cement marketed; both air-entrained and nonair-entrained types were produced. High-early-strength cement was also produced and shipped. Most of the shipments were in bulk and were made by railroad, but sizable bulk shipments were also made by truck. Shipments of cement in paper bags were also sizable and were made by railroad and truck.

Portland cement was distributed for various consumer uses as follows: 59 percent to ready-mixed concrete companies (60 percent in 1963); 19 percent to concrete-products manufacturers (19 percent in 1963); 15 percent to contractors, including highway contractors (12 percent in 1963); 6 percent to building-material dealers (8 percent in 1963) and the remaining 1 percent (1 percent in 1963) to Federal, State, and local government agencies and miscellaneous customers. Marketing areas for portland cement were chiefly Virginia, North Carolina, West Virginia, Kentucky, and Maryland. The bulk of masonry cement was shipped to Virginia, North Carolina, the District of Columbia, and Maryland.

Clays.—Production of clay was 2 percent higher than in 1963, and only 2 percent lower than 1962, the record year for clay output. Value however, rose to $1,613,523, a new record, exceeding by 4 percent the previous record of 1963. Miscellaneous clay or shale was the only type of clay produced, and a little over half the output was consumed in brick manufacture. The principal uses for the balance were lightweight aggregate and the manufacture of portland cement; some was consumed in the making of vitrified sewer pipe, flue linings, and other heavy clay products. Clay production was reported from 22 operations in 16 counties. The chief clay-producing counties in order of tonnage mined were Botetourt, Nansemond, Russell, and Orange; in order of output value they were Botetourt, Orange, Prince William, and Nansemond. A report of a comprehensive evaluation of the potential ceramic and nonceramic uses of a large number of samples of various clay types obtained in west-central Virginia counties was published.[14]

The counties included were Albemarle, Alleghany, Augusta, Bath, Botetourt, Buckingham, Craig, Fluvanna, Highland, Louisia, Montgomery, Nelson, Roanoke, and Rockbridge. The materials sampled and evaluated included clay, shale, mudstone, slate, phyllite, and schist.

TABLE 5.—Clays sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1955–59 (average)	1,065,616	$1,086,382	1962	1,464,417	$1,443,927
1960	1,347,766	1,394,665	1963	1,410,098	1,558,327
1961	1,406,201	1,332,165	1964	1,440,385	1,613,523

Feldspar.—One company mined feldspar in one county (Bedford). Combined output from three mines increased 26 percent compared with that of 1963, while the average value per ton remained the same.

[14] Calver, James L., C. E. Smith, and D. C. LeVan. Analyses of Clay, Shale, and Related Materials—West-Central Counties. Virginia Div. Miner. Res. (Charlottesville, Va.), Miner. Res. Rept. 5, 1964, 230 pp.

Potash feldspar and mixed feldspar were mined. Ground feldspar, produced at the company mill in Bedford, was marketed chiefly in Maryland, Ohio, New Jersey, and New York, principally for pottery and enamel manufacture, although smaller quantities were used in the manufacture of soaps, abrasives, and welding-rod coatings.

Gem Stones.—Gems and mineral specimens gathered by mineral collectors and hobbyists included agate, amazonite, blue corundum, lepidolite, olivine, staurolite, unakite.

Gypsum.—Crude gypsum, mined at Plasterco, Washington County, and near Chatham Hill, Smyth County, was calcined and manufactured into plasterboard and other gypsum products by United States Gypsum Co. at their Plasterco plant. Production of crude gypsum was less than in 1963. The company also calcined domestic and imported gypsum at a mill near Norfolk. Crude gypsum imported from Nova Scotia was ground by several firms in the Norfolk area for use as a land dressing.

Kyanite.—Although production of crude kyanite ore decreased 2 percent, recovery of the refined material improved 10 percent over comparable figures reported for 1963. Sales of refined kyanite increased moderately. Two mines and two flotation plants were operated by the Kyanite Mining Corp. in Buckingham and Prince Edward Counties and the company also operated a pulverizing plant in the latter county.

Lime.—Lime output and value exceeded those of 1963 by more than one-fifth. The gains were attributed chiefly to sharply increased demand for lime in chemical and other industrial uses. Sales of building lime were greater than in 1963, while sales of agricultural lime declined. Quicklime comprised 92 percent of the total production and hydrated lime the balance. All but 5 percent of the lime sold or used, including both quicklime and hydrated lime, was consumed in chemical and industrial uses. Nine companies produced lime in seven counties; one company, active in 1963, was idle. Giles, Smyth, and Shenandoah Counties were the chief limestone calcining counties. Fuels used in calcination included natural gas, bituminous coal, and coke. Processing equipment used in lime manufacturing included pot, shaft, and rotary kilns and batch and continuous hydrators. Uses for quicklime included the manufacture of calcium carbide, paper, whiting, flux in steel manufacture, alkalies, and agricultural lime. Hydrated lime was marketed principally for use in the purification and treatment of water,

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
1955–59 (average)	W	W	W	W	W	$5,742,035	550,682	$6,141,000
1960	27,011	$319,829	5,541	$82,753	678,487	7,625,404	711,039	8,027,986
1961	28,760	375,489	4,932	72,584	623,075	6,926,661	656,767	7,374,734
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	7,572,738	638,800	8,058,415
1964	W	W	W	W	742,065	9,251,156	780,290	9,780,920

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

leather tanning, sewage and trade waste treatment, construction, and agriculture.

Mica.—As in 1963, no sales of crude mica were reported. Domestic and foreign scrap mica were wet-ground by Richmond Mica Corp., Newport News, for use in paint, rubber, wallpaper, plastics, and other products.

Nitrogen Compounds.—Allied Chemical Corp., Nitrogen Division, Hopewell, Prince George County, manufactured nitrogen compounds for use chiefly as fertilizer ingredients. Included among products manufactured were ammonia, urea solution, and ammonium sulfate.

Perlite.—Perlite, obtained from a western source, was expanded by a firm at Hopewell, Prince George County, chiefly for use in concrete aggregate, soil conditioning, and building plaster.

Salt.—Olin-Mathieson Chemical Corp., Saltville, Smyth County, produced soda ash, chlorine, and other chemicals from brine recovered from nearby salt wells. Production was slightly higher than in 1963.

Sand and Gravel.—Production of sand and gravel reached a new high in 1964, exceeding 1963, the former year of record output, by 2 percent. Value declined considerably, however, mainly because more of the output had lower priced uses than in 1963. Paving and building uses comprised 85.4 percent of the commercial production (49.9 percent paving, 35.5 percent building). Other types of sand and gravel uses included glass sand, engine sand, filtration sand, railroad ballast, fill material, and sand and gravel for miscellaneous uses. Gravel comprised 48 percent of the total commercial output and 54 percent of the commercial value. Commercial output comprised 98 percent of the total production and value. The small remainder of the total output (2 percent) was State and local government production, of which 46 percent was processed material. Eighty-four percent of the commercial production was washed, screened, or otherwise prepared, as compared with 91 percent in 1963.

Sand and gravel production was reported from 35 counties and 2 independent cities. Nearly three-quarters of the commercial tonnage was shipped by truck, and the remainder by railroad and waterway.

In order of decreasing contribution, the principal sand and gravel producing areas were Fairfax, Henrico, City of Virginia Beach, Chesterfield, and Prince George. The output of these five producing areas alone comprised over three-quarters of the total tonnage value of Virginia sand and gravel. Five mines with an output range of from 500,000 to 1,000,000 tons accounted for 35 percent of the output; 26 mines with an output range of from 50,000 to 500,000 tons accounted for 46 percent; and 37 mines with an output range of up to 50,000 tons accounted for 19 percent.

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.—For the seventh consecutive year the production of stone in Virginia in 1964 broke all records in both quantity and value. Stone, the second most important mineral commodity produced in Virginia is exceeded only by coal in output and value. Production totaled 30.4 million tons valued at $52.2 million, a gain of 10 percent in output and

TABLE 7.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1963		1964	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Building	1,901,102	$2,841,615	2,002,000	$2,608,000
Paving	2,128,500	2,927,665	1,975,000	2,036,000
Engine	W	W	79,000	128,000
Fill	435,464	231,455	927,000	533,000
Filtration	8,296	16,859	W	W
Other [1]	532,671	1,139,439	387,000	889,000
Total	5,006,033	7,157,033	5,370,000	6,194,000
Gravel:				
Building	1,890,998	4,012,714	1,667,000	2,718,000
Paving	[2] 3,280,783	[2] 6,323,109	3,183,000	4,440,000
Other	W	W	[3] 114,000	[3] 115,000
Total	5,171,781	10,335,823	4,964,000	7,273,000
Total sand and gravel	10,177,814	17,492,856	10,334,000	13,467,000
Government-and-contractor operations:				
Sand:				
Paving	32,727	11,736	104,000	36,000
Other	22,984	9,194	29,000	12,000
Total	55,711	20,930	133,000	48,000
Gravel:				
Paving	151,236	233,205	121,000	207,000
Fill	15,000	5,250	----------	----------
Total	166,236	238,455	121,000	207,000
Total sand and gravel	221,947	259,385	254,000	255,000
All operations:				
Sand	5,061,744	7,177,963	5,503,000	6,242,000
Gravel	5,338,017	10,574,278	5,085,000	7,480,000
Total	10,399,761	17,752,241	10,588,000	13,722,000

W Withheld to avoid disclosing individual-company confidential data.
[1] Includes engine sand (1963), railroad ballast (1964), filtration sand (1964), glass sand, and ground sand.
[2] Includes fill and other gravel.
[3] Includes fill and miscellaneous gravel.

14 percent in value over that of 1963. Most contributary to the gain in output were increases in the production of limestone (15 percent over that of 1963) and granite (8 percent over that of 1963); limestone and granite, the leading stone types, accounted for more than five-sixths of the total stone tonnage and more than three-quarters of the value. The substantially greater demand for concrete aggregate and roadstone was the major reason for the rise in output of granite, and in considerable measure for the rise in limestone production, reflecting an accelerated rate of building and local and interstate highway construction in 1964. In addition, greater demand by lime and cement industries contributed to the increase in limestone output. Mainly crushed or broken material was produced; no dimension limestone and only a limited amount of dimension granite production was reported in Virginia in 1964. Increases in output and value were also reported for slate and marble, while basalt, the third-leading stone produced in Virginia, declined moderately in output and slightly in value. Overall production of miscellaneous stone, including soap-

stone and "Virginia Greenstone," decreased sharply, but average value per ton increased moderately, mainly because of increased output of the relatively higher-priced dimension product. Sandstone output decreased slightly, but average value per ton also rose moderately, because of increased demand for the crushed product.

Many types of stone were quarried in Virginia, including limestone, granite, basalt, slate, sandstone, calcareous marl, miscellaneous stone (including soapstone and "Virginia Greenstone"), and marble, in order of decreasing output. Seventy-one percent of the total stone production was used as concrete aggregate and roadstone; 6 percent and 5 percent in the manufacture of cement and lime, respectively; 4 percent as metallurgical fluxstone; and the balance for uses such as stone sand, riprap, railroad ballast, and agricultural dressings. Limestone, either as such or as lime, had additional application in the chemical and glass industry. Marine shell, a product of oyster and other mollusk processing, was used chiefly as an agricultural liming material similar to agricultural stone (agstone), and in the manufacture of lime. Roofing granules were produced from crushed slate by a firm in Buckingham County. Limestone output accounted for 63 percent of the total stone production, granite output for 24 percent, and basalt output for 8 percent. Of the total Virginia stone output, almost all the tonnage was crushed or broken stone (99.8 percent); dimension stone—miscellaneous, sandstone, slate, and granite—accounted for the balance.

In terms of tonnage, the principal stone-producing counties were Frederick, Botetourt, Loudoun, Wythe, and Roanoke. In terms of product value, the most important counties were Frederick, Botetourt, Nelson, Loudoun, and Giles. Ten counties produced more than 1 million tons of output, compared with 8 in 1963, and there were 22 counties with production valued at more than $1 million each (18 in 1963).

TABLE 8.—Stone sold or used by producers, by kinds and uses

Kind and use	1963		1964	
	Short tons	Value	Short tons	Value
Dimension stone:				
Granite: Rough monumental	1,948	$94,453	W	W
Sandstone: All uses	1,589	23,594	1,551	$20,029
Crushed and broken stone:				
Basalt: Concrete and roadstone [1]	2,961,972	4,590,415	2,554,958	4,405,082
Granite:				
Concrete and roadstone	6,128,677	9,651,958	6,833,728	11,097,722
Riprap	[2] 573,144	[2] 1,195,275	123,995	196,742
Railroad ballast	W	W	275,097	396,710
Limestone:				
Fluxing stone	1,075,534	1,763,795	1,265,548	2,034,365
Concrete and roadstone	10,135,706	13,650,892	11,803,660	16,463,698
Railroad ballast	308,478	390,134	165,982	194,735
Agricultural	1,071,160	1,969,101	1,038,857	1,959,948
Miscellaneous [3]	4,109,078	6,700,226	4,974,505	8,333,293
Sandstone: All uses	435,965	631,494	431,945	688,071
Undistributed [4]	849,592	4,867,207	937,380	6,362,520
Total	27,652,843	45,528,544	30,407,206	52,152,915

W Withheld to avoid disclosing individual-company confidential data.
[1] Includes riprap.
[2] Includes railroad ballast and miscellaneous uses.
[3] Includes riprap.
[4] Includes dimension granite (1964), dimension and crushed and broken miscellaneous stone and slate, crushed and broken calcareous marl and marble, and shell.

Commercial stone was produced by 127 quarrying operations in 48 counties, and 9 quarries were operated in 9 counties by State or municipal agencies producing Government-and-contractor stone. Commercial production of limestone was reported from 69 quarries in 24 counties; granite, from 24 quarries in 19 counties; basalt, from 9 quarries in 5 counties; slate, from 4 quarries in 2 counties; sandstone, from 14 quarries in 8 counties; calcareous marl, from 2 quarries in 2 counties; miscellaneous stone, from 4 quarries in 3 counties; and marble from 1 quarry in 1 county. The number of counties listed in the preceding sentence exceeds the number of counties in which all types of commercial stone was produced because of duplication of counties when considering each stone type quarried.

Sulfur.—Hydrogen sulfide was recovered from fuel gas and converted to sulfur by the American Oil Co. at its Yorktown Refinery in York County. Both production and shipments increased 4 percent over those of 1963, and the value of shipments also increased.

METALS

Ferroalloys.—Reopening of the ferromanganese plant of E. J. Lavino & Co., near Lynchburg, Campbell County, was announced in August 1964.[15]

The Lynchburg plant had discontinued production of ferromanganese about mid-1962, selling small quantities from stock during 1963. A strong demand for ferromanganese was chiefly responsible for the resumption of production by the company.

Iron Ore (Pigment Material).—Natural and manufactured iron-oxide pigments were produced by one firm near Henry, Franklin County. Crude brown-and-yellow-oxide pigments were produced and marketed by another firm near Hiwassee, Pulaski County. This company also produced sienna, umber, and ocher, natural red-and-yellow-iron-oxide pigments, and a variety of finished natural and manufactured pigments. In contrast to the decline of sales in 1963, total sales of iron-oxide pigments increased substantially in 1964. A brief but informative discussion of the iron pigment industry in Virginia has been published.[16]

Lead and Zinc.—Output of zinc decreased moderately but the value declined only slightly because of the higher unit price prevailing in 1964. While lead output rose only moderately, value increased substantially, due partly to the increase in production and partly to a rise in the average value per ton over 1963. Production of lead and zinc was limited to two mines in Wythe County.

Titanium Concentrates.—Continuing an increasing trend, marketed production of titanium concentrates (ilmenite and rutile) rose moderately in output and gained substantially in value. Production of both ilmenite and rutile increased, with rutile having the greatest rate of increase compared with 1963 output. Ilmenite was produced near Piney River, Amherst County, by American Cyanamid Co., and both ilmenite and rutile were produced by M&T Chemicals, Inc., near Montpelier, Hanover County.

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[15] The Commonwealth. Lavino Reopens Lynchburg Works. V. 31, No. 8, August 1964, p. 45.

[16] Johnson, Stanley S. Iron and Titanium Mineral Pigments in Virginia. Virginia Minerals, v. 10, No. 3, August 1964, pp. 1–6.

TABLE 9.—Mine production of recoverable lead and zinc

Year	Lead		Zinc	
	Short tons	Value	Short tons	Value [1]
1955–59 (average)	2,976	$813,730	19,882	$4,687,334
1960	2,152	503,568	19,885	5,142,275
1961	3,733	768,998	29,163	6,726,462
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

[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.

An informative description of the titanium-mineral-pigment industry has been published.[17] In addition to a brief discussion of pigment technology, a list of the producers of mineral pigments in Virginia was included.

REVIEW BY COUNTIES

Producers reported mineral production from 72 counties and 3 independent cities. Several reporting companies did not show a breakdown by area of origin. Consequently, the county table (table 10) will not indicate all producing areas.

Production of sand and gravel by Government-and-contractor operations by the Virginia Department of Highways was reported in Accomack, Augusta, and Northumberland Counties. Henrico County highway department also produced sand and gravel for its own use. Washed, screened, or otherwise-prepared sand and gravel comprised almost half of all the Government-and-contractor sand and gravel output. Most of the material, prepared and unprocessed, was used for road construction and maintenance.

Crushed limestone for use in road building and maintenance was produced by Virginia Department of Highways in Clarke and Highland Counties, and by the cities of Radford and Wytheville in Pulaski and Wythe Counties, respectively. Crushed granite for concrete aggregate and roadstone was produced by the Public Works Departments of the cities of Martinsville and Danville in Henry and Pittsylvania Counties, respectively.

Accomack.—Commercial sand and gravel decreased in output and value. Charles F. Matthews, Oak Hall, dredged and processed construction sand and gravel near New Church; unprocessed construction sand was produced by Lance J. Eller, Inc., Keller, from a deposit near Mappsville.

Albemarle.—Superior Stone Co., Division of Martin Marietta Corp., quarried and crushed granite at its Red Hill quarry near North Garden, for concrete aggregate, roadstone, and railroad ballast. Charlottesville Stone Corp., near Shadwell, produced crushed basalt for concrete aggregate and roadstone. Production of both granite and basalt increased. Vein quartz was produced during 1964 by

[17] Work cited in footnote 16.

Economy Cast Stone Co. near Free Union and Stone & Mineral Corp., near Boyd Tavern. The crushed material was used as an exposed aggregate. Reports of actual tonnages were not received, consequently these data were not available for inclusion in statistics. Construction sand was mined by various producers.

Alexandria (City).—A limited quantity of sand was processed for ice control and road construction. Oystershells, purchased from various producers in the Tidewater area, were crushed and dry-ground for agricultural purposes.

Alleghany.—Production and value of limestone increased, primarily because of output from a new reporting producer. W. G. Mathews, Jr., Inc., produced low-magnesia limestone for use as concrete aggregate and roadstone, and agstone (agricultural limestone) at its quarry near Clifton Forge. This quarry was purchased in July by Lambert Brothers, Inc., Division of Vulcan Materials Co. Liberty Limestone Corp. produced crushed limestone for road construction at its stationary plant near Covington. West Virginia Pulp & Paper Co., Covington, regenerated lime in a natural gas-fired rotary kiln for use in its manufacture of paper.

Amherst.—American Cyanamid Co. mined ilmenite near Piney River for use in its nearby titanium pigment plant in Nelson County. Construction sand was dredged and processed by Smiley Sand Co.

TABLE 10.—Value of mineral production in Virginia, by counties [1]

County	1963	1964	Minerals produced in 1964 in order of value
Accomack	$49,856	$30,000	Sand and gravel.
Albemarle	W	W	Stone, sand and gravel.
Alexandria (city)	15,035	W	Sand and gravel.
Alleghany	W	W	Stone.
Amelia	W		
Amherst	W	W	Titanium concentrate, sand and gravel.
Appomattox	72,092	98,537	Stone.
Augusta	W	W	Cement, stone, sand and gravel, clays.
Bath	1,414		
Bedford	W	W	Stone, feldspar.
Bland	16,614	14,986	Stone.
Botetourt	W	W	Cement, stone, clays.
Brunswick	W	W	Stone, clays.
Buchanan	50,783,857	57,712,626	Coal, natural gas.
Buckingham	2,540,367	3,348,818	Stone, kyanite, sand and gravel.
Campbell	1,486,867	2,586,018	Stone.
Caroline	W	W	Sand and gravel.
Carroll	85		
Chesapeake (city)	W	W	Cement, lime, sand and gravel.
Chesterfield	W	W	Sand and gravel, stone, clays.
Clarke	140,860	W	Stone.
Craig	W	W	Sand and gravel.
Culpeper	314,405	W	Stone, sand and gravel.
Dickenson	32,886,682	28,665,094	Coal, natural gas, sand and gravel.
Dinwiddie	W	W	Stone, clays.
Fairfax	8,082,407	7,183,821	Sand and gravel, stone.
Fauquier	W	W	Stone.
Fluvanna	W	W	Do.
Franklin	9,240	9,438	Soapstone.
Frederick	3,977,000	4,871,654	Stone, lime, sand and gravel, clays.
Giles	4,394,235	W	Lime, stone.
Goochland	W	W	Stone.
Grayson	93,511	90,908	Do.
Greensville	W	W	Do.
Halifax	W	W	Do.
Hanover	W	W	Stone, aplite, titanium concentrate.
Henrico	W	W	Sand and gravel.
Henry	W	W	Stone.
Highland	20,923	31,127	Do.
Isle of Wight [2]	78,150	W	Lime, sand and gravel, stone.
King William	W	60,000	Sand and gravel.
Lee [3]	2,064,740	1,826,593	Coal, stone, petroleum.
Loudoun	2,918,512	2,709,639	Stone.

See footnotes at end of table.

TABLE 10.—Value of mineral production in Virginia, by counties [1]—Continued

County	1963	1964	Minerals produced in 1964 in order of value
Louisa	W	W	Stone.
Mecklenburg	W	W	Stone, sand and gravel.
Montgomery [4]	$417,577	W	Stone, clays, coal.
Nansemond	W	W	Clays, stone.
Nelson	W	W	Stone, aplite.
New Kent	W	$96,000	Sand and gravel.
Northampton	W	W	Do.
Northumberland		26,000	Do.
Nottoway	W	W	Stone.
Orange	W	W	Clays.
Page	1,415		
Pittsylvania	517,739	772,839	Stone, clays, sand and gravel.
Powhatan		W	Stone.
Prince Edward	W	W	Kyanite, sand and gravel.
Prince George	W	W	Sand and gravel.
Prince William	W	W	Stone, clays.
Pulaski	W	W	Stone, iron ore (pigment material).
Roanoke	2,469,535	W	Stone, clays.
Rockbridge	969,368	1,004,216	Stone, sand and gravel, clays.
Rockingham	1,743,037	1,391,204	Stone, sand and gravel.
Russell	9,174,473	[5] 7,316,815	Coal, stone, clays.
Scott	952,667	944,095	Stone, coal.
Shenandoah	W	W	Lime, stone.
Smyth	W	W	Lime, salt, stone, sand and gravel, clays.
Spotsylvania	W	W	Sand and gravel, stone.
Stafford	W	W	Sand and gravel.
Sussex	96,720	49,000	Do.
Tazewell [6]	1,636,442	904,288	Stone, coal, lime, clays, natural gas.
Virginia Beach (city)	505,669	938,000	Sand and gravel.
Warren	W	W	Cement, stone, sand and gravel.
Washington	3,277,145	2,115,098	Stone, gypsum, sand and gravel.
Westmoreland	69,156	W	Sand and gravel.
Wise [7]	25,338,855	27,413,732	Coal, stone, sand and gravel.
Wythe	6,700,348	8,347,488	Zinc, stone, lead, sand and gravel.
York	W	W	Sand and gravel.
Undistributed [8]	r 65,246,755	76,857,184	
Total	r 229,064,000	237,415,000	

r Revised. W Withheld to avoid disclosing individual companies confidential data.
[1] The following counties are not listed because no production was reported: Arlington, Charles City, Charlotte, Cumberland, Essex, Floyd, Gloucester, Greene, James City, King and Queen, King George, Lancaster, Lunenburg, Madison, Mathews, Middlesex, Patrick, Rappahannock, Richmond, Southampton, and Surry.
[4] Excludes clays; included with "Undistributed."
[5] Excludes stone and clays: included with "Undistributed."
[6] Excludes stone; included with "Undistributed."
[7] Excludes stone and sand and gravel; included with "Undistributed."
[8] Includes gem stones, and values indicated by symbol W.

nearby Lynchburg. Output decreased slightly, but unit value increased.

Appomattox.—Limestone for use as agstone was quarried and processed by the Virginia Department of Agriculture and Immigration at its No. 2 grinding plant near Appomattox.

Augusta.—Lehigh Portland Cement Co. mined shale and limestone for use in the manufacture of cement at Fordwick. Both general-use and high-early-strength portland cement were produced by the dry process in six kilns of varying dimensions. Masonry cement, in sizable quantity, was also produced. Electric power was both generated and purchased. In addition to the shale and limestone mined, material purchased for use in making cement included gypsum, mill scale and pyrite cinders, and resin.

Crushed limestone for concrete aggregate was produced by Augusta Stone Corp. (Middle River Plant), Belmont Trap Rock Co., Inc., and Valley Stone Co., all near Staunton. Output was comparable to that of 1963. Greenville Stone Corp., near Greenville, produced

crushed dolomite for road aggregate. The Virginia Department of Agriculture and Immigration quarried and ground limestone for use as agstone at its No. 1 grinding plant near Staunton. The Staunton quarry of Augusta Stone Corp received a Certificate of Achievement in Safety for operating throughout 1964 without a lost-time work injury. A similar certificate was issued to the Fordwick quarry of Lehigh Portland Cement Co. Building sand was mined and processed by D. M. Conner Sand Co., Inc., at its stationery plant at Stuarts Draft. Shale was mined by North Mountain Brick of Virginia, near Swoope, for use in the manufacture of building brick.

Bedford.—Blue Ridge Stone Corp. quarried and crushed limestone for concrete aggregate and roadstone, railroad ballast, and stone sand. Output increased moderately over that reported in 1963. The Simms quarry, owned by Stone & Mineral Corp., was idle; a limited amount of crushed quartz had been produced in 1963. Clinchfield Sand & Feldspar Corp. mined potash feldspar and mixed soda and potash feldspar at its Overacre, Mitchell, and Peakesville mines near Bedford. Production was over one-quarter greater than in 1963. Sales of feldspar, ground at the company mill at Bedford, were chiefly for pottery and enamel manufacture. Smaller quantities were marketed for use in soaps, abrasives, and welding-rod coatings. Principal marketing areas were Maryland, Ohio, New Jersey, and New York.

Bland.—Agstone and riprap were produced by Bland Correctional Farm from limestone quarried near White Gate.

Botetourt.—Limestone was quarried captively for use in cement manufacture by Lone Star Cement Corp. at its Cloverdale plant.

Both general-use and high-early-strength portland cement was manufactured by the dry process in four 9- by 340-foot rotary kilns. In addition to the limestone mined, materials purchased for use in making cement included sand, gypsum, mill scale and pyrite cinders, air-entraining compounds, and other additives. Non-air-entrained cement, however, comprised the bulk of both production and shipments; masonry cement was also prepared and shipped. Electric power was purchased. Shipments increased, compared with those of 1963; distribution was mostly to Virginia and North Carolina.

As in 1963, Botetourt was the second largest limestone-producing county in Virginia, surpassed only by Frederick County. Output and value were 2.1 million short tons and $3.2 million, in each case 11 percent more than the production and value reported in 1963, notwithstanding the abandonment of the Salem Stone Corp. plant near Buchanan during 1963. Limestone marketed for use as concrete aggregate, roadstone, metallurgical flux, agstone, asphalt and fertilizer filler, railroad ballast, stone sand, and raw material for chemical use, was quarried by three producers: Liberty Limestone Corp. (two quarries) and James River Hydrate & Supply Co., Inc., both near Buchanan; and Eagle Rock Limestone Corp., near Eagle Rock.

The Rocky Point quarry of Liberty Limestone Corp. received a Certificate of Achievemet in Safety for operating throughout 1964 without a lost-time work injury.

The county continued to rank first among the clay-producing counties in the State; production was 11 percent higher than in 1963. Miscellaneous clay and shale for building brick and lightweight aggregate,

respectively, were produced by Webster Brick Co., Inc., and Weblite Corp., both at Webster.

Brunswick.—Granite for concrete aggregate and roadstone was quarried and crushed by Southern Materials Co., Inc., at its quarry near Rawlings. Miscellaneous clay was mined by Brick & Tile Corp of Lawrenceville, for use in building brick manufacture.

Buchanan.—The county continued to lead in coal production, accounting for 14.5 million tons, or 46 percent of the State total. Although the number of active mines decreased by 28, production rose by 10 percent compared with that of 1963. Of the 855 mines reporting production, 822 were underground, 9 were strip, and 24 were auger mines. Ninety-two percent of the output was from underground mines, compared with 94 percent in 1963 and 97 percent in 1962. The larger producers in the county included Harmon Mining Corp., Island Creek Coal Co., and Jewel Ridge Coal Corp. The chief producing-coal seams included Red Ash, Jewel Ridge, and Splashdam.

Beehive coke was produced by Jewell Smokeless Coal Corp., Vansant, in 210 rectangular machine-drawn nonrecovery-type ovens.

Natural gas, totaling 1,285 million cubic feet, was produced and delivered to the pipelines of Atlantic Seaboard Co. and Hope Natural Gas Co.

Buckingham.—Slate was quarried and processed for roofing slate, structural and sanitary slate, and flagging by Arvonia-Buckingham Slate Co., Inc., and LeSueur-Richmond Slate Corp., both near Arvonia. Arvonia-Buckingham Slate Co., Inc., also produced and marketed crushed slate. Expansion of fabrication facilities at its Arvonia quarry was reported by this company. The opening of a new quarry, near its existing operation, was reported by LeSueur-Richmond Slate Corp. Blue Ridge Slate Corp. quarried and crushed slate for roofing granules at its Dutch Gap quarry near New Canton. Expanded slate for lightweight aggregates was produced by Solite Corp. near Arvonia. Output and value of slate produced in the county increased substantially.

Kyanite Mining Corp. mined and beneficiated raw kyanite at its Willis Mountain mine and Dillwyn Mill, respectively, for marketing to manufacturers of refractories and other ceramic products. Output and value of construction and industrial sand, produced as a by-product, increased somewhat; the material was marketed under the name Dixon Sand Co.

Campbell.—Rockydale Stone Service Corp., near Concord, and Blue Ridge Stone Corp., near Lynchburg, quarried and crushed limestone for concrete aggregate and roadstone. Output increased moderately, while average value per ton rose sharply. Dressed building stone, dimensioned and dressed hearth stone, and dimensioned and random broken stone for flagging were prepared from rock quarried near Lynchburg by Virginia Greenstone Co., Inc. A limited quantity of waste or scrap stone was marketed for various uses. Lynlite Materials Co. produced lightweight aggregate from schist mined near Lynchburg. The product was used as aggregate in an affiliated block plant.

Caroline.—Sand and gravel was produced at operations near Milford, Guinea, and Point Eastern. Most of the output was processed

for use in paving and construction; a limited quantity of bank-run sand and gravel for building was sold. Production decreased compared with that of 1963.

Carroll.—A small quantity of pyrite was produced from an open pit near Galax.

Chesapeake (City).—Portland cement was produced by Lone Star Cement Corp. in Chesapeake. Calcareous marl and clay, captively mined in Nansemond County, were used in the product manufacture, which was by the wet process. Non air-entrained portland cement was the chief product; no masonry cement was made. Four kilns—three 7.7- by 219-foot and one 10.5- by 340-foot—were used.

Hydrated lime was produced by Reliance Fertilizer & Lime Corp., West Chesapeake, and marketed for agricultural purposes. Four coal-fired pot kilns calcined a mixture of 50-percent dolomitic limestone and 50-percent oystershell.

Interstate Division, Commonwealth Sand & Gravel Corp., dredged and processed construction sand and gravel near Norfolk.

Crude gypsum was calcined at a plant near Norfolk by United States Gypsum Co. for plaster and other products. F. S. Royster Guano Co., Baugh Chemical Co., and Chas. W. Priddy & Co., Inc., ground imported gypsum for use as a land dressing.

Chesterfield.—Production continued a decreasing trend, but the county continued to rank third among the sand-and-gravel-producing counties. Sand and gravel for road construction was processed by Southern Materials Co., Inc., at its Kingsland Reach plant.

Crushed granite was produced for use as concrete aggregate, roadstone, railroad ballast, and riprap by Tidewater Crushed Stone Co. at its Richmond quarry. Production increased over that of 1963.

Miscellaneous clay, mined near Richmond, was used for building brick manufacture by Redford Brick Co. and Southside Division, General Shale Products Corp. Southern Pottery at Richmond produced flower pots from clay purchased from Southside Division, General Shale Products Corp. Miscellaneous clay was also used by Daniels Brick & Tile Co., Inc., Richmond, for the manufacture of vitrified sewer pipe and tile.

Clarke.—Stuart M. Perry, Inc., quarried and crushed magnesium limestone at a portable plant near Berryville for use as concrete aggregate, roadstone, and agstone. J. C. Digges & Sons, White Post, mined, pulverized, dried, and screened calcareous marl for agricultural use.

Craig.—Castle Sands Co. processed sand for building and industrial use at its operation near New Castle. Production increased.

Culpeper.—Culpeper Stone Co., Inc., crushed sandstone at its stationary plant near Culpeper for concrete aggregate and roadstone. The Virginia Granite Co., Inc., and the Buena Black Granite Corp. quarried diabase for use as monumental and architectural stone near Rapidan. A limited quantity of sand was processed for use in paving and ice control.

Dickenson.—Dickenson County continued to rank second in Virginia in output of bituminous coal. Although the number of mines decreased by about one-tenth of those active in 1963, production declined only slightly. Included among the 154 active mines were 132 under-

ground mines, 11 strip mines, and 11 auger mines. The leading coal producers were Clinchfield Coal Co., Wisco Coal Corp., Baker Coal Co. (Betty B.), and Contracting Enterprises, Inc. Production was chiefly from the Upper and Lower Banner, Splashdam, and Clintwood seams. Natural gas was produced by the Clinchfield Coal Co., Division of Pittston Co., and 584 million cubic feet were delivered to Kentucky-West Virginia Gas Co. pipelines for local consumption.

Honaker Sand Co. dredged bank-run sand for building construction.

Dinwiddie.—Granite was quarried and crushed by Southern Materials Co. at its Jack quarry near Petersburg for concrete aggregate and roadstone. Production increased moderately, compared with that of 1963. Daniels Brick & Tile Co., Inc., mined schist under contract at its Hardy shale pit for use in manufacturing vitrified sewer pipe and other heavy-clay products at its plant near Richmond.

Fairfax.—Fairfax County continued to rank first among the sand-and-gravel producing counties; the output totaled 3.4 million tons, a 5-percent decrease compared with that of 1963. Production and value constituted 32 and 35 percent, respectively, of the State total. All but 12 percent of the output was wet or dry screened, washed, or otherwise processed. Most of the tonnage produced was used for building and road construction. Alexandria Sand & Gravel Corp. and Modern Sand & Gravel Corp., both of Springfield, merged with Virginia Sand & Gravel Co., Inc., Springfield, at the beginning of 1964. Leading producers with stationary plants included Virginia Sand & Gravel Co., Inc., Alexandria, and Potomac Sand & Gravel Co., near Washington, D.C. George F. Dodd Corp. and Mount Vernon Gravel Co., Inc., both of Alexandria, were among the large producers having portable plants.

Crushed granite for use in road construction and as riprap and railroad ballast was produced by W. E. Graham & Sons Division, Vulcan Materials Co., at its quarry and plant near Occoquan. Fairfax Quarries, Inc., quarried and crushed basalt for concrete aggregate and roadstone at its operation near Centreville. A Certificate of Achievement in Safety for operating throughout 1964 without a lost-time work injury was awarded to Fairfax Quarries, Inc. (Manassas quarry).

Fauquier.—Chadbourn Gotham, Inc., Paris, and Sanders Quarry, Inc., near Warrenton, quarried and crushed basalt (traprock) for concrete aggregate and roadstone. Irregularly shaped sandstone rubble and flagging were produced and marketed by J. W. Costello and Lofton Lambert, The Plains, and W. A. Landsdowne and Will Miller, of Warrenton and Haymarket, respectively. Crushed quartz was used for manufacturing architectural facing (exposed aggregate) by Stone & Mineral Corp. The material was from the Hornor Quarry near Flint Hill in Rappahannock County.

Floyd.—Newman Brothers produced miscellaneous stone (amphibolite) from a quarry near Floyd.

Fluvanna.—Stone & Mineral Corp. produced crushed quartz at its Haden and Perkins quarries, both near Nahor, and at its Davis quarry, near Scottsville. The output was used for architectural facing material.

Franklin.—Blue Ridge Talc Co., Inc., produced ground soapstone at its King-Ramsey mine and plant near Henry. The output was marketed chiefly for use in insecticides and foundry facings. Finished natural and manufactured iron-oxide pigments also were processed at the company plant near Henry.

Frederick.—Frederick County continued to lead in both quantity and value among limestone-producing counties. Output totaled 2.8 million tons valued at $3.7 million, an increase of 34 percent in production and 22 percent in value. Limestone chiefly for use as fluxstone for blast- and open-hearth furnaces, concrete aggregate, and roadstone was quarried and crushed by W. S. Frey Co., near Clearbrook; a limited quantity was also marketed for railroad ballast and for use in cement manufacture. Development of underground mining operations was continued by the company at their quarry near Clearbrook during 1964. M. J. Grove Lime Co., Division of The Flintkote Co., quarried and crushed limestone at Middletown and Stephens City for use mainly as metallurgical flux, agstone, and in cement, lime, and glass manufacture. Limestone for use as concrete aggregate and roadstone was produced by Salem Stone Corp. The Salem Stone Corp. reported discontinuance of its operation near Stephens City and the opening of new operations near Stephenson and Middletown. This corporation's output was substantially higher than in 1963, because of greater highway-construction activity. Stuart M. Perry, Inc., continued to quarry and crush limestone near Winchester for concrete aggregate, roadstone, agstone, stone sand, and other uses.

A Certificate of Achievement in Safety was awarded to the M. J. Grove Lime Company, Middletown quarry, for operating through 1964 without a lost-time injury.

Quicklime and hydrated lime were both 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 agricultural uses, and for construction uses (mason's lime and soil-stabilization lime). Process equipment included seven natural-gas-fired shaft-kilns, one batch and one continuous hydrator, and one Azbe vertical and two Corson kilns.

Virginia Glass Sand Corp. produced sand at its stationary plant near Gore for use in glass production; a limited quantity of building sand was also a product. Shenandoah Silica Co., Inc., Gore, operated a processing plant utilizing sand quarried by Virginia Glass Sand Corp. Shenandoah Brick & Tile Corp. mined shale near Winchester, for use in making building brick.

Giles.—National Gypsum Co., near Kimballton, again produced lime the entire year. Both quicklime and hydrated lime were produced chiefly for chemical and other industrial uses; process equipment included three coal-fired rotary kilns and one continuous hydrator. Foote Mineral Co., also near Kimballton, produced lime for chemical and other industrial uses; process equipment included two coal-fired rotary kilns.

Limestone was quarried and processed by Virginian Limestone Corp. and Ripplemead Limestone Co., Division of the Fincastle Co., both near Ripplemead, and National Gypsum Co. and Foote Mineral Co., both near Kimballton. Total production in Giles County continued an

increasing trend. The output was used in lime manufacture and as concrete aggregate, roadstone, fluxstone, railroad ballast, coal-mine dust, and agstone. Some stone sand was also produced as well as a limited quantity of material for other uses. For its outstanding safety record in 1964, Ripplemead quarry of Ripplemead Limestone Co., Inc., was awarded a Certificate of Achievement in Safety.

Goochland.—Granite for concrete aggregate and roadstone was quarried and crushed by Boscobel Granite Corp. and W. E. Graham & Sons, Division of Vulcan Materials Co., at their Manakin and Royal Stone quarries, respectively. The Royal Stone quarry of Vulcan Materials Company, W. E. Graham & Sons Division, was awarded a Certificate of Achievement for its outstanding safety record. Crushed rock was produced by Goochland Stone Products, near Rockville.

Grayson.—Grayson Stone Corp., at Fries, quarried and crushed granite for concrete aggregate and roadstone.

Greensville.—Trego Stone Corp. quarried and crushed granite at its stationary plant near Skippers for use as concrete aggregate, roadstone, railroad ballast, and riprap. In contrast to 1963, no gravel production was reported.

Halifax.—W. E. Graham & Sons, Division of Vulcan Materials Co., quarried and crushed granite for concrete aggregate and roadstone at their stationary plant near South Boston. A Certificate of Achievement in Safety was awarded to the quarry for working throughout 1964 without a lost-time injury.

Hanover.—The General Crushed Stone Co. produced crushed granite for concrete aggregate and roadstone and railroad ballast at its Verdon quarry near Doswell. M&T Chemicals, Inc., produced ilmenite, rutile, and aplite (for glass manufacture) at a plant near Montpelier,

Henrico.—Sand and gravel increased slightly in output, but the average value per tone decreased sharply. However, Henrico County continued to rank second in output and value among the sand-and-gravel-producing counties. All but 2 percent of the commercial production was processed. The output was marketed mainly for building and road construction; limited quantities were used for fill and septic tank drain fields. Dredge No. 12, owned by Southern Materials Co., Inc., continued to operate on the James River. Producers operating stationary plants included West Sand & Gravel Co., Inc., Carter Sand & Gravel Co., Inc., and Commonwealth Sand and Gravel Corp., all near Richmond. The relatively new Mankin processing plant of West Sand & Gravel Co., Inc., near Highland Springs, was placed in operation in April 1963. The 800,000-ton-per-year plant is highly automated and is described in detail in a recent publication.[18] Southern Material's new 600-ton-per-hour floating sand-and-gravel crushing and screening plant (No. 18) was placed in operation on the James River below Richmond, in April. Described as highly automated and more economical to build than a regular stationary plant of the same size, the new floating unit supplements plant No. 12, the No. 4 dredge, and the Kingsland Reach Land plant.[19]

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[18] Bergstrom, John J. Triple Threat Aggregate Plant. Rock Products, v. 66, No. 10, October 1963, pp. 54–55, 57–58.

[19] Trauffer, Walter E. Southern Materials' Latest Floating Crushing and Screening Plant. Pit and Quarry, v. 57, No. 3, September 1964, pp. 86–93, p. 102.

Sadler Materials Corporation began production of sand and gravel at Turkey Island Farm, near Varina. The material was barged down James River to the company's processing plant at Little Creek, Norfolk.

Henry.—Granite was quarried and crushed for concrete aggregate and roadstone by Martinsville Stone Corp., Snyder Stone Quarry, and Wilson Quarries, all with operations near Martinsville.

Highland.—A limited quantity of crushed limestone was produced by the Virginia Department of Highways for road construction and maintenance.

Isle of Wight.—Battery Park Fish & Oyster Co. produced lime by calcining oystershell obtained as a byproduct of oyster-cannery operations. The product was hydrated and marketed for agricultural purposes.

Construction sand was produced by Benns Church Sand Co., Benns Church. A limited quantity also was produced for fill. The Zuni Sand Company, Inc., produced sand for masonry use and as fill from a pit near Zuni.

King William.—Fox Co., Aylett, produced building sand and gravel; a limited amount of fill sand also was mined.

Lee.—Production of bituminous coal in Lee County was 6 percent less than in 1963. The number of active mines also decreased from 81 in 1963 to 70 in 1964. Of these, 67 were underground, 2 were auger mines, and 1 was a strip mine. Underground mining accounted for 98 percent of the county output. Laurel Branch Coal Co., Dean Jones Coal Co., and Reed's Creek Coal Co., Inc., were among the leading producers. Output was largely from the Darby No. 5 and Marker seams.

Kentucky-Virginia Stone Co., Inc., quarried and crushed limestone for concrete aggregate, roadstone, agstone, and coal-mine dust at its Wheeler quarry, near Gibson Station. High-calcium limestone for concrete aggregate, roadstone, and agstone was produced by Woodway Stone Co. at its stationary plant near Woodway.

Lee County was the only oil-producing area in the State; the Rose Hill and Ben Hur fields produced 5,828 barrels of crude oil, an increase of 68 percent compared with the 3,466-barrel output in 1963. Eight wells were productive at the end of 1964.

Loudoun.—The county continued to lead in basalt production and ranked third in tonnage and fourth in value among all stone-producing counties. Production continued a declining trend, totaling 1.5 million tons as compared with 1.7 million tons in 1963 and 1.8 million tons in 1962. Traprock (basalt) for use in highway construction and maintenance and for building purposes was quarried and crushed by Arlington Stone Co., Leesburg; Bull Run Stone Co., Inc., near Manassas; Chantilly Crushed Stone, Inc., Chantilly, near Arcola; and Virginia Trap Rock, Inc., Leesburg. Basalt was the only stone type produced in Loudoun County.

Louisa.—Limestone for concrete aggregate and roadstone was quarried and crushed by Superior Stone Co., Division of Martin Marietta Corp., at its Gordonsville quarry. A. H. Smith Stone Co. produced crushed stone from a granite quarry near Louisa.

Mecklenburg.—W. E. Graham & Sons, Division of Vulcan Materials Co., quarried and crushed granite for concrete aggregate, roadstone,

railroad ballast, and riprap. Production continued a declining trend. Their Buggs Island quarry was awarded a Certificate of Achievement in Safety for its outstanding safety record in 1964. Southern Materials Co., Inc., quarried and crushed granite near Bracey for use in road construction.

A relatively small tonnage of gravel was processed for use in construction.

Montgomery.—Limestone output increased sharply over that of 1963, mainly because of the first full year's production of the portable plant near Radford operated by Lambert Brothers, Inc., Division of quarry Vulcan Materials Co. The company quarried and crushed high-calcium limestone for use as concrete aggregate and roadstone. A Certificate of Achievement in Safety was awarded the Radford for operating throughout 1964 without a lost-time work injury. Montgomery Limestone Corp. quarried limestone at its Shawsville and Ellett quarries for concrete aggregate and roadstone; a limited quantity was processed for agricultural uses at the Ellett quarry.

Ironto Sand Co., Division of Montgomery Limestone Corp., produced crushed sandstone for concrete aggregate and roadstone.

Old Virginia Brick Co., Inc., mined shale near Elliston for use in making building brick.

A limited quantity of semianthracite coal was mined from the Brushy Mountain seam.

Nansemond.—Calcareous marl was mined at Chuckatuck by Lone Star Cement Corp., which also dredged clay from the Nansemond River, near Oakland; these captive materials were used in the manufacture of cement at South Norfolk, in the city of Chesapeake. Webster Brick Co., Inc., manufactured building brick from miscellaneous clay mined near Suffolk.

Nelson.—Alberene Stone Division of the Georgia Marble Co. produced dimensioned soapstone near Schuyler. Laboratory and architectural stone and flagging were the principal products. Output was greater than in 1963. International Minerals & Chemical Corp., Industrial Minerals Division, mined and processed aplite, mostly for glass manufacture, near Piney River. Shipments of ground aplite were made to glassmakers in midwestern, southern, and eastern States.

New Kent.—Sand and gravel for use mainly in building and road construction was produced and processed by J. R. Parker & Co., Inc., at a stationary plant near Providence Forge.

Norfolk (City).—Radcliff Materials, Inc., dredged buried shell deposits in Hampton Roads off Craney Island Disposal Area. The shells were sold for road material (sub-base), base for oyster seeding grounds, and for use in manufacturing agricultural lime and cement. Production from this operation was not reported and is not included in the statistical tables. Sadler Materials Corporation operated a sand-and-gravel processing plant at the east end of Pleasant Avenue (Little Creek area) to process sand and gravel produced from their pits at Turkey Island Farm near Varina, Henrico County.

Northampton.—Paving sand was washed and screened by Southern Materials Co., Inc., at its Eastern Shore portable sand plant, near Sea View. Sand for use in asphalt was produced by Clyde R. Royals, Inc., at a pit near Nassawadox.

Northumberland.—Sand and gravel in limited amount was produced by the Virginia Department of Highways for road construction and maintenance.

Nottoway.—Burkeville Stone Corp. produced crushed granite for concrete aggregate and roadstone. Output was greater than in 1963. The Burkeville quarry received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Orange.—Miscellaneous clay (Triassic mudstone) for use in the manufacture of building brick was mined by Webster Brick Co., Inc., near Orange.

Patrick.—Wilson Quarries crushed stream gravel near Patrick Springs, for use by the Virginia Department of Highways.

Pittsylvania.—Crushed granite chiefly for concrete aggregate and roadstone was produced by Superior Stone Co., Division of Martin Marietta Corp., and W. E. Graham & Sons Division, Vulcan Materials Co., at quarries near Danville and Chatham, respectively. Compared with 1963, production increased substantially. The Chatham quarry was awarded a Certificate of Achievement in Safety for operating throughout 1964 without a disabling injury.

Virginia Solite Corp. mined shale along the Virginia-North Carolina State line for use in the manufacture of lightweight aggregate at a nearby plant. Over one-half of the output was from Virginia.

Sand was dredged by portable drag lines and processed for building and paving applications by the Kendall Sand Works and Marshall Sand & Gravel Co., Danville.

Powhatan.—W. E. Graham & Sons Division, Vulcan Materials Co., near Genito, marketed crushed granite for concrete aggregate and roadstone.

Prince Edward.—Kyanite was produced by Kyanite Mining Corp. at its Baker Mountain mine and processed at its Cullen plant. Concentrates from the Cullen and Dillwyn (Buckingham County) flotation plants were ground for special applications at the company Pamplin city processing and storage plant. Chief users were the ceramic and refractory industries.

Construction and industrial sand was also produced and prepared at Baker Mountain and sold by the Dixon Sand Co.

Prince George.—Southern Materials Co., Inc., and Hitch Gravel Corp., both of Norfolk, and Friend Sand & Gravel Co., Inc., Petersburg, produced sand and gravel, most of which was processed, for road construction, building, and fill. Virginia Perlite Corp. at Hopewell expanded perlite from a western-State source and vermiculite imported from Africa at Hopewell for building plaster, concrete aggregate, and soil conditioning.

Prince William.—Granite and basalt (diabase) for concrete aggregate and roadstone was quarried and crushed by W. E. Graham & Sons Division, Vulcan Materials Co., at quarries near Manassas and Gainesville respectively; limited quantities of the crushed stone were also marketed for riprap and railroad ballast. The Manassas quarry of W. E. Graham & Sons was awarded a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury. McCanless Construction Co., Inc., produced a miscel-

laneous rock material for road construction at its Aldie shale pit, near Aldie, Loudon County.

Miscellaneous clay 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 their Newbern quarry, processed limestone principally for use in building and road construction; other uses were agstone and railroad ballast.

The American Pigment Corp. was sold in early 1964 to Hercules Powder Co., and was operated for the latter half of the year as Imperial Color & Chemical Department, Hercules Powder Co., with operations near Hiwassee and at Pulaski. The company mined crude iron oxide near Hiwassee. The crude material included metallic-brown, sienna, umber, and natural-yellow iron oxide. The company also produced finished iron-oxide pigments, including manufactured brown, red, and yellow pigments.

Roanoke.—Rockydale Quarries Corp., at its Rockydale quarry, and Blue Ridge Stone Corp., both near Roanoke, quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Total output was somewhat lower, but value was higher than in 1963.

Shale for use in the manufacture of building brick was produced by Old Virginia Brick Co., Inc., near Salem. Production continued an increasing trend. Ararat Rock Products Co. produced crushed limestone near Hanging Rock, and Cardinal Construction Co. quarried sandstone near Glenvar; both materials were used in highway construction.

Rockbridge.—Output and value of crushed limestone increased moderately over that of 1963, chiefly because of increased demand for materials required in highway construction. Charles W. Barger & Son, Inc., quarried and crushed limestone for concrete aggregate and roadstone at its quarry near Lexington. Lone Jack Limestone Co., Inc., Glasgow, produced crushed limestone and quartzite at nearby quarries for concrete aggregate and roadstone. Limestone for use in Interstate 81 construction was produced by Arrat Products Co. at a quarry near Natural Bridge.

Sand marketed primarily in the glass industry was produced from sandstone quarried near Goshen by the Locher Silica Corp.

Miscellaneous clay was recovered near Glasgow by Locher Brick Co., Inc., for use in manufacturing building brick.

Rockingham.—R. Y. Frazier (The Frazier Quarry, Inc.), and Fred K. Betts, III, Quarry, Inc., both near Harrisonburg, quarried and crushed limestone for use in building and road construction; some agstone was also produced by the latter company, which also installed a new crushing plant in 1964. Interstate Stone Corp., newly reporting in 1964, also near Harrisonburg, produced and crushed limestone for concrete aggregate and roadstone. C. S. Mundy Quarries, Inc., produced and processed limestone at its stationary plant near Broadway. The output was used for concrete aggregate and roadstone, agstone and in cement and lime manufacture. Elkton Lime & Stone Co., Elkton, produced crushed limestone for road material and agstone. Jamison Black Marble Co., Division of General Stone & Materials Corp., crushed marble for use as terrazzo near Harrisonburg.

W. E. Graham & Sons Division, Vulcan Materials Co., newly reporting in Rockingham County, produced crushed stone for concrete aggregate and roadstone at its portable plant near New Market; a limited quantity of riprap was also marketed. A Certificate of Achievement in Safety was awarded to the quarry for operating throughout 1964 without a disabling work injury.

Continuing an upward trend, sand and gravel output increased. Grottoes Sand & Gravel Co., Inc., Grottoes, produced sand and gravel, most of which was processed for building and road construction; a limited quantity was used for fill.

Russell.—Output of coal in Russell County was virtually equal to that mined in 1963; underground operations again accounted for 98 percent of the total production. Producers were Clinchfield Coal Co., Pine Creek Coal Co., and Smith Coal Co. The Upper and Lower Banner, Red Ash, and Kennedy seams were chiefly mined. Operations of the Smith Coal Co. have been conducted by Griffith Banner Coal Co. since July 1964.

Clinch River Quarries, near St. Paul, quarried and crushed limestone principally for use in road construction and maintenance. James River Hydrate & Supply Co., Inc., near Gardner, produced crushed limestone for aggregate, agstone, mine safety dust, and other uses.

Shale used in the manufacture of lightweight aggregate by the Lightweight Aggregate Division, Clinchfield Coal Co., was obtained from the coal-preparation plant of the Moss No. 2 mine of Clinchfield Coal Co., near South Clinchfield.

Scott.—Limestone output and value decreased slightly. Tri-State Lime, Inc., Blountville, Tenn., mined and processed limestone for use as concrete aggregate and roadstone, agstone, fertilizer filler, and filtration use. Natural Tunnel Stone Co., Inc., mined and processed high-magnesium limestone near Clinchport for use in road construction and as railroad ballast. Foote Mineral Co. obtained limestone from its underground mine near Duffield for use in manufacturing lithium hydroxide at its spodumene-processing plant at Sunbright. Penn-Dixie Cement Corp. mined and crushed limestone near Speers Ferry for captive use at its Kingsport, Tenn., cement plant.

A small output of coal was produced in Scott County by three underground operations.

Shenandoah.—Quicklime and hydrated lime were produced from captive limestone quarried nearby by Chemstone Corporation, Strasburg. Limestone was calcined in four gas-fired shaft kilns; a continous hydrator was used to produce hydrated lime. 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 Pennsylvania, Maryland, Ohio, and Virginia.

Chemstone Corp., subsidiary of Minerals & Chemicals Philipp Corp., operated the Lease and Fee limestone quarry operations near Strasburg, which were combined as the Dominion quarries in 1964. The output was processed primarily for use in lime manufacture and as metallurgical fluxstone in blast and open-hearth furnaces. Other uses were in road construction and as filler in asphalt products.

Shenandoah Valley Lime & Stone Corp., Strasburg, quarried and mined high-calcium limestone for fluxstone, chiefly for use in blast furnaces and open-hearth steel plants; some output was used in lime and cement manufacture and as railroad ballast. Toms Brook Lime & Stone Co., Inc., Toms Brook; C. S. Mundy Quarries, Inc., Timberville; and Kipps' Magnesium Limestone Quarry, operated by Nenetah K. Kipps, Mt. Jackson, quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Smyth.—Lime was produced during the entire year by Olin-Mathieson Chemical Corp. from captive limestone quarried near Saltville. Calcining equipment included 3 rotary and 14 vertical kilns that were coal-and-coke fired. All of the output was captively consumed in the production of soda ash, together with salt brine from the company's nearby salt wells. Chlorine was another principal product manufactured from the captive brine.

Crushed limestone for concrete aggregate and road construction purposes was produced by Holston River Quarry, Inc., near Marion. Limestone quarried from its Worthy mine near Saltville by Chemical Division, Olin-Mathieson Chemical Corp., was used primarily for the production of lime at the company kilns, also near Saltville; a limited quantity was used as concrete aggregate.

Crushed stone was produced by Ararat Rock Products Co., near Atkins, chiefly for road construction.

C. R. Snider & Sons Sand Co. and Sayers Sand Co., both near Marion, produced crushed stone and sand. Total output was processed for building and road construction.

Appalachian Shale Division, General Shale Products Corp, mined shale near Marion for use in the manufacture of building brick.

The United States Gypsum Co. began production of gypsum at its new Locust Cove mine near Chatham Hill. The gypsum was trucked to the company's processing plants at Plasterco in Washington County.

Spotsylvania.—Massaponax Sand & Gravel Corp. mined sand and gravel from several pits and processed the material at its stationary plant near Fredericksburg. Output was used in building and road construction.

Crushed granite for concrete aggregate and roadstone was produced by Fredericksburg Stone Co., Fredericksburg; a small quantity was marketed for riprap.

Stafford.—Fredericksburg Sand & Gravel Co., Inc., produced sand and gravel for building and paving uses near Fredericksburg. Ninety percent of the output was processed. Jobe Newton, Fredericksburg, produced sand and gravel, 67 percent of which was processed; the total output was used for building, fill, and miscellaneous uses.

Sussex.—Sand and gravel production decreased, compared with that of 1963. Adams Construction Co. mined and processed sand and gravel for road construction at its stationary plant near Stony Creek.

Tazewell.—Output and value of limestone increased moderately, compared with that of 1963. Crushed limestone, chiefly for concrete aggregate and roadstone, was produced by Pounding Mill Quarry Corp. at Bluefield and at Pounding Mill. Other uses included railroad ballast, stone sand, and coal-mine dust. The corporation re-

ported substantial capital improvement made during 1964. A Certificate of Achievement in Safety was awarded to the Pounding Mill quarry for operating throughout 1964 without a disabling work injury. Limestone quarried by Peery Lime Co., Inc., North Tazewell, and Blue Grass Lime Co., Maxwell, was consumed in the companies' lime kilns in the manufacture of hydrated lime. Coal was used as fuel in the pot kilns. Production was consumed as mason's lime and agricultural lime. Shipments of products were to Virginia and neighboring States, including North Carolina, Tennessee, and West Virginia. Mine safety dust was manufactured by Limestone Dust Corp. at its plant near St. Clair from limestone purchased from Pounding Mill Quarry Corp.'s Bluefield quarry.

Output of coal mined in Tazewell County decreased to almost half that produced in 1963, even though only two less mines were active in 1964. Of the 18 active mines, 14 were underground mines, 2 were strip mines, and 2 were auger mines. Underground mine operations accounted for 83 percent of the coal produced, compared with 48 percent in 1963. Leading producers were Rebecca Coal Co., Alfredton Coal Co., and Bandy Bros. Coal Co. The Upper Seaboard, Red Ash, and Jawbone seams were chiefly mined.

General Shale Products Corp. mined shale from a pit near Richlands for use in building-brick manufacture.

Production of natural gas totaled 12 million cubic feet and was delivered to the pipeline of the Atlantic Seaboard Corp.

Virginia Beach (City).—Output of sand totaled 1,455,000 tons, a 79-percent gain compared with 812,000 tons reported in 1963, and resumed an upward trend interrupted in 1963. The city continued to rank fourth among sand-and-gravel-producing areas in the State. The output, chiefly unprocessed, was used principally for building and road construction and fill. A limited quantity was marketed for industrial use. There was no gravel production reported. Leading in the recovery of sand Were E. C. Womack, Inc., and R. H. Baillio Co., both of Virginia Beach, and E. V. Williams Co., Inc., Norfolk.

Warren.—Argillaceous limestone was quarried by Riverton Lime & Stone Co., Inc., Riverton, for use in the manufacture of masonry cement. Most of the finished product was shipped to Virginia, North Carolina, and the District of Columbia; distribution, however, also included many Eastern and Southern States. The company also quarried and crushed limestone for use in road construction and highway maintenance and for agstone; a limited quantity was marketed as railroad ballast. The company reported that crushing, screening, and storage facilities were improved at its No. 1 quarry during 1964.

A limited quantity of crushed quartzite was produced by J. B. Earle, Front Royal, for use in road construction.

Washington.—Limestone production and value continued a decreasing trend. Crushed limestone, chiefly for concrete aggregate, roadstone, and agstone, was produced by Acme Stone Co., Inc., Division of Lambert Bros., Inc., Division of Vulcan Materials Co., Abindon; Washington County Stone Co., Glade Spring; Meadowview Lime & Stone Corp., Meadowview; and Lambert Bros. Division, Vulcan Materials Co., at Bristol and Glade Spring (abandoned during 1964). A Certificate of Achievement in Safety was awarded the company for

operating throughout 1964 at their Bristol quarry without a disabling work injury. The United States Gypsum Co. mined and processed gypsum at Plasterco. Materials marketed included plasterboard and other gypsum products for distribution, chiefly to the construction industries.

Paving gravel, and a limted amount of paving sand, was mined and processed.

Westmoreland.—Potomac Sand & Gravel Co. produced and processed building and road-construction sand at its stationary plant at Coles Point. A limited amount was produced for other uses.

Wise.—Bituminous-coal production in Wise County totaled 6.8 million tons, compared with 6.2 million tons in 1963, even though the number of mines was 33 less than the 290 active last year. The county produced 21 percent (20 percent in 1963) of the coal mined in Virginia and was first in production of strip-mined coal. Of the 257 mines active in 1964, 221 were underground mines, 20 were strip mines, and 16 were auger mines. Three-quarters of the total tonnage was from underground mines; strip mines accounted for 19 percent. Leading coal producers included Westmoreland Coal Co., Stonega Division (formerly Stonega Coke & Coal Co.), Coal Processing Corp., Stamach Mining Corp., Stallard-Womack Mining Corp., and Sunrise Coal Co., Inc. Important producing seams were Kelly-Imboden, Upper Banner, Clintwood, Blair, and Taggart.

Coke producers (beehive) in 1964 were Wise Coal & Coke Co., Dorchester; Westmoreland Coal Co. (formerly Stonega Coke & Coal Co.), Pine Branch; Norton Coal Co. (two plants at Norton); and Christie Coal & Coke Co., Esserville.

Southwest Quarries, Inc., Big Stone Gap, quarried and crushed high-calcium limestone for concrete aggregate and roadstone. A small quantity of building sand was mined and processed.

Wythe.—Value and output of zinc decreased, while lead production and value increased. The New Jersey Zinc Co. treated zinc and lead ores from both the Ivanhoe and Austinville 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. and the East Chicago, Ind., smelter of Grasselli Chemicals Dept., E. I. du Pont de Nemours & Co., Inc. Lead concentrate was shipped to American Smelting and Refining Co., Baton Rouge, La., and also to an El Paso, Texas, smelter.

Crushed limestone for concrete aggregate and road material was produced by H. D. Crowder & Sons Quarry, Austinville; Pendelton Construction Corp., Wytheville; and a newly reporting producer, Holston River Quarry, Inc., Rural Retreat. Production increased sharply, due principally to construction of Interstate Highway Route 81 in the area. Finely divided limestone recovered from lead and zinc concentration at the New Jersey Zinc Co. operations at Austinville, was marketed chiefly for agricultural purposes, although some material was produced for road construction and fertilizer filler.

Newman Bros. Quarry, Inc., Sylvatus, produced crushed sandstone for concrete aggregate and roadstone. Carrol Rock Co. produced crushed sandstone for subbase material for Interstate Highway 81. Silica Products Co., Wytheville, produced and prepared sand for masonry use.

Limestone in limited amount was quarried and crushed by the city of Wytheville for concrete aggregate and roadstone. Newman Bros. Quarry, Inc., Sylvatus, produced crushed sandstone for concrete aggregate and roadstone.

Silica Products Co., Wytheville, produced and prepared building sand.

York.—Sand for building and road construction was produced and processed by Southern Materials Co., Inc., at its Seaford sand plant. Presson & Brandt, Grafton, mined sand.

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 William N. Hale [1] and Jerry J. Gray [1]

MINERAL production value in Washington totaled $81 million, a record for the State. It was 13 percent greater than in 1963, due principally to increased output of sand and gravel which reached the record level of 31.9 million tons. Value increases also were reported for cement, clays, diatomite, lead, lime, magnesite, olivine, pumice, silver, uranium, and zinc. Declines in value were recorded for carbon dioxide, coal, gold, peat, and stone.

Significant developments occurred throughout the mineral industry. To fulfill increased requirements for cement, Ideal Cement Co. announced plans for a plant at Seattle. Greater demand by the steel industry for refractory magnesia stimulated higher magnesite production. In response to expanding use of olivine as a foundry sand in the United States and Canada, a grinding and sizing plant was constructed at Bellingham.

TABLE 1.—Mineral production in Washington [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stone (grinding pebbles)—short tons	5	(2)		
Clays [3]—thousand short tons	134	$123	128	$119
Coal (bituminous)—do	190	1,380	68	575
Copper (recoverable content of ores, etc.)—short tons	W	W	35	23
Lead (recoverable content of ores, etc.)—do	5,374	1,161	5,731	1,502
Peat—do	37,248	188	35,609	170
Sand and gravel—thousand short tons	22,760	20,490	31,920	25,971
Stone—do	12,934	16,346	10,276	14,871
Talc and soapstone—short tons	2,969	18	2,680	18
Uranium ore—do	117,286	2,545	147,005	3,601
Zinc (recoverable content or ores, etc.)—do	22,270	5,122	24,296	6,609
Value of items that cannot be disclosed: Carbon dioxide, cement, fire clay, diatomite, epsomite (1963), gem stones, gold, lime, magnesite, olivine, pumice, silver, and values indicated by symbol W	xx	24,057	xx	27,518
Total	xx	71,430	xx	80,977

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.
[3] Excludes fire clay; included with "Value of items that cannot be disclosed."

[1] Mineral specialist, Bureau of Mines, Albany, Oreg.

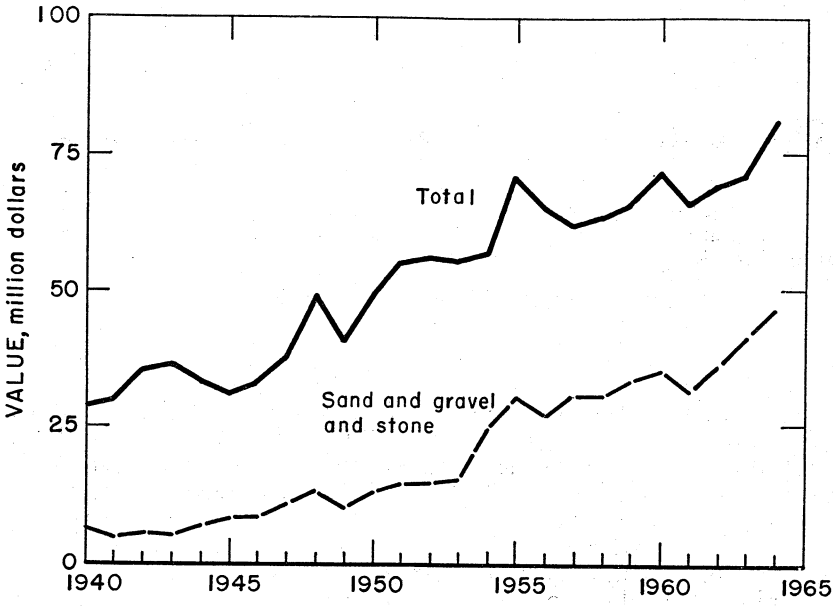


FIGURE 1.—Value of sand and gravel and stone, and total value of mineral production in Washington.

Aluminum output reached a record high of 489,919 tons. To meet increased demand for the metal, Kaiser Aluminum & Chemical Corp. reactivated the Tacoma plant, and Intalco Aluminum Corp. announced plans to build a primary aluminum-reduction plant at Bellingham.

Higher lead-zinc prices increased the value for the commodities and provided for additional exploration and production, despite cessation of mining at two major lead-zinc operations (Grandview and Mineral Right mines).

The lowest recorded coal production in the State's history followed closure of the Kittitas County Roslyn mine. A proposal to reopen the mine through a Federal Small Business Administration (SBA) and Area Redevelopment Administration (ARA) loan failed, and the equipment at the mine and processing plant was sold.

Exploration activity for petroleum heightened as oil companies endeavored to evalute subsurface structures on submerged lands off the Washington coast prior to a Federal-lease sale. Seven companies or coalition of companies leased 27 of the 47 tracts of submerged lands offered for leasing on October 1.

A review was prepared of public issues involved in development of the middle reach of the Snake River.[2]

Consumption, Trade, and Markets.—Indicators of business activity registered both gains and losses. Total personal income and per capita personal income advanced 3.8 percent and 3 percent, respectively. Declines were indicated for heavy engineering awards and

[2] Bessey, Roy F. The Public Issues of Middle Snake River Development. State of Wash. Dept. of Conservation, Division of Power Resources, Bull. No. 9, 1964, 138 pp.

building permit valuation. Value of contracts awarded and work performed by the State highway commission increased. Cash receipts from farm marketings were up, and factory payrolls increased slightly.

Employment.—Total employment aggregated for all industries remained about the same as in 1963. Annual employment in the mineral industries remained about the same, except in the aluminum industry which gained over 600 employees.

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

(Thousands)

Year	Value	Year	Value
1955	$66,173	1960	$71,383
1956	57,207	1961	r 66,381
1957	60,608	1962	r 68,315
1958	61,932	1963	r 71,341
1959	64,565	1964	79,416

r Revised.

TABLE 3.—Indicators of Washington business activity

	1963	1964 p	Change, percent
Personal income:			
Total ..... million dollars	7,575	7,861	+3.8
Per capita ..... dollars	2,558	2,634	+3.0
Construction activity:			
Building permits ..... million dollars	413.3	404.2	−2.2
Heavy engineering awards ..... do	333.9	314.9	−5.7
State highway commission:			
Value of contracts awarded ..... do	79.6	91.8	+15.3
Value of contract work performed ..... do	77.3	83.6	+8.2
Cement shipments to and within Washington ..... thousand 376-pound barrels	5,223.1	5,360.2	+2.6
Cash receipts from farm marketings ..... million dollars	587.4	619.2	+5.4
Factory payrolls ..... do	1,535.5	1,543.5	+.5
Annual average labor force and employment:			
Total labor force ..... thousands	1,128.7	1,134.1	+.5
Unemployment ..... do	67.4	69.5	+3.1
Employment:			
Construction ..... do	43.2	40.9	−5.3
Aircraft ..... do	64.2	52.5	−18.2
Lumber and wood products ..... do	43.7	46.2	+5.7
Food processing ..... do	26.3	26.1	−.8
All manufacturing ..... do	224.0	218.9	−2.3
All industries ..... do	1,059.5	1,064.3	+.5

p Preliminary.

Sources: Survey of Current Business, Construction Review, Pacific Builder and Engineer, Washington State Highway Commission, The Farm Income Situation, Washington Employment Security Department, and Federal Bureau of Mines.

TABLE 4.—Annual employment and total wages in the mineral industries

Industry	1963		1964	
	Employment	Wages (thousands)	Employment	Wages (thousands)
Mining:				
Metal mining	567	$3,656	579	$3,896
Bituminous coal, crude petroleum, and natural gas	280	1,845	164	1,229
Nonmetallic mining and quarrying	1,055	7,316	983	6,956
Total	1,902	12,817	1,726	12,081
Stone, clay, and glass products:				
Cement, hydraulic	505	3,457	509	3,652
Structural clay products	252	1,430	238	1,421
Concrete, gypsum, and plaster products	3,664	24,447	3,551	24,930
Other	902	5,741	925	6,011
Total	5,323	35,075	5,223	36,014
Smelting, refining, and casting:				
Blast furnaces, steel works, rolling and finishing mills	1,511	10,588	1,622	12,063
Iron and steel foundries	925	5,966	1,029	7,052
Smelting, refining, and casting of nonferrous metals, except aluminum	1,073	6,654	1,100	7,363
Smelting, rolling, drawing, and casting of aluminum	6,558	48,487	7,192	54,910
Miscellaneous	732	5,212	796	5,825
Total	10,799	76,907	11,739	87,213
Industrial chemicals [1]	9,219	78,170	9,229	81,763
Petroleum refining and related industries	1,284	9,752	1,314	9,977
Grand total	28,527	212,721	29,231	227,048

[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 Federal Bureau of Mines canvass.

TABLE 5.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	200	38	300	----	54	180
Metal	385	104	830	----	52	63
Nonmetal	207	38	300	----	11	37
Sand and gravel	1,382	291	2,330	1	69	30
Stone	1,332	266	2,137	----	35	16
Peat	31	4	30	----	----	----
Total	3,537	741	5,927	1	221	37
1964: [p]						
Coal	207	39	300	----	51	170
Metal	350	91	738	1	24	34
Nonmetal	165	22	173	----	1	6
Sand and gravel	1,940	409	3,268	2	55	17
Stone	1,320	269	2,145	----	46	21
Peat	45	7	58	----	----	----
Total	4,027	837	6,682	3	177	27

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Abrasive-grade crude silicon carbide, manufactured by the 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 use in bonded and coated abrasive products.

Barite.—No barite was produced. A report described 28 mines and prospects in Stevens and Pend Oreille Counties.[3]

Cement.—Combined output of portland and masonry cement increased 18 percent, and shipments were 17 percent greater than 1963 totals. The industry, comprised of six plants owned by four companies, operated at about 79 percent of capacity compared with 67 percent in 1963. Yearend stocks increased slightly. About 84 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, 77 percent was transported by truck, 22 percent by rail, and 1 percent by boat. The ratio of bulk to paper bag shipments was about 7 : 1.

Cement was distributed to consumers in the State and surrounding region from the six operating plants and from seven distribution terminals. Ideal Cement Co. operated cement distribution plants at Seattle and Vancouver. Kaiser Cement & Gypsum Corp. operated two terminals at Seattle and one at Pasco. Oregon Portland Cement Co. distributed cement from a terminal at Richland, and Lehigh Portland Cement Co. supplied consumers from a Spokane terminal. Lone Star Cement Corp. announced plans to construct a distribution plant at Pasco.

Ideal Cement Co., Denver, Colo., announced plans to build a cement plant with 2.5-million-barrel annual capacity on a 25-acre tract along the Duwamish River in Seattle. The company storage and distribution terminal, which was constructed on the same tract in 1961, would be integrated into the planned operation.

Nine cement plants in Washington and Oregon produced 8,244,000 barrels (376 pounds each) of finished portland cement; shipments from the same plants totaled 8,219,000 barrels. The average value of portland cement shipped from the nine plants was $3.59 per barrel, f.o.b. plant, compared with $3.57 in 1963.

Clays.—The quantity of clays sold or used by Washington producers remained substantially the same as the 1963 total. Less miscellaneous clay for heavy clay products (building brick and draintile) was produced; however, increased output of fire clay for making refractory products (firebrick and block) resulted in a 5-percent rise in total clay value over that of 1963.

Fire clay was mined at six 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

[3] Moen, Wayne S. Barite in Washington. Wash. Div. of Mines and Geol. Bull. No. 51, 1964, 112 pp.

heavy clay products was obtained from 11 pits in 8 counties. King, Spokane, and Whatcom Counties were the sources of clay used in manufacturing cement.

Diatomite.—Quantity and value of diatomite production increased 13 and 38 percent, respectively, over the 1963 totals.

Kenite Corp., the only producer, mined diatomite at a pit 18 miles southeast of Quincy, Grant County. Material, prepared at a company processing plant at Quincy, was sold mainly as a filler to paper manufacturers in the Western and Southern United States. Considerable quantities also were marketed for use as a filter-aid to domestic and foreign consumers. Some was sold for insulation purposes.

Gypsum.—There was no production of gypsum. Gypsite (a mixture of gypsum, quartz, and clay), mined in previous years from the Poison Lake deposit, was processed from stockpiles by Agro Minerals, Inc., at Tonasket. The material was sold for agricultural use.

Gypsum building products were made in Seattle by Kaiser Gypsum Co., Inc., from raw material mined in Baja California, Mexico. Gypsum from Canada was marketed by Greenacres Gypsum Co., Spokane, for agricultural purposes.

National Gypsum Co. announced plans to construct a gypsum-products plant at Tacoma. Gypsum from company deposits in Mexico was to be used at the installation.

Lime.—Output of lime increased 16 percent over the 1963 total.

Pacific Lime, Inc., Tacoma, marketed 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 tannery industries. The Tacoma lime operation received limestone by barge from company quarries at Texada Island, British Columbia.

Limestone was calcined to lime for use in sugar refining at Utah-Idaho Sugar Co. refineries in Grant and Yakima Counties. Calcium carbonate sludge was converted to lime at seven pulp operations for their own use in manufacturing pulp and paper products.

Magnesian Minerals.—Continuing increased demand for refractory magnesia by the steel industry resulted in a 4-percent increase in tonnage and value of crude magnesite mined at the Stevens County Red Marble quarry by Northwest Magnesite Co.

Olivine production continued to increase; processed olivine tonnages were 26 percent greater, and value of processed material increased 29 percent from the 1963 total. Crude material was mined by Northwest Olivine Co., Pacific Olivine, and Scheel Stone Co. in Skagit County, and by Olivine Corp., Whatcom County. Olivine was processed by crushing, grinding, and sizing at plants of Northwest Olivine Co., Hamilton; Northwest Talc & Magnesium Co., Clear Lake; and Olivine Corp., Bellingham. Finished material was sold principally as foundry sand to consumers in the Western and Midwestern States and in Canada.

Pumice.—Output of pumice and pumiceous materials was 50 percent greater than that of 1963.

Pumice was produced for use as concrete aggregate by Ewer Lumber Co. from a deposit near the southern part of Chelan Lake,

Chelan County, and by Dura-Blox, Inc., from a pit near Mt. St. Helens, Skamania County.

Sand and Gravel.—Requirements for sand and gravel by the U.S. Army Corps of Engineers at dam construction activities continued to increase. Greater output was largely the result of increased requirements for materials by the Corps of Engineers for use in railroad and dam embankment and cofferdam construction in Walla Walla County.

Sand and gravel was produced in 37 of the 39 counties. Commercial firms reported operating 167 plants. Output was valued at over $5 million in King County, more than $3 million in Walla Walla County, over $2 million in both Pierce and Spokane Counties, and more than $1 million each in Columbia, Snohomish, and Yakima Counties.

Distribution by use follows: Road building and maintenance, 69 percent; construction, 17 percent; fill, 10 percent; railroad ballast, 1 percent; and miscellaneous, 3 percent. Included under miscellaneous were small but important quantities of special industrial silica-bearing sands utilized for glass manufacturing, grinding, polishing, sandblasting, and foundry applications.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	5,794	$6,504	5,496	$6,316
Road material	3,491	3,431	5,524	5,801
Fill	2,033	1,324	2,714	1,821
Railroad ballast	468	446	376	271
Other [1]	612	780	527	806
Total	12,399	12,485	14,637	15,015
Government-and-contractor operations:				
Building			120	180
Road material	7,773	6,428	16,409	10,235
Fill	2,546	1,530	397	233
Other [1]	43	47	357	308
Total	10,362	8,005	17,283	10,956
All operations:				
Building	5,794	6,504	5,616	6,496
Road material	11,264	9,859	21,933	16,036
Fill	4,578	2,854	3,111	2,054
Railroad ballast	468	446	376	271
Other [1]	656	827	884	1,114
Grand total [2]	22,760	20,490	31,920	25,971

[1] Includes special sands for construction and industrial uses and sand and gravel for miscellaneous unspecified purposes.
[2] Owing to rounding, individual items may not add to totals shown.

Stone.—Stone was quarried in 38 of the 39 counties. Snohomish, Whatcom, and King Counties, in order of descending value, each had production valued at over $1 million.

Basalt, greatest in tonnage quarried, was used for concrete aggregate, roadstone, riprap, ballast, and dimension stone. Dimension stone was produced from basalt deposits in Grant, King, Pierce, and Skamania Counties; from marble quarries in Stevens County; from sand-

stone quarries in Chelan, Ferry, Kittitas, and Pierce Counties; and from miscellaneous-type stone (unclassified) quarries in Whatcom County.

Stone, primarily basalt with other types indicated in parentheses, was quarried for use as riprap in Adams, Clallam, Columbia, Cowlitz, Franklin, Grant, Grays Harbor, Jefferson, King (also granite), Klickitat, Mason, Pacific, Pierce (also sandstone), Skagit, Skamania, Snohomish (also granite and miscellaneous stone), Walla Walla, and Yakima Counties.

Crushed granite from King and Spokane Counties was used as poultry grit; whereas crushed granite from Chelan, Ferry, and Okanogan Counties was used as roadstone.

Limestone production totaled 1.1 million tons valued at $2.4 million. Limestone used in manufacturing cement was from Chelan, Skagit, Pend Oreille, Stevens, and Whatcom Counties. Metallurgical-grade limestone and roadstone was quarried in Stevens County. Crushed limestone for agricultural purposes came from Snohomish, Stevens, and Whatcom Counties. Limestone for use by the paper industry was quarried in San Juan, Stevens, and Whatcom Counties, and limestone for the sugar industry was produced in Spokane County.

TABLE 7.—Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1963		1964	
	Quantity	Value	Quantity	Value
Dimension stone (building)	77	$323	W	W
Concrete and roadstone	8,948	10,271	7,709	$9,745
Riprap	2,439	2,799	1,080	1,365
Railroad ballast	W	W	227	278
Other [1]	1,471	2,954	1,261	3,484
Total [2]	12,934	16,346	10,276	14,871

W Withheld to avoid disclosing individual company confidential data.
[1] Used at cement, paper, metallurgical, and chemical plants; sugar refineries; and for miscellaneous unspecified purposes; and items indicated by symbol W.
[2] Owing to rounding, individual items may not add to totals shown.

Marble output totaled 18,494 tons valued at $266,118. Ground marble whiting for fertilizer filler, dimension stone, and crushed marble for terrazo chips, roofing granules, plaster aggregates, and furnace flux were products from Stevens County quarrying operations. Crushed marble for roofing granules and plaster aggregate also was produced in King County.

Sandstone, quartz, and quartzite output for use as industrial silica totaled 83,792 tons valued at $601,434. The material—produced in Chelan, Pend Oreille, Spokane, and Stevens Counties—was used by the abrasives, cement, glass, metallurgical, and chemical industries.

Talc and Soapstone.—Soapstone output totaled 2,680 short tons valued at $18,372. Production was from three operations in Skagit County. Two operators 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. Ground material was

used in insecticides and paint manufacture. Another producer sold output for sculpturing purposes.

Vermiculite (Exfoliated).—Crude vermiculite mined in Montana was exfoliated at the Spokane plant of Vermiculite Northwest, Inc. Output of the finished product, marketed principally for use in insulation and in lightweight-plaster and concrete aggregates, was slightly less than that of 1963.

METALS

Aluminum.—Aluminum output reached a record high of 489,919 tons, 12 percent more than that of 1963 and 1 percent more than the previous high in 1956.

Kaiser Aluminum & Chemical Corp. partially reactivated the Tacoma plant, and a new firm, Intalco Aluminum Corp., announced plans to build a primary aluminum reduction plant near Bellingham. By yearend, two-thirds of the 41,000-ton annual capacity of the Tacoma plant was in operation; the rest of the capacity was to be activated early in 1965. Intalco Aluminum Corp., a joint venture of American Metal Climax (which owned 50 percent), Pechiney Compagnie of France (25 percent), and Howe Sound Aluminum (25 percent), planned to initiate production from a 73,000-ton-capacity plant by the middle of 1966.

Cadmium.—According to Pend Oreille Mines and Metals Co., each ton of its Metaline district zinc concentrate shipped to the smelter at Kellogg, Idaho, contained an average of 4 pounds of cadmium, for which payment was about $6.50.

TABLE 8.—Primary aluminum plant annual 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)	
1955–59 (average)	476,600	405,964	24	$196,130	26.2
1960	483,000	346,126	17	181,138	[1] 26.0
1961	483,000	331,264	17	168,921	25.5
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	23.7

[1] Price of pig now applied to ingot. The use of the term "pig" was discontinued in August 1960.

Copper.—Most of the 35-ton copper output was a byproduct of lead-zinc mining in the northeastern portion of the State.

In an effort to insure future operations at the Tacoma copper smelter, which had been operating mostly on foreign ores, American Smelting and Refining Company (Asarco) agreed to assist in financing development of a copper property on the north coast of Vancouver, British Columbia. The property, owned by Granduc Mines, Ltd., a subsidiary of Newmont Mining Co., was reported to have an ore reserve of about 32.5 million tons, averaging 1.93 percent copper. Under the agreement, Asarco was to process concentrates from the operation for 10 years and was to advance $10 million on the purchase of this material. Production expected to begin early in 1968, was to be

approximately 2.5 million tons of ore per year, from which concentrate containing an estimated 42,500 tons of copper was to be recovered.

Ferroalloys.—Ohio Ferro-Alloys Corp., Tacoma, and Keokuk Electro-Metals Co., Wenatchee, increased production of ferrosilicon and silicon. Silica rock was obtained from Washington, Montana, and British Columbia (Canada).

Gold.—Output of gold decreased 5 percent below the 1963 figure. The principal gold producers were Knob Hill Mines, Inc. (Knob Hill mine and the adjoining Day Mines, Inc., Gold Dollar mine, Ferry County), and L-D Mines, Inc. (Gold King mine, Chelan County). According to Day Mines, Inc., during the past 3 years L-D Mines mined and milled (or direct smelted) the following tonnages and grades of ore: 1962—44,176 dry tons containing 0.42 ounce of gold and 0.45 ounce of silver per ton; 1963—88,728 dry tons containing 0.30 ounce of gold and 0.32 ounce of silver per ton; 1964—94,002 dry tons containing 0.22 ounce of gold and 0.70 ounce of silver per ton. Knob Hill Mines, Inc., mined ore from the Day-owned Gold Dollar ore body that totaled 29,563 tons, averaging 1.24 ounces of gold and 4.0 ounces of silver per ton.

Lead.—Lead output and value increased 7 and 29 percent, respectively, over the 1963 totals, as the average selling price of lead rose to 13.1 cents a pound compared with 10.8 cents in 1963. Three firms produced nearly all of the lead from four mines—American Smelting and Refining Company (Van Stone mine, Stevens County), American Zinc, Lead & Smelting Co. (Mineral Right and Grandview mines, Pend Oreille County), and Pend Oreille Mines and Metals Co. (Pend Oreille mine, Pend Oreille County). Higher lead-zinc prices provided the impetus to reopen the Van Stone mine and mill that had been idle for 7 years. By yearend, a 50-man crew was operating the open-pit mine 40 hours per week and the 1,000-ton-per-day mill continuously. To operate the mine at capacity, about 75 men would be needed. The Mineral Right and Grandview mines and mill were closed September 10 because ore on the existing mining levels had been exhausted.

Small quantities of lead came from two mines in Stevens County—Gladstone mine (Gladstone Mountain Mining Co.) and Lead Trust mine (Clayloon Uranium Co., Inc.); and from the Lucky Joe mine (Lucky Joe Mining Co.) in Pend Oreille County.

Silver.—Silver output (nearly equal to that of 1963) was primarily a byproduct of gold mining at the Knob Hill and Gold Dollar mines (Ferry County) and the Gold King mine (Chelan County) and of lead-zinc mining at the Pend Oreille mine (Pend Oreille County). The two gold producers supplied 90 percent of the total silver output. Silver was recovered at the average rate of 3.5 ounces per ounce of recoverable gold. Seven lead and zinc operations yielded 9 percent of the silver output, with an average of 5.9 ounces of silver per ton of lead. The remainder was supplied by Cecil B. Murray (Fourth of July mine, Okanogan County) and Miner's Mining, Inc. (Gold King mine, Kittitas County).

Uranium.—Dawn Mining Co. operated its Ford mill on stockpiled ore. Uranium ore output (ore milled) was 147,000 tons valued at $3.6 million, compared with 117,000 tons and $2.5 million in 1963. Mining of uranium ore ended with the 1963 closure of the Midnite mine. The

company stockpile was more than sufficient to fufill a uranium oxide purchase contract with the Atomic Energy Commission. The contract was to expire at the end of 1966.

Zinc.—A higher price for zinc caused the value of production to climb 29 percent, while output increased 9 percent, compared with that in 1963. Higher prices for lead and zinc also stimulated exploration.

American Zinc, Lead & Smelting Co. acquired a purchase-option lease on the Anderson Ranch property near Deep Lake, Stevens County. After evaluating the property, the company announced that 1,000 tons of lead-zinc ore per day would be produced from the mine (renamed Calhoun after R. E. Calhoun, Manager of Mines) by the end of 1965. On September 10, the company closed the Mineral Right and Grandview mines (Pend Oreille County) and was preparing to move the mill to the Calhoun property.

MINERAL FUELS

Carbon Dioxide.—There was a 37-percent decline in the quantity of carbon dioxide recovered from mineral waters in Klickitat County by Gas-Ice Corp. The gas was converted to Dry Ice by the company. Another plant was maintained by the same firm at Finley, Benton County, for making carbon dioxide from an ammonia-plant waste product. Dry Ice and liquid and gaseous carbon dioxide were marketed.

Coal.—Output from five coal mines in three counties was 68,058 tons, a decline of 64 percent from the 1963 tonnage. The major cause of the decline was closure of the Roslyn mine, Kittitas County. King County led in coal production, followed by Thurston and Lewis Counties.

Application for a Federal SBA and ARA loan, submitted for reopening of the Roslyn mine, was denied because the plan was not feasible; a marketing study made by the ARA and SBA indicated that there was no immediate market for the coal. Upon failure of the proposed loan, Northern Pacific Railway Co., at its idle Roslyn operation, auctioned equipment from the Roslyn mine and processing plant in July. Reportedly, equipment valued at $1.5 million was sold for $250,000.

Reports on hydraulic mining research by the Bureau of Mines at Roslyn were published.[4]

Peat.—Production of peat was 35,017 tons from 15 operations, and sales totaled 35,609 tons. King County led in peat production, followed by Snohomish, Thurston, Kitsap, Pierce, and Skagit Counties.

Petroleum and Natural Gas.—Exploration for petroleum intensified as oil companies endeavored to evaluate subsurface structures of submerged lands off the Washington coast prior to a Federal-lease offering scheduled for October 1. Major companies, using geophysical techniques, examined offshore subsurface structures mainly in the Cape

[4] Nasiatka, T. M., and Frank Badda. Hydraulic Coal Mining Research: Tests in a Steeply Pitching Coalbed, Roslyn, Wash. BuMines Rept. of Inv. 6276, 1963, 16 pp. Palowitch, E. R., and W. T. Malenka. Hydraulic Mining Research—A Progress Report. Min. Cong. J., v. 50, No. 9, September 1964, pp. 66–73.

Flattery area off Clallam County and the Copalis Beach area off Grays Harbor County.

Early in the year, the U.S. Department of the Interior, Bureau of Land Management, announced that it would offer for leasing 47 tracts covering 253,940 acres of submerged lands off the coast of Washington in the Copalis Beach-Cape Flattery areas. Annual acreage rental was fixed at $3.00 per acre, and minimum bid was set for $5.00 per acre. The tracts were offered for leasing on October 1 and seven companies or coalition of companies leased 27 tracts containing 155,420 acres. Average bid per acre was $49.96, and the lease revenue totaled $7,764,928. Annual rental fees on the leased acreage totaled $466,260.

In the Copalis Beach area, out of 34 tracts offered, 18 containing 103,580 acres were leased, and total leasing revenue was $6,676,444. Of 13 offered, 9 tracts containing 51,840 acres were leased in the Cape Flattery area; revenue from successful leasing totaled $1,088,484.

TABLE 9.—Test holes drilled for oil and gas in 1964

Company	Well	Total depth (feet)	County
Armour Properties	Bloedel-Ruddock No. 1	4,403	Clallam.
Kincaid-Seattle Hoh Associates	Barlow No. 1	1,550	Jefferson.
Wise & West	Norman No. 1	1,541	Lewis.
E. A. Holman Drilling Co	Floch No. 1	600	Spokane.
Bomar Drilling Corp	Bomar-Jodee No. 1	1,800	Thurston.
Union Oil Co. of California	Tidelands State No. 2	5,073	Offshore.

Source: Washington Division of Mines and Geology.

Oil and gas companies also continued to show strong interest in State-owned lands. Five inland wells and one offshore well were drilled on State-owned property. Washington Water Power Co., continuing exploration for an underground natural gas storage reservoir, drilled five wells in Lewis County. State income from oil and gas leases totaled $119,019. Reportedly, since 1957, the State Department of Natural Resources had received income totaling $588,066 from leased State-owned lands. Although there were no producing wells in Washington, several major oil companies held 5-year leases for exploratory drilling. Most of the outstanding leases on State-owned land were in Whatcom, Pierce, King, Lewis, Clallam, Jefferson, Grays Harbor, and Pacific Counties.

It was announced that a $2.3 million natural gas compressor station would be constructed near Rosalia, Whitman County. The station would be part of a major overall expansion program announced for segments of the Alberta-California natural gas pipeline.

Construction was started in September on a 267-mile pipeline from refineries in the Ferndale-Anacortes area to Portland, Oreg.

REVIEW BY COUNTIES

Mineral production was reported from all 39 counties. With certain important exceptions, output was principally from nonmetal deposits.

Chelan.—Ideal Cement Co. mined and trucked limestone 21 miles from the Soda Springs quarry near Leavenworth to the Merritt rail-

way siding from where it was shipped 35 miles by rail to the company cement plant at Grotto, King County. Ewer Lumber Co. produced pumice from a pit near the southern edge of Chelan Lake. Screened material was sold to Pacific Northwest and Canadian consumers for use in manufacturing concrete blocks. L-D Mines, Inc., quarried sandstone at a deposit near Wenatchee and marketed the silica-bearing material to cement plants.

According to the Day Mines, Inc., annual report to shareholders, L-D Mines, Inc., operated the Gold King mine at capacity throughout the year, and development totaled 4,876 feet of drifts and crosscuts, 2,386 feet of raises, and 21,524 feet of test drilling. A surface ore showing in Dry Gulch, a mile north of the Gold King mine, was evaluated. Because the ore was highly oxidized and did not yield good recoveries of gold and silver by flotation, it was shipped directly to the Asarco smelter at Tacoma.

The aluminum-reduction plant of Aluminum Company of America (Alcoa) at Wenatchee was operated at capacity throughout the year.

TABLE 10.—Value of mineral production in Washington, by counties

(Thousand dollars)

County	1963	1964	Minerals produced in 1964 in order of value
Adams	$229	$65	Sand and gravel. stone.
Asotin	19	62	Stone, sand and gravel.
Benton	179	283	Do.
Chelan	W	1,445	Gold, stone, silver, sand and gravel, pumice.
Clallam	279	231	Sand and gravel, stone.
Clark	1,206	968	Sand and gravel, stone, clays.
Columbia	1,435	2,203	Sand and gravel, stone.
Cowlitz	171	447	Sand and gravel, stone, clays.
Douglas	791	178	Do.
Ferry	W	W	Gold, silver, sand and gravel, stone, copper, lead.
Franklin	580	916	Sand and gravel, stone.
Garfield	164	71	Stone.
Grant	1,591	1,786	Diatomite, stone, lime, sand and gravel.
Grays Harbor	338	634	Sand and gravel, stone.
Island	W	72	Stone, sand and gravel.
Jefferson	317	W	Do.
King	9,418	12,826	Cement, sand and gravel, stone, coal, clays, peat.
Kitsap	493	372	Sand and gravel, stone, peat.
Kittitas	1,020	255	Sand and gravel, stone, gold, silver.
Klickitat	742	1,507	Stone, sand and gravel, carbon dioxide.
Lewis	688	649	Stone, sand and gravel, coal, clays.
Lincoln	122	230	Do.
Mason	133	234	Do.
Okanogan	175	223	Stone, sand and gravel, silver, gold, copper.
Pacific	387	143	Stone.
Pend Oreille	W	W	Zinc, cement, lead, stone, sand and gravel, silver, copper.
Pierce	4,470	4,327	Sand and gravel, lime, stone, clays, peat.
San Juan	W	W	Sand and gravel, stone.
Skagit	3,751	4,108	Cement, olivine, sand and gravel, stone, soapstone, peat.
Skamania	87	169	Stone, sand and gravel, pumice.
Snohomish	2,313	3,358	Sand and gravel, stone, peat, clays.
Spokane	3,773	6,292	Sand and gravel, cement, stone, clays, uranium.
Stevens	4,364	5,294	Uranium, zinc, magnesite, stone, lead, sand and gravel, silver, clays, copper, gold.
Thurston	314	347	Sand and gravel, coal, stone, peat.
Wahkiakum	46	12	Sand and gravel.
Walla Walla	4,593	4,038	Sand and gravel, stone.
Whatcom	W	W	Cement, stone, sand and gravel, olivine, clays.
Whitman	1,085	364	Stone, sand and gravel.
Yakima	1,563	1,356	Sand and gravel, lime, stone.
Undistributed [1]	24,594	25,512	
Total	71,430	80,977	

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.

Clark.—Hidden Brick Co., Vancouver, and Ridgefield Brick & Tile Co., Ridgefield, produced clay for use in making building brick and draintile.

The Alcoa Vancouver aluminum-reduction plant was operated at capacity throughout the year.

Cowlitz.—Reynolds Metals Co. aluminum-reduction plant at Longview was operated at capacity.

Douglas.—Keokuk Electro-Metals Co. operated its Wenatchee alloy plant at about 80 percent of rated capacity; three furnaces were used until October, when the one remaining furnace was added. Seventy percent of the production was silicon metal, and 30 percent was ferrosilicon. Silica rock for the plant was shipped from British Columbia (Canada) and Montana.

Ferry.—Knob Hill Mines, Inc., leading producer of gold and silver in the State, experienced a year of uninterrupted production from its Knob Hill mine and the adjacent Gold Dollar mine owned by Day Mines, Inc., except for a 10-day period in March when the main shaft, damaged by heavy ground, was being repaired. Day Mines, Inc., reported in its anual report to shareholders that earnings from the Gold Dollar ore body were based upon 29,563 tons of ore, averaging 1.24 ounces of gold and 4.0 ounces of silver per ton. Combined development of the Knob Hill and Gold Dollar mines totaled 5,018 feet of drifts and crosscuts, 1,005 feet of raises, 90 feet of shaft sinking, and 8,583 feet of diamond drilling. The JO No. 3 vein was opened on the 12th level for more than one-half of its anticipated length. The vein showed a small improvement in grade over that of the 11th level.

Bear Creek Mining Co. obtained a 2-year permit from the Bureau of Indian Affairs to prospect 20,000 acres of the Colville Indian Reservation by a series of geologic, geophysical, and geochemical surveys. The major objective was to determine the extent of the copper mineralization in the San Poil area.

The geology of the Bald Knob quadrangle, Ferry and Okanogan Counties, was described in a Geological Survey report.[5]

Grant.—Kenite Corp. trucked crude diatomite from a pit 18 miles southeast of Quincy to a company plant at Quincy where it was ground, calcined, classified, and packaged in 50-pound bags for shipment.

King.—The county, in terms of value of mineral commodities, was the principal nonmetal-producing area in the State, with total output valued at $12.8 million. Cement production declined slightly at the Ideal Cement Co. Grotto plant; however, the Lone Star Cement Corp. Seattle plant was operated at an increased rate. Cement consumers in the Seattle area, in addition to receiving cement from the two plants, were supplied from two local distribution terminals of Kaiser Cement & Gypsum Corp. and from one Seattle distribution plant of Ideal Cement Co.

International Pipe & Ceramics Corp. produced clay from the Blum and Harris pits for use in making firebrick. The company also produced clay from the Harris, Palmer, Renton, Pit 55, and Preston pits

[5] Staatz, M. H. Geology of the Bald Knob Quadrangle, Ferry and Okanogan Counties, Wash. U.S. Geol. Survey Bull. 1161–F, 1964, 79 pp.

for use in making building brick and draintile. 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., supplied coal production from the Rogers No. 2, Rogers No. 3, and Franklin No. 12 mines. Peat was dug from seven bogs; the county ranked first as a peat-producing area.

Sand and gravel production of 4.4 million tons valued at $5.0 million was the highest for any county in the State. Most of the output was by commercial firms for building purposes (concrete and mortar) and road construction.

Kittitas.—Coal mining ceased in 1963 with closure of the Roslyn mine, and 1964 was the first year that no coal was produced in the county since records were kept in the early 1900's. Total recorded production (1900–63) from the Roslyn field, which covers an area of 30 square miles southeast of Lake Cle Elum and north of the confluence of the Cle Elum and Yakima Rivers, was 56.2 million tons valued at $187.5 million.

Okanogan.—Gold and silver were produced at two mines—Brethern Lake Quartz (J.H. Ahrendt, gold) and Fourth of July (Cecil B. Murray, silver).

Pend Oreille.—The Metaline Falls plant of Lehigh Portland Cement Co. was the principal nometallic industry. Cement production by the company increased 91 percent, and shipments were 53 percent greater than the 1963 total.

Pend Oreille Mines and Metals Co. reported to stockholders that the ore mined and milled from the Pend Oreille mine totaled 697,000 tons, compared with 652,000 tons produced in 1963. Recoverable metal totaled 4,444 tons of lead and 17,142 tons of zinc. Operating costs were $3.353 per ton of ore, compared with $3.253 the previous year. The property was not operated at capacity because of a shortage of skilled underground workers.

The shortage of workers was due to employment opportunities at a dam being built on the Pend Oreille River near Metaline Falls where higher wages were paid and more overtime work available. The labor shortage may increase as only 200 workers were needed at the site in 1964, but by 1966 1,000 workers would be needed. At midyear, a new 3-year labor contract was signed between the Pend Oreille company and the United Steelworkers of America, and the major benefit gained by the union was wage increases of 8 cents per hour effective July 1, 1964; 17 cents July 1, 1965; and 6 cents July 1, 1966.

Pierce.—Pacific Lime, Inc., marketed lime from its Tacoma plant to Pacific Northwest and Canadian customers for chemical and construction purposes. Builders Brick Co. mined clay from the Clay City pit for use in making brick.

Ohio Ferro-Alloys Corp. operated at capacity its Tacoma plant, that consisted of two electric furnaces producing ferrosilicon and silicon. Silica rock was obtained from Washington and Montana.

Skagit.—The Lone Star Cement Corp. plant at Concrete was the major mineral industry in terms of value. Output was 12 percent greater than the 1963 total. Limestone was hauled about 1 mile in ¾-cubic-yard buckets by aerial tram from the Lang quarry to the Concrete plant.

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 (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)
1960	3	960	----------	21,190	41	7,725	21,317	$7,353
1961	3	982	----------	43,729	38	8,032	20,215	6,367
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
1906–64	NA	15,356	307	[1] 618,895	451	173,651	387,607	[1] 127,809

NA Not available.
[1] Revisions of data presented in Washington chapter of 1963 Minerals Yearbook, Table 14—Production of gold and silver 1906–63.

Olivine mined at the Twin Sisters quarry north of Hamilton was trucked to the Northwest Olivine Co. Hamilton plant for processing. Olivine also was mined at the Yellow Slide quarry by Pacific Olivine and at the Sister 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. Lowell Brick & Tile Co. used clay, dug from a pit near Lowell, to make building brick. Limestone for agricultural purposes was quarried by Miller Lime Co. at the Haystack quarry and by Western Lime Co. from the Bryant quarry.

Spokane.—The county ranked third in terms of nonmetal mineral production value with output valued at $4.7 million. The Irvin plant of Ideal Cement Co. continued to be the principal nonmetallic industry; output increased 1 percent over that of 1963. Clay and limestone for the operation came from the company-owned Spokane County clay pit and the Stevens County Limerock quarry.

International Pipe & Ceramics Corp. produced clay from the Adams, Mica, and Sommer pits. Various clay products and fire clay refractories were made at the company Mica plant.

Stevens.—Magnesite from the Red Marble quarry of Northwest Magnesite Co. was the most valuable nonmetallic mineral produced in the county.

Limestone, marble, and silica-bearing materials were quarried. Limestone was produced by Allied Minerals, Inc., Ideal Cement Co., Peter Janni & Sons, and Northport Limestone Co. Marble was quarried by Ralph Kifers, W. A. Madsen, Manufacturers Mineral Co., and North American Non Metallics, Ltd. Silica-bearing materials were produced by Lane Mountain Silica Co., Manufacturers Mineral Co., and Lovejoy Mining and Leasing Co.

American Smelting and Refining Company reopened the Van Stone mine and mill after 7 inactive years. Higher prices for lead and zinc prompted the reopening.

Triton Mining Co. purchased a 50-percent interest in the Casteel mine, renamed it Silver Crown, and mined and test-milled about 200 tons of ore from the open-pit operation.

The Gladstone and the Electric Point properties were being developed by Stardust Mining Co., a new firm headed by Firmer Walkey and John H. Pyatt. At the Electric Point property percussion drilling disclosed the presence of ore, detected by geochemical methods. A 78-foot vertical shaft was sunk to test and exploit the ore.

Whatcom.—The county continued to rank second in value of nonmetal mineral commodities. The Kaiser Cement & Gypsum Corp. cement plant at Bellingham, the leading nonmetallic operation in the county, continued as the largest source of cement in the State. The plant used limestone from a company quarry near Maple Falls. Mitchell Bay Lime Co. quarried limestone for use in manufacturing paper.

Olivine Corp., at a Bellingham plant, processed olivine quarried in the Twin Sisters olivine-bearing zone. Crude material was trucked 40 miles from the quarry to the 250-ton-per-day crushing, grinding, and screening plant.

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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 James R. Kerr [1]



WEST Virginia mineral production increased by $54.4 million, a 7-percent gain over that of 1963. Coal production, stimulated by generally increased industrial activity and greater captive coal consumption by the electric utility and metallurgical markets, increased by 8.8 million tons. Because the vigor of the mineral economy of the State is closely tied to the coal industry (84 percent of the total), variations in coal production cause similar variations in the total State mineral industry.

Stone production decreased by $1.4 million, mainly because of the completion of a contract for sandstone aggregate and fill. Output of Government-and-contractor limestone and sandstone for road construction was only a small fraction of the 1963 output, indicating completion of major roadbuilding activity.

Output of cement, lime, clay, and sand and gravel increased over that of 1963, but the value of production of the mineral fuels, other than coal, decreased.

Counties leading in value of mineral production, in declining order, were McDowell, Wyoming, Logan, Marion, Kanawha, Monongalia, Raleigh, Boone, Nicholas, and Harrison. All these counties were leading coal-producing areas, and each had production valued in excess of $30 million.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Increased industrial purchases of bituminous coal, and greater production of captive coal by both the utility and metallurgical markets, combined to bring about a 7-percent increase in coal production over that of 1963. Captive coal production increased by 14 percent to 19.1 million tons; open market coal increased by 8 percent to 122.3 million tons. The value of production increased at a greater rate (9 percent) because of increased prices. Average price of total coal output increased by $0.11 to $4.90 per ton. Productivity increased from 14.0 to 15.9 tons per man-day.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

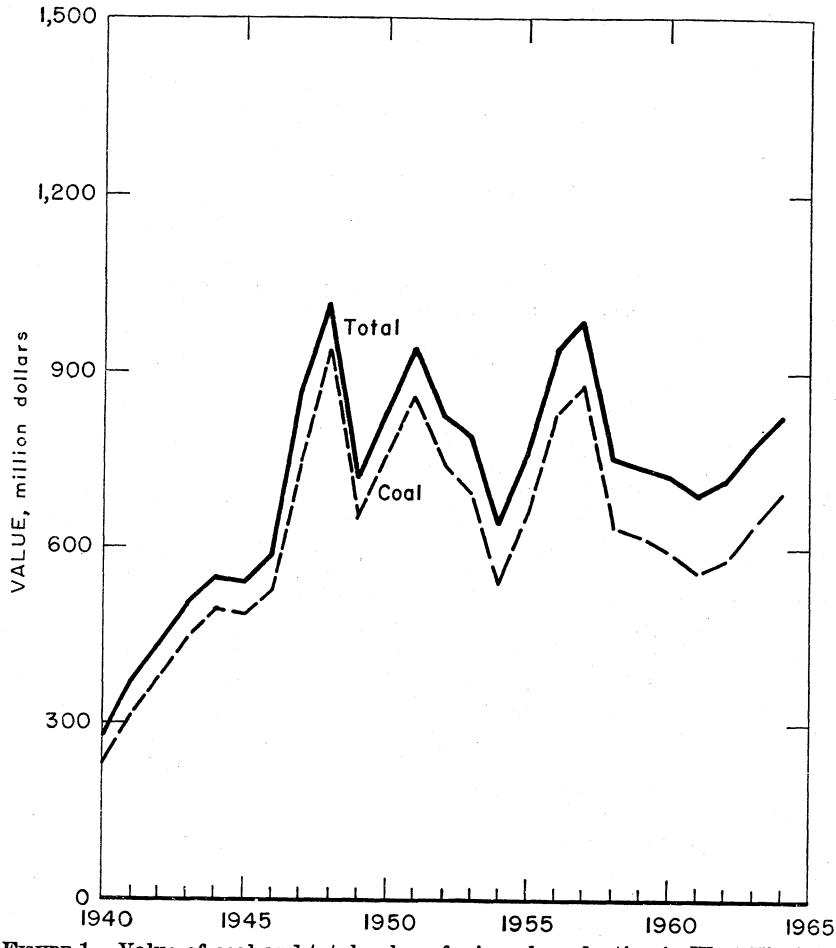


FIGURE 1.—Value of coal and total value of mineral production in West Virginia.

TABLE 1.—Mineral production in West Virginia [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	414	$2,044	[2] 261	[2] $309
Coal (bituminous) do	132,568	634,794	141,409	693,572
Natural gas million cubic feet	210,223	55,919	203,872	50,968
Petroleum (crude) thousand 42-gallon barrels	3,350	13,367	3,370	12,975
Salt thousand short tons	W	W	1,033	3,666
Sand and gravel do	4,808	10,578	5,472	11,555
Stone [3] do	9,452	14,489	7,481	13,105
Value of items that cannot be disclosed: Calcium-magnesium chloride, cement (portland and masonry), fire clay (1964), gem stones, lime, natural gas liquids, dimension sandstone, and values indicated by symbol W	XX	37,051	XX	36,541
Total	XX	r 768,242	XX	822,691

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] 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	Year	Value
1940	$852	1953	$793
1941	969	1954	685
1942	1,056	1955	767
1943	1,089	1956	960
1944	1,064	1957	954
1945	881	1958	755
1946	862	1959	760
1947	1,039	1960	754
1948	1,024	1961	731
1949	741	1962	r 770
1950	855	1963	r 840
1951	946	1964	905
1952	834		

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million
				Fatal	Nonfatal	
1963:						
Coal	44,647	9,287	73,442	123	4,292	60
Nonmetal	1,290	399	3,195	1	38	12
Sand and gravel	298	62	549	1	15	29
Stone	1,346	324	2,733	1	52	19
Total	47,581	10,072	79,919	126	4,397	57
1964: p						
Coal	45,200	9,887	78,200	87	4,360	57
Nonmetal	900	269	2,153		28	13
Sand and gravel	340	70	624	1	11	19
Stone	1,505	375	3,148	1	46	15
Total	47,945	10,601	84,125	89	4,445	5

p Preliminary.

Of the State's coal production, output from 1,452 underground mines comprised 91 percent; 188 strip mines, 6 percent; and 103 auger mines, 3 percent. Surface production increased at a more rapid rate than underground, but because of the magnitude of underground production, it continued to comprise 91 percent of total coal output. Of the underground production, 93 percent was mechanically loaded. Mobile loading machines loaded 51 percent of the mechanically loaded output. Of 811 mobile loading machines—118 less than in 1963—717 were used to load shuttle cars; 57, mine cars; and 37, conveyors. Continuous mining machines loaded 48 percent of the mechanically loaded tonnage, or 21 percent more than in 1963. The number of continuous miners increased by 24.

Of the continuous miners in use, 330 loaded into shuttle cars and 139 loaded onto conveyors. The principal difficulty hindering successful continuous mining has involved the development of haulage systems with adequate capacity to keep the continuous miners operating for maximum amounts of time. Efforts to accomplish continuous transportation resulted in piggy-back and extensible conveyors and high-capacity surge shuttle cars. The technique at some mines is to use mobile loaders in conjunction with continuous miners. Under this

system, which is similar to conventional mining, the continuous miners cut the coal and load it onto the bottom; the mobile loader then loads the coal into shuttle cars. In 1964, 119 mobile loaders were used for this purpose, 14 less than in 1963.

Other equipment in use at underground mines included 205 hand-loaded face conveyors; 1,595 cutting machines (a decrease of 102); 2,160 hand-held and post-mounted drills (a decrease of 186); 184 mobile drills (a decrease of 31); and 1,047 roof-bolting and other drills (711 rotary and 336 percussion). Equipment at strip mines included 299 power shovels, 24 draglines, 10 carryall scrapers, 279 bulldozers, and 59 vertical and 64 horizontal overburden drills. In 1964, haulage equipment included 536 trucks with an average capacity of 16 tons, traveling an average distance of 5 miles from pit to tipple. Equipment at auger mines included 112 augers, 17 power shovels, 1 dragline, 92 bulldozers, and 8 drills, 4 horizontal and 4 vertical. A total of 214 trucks, with average capacity of 17 tons, traveled 6 miles from pit to tipple.

Of total coal production, 76 percent was mechanically cleaned at 153 preparation plants. Of the cleaned coal, 60 percent was washed by wet washing methods other than jigs, 32 percent by jigs, and 8 percent by pneumatic methods. In addition, 33 percent of the output was crushed, and 14 percent was treated, mostly with oil, for dust control. At 54 of the cleaning plants, 96 thermal drying units were in operation, drying 28.4 million tons of coal. Of total coal shipments, 95 percent traveled by rail or water, 3 percent by truck, and 2 percent by other methods.

There were 87 fatal and 4,360 nonfatal injuries in the State, compared with 123 fatal and 4,220 nonfatal injuries in 1963. Injury rates per million manhours of exposure in 1964 were 1.11 fatal (1.67 in 1963) and 55.75 nonfatal (56.80 in 1963).

Fatality rates per million tons of production in 1964 were 0.62 (0.93 in 1963), and nonfatality rates were 31.19 (32.59 in 1963). A total of 45,200 men worked an average of 218.7 days, or 78.2 million manhours. The average number of men working increased 1,900 to 45,200. There were no major disasters in 1964, and the number of fatalities decreased by 36 to 87. Of the total number of fatalities, 79 occurred underground, and 4 took place at surface facilities serving underground mines. Of the underground fatalities, 42 men were killed by falls of roof, 20 in haulage accidents, 9 by machinery, 3 by gas or dust explosions, 2 by falls of face or rib, 1 by electricity, and 1 by a mine fire, and 1 by pressure bump or burst. At surface facilities, two fatal accidents were caused by machinery, one by haulage equipment, and one by an unspecified cause. At strip mines, two fatalities were caused by machinery and one by an unspecified reason. At auger mines the sole fatal injury resulted from a haulage accident.

A method to remove methane from the coal seams before and during mining was being tested by the Federal Bureau of Mines. The methane removal process showed initial success because up to 1,540 cubic feet per minute of methane were removed. Bureau of Mines tests were being conducted cooperatively with the Olga Coal Company on the effectiveness of the water infusion technique developed by the Bureau. Primary emphasis centered on finding a way to incorporate

the water-infusion procedure into the normal work cycle.[2] A company in Worcester, Mass., was reported to be the first industrial concern in New England to receive a unit-train shipment (63 cars—4,500 total tons) of bituminous coal. Ten more such train loads would meet requirements of 43,000 tons per year. The coal originated at the Crichton Mines in West Virginia.[3]

TABLE 4.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1955–59 (average)	138,212	$721,844	1962	118,499	$578,293
1960	118,944	597,222	1963	132,568	634,794
1961	113,070	558,525	1964	141,409	693,572

TABLE 5.—Coal (bituminous) production by counties

(Thousand short tons and thousand dollars)

County	1963		1964	
	Quantity	Value	Quantity	Value
Barbour	2,974	$12,137	2,328	$10,108
Boone	7,419	32,480	8,593	38,454
Braxton	W	W	74	324
Brooke	867	2,997	1,030	3,422
Clay	W	W	73	301
Fayette	5,397	24,253	5,738	25,881
Gilmer	1,112	4,611	W	W
Grant	62	208	W	W
Greenbrier	627	2,385	945	4,069
Hancock			35	92
Harrison	7,125	29,241	8,287	34,351
Kanawha	11,213	44,518	11,002	49,180
Lewis	W	W	170	581
Lincoln	12	28	18	45
Logan	16,275	71,897	15,886	71,771
McDowell	16,067	99,556	17,310	106,715
Marion	9,119	47,694	11,768	60,942
Mason	437	1,448	458	1,537
Mercer	1,366	8,131	1,462	8,751
Mineral	73	269	73	293
Mingo	5,638	28,101	5,609	28,332
Monongalia	W	W	8,528	41,443
Nicholas	6,567	31,133	7,856	37,792
Pocahontas	156	563	W	W
Preston	3,469	12,236	3,534	13,087
Putnam	47	202	5	22
Raleigh	7,628	40,501	7,657	42,777
Randolph	1,027	4,442	1,051	3,874
Taylor	421	1,353	430	1,384
Tucker	98	304	245	843
Upshur	785	3,276	422	1,691
Wayne	69	311	30	139
Webster	1,151	4,971	825	3,501
Wyoming	12,398	66,503	13,480	72,811
Undistributed [1]	12,969	59,045	6,487	29,059
Total	132,568	634,794	141,409	693,572

W Withheld to avoid disclosing individual company confidential data.
[1] Includes data for Marshall and Ohio Counties, and counties indicated by symbol W.

Coke and Coal Chemicals.—Three oven-coke plants with 668 ovens in use produced 3.4 million tons of coke, which was primarily used in blast furnaces of the producing companies. Beehive coke was pro-

[2] Mining Journal. V. 262, No. 6699, p. 53.
[3] New Englander. June 1964, p. 35.

duced at one 194-oven plant. The following data exclude beehive coke statistics to avoid revealing individual company data. Total value of the oven coke, f.o.b. ovens, was $55.7 million; average value per ton was $16.42, a decrease of $0.20 from that of 1963.

A total of 4.9 million tons was carbonized, yielding 68.57 percent per ton of carbonized coal. Total value of the carbonized coal was $37.9 million; average value was $7.66 per ton. To produce 1 ton of coke, 1.46 tons of coal were required, or $11.18 worth of coal per ton of coke. Sources of the coal received at the coke plants were West Virginia (1.4 million tons), Pennsylvania (3.5 million tons), and Virginia (102,000 tons). All of the coal receipts had been washed at cleaning plants before shipment. Of the total coal receipts, 4.1 million tons (83 percent) was high-volatile and 854,000 tons (17 percent) was low-volatile; only a small quantity of medium-volatile coal was received.

Byproducts included 222,000 tons of coke breeze valued at $1.34 million. Average breeze yield was 4.49 percent per ton of coal carbonized. Additional byproducts were coke-oven tar (48.4 million gallons), coke-oven gas (55.6 billion cubic feet), and ammonium sulfate (45,000 tons). Significant quantities of crude light oil were produced, from which benzene, toluene, xylene, and solvent naphtha were recovered.

Natural Gas Liquids.—Production of natural gas liquids increased over that of 1963, but value declined. The latest published statistics for production of this commodity were for the year 1962, when $19.7 million of output was reported. In that year, output of natural gasoline totaled 32.9 million gallons and LP gases production was 345 million gallons. According to the American Gas Association, reserves of all natural gas liquids were 69.8 million barrels. Thirty-five natural gas processing plants were in operation at the beginning of 1964. Of this total, 29 had compression facilities, 5 had absorption facilities, and 1 had refrigeration-absorption facilities. Capacity by types of plants in gallons were (1) absorption, 801,700; (2) compression, 640,700; and (3) refrigeration-absorption, 5,000. Types of natural gas liquids recovered included propane, butane, liquified-petroleum gas mixtures, and natural gasoline. Principal producers were South Penn Oil Co. (26 plants), Hope Natural Gas Co., Manufacturers Light & Heat Co., Libbey Owens Gas Dept., and Pure Oil Co.

Petroleum and Natural Gas.—Production of crude oil increased slightly, but because of a decrease of $0.14 in the wellhead price per barrel to $3.85, the value of production declined 3 percent below that of 1963. Marketed output of the natural gas industry was 3 percent less than that of 1963. The average wellhead price of natural gas was $0.25, the lowest since 1958. Income from marketed natural gas dropped almost $5 million below that of 1963.

During the year, a total of 1,189 new wells (excluding 357 holes drilled for unspecified purposes) were drilled. Of this total, 620 were gas wells, 74 were oil wells, and 280 were combinations of oil and gas. Other drilling included 65 service wells (storage, water injection, brine, rock salt, water, and pressure) and 150 dry holes. Included in the number of completions were 35 wildcat tests, of which 3 resulted in oil discoveries, 18 in gas discoveries, and 14 in dry holes. The State issued 1,327 permits to drill or deepen holes, 100 less than in 1963. Except for well completions having combinations of oil and gas, which

increased by 38 wells, there was a decline in drilling completions compared with 1963.

Depth of wells drilled during 1964 ranged from 67 to 13,999 feet. Of 1,189 new wells drilled, total footage was 3.15 million, an average of 2,650 per well. Total footage drilled was 600,000 less than that of 1963. Drilling activity was centered in the north-central counties. Ritchie County led with 131 well completions, but Lewis County logged the greatest drilling footage (335,000). Counties with the largest number of total completions were Ritchie (131), Doddridge (122), Roane (118), Lewis (111), and Calhoun (98). Completions in these counties comprised almost half of the State total. Forty-five wells were drilled to the Lower Devonian Oriskany sandstone or deeper. Of these, one-third were dry, and no oil was found below the Oriskany. One Oriskany well in the Lost River gasfield in Hardy County reportedly had an initial flow potential of 44 million cubic feet of gas per day, after acidizing. The Lost River field was placed on production in the winter of 1964–65. Exploratory drilling for Oriskany gas continued in Hampshire County in an effort to extend the small Augusta gasfield, which has never been put on production. Two gas wells, with initial flow potentials of 16 and 22 million cubic feet per day, were completed in the Lower Silurian Tuscarora sandstone in southern Preston and northern Tucker Counties. However, gas from these wells contained 16 to 18 percent nitrogen, which reduced calorific content to approximately 800 Btu per thousand cubic feet. Most of the gas production in the north-central counties was from the Big Injun sandstone (Mississippian). Much of the oil production was also from the Big Injun, which has yielded most of the "new" oil since 1960. In Barbour and Upshur Counties in the north-central area, the Riley and Benson sands (Upper Devonian) were the principal producing zones. However, rapid declines in production are typical of the Big Injun, Riley, Benson, and Oriskany sandstones. Approximately nine-tenths of the completed producing wells were fractured, thereby greatly increasing rates of production. Data on hydraulic fracturing is collected by the University of West Virginia Engineering Experiment Station. Secondary recovery operations continued to increase, with gas injection giving better results than most waterflood projects. The number of producing wells as of December 31, 1964, was 33,008 (35,047 in 1963), of which 13,205 were oil wells and 19,803 were gas wells. At yearend, 452 wells were in various stages of completion.[4]

Gas storage facilities were operated in 33 fields in 18 counties. An estimated 50 billion cubic feet of gas went to underground storage in 1964. Ultimate gas storage in the State was estimated at 368.5 billion cubic feet. Principal storage companies were Atlantic Seaboard Corp., Cabot Corp., Equitable Gas Co., Hope Natural Gas Co., Manufacturers Light & Heat Co., and United Fuel Gas Co.[5]

There were two petroleum refineries in operation in 1964. These refineries had facilities for skimming, cracking, and lube lubricating oil recovery.

Reserves of crude oil, as estimated by the American Petroleum Institute, totaled 58.7 million barrels, or 2 percent more than in 1963.

[4] Bulletin of the American Association of Petroleum Geologists. V. 49, No. 6, June 1965, pp. 679–683.
[5] Oil and Gas Journal. V. 63, No. 18, May 3, 1965, p. 144.

According to the American Gas Association, the natural gas reserve was 2,348 billion cubic feet, 36.8 billion cubic feet more than in 1963.

NONMETALS

Clays.—Combined output of fire clay and miscellaneous clay increased by more than 100,000 tons over that of 1963. A major portion of the increased output was miscellaneous clays for manufacturing building brick; fire clay consumption for building bricks also increased significantly. Larger quantities of miscellaneous clays were consumed in cement manufacture. Fire clay output for firebrick and fireblock (mostly ladle brick) remained at virtually the same rate as that of 1963. Eleven companies operated 7 open-cut and 4 underground mines. Hancock County was the leading clay-producing area, followed closely by Berkeley.

TABLE 6.—Clays sold or used by producers

Year	Fire clay		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1955–59 (average)	365,908	$2,161,228	292,095	$269,777	658,003	$2,431,005
1960	346,053	2,328,865	279,570	310,341	625,623	2,639,206
1961	259,340	1,964,265	215,497	228,531	474,837	2,192,796
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

W Withheld to avoid disclosing individual company confidential data.

Cement.—The combined shipments of portland and masonry cement was 10 percent greater than in 1963; average value per barrel was slightly lower. The only producer in the State was located at Martinsburg in Berkeley County. The plant used the wet process, and most of the cement manufactured was of the non-air-entrained, general use and moderate heat type. The company purchased most of its energy requirements. Cement shipments, which were almost evenly divided between truck and railroad haulage, were mainly to Maryland, Virginia, District of Columbia, Western Pennsylvania, and West Virginia. Much of the output was sold to ready-mixed concrete companies and concrete product manufacturers. The company quarried its cement rock, limestone, and shale requirements.

Gem Stones.—Miscellaneous mineral specimens were collected by hobbyists and amateur lapidarists at scattered locations throughout the State. Specimens collected in recent years included stilbite, fossils, cave onyx, and aragonite.

Lime.—Lime production in 1964 increased for the first time in recent years. Virtually all of the increase was attributed to higher output of refractory lime (dead-burned dolomite). In addition, a significant quantity of captive lime production was consumed as flux in open-hearth steel furnaces. Three plants were in operation, two in Berkeley County and one in Jefferson County.

Sand and Gravel.—Output of sand and gravel increased 14 percent over that of 1963. Value of output increased at a lower rate because of price reductions. Average prices decreased $.09 to $2.11 per ton.

Building sand and gravel increased 26 percent over that of 1963, but paving sand and gravel was produced at virtually the same rate. The value of ground sand output dropped 7 percent during 1964. Ground sand uses with the largest decreases in value of production were glass and pottery. Virtually the entire sand and gravel output was washed, screened, or otherwise prepared. Over half the State output was shipped by barge; truck and railroad shipments both were in excess of 1 million tons.

The leading producing areas in terms of tonnage were Hancock, Morgan, Wood, and Ohio Counties. Leading in terms of value of production were Morgan, Hancock, and Wood Counties.

There was no Government-and-contractor production during 1964. Sand and gravel was produced at 26 locations in 15 counties. A significant quantity of sand and gravel output was dredged from State rivers.

TABLE 7.—Sand and gravel sold or used by producers, by classes of operations and by uses

(Thousand short tons and thousand dollars)

Class of operation and use	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,156	$1,493	1,446	$1,807
Paving	702	1,034	601	931
Fire or furnace	54	62	61	70
Railroad ballast	10	15	11	17
Gravel:				
Building	1,052	1,305	1,340	1,642
Paving	630	1,026	748	1,242
Fill	27	46	W	W
Undistributed [1]	1,177	5,597	1,265	5,846
Total sand and gravel	4,808	10,578	5,472	11,555

W Withheld to avoid disclosing individual company confidential data.
[1] Includes other construction sand (1963), glass, molding, blast, engine, other industrial, ground sands, and fill, and miscellaneous gravel (1963), fill gravel (1964), railroad ballast, and other gravel, and items indicated by symbol W.

Natural Salines.—Calcium-magnesium chloride was produced from well brines at a plant in South Charleston. Output, which increased significantly over that of 1963, was sold mostly for coal preparation use.

Salt.—All of the salt produced was consumed by the producer, mostly in the manufacture of chlorine, but also in other chemical applications. With the exception of the Kanawha County plant, which recovers naturally occurring brines, the other salt-producing companies produced brines by dissolving rock salt.

Slag (Iron-Blast-Furnace).—Crushed air-cooled blast furnace slag was produced at Weirton for sale as an aggregate material.

Stone.—Total output of stone decreased 21 percent from that of 1963. Most of the decrease was attributed to a loss of more than 2 million tons in crushed sandstone production. Large sandstone requirements in the construction of a rock-fill dam in Grant County were met in 1963; there was no output of sandstone in the county in 1964. In addition, Government-and-contractor production of limestone and sand-

stone, which totaled almost 1.2 million tons in 1963, was reduced to less than 70,000 tons in 1964. This major loss in noncommercial output of aggregate and roadstone reflected a temporary lull in the initial phases of road construction. Production of crushed limestone was the only stone industry in the State with increased activity over that of 1963. Crushed limestone output increased by almost 1.5 tons to a total of 7.0 million tons in 1964. Commercial output of aggregate and roadstone was about one-third higher, and output of flux increased by more than 20 percent.

Leading areas for stone production were Berkeley, Jefferson, Monongalia, and Greenbrier Counties, all leading limestone-producing counties. The leading sandstone-producing counties were Randolph and Harrison.

TABLE 8.—Stone sold or used by producers, by uses

Use	1963		1964	
	Short tons	Value	Short tons	Value
Crushed and broken stone:				
Concrete and roadstone	3,690,708	$5,985,389	2,725,191	$4,303,718
Railroad ballast	514,665	678,323	663,994	847,182
Agriculture	140,469	309,763	131,012	317,033
Undistributed [1]	5,106,374	7,515,997	3,960,600	7,636,846
Total	9,452,216	14,489,472	7,480,797	13,104,779

[1] Includes limestone for glass, asphalt filler, coal dust, poultry grit, stone sand, cement, lime, riprap, flux, and miscellaneous uses; and refractory sandstone.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. had a full year's operation at its five-stand rolling mill in its primary aluminum plant at Ravenswood.

Ferroalloys.—Production of ferroalloys increased over that of 1963. Fourteen different ferroalloys were produced, the leading of which were ferrosilicon, ferromanganese, and ferrochromium. Output of the latter increased significantly over that of 1963, but there was large reduction in production of ferrochromium silicon.

Iron and Steel.—National Steel Corp. planned to renovate its Weirton facilities, by combining two large oxygen furnaces, a large degassing unit, and the world's largest continuous casting machine, to make steel slabs in one coordinated operation. Estimates of the cost of the program ranged from $50 to $75 million.[6] Wheeling Steel announced its continuing $145 million expansion program with contracts awarded for new equipment at its Wheeling plant.[7]

Zinc.—Matthiessen & Hegeler Zinc Co. operated a vertical-retort zinc smelter at Meadowbrook.

Zirconium.—The Parkersburg zirconium-hafnium plant of Carborundum Metals Co. was to be closed in 1964. A slowdown in sales of the metals for nuclear applications was reported.

[6] American Metal Market. V. 71, No. 55, Mar. 19, 1964, pp. 1, 6.
[7] American Metal Market. V. 71, No. 87, May 5, 1964, p. 4.

REVIEW BY COUNTIES

Barbour.—Coal production in the county decreased 22 percent, as 10 fewer mines were in operation. Of total production, 68 percent was mined at 21 underground mines, 29 percent at 14 strip mines, and 3 percent at 2 auger mines. Of the underground output, 88 percent was mechanically loaded. A greater portion was loaded by continuous miners even though three fewer machines were in use. A decrease of eight mobile loading machines brought about a sharp decrease in mobile-loaded tonnage. Two cleaning plants prepared 45 percent of total output. Clinchfield Coal Co. closed its heavy media plant in 1963. Grafton Coal Co. re-opened its Pepper strip mine in May and was the leading producer of strip coal in the County. Strip mining equipment included 25 power shovels, 2 drag lines, and 3 carryall scrapers. La Rosa Fuel Co., the leading strip producer in 1963, abandoned operations in March 1964. The leading underground mining companies were Badger Coal Co., Inc., and Bethlehem Mines Corp.

TABLE 9.—Value of mineral production in West Virginia, by counties [1]

County	1963	1964	Mineral production in 1964 in order of value [2]
Barbour	$12,140,987	$10,107,739	Coal.
Berkeley	15,872,596	17,579,928	Cement, stone, lime, clays.
Boone	32,480,214	38,453,749	Coal.
Braxton	W	W	Coal, stone.
Brooke	3,467,899	3,836,906	Coal, sand and gravel.
Cabell	W	W	Sand and gravel, clays.
Clay	W	300,856	Coal.
Doddridge	44,136	155	Stone.
Fayette	24,252,827	25,881,332	Coal.
Gilmer	4,610,828	W	Do.
Grant	W	W	Coal, stone.
Greenbrier	W	W	Do.
Hampshire	26,000	----------	
Hancock	W	W	Clays, sand and gravel, coal.
Hardy	W	W	Stone.
Harrison	W	34,742,424	Coal, stone.
Jefferson	W	4,208,251	Stone, lime.
Kanawha	45,173,193	50,103,809	Coal, salt, clays, stone, calcium-magnesium chloride.
Lewis	1,340,131	W	Coal, stone, clays.
Lincoln	W	W	Coal, sand and gravel.
Logan	71,897,345	71,770,931	Coal.
McDowell	99,555,784	106,715,453	Do.
Marion	47,693,854	60,942,148	Do.
Marshall	W	15,487,799	Coal, salt.
Mason	W	1,596,272	Coal, sand and gravel.
Mercer	8,215,999	W	Coal, stone, clays.
Mineral	531,932	W	Stone, coal.
Mingo	28,101,056	28,331,698	Coal.
Monongalia	37,364,059	43,583,022	Coal, stone, sand and gravel.
Morgan	W	W	Sand and gravel.
Nicholas	31,140,868	37,801,132	Coal, stone.
Ohio	W	W	Coal, sand and gravel.
Pendleton	369,358	569,243	Stone.
Pleasants	W	W	Salt.
Pocahontas	W	749,394	Coal, stone, sand and gravel.
Preston	W	W	Coal, stone.
Putnam	201,680	22,253	Coal.
Raleigh	40,606,716	W	Coal, stone, sand and gravel.
Randolph	W	W	Coal, stone.
Taylor	W	W	Coal, clays.
Tucker	W	1,040,983	Coal, stone, sand and gravel.

See footnotes at end of table.

TABLE 9.—Value of mineral production in West Virginia, by counties [1]—Continued

County	1963	1964	Mineral production in 1964 in order of value [2]
Tyler	W	W	Sand and gravel, salt.
Upshur	$3,320,488	W	Coal, stone.
Wayne	W	$138,574	Coal.
Webster	4,971,295	3,501,090	Do.
Wetzel	W	W	Sand and gravel.
Wood	W	1,582,000	Do.
Wyoming	66,511,297	72,820,851	Coal, sand and gravel.
Undistributed	188,351,283	190,822,836	
Total	r 768,242,000	822,691,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Calhoun, Jackson, Monroe, Ritchie, Roane, Summers, and Wirt Counties are not listed because no production was reported.
[2] Excludes natural gas, natural gas liquids, petroleum, gem stones, and some stone not assigned to specific counties; included with "Undistributed."

Berkeley.—The cement industry was the leading mineral industry, with Standard Lime & Cement Co. producing both portland and masonry cement near Martinsburg. The company also produced limestone and clay from nearby mines for raw material. Cement production, which was shipped mainly to ready-mixed concrete companies, was 10 percent greater than that of 1963.

The county also was the leading limestone-producing area. In addition to consumption by the cement industry, limestone was produced for concrete aggregate and roadstone, blast- and open-hearth flux, lime manufacture, and railroad ballast. Producers were Standard Lime & Cement Co. and Appalachia Stone, both divisions of Martin-Marietta Corp., and Blair Limestone Division, Jones & Laughlin Steel Corp., all of Martinsburg; and Inwood Quarry, Inc., Inwood. Blair Limestone Division and Standard Lime & Cement Co. also produced lime. Output of the former company was mostly for open hearth flux; output of the latter company was for masonry mortar plus a small quantity for water treatment. Both the Martinsburg mine and quarry received Certificates of Achievement in Safety for operating the year without a disabling work injury.

Clay production increased 59 percent; the county ranked second in clay output. Clay for building brick was produced by Continental Clay Products Co., Martinsburg, and by The United Clay Products Co., North Mountain.

Boone.—Coal production increased 16 percent, as 21 additional mines were in operation. Of total production, 79 percent was produced at 68 underground mines, and 21 percent at 5 strip and 10 auger mines. The county advanced from eighth to sixth rank in coal production. Increased auger production brought it to first ranking in auger production. At the 5 strip mines in operation, 13 power shovels, 17 bulldozers, and 24 large capacity trucks (23 tons) were used. At the underground mines, 92 percent of the output was mechanically loaded by 48 mobile loaders and 6 continuous miners (3 less than in 1963). Seven cleaning plants prepared 71 percent of total output; 20 percent was crushed, and 3 percent was treated. Four of these plants had thermal drying equipment. Leading underground producers were Westmoreland Coal Co. (two mines), Eastern Gas & Fuel Associates, and Armco Steel Corp. The leading auger mining companies were

Ranger Fuel Corp., Glenn-Brooke Coal Co., Desrosiers Brothers Coal Co., and Princess Susan Coal Co. Auger mines were opened by Whitesville A & S Coal Co. and Ranger Fuel Corp. The largest strip mine was operated by Glenn-Brooke Coal Co. The P & S Coal Co. purchased the mine and cleaning plant of Glogora Coal Co. in early 1964.

Braxton.—Coal production decreased sharply as the Guardian Coal Co. closed its mine and cleaning plant in March 1964. Four underground mines were in operation. Meadow Stone & Paving Co., the only stone producer in the county, produced smaller quantities of sandstone aggregate in 1964.

Brooke.—Increased auger mining activity was the leading factor in the 19-percent increase in coal production in 1964. Of total production, 56 percent was mined at four underground mines, 38 percent at six strip mines, and 6 percent at four auger mines. Huberta Coal Co. was the leading strip mining company. Maglich Coal Co. also opened an auger mine in 1964. Windsor Power House Coal Co., the leading underground mining company, produced captive coal for power generation. Cleaning plants were operated by Weirton Ice & Coal Supply Co. and Windsor Power House Coal Co. The former company operated a merchant cleaning plant, washing coal for mines located in both West Virginia and Ohio.

Production of sand and gravel decreased 10 percent below that of 1963. Duquesne Sand Co., the largest producer, operated a dredge on the Ohio River producing construction aggregate. The Brilliant Materials Co. produced fire or furnace sand and gravel for aggregate at a stationary plant near Follansbee.

Cabell.—Sand and gravel, dredged from the Ohio River by two companies, was produced at a significantly lower rate than in 1963. Ohio River Dredging Co. and Tri-State Materials Corp., both of Huntington, produced construction aggregate. The latter company took over the assets of Union Sand & Gravel Co. in July 1964.

Red shale was produced near Barboursville by Barboursville Clay Manufacturing Co. for building brick manufacture.

Clay.—Clinchfield Coal Co., which had produced the major portion of the coal output in the county in 1963, did not operate in 1964. This was the reason for the sharp decrease in coal output. Five underground mines and one auger mine were active. Most of the underground production was hand-loaded onto face conveyors. There was no mechanical cleaning, but 14 percent was crushed and 3 percent was treated with oil for dust allaying purposes.

Doddridge.—Feather Construction Co. was idle in 1964 but sold a small quantity of sand stone aggregate from stockpile.

Fayette.—Coal production increased 6 percent in 1964, even though 32 fewer mines were in operation. Of total output, almost nine-tenths was produced at 148 underground mines (37 less), the balance at 8 strip mines (5 more) and 4 auger mines. Of the underground output, 81 percent was loaded mechanically. Of this total, 64 percent was loaded by 59 mobile loaders, and 35 percent by 21 continuous miners (6 more). Of the total output, 63 percent was cleaned at nine preparation plants; 19 percent was crushed, and 7 percent was treated. Two of the cleaning plants use thermal drying equipment. The leading

underground producers were Allied Chemical Corp., The New River Co., Clifftop Smokeless Coal Co., Ranger Fuel Corp., and Riverton Coal Co. The leading strip mining company was Ranger Fuel Corp., the leading auger mining company was Eagle Coal & Dock Co., a new producer which also opened two strip mines. Mary Frances Coal Co. abandoned all four of its underground mines in 1964.

Gilmer.—Coal production increased over that of 1963. Two new underground mines were put into production, and a strip mine was opened. Rochester & Pittsburgh Coal Co. operated the only coal cleaning plant. Most of the underground output was loaded mechanically by 11 mobile loaders and 1 continuous miner. The entire coal output was from the Pittsburgh seam, which averaged 72 inches in thickness.

Grant.—The Alpine Coal Co., which began operating in 1963, went into full production in 1964 and caused more than a tenfold increase in county output. The company also put into operation a large modern cleaning plant with thermal drying equipment. North Branch Coal Co. also operated a cleaning plant.

Limestone production decreased significantly. Crushed limestone, mostly for aggregate and roadstone, was produced by Bean's Lime & Stone, Inc. (Petersburg), and Keplinger Lime Co., Inc. (Maysville). Stone & Webster Engineering Corp., a major sandstone producer in 1963, was idle all of 1964 because of the completion of a stone-fill dam.

Greenbrier.—Ten additional underground mines were in operation, and coal output increased by over half that of 1963. One strip mine was operated by Milem Construction Co. The leading underground producer was Gauley Coal & Coke Co., which opened the Saxswell No. 5 mine in May 1964 and produced large quantities of coal. There was no mechanical cleaning plant operating in the county, but Gauley Coal & Coke Co. shipped its output to a company cleaning plant in Nicholas County. Less than one-fifth of underground output was loaded mechanically; three mobile loaders and one continuous miner were used.

Production of crushed limestone increased 17 percent over that of 1963. Uses were for concrete aggregate and roadstone, railroad ballast, dust for coal mines, stone sand, and agricultural stone. Producers were Acme Limestone Co. and The H. Frazier Co., Inc., both of Fort Spring, and Savannah Lane Quarries, Frankford. The latter company was new in 1964.

Hampshire.—There was no limestone production in 1964. Williams Quarry, Inc., which went out of business in April, leased its quarry to Fairfax Sand and Crushed Stone Co. Terra Alta Limestone Co. also was idle in 1964.

Hancock.—The county was the leading area for clay production in the State. The Globe Brick Co., Newell, mined fire clay for manufacturing ladle brick. Crescent Brick Co., Inc., New Cumberland, produced fire clay for manufacturing firebrick and fire block and for use in foundries. The latter company was on strike from September 1 to the end of 1964. The Globe Brick Co. purchased new diesel loading machines in 1964. West Virginia Fire Clay Manufacturing Co. closed its mining operation in September 1963.

Sand and gravel production increased 36 percent, and the county continued to be first ranked in the State. Dravo Corp. operated two

dredges on the Ohio River near New Cumberland, producing sand and gravel for building. Volino Brothers Blocks, Arroyo, produced sand and gravel for building at a stationary plant.

C. & S. Coal Co. operated a strip coal mine.

Hardy.—Production of crushed limestone increased 38 percent over that of 1963. The Baker Lime plant of the State Soil Conservation Service, Potomac Valley District, operated a quarry near Baker and produced crushed limestone for paving aggregate and agricultural purposes.

Harrison.—Coal production increased 16 percent even though five fewer mines were active. Of the total production, 80 percent was mined at 49 underground mines, 17 percent at 30 strip mines, and 3 percent at 12 auger mines. The county was first ranked in strip production. Equipment in use at the strip mines included 49 power shovels (31 in 1963), 5 draglines, 40 bulldozers, and 71 trucks which averaged 13 tons in capacity. Strip production increased 26 percent over that of 1963. Leading strip producers were Bitner Fuel Co., Wesgin Mining Co., Panora Co., Inc., and Mountaineer Coal Co. Doyle Coal Co., Inc., opened a new strip pit in June. Other strip mines opened were operated by Scott Coal Co. and Thompson Coal and Construction Co. Yochym Bros. Coal Co., the leading strip mining company in 1963, was idle in 1964. Of the underground production, 96 percent was mined by mechanical means. Twenty-five continuous miners loaded 70 percent of output; the balance was loaded by 25 mobile loading machines. The largest underground producers were Clinchfield Coal Co. (three mines) and Mountaineer Coal Co. (two mines). Of the total production, 55 percent was washed at six cleaning plants, one less than in 1963, as Petitto Bros. Coal Co. plant was idle. All six plants had thermal drying equipment.

Paul Harrold doubled production of crushed limestone at a quarry near Wolf Summit. Total crushed sandstone production increased 27 percent. North View Stone Co., Clarksburg, and Salerno Bros., Inc., Shinnston, produced crushed sandstone for concrete aggregate and roadstone.

Jefferson.—The county ranked second in limestone production. The output was used primarily for blast furnace flux and for the manufacture of dead-burned dolomite. Other uses included open hearth flux, refractory uses, aggregate, railroad ballast, and agricultural uses. Producers were Blair Limestone Division, Jones & Laughlin Steel Corp.; Eastern Limestone Operations of the United States Steel Corp.; and Standard Lime and Cement Co., Division of Martin Marietta Corp., all of Millville. The last-named company also produced quicklime for refractory uses. West Virginia Lime Co. produced calcareous marl near Charles Town for agricultural uses.

Kanawha.—Coal production decreased 2 percent from that of 1963; the county was ranked fifth in coal production. Of total production, 88 percent was mined at 104 underground mines, 10 percent at 15 auger mines, and 2 percent at 7 strip mines. Of the underground production, 96 percent was mechanically loaded, of which 84 percent was loaded by 81 mobile loading machines, 15 percent by 16 continuous miners (4 more than in 1963), and the balance by 5 hand-loaded face conveyors. Leading producers were The Carbon Fuel Co. (11 mines), Union Carbide Corp. (5 mines), Valley Camp Coal Co. (3 mines),

Cannelton Coal Co. (4 mines), and Oglebay Norton Co. (5 mines). These companies produced 76 percent of the county output. Strip production decreased sharply, chiefly because of the lower production by the major strip mining companies. In addition Perry and Hylton, Inc., closed its strip mine in March 1964. The county dropped from first to second place in auger production. Union Carbide Olefins Co., a large auger mining company, abandoned its auger operation. Eight cleaning plants were in operation, washing 59 percent of county output; 47 percent was crushed and 9 percent was treated with oil. The Turner Fork No. 4 mine of Union Carbide Corp., Metals Division, received a Certificate of Achievement in Safety for operating the year without a disabling work injury.

Inorganic Chemical Division, FMC Corp., produced and consumed salt in brine for the manufacture of chlorine at South Charleston. The company also recovered calcium-magnesium chloride.

Fire clay was produced by West Virginia Brick Co. and Charleston Clay Products Co., both of Charleston, for manufacturing building brick. Dimension and crushed sandstone was quarried by Tony Pacifico Stone Quarry, Inc., near Charleston. Crushed standstone was produced by Mazzella Quarries, Inc., South Charleston, for aggregate uses.

Lewis.—Coal production decreased by more than one-half, even though four additional mines were in operation. Of total coal production, 70 percent was mined at six strip mines (four more than in 1963), 23 percent at two auger mines, and 7 percent at two underground mines. There was no mechanical loading or mechanical cleaning in 1964.

Crushed sandstone, chiefly for roadbuilding aggregate, was produced by Andersons' Black Rock, Inc., Charleston, and Weston Stone Co., Weston. Miscellaneous clay was mined by Weston-Jane Lew Brick and Tile Co., Weston, for manufacturing building brick.

Lincoln.—Coal was dredged from the Guyandote River by four companies, one more than in 1963. Dial Coal Co. dredged a small quantity of engine sand near Branchland.

Logan.—The county dropped from first to second place in coal production; output decreased 2 percent from that of 1963. Underground production comprised 97 percent of total output. In 1964, 61 underground mines, 6 auger mines, and 1 strip mine were in operation. Virtually all of the underground production was loaded mechanically. There were 135 mobile loading machines (38 less than in 1963) and 18 continuous miners (2 more) in operation. The leading underground mining companies were Island Creek Coal Co. (6 mines), Amherst Coal Co. (5 mines), Omar Mining Co. (3 mines), and Boone County Coal Corp. These companies produced over two-thirds of the total county production. The county ranked third in auger production. The leading auger mining company was Raleigh Eagle Coal Co. Of the total production, 85 percent was cleaned by 20 cleaning plants, 5 of which had thermal drying equipment; 18 percent was crushed and 22 percent was treated for dust-allaying mainly with oil. Mines abandoned during the year included the No. 33 underground mine of Island Creek Coal Co. and the Alma No. 2 mine of The Jewel Ridge Coal Corp., which had employed 110 men. A new underground mine was opened by Princess Coals, Inc., and Buffalo Mining Co. reopened a mine that had been abandoned in 1960.

McDowell.—Coal production increased 8 percent, and the county assumed first position among the coal-producing counties in the State. Of the total production, 94 percent was mined at 223 underground mines, 4 percent at 10 strip mines, and 2 percent a 10 auger mines. Of the underground output, 89 percent was mechanically loaded, of which 75 percent was mined by 79 continuous miners, 24 percent by 61 mobile loading machines, and the balance by 12 hand-loaded face conveyors and 4 duckbills. The county ranked third in strip production. Stripping equipment included 23 power shovels, 1 carryall scraper, 17 bulldozers, and 36 trucks averaging 22 tons in capacity. At 10 auger mines, 12 augers, 5 bulldozers, and 33 trucks averaging 20 tons in capacity were in use. Of the total production, 91 percent was washed at 20 cleaning plants, 1 less than in 1963; 38 percent was crushed, and 45 percent was treated with oil. Six of the cleaning plants had thermal drying equipment. The leading producers were United States Steel Corp. (7 mines), Bishop Coal Co., Island Creek Coal Co. (3 mines). Eastern Associated Coal Co., Olga Coal Co., and Pocahontas Fuel Co. (4 mines). These companies produced 78 percent of the total output. The leading strip and auger mines were operated by United States Steel Corp. This corporation opened an underground mine, No. 17, at Gary in September. A Certificate of Achievement in Safety was awarded to the No. 1 mine of United States Steel Corp. for operating a full year without a disabling work injury.

The Semet-Solvay Division of Allied Chemical Co., Inc., purchased the Superior Pocahontas Mining Co. in November.

Marion.—Even though only 12 mines were in operation, the county ranked fourth in coal production. Production increased 29 percent with two fewer mines in operation. Most of the output was mined at 10 underground mines; 2 strip mines were active. Continuous mining accounted for 91 percent of the mechanically loaded production. A total of 62 continuous miners (7 more than in 1963) were in use, and 45 mobile loaders were used in conjunction with the miners. The balance of the mechanically loaded tonnage was loaded by 12 mobile loading machines into shuttle cars. Almost the entire output was prepared at eight cleaning plants; 33 percent was crushed. Six of the cleaning plants had thermal drying equipment. Leading producers were Mountaineer Coal Co. (3 mines), Bethelhem Mines Corp. (two mines), Eastern Gas & Fuel Associates, and Joanne Coal Co.

Marshall.—Coal production increased 9 percent over that of 1963. Mines operated by Hanna Coal Co. and Valley Camp Coal Co. produced most of the coal output. Of the mechanically loaded coal, 97 percent was loaded by 19 continuous miners. Of total output, 80 percent was mechanically cleaned; 75 percent of output was crushed.

The county continued as the leading salt-producing area, although production decreased 4 percent from that of 1963. Output, for manufacturing chemicals (mostly chlorine), was produced by Pittsburgh Plate Glass Co., New Martinsville, and Solvay Process Division, Allied Chemical Corp., Moundsville.

Mason.—Coal production increased 5 percent over that of 1963. Of total output, 69 percent was mined at 10 underground mines, 30 percent at 3 strip mines, and the balance at 1 auger mine. The leading underground producing company was Lieving Coal Co. Of the underground production, 96 percent was loaded mechanically by 6 mobile loading machines and 13 hand-loaded face conveyors.

Production of sand and gravel increased 58 percent over that of 1963. Output was used mostly for building and paving aggregate. Producers were Mason Aggregates, Inc., West Columbia, and Letart Sand and Gravel Co., Inc., Letart. Liverpool Salt Co. abandoned its operation in 1963.

Mercer.—Even though 11 fewer mines were in operation, coal production increased 7 percent over that of 1963. Mines active included 28 underground, 6 strip, and 6 auger. Of the underground output, 91 percent was loaded by 11 mobile loading machines, 3 continuous miners (2 more), and 5 hand-loaded face conveyors. Cleaning plants washed 86 percent of the total output. There was no thermal drying, and a small quantity was treated and crushed. The leading underground producing coal company was the Pocahontas Fuel Co., and the leading strip mining company was Junior Pocahontas Fuel Co.

Oakvale Stone Co., produced crushed sandstone for concrete aggregate and roadstone at a portable plant near Princeton. Virginia Brick & Tile Co. mined shale near Princeton for manufacture of building brick and other heavy clay products.

Mineral.—Crushed limestone was produced in larger quantities, mostly for use as construction aggregate. Producers were Aurora Stone Co., Short Gap, and Spencer Lime Co., Keyser.

Coal production continued at virtually the same rate in 1964. Three underground mines loaded 64 percent of the county output; the balance was mined at one strip operation. Of the underground production, almost one-third was mechanically loaded by one mobile loading machine. There was no mechanical cleaning in the county, but 34 percent of the coal was crushed and 3 percent was treated with oil.

Mingo.—The number of active mines decreased by 23 to 80, and production decreased slightly from that of 1963. Of total coal production, 96 percent was mined at 72 underground mines, 1 percent at 1 strip mine, and 3 percent at 7 auger mines. Of the underground production, 91 percent was mechanically loaded by 64 mobile loaders (10 less than in 1963) and 7 continuous miners (1 less). Of total county output, 80 percent was washed at seven cleaning plants, five of which operated thermal drying equipment. The leading underground producing companies were Island Creek Coal Co. and National Coal Mining Co. The Lobata Mining Co. purchased the property of the By-Product Coal Co. in April.

Monongalia.—Coal production increased even though 13 less mines were in operation in 1964. Of the total output, 98 percent was mined at 42 underground mines, the balance from 7 strip and 2 auger mines. Of the underground production, 98 percent was mechanically loaded by 14 mobile loading machines and 34 continuous miners (7 more than in 1963). Three cleaning plants prepared 67 percent of output; one plant used thermal drying equipment. The leading underground mining company continued to be Christopher Coal Co., with four mines in operation. Indian Creek Mining Corp. purchased the Fort Rand Mining Co. in May.

Production of crushed limestone increased 62 percent over that of 1963, and the county ranked third among the limestone-producing counties. Two producers wer in operation; Greer Limestone Co. produced mostly concrete aggregate and roadstone, and Green Bag Cement Co., Division of Marquette Cement Manufacturing Co., pro-

duced crushed limestone chiefly for use in cement manufacture. Other uses for limestone included railroad ballast, agricultural stone, and riprap. Sand and gravel was produced by Deckers Creek Sand Co. at a stationary plant near Masontown for use as glass sand and engine sand.

Morgan.—Pennsylvania Glass Sand Corp. produced industrial sand near Hancock, with output used chiefly for manufacturing glass, abrasives, and pottery, and for engine sand. The county ranked second in the State in sand and gravel production but first in value of production.

Nicholas.—The county ranked ninth in coal production; production increased 20 percent. Of the total production, 96 percent was mined at 95 underground mines, 3 percent at 8 strip mines, and the balance at 5 auger mines. Of the underground production, 95 percent was mechanically loaded. Loading equipment included 36 mobile loading machines (9 less than in 1963), 63 continuous miners (1 more), and 61 hand-loaded face conveyors. Of the total output, eight cleaning plants washed 84 percent; this was one plant less than in 1963, as Sewell Coal Co. closed a mine and plant in 1964. Leading underground producers were Gauley Coal & Coke Corp. (six mines), Sewell Coal Co., Johnstown Coal & Coke Co., Summersville Coal Co., and Peerless Eagle Coal Co. Gauley Coal & Coke Corp. purchased the Burton mine from Oglebay-Norton Coal Co. The company closed its Saxwell No. 3 mine and opened the Saxwell No. 6 mine during the year. Leading strip-mining companies were Imperial Coal & Construction Co. and Janutolo Construction Co., Inc.

A small amount of sandstone was produced by Nettie Sand Co., Nettie, for use as construction sand. The Rupert mine of the Imperial Coal & Construction Co. received a Certificate of Achievement in Safety for operating throughout 1964 without a disabling work injury.

Ohio.—The Valley Camp Coal Co., which employed 120 men and was the only coal-producing company in the county, closed its No. 5 mine in May 1964. The entire county output was mechanically loaded by 10 mobile loading machines. Most of the coal was mined from the Pittsburgh No. 8 coal seam, which averaged 60 inches in thickness.

The county ranked fourth in the State in sand and gravel production. The only producer, Delta Concrete Co., produced building sand and gravel at a dredge on the Ohio River, near Wheeling.

Pendleton.—Production of crushed limestone increased 16 percent over that of 1963. Output was mostly for aggregate use, rock dust for coal mines, agricultural purposes, glass and lime manufacture, and metallurgical use. Producers were Germany Valley Limestone Co., Division of Greer Limestone Co., and North Fork Lime Producers Cooperative, Inc., both at Riverton, and Ruddle Lime Co., Franklin.

Pleasants.—A large increase in salt production was reported by the Inorganic Chemical Division, FMC Corp., Bens Run. Salt brine was shipped by barge to South Charleston, where it was used for manufacturing chlorine.

Pocahontas.—Coal production remained at virtually the same rate as that of 1963. Only four underground mines were in operation, compared with nine underground and one auger mine in 1963. The leading producer was McCombs & Nutter Coal Co. There was no cleaning, drying, or treatment of coal production.

Terra Alta Limestone Co. produced small quantities of road-building aggregate near Marlinton.

Preston.—Coal production increased 2 percent as 11 new mines were in operation. Strip-mine production continued to increase, being 7 percent greater than that of 1963; the county ranked second in strip production. Auger production increased by half that of 1963. Of underground production, 49 percent was mechanically loaded by 21 mobile loading machines (8 more than in 1963), 2 continuous mining machines (1 less), and 8 hand-loaded face conveyors. Strip-mining equipment included 38 power shovels, 10 draglines, 36 bulldozers, and 71 trucks, averaging 19 tons in capacity. Five cleaning plants, one more than in 1963, prepared 37 percent of the total output. A new plant was operated by PBS Coals, Inc., using pneumatic methods. The leading strip producers were Kingwood Mining Co., Daugherty Coal Co., Inc., and Mary Ruth Corp. The leading underground producers were Chapel Coal Co. and Sandy Creek Fuel Corp. The Chapel Coal Co. closed its No. 3 mine, idling 30 men, and Sandy Creek Fuel Corp. opened a new mine (No. 12) in January, employing 37 men. Preston Limestone Co., Inc., Kingwood, produced crushed limestone for aggregate and agstone. Rhine Creek Stone Co., formerly Brookside Stone Co., quarried dimension sandstone for irregular shaped stone at a quarry near Brookside.

Putnam.—Two small underground mines produced only a small fraction of their 1963 output.

Raleigh.—Coal production remained at virtually the same rate as that of 1963, but the county dropped from 6th to 10th place in output. Of total production, 93 percent was produced at 108 underground mines, 4 percent at 7 strip mines, and 3 percent at 7 auger mines. Twelve fewer underground mines were in operation. Of the underground production, 92 percent was mechanically loaded. Of this total, 69 mobile loaders (8 less than in 1963) loaded 83 percent, 26 continuous miners (6 more) loaded 16 percent, and 17 hand-loaded face conveyors loaded the balance. There were 17 cleaning plants in operation, washing 81 percent of the total output. Three new cleaning plants were in operation, Low Volatile Coals Inc., Royal Mines, Inc., and Smith & Stover Coal Co. There was no thermal drying, but 13 percent of the output was crushed and 6 percent was treated. Leading underground mining companies were Winding Gulf Coals, Inc., Eastern Gas & Fuel Associates, Armco Steel Corp., and Slab Fork Coal Co. The leading strip and auger mining company was the Ranger Fuel Corporation. Smith & Stover Coal Co. opened a mine in May employing 29 men, and Monarch Fuels Inc. opened a mine in June employing 22 men. Winding Gulf Coals Inc. purchased the Corder Smokeless Coal Co. in July, and McCormick Enterprises purchased the abandoned No. 3 mine of Amigo Smokeless Coal Co.

The county ranked first in sandstone production. Raleigh Stone Co. operated the Sullivan quarry and crushing plant near Glen Morgan, and Table Rock sand plant quarried sandstone near Beckley. Output was entirely for concrete aggregate and roadstone. A small quantity of building sand was produced by Beaver Rock Co. at a stationary plant near Beaver.

Randolph.—Coal production increased slightly. Of the total output, 88 percent was mined underground and 12 percent at strip and auger mines. Of the underground production, 84 percent was mechanically

loaded. Equipment included 4 mobile loading machines, 15 continuous miners, and 22 hand-loaded face conveyors. The leading producer was the A. C. & H. Coal Co., Inc. One small cleaning plant was in operation. Three Fork Coal Co. purchased the Cassity Coal Co., Inc., in April, employing 49 miners.

Limestone production increased 40 percent. Output was used primarily for concrete aggregate and roadstone. Small quantities of railroad ballast and agricultural stone also were produced. Elkins Limestone Co., Inc., and Sam G. Polino & Co. operated stationary plants near Elkins and Bowden, respectively. The Aggregate mine of Elkins Limestone Co., Inc., received a Certificate of Achievement in Safety for operating without a disabling work injury in 1964.

Taylor.—Even though four less mines were active, production of bituminous coal increased 2 percent over that of 1963. Of the total output, 47 percent was mined at 22 underground mines and 53 percent at 5 strip mines. Two auger mining companies active in 1963 did not operate in 1964. Most of the underground mines were small hand-loading operations. There was no cleaning or treatment, but 44 percent of the output was crushed. Thompson Coal & Construction Co. was the largest strip producer. Lang Bros., Inc., abandoned its mine, and R. T. McVicker Coal Co. was idle. Miscellaneous clay and shale was produced by Grafton Brick Co., Thornton, for manufacturing building brick.

Tucker.—Coal production in Tucker County was two and one-half times greater than that of 1963. Of total output, 80 percent was mined at five strip mines and 20 percent at one underground mine. The Douglas Coal Co. operated four strip mines, and the sole underground mine was operated by Pittman Coal Co. There was no preparation or other treatment of the coal output.

Elkins Asphalt Co. quarried limestone near Parsons for aggregate. Sandstone was quarried by the Feather Construction Corp. at the Tucker "G" portable plant near Davis. Sand for building and paving was produced by Fairfax Sand & Crushed Stone Co. near Thomas.

Tyler.—Ohio River Sand & Gravel Corp. operated a dredge on the Ohio River and produced sand and gravel for building and paving, and gravel for railroad ballast and fill.

Inorganic Chemical Division, FMC Corp., produced salt brines at Bens Run for chlorine manufacture at the company plant at South Charleston.

Upshur.—Coal production decreased 46 percent from that of 1963, continuing the decline in coal production in the county in recent years. Of the county production, 90 percent was loaded at 19 underground mines and 10 percent at 2 strip mines. The main factor in the decreased production was the permanent closing of Reppert Fairmont Coal Co. in July, which had employed 115 men. Of the underground production, 75 percent was mechanically loaded by six mobile loaders (four less than in 1963) and two continuous miners (two less). The Marino Coal Co. was idle. Two cleaning plants washed 66 percent of county output. Hackers Creek Coal Co. closed its mine in 1963.

Crushed sandstone was produced by Basil R. Heavner at a portable plant near Buckhannon for aggregate and roadstone.

Wayne.—Less production of bituminous coal was reported. Five small underground mines were in operation. Laval Sand Co., Inc., indefinitely abandoned its plant in 1963.

Webster.—Coal production decreased 28 percent from that of 1963; nine less mines were active in 1964. Of total production, 92 percent was mined at 32 underground mines and the balance at 2 strip mines and 1 auger mine. Of the underground production, 91 percent was mechanically loaded by 12 mobile loading machines (6 more than in 1963), 8 continuous miners, and 17 hand-loaded face conveyors. Of total production, 89 percent was washed at three cleaning plants, one of which had thermal drying equipment; 23 percent was crushed, 24 percent was treated. The leading underground producers were The Bergoo Corp. (opening two mines in 1964) and Johnstown Coal & Coke Co. Cherry River Coal & Coke Co. was idle in 1964, and Sugar Creek Coal Corp. significantly decreased its mining activity in 1964.

Wetzel.—Ohio Valley Sand Co., Inc., produced sand and gravel for building and paving from a dredge on the Ohio River near New Martinsville.

Wood.—Sand and gravel production more than doubled over that of 1963; the county ranked third in sand and gravel output. Ohio River Sand & Gravel Co., which had been idle, was active again in 1964. Ohio Sand & Gravel Co., Kanawha Sand Co., and Pfaff & Smith Builders Supply Co. operated dredges. Output was used mostly for construction aggregate, plus a small quantity of railroad ballast and fill.

Wyoming.—The county ranked third in bituminous coal production; output increased 9 percent over that of 1963. Four additional mines were in operation in 1964. Underground production increased 7 percent, auger production increased 35 percent, and strip production was six times more than that of 1963. The chief reason for the large increase in strip mining activity was the opening of large mines by Lafayette Springs Coal Co. and United Pocahontas Coal Co. Of the underground production, 94 percent was mechanically loaded, of which 95 mobile loaders (19 less than in 1963) loaded 61 percent, 44 continuous miners, 38 percent, and hand-loaded face conveyors, 1 percent. Of total county output, 91 percent was cleaned at 13 preparation plants, 5 of which had thermal drying equipment. Sixteen percent was crushed; 14 percent was treated. The leading underground producers were Eastern Gas & Fuel Associates, Itmann Coal Co., Island Creek Coal Co., Semet Solvay Division of Allied Chemical Co., Pocahontas Fuel Co., and Amigo Smokeless Coal Co. Both Robinson Phillips Coal Co. and Wyoming Pocahontas Coal Co. opened new mines late in 1964, employing 20 and 18 men, respectively.

A small quantity of sand was produced by Tolers Sand Co., Clear Fork, 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 Wesley A. Grosh [1]

MINERAL production in Wisconsin was valued at $70.0 million, an increase of nearly 5 percent over that of 1963. Nonmetals represented nearly 83 percent of the total value, metals 17 percent, and mineral fuels (peat) the remainder. Metals increased in value of production by 8, and nonmetals by 4 percent. The increase in metal production value was due to increased production and value of lead and zinc, which more than offset the decrease in value of iron ore production.

The increased value of mineral production over that of 1963 on a constant dollar basis was only 3 percent, as compared with 5 percent on a current dollar basis.

Consumption, Trade, and Markets.—Total minerals used in construction-cement shipments and imports, sand and gravel, stone, clays, other than used in cement manufacture, and lime shipments, plus imports, increased in value about 2 percent over 1963, as a result of sustained construction activity in the State.

TABLE 1.—Mineral production in Wisconsin [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones: Grinding pebbles---short tons	561	$21	W	W
Clays---thousand short tons	111	140	119	$147
Iron ore (usable)---thousand long tons, gross weight	938	W	524	W
Lead (recoverable content of ores, etc.)---short tons	1,116	241	1,742	456
Peat---do	2,667	136	3,261	136
Sand and gravel---thousand short tons	r 35,363	r 24,863	34,348	24,695
Stone---do	13,583	18,744	13,901	20,232
Zinc (recoverable content of ores, etc.)---short tons	15,114	3,476	26,278	7,148
Value of items that cannot be disclosed: Abrasive stones (tube-mill liners), cement, gem stones, lime, and values indicated by symbol W	XX	19,220	XX	17,193
Total	XX	r 66,841	XX	70,007

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).

[1] Physical science administrator, Bureau of Mines, Minneapolis, Minn.

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

(Thousands)

Year	Value	Year	Value
1953	$59,389	1959	$71,276
1954	58,234	1960	77,575
1955	68,633	1961	73,148
1956	64,560	1962	r 68,246
1957	70,250	1963	r 67,190
1958	73,056	1964	69,350

r Revised.

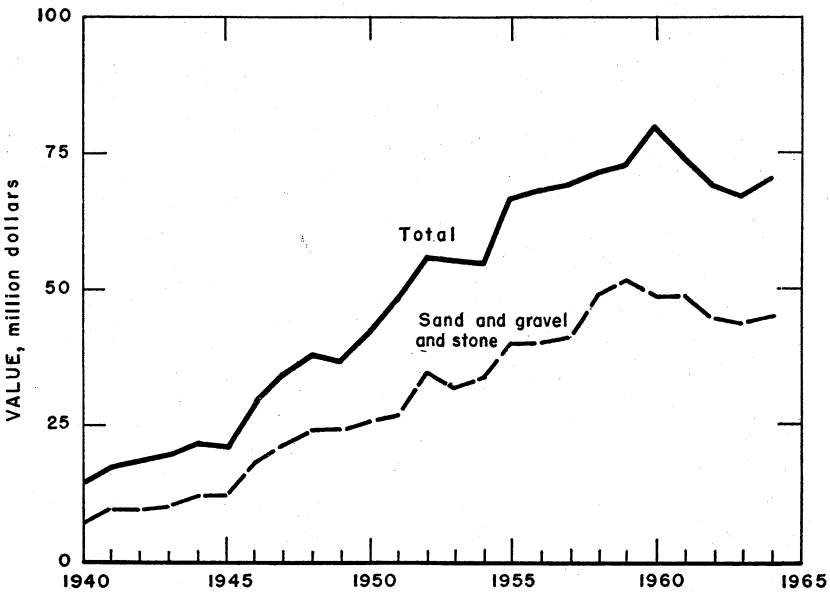


FIGURE 1.—Value of sand and gravel and stone, and total value of mineral production in Wisconsin.

Iron ore production continued the decline which had started in 1961, reflecting the continued decline in the competitive position of underground direct-shipping ores. The increase in lead-zinc prices since midyear 1963 was more fully reflected in the increased production in 1964 as more mines and mining companies became active.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Metal	286	72	575		34	59
Nonmetal	75	16	132		1	8
Sand and gravel	2,210	397	3,375	2	43	13
Stone	1,907	397	3,323	1	94	29
Peat	12	1	12			
Total	4,490	883	7,417	3	172	24
1964: p						
Metal	300	77	616	3	23	42
Nonmetal	65	13	110		2	18
Sand and gravel	2,125	383	3,253		58	18
Stone	2,060	425	3,605	1	83	23
Peat	15	3	23		2	86
Total	4,565	901	7,607	4	168	23

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Baraboo Quartzite Co., Inc., produced grinding pebbles from a quartzite deposit in Sauk County. Quantity and value of production increased from 1963.

Cement.—Production of portland cement increased less than 1 percent in quantity over that of 1963; shipments increased 7 percent in quantity and 8 percent in value. Production of masonry cement increased 5 percent in quantity but shipments increased less than one-half percent. Although some cement was shipped to Illinois, Michigan, and Minnesota, over 5.7 million barrels of portland and 390,000 barrels of masonry cement were shipped into Wisconsin from plants in Illinois, Indiana, Iowa, Michigan, and Minnesota.

Types of cement produced were general use and moderate heat and high-early strength portland cements, and masonry cement. The average mill value per 376-pound barrel of portland cement was $3.48, compared with $3.47 in 1963.

Marquette Cement Manufacturing Co. produced portland and masonry cements at Milwaukee by the dry process using limestone from Michigan and shale from Illinois. One kiln was operated. Manitowoc Portland Cement Co., subsidiary of Medusa Portland Cement Co., manufactured cement at Manitowoc by the wet process using limestone from Michigan and clay obtained locally. Four kilns were operated.

Most of the cement produced in the State was shipped by truck, although truck shipments decreased 8 percent from 1963. Rail shipments increased 65 percent. Eighty-nine percent of the production was shipped in bulk, the same as in 1963.

Clays.—Miscellaneous clay or shale was produced in the State by five companies. Production increased 7 percent in quantity and 5 percent

in value over 1963. The value used for clay production is an approximate mining cost, since all clay was used by producing companies in their own plants. Products manufactured from clay, in decreasing order of quantity of clay used, were cement, building brick, vitrified sewer pipe, and other heavy clay products. Clay was produced in Dunn, Fond du Lac, Manitowoc, Pierce, and Racine Counties.

Lime.—Production of lime increased 13 percent in quantity and 11 percent in value over 1963. Quicklime constituted 72 percent of the production; the remainder was hydrated lime. Lime was shipped into Wisconsin from Illinois, Iowa, Michigan, and Minnesota. Total shipments into the State decreased 7 percent, although there was a slight increase in the quantity of hydrated lime shipped in.

Four companies at six plants produced quicklime or hydrated lime. The Western Lime & Cement Co. operated three plants producing quicklime and hydrated lime at Green Bay and at Eden, and hydrated lime at Knowles. Cutler-La Liberte-McDougall Corp. produced quicklime at Superior. Mayville White Lime Works at Mayville produced quicklime principally for their own use although a small quantity was sold. Rockwell Lime Co. produced quicklime and hydrated lime at Rockwell. Principal uses of chemical and industrial lime in decreasing order of quantities were for paper manufacture, water purification, metallurgy, sewage treatment, metal polishing, tanning, brick, petroleum refining, and miscellaneous purposes.

Perlite and Vermiculite.—The quantity and value of sales of perlite expanded in the State remained almost the same as 1963; however, sales of vermiculite exfoliated decreased 12 percent in quantity and 11 percent in value. Midwest Perlite Co. expanded perlite from New Mexico in its Appleton plant. Western Mineral Products Co. expanded perlite from New Mexico and exfoliated vermiculite from Montana in its plant in Milwaukee. Principal use of perlite was for concrete aggregate, with some being used for building plaster, loose fill insulation, and soil conditioning, in decreasing order. Uses of exfoliated vermiculite, in decreasing order of quantity, were as loose fill insulation, in plaster aggregate, and in concrete aggregate.

Sand and Gravel.—Wisconsin contributed 4 percent of the total sand and gravel production in the United States and ranked 7th in quantity and 12th in value of sand and gravel produced. Sand and gravel was produced in 67 of the 71 counties; however, several producers did not indicate the source of their production. Total production of sand and gravel decreased 3 percent in quantity and 1 percent in value from that of 1963. Total sand decreased 8 percent in quantity and 4 percent in value. Total gravel production decreased less than 1 percent in quantity but increased over 1 percent in value. Average value of all sand produced in the State was $0.81 per ton; gravel, $0.68 per ton; and combined sand and gravel, $0.72 per ton. Four counties produced over 1 million tons of sand and gravel.

Commercial sand and gravel, which comprised over 65 percent of the production, decreased slightly in quantity but increased 3 percent in value over that of 1963. Increases in commercial sand production were building, 5 percent in quantity and 6 percent in value; paving, 28 percent in quantity and 30 percent in value; and molding, 21 per-

cent in quantity and 14 percent in value. Commercial fill sand decreased 10 percent in quantity and 16 percent in value.

Production of sand by Government-and-contractor operations decreased 29 percent in quantity and 33 percent in value, but gravel production increased 8 percent in quantity and 3 percent in value.

Shipments of commercial sand and gravel were 92 percent by truck, 7 percent by rail, and less than 1 percent by waterway. Eighty-six percent of the commercial sand and gravel was processed and had an average value of $0.87 per ton; the unprocessed material had an

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,318	$2,630	3,481	$2,783
Paving	1,320	934	1,689	1,214
Blast	W	W	23	85
Engine	W	W	25	21
Fill	1,237	679	1,115	572
Molding	690	1,871	833	2,125
Oil (hydrafrac)	r 30	r 187	14	69
Other [1]	134	306	118	258
Total	r 6,729	r [2] 6,608	7,298	7,127
Gravel:				
Building	3,305	2,735	3,270	2,769
Paving	10,723	7,298	10,579	7,663
Railroad ballast	W	W	215	138
Fill	1,279	722	927	406
Other [3]	439	234	89	71
Total	15,746	[2] 10,988	15,080	11,047
Total sand and gravel	r 22,475	r 17,596	22,378	18,174
Government-and-contractor operations:				
Sand:				
Building	103	49	----	----
Paving	4,472	2,371	2,903	1,485
Fill	408	140	564	186
Other	163	60	174	73
Total	5,146	2,620	3,641	1,744
Gravel:				
Building	35	19	112	62
Paving	6,996	4,332	7,889	4,633
Fill	711	296	280	73
Other	----	----	48	9
Total	7,742	4,647	8,329	4,777
Total sand and gravel	12,888	7,267	11,970	6,521
All operations:				
Sand	r 11,875	r 9,228	10,939	8,871
Gravel	23,488	15,635	23,409	15,824
Grand total	r 35,363	r 24,863	34,348	24,695

r Revised. W Withheld to avoid disclosing individual company confidential data, included with "Other."

[1] Includes filtration, foundry, glass, railroad ballast, other construction and industrial sands, and items indicated by symbol W.

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

[3] Includes railroad ballast (1963) and other miscellaneous gravel.

average value of $0.47 per ton. Ninety-three percent of the Government-and-contractor sand and gravel was processed, with an average value of $0.56 per ton, compared with $0.30 per ton for unprocessed material.

Leading producers of sand and gravel in Wisconsin, in alphabetical order, included: Consumers Company, Division of Vulcan Materials Co., Chicago, Ill.; Janesville Sand & Gravel Co., Janesville; T. Johnson & Sons, Waukesha; Edward Kraemer & Sons, Inc., Plain; C. C. Linck, Inc., Beaver Dam; Manley Sand Division (Martin Marietta Corp.), Rockton, Ill.; Arthur Overgaard, Inc., Elroy; Rein, Schultz & Dahl, Inc., Madison; State Sand & Gravel Co., Milwaukee; and Wissota Sand & Gravel Co., Eau Claire.

Stone.—Total stone production increased 2 percent in quantity and 8 percent in value over that of 1963. Basalt, granite, limestone, marl, marble, quartzite, and sandstone were produced. Average value of all stone produced was $1.46 per ton.

TABLE 5.—Limestone sold or used by producers, by uses

Use	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction, thousand short tons	9	$69	8	$70
Rubble, do	21	127	34	211
Rough architectural, thousand cubic feet	26	18	62	100
Sawed, do	39	125	46	155
House stone veneer, do	467	1,070	450	1,063
Cut, do	23	133	58	180
Flagging, do	55	54	94	93
Total, approximate thousand short tons [1]	79	[2] 1,595	98	[2] 1,873
Crushed and broken:				
Riprap, thousand short tons	37	55	101	139
Concrete aggregate and roadstone, do	10,007	9,560	10,189	10,353
Agriculture, do	1,591	2,045	1,310	1,741
Other [3], do	292	376	193	439
Total, do	[2] 11,928	12,036	11,793	12,672
Grand total, do	12,007	13,631	11,891	14,545

[1] Average weight of 160 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 flux, lime, asphalt, fertilizer, filter beds, and other uses.

Over 99 percent of the stone was crushed and broken, representing over 80 percent of the value of stone produced. Limestone comprised 86 percent of the total quantity and 72 percent of the value of all stone produced.

Crushed and broken stone increased 2 percent in quantity and 6 percent in value over that of 1963, and increased in value from $1.14 per ton in 1963 to $1.18 per ton in 1964. Limestone constituted 86 percent of all crushed and broken stone produced. Crushed and broken limestone was produced in 35 counties, although some companies failed to report the source of their production. Principal use was for concrete aggregate and roadstone. Other uses included agricultural limestone, lime, riprap, asphalt, filter beds, flux, and fertilizer, in descending order of use.

The Ruberoid Co. produced roofing granules from basalt near Pembine, and Minnesota Mining & Manufacturing Co. produced roofing granules from argillite near Wausau. Wisconsin Aggregate Co., formerly U.S. Aggregate Co., sold terrazzo chips from a marble quarry near Grandview.

Dimension stone increased 25 percent in quantity and 15 percent in value from 1963. Dimension limestone was produced by 32 companies, dimension sandstone by 9 companies, and dimension granite by 8 companies. The value of dimension stone increased—41 percent for sandstone, 17 percent for limestone, and 13 percent for granite over that of 1963. Rough and dressed monumental stone constituted 83 percent of the dimension granite production by volume and 85 percent by value. House veneer accounted for 63 percent of the volume and 67 percent of the value of dimension limestone, excluding rubble and irregular-shaped stone. Other uses of dimension limestone, in descending order of quantity, were rubble, rough construction, flagging, rough architectural, cut stone, and sawed stone. Cut stone comprised 20 percent of the quantity and 42 percent of the value of dimension sandstone produced. Dressed monumental granite had the highest average unit value at $23.19 per cubic foot.

METALS

Iron Ore.—The one remaining iron mine in Wisconsin, the Cary, an underground mine, was responsible for all production and shipments of iron ore. Shipments declined 44 percent and production declined 9 percent from that of 1963. All ore was direct-shipping grade. Shipments from the port of Ashland, Wis., began May 26 and concluded October 23. At Escanaba, Mich., the shipping season extended from April 3 to December 18.

Iron ore prices per long ton on 51.50 percent natural iron for delivery at rail of vessel, lower Lake ports, were: High Phosphorus and Mesabi non-Bessemer, $10.55; Mesabi Bessemer, $10.70; Old Range non-Bessemer, $10.80; Old Range Bessemer, $10.95. Variations in grade from this base and differences in physical structure from established norms call for premiums or penalties. Portions of the prices reflecting shipping costs from mines to lower Lake ports are not included in the total value of iron ore production for Wisconsin.

Inland Steel Co. continued exploration drilling in the Black River Falls area. United States Steel Corp. terminated its lease and ex-

TABLE 6.—Iron-ore production and shipments

Year	Number of mines	Production (thousand long tons)	Shipments (thousand long tons)	Iron content of shipments natural (percent)
1960	4	1,484	1,502	53.50
1961	2	1,129	1,122	53.61
1962	2	1,081	1,045	54.24
1963	2	413	938	54.31
1964	1	376	524	W

W Withheld to avoid disclosing individual company confidential data.

ploration program for iron ore on the periphery of the main Black River Falls area.

Lead and Zinc.—Wisconsin accounted for nearly 5 percent of the total zinc production in the United States and ranked tenth in production of this metal. Lead production increased 56 percent in quantity and 89 percent in value from that of 1963. Zinc production increased 74 percent in quantity and 106 precent in value from that of 1963. The increased activities in the southwest Wisconsin lead-zinc district, due to the increased price of metal in 1963, was reflected in the production in 1964. Three companies, inactive in 1963, operated mines during the year, making a total of 6 companies operating 13 mines.

The Eagle-Picher Co. made the final payment on a $155,068 exploration contract with the Office of Minerals Exploration. The contract dates back to 1951 when Calumet & Hecla, Inc., obtained it to explore for lead and zinc minerals in Lafayette County, Wis., and Jo Daviess County, Ill. During 1964 the company started production from the Kennedy and Birkett-Bastian-Andrews mines. The company continued to operate the Booty-Thompson and Shullsburg mines. Ore was beneficiated in mills at Shullsburg, Wis., and Galena, Ill.

American Zinc, Lead & Smelting Co. reopened the Champion and Teasdale mines. The company continued to operate the Temperly-Thompson and Hancock-Winskell mines. Piquette Mining & Milling Co. reopened the Piquette Nos. 1 and 2 mines near Tennyson. Grimes Mining Co. continued operating a mine near Platteville. The Doyle mine near Shullsburg was reopened and a small shipment of ore made. The Mifflin Mining Co. reactivated the Coker No. 1 mine. Ivey Construction Co. poured footings in November for a lead-zinc mill at

TABLE 7.—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	
1955-59 (average)	10	3	611,260	37,649	1,595	$458,641	17,513	$4,242,413	$4,701,054
1960	8	1	686,085	993	1,165	272,610	18,410	4,749,780	5,022,390
1961	9	1	465,407	99	680	140,080	13,865	3,188,950	3,329,030
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

TABLE 8.—Mine production of lead and zinc in 1964, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	165	1,690	August	145	2,565
February	170	1,665	September	150	2,595
March	145	1,790	October	170	2,545
April	155	1,965	November	140	2,325
May	125	2,055	December	152	2,408
June	95	2,195			
July	130	2,480	Total	1,742	26,278

Mineral Point. The company also did exploratory drilling on several properties near Mineral Point.

Average yearly weighted prices used to calculate values for lead and zinc in table 1 were 13.1 cents per pound for lead and 13.6 cents per pound for zinc, compared with 10.8 cents for lead and 11.5 cents for zinc in 1963.

MINERAL FUELS

Peat.—Sales of peat increased 22 percent in quantity but less than one-half percent in value of sales from 1963. Moss peat was produced by two companies and humus peat by one company. Over half of the output was for general soil improvement and was sold in bulk form. The remainder, sold in packaged form, was for seed inoculant, and for packing flowers and shrubs.

REVIEW BY COUNTIES

Mineral production was reported from all of the 71 counties in the State. Total value of production increased in 48 counties and decreased in 23 counties, although some producers did not specify the source of their production. Mineral production was valued at over $1 million in 17 counties. Sand and gravel production was reported from 67 counties and stone production from 44 counties. Zinc and/or lead were produced in 3 counties. Table 9 shows the minerals produced in each county, although all counties are not discussed in the text.

Ashland.—Cold Spring Granite Co. produced dressed dimension granite for architectural and monumental use from their quarry near Mellen. The Primax Corp., a new operator in the area, produced rough granite blocks, rubble, and riprap.

Barron.—Value of production decreased 39 percent from 1963. Ray Karshbaum produced sand and gravel for building, paving, and fill. Pioneer Sand & Gravel Co., Inc., produced sand for fill. Smith Bros. produced gravel for paving and fill. The county highway department produced fill sand and paving gravel.

Bayfield.—Wisconsin Aggregate Co. produced marble for agricultural purposes and marble chips for terrazzo from a quarry formerly operated by U.S. Aggregate Co. Bayfield County Highway Department produced sand and gravel for road use and other purposes with a portable plant.

Brown.—The Western Lime & Cement Co. produced quicklime and hydrated lime for construction, chemical, and other industrial uses. Five companies produced sand and gravel, four with portable plants and one with a stationary plant, mostly for building and paving. One company produced pit run material for fill. Crushed limestone for concrete and roadstone was produced by Daanen & Janssen at three quarries with portable plants. Scray Quarries produced dimension limestone for house veneer and rough architectural blocks.

Buffalo.—The substantial decrease in value of production from that of 1963 is due largely to a 78-percent decrease in quantity of agricultural limestone. Mon-Arc Quarries, Inc., Herbert Tiffany, Jr., and J. Allen Wiles operated portable plants in 11 limestone quarries. Limestone was used for concrete, roadstone, riprap, and agricultural

TABLE 9.—Value of mineral production in Wisconsin, by counties

County	1963	1964	Minerals produced in 1964, in order of value
Adams	W	W	Sand and gravel.
Ashland	W	W	Stone.
Barron	W	W	Sand and gravel.
Bayfield	W	$58,000	Sand and gravel, stone.
Brown	$787,275	847,149	Lime, sand and gravel, stone.
Buffalo	660,053	268,837	Stone, sand and gravel.
Burnett	70,528	65,000	Sand and gravel.
Calumet	187,545	W	Sand and gravel, stone.
Chippewa	190,872	W	Sand and gravel.
Clark	W	W	Sand and gravel, stone.
Columbia	W	W	Do.
Crawford	177,635	210,367	Stone, sand and gravel.
Dane	1,721,918	2,040,410	Sand and gravel, stone.
Dodge	1,065,670	1,228,118	Lime, sand and gravel, stone.
Door	195,985	211,493	Sand and gravel, stone.
Douglas	W	W	Lime, sand and gravel.
Dunn	107,667	166,810	Stone, sand and gravel, clays.
Eau Claire	W	W	Sand and gravel.
Florence	34,250	25,000	Do.
Fond du Lac	1,308,112	1,556,435	Stone, sand and gravel, lime, clays.
Forest	52,155	74,000	Sand and gravel.
Grant	689,306	1,128,584	Stone, zinc, sand and gravel, lead.
Green	572,909	638,859	Stone, sand and gravel.
Green Lake	369,963	383,000	Sand and gravel.
Iowa	401,401	682,094	Zinc, stone.
Iron	W	W	Iron ore, sand and gravel.
Jackson	138,417	177,000	Sand and gravel.
Jefferson	227,647	198,000	Sand and gravel, stone.
Juneau	W	W	Stone, sand and gravel.
Kenosha	231,678	253,000	Sand and gravel.
Kewaunee	333,470	W	Do.
La Crosse	W	W	Stone, sand and gravel.
Lafayette	W	W	Zinc, lead, stone.
Langlade	244,967	150,000	Sand and gravel.
Lincoln	W	152,200	Sand and gravel, peat.
Manitowoc	W	W	Cement, sand and gravel, stone, lime, clays.
Marathon	2,700,862	2,859,946	Stone, sand and gravel.
Marinette	W	W	Do.
Marquette	W	W	Do.
Milwaukee	W	W	Cement, stone, sand and gravel.
Monroe	W	274,725	Stone, sand and gravel.
Oconto	211,503	420,276	Sand and gravel, stone.
Oneida	219,916	209,000	Sand and gravel.
Outagamie	1,056,754	759,258	Stone, sand and gravel.
Ozaukee	382,512	327,000	Sand and gravel.
Pepin	1,362	19,000	Do.
Pierce	308,211	387,520	Sand and gravel, stone, clays.
Polk	509,357	629,208	Stone, sand and gravel.
Portage	280,398	352,570	Sand and gravel, stone.
Price	59,666	101,000	Sand and gravel.
Racine	1,054,951	1,339,200	Stone, sand and gravel, clays.
Richland	W	46,000	Sand and gravel.
Rock	1,732,190	1,763,202	Sand and gravel, stone.
Rusk	82,632	74,000	Sand and gravel.
St. Croix	404,690	259,162	Stone, sand and gravel.
Sauk	993,719	1,185,286	Stone, sand and gravel, abrasives.
Sawyer	63,741	51,000	Sand and gravel.
Shawano	278,229	244,781	Sand and gravel, stone.
Sheboygan	301,898	446,000	Do.
Taylor	389,597	276,000	Sand and gravel.
Trempealeau	W	W	Stone, sand and gravel.
Vernon	W	146,542	Do.
Vilas	137,438	79,000	Sand and gravel.
Walworth	372,510	411,000	Do.
Washburn	W	W	Do.
Washington	785,393	893,000	Do.
Waukesha	5,840,921	5,729,966	Sand and gravel, stone, peat.
Waupaca	W	306,557	Sand and gravel, stone.
Waushara	W	W	Stone, abrasives.
Winnebago	1,556,054	1,562,217	Stone, sand and gravel.
Wood	W	W	Sand and gravel, stone.
Undistributed [1]	r 37,347,073	38,340,228	
Total	r 66,841,000	70,007,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by symbol W.

lime. The county highway department produced sand and gravel with portable plants.

Calumet.—Sand and gravel for building, paving, and fill was produced by Arnold M. Ortlepp, Quality Sand & Gravel Co., and Sell Bros. Stone & Gravel Co. The county highway department produced gravel and crushed limestone for paving.

Chippewa.—The county highway department reported an increased production of 140,000 tons of gravel with their own crews over that of 1963. Chippewa Sand & Gravel Co. produced building sand and gravel with a stationary plant near Chippewa Falls. C. C. Linck, Inc., reported sand and gravel production from a pit near Stanley.

Clark.—A 29-percent decrease in value of production was due to decreased demand for sand and gravel. Hatfield Sand & Gravel operated a stationary plant near Merrillan producing building sand and gravel and fill sand. Carl Opelt Sand & Gravel produced sand and gravel from a pit near Neillsville. Plautz Bros., Inc., and the county highway department operated portable plants producing sand and gravel. Ellis Quarries, Inc., produced irregular-shaped and flagging sandstone from a quarry near Dorchester.

Columbia.—Value of production increased 23 percent over 1963. The Manley Sand Division (Martin Marietta Corp.) produced sand for paving, glass manufacture, and molding in a stationary plant near Portage. The company mines an 80-foot bank of loosely consolidated sandstone member of the Cambrian formation. Two drying drums were converted from fuel oil to gas for drying the industrial sand. A stationary sand and gravel plant was operated by Columbia Ready-Mix Co. near Pardeeville. Portable sand and gravel plants were operated by James Sand & Gravel near Doylestown and C. C. Linck, Inc., near Columbus. Wisconsin Dells Sand & Gravel operated a pit near Wisconsin Dells. The county highway department produced paving gravel and crushed limestone. Dann & Wendt produced agricultural limestone in a stationary plant near Rio.

Crawford.—The 18-percent increase in value of production was due to a substantial increase in quantity of limestone for concrete and roadstone. Loren J. Slaght operated portable limestone plants near Eastman, Prairie du Chien, Gays Mills, and Ferryville. Velmer Monroe operated portable and stationary plants near Steuben. Turner Stone Corp., formerly H. Turner & Sons, operated portable plants at several limestone quarries. Stationary sand and gravel plants were operated by Lakeside Sand & Gravel and Prairie Sand & Gravel Co., Inc., near Prairie du Chien.

Dane.—The 18-percent increase in value of mineral production to over $2 million was due principally to a 21-percent increase in quantity and a 28-percent increase in value of sand and gravel production. About 53 percent of the sand and gravel was used for paving, 34 percent for building, 11 percent for fill, and the remainder for molding and other uses. The six principal producers, in alphabetical order, were Capitol Sand & Gravel Co., Hartland-Verona Gravel Co., Madison Sand & Gravel Co., Rein, Schultz & Dahl, Inc., Stewart Watson Construction Co., and Yahara Materials, Inc. Crushed limestone accounted for 34 percent of the value of mineral production in the county. Crushed and broken limestone for concrete and roadstone accounted

for 91 percent of the limestone production, and agricultural limestone constituted most of the remainder. Principal producers were Hammersley Stone Co., Inc., and Wingra Limestone Co. with portable plants near Fitchburg and Madison Stone Co., Inc., with a stationary plant near Madison.

Dodge.—The Western Lime & Cement Co. produced hydrated lime for construction use in their plant near Knowles. Mayville White Lime Works operated a kiln intermittently, producing quicklime for use in its plant at Mayville. Both companies produced limestone for concrete and roadstone, as well as lime manufacture. The latter company also produced crushed limestone for other metallurgical uses and for agricultural purposes. Three companies, Martin Kaddatz Gravel Co., a new operation in the county, C. C. Linck, Inc., and Linck-Henes Construction Co. produced sand and gravel with portable plants from 20 pits. Principal use was for paving gravel.

Door.—The increase in value of mineral production was due to an increase in crushed limestone produced by the county highway department. Hubert Charles, near Rosiere, and Vernon E. Olson Excavating Co., near Sturgeon Bay, produced sand and gravel from stationary plants for building, paving, and fill. Adamski-Fisher Quarry produced dimension limestone for house veneer and flagging.

Douglas.—Cutler-La Liberte-McDougall Corp., the largest producer of quicklime in the State, operated two rotary kilns at Superior, using natural gas and bituminous coal for fuel. Otto Wiesner, Inc., produced paving gravel from a portable plant near Superior. The county highway department and the City of Superior Engineering Department operated portable sand and gravel plants.

Dunn.—The increase in value of mineral production was due to activities of the county highway department, which increased its production of sand and gravel by 74,000 tons and produced 62,000 tons of crushed limestone. This more than made up for decreased production of agricultural limestone by the Barron County Agricultural Department and decreases in recorded production of commercial limestone. Menomonie Brick Co. continued operation at its plant near Menomonie using clay from their own pit.

Fond du Lac.—Value of mineral production was $1,556,435, a record high for the county. The value of limestone production exceeded $1 million, of which 57 percent was dimension stone totaling 440,375 cubic feet. Rough architectural stone, house veneer, and flagstone were the principal shapes produced. Oak Stone Co. and Rademann Stone Co. added to or improved their cutting machinery and loading equipment. The Eden Stone Co. near Eden, and the Rademann Stone Co. near Fond du Lac reported production. C. C. Linck, Inc., added a larger crusher to their portable plant near Waupun where they produced crushed limestone for concrete and roadstone. Four companies and the county highway department operated portable sand and gravel plants. Lake View Sand & Gravel Co. operated a stationary sand and gravel plant near Fond du Lac. The Western Lime & Cement Co. produced quicklime and hydrated lime for construction, agricultural, chemical, and other industrial uses at its plant near Eden. Oakfield Shale Brick & Tile Co. continued its operation near Oakfield, using over 12,000 tons of clay from their own pit.

Grant.—Value of mineral production exceeded $1 million for the first time since 1957, largely because of the increased production of lead and zinc. Piquette Mining & Milling Co. resumed operation of its mill June 1, concentrating ore produced in the Piquette No. 1 and No. 2 mines near Tennyson. Grimes Mining Co. continued operation of a zinc mine on the Burnham property near Platteville. Crushed limestone, principally for concrete and roadstone, and for agricultural purposes was produced by eight companies operating portable plants. Piquette Mining & Milling Co. sold limestone tailings from its mill for roadstone. Stationary sand and gravel plants were operated by Becker & Tuckwood near Lancaster, and by Dubuque Sand & Gravel Co. near Kieler. Rein, Schultz & Dahl, Inc., operated a portable plant producing paving gravel near Lancaster.

Green.—Although production of sand and gravel decreased 8 percent, crushed limestone increased 23 percent, resulting in a net increase in tonnage and value of mineral production. Crushed limestone was produced in portable plants by four companies: Bergen Rock & Lime Co. near Brooklyn; Rees Construction Co. from 10 quarries; P. W. Ryan Sons, Inc., from 13 quarries; and Ted Stauffacher near Monroe. Ninety-six percent of the production was for concrete and roadstone, the remainder for agricultural limestone. Lyle T. Manley Co., Inc., produced ground foundry sand at a plant near Browntown. The county highway department produced and contracted for sand and gravel; Wm. J. Kennedy & Son produced sand and gravel for building and paving near Brodhead; and Rein, Schultz & Dahl, Inc., produced paving gravel near Monroe. John W. Dieckman produced fill sand from a pit near Monroe.

Green Lake.—Molding sand accounted for 42 percent of the 232,000 tons of sand and gravel produced. The molding sand was produced by four companies near Berlin: Chier St. Marie Sand Co.; C. A. Chier Sand Co.; F. B. Dubberstein & Sons, Inc.; and Wilbur W. Wick. Kopplin & Kinas Co., Inc., produced building sand and miscellaneous gravel in a portable plant near Green Lake. Paul Polenska & Son operated a portable and a stationary plant near Manchester, producing sand and gravel for building and fill. The county highway department produced paving gravel with a portable plant.

Iowa.—Increased value of mineral production over 1963 was largely due to increased zinc production and price, although there was a moderate increase in limestone production. Ivey Construction Co. operated the Kickapoo mine near Linden until September when it was closed. Mifflin Mining Co. started an incline into the Coker No. 1 mine January 4 and completed development May 15. The underground portion of the incline is 150 feet long on a 15 percent grade and started from an open cut excavated by H. Turner & Sons in 1957. The underground mine was last operated from a vertical shaft in 1925 by Mineral Point Zinc Co. Ore from the mine was being treated in the Mifflin Mining Co.'s mill which had been modified to a straight flotation mill without jigs. Ivey Construction Co. poured footings for a flotation mill near Mineral Point and did exploration drilling in the area. Crushed limestone was produced by 3 companies with portable plants—Davis & Richardson, 2 quarries; G. A. Watson,

3 quarries; and George Wendtlandt, 11 quarries—and by the county highway department from 2 quarries.

Iron.—The county ranked fifth in value of mineral production in the State; in 1963 it ranked first. The lower value was entirely due to reduction in amount of iron ore shipped. Only one mine produced, the Cary underground mine, operated by Pickands Mather & Co. Quantity of ore produced by this company was only slightly less than that in 1963. The county highway department contracted for 27,000 tons of paving gravel.

Jackson.—Production of sand and gravel was 327,000 tons, an increase of 34 percent over that of 1963. Laurence Murphy produced paving gravel near Black River Falls, H. T. Smith Sand & Gravel produced building sand and paving gravel near Hixton, and the county highway department produced paving sand and gravel. United States Steel Corp. conducted ground magnetic surveying and exploration drilling near Black River Falls and terminated its leases after completing the exploration program.

Jefferson.—The county highway department production of sand and gravel was 123,000 tons, almost 50 percent less than that of 1963. This was partly compensated by increased commercial production. Paving gravel was produced by Arne Evensen Sand & Gravel and Hausz Bros., Inc., near Lake Mills; Rein, Schultz & Dahl, Inc., near Johnson Creek; and Rude Sand & Gravel near Oakland, which also produced material for building use and fill. Hausz Bros., Inc., produced crushed limestone for road use.

Juneau.—Arthur Overgaard, Inc., operated a stationary crushed limestone plant near Elroy and produced riprap, concrete and roadstone, and agricultural limestone. The county highway department produced sand for paving, fill, and other uses.

Kewaunee.—Schuster Construction Co. produced building sand and gravel and paving gravel in a stationary plant near Casco. Koepke Sand & Gravel Co. produced paving gravel in a portable plant near Luxemburg. The county highway department produced paving gravel.

La Crosse.—A substantial increase in value of mineral production was caused principally by an increase in limestone production. Arthur Overgaard, Inc., operated a portable plant near La Crosse, producing concrete aggregate and roadstone, agricultural limestone, and riprap. Kammel-Smith Sand & Gravel Co., Inc., produced paving gravel from a stationary plant. La Crosse Sand & Gravel, Inc., produced sand and gravel for building, and paving and fill. The county highway department produced paving sand.

Lafayette.—The county advanced from fifth place in 1963 to first in value of mineral production due primarily to the increase in quantity and price of lead and zinc produced. The value was the highest on record for the county.

The American Zinc, Lead & Smelting Co. started in August to drive a 700-foot incline on a minus 14 percent grade into the Champion mine near New Diggings, and holed into the old workings in December. This mine was last operated in 1947 by W. E. Faithorn from a vertical shaft. A 300-foot incline, started in November 1963, was

completed into the Teasdale mine, and production started in March. Highway trucks hauled ore from the face to the company's mill near Shullsburg. This mine was last operated in 1957. Mining continued at the Blackstone-Hancock-Winskell and the Thompson-Temperly mines. The company had one or two churn drills operating most of the year on exploration.

The Eagle-Picher Co. started a 400-foot, minus 14 percent incline into the Kennedy mine near Hazel Green in April and completed it in July. Production started in August with highway trucks hauling from the face to the company's Graham mill near Galena, Ill. The mine was last operated by the Wisconsin Zinc Co. in 1919. The company reopened the Birkett-Bastian-Andrews mine near Hazel Green and hauled the ore with highway trucks from the face to the Graham mill in Illinois. Ore from the Booty-Thompson mine was trucked to the Graham and to the Shullsburg mills. The company had three churn drills on exploration drilling most of the year.

The New Doyle Mine Partners made a small shipment of custom lead-zinc ore from the Doyle mine near Shullsburg to the American Zinc, Lead & Smelting Co.'s mill.

New Jersey Zinc Co. continued exploration drilling in the area.

Crushed limestone, principally for concrete and roadstone, was produced by six companies using portable plants. Oscar Zwalanek purchased McGettigan Lime Co.'s operation near Gratiot and rebuilt part of the plant.

Lincoln.—Sand and gravel for building, paving, and fill was produced by Merrill Gravel & Construction Co. in a stationary plant near Merrill. Rein, Schultz & Dahl, Inc., operated a portable plant producing paving gravel. The county highway department operated a portable plant and produced sand and gravel for paving and other uses. Superior Brand Peat produced and packaged moss peat near Tomahawk.

Manitowoc.—The county advanced from third to second in value of mineral production. Manitowoc Portland Cement Co., the largest producer in the State, used local clay and limestone imported from Michigan to make types I and II, general use and moderate heat portland cement. The quantity of cement, hydrated lime, and clay produced increased from that of 1963. Quantity of sand and gravel produced decreased 22 percent, and limestone 49 percent from that of 1963. The city of Manitowoc and four companies operated stationary sand and gravel plants: R. & J. Fricke Co. and Kasper Construction Co. near Manitowoc; Fred Radandt Sons near Manitowoc and Shoto; and August Ehnert & Sons, Inc., near Kiel. Portable plants were operated by Evenson Bros. near Valders, and by the county highway department. Valders Lime & Stone Co. produced dimension stone principally for architectural use. There was a substantial reduction in the amount of cut stone from 1963, although production of riprap and roadstone increased. Rockwell Lime Co. quarried limestone and manufactured quicklime and hydrated lime.

Marathon.—About 104,000 cubic feet of dimension granite valued at $1.5 million was produced. Seventy-eight percent of the value of dimension granite in the State came from this county. The volume

increased 7 percent and the value 4 percent over that of 1963. Five companies, Anderson Bros. & Johnson Co., Cold Spring Granite Co., Lake Wausau Granite Co., Prehn Granite Quarries, Inc., and Wisconsin Quarries, Inc., produced rough and dressed monumental granite in the vicinity of Wausau. Ray Fitzgerald Granite, Gottschalk Bros., Inc., Phillip Knauf, and Tony Schilling Granite Pit produced crushed granite for concrete and roadstone. Stationary sand and gravel plants were operated by Edmund Gesicki, Sr., near Athens Heiser Ready Mix Co., Lotz Sand & Gravel Co., and Riverside Gravel Co. near Wausau. Rein, Schultz & Dahl, Inc., operated two portable plants near Mosinee, and Frank Drewek mined fill sand from a pit near Athens. Dimension sandstone was produced by Ellis Quarries, Inc., near Mosinee, Ernest F. Liebe near Wausau, and Nemke's Stone Quarry near Hatley. Minnesota Mining & Manufacturing Co. produced material principally for concrete and roadstone and roofing granules from their Greystone quarry and for abrasives from their Rib Mountain quarry.

Marinette.—The Ruberoid Co. produced roofing granules from basalt quarried near Pembine. Rough and finished monumental granite was produced by Anderson Bros. & Johnson Co. Midwest Granite Co. produced rough granite for a plant in Michigan. Mason Sand & Trucking produced building sand with a stationary plant near Marinette. The Soo Line Railroad Co. produced gravel for railroad ballast and sand for paving and fill with a portable plant near Kremlin. The county highway department produced sand and gravel for paving, fill, and other uses.

Marquette.—Montello Granite Co., at their plant near Montello, produced finished monumental granite used almost exclusively for tombstones. The granite was broken by channel blasting, hoisted to the quarry's edge by derrick, and trimmed. In the adjacent plant, it was cut to size with a wire saw and polished. The stone is a uniform red color and takes a high polish. The county highway department produced paving gravel with a portable plant.

Milwaukee.—The county advanced from fourth to third in value of mineral production. The Marquette Cement Manufacturing Co. produced masonry cement and types I and II, general use and moderate heat, and type III, high-early-strength portland cements. The plant in Milwaukee used limestone from Michigan and shale from Illinois. Shipments were mostly in bulk by truck. Ray Anderson & Son Sand & Gravel, Inc., produced sand for building and fill and gravel for building and paving with a portable plant near Franklin. Consumers Co., Division of Vulcan Materials Co., and Fink Sand & Gravel produced gravel for fill. Consumers Co. also produced crushed limestone for concrete and roadstone with a stationary plant near Hales Corners, as did Franklin Stone Products, Inc., at a stationary plant near Franklin. Western Mineral Products Co. in Milwaukee expanded perlite from New Mexico for concrete aggregate and building plaster. The company also exfoliated vermiculite from Montana for loose fill insulation, plaster aggregate, and concrete aggregate.

Monroe.—Crushed limestone for concrete and roadstone and agricultural use was produced with portable plants by Schendel Brothers

near Norwalk and Schultz Quarry Co. near Wilton. Otto Meyer crushed limestone for concrete and roadstone in a portable plant near Tomah. The county highway department produced sand for paving and other uses.

Oconto.—The 99 percent increase in value of mineral production was due principally to a 91-percent increase in volume and 105-percent increase in value of sand and gravel production. Foster Construction Co., Inc., produced paving gravel with a portable plant near Little Saumico, crushed limestone for concrete and roadstone with a portable plant near Abrams, and crushed limestone for agricultural purposes with a portable plant near Gillett. Gillett Cement Products, Inc., operated a stationary plant near Gillett for producing paving and building gravel. John Jaworski produced paving gravel in a portable plant near Pulaski. M. R. K. Construction Co., Inc., produced building sand and gravel in a portable plant near Pulaski.

Oneida.—Pitlik & Wick Const. Co., the largest mineral producer in the county in terms of quantity and value, produced 185,000 tons of building, paving, and fill gravel from a portable plant near Eagle River. Musson Bros., Inc., the second largest commercial producer, operated a stationary plant near Rhinelander, producing building, paving, and fill sand, and paving and fill gravel. Fred H. Bonack & Sons, Inc., produced 4,000 tons of fill sand and building gravel with a stationary plant near Three Lakes. Sampson's Cranberry Marsh produced a small quantity of sand with a portable plant near Three Lakes. The county highway department operated a portable plant and produced sand and gravel for fill and road use. The city of Rhinelander produced fill sand.

Outagamie.—Value of mineral production decreased 28 percent from 1963. Although sand and gravel production decreased 71 percent in quantity and 65 percent in value, limestone production increased 63 percent in quantity and 86 percent in value. Paving gravel was produced by Koepke Sand & Gravel Co. near Kunesh; Landwehr, Inc., near Appleton; M. R. K. Construction Co., Inc., near Seymour; and Murphy Construction Co. near Black Creek. The latter two companies also produced sand, as did the county highway department. Crushed limestone for concrete and roadstone was produced by Landwehr, Inc.; M. R. K. Construction Co., Inc.; and Black Creek Limestone Co. The latter company also produced agricultural limestone at their stationary plant near Black Creek. The Midwest Perlite Co. expanded perlite from New Mexico for building plaster, loose fill insulation, concrete aggregate, and soil conditioning at their plant near Appleton.

Pepin.—The $17,638 increase in value of mineral production was due principally to the county highway department, which reported 52,000 tons of sand and gravel production valued at $17,000. Charles M. Serene, Jr., produced sand and building gravel from a pit near Pepin.

Pierce.—Industrial sands for molding, blast, and engine use were produced by Bay City Sand Co. near Bay City, and Pepin Shore Silica Sand Co., Inc., near Maiden Rock. The latter company also produced hydrafrac sand and other industrial sand. Funk Bros. Transfer near Esdaile, and River Falls Sand & Gravel Co. near

River Falls produced building sand and gravel. The county highway department produced over 200,000 tons of sand and gravel for paving and building use and 27,000 tons of crushed limestone for concrete and roadstone. Herbert Tiffany, Jr., produced limestone for concrete and roadstone, agricultural limestone, and riprap near Elmwood. Red Wing Sewer Pipe Corp. produced clay for the manufacture of vitrified sewer pipe in their plant at Red Wing, Minn.

Polk.—The 24-percent increase in value of mineral production was due principally to a substantial increase in the quantity and value of sand and gravel for paving, produced by the county highway department, and an increase in the quantity and value of basalt. Atlas Gravel Co. produced paving sand and gravel near Luck; Bohn Sand & Gravel produced sand and gravel for paving, building, and fill near West Sweden; Jorgenson Const. Co. produced sand and gravel for fill near Luck; and Ostermann Sand & Gravel, Inc., produced paving gravel near Turtle Lake. The county highway department produced paving sand and gravel. The Polk County Agricultural Agency produced crushed limestone for concrete and roadstone and agricultural limestone. Bryan Dresser Trap Rock, Inc., produced basalt for concrete and roadstone, railroad ballast, and riprap near Dresser.

Portage.—The 26-percent increase in value of mineral production was due principally to a 37-percent increase in quantity and 44-percent increase in value of sand and gravel production by F. F. Mengel Co. at a stationary plant near Custer. The company produced sand and gravel for building, paving, and railroad ballast. Wimme Sand & Gravel produced sand and gravel for building, paving, railroad ballast, and fill at a stationary plant near Stevens Point. The city of Stevens Point produced fill sand and the county highway department produced paving gravel. Caldwell's Dredging Co. mined marl from Dean's Lake about 9 miles east of Almond. Ellis Quarries, Inc., did not operate their sandstone quarry in 1964.

Price.—The 69-percent increase in value of mineral production was due to an increase of 87 percent in quantity and 84 percent in value of paving sand and gravel produced by the county highway department. The Soo Line Railroad Co. reopened its pit near Coolidge and produced gravel, chiefly for railroad ballast, with a portable plant.

Racine.—An increase in sand and gravel production of 104 percent in quantity and 96 percent in value was principally responsible for the 27-percent increase in value of mineral production. Burlington Sand & Gravel Corp., with a stationary plant near Burlington, produced building and fill sand. Wm. J. Kennedy & Son operated a portable plant near Rochester and produced sand and gravel for building and paving. Root River Sand & Gravel Co., Inc., and Hillside Sand Co., Inc., produced fill sand near Franksville and Caledonia, respectively. Morrow & Reesman produced paving sand and gravel near Burlington; J. W. Peters & Sons, Inc., produced sand and gravel for building, paving, and fill near Burlington. The county highway department produced paving gravel. The Consumers Co. produced crushed limestone for concrete and roadstone near Racine. Union Grove Drain Tile Co. mined clay for use at its plant near Union Grove, and reported installation of a new dryer.

Rock.—Sand and gravel constituted 79 percent of the value of mineral production with 429,000 tons of limestone accounting for the remainder. Most of the sand and gravel was used for building, paving, railroad ballast, and other construction purposes. Lyle T. Manley Co., Inc., at Hanover produced molding sand. Principal producers in alphabetical order were Edgerton Sand & Gravel Co., Janesville Sand & Gravel Co., Wm. J. Kennedy & Son, and Lyle T. Manley Co., Inc. Limestone for riprap, concrete and roadstone, and agricultural use was produced by 10 companies and the county highway department. All but one used portable plants.

St. Croix.—The county highway department reported no production of sand and gravel, causing a net reduction in value of mineral products of $145,528, despite increases in value of commercial production of sand and gravel, limestone, and the county highway department's increase in limestone production. Casey Gravel Works, near New Richmond, produced sand and gravel for building, paving, and fill. Leary Construction Co., Inc., near River Falls produced gravel for building and fill. The latter company also produced limestone for concrete and roadstone, agricultural use, and riprap at their River Falls plant. Wilson Rock & Limestone Co. produced crushed limestone for concrete and roadstone at plants near Emerald and Wilson, and agricultural limestone at the latter plant.

Sauk.—Sandstone constituted over 70 percent of the value of mineral production. General Refractories Co. and Harbison-Walker Refractories Co. near Baraboo produced crushed sandstone for silica brick. Baraboo Quartzite Co., Inc., produced sandstone for roadstone, filter use, and grinding pebbles at a quarry near Baraboo. Foley Bros., Inc., continued operation of its large quarry producing railroad ballast. Dimension sandstone, including cut stone, irregular shapes, rubble, and flagging valued at about $19,000, was produced by three companies—Bloss Stone Co. and Alfred Boyles Flagstone Quarry near Rock Springs, and Hildebrandt Stone Co. near Sauk City. Sand and gravel for building, paving, and fill was produced near Baraboo by Baraboo Concrete Co., Inc., and paving gravel by W. R. Du Bois & Son, Inc., and the city of Baraboo. Frederic Bindl, near Plain, and Davis & Richardson, near Spring Green, produced crushed limestone for concrete and roadstone, and for agricultural uses. Holtz & Schulenburg Lime Works produced agricultural limestone, near Loganville.

Sheboygan.—The 48-percent increase in value of mineral production over 1963 was attributed largely to the 237,000 tons of sand and gravel, valued at $101,000, produced by the county highway department, which reported no production for 1963. Stationary sand and gravel plants were operated by Cascade Sand & Gravel Co., near Cascade; Crystal Lake Crushed Stone Co., near Elkhart Lake; and Plymouth Sand & Gravel, Inc., near Plymouth. Schroeder Bros. Sand & Gravel Co. operated portable plants at Elkhart Lake and Greenbush. The county agricultural department produced crushed limestone for concrete and roadstone, and agricultural use.

Taylor.—Paul B. Anderson Corp., Francis Melvin, and James Peterson Sons, Inc., produced sand and gravel with portable plants near Medford. Output was for building, paving, and fill. The county

highway department produced sand and gravel for paving, fill, and other uses.

Trempealeau.—Limestone for concrete and roadstone, agricultural use, and riprap was produced near Arcadia by Clarence Weiss and Wilbur Lime Products. The county highway department produced sand for fill and other uses.

Vernon.—Limestone for concrete and roadstone, and for agricultural use was produced by Ellefson Bros. near Viroqua. Ed Muller & Son, Inc., produced concrete aggregate and roadstone with portable plants at three quarries near La Farge. Otto Novy continued production of agricultural limestone near Hillsboro. The county highway department produced paving and fill sand.

Vilas.—The decrease in value of mineral production from 1963 was due to a substantial reduction in sand and gravel production. Ahl-Brook Co. operated a portable plant near Sayner for paving gravel. Nelson's Sand & Gravel Co. produced paving sand and gravel near Conover. Trapp Bros. continued to operate a stationary plant near Arbor Vitae, producing sand and gravel for building and paving use. The county highway department produced paving gravel.

Walworth.—About 603,000 tons of sand and gravel was produced in the county. Principal uses were 65 percent for paving, 23 percent for building, and the remainder for fill. Principal producers were B. R. Amon & Sons; Mann Bros. Sand & Gravel, Inc.; and R. W. Miller & Sons, Inc. Portable plants were operated near Elkhorn, Delavan, Lake Geneva, Whitewater, and Fontana, where a stationary plant was also located.

Washington.—The increase in value of mineral production was due to an increase of 24 percent in quantity and 20 percent in value of sand and gravel, which more than compensated for the discontinued production of limestone by the county highway department. Principal producers of sand and gravel, all for construction purposes, were R. M. Hinze, Inc.; Milwaukee Gravel Products; Reiske Sand & Gravel Corp.; and the county highway department. Commercial production was by portable plants near Richfield and stationary plants near West Bend, Colgate, Newburg, Germantown, and Barton.

Waukesha.—The county dropped from second to fourth in value of mineral production, although the dollar value decreased less than 2 percent from 1963. The 4,921,000 tons of sand and gravel produced accounted for 54 percent of the value with limestone production of 1,008,000 tons comprising most of the remaining value, as peat production was less than 2 percent of the total value. Sand and gravel production was for building, paving, fill, and other purposes, in descending order of use. Fifteen companies each produced over 100,000 tons of sand and gravel. Principal producers included Consumers Co., Jaeger Sand & Gravel Co., Inc., T. Johnson & Sons, State Sand & Gravel Co., and Valley Sand & Gravel Co. Dimension limestone accounted for 45 percent of the stone value. Principal types of dimension limestone, in descending order of quantity, were house veneer, rubble, cut stone, and flagging. There were 23 producers of dimension stone, chiefly in the Lannon-Sussex area. Principal producers were Halquist Lannon Stone Co., Milwaukee Lannon Stone Co., and

Wislanco Lannon Stone Co., Inc. Crushed limestone for construction use was produced by Consumers Co., Halquist Lannon Stone Co., and Waukesha Lime & Stone Co., Inc.

Demilco, Inc., mined humus peat near Delafield for general soil improvement and operated a plant for drying and pulverizing peat for use as a seed inoculant. H. Geipel's Custom Soil Inc., mined moss peat near New Berlin which was marketed in bulk for general soil improvement.

Waupaca.—There was a moderate increase in value of mineral production although no clay or marl production was recorded. Sand and gravel was produced by Mantin Bros. and Stilen's Sand & Gravel near Clintonville and by C. H. Peters near Readfield. The latter company also produced crushed limestone. The county highway department produced sand and gravel and crushed limestone.

Winnebago.—About 863,000 tons of limestone for concrete and roadstone, agricultural use, asphalt filler, and riprap was produced. The tonnage of sand and gravel was less and was used mostly for building and paving. Limestone was produced in stationary plants by Badger Highways Co., Inc., near Menasha and Consumers Co. near Oshkosh, and in a portable plant by Courtney & Plummer, Inc., near Neenah. The latter company and Schulz Sand & Gravel, Inc., near Neenah, Friedrich, Loots & Below, Inc., near Omro, and the county highway department produced sand and gravel.

Wood.—Dimension sandstone was produced near Rudolph by Ellis Quarries, Inc., Klesmith Stone Co., and Tony Schmick. The county highway department produced sand and gravel for paving and crushed granite for concrete and roadstone.

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 C. A. Koch [2]

THE value of mineral production reached a record high in 1964, largely as a result of increased output of iron ore and uranium ore. Mineral fuels comprised 80 percent of the total value, and metals and nonmetals each 10 percent.

Petroleum production was 69 percent of the total mineral value. Other commodities, in order of value, were natural gas, uranium ore, iron ore, sodium carbonate (trona), clay (principally bentonite), coal, LP gases, sand and gravel, natural gasoline, stone, cement, phosphate rock, gypsum, lime, vanadium, gem stones, pumice, sodium sulfate, copper, beryllium, gold, and silver.

TABLE 1.—Mineral production in Wyoming [1]

Mineral	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	r 1,187	r $12,385	1,271	$12,816
Coal (bituminous)—do	3,124	9,922	3,101	9,774
Copper (recoverable content of ores, etc.)—short tons	—	—	5	3
Gem stones	(2)	110	(2)	120
Gold (recoverable content of ores, etc.)—troy ounces	4	(3)	6	(3)
Iron ore (usable)—thousand long tons, gross weight	1,604	17,504	2,056	24,543
Natural gas (marketed)—million cubic feet	209,060	29,687	232,878	29,808
Natural gas liquids:				
LP gases—thousand gallons	150,437	6,203	152,982	6,433
Natural gasoline and cycle products—do	86,014	5,523	86,803	5,607
Petroleum (crude)—thousand 42-gallon barrels	144,407	361,018	138,752	351,043
Sand and gravel—thousand short tons	7,901	7,874	5,632	5,936
Silver (recoverable content of ores, etc.) thousand troy ounces	—	—	(3)	(3)
Stone—thousand short tons	1,940	2,991	2,154	3,671
Uranium ore—short tons	r 1,173,420	r 23,849	1,490,353	27,911
Vanadium—do	W	435	W	359
Value of items that cannot be disclosed: Beryllium concentrate, cement, gypsum, lime, phosphate rock, pumice, sodium carbonate, sodium sulfate, vermiculite (1963), and values indicated by symbol W	XX	24,736	XX	26,822
Total	XX	r 502,237	XX	504,846

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] Weight not recorded.

[3] Less than ½ unit.

[1] Geologist, Bureau of Mines, Denver, Colo.

[2] Petroleum engineer, Bureau of Mines, Laramie, Wyo.

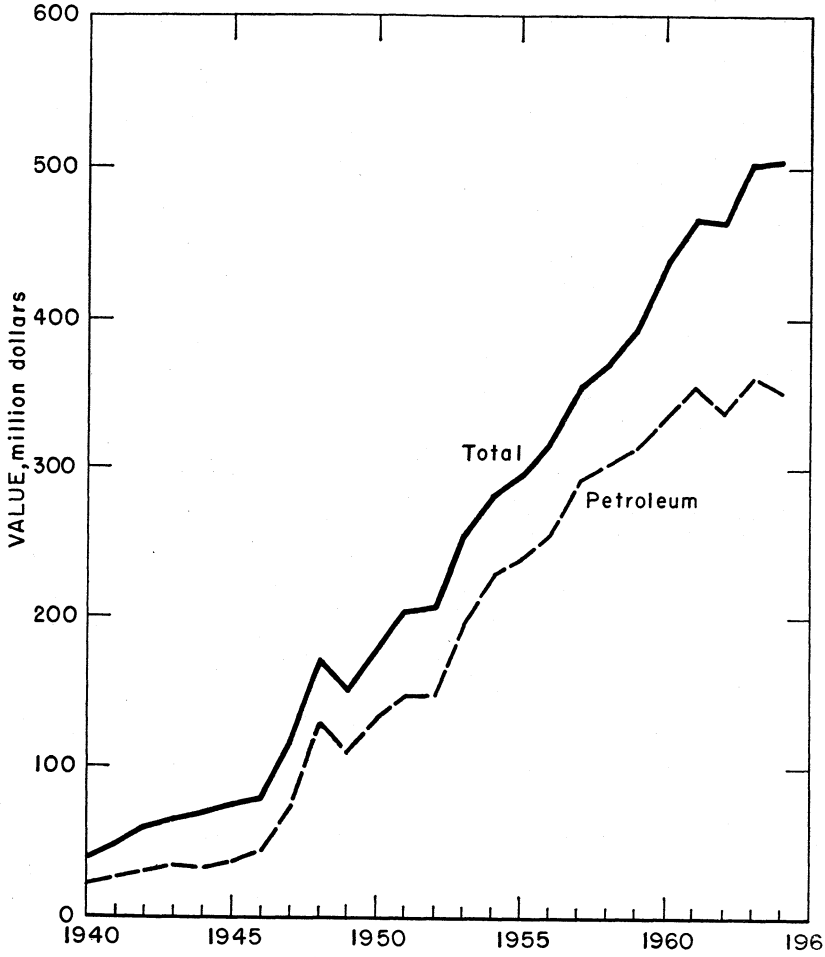


FIGURE 1.—Value of petroleum and total value of mineral production in Wyoming.

Noteworthy mineral industry developments included the dedication of the third unit of the Pacific Power & Light Co. Dave Johnston plant near Glenrock and The Colorado Fuel and Iron Corp. (CF&I) Sunrise mine new facilities; start of construction for new natural-gas-processing plants by Pan American Petroleum Corp. at Beaver Creek and by Ralston Associates, Inc., in the Big Horn basin; and start of shaft sinking and plant layout of trona properties of Solvay Process Division, Allied Chemical Corp.

Employment and Injuries.—Statistics of employment and injuries for 1963 and preliminary data for 1964 in the mineral industries, excluding mineral fuels except coal, are given in table 3.

Government Programs.—Research programs on Wyoming resources at the Federal Bureau of Mines Laramie Petroleum Research Center included studies of crude petroleum from the Sage Creek field in Big

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

(Millions)

Year	Value	Year	Value
1953	$290	1959	$399
1954	309	1960	440
1955	326	1961	r462
1956	342	1962	452
1957	349	1963	488
1958	370	1964	484

r Revised.

TABLE 3.—Employment and injury experience in the mineral industries

Year and industry	Men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Injuries		Injuries per million man-hours
				Fatal	Nonfatal	
1963:						
Coal	405	70	541	1	19	37
Metal	1,472	378	3,124		80	26
Nonmetal	896	251	2,031		27	13
Sand and gravel	442	78	624		21	34
Stone	434	88	713		10	14
Total	3,649	865	7,033	1	157	22
1964: p						
Coal	421	71	550		18	33
Metal	1,535	376	3,123	1	96	31
Nonmetal	1,145	273	2,195		33	15
Sand and gravel	315	56	445		21	47
Stone	915	141	1,143		9	8
Total	4,331	917	7,456	1	177	24

p Preliminary.

Horn County; Alkali Butte, Maverick Springs, Plunkett, and Rolff Lake fields in Fremont County; and Gebo field in Hot Springs County; recovery of shale oil in the Green River basin of Wyoming; sulfur-recovery problems in petroleum production; and bacterial process in oil-shale conversion.

Several reports on the mineral resources in Wyoming were published by the Federal Bureau of Mines, the Federal Geological Survey, and others.[3]

[3] Bradley, W. H. Geology of Green River Formation and Associated Eocene Rocks in Southwestern Wyoming and Adjacent Parts of Colorado and Utah. Geol. Survey Prof. Paper 496–A, 1964, pp. A1–A62.

Cupps, C. Q., J. Fry, and R. F. Zaffarano. Areal Variation in Reservoir Oil Characteristics, Newcastle Sandstone, Greater Clareton Area, Wyo. BuMines Rept. of Inv. 6389, 1964, 34 pp.

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Mapel, William J., and Charles L. Pillmore. Geology of the Upton Quadrangle, Crook and Weston Counties, Wyo. Geol. Survey Bull. 1181–J, 1964, pp. J1–J54.

Sharp, William N., and Anthony B. Gibbons. Geology and Uranium Deposits of the Southern Part of the Powder River Basin, Wyo. Geol. Survey Bull. 1147–D, 1964, pp. D1–D60.

Sharp, W. N., E. J. McKay, F. A. McKeown, and A. M. White. Geology and Uranium Deposits of the Pumpkin Buttes Area of the Powder River Basin, Wyo. Geol. Survey Bull. 1107–H, 1964, pp. 541–638.

Stephens, James G., and Don L. Healey. Geology and Uranium Deposits at Crooks Gap, Fremont County, Wyo. Geol. Survey Bull. 1147–F, 1964, pp. F1–F82.

Van Houten, Franklyn B. Tertiary Geology of the Beaver Rim Area, Fremont and Natrona Counties, Wyo. Geol. Survey Bull. 1164, 1964, 99 pp.

White, Elliot J., Oren C. Baptist, and Carlon S. Land. Formation Damage Estimated

According to the Federal Bureau of Land Management, Wyoming received $8 million, the largest sum ever received, for bonuses, royalties, and rentals from leasing on Federal lands for the first 6 months of 1964.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral-fuel production decreased in value by 2 percent; petroleum had the highest output value, followed, in order of value, by natural gas, coal, LP gases, and natural gasoline.

Coal (Bituminous).—The 1964 output and value of coal in Wyoming decreased 1 percent. The following firms had increases in output: Monolith Portland Midwest Co., in Carbon County, Best Coal Co. in Converse County, Dusky Diamond Coal Co. and Roncco Coal Co., Inc., in Hot Springs County, Kemmerer Coal Co. (Sorensen open pit) in Lincoln County, Big Horn Coal Co. and Welch Coal Co. in Sheridan County, and Edwin L. Swanson Brothers and Gunn-Quealy Coal Co. in Sweetwater County. Decreases in output were recorded for Wyodak Resources Development Corp. in Campbell County, Hanna Basin Construction & Coal Co. and Rosebud Coal Sales Co. (Rosebud No. 2 strip) in Carbon County, Pacific Power & Light Co. in Converse County, T–K Coal Co. in Hot Springs County, and Kemmerer Coal Co. (Elkol strip) in Lincoln County.

Nineteen mines reported production; production from two mines, being less than 1,000 tons for the year, was not included in the tabulations. The following strip operations, in order of output, yielded the largest production: Dave Johnston (Pacific Power & Light Co.), Wyodak (Wyodak Resources Development Corp.), Sorensen (Kemmerer Coal Co.), Big Horn No. 1 (Big Horn Coal Co.), Rosebud No. 2 (Rosebud Coal Sales Co.), Elkol (Kemmerer Coal Co.), and Rosebud No. 3 (Rosebud Coal Sales Co.). Most of the production from these operations was used in coal-based electric powerplants in Wyoming and neighboring States.

Kemmerer Coal Co. and the University of Wyoming announced a $25,000-cooperative-5-year-research program on reclamation and conservation of mined-out-strip areas for the company strip mines near Kemmerer.

Gunn-Quealy Coal Co., a subsidiary of Kemmerer Coal Co., completed a coke-breeze plant at Rock Springs. The coke breeze was shipped to Monsanto Chemical Co. at Soda Springs, Idaho, for use in electrolytic refining of phosphate ores for the production of elemental phosphorus.

Near Glenrock, the third unit of the Dave Johnston plant of Pacific Power & Light Co. was dedicated on September 11. The company

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From Water Sensitivity Tests, Patrick Draw Area, Wyo. BuMines Rept. of Inv. 6520, 1964, 20 pp.

Whitcomb, Harold A., Donald A. Morris, and Russell H. Langford. Ground-Water Resources and Geology of Northern and Western Crook County, Wyo. Geol. Survey Water-Supply Paper 1698, 1964, 92 pp.

Wilson, W. H. The Kirwin Mineralized Area, Park County, Wyo. Geol. Survey of Wyo. Prel. Rept. No. 2, 1964, 12 pp.

———. Geological Reconnaissance of the Southern Absaroka Mountains, Northwestern Wyoming, Part I—The Wind River—Greybull River Area. Contribs. to Geol. (Univ. Wyo.), v. 3, No. 2, 1964, pp. 60–77.

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

(Excludes mines producing less than 1,000 short tons)

County	1963		1964	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Campbell	495,886	$1.31	488,846	$1.35
Carbon	531,021	3.96	446,509	3.85
Converse	[2] 1,109,322	[2] 3.44	[3] 1,722,650	[3] 3.40
Hot Springs	(2)	(2)	11,788	8.29
Lincoln	612,053	3.45	(3)	(3)
Sheridan	375,823	3.32	431,521	3.32
Sweetwater	(2)	(2)	(3)	(3)
Total	3,124,105	3.18	3,101,314	3.15

[1] Value received or charged f.o.b. mine, including selling cost. (Includes a 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] Production of Hot Springs and Sweetwater Counties combined with Converse County to avoid disclosing individual-company confidential data.
[3] Production of Lincoln and Sweetwater Counties combined with Converse County to avoid disclosing individual-company confidential data.

completed three 230,000-volt-transmission lines in the Big Horn basin and a 230,000-volt substation northwest of Green River to supply operators of trona-producing facilities. The company also announced plans to build a new steam-electric plant near Rawlins, using coal from the nearby Cherokee coal field. The new plant was to be equal to or larger than its Dave Johnston plant.

Natural Gas.—According to the Wyoming State Board of Equalization, an increase of approximately 14 percent in natural gas output was made in 1964. Seven new gasfields were discovered, compared with four in 1963. The most notable discovery was the Kirby Royalties, Inc., No. 2 Baggs well in Carbon County, which had an initial daily flow of 17 million cubic feet of gas from the Lance and Lewis formations. One natural-gas processing plant began operations, and one was shut down during the year; two plants were being constructed.

Construction of several natural-gas pipeline projects began during the year. Kansas-Nebraska Natural Gas Co. started taking gas from Dolis Hills, Frenchie Draw, and Cooper Reservoir fields in the northern Wind River basin. The gas was marketed through the Northern Utilities Co. system. Northern Utilities Co. added "loops" to existing pipelines and added compressors to its system. Montana-Dakota Utilities Co. completed construction of 52 miles of gathering lines and auxiliary equipment to handle gas production from the Dinty Moore, Howard Ranch, Muddy Ridge, and Pavillion fields. The gas was to be processed in the company Riverton Dome plant and piped to eastern Montana via Worland.

Kansas-Nebraska Natural Gas Co. proposed the addition of 3,000-compressor horsepower in Casper and on lines east of Casper. Also, replacement of 66 miles of pipeline in eastern Wyoming was planned.

Pan American Petroleum Corp. began constructing a gasoline plant to process 15 million cubic feet of natural gas per day and to recover 55 long tons of sulfur daily from the Phosphoria formation in the Beaver Creek field.

Ralston Associates, Inc., formerly Planet Engineers, Inc., and Husky Oil Co. were constructing a gas-and-sulfur processing plant in the Big Horn basin.

Colorado Interstate Gas Co. (CIG) announced plans to construct a $4.8-million hydrocarbon extraction and storage facility near Rawlins. The company completed a new $6-million ammonium nitrate fertilizer facility near Cheyenne.

Natural Gas Liquids.—GGG Corp. processed natural gas at a plant in the Cheyenne River field during the year. The Cottonwood Creek natural-gas-processing and sulfur-recovery plant of Pan American Petroleum Corp. ceased operations in December.

Petroleum.—Production and value of petroleum decreased 4 percent and 3 percent, respectively. Production was from 8,019 wells in 319 fields; 28 fields had an annual output of more than 1 million barrels.

TABLE 5.—Wildcat- and development-well completions in 1964, by counties

County	Oil	Gas	Dry	Total	Footage
Wildcat:					
Albany			3	3	9,200
Big Horn	1		12	13	46,000
Campbell	11		51	62	468,900
Carbon	1	3	18	22	100,200
Converse		1	7	8	37,000
Crook	8		31	39	229,600
Fremont	1	2	17	20	91,800
Goshen			1	1	7,000
Hot Springs	1		16	17	64,000
Johnson			8	8	49,600
Laramie			1	1	7,700
Lincoln	1		14	15	55,300
Natrona	3		21	24	98,000
Niobrara	2		22	24	126,300
Park	1		6	7	32,200
Sheridan			2	2	10,400
Sublette			15	15	80,300
Sweetwater	1	1	34	36	214,600
Uinta			3	3	5,100
Washakie			12	12	62,200
Weston	3		25	28	166,000
Total	34	7	319	360	1,961,400
Development:					
Albany			3	3	13,100
Big Horn	1		6	7	20,700
Campbell	36	1	28	65	523,900
Carbon	3	1	11	15	74,300
Converse	9	2	12	23	91,500
Crook	50		29	79	418,200
Fremont	20	9	12	41	199,700
Hot Springs	8		6	14	38,900
Johnson	14		6	20	104,500
Laramie			1	1	7,400
Lincoln	10	2	6	18	63,800
Natrona	149	5	20	[1] 221	422,300
Niobrara	9	2	6	[2] 18	61,300
Park	26		11	[2] 38	168,900
Sublette	35	16	26	77	282,100
Sweetwater	11	6	14	[2] 32	200,400
Washakie	3		7	10	16,600
Weston	37		6	43	185,100
Total	421	44	210	[3] 725	2,892,700
Total all drilling	455	51	529	[3] 1,085	4,854,100

[1] Includes 47 service wells. [2] Includes 1 service well.
[3] Includes 50 service wells.

Source: Oil and Gas Journal.

TABLE 6.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1963	1964	Principal fields in 1964, in order of production
Albany	837	600	Quealy Dome.
Big Horn	10,194	9,409	Garland, Byron, Bonanza, Sage Creek.
Campbell	8,111	6,840	Raven Creek, Timber Creek, Rozet, Dead Horse Creek.
Carbon	3,574	3,564	Wertz, Rock River, Cooper Cove, O'Brien Springs.
Converse	4,034	4,544	Glenrock South, Big Muddy.
Crook	6,239	6,755	Coyote Creek, Donkey Creek, Moorcroft West.
Fremont	12,655	12,195	Beaver Creek, Steamboat Butte, Winkleman Dome, Big Sand Draw.
Goshen	9	----	
Hot Springs	23,649	21,779	Hamilton Dome, Grass Creek, Little Buffalo Basin, Murphy Dome.
Johnson	6,465	7,364	Sussex Meadow Creek, North Fork, Sussex West.
Laramie	435	399	Horse Creek.
Lincoln	----	3	Stead Canyon.
Natrona	14,381	15,635	Salt Creek, Grieve, Salt Creek East.
Niobrara	976	975	Lance Creek, Lance Creek East, Mule Creek, Ant Hills North.
Park	33,975	30,404	Elk Basin, Oregon Basin, Frannie, Pitchfork.
Sheridan	607	511	Ash Creek South, Ash Creek.
Sublette	4,248	4,531	Big Piney, Birch Creek, La Barge.
Sweetwater	8,684	7,634	Patrick Draw, Lost Soldier.
Uinta	4	2	Spring Valley.
Washakie	2,105	1,974	Cottonwood Creek, Worland, Hidden Dome, Slick Creek.
Weston	3,225	3,634	Fiddler Creek, Osage, Clareton.
Total	144,407	138,752	

Source: Wyoming Ad Valorem Tax Division, State Board of Equalization, and Petroleum Information Corporation. 1964 Resume, Oil and Gas Operations in the Rocky Mountain Region.

Drilling in the Powder River basin accounted for about half of the total drilling.

The drilling objective in the Powder River basin generally was the Minnelusa formation. Seventeen producing oil wells were developed in the Dillinger Ranch field after the discovery of the Tenneco Oil Co. and United States Smelting Refining and Mining Co. No. 1–A Helen V. Smith well with an initial daily production of 299 barrels of oil. The Wind River basin accounted for 17 percent of the total drilling; Green River basin, for 13 percent; Big Horn basin, for 11 percent; and the Hanna, Laramie, Denver-Julesburg, Red Desert, Washakie basins combined for 9 percent. Fields yielding more than 5 million barrels of crude oil included Elk Basin, Park County, 19.2 million; Salt Creek, Natrona County, 10.5 million; Hamilton Dome, Hot Springs County, 9.7 million; Oregon Basin, Park County, 7.1 million; and Grass Creek, Hot Springs County, 5.6 million. The average value of crude oil at or delivered to pipeline entry was $2.53 per barrel.

Nine refineries in the State processed 40.6-million barrels of oil, a decrease of 11 percent from the number processed in 1963; of the barrels processed, 1.6 million were from out of the State, over 1.5 million from Colorado, and 36,000 from Nebraska, and North and South Dakota.

Other States refined 71 percent of the crude oil produced in Wyoming: Indiana (30.8 million barrels), Montana (17.9 million), Illinois (10.5 million), Michigan (9.7 million), Colorado (9.4 million), Utah (8.3 million), Missouri and Nebraska (7.2 million), Ohio (6.6 million), Minnesota (2.1 million), and Kansas (90,000 barrels).

TABLE 7.—Oil and gas discoveries in 1964

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 oil per day	Thousand cubic feet of gas per day		
Big Horn County:												
Cowley	No. 1 Dalton	Union Oil Co. of California.	34	57 N.	97 W.	Tensleep	4,538–4,548	4,717	400		Feb. 1	Pumped. New field.
Campbell County:												
Dillinger Ranch	No. 1-A USA-Helen V. Smith.	Tenneco Oil Co	7	47 N.	69 W.	Minnelusa	9,132–9,165	9,282	299		Mar. 15	Do.
Yellow Hammer	No. 1 Raitt	Skelly Oil Co	35	47 N.	70 W.	do	10,050–10,078	10,200	284		Oct. 13	Do.
Clabaugh	No. 31-2 Clabaugh-Floyd.	Shell Oil Co	2	47 N.	71 W.	do	9,962–10,035	10,259	92		Nov. 9	Do.
Hoe Creek	No. 1-17 Federal	W. C. Roberts-J. C. Lowrance.	17	47 N.	74 W.	Parkman	7,120–7,130	7,132	123		Feb. 3	Do.
Duvall Ranch	No. 1 Duvall	True Oil Co	11	49 N.	69 W.	Minnelusa	8,140–8,180	8,318	140		May 5	Do.
East Rozet	No. 1 Brennan	do	21	50 N.	69 W.	do	8,149–8,166	8,270	490		Aug. 8	Pumped. New pay.
Southeast Ward Creek.	No. 1 USA-Laws	Tenneco Oil Co	3	50 N.	70 W.	Muddy	7,377–7,382	9,225	115		Feb. 18	Pumped. New field.
Pownall Ranch Area.	No. 1 Government.	Wayne Blackman	12	53 N.	70 W.	Minnelusa	7,482–7,496	7,568	120		Oct. 30	Swabbed. New field.
East Soda Well	No. 1-11 Government.	Tipps Drilling Co.	11	54 N.	70 W.	Muddy	5,737–5,742	7,463	85		Jan. 17	Pumped. New field.
Olmstead	No. 1 Unit	Humble Oil & Refining Co.	13	57 N.	72 W.	do	6,028–6,043	7,775	282		Aug. 15	Swabbed. New field.
Carbon County:												
West Side Canal	No. 2 Baggs-Government.	Kirby Royalties, Inc.	17	12 N.	91 W.	Lewis	3,540–3,560	6,550		1,651	July 27	Flowed. New field: Dual completion.
						Lance	3,227–3,261			15,327		
Platte River Bend.	No. 24-26 Unit	A. R. Dillard, Jr.	26	24 N.	85 W.	Lewis	4,768–4,782	5,584	25		Feb. 17	Flowed. New field.
Separation Flats	No. 7-1 UPRR Buzzard Ranch.	Amax Petroleum Corp.	7	24 N.	87 W.	Muddy	2,848–2,854	3,100		6,800	Apr. 10	Do.
Converse County:												
LaPrele	No. 1 Government-Hawks-A	Texaco Inc	23	33 N.	71 W.	Frontier	11,572–11,850	12,831		500	Mar. 17	Do.

Crook County: South Robinson Ranch.	No. 2 Government-Hoffine.	Arrowhead Exploration Co.	5	49 N.	67 W.	Lakota	4,966	6,418	38 (per hour)		Feb. 8	Flowed. New pay.
West Kummerfeld.	No. 7-1 Climax	True Oil Co	7	50 N.	68 W.	Minnelusa	7,680- 7,724	7,794	288		Feb. 12	Pumped. New field.
Do	No. 7-2 Climax	U.S. Smelting Refining and Mining Co.	7	50 N.	68 W.	Dakota	6,312- 6,316	7,926	115		May 11	Pumped. New pay.
West Moorcroft	No. 3-C Meyer	Anschutz Oil Co., Inc.	1	51 N.	68 W.	do	4,646- 4,701	4,797	1,089		Sept. 12	Flowed. New pay.
Do	No. 3 Mellott	Sinclair Oil & Gas Co.	2	51 N.	68 W.	Minnelusa	6,340- 6,362	6,472	37		Dec. 22	Pumped. New pay.
Muddy Discovery.	No. 1 Meyer	Davis Oil Co	12	51 N.	68 W.	Muddy	4,312- 4,318	6,296	100		May 9	Pumped. Old well, work-over. New pay.
West Semlek	No. 1 Semlek	Texaco Inc	28	52 N.	68 W.	do	5,460- 5,492	7,379	8		Mar. 29	Pumped. New pay.
Fremont County: Sharp Nose	No. 2 Tribal	Wolfe Drilling Co.	36	1 S.	1 E.	Muddy (open hole).	511- 513	513		5,500	June 3	Flowed. New field.
Hot Springs County: King Dome	No. 2 Ogle-Federal.	Shamrock Oil and Gas Corp.	19	44 N.	96 W.	Phosphoria	2,864	2,875	45		Nov. 14	Pumped. New field.
Baird Peak	No. 1 Murray-Government.	Chandler-Simpson	4	45 N.	100 W.	Curtis	5,834	7,203	32		Mar. 26	Pumped. Old well, work-over. New field.
Lincoln County: Stead Canyon	No. 1 USA-Wexall.	Pan American Petroleum Corp.	22	26 N.	112 W.	Ft. Union	3,343- 3,348	3,950	30		Mar. 3	Pumped. New field.
Natrona County: Schrader Flats	No. 4-26 Government.	Ferguson & Bosworth.	26	31 N.	82 W.	Lakota	2,669- 2,725	3,458	150		Sept. 12	Pumped. New pay.
Do	No. 3-26 Government.	do	26	31 N.	82 W.	3d Sundance 2d Sundance	3,330- 3,340 3,227- 3,249	4,635	140 30		Sept. 13	Do.
Frontier Discovery.	No. 1 Government.	M. J. Wallway	21	35 N.	84 W.	2d & 3d Frontier (open hole).	197- 523	523	3	625	May 29	Flowed. New field.
Niobrara County: North Krejci	No. 34-20 Government.	Arrowhead Exploration, et al.	20	37 N.	64 W.	Lakota	7,666- 7,672	7,750	312		Feb. 3	Pumped. New field.
Red Bird	No. 1 Government-Ming	Sterling Drilling Co.	25	38 N.	62 W.	Leo	3,106- 3,115	3,847	80		Mar. 15	Flowed. New field.

TABLE 7.—Oil and gas discoveries in 1964—Continued

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 oil per day	Thousand cubic feet of gas per day		
Sweetwater County:												
Continental Divide	No. 1 Federal	Murphy Oil Corp.	10	22 N.	93 W.	Ft. Union	3,212–3,216	7,140	144	----------	Aug. 30	Pumped. New field.
Pine Canyon	No. 1 Unit	Sohio Petroleum Co.	32	23 N.	103 W.	Dakota	8,352–8,492	8,652	15 (condensate)	1,250	Feb. 27	Flowed. New field.
Weston County:												
Wildcat Creek	No. 1 Thompson-Baker.	Edward C. Colling.	4	41 N.	64 W.	Carlile	4,890–4,954	5,024	17	----------	June 10	Pumped. New pay.
Do	No. 1 Government.	----do----------	18	41 N.	64 W.	Wall Creek (open hole).	5,348–5,443	5,443	11	----------	Mar. 10	Pumped. New field.
Turner Discovery	No. 1 La Bounty	True Oil Co	19	48 N.	67 W.	Turner	5,205–5,210	6,560	20	----------	May 26	Do.

Source: Petroleum Information Corp., 1964 Resume, Oil and Gas Operations in the Rocky Mountain Region.

The refinery of American Oil Co. at Casper had the largest output with 10-million barrels; Sinclair Refining Co. at Sinclair refined 8.1 million; Texaco Inc. at Casper, 7.9 million; The Frontier Refining Co. at Cheyenne, 5.7 million; Husky Oil Co. at Cody, 3.7 million; Mobil Oil Co. Division, Socony-Mobil Oil Co., Inc., at Casper, 3.3 million; Empire State Oil Co. at Thermopolis, 2.4 million; Sioux Oil Co. at Newcastle, 1.7 million; and C & H Refinery at Lusk, 16,830 barrels.

Sinclair Refining Co. completed a multimillion-dollar modernization program.

METALS

The value of metal production, representing 10 percent of the State mineral output, increased 26 percent. Beryllium, copper, gold, silver, iron ore, uranium ore, and vanadium were produced.

Beryllium.—A small quantity of hand-cobbed beryl was produced from a single operation in Fremont County.

Gold, Silver, and Copper.—The Manson Mines, Ltd., Los Angeles, Calif., mined and shipped 68 tons of ore containing copper and silver from the Big Creek mine near Encampment. One ounce of gold valued at $35 was recovered from a stream placer in Teton County, 5 ounces of gold valued at $175, recovered in previous years from a stream deposit in Albany County, was sold.

Iron Ore.—A substantial increase in iron-ore production and value—28 and 40 percent, respectively—was recorded. Atlantic City Ore Operations, United States Steel Corp. (USS), neared the 3-millionth-ton mark in shipments of taconite iron ore agglomerates. CF&I shipped upgraded iron ore from the Sunrise new facilities to Pueblo, Colo., for processing at the company iron and steel plant. Plicoflex, Inc., formerly Magnetite Products, Inc., produced titaniferous magnetite ore from Albany County for use as heavy aggregate.

Uranium Ore.—Production and value of uranium ore increased 27 and 17 percent, respectively. Output, which came from 70 operations at 45 mines in 10 counties, was processed in 6 mills in Wyoming, 2 in Colorado, and 1 in South Dakota. The quantity of recoverable uranium oxide from Wyoming ores was 6.6 million pounds valued at $53 million, ranking the State second in production.

Atlas Minerals Division, Atlas Corp., placed the Peach property on standby in September, allowing the 500-foot shaft to flood.

Western Nuclear, Inc., shut down the Spook concentrator in September. The company awarded a contract to Centennial Development Co., Eureka, Utah, for an 800-foot, 7-by-17-foot shaft on the Golden Goose No. 3 claim.

The Gas Hills Operations (formerly Globe Mining Co. Division) of Union Carbide Corp., Mining and Metals Division, sunk the Rox and Thunderbird shafts for an underground operation in the East Gas Hills.

Continental Uranium Co. of Wyoming contracted with Green Mountain Uranium Co. to mine uranium ore through the Seismic mine.

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TABLE 8.—Mine production of uranium ore, by counties [1]

County	1963				1964			
	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]
Albany	------	------	------	------	1	W	W	W
Big Horn	4	293	2,590	$11,483	1	322	2,995	$13,105
Campbell	2	W	W	W	2	W	W	W
Carbon	6	195,197	1,099,912	4,588,441	6	206,742	978,135	3,972,596
Converse	10	175,273	511,829	1,574,244	7	64,342	195,277	645,616
Crook	6	73,454	322,631	1,296,051	6	93,188	379,927	1,509,459
Fremont	r 39	r 727,591	r 3,951,405	r 16,368,938	40	1,075,135	5,246,686	21,329,339
Johnson	1	W	W	W	1	W	W	W
Natrona	------	W	W	W	5	W	W	W
Sweetwater	1	W	W	W	1	W	W	W
Undistributed	------	r 1,612	r 3,871	r 9,533	------	50,624	147,827	441,071
Total	r 69	r 1,173,420	r 5,892,238	r 23,848,690	70	1,490,353	6,950,847	27,911,186

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.

Some uranium ore contained significant quantities of vanadium which were recovered from the Wyoming ores processed by Mines Development, Inc., a subsidiary of Susquehanna Corp., at Edgemont, S. Dak. The quantity recovered was 2 percent less than that in 1963.

NONMETALS

Nonmetal production, representing 10 percent of the State mineral output, increased 3 percent in value compared with that of 1963. Increased production was recorded for gypsum, sodium carbonate (trona), stone, phosphate rock, and clays (bentonite, fire clay, and miscellaneous clay).

Cement.—An 8-percent decline in production and value was recorded for cement. Monolith Portland Midwest Co., the only producer in the State, produced limestone and sandstone, and its subsidiary, Wyoming Construction Co., mined cement rock and gypsum for making cement. The company produced coal from the Hanna No. 2 strip mine at Hanna for use at its plant near Laramie.

Clays.—Production of bentonite, fire clay, and miscellaneous clay increased 3 percent in value. The output of bentonite, the most important of the clays produced, increased 10 percent, from 1.1 million tons valued at $12.2 million to 1.2 million tons valued at $12.6 million. The State led the Nation in the production of high-swelling bentonite. Approximately 32 percent of the bentonite was used for pelletizing taconite iron concentrates, a relatively new large-volume use. Other uses, in order of quantity, included 29 percent in rotary drilling; 26 percent in the foundry industry; 5 percent in reservoir sealing, briquetting, animal feed, other refractory chemicals, paper products, filtering and clarifying, insecticides and fungicides, enameling, plaster, adhesives, and cements; 5 percent for exports; and 3 percent for miscellaneous uses.

Producing companies, in order of output, were American Colloid Co. with one plant in Crook County, Magnet Cove Barium Corp. with a plant in Big Horn County, National Lead Co. with plants in Crook and Weston Counties, Archer Daniels Midland Co. (ADM) with plants in Crook and Weston Counties, International Minerals & Chemical Corp. (IMC) with a mine in Crook County, and a plant in South Dakota; Wyo-Ben Products Co. with a plant in Big Horn County, Black Hills Bentonite Co. with a plant in Crook County, and Benton Clay Co., Inc., with a plant in Natrona County.

Black Hills Bentonite Co. was scheduled to terminate its operations at Moorcroft in Crook County in January 1965 in favor of operating a new $400,000 processing plant near Casper. The new deposit of bentonite being developed near Barnum in Johnson County, 75 miles from Casper, was considered to be one of the largest in the United States.

Wyo-Ben Products Co., Greybull, was developing a new deposit from a 50-foot-deep open pit in which the bentonite beds were from 7 to 9 feet thick.

Included in the miscellaneous clays produced were shale for lightweight aggregate by The Idealite Co., a subsidiary of Ideal Cement Co., at Laramie; clay for building brick, vitrified sewer pipe, and other products by Lovell Clay Products Co. at Lovell; and clay for building bricks by Sheridan Press Brick & Tile Co. at Sheridan and Interstate Brick Co. at Evanston.

Gypsum.—A 41-percent increase in production and a 42-percent increase in value were recorded for gypsum. Gypsum Products of America Corp. began constructing a new $3-million gypsum plant near Lovell. Big Horn Gypsum Co., a subsidiary of The Celotex Corp., added 30,000 square feet to its existing facilities at Cody for manufacturing gypsum wallboard. Wyoming Construction Co. mined gypsum for Monolith Portland Midwest Co. for use as a retarding agent in cement. Cody Sulphur Products Co. at Cody milled and shipped gypsum, mined in 1955, for agricultural use.

Lime.—Value of quicklime manufactured was $11,000 less than that of 1963. The Great Western Sugar Co., at Lovell, and Holly Sugar Co., at Torrington and Worland, produced quicklime for use in the refining of beet sugar.

Phosphate Rock.—San Francisco Chemical Co., the only phosphate rock producer in the State, increased output 10 percent. Ore from Wyoming and company-owned mines in Utah was beneficiated in the company plant near Sage.

Susquehanna-Western, Inc., a subsidiary of Susquehanna Corp., obtained leases on 7,100 acres of phosphate-bearing deposits near South Pass, Fremont County.

Pumice.—Output of scoria (pumice) by Tongue River Stone Co. of Sheridan declined. The crushed and screened scoria was used for railroad ballast.

Sand and Gravel.—Production and value of sand and gravel decreased 29 percent and 25 percent, respectively; the average value increased from $1 in 1963 to $1.05 per short ton in 1964. The decreased output was attributed mainly to a reduction in the 1964 Wyoming highway

program.[4] Under the program for 1964, road-construction contracts awarded totaled $43.1 million: $1.2 million for roads financed by the State, $12.1 million for roads in the Federal-aid primary and secondary (ABC) program, and $29.7 million under the Interstate Highway System. Planned expenditures for road construction in 1965 totaled $51.7 million: $1.9 million by the State, $10.8 million with ABC funds, and $38.9 million for the Interstate program. Under the Interstate program for 1964,[5] 72.9 miles of road was opened to traffic, bringing the total to 441.8 miles of road opened to traffic since the program began on July 1, 1956; Wyoming was ranked 14th in miles open to traffic. At yearend, roads under construction and in engineering or right-of-way status totaled 180.9 miles; work in the preliminary stage or not yet in progress totaled 294.6 miles. The total designated mileage for the State was adjusted to 917.3 miles.

TABLE 9.—Sand and gravel production in 1964, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Albany	W	W	Platte	W	W
Big Horn	250	$290	Sheridan	53	$73
Carbon	264	273	Sublette	80	69
Converse	26	26	Sweetwater	64	76
Crook	82	73	Teton	186	213
Fremont	48	62	Uinta	15	20
Goshen	329	328	Washakie	579	581
Hot Springs	34	42	Weston	7	8
Johnson	601	618	Yellowstone National Park	W	W
Laramie	867	917	Undistributed	293	272
Lincoln	262	269			
Natrona	1,253	1,379	Total	5,632	5,936
Niobrara	W	W			
Park	339	347			

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

Production of sand and gravel, from 52 commercial operations and 43 Government-and-contractor operations, was reported for all but one county (Campbell) and Yellowstone National Park. Ninety-seven percent of the sand and gravel was prepared for use by washing, crushing, or screening. The distribution of sand and gravel, according to use, was 89 percent for road construction, 7 percent for building, and 4 percent for railroad ballast, fill, and miscellaneous uses. Companies reporting the largest output of sand and gravel were Gilpatrick Construction Co., Inc., Fremont and Washakie Counties; Big Horn Construction Co., Johnson and Laramie Counties; Asbell Bros., Inc., Johnson and Natrona Counties; Western Paving Construction Co., Carbon and Goshen Counties; Read Construction Co., Natrona County; Rissler & McMurry Co., Inc., Natrona County; Naranche and Konda Construction Co., Big Horn, Carbon, and Park Counties; and Western Construction Co., Laramie County.

Sodium Carbonate and Sulfate.—An increase in sodium-carbonate (trona) production, 15 percent, and value, 11 percent, resulted from expanded facilities at both the Stauffer Chemical Co. of Wyoming, and the Inorganic Chemical Division of FMC Corp. plants.

[4] Engineering News-Record. State Highway Contract Awards Will Jump to a Record High. V. 174, No. 12, Mar. 25, 1965, pp. 30–32.

[5] Bureau of Public Roads. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1964. Press Release BPR 65–10, Feb. 11, 1965.

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	1963		1964	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	123	$165	202	$266
Paving	339	345	141	184
Railroad ballast	W	W		
Fill	52	26	4	4
Other			7	4
Total	514	536	354	458
Gravel:				
Construction:				
Building	172	226	207	286
Paving	1,419	1,298	1,473	1,661
Railroad ballast	W	W	W	W
Fill	35	26	151	80
Miscellaneous	34	38		
Total	1,660	1,588	1,831	2,027
Total sand and gravel	2,174	2,124	2,185	2,485
Government-and-contractor operations:				
Sand:				
Building	(1)	(1)		
Paving	36	36	17	17
Fill			6	3
Total	36	36	23	20
Gravel:				
Building	35	31	11	5
Paving	5,576	5,603	3,375	3,392
Fill	80	80	38	34
Total	5,691	5,714	3,424	3,431
Total sand and gravel	5,727	5,750	3,447	3,451
All operations:				
Sand	550	572	377	478
Gravel	7,351	7,302	5,255	5,458
Total	7,901	7,874	5,632	5,936

W Withheld to avoid disclosing individual company confidential data; included with "Fill."
[1] Less than ½ unit.

Solvay Process Division, Allied Chemical Corp., awarded a contract to Boyles Bros. Drilling Co., Salt Lake City, Utah, in November for sinking a 12-foot-diameter, 1,600-foot-circular-production shaft on its trona deposits 12 miles west of Green River.

Texas Gulf Sulphur Co. (TGS), successful bidder for 7,500 acres of trona-bearing land near the FMC Corp. operations, announced plans for a trona-producing project.

Output of natural sodium sulfate from saline lake deposits in Natrona County declined in 1964.

Stone.—Production and value of stone from 28 operations increased 11 percent and 23 percent, respectively. Stone produced was crushed and broken, except for a small amount of dimension sandstone used for constructing and decorating buildings. Limestone accounted for 58 percent; granite, for 30 percent; sandstone, for 11 percent; and miscel-

laneous stone and marble, for 1 percent. Limestone was used for manufacturing cement and lime and as flux, railroad ballast, riprap, road-construction aggregate, and mineral food; granite, for railroad ballast, roadstone, and riprap; sandstone, for manufacturing cement and as roadstone and riprap; marble, for cement filler, roofing and driveway chips, and in exposed aggregate for building; and miscellaneous stone, for manufacturing fertilizer and as roadstone and riprap.

Allstar Enterprises, Inc., cut and polished marble and valuable building materials for various types of decorative blocks for use by contractors in northern Wyoming. The firm was able to produce 200 cement blocks per hour with updated machinery.

TABLE 11.—Stone production in 1964, by counties

County	Short tons	Value	County	Short tons	Value
Albany	351,799	$630,146	Platte	W	W
Big Horn	W	W	Sheridan	58,590	$80,684
Carbon	188,971	225,234	Sublette	W	W
Crook	W	W	Teton	W	W
Fremont	500	750	Undistributed	756,685	1,329,584
Goshen	61	3,202			
Laramie	796,920	1,401,505	Total	2,153,526	3,671,105

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

Sulfur.—Sulfur was recovered from hydrogen-sulfide-bearing natural gas by four companies at five plants. Sulfur shipments of 41,000 long tons were valued at $545,000, 32 percent less than in 1963. Plant operators, according to output, were Pan American Petroleum Corp. in Park and Washakie Counties, Texas Gulf Sulphur Co. in Washakie County, Kern County Land Co. in Big Horn County, and Atlantic Refining Co. in Fremont County.

REVIEW BY COUNTIES

Albany.—Output by Monolith Portland Midwest Co. at Laramie, the only cement plant operation in Wyoming, accounted for over half of the mineral production in the county through mining of cement rock, gypsum, limestone, and sandstone. Shale was mined by The Idealite Co. and expanded into lightweight aggregate at facilities adjacent to the cement plant. Because the Rocky Flats plant of Idealite near Arvada, Colo., supplied the Denver, Colo., market outlets, shale output was 34 percent less than in 1963. Plicoflex, Inc., formerly Magnetite Products, Inc., increased output of iron ore for heavy aggregate sevenfold from deposits west of Farthing. Peterson, Anderson & Kneisley produced iron ore from the Shanton deposit for heavy aggregate.

Production of crude petroleum from four fields decreased 28 percent; Quealy Dome had the largest production with 497,000 barrels, down 207,000 barrels from 1963. Sand and gravel production, 43 percent less than in 1963, was reported by two operators, compared with three in 1963. Five ounces of gold recovered in previous years from Douglas Creek was reported sold.

TABLE 12.—Value of mineral production in Wyoming, by counties

County	1963	1964	Minerals produced in 1964, in order of value
Albany	$6,967,579	$7,490,242	Cement, iron ore, petroleum, stone, sand and gravel, clays, gypsum, gold, uranium ore.
Big Horn	30,473,172	28,848,801	Petroleum, clays, natural gas, sand and gravel, lime, uranium ore, stone.
Campbell	21,683,625	18,358,563	Petroleum, coal, natural gas, LP gases, uranium ore, vanadium.
Carbon	16,723,736	15,715,538	Petroleum, uranium ore, coal, natural gas, sand and gravel, stone, LP gases, copper, silver.
Converse	r 16,113,286	16,349,371	Petroleum, coal, uranium ore, LP gases, natural gas, natural gasoline, vanadium, sand and gravel,
Crook	r 24,074,535	25,892,100	Petroleum, clays, uranium ore, stone, natural gas, vanadium, sand and gravel.
Fremont	r 66,645,174	76,594,043	Petroleum, uranium ore, iron ore, natural gas, natural gasoline, LP gases, sand and gravel, stone, beryllium concentrate.
Goshen	232,983	W	Sand and gravel, lime, stone.
Hot Springs	59,430,925	55,486,702	Petroleum, natural gas, coal, natural gasoline, sand and gravel.
Johnson	18,435,094	20,414,205	Petroleum, natural gas, sand and gravel, natural gasoline, LP gases, uranium ore.
Laramie	2,515,646	3,329,505	Stone, petroleum, sand and gravel, natural gas.
Lincoln	5,671,111	8,992,077	Natural gasoline, coal, phosphate rock, LP gases, sand and gravel, petroleum.
Natrona	r 41,948,622	44,274,262	Petroleum, sand and gravel, natural gas, LP gases, uranium ore, clays, natural gasoline, sodium sulfate.
Niobrara	2,595,000	2,607,000	Petroleum, natural gas, sand and gravel, LP gases.
Park	90,589,063	81,067,981	Petroleum, natural gas, LP gases, gypsum, sand and gravel, natural gasoline.
Platte	W	3,633,432	Iron ore, stone, sand and gravel.
Sheridan	3,075,710	2,898,235	Coal, petroleum, stone, sand and gravel, pumice, clays.
Sublette	22,316,000	22,899,140	Petroleum, natural gas, sand and gravel, LP gases, stone.
Sweetwater	48,102,698	47,337,255	Sodium carbonate, petroleum, natural gas, LP gases, coal, natural gasoline, sand and gravel, uranium ore.
Teton	372,028	W	Sand and gravel, stone, gold.
Uinta	1,193,780	1,201,743	Natural gas, clays, natural gasoline, sand and gravel, petroleum.
Washakie	8,845,979	8,536,812	Petroleum, natural gas, LP gases, sand and gravel, lime.
Weston	10,766,443	11,952,831	Petroleum, clays, LP gases, natural gas, natural gasoline, sand and gravel.
Yellowstone National Park	W	W	Sand and gravel.
Undistributed [1]	3,464,764	965,945	
Total	r 502,237,000	504,846,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes some stone (1963) and gem stones that cannot be assigned to specific counties and values indicated by symbol W.

Big Horn.—Petroleum production, from 18 fields, and natural gas production, from 8 fields, decreased 8 percent and 9 percent, respectively, according to the Wyoming State Board of Equalization. The largest petroleum fields were Garland with 4.3-million barrels, down 300,000 barrels, and Byron with 2.7 million barrels, down 200,000 barrels. The largest natural gas fields were Byron-Garland with 4.9-million cubic feet and Manderson with 1.3-million cubic feet. Clay output, up 23 percent, was second to petroleum in value of minerals produced. Output of bentonite by Magnet Cove Barium Corp. and Wyo-Ben Products Co. increased. Lovell Clay Products Co. increased output of miscellaneous clay used for building brick, heavy clay pipe, and tile products. Seven sand and gravel operators in the county produced a total of 250,000 tons; four operators in 1963 had produced 64,000 tons. Lime, processed and used by The Great Western Sugar Co. at its Lovell beet-sugar refining plant, decreased 4 per-

cent in output. The county had one uranium-ore operator in 1964, compared with four operators in 1963.

Kern County Land Co. acquired the Garland sulfur plant from Gas Processors, Inc.

Campbell.—Although 10 new fields were discovered, bringing the operating total to 30 for 1964, petroleum and natural gas output decreased 16 percent and 4 percent, respectively, according to the Wyoming State Board of Equalization. The most important discovery was Dillinger Ranch, with an initial daily production of 299 barrels. A new pay zone in the East Rozet field had an initial daily production of 490 barrels. Two gas processing plants in Rozet field, N.C. Ginther and Kern County Land Co., formerly operated by Gas Processors, Inc., recovered 4.2-million gallons of LP gases, 181,000 gallons less than in 1963.

A 1-percent decrease in coal production was recorded by Wyodak Resources Development Corp., a subsidiary of Black Hills Power and Light Co. Two uranium operations, the same number as in 1963, produced uranium ore.

Carbon.—Petroleum production from 17 fields, compared with 15 in 1963, accounted for 57 percent of the mineral-production value. The two largest fields were Wertz, with 2.4-million barrels, and Rock River, with 409,000 barrels. According to the State Board of Equalization, natural-gas production increased 13 percent.

Sinclair Refining Co. at Sinclair completed its multimillion-dollar modernization program by adding new units for high-octane gasoline, improving heating and diesel oil, increasing the yield of high-octane motor fuels, and improving the sulfur-recovery unit. The plant reduced its throughput 11 percent; output remained the second highest in the State. The McFadden natural-gas-processing plant of Marathon Oil Co., near Rock River, produced 2.7-million gallons of LP gases, an increase of 600,000 gallons.

Six uranium operations, the same as in 1963, increased output by 6 percent. Sigma Mining Co. produced from two operations and Joe Wentz produced from one operation in the Poison basin area west of Baggs; Petrotomics Co. produced from one operation and Utah Construction & Mining Co. produced from two operations in the Shirley basin area.

Rosebud Coal Sales Co., Monolith Portland Midwest Co., and Hanna Basin Construction & Coal Co. collectively recorded a decrease of 16 percent in coal output. Rosebud Coal Sales Co. closed the Rosebud strip mine and opened the Rosebud No. 3 strip mine.

Sand and gravel output decreased 52 percent as a result of the completion of that section of Interstate 80 contracted in the county. Production was from two commercial and three Government-and-contractor operations. An elevenfold increase in stone output was accounted for by Naranche and Konda Construction Co., contractors doing work for the U.S. Forest Service.

The Federal Bureau of Reclamation Savory-Pot Hook project was authorized on September 2 at a cost of $5.5 million for constructing two reservoirs: 18,600-acre feet at Savory and 65,000-acre feet at Pot Hook; $225,000 was to be used for recreation, fish, and wildlife enhancement.

Converse.—Petroleum, produced from 11 oilfields, represented 70 percent of the mineral-production value of the county. Production of natural gas increased 95 percent according to the Board of Equalization, whereas production of natural gasoline and LP gases decreased 29 and 14 percent, respectively.

The third unit of the Dave Johnston powerplant of Pacific Power & Light Co. was dedicated in September. The new unit, rated 220,000 kilowatts, increased the total capacity of the plant to 420,000 kilowatts, the largest electrical generating station in the Rocky Mountain region. The three generating units—combined with the associated coal mine and $3.2-million 16-mile railroad, completed in October—represented an investment of over $70 million. Electrical energy was transmitted to a large substation in Casper for distribution to service areas in Wyoming and neighboring States.

Coal output from the Dave Johnston strip mine and the Best Coal Co. Antelope strip mine was down 3 percent.

A 63-percent decrease in uranium-ore output was recorded for the county. Western Nuclear, Inc., closed the Spook mine and used the Spook concentrator only on stockpiles mined in 1963. B. & H. Mines, Inc., and Vernon A. Mrak, the only producers in the county, operated in the Dry Fork area.

Production of sand and gravel was reported by two operators; output decreased substantially.

Crook.—Of the total mineral value, petroleum accounted for 66 percent, bentonite for 23 percent, and uranium ore for 6 percent. Petroleum output from 25 fields, the same as in 1963, increased 8 percent. Coyote Creek with 1.8-million barrels and Donkey Creek with 996,000 barrels were the leading oilfields. Natural-gas production, from four fields, increased 26 percent, according to the Board of Equalization.

Output of bentonite increased 2 percent. Producers, in order of output, were American Colloid Co., IMC, Baroid Division of National Lead Co., ADM, and Black Hills Bentonite Co.

Uranium-ore production, 27 percent more than in 1963, came from six operations by three companies. In the Hulett area, Balboa Mining & Development Co., Homestake Mining Co., and Susquehanna-Western, Inc., mined uranium ore which was processed by Mines Development, Inc., at Edgemont, S. Dak. Vanadium, recovered from uranium ores, was 11 percent under the 1963 output.

Crushed stone was produced by Big Horn Construction Co., a subsidiary of Peter Kiewit Sons' Co., under contract for the Wyoming State Highway Department and by Roberts Construction Co., Inc., for commercial use. Sand and gravel was produced by one commercial operator and by two contractors for the U.S. Forest Service. Output of crushed stone increased 71 percent; sand and gravel production decreased 67 percent.

Fremont.—This county maintained the second position in the State in total value of mineral production, which increased 15 percent. Petroleum represented 40 percent of the total value and uranium ore 28 percent. Crude oil, from 29 fields, decreased 4 percent and natural gas, from 19 fields, increased 70 percent, according to the Board. Leading oilfields were Beaver Creek, Steamboat Butte, and Winkleman Dome. Pan American Petroleum Corp. was constructing a gas-

oline-and-sulfur-extraction plant in the Beaver Creek field to process gas from the Phosphoria reservoir. The company ceased operations at its Cottonwood Creek plant in December.

TABLE 13.—Uranium operators in Fremont County in 1964

Operator	Locality	Type of mine
Atlas Corp., Atlas Mineral Div.	Gas Hills	Open pit and underground.
Continental Uranium Company of Wyoming	Crooks Gap	Underground.
Federal-Gas Hills Partners	Gas Hills	Open pit.[1]
Green Mountain Uranium Corp.	Crooks Gap	Underground.
Dale B. Levi	Gas Hills	Open pit.
P. C. Mining Corp.	do.	Do.
Peters Mining Co.	do.	Do.
H. M. Pursel	do.	Do.
Susquehanna Corp., Susquehanna-Western, Inc.	Copper Mountain	Underground.
Union Carbide Corp., Gas Hills Operations	Gas Hills	Open pit.[1]
Utah Construction & Mining Co., Lucky Mc Operation	do.	Do.[1]
J. M. Wade	do.	Do.
Western Nuclear, Inc.	do.	Do.[1]

[1] Some underground operations conducted from the floor of the open pits.

Susquehanna-Western, Inc., purchased molten sulfur from Ralston Associates, Inc., at Powell and from Atlantic Refining Co. at Riverton Dome for manufacturing sulfuric acid in its Riverton plant.

Uranium ore output from Fremont County accounted for 72 percent of the total State output. Most of the production came from the Gas Hills area, with lesser amounts from the Crooks Gap area and Copper Mountain. Atlas Minerals placed the underground Lisbon mine on standby; the company began underground development at the Sunset open-pit mine.

Federal-Gas Hills Partners; Union Carbide Corp., Gas Hills Operations; and Utah Construction & Mining Co. negotiated contracts with the U.S. Atomic Energy Commission (AEC) for the stretchout purchasing program. Federal-Gas Hills Partners made improvements in its mill that were to double 1963 capacity.

Union Carbide Corp. leased the P–C claims on the Rox property, completed stripping 2-million cubic yards on the Susie claims, and connected the Rox and Thunderbird shafts underground. Utah Construction & Mining Co. drove an adit into a new ore body at the Rim pit in east Gas Hills.

A new Eluex milling circuit was installed in Western Nuclear, Inc., Split Rock mill. The company had recovered more than 400,000 pounds of uranium oxide from low-grade ores by heap-leaching methods: Conventional or straight gravitational downflow through an open-ore pile and percolation or controlled flow, upward and downward, through a contained pretreated-ore pile. The 10-millionth pound of uranium oxide concentrate was sold to the AEC by Western Nuclear, Inc.

The Arrowhead (Little Mo) mine, Susquehanna-Western, Inc., ceased operations in October after fulfilling the AEC allocation. USS completed the second year of continuous production with a 17-percent increase of iron-ore agglomerates. Electricity used for the beneficiation and agglomerating of taconite-iron ore made the plant the largest consumer on the Pacific Power & Light Co. Wyoming distribution system.

Production of sand and gravel, from 7 operations, decreased 90 percent.

Goshen.—The value of mineral production increased over that of 1963. Sand and gravel for highway construction provided most of the county mineral value, followed by lime by the Holly Sugar Co. Sixty-one tons of stone, for use in fertilizer, was produced by Wallace Minerals.

One wildcat well drilled 3 miles south of the Torrington field was dry.

Hot Springs.—The county retained its ranking of second in the State in petroleum production. Output from 19 fields, 4 more than in 1963, decreased 8 percent, from 23.6 million barrels to 21.8 million barrels. The largest oilfields were the Hamilton Dome with 9.1 million barrels; Grass Creek, 4.4 million; Little Buffalo, 2.2 million; and Murphy Dome, 1.7 million. Natural gas production increased 90 percent, according to the Board of Equalization. Kern County Land Co. recovered LP gases from the Grass Creek field.

The Dusky Diamond Coal Co. accounted for most of the increase in coal output for the county. Production of sand and gravel was 42 percent greater.

Johnson.—Petroleum production, which increased 14 percent, accounted for 91 percent of the county mineral value. The largest petroleum production was from the Sussex field with 4.1-million barrels, an increase of 1.3 million, followed by Meadow Creek and North Fork. Continental Oil Co. operated the Sussex field natural gas plant the entire year, recovering LP gases and natural gasoline.

Sand and gravel output, from six operations, decreased. Black Hills Bentonite Co. was developing a bentonite mine near Barnum, 75 miles from Casper. The deposit, reportedly, was one of the largest in the United States. Mt. Hi Uranium and Oil Corp. shipped uranium ore.

Laramie.—Mineral-output value was divided among crushed and broken stone, 42 percent; petroleum, 30 percent; sand and gravel and natural gas, 28 percent. Morrison-Knudsen Co., Inc., contractor for Union Pacific Railroad Co., mined and crushed granite at Granite Mountain for railroad ballast, concrete aggregate and roadstone, and riprap. The Great Western Sugar Co. mined limestone from its underground operations at Horse Creek. Most of the crushed and screened product was used for beet-sugar refining; some was used for railroad ballast, roadstone, and metallurgical flux. Broken limestone was used for riprap. Peter Kiewit Sons' Co. crushed and screened some of the Horse Creek product for use as concrete aggregate and roadstone. Teton Construction Co., contractor for the U.S. Army Corps of Engineers, produced crushed granite for use as roadstone. Petroleum output decreased 8 percent, and natural gas output decreased 6 percent, according to the Board. The Horse Creek field, with a production of 224,000 barrels, was largest in the county. The Frontier Refining Co. operated the fourth-largest refinery in the State at Cheyenne; throughput was increased 5 percent. Wycon Chemical Co., a newly created division of Colorado Oil & Gas Corp., a subsidiary of CIG began production at its new $6-million fertilizer facilities near

Cheyenne; capacity of the new facilities was 18,000 tons of anhydrous ammonia and 33,000 tons of ammonium nitrate per year.

Lincoln.—The Opal plant of El Paso Natural Gas Co. in the Big Piney field was operated the entire year, producing natural gasoline, propane, and butane. The county was ranked second in the State in coal output which came from two open-pit mines and one underground mine, operated by Kemmerer Coal Co.; the company Brilliant No. 8 underground mine near Kemmerer was closed April 30. A research project sponsored by the company was started by the University of Wyoming to reclaim land where coal was strip mined; the project was to determine what types of grasses, trees, and shrubs are best adapted to Wyoming overburden, as well as to investigate various seeding methods and management policies. An objective of the project was to develop an even more productive program of land use after mining than the original surface provided.

At the company-operated open pit, San Francisco Chemical Co. increased output of phosphate rock 10 percent. Sand and gravel production decreased 13 percent; most of the output was used by the Wyoming highway department for construction on Interstate Highway 80.

Natrona.—Petroleum accounted for 89 percent of the value of mineral production in the county, which increased 6 percent. Crude-oil output from 36 fields, 5 more than in 1963, increased by 1.3-million barrels. Leading oilfields were Salt Lake with 9.6-million barrels and Grieve with 1.7 million. Wildcat drilling resulted in the discovery of an oilfield and of two pay zones in the Schrader Flats field. Three refineries at Casper processed crude oil: American Oil Co. in processing the largest quantity in the State, reduced throughput by 300,000 barrels; Texaco, Inc., reduced throughput by 800,000 barrels; and Socony-Mobil Oil Co., Inc., reduced throughput by 1.3-million barrels. Pan American Petroleum Corp. processed 26.8-million cubic feet of natural gas daily at its Salt Creek field plant at an average daily output of 43,000 gallons of combined natural gasoline-LP gases, 29,000 gallons of butane, and 22,000 gallons of propane. Amax Petroleum Corp. operated the Boone Dome field plant at a daily average throughput of 4.3-million cubic feet with a daily output of 4,200 gallons of propane, 2,400 gallons of natural gasoline, and 1,500 gallons of butane. An economic study was made of the Socony-Mobil Oil Co. Inc., refinery to determine whether operation was to be continued. According to the Board of Equalization, natural gas production decreased 3 percent.

Black Hills Bentonite Co. moved its processing operations from Moorcroft to a new $400,000 plant at Casper. Benton Clay Co., Inc., operating mines near Midwest and Natrona, processed more bentonite in the company plant at Casper than in 1963. Sand and gravel output, by seven operators, decreased 14 percent or 197,000 tons. Union Carbide Corp. mined uranium ore from five deposits. William E. Pratt continued to harvest sodium sulfate from a saline deposit near Natrona.

Niobrara.—Mineral-production value increased; petroleum output accounted for most of the total. Crude oil production from 13 fields, 4 more than in 1963, remained unchanged. The largest oilfield was

Lance Creek with 543,000 barrels. The Lance Creek field plant of Marathon Oil Co. had a daily throughput of 1.4-million cubic feet of natural gas and a daily production of 1,700 gallons of combined natural gasoline-LP gases. Natural gas output decreased 9 percent according to the Board. Sand and gravel output increased substantially.

Park.—The county's mineral production continued to have the highest value in the State in spite of a 9-percent decrease in value. Petroleum output from 28 fields, 3 more than in 1963, was the highest in the State; fields with more than 1-million barrels of output were Elk Basin with 15.9 million, Oregon Basin with 6.8 million, and Frannie with 1.6 million. The Cody refinery of Husky Oil Co. increased its output by 21 percent, processing 3.7-million barrels of oil. An increase of 5 percent was recorded for natural gas output, according to the Board. The Elk Basin gas plant, Pan American Petroleum Corp., had a daily average throughput of 16-million cubic feet of natural gas. Average daily output was 49,000 gallons of combined natural gasoline-LP gases, 30,000 gallons of butane, and 19,000 gallons of propane. Kern County Land Co. operated two plants in the county; namely, the Elk Basin plant, which had a daily average throughput of 500,000 cubic feet of natural gas with an average output of 850 gallons of combined natural gasoline-LP gases, and the South Elk Basin plant, which had an average daily throughput of 4.5-million cubic feet of natural gas and a daily output of 1,400 gallons of combined natural gasoline-LP gases. Elemental sulfur was recovered by Pan American Petroleum Corp. at the Elk Basin plant and by Texaco Inc. at the Silver Tip plant. Ralston Associates, Inc., plant, under construction, was to process natural gas from the Ralston and Silver Tip fields; fuel gas was to be supplied from the Whistle Creek field.

Big Horn Gypsum Co. required 44-percent more gypsum for its plaster board plant at Cody.

Output of sand and gravel, from 11 operations, increased from 288,000 tons in 1963 to 339,000 tons in 1964.

Platte.—An increase in mineral-production value resulted from increased iron-ore output. The new beneficiating facilities at the Sunrise mine of CF&I were dedicated December 5. Upgraded iron-ore output was to increase from 420,000 to 600,000 tons annually; plant output was to include 400,000 tons of upgraded coarse, 6 inches to ¼ inch concentrated by heavy media separation, and 200,000 tons of fine, ¼ inch to 28 mesh, concentrated by jigging.[6]

Stone output, from four operations, increased. Guernsey Stone Co. produced crushed and broken dolomite for railroad ballast, riprap, and roadstone. Crown, Inc., contractors for the Federal Bureau of Reclamation, produced crushed and broken limestone for riprap and concrete and roadstone. Basin Engineering Co., using the Great Western old sugar plant at Wheatland, installed equipment with a capacity for crushing 35 tons per hour of white, yellow, and blue marble mined in a quarry 17 miles west of Wheatland. The company produced products ranging from 1,000-pound blocks to minus 100-mesh.

Sheridan.—Coal output from the Big Horn Coal Co. and the Welch

[6] Skillings' Mining Review. Sunrise Mine of CF&I. V. 53, No. 40, Oct. 3, 1964, p. 9.

Coal Co. strip mines increased 56,000 tons. Crude oil from two fields—Ash Creek South, 310,000 barrels, and Ash Creek, 164,000 barrels—decreased 100,000 barrels.

J. D. Pelesky Construction Co. produced crushed granite for concrete and roadstone. Sand and gravel output, from five operations compared with nine in 1963, was down 233,000 tons. Crushed and sized scoria (pumice) output for railroad ballast decreased 19 percent. Clay for manufacturing building brick was mined by Sheridan Press Brick & Tile Co.

Sublette.—An increase of 3 percent was recorded in the value of mineral products. Natural gas accounted for 49.5 percent of the county total; petroleum, for 50.1; and sand and gravel, LP gases, and stone, for 0.4. Natural-gas production increased 22 percent, according to the Board. The California Oil Co. Birch Creek gas plant had an average daily throughput of 17 million cubic feet, recovering a daily average of 2,600 gallons of combined natural gasoline-LP gases. Output from six fields advanced crude-oil production from 4.2 million barrels to 4.5 million; fields with the largest production were in the Big Piney-La Barge area.

Two operators produced sand and gravel. Sunset Rock Quarry, Inc., produced dimension sandstone for rough construction.

Sweetwater.—Mineral-production value for the county, fourth highest in the State, decreased 1 percent. Increased output was registered for trona, coal, natural gas, and natural gasoline; petroleum, sand and gravel, LP gases, and uranium ore output decreased.

At its plant near Green River, Stauffer Chemical Co. completed additions estimated to double the 1963 output.[7] FMC Westvaco new facilities were to increase production by 85,000 tons per year; bringing the total to 900,000 tons per year. New facilities [8] were constructed to supply sodium tripolyphosphate for manufacturing detergents for consumers in the West and Midwest and to supplement phosphate production from FMC plants in California and Kansas. By yearend, the Solvay Process new shaft was concrete lined to 82 feet deep. Plans for 1965 included completing the production shaft and beginning construction of a 500,000-ton-per-year facility.

Petroleum output from 15 fields; 3 less than in 1963, decreased 12 percent; largest fields were Patrick Draw area with 3.6 million barrels and Lost Soldier with 3.3 million. Discovery of the Continental Divide oilfield and Pine Canyon natural-gas field resulted from 36 wildcat wells. Output of natural gas increased 22 percent, according to the Board. Union Pacific Railroad Co. Patrick Draw plant, Colorado Oil & Gas Corp. Patrick Draw plant, and Sinclair Oil & Gas Co. Bairoil plant had a combined average daily throughput of 40.7 million cubic feet, a combined average daily recovery of 27,000 gallons of combined natural gasoline-LP gases, 22,000 gallons of propane, and 19,000 gallons of butane.

[7] Wyoming Progress Reports. V. 4, No. 11, November 1964, p. 2.
[8] Engineering and Mining Journal. News of the Industries. V. 165, No. 9, September 1964, pp. 159–160.

Edwin L. Swanson Bros. and Gunn-Quealy Coal Co. increased coal output. The Gunn-Quealy Coal Co. coke-breeze plant at Rock Springs was completed in August. About 100 tons per day of locally mined coal was used in the test program; this amount was to be increased as experiments for making coke progressed.

Sand and gravel output from 4 operations decreased to 64,000 tons from the 1963 high of 1.3 million tons produced from 12 operations.

Fremont Uranium Corp. shipped uranium ore.

It was reported that there is a 43-billion-barrel reserve in oil shale containing over 25 gallons per ton (21 billion barrels in the Wilkins Peak sector and 22 billion in the Tipton sector) and a 330-billion-barrel reserve in oil shale containing more than 10 gallons per ton (170 billion in the Wilkins Peak sector and 160 billion in the Tipton sector).[9]

Teton.—Sand and gravel output from five operations decreased. Utah-Idaho Sugar Co. mined and crushed limestone from the Fox Creek quarry, east of Victor, Idaho, for use in beet-sugar refinery plants in Idaho.

Uinta.—The combined output of natural gas and petroleum accounted for 85 percent of the mineral value. Production of natural gas increased 42 percent, according to the Board. The Church Buttes plant of Mountain Fuel Supply Co. processed natural gas, recovering a daily average of 1,000 gallons of natural gasoline. Petroleum production, from two fields, was half that of 1963.

Interstate Brick Co. mined miscellaneous clay north of Evanston for manufacturing building brick in a plant in Utah. International Pipe and Ceramics Corp. mined fire clay which was shipped to Salt Lake City, Utah, for processing and marketing. Sand and gravel production was almost 90 percent less than in 1963.

Washakie.—Mineral production was valued 4-percent less than that of 1963. Fifty-eight percent of the county value was accounted for by petroleum and 24 percent by natural gas (according to the Board of Equalization). Crude-oil output from 11 fields decreased 6 percent; the largest was Cottonwood Creek with 1.2-million barrels, followed by Worland with 180,000 barrels. According to the Board production of natural gas decreased 2 percent. Pan American Petroleum Corp., Pure Oil Co., and TGS operated sulfur-recovery-and-purifying plants in the Worland area. The three plants had a combined average daily recovery of 6,500 gallons of butane, 35,000 gallons of propane, and 33,000 gallons of combined natural gasoline-LP gases from a daily throughput of 63.4-million cubic feet of natural gas. Elemental sulfur was recovered by Pan American Petroleum Corp. at its Cottonwood Creek plant, which was shut down in December, and by TGS at its Worland plant. Because of increased highway construction, output of sand and gravel increased. Lime was processed by Holly Sugar Corp. for use in beet-sugar refining at Worland.

Weston.—Petroleum accounted for 77 percent of the mineral-production value, which increased 11 percent. Following were clay, which accounted for 20 percent, and LP gases, natural gas, natural

[9] Culbertson, W. C. Oil Shale Resources and Stratigraphy of the Green River Formation in Wyoming. Geol. Survey Prof. Paper 501–A. 1964, p. 287.

gasoline, and sand and gravel, 3 percent. Crude-oil output, which increased 409,000 gallons or 13 percent, was from 18 fields, 4 less than in 1963. The largest field was Fiddler Creek, with 1.6 million barrels; followed by Osage, with 619,000 barrels; and Clareton, with 381,000 barrels. Twenty-eight wildcat wells discovered a new pay zone, in the Wildcat Creek field, and two new oilfields, the Turner Discovery and the Wildcat Creek. Forty-three development wells resulted in 37 oil wells. Output of natural gas increased 4 percent according to the Board. The Newcastle oil refinery of Sioux Oil Co. decreased throughput by 6.6 percent. The Lonetree field plant of N. C. Ginther was operated at a daily throughput of 2.5 million cubic feet, recovering a daily average of 4,500 gallons of propane and 6,500 gallons of combined natural gasoline-LP gases. The GGG Corp. plant in the Cheyenne River field recovered 1,300 gallons of butane, 1,500 gallons of propane, and 1,400 gallons of natural gasoline daily from a throughput of 1.9 million cubic feet.

American Colloid Co., ADM, and Baroid increased total bentonite output 23,000 tons valued at $156,400. Sand and gravel production, from two operations compared with five in 1963, decreased 90 percent.

Yellowstone National Park.—Sand and gravel output from one commercial and one Government-and-contractor operation was used primarily for road construction.

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