Minerals yearbook: Area reports 1960. Year 1960, Volume 3 1961

Bureau of Mines
Washington, D. C.: Bureau of Mines : United States Government Printing Office, 1961

MINERALS YEARBOOK

1960

Volume 3 of Three Volumes

AREA REPORTS

Prepared by the field staff of the

BUREAU OF MINES

REGIONAL DIVISIONS OF MINERAL INDUSTRIES

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

BUREAU OF MINES

MARLING J. ANKENY, *Director*

OFFICE OF THE DIRECTOR:

THOMAS H. MILLER, *Deputy Director*
PAUL ZINNER, *Assistant Director—Programs*
JAMES WESTFIELD, *Assistant Director—Health and Safety*
HENRY P. WHEELER, Jr., *Assistant Director—Helium*
CHARLES H. JOHNSON, *Executive Assistant for Regional Activities*
PAUL T. ALLSMAN, *Chief Mining Engineer*
EARL T. HAYES, *Chief Metallurgist*
CARL C. ANDERSON, *Chief Petroleum Engineer*
LOUIS L. NEWMAN, *Chief Coal Technologist*
JOHN E. CRAWFORD, *Chief Nuclear Engineer*
WILLIAM A. VOGELY, *Chief Economist*
REXFORD C. PARMELEE, *Chief Statistician*
ALLAN SHERMAN, *Chief, Office of Mineral Reports*

DIVISIONS:

CHARLES W. MERRILL, *Chief, Division of Minerals*
T. REED SCOLLON, *Chief, Division of Bituminous Coal*
JOSEPH A. CORGAN, *Chief, Division of Anthracite*
R. A. CATTELL, *Chief, Division of Petroleum*
ELMER W. PEHRSON, *Chief, Division of Foreign Activities*
W. E. RICE, *Chief, Division of Administration*

REGIONAL OFFICES:

MARK L. WRIGHT, *Regional Director, Region I, Albany, Oreg.*
R. B. MAURER, *Regional Director, Region II, San Francisco, Calif.*
R. W. GEEHAN, *Regional Director, Region III, Denver, Colo.*
ROBERT S. SANFORD, *Acting Regional Director, Region IV, Bartlesville, Okla.*
EARLE P. SHOUB, *Regional Director, Region V, Pittsburgh, Pa.*

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1961

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price $4.25

FOREWORD

MINERALS YEARBOOK, 1960, published in three volumes, provides a record of performance of the Nation's mineral industries during the year, with enough background information to interpret the year's developments.

The three-volume issues of the Yearbook follow this pattern:

Volume I includes 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. One new chapter, High-Purity Silicon, has been added to the list of commodity chapters. The chapter on Nonferrous Secondary Metals has been discontinued and the statistical material in it distributed to the appropriate nonferrous metals commodity chapters.

Volume II includes chapters on each mineral fuel, an employment and injuries presentation, and a mineral-fuels review chapter that summarizes developments in the fuel industries.

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

Figures in the Minerals Yearbook are based largely upon information supplied by mineral producers, processors, and users, and acknowledgment is made of this indispensable cooperation given by industry. Information obtained from individuals through confidential surveys has been grouped to provide statistical aggregates. Data on individual producers are presented only if available from published or other nonconfidential sources, or when permission of the individuals concerned has been granted.

MARLING J. ANKENY, *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.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Geological Survey of Georgia.
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.
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.
Minnesota: Minnesota Geological Survey.
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 Administration.
Montana: Montana Bureau of Mines and Geology.
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.
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 Economic Survey.
Wisconsin: Wisconsin Geological Survey.
Wyoming: The Geological Survey of Wyoming.

Except for the two review chapters, this volume was prepared by the field staffs of the five Divisions of Mineral Resources. The following supervised preparation of the chapters: Ottey M. Bishop, chief, Division of Mineral Resources, Region I, Albany, Oreg.; W. F. Dietrich, chief, Division of Mineral Resources, Region II, San Francisco, Calif.; A. S. Konselman, acting chief, Division of Mineral Resources, Region III, Denver, Colo.; Robert S. Sanford, chief, Division of Mineral Resources, Region IV, Bartlesville, Okla.; and G. W. Josephson, chief, Division of Mineral Resources, Region V, Pittsburgh, Pa. Preparation of this volume was supervised and the chapters coordinated with those in volumes I and II by Donald R. Irving, assistant to the chief, Division of Minerals.

Statisticians and researchers in the Division of Mineral Resources who gave substantial assistance to the authors of the chapters were: In Region I, Clara M. Hutcheson; in Region II, Betty Tong and Sophie H. Chibidakis; in Region III, Stella K. Drake, Mary Jelliffe, Muriel Clark, and Elsie Kellogg; in Region IV, Dorothy Underwood, Lorraine Collier, Betty Siggins, Lydia DeRuvo, and Lovenia Edwards; in Region V, (Pittsburgh) Michael E. Bursic, Victoria M. Dorchak, and Stephanie A. Dzienis, (Knoxville) Martha E. Peeples and Mildred K. Rees, (Minneapolis) Marguerite H. Beahan, Richard J. Bishop, Estelle E. Rand, Don N. West, Wanda J. West, and Agnes N. Anshus.

The manuscripts upon which this volume is based have been reviewed to insure statistical consistency among the tables, figures, and text, between this volume and volume I and between this volume and those for former years, by a staff supervised by Kathleen J. D'Amico, who was assisted by Julia Muscal, Helen L. Gealy, Helen E. Tice, Dorothy Allen, Mary E. Daugherty, and Joseph Spann.

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

CHARLES W. MERRILL,
Chief, Division of Minerals.

CONTENTS

Statistical Summary of Mineral Production

By Kathleen J. D'Amico [1]

THIS SUMMARY is shown in Minerals Yearbook volumes I and III of this series on mineral production in the United States, its island possessions, the Canal Zone, and the Commonwealth of Puerto Rico, and on 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 re-

TABLE 1.—Value of mineral production in the United States,[1] 1925–60, 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	1943	$4,028	$916	$987	$5,931
1926	3,371	1,219	721	5,311	1944	4,574	836	900	6,310
1927	2,875	1,201	622	4,698	1945	4,569	888	774	6,231
1928	2,666	1,163	655	4,484	1946	5,090	1,243	729	7,062
1929	2,940	1,166	802	4,908	1947	7,188	1,338	1,084	9,610
1930	2,500	973	507	3,980	1948	9,502	1,552	1,219	12,273
1931	1,620	671	287	2,578	1949	7,920	1,559	1,101	10,580
1932	1,460	412	128	2,000	1950	8,689	1,822	1,351	11,862
1933	1,413	432	205	2,050	1951	9,779	2,079	1,671	13,529
1934	1,947	520	277	2,744	1952	9,616	2,163	1,617	13,396
1935	2,013	564	365	2,942	1953	10,257	2,350	1,811	14,418
1936	2,405	685	516	3,606	1954	9,919	[3] 2,630	1,518	14,067
1937	2,798	711	756	4,265	1955	10,780	[3] 2,957	2,055	15,792
1938	2,436	622	460	3,518	1956	11,741	[3] 3,266	2,358	17,365
1939	2,423	754	631	3,808	1957	12,709	[3] 3,267	2,137	18,113
1940	2,662	784	752	4,198	1958	11,589	[3] 3,346	[4] 1,594	[4] 16,529
1941	3,228	989	890	5,107	1959	[4] 11,950	[3] 3,721	1,570	[4] 17,241
1942	3,568	1,056	999	5,623	1960	12,141	[3] 3,730	2,021	17,892

[1] Excludes Alaska and Hawaii, 1925–53.
[2] Data for 1925–46 are not strictly comparable with those for subsequent years, since for the earlier years the value of heavy clay products has not been replaced by the value of raw clays used for such products.
[3] Total adjusted to eliminate duplicating value of clays and stone.
[4] Revised figure.

[1] Publications editor.

coverable 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.

Data for clays and stone, 1954–60, included output used in making cement and lime. Mineral-production totals have been adjusted to eliminate duplicating these values.

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

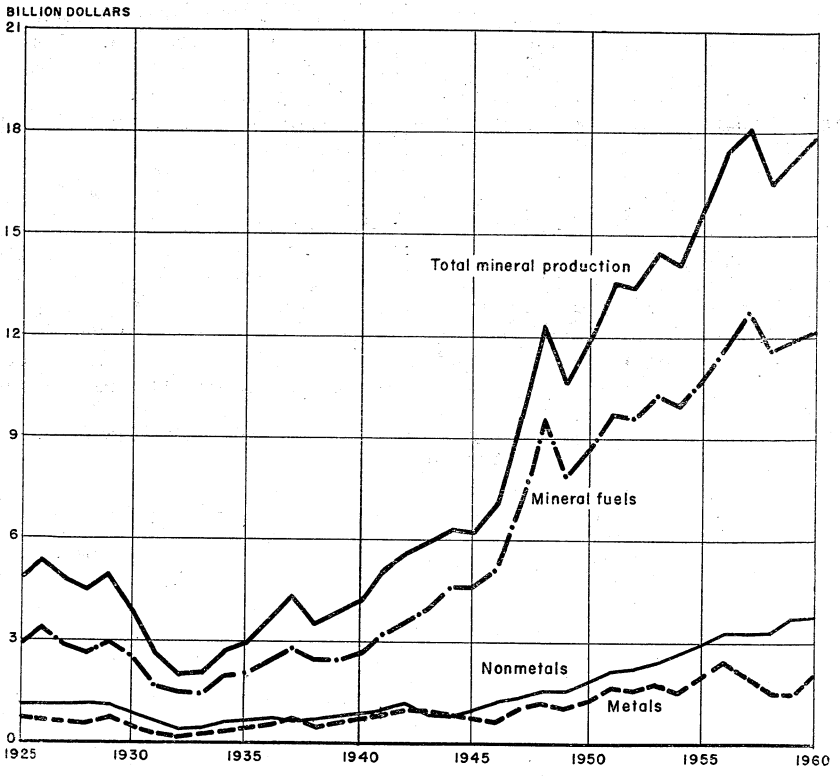

FIGURE 1.—Value of mineral production in the United States, 1925–60.

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

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Mineral fuels:								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone—short tons	1,168,507	$3,221	1,326,493	$3,343	1,518,765	$3,868	1,242,874	$3,070
Gilsonite—do	207,704	4,259	317,280	4,864	379,362	9,385	383,037	10,020
Carbon dioxide, natural (estimate)—thousand cubic feet	704,276	139	722,615	102	485,179	71	521,169	99
Coal:								
Bituminous and lignite [2]—thousand short tons	492,704	2,504,406	410,446	1,996,281	412,028	1,965,607	415,512	1,950,425
Pennsylvania anthracite—do	25,338	227,754	21,171	187,898	20,649	172,320	18,817	147,116
Helium—thousand cubic feet	310,365	5,112	352,134	5,741	375,408	6,144	475,179	7,768
Natural gas—million cubic feet	10,680,258	1,201,759	11,030,298	1,317,492	12,046,115	1,556,800	12,771,038	1,789,970
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	5,734,307	415,791	5,596,458	393,139	5,597,102	408,694	5,842,507	416,819
LP gases—do	6,655,282	263,665	6,783,000	296,571	7,874,706	349,802	8,444,074	391,566
Peat—short tons	316,217	3,458	327,813	3,446	419,460	4,372	470,889	5,138
Petroleum (crude)—thousand 42-gallon barrels	2,616,901	8,079,259	2,449,016	7,380,065	2,574,590	7,473,336	[3] 2,574,933	[3] 7,419,382
Total mineral fuels		12,709,000		11,589,000		[5] 11,950,000		12,141,000
Nonmetals (except fuels):								
Abrasive stone [4]—short tons	(6)	331	(6)	[3] 182	3,672	315	2,539	240
Asbestos—do	43,653	4,917	43,979	5,127	[5] 45,459	[5] 4,391	45,223	4,231
Barite—do	1,145,791	12,397	605,402	[5] 7,508	901,815	10,301	713,926	8,563
Boron minerals—do	541,124	38,041	528,209	38,310	619,946	46,150	640,591	47,550
Bromine—thousand pounds	191,971	48,038	176,397	46,689	195,483	51,508	175,010	44,637
Cement—thousand 376-pound barrels	299,189	961,499	317,263	1,038,672	346,675	1,144,867	321,646	1,089,134
Clays—thousand short tons	45,620	155,805	43,750	143,487	49,383	159,659	49,054	162,372
Emery—short tons	11,893	184	7,687	126	8,555	150	8,169	142
Feldspar—long tons	498,057	4,935	469,738	4,278	548,390	[3] 5,372	502,380	4,779
Fluorspar—short tons	328,872	15,777	319,513	15,071	185,091	8,680	229,782	10,391
Garnet (abrasive)—do	9,776	1,080	12,303	869	14,568	1,211	10,522	986
Gem stones (estimate)	(7)	882	(7)	1,006	(7)	1,184	(7)	1,188
Gypsum—thousand short tons	9,195	29,871	9,600	32,495	10,900	39,231	9,825	35,690
Lime—do	10,266	135,143	9,203	120,921	12,498	163,890	12,963	173,050
Magnesite—short tons	678,489	3,258	492,982	2,409	594,307	2,401	498,528	2,051
Magnesium compounds from sea water and brine (except for metals)—short tons, MgO equivalent	184,236	15,997	207,053	16,419	276,309	21,636	293,454	21,903
Mica:								
Scrap—short tons	92,438	2,109	93,347	2,065	[5] 101,541	[5] 2,665	119,929	2,962
Sheet—pounds	690,052	2,492	661,344	2,845	706,395	3,419	578,985	2,830
Perlite—short tons	301,605	2,562	291,994	2,463	324,669	2,737	312,153	2,665
Phosphate rock—thousand long tons	13,976	87,689	14,879	93,693	15,869	98,758	17,516	117,041

See footnotes at end of table.

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

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands
Nonmetals (except fuels)—Continued								
Potassium salts—thousand short tons, K_2O equivalent	2,266	$84,612	2,147	$75,000	2,383	$80,393	2,638	$87,054
Pumice—thousand short tons	1,827	4,628	1,973	5,287	2,276	5,863	2,212	5,569
Pyrites—thousand long tons	1,067	9,087	974	7,987	(8)	(8)	1,016	7,936
Salt—thousand short tons	23,844	148,887	21,911	141,486	25,160	155,839	25,479	161,140
Sand and gravel—do	632,255	599,750	684,498	652,789	730,205	728,712	[15] 709,495	[15] 719,952
Slate—short tons	632	11,029	(9)	(9)	(9)	(9)	(9)	(9)
Sodium carbonate (natural)—do	652,717	17,792	628,619	17,032	735,261	19,078	808,624	20,865
Sodium sulfate (natural)—do	331,382	6,542	347,445	6,716	402,743	7,689	449,631	8,706
Stone [10]—thousand short tons	532,791	814,373	535,923	826,685	584,163	911,982	[15] 616,735	[15] 952,454
Sulfur:								
Frasch-process mines—thousand long tons	5,035	122,915	4,644	109,272	5,222	121,777	5,003	115,494
Other mines—long tons	172,169	1,521	153,574	1,505	151,932	1,418	(8)	(8)
Talc, soapstone, and pyrophyllite—short tons	684,453	4,796	718,165	4,718	[6] 791,558	[6] 5,641	734,473	5,378
Tripoli—do	50,717	195	47,044	183	52,968	219	57,713	247
Vermiculite—thousand short tons	184	2,603	191	2,728	207	3,082	199	3,108
Value of items that cannot be disclosed: Aplite, brucite (1957–59), calcium-magnesium chloride, diatomite, epsom salts from epsomite (1957), graphite, iodine, kyanite, lithium minerals, greensand marl, nitrogen compounds (1957–58), olivine, staurolite (1957–58, 1960), sharpening stones (1957–58), wollastonite, and value indicated by footnote 8		35,565		39,765		50,470		44,395
Total nonmetals [11]		3,267,000		[6] 3,346,000		[6] 3,721,000		3,730,000
Metals:								
Antimony ore and concentrate—short tons, antimony content	710	(12)	716	(12)	688	(12)	635	(12)
Bauxite—long tons, dried equivalent	1,416,172	12,868	1,310,685	12,815	1,700,235	17,725	1,997,827	21,107
Beryllium concentrate—short tons, gross weight	521	276	[6] 505	[6] 243	[6] 425	[6] 179	509	162
Chromite—do	166,157	7,816	143,795	6,187	[13] 105,000	[13] 3,765	[13] 107,000	[13] 3,813
Cobalt (content of concentrate)—thousand pounds	4,123	(13)	4,832	(12)	2,944	(13)	(12)	(12)
Columbium-tantalum concentrate [14]—pounds	370,483	(12)	428,347	(12)	189,263	(12)		
Copper (recoverable content of ores, etc.)—short tons	1,086,859	654,289	979,329	515,127	824,846	506,455	1,080,169	693,468
Gold (recoverable content of ores, etc.)—troy ounces	1,793,597	62,776	1,739,249	60,874	[6] 1,602,931	[6] 56,103	1,666,772	58,336
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	104,157	865,703	66,288	569,154	59,164	514,067	82,957	723,496
Lead (recoverable content of ores, etc.)—short tons	338,216	96,730	267,377	62,566	255,586	58,786	246,669	57,722
Manganese ore (35 percent or more Mn) short tons, gross weight	366,334	29,363	327,309	23,637	[6] 229,199	[6] 17,904	80,021	5,352
Manganiferous ore (5 to 35 percent Mn)—do	865,127	5,413	520,601	3,532	[6] 470,600	[6] 3,153	658,455	4,466
Mercury—76-pound flasks	34,625	8,552	38,067	8,720	31,256	7,110	33,223	7,002
Molybdenum (content of concentrate)—thousand pounds	57,143	67,605	42,328	50,371	51,603	64,655	69,941	87,406

Nickel (content of ore and concentrate)---short tons	12,901	(12)	13,489	(12)	13,374	(12)	14,079	(12)
Rare-earth and thorium concentrates---do	3,079	653	2,021	286	1,143	206	(12)	(12)
Silver (recoverable content of ores, etc.) thousand troy ounces	38,165	34,541	34,111	30,872	31,194	28,233	30,766	27,846
Tin (content of ore and concentrate)---long tons					50	60	10	12
Titanium concentrate:								
Ilmenite---short tons, gross weight	782,975	21,802	565,164	11,152	637,263	12,106	789,283	14,655
Rutile---do	10,644	1,544	1,863	210	8,648	877	9,433	879
Tungsten ore and concentrate short tons, 60-percent WO_3 basis	5,520	8,186	3,788	3,991	3,649	4,502	7,325	9,815
Uranium ore---short tons	3,682,543	81,181	5,178,315	116,397	6,934,927	141,349	7,970,211	152,188
Vanadium (recoverable in ore and concentrate)---do	3,691	(12)	3,030	10,817	3,719	13,278	4,971	[15] 17,749
Zinc (recoverable content of ores, etc.)---do	531,735	123,235	412,005	84,113	425,303	97,787	435,427	112,365
Value of items that cannot be disclosed: Magnesium chloride for magnesium metal, manganiferous residuum, platinum-group metals (crude), zirconium concentrate, and values indicated by footnote 12		[6] 54,145		[6] 23,245		21,763		23,078
Total metals		2,137,000		[6] 1,594,000		1,570,000		2,021,000
Grand total mineral production		18,113,000		[6]16,529,000		[6]17,241,000		17,892,000

[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] Preliminary figure.
[4] Grindstones, pulpstones, millstones, grinding pebbles, and tubemill liners, weight not recorded; excludes value of sharpening stones (1957-58), value for which is included with "Nonmetal items that cannot be disclosed."
[5] Excludes tubemill liners, value for which is included with "Nonmetal items that cannot be disclosed."
[6] Revised figure.
[7] Weight not recorded.
[8] Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."
[9] Beginning with 1958 slate included with stone.
[10] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table.
[11] Total adjusted to eliminate duplicating value of clays and stone.
[12] Figure withheld to avoid disclosing individual company confidential data; value included with "Metal items that cannot be disclosed."
[13] Excludes quantity consumed by American Chrome Co.
[14] Total weight of columbite-tantalite plus (Cb-Ta)$_2O_5$ content of euxenite.
[15] Final figure. Supersedes preliminary figure given in commodity chapter.

TABLE 3.—Minerals produced in the United States and principal producing States in 1960

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

TABLE 3.—Minerals produced in the United States and principal producing States in 1960—Continued

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

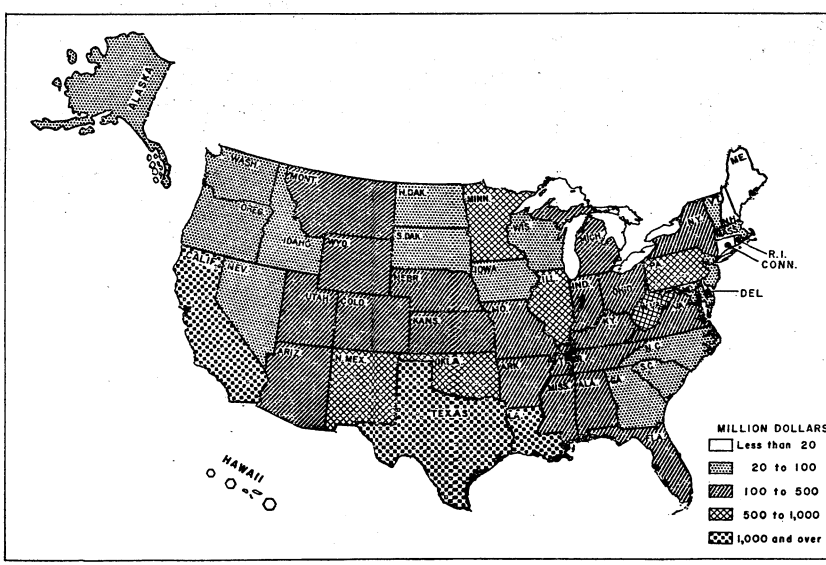

FIGURE 2.—Value of mineral production in the United States, 1960, by States

TABLE 4.—Value of mineral production in the United States and principal minerals produced in 1960

(Thousand dollars)

State	1957	1958	1959	1960			
				Value	Rank	Percent of U.S. total	Principal minerals in order of value
Alabama	$209,549	$188,938	$200,847	$217,617	19	1.22	Coal, cement, stone, iron ore.
Alaska	28,792	21,450	20,495	21,858	44	.12	Coal, gold, sand and gravel, petroleum.
Arizona	372,641	314,520	326,862	415,776	14	2.32	Copper, sand and gravel, cement, zinc.
Arkansas	142,685	132,520	140,594	155,039	26	.87	Petroleum, bauxite, stone, sand and gravel.
California	1,650,035	1,500,367	1,433,626	1,402,214	3	7.84	Petroleum, natural gas, cement, sand and gravel.
Colorado	338,504	306,566	314,677	342,223	17	1.91	Petroleum, molybdenum, natural gas, uranium.
Connecticut	16,055	13,128	12,930	15,255	45	.09	Stone, sand and gravel, lime, clays.
Delaware	1,042	1,142	1,284	989	50	.01	Sand and gravel, stone, clays.
District of Columbia	72	72	75	71	----------	(1)	
Florida	140,467	142,114	163,446	176,920	24	.99	Phosphate rock, stone, cement, titanium.
Georgia	69,799	75,106	86,262	91,203	30	.51	Clays, stone, cement, sand and gravel.
Hawaii	5,930	6,298	7,630	9,254	47	.05	Stone, sand and gravel, pumice, cement.
Idaho	73,502	64,648	70,209	57,441	35	.32	Silver, phosphate rock, lead, zinc.
Illinois	576,324	576,862	572,275	590,800	8	3.30	Petroleum, coal, stone, sand and gravel.
Indiana	193,034	197,677	206,359	206,882	20	1.16	Coal, cement, stone, petroleum.
Iowa	68,986	85,356	88,557	95,030	29	.53	Cement, stone, sand and gravel, gypsum.
Kansas	511,513	503,788	508,077	483,958	10	2.70	Petroleum, natural gas, cement, stone.
Kentucky	449,390	402,121	418,821	413,517	15	2.31	Coal, petroleum, stone, natural gas.
Louisiana	1,517,522	1,523,370	1,766,269	1,967,652	2	11.00	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	12,711	12,574	13,278	13,648	46	.08	Cement, sand and gravel, stone, mica.
Maryland	39,625	45,735	53,189	55,527	37	.31	Cement, stone, sand and gravel, coal.
Massachusetts	24,789	23,887	25,916	27,588	42	.15	Sand and gravel, stone, lime, clays.
Michigan	404,673	343,487	381,297	429,055	13	2.40	Iron ore, cement, petroleum, sand and gravel.
Minnesota	584,038	395,880	347,178	515,255	9	2.88	Iron ore, sand and gravel, stone, cement.
Mississippi	144,950	151,411	186,116	19 ,862	22	1.11	Petroleum, natural gas, cement, sand and gravel.
Missouri	152,913	144,120	157,189	156,033	25	.87	Cement, stone, lead, lime.
Montana	191,750	176,728	167,328	178,854	23	1.00	Petroleum, copper, sand and gravel, phosphate rock.
Nebraska	82,928	90,047	97,130	103,687	28	.58	Petroleum, cement, sand and gravel, stone.
Nevada	86,023	68,291	70,164	80,285	31	.45	Copper, sand and gravel, lime, iron ore.
New Hampshire	3,331	3,919	4,722	5,317	49	.03	Sand and gravel, mica, stone, feldspar.
New Jersey	64,642	50,380	59,479	56,409	36	.32	Stone, sand and gravel, iron ore, magnesium compounds.
New Mexico	551,155	559,777	592,535	652,200	7	3.65	Petroleum, natural gas, potassium salts, uranium.
New York	244,114	205,338	234,642	254,713	18	1.42	Cement, stone, sand and gravel, iron ore.
North Carolina	37,570	39,891	40,789	44,968	40	.25	Stone, sand and gravel, copper, feldspar.
North Dakota	56,702	59,445	67,342	78,275	32	.44	Petroleum, sand and gravel, coal, natural gas liquids.
Ohio	383,000	344,856	397,326	389,828	16	2.17	Coal, cement, stone, lime.
Oklahoma	809,004	761,936	765,439	779,116	5	4.36	Petroleum, natural gas, natural gas liquids, stone.
Oregon	42,820	45,190	49,842	54,419	38	.30	Stone, sand and gravel, cement, nickel.
Pennsylvania	1,077,157	882,040	862,150	824,493	4	4.61	Coal, cement, stone, petroleum.
Rhode Island	1,369	2,249	2,333	5,727	48	.03	Stone, sand and gravel.

South Carolina	22,168	22,412	30,598	30,001	41	.17	Cement, stone, clays, sand and gravel.
South Dakota	39,997	41,534	48,553	46,780	39	.26	Gold, sand and gravel, stone, cement.
Tennessee	128,739	124,934	140,738	143,439	27	.80	Stone, cement, zinc, coal.
Texas	4,484,538	4,033,311	4,219,757	4,134,901	1	23.11	Petroleum, natural gas, natural gas liquids, cement.
Utah	359,335	367,232	373,515	431,396	12	2.41	Copper, petroleum, coal, uranium.
Vermont	21,893	21,443	23,359	22,879	43	.13	Stone, asbestos, sand and gravel, talc.
Virginia	227,108	203,277	222,501	203,819	21	1.14	Coal, stone, cement, sand and gravel.
Washington	60,471	60,896	63,894	70,005	34	.39	Sand and gravel, cement, stone, zinc.
West Virginia	981,654	749,747	737,616	720,674	6	4.03	Coal, natural gas, natural gas liquids, stone.
Wisconsin	68,644	71,334	71,959	77,171	33	.43	Sand and gravel, stone, iron ore, cement.
Wyoming	352,532	369,938	393,841	442,738	11	2.47	Petroleum, uranium, natural gas sodium carbonates and sulfates.
Total	18,113,000	16,529,000	17,241,00	17,892,000	----------	100.00	Petroleum, coal, natural gas, cement.

[1] Less than 0.005 percent.

615629—61—2

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

ALABAMA

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement [2] thousand 376-pound barrels	13,000	$40,279	13,588	$42,930	14,819	$46,639	12,931	$42,706
Clays [3] thousand short tons	1,316	1,504	1,548	1,787	1,786	2,089	1,840	2,170
Coal do	13,260	86,114	11,182	72,360	11,947	78,212	13,011	92,439
Iron ore (usable) thousand long tons, gross weight	6,223	40,518	3,659	23,393	4,165	23,922	4,068	23,511
Lime thousand short tons	554	6,271	520	5,851	579	6,847	564	6,912
Mica (sheet) pounds	(4)	(4)	(4)	(4)	818	7	(4)	(5) 4
Natural gas million cubic feet	190	12	323	30	172	17	57	
Petroleum (crude) thousand 42-gallon barrels	5,406	(4)	5,887	(4)	5,524	(4)	[6] 7,257	(4)
Sand and gravel thousand short tons	5,065	4,883	4,128	4,210	4,352	4,594	4,359	4,759
Stone [7] do	9,519	11,972	11,080	17,068	11,886	18,728	13,503	19,970
Talc short tons	1,600	3	(4)	(4)	(4)	(4)	(4)	(4)
Value of items that cannot be disclosed: Native asphalt, bauxite, slag cement, clays (kaolin), scrap mica, salt, stone (dimension limestone and marble, shell, 1957, 1959–60, crushed sandstone 1959–60), and values indicated by footnote 4		23,344		26,508		[8] 25,401		29,441
Total Alabama [9]		209,549		188,938		[8] 200,847		217,617

ALASKA

Antimony ore and concentrate short tons, antimony content	17	(4)						
Chromite short tons, gross weight	4,207	$431						
Clays thousand short tons					(10)	$1	1	$10
Coal do	842	7,296	759	$6,931	660	5,869	722	6,318
Copper (recoverable content of ores, etc.) short tons	(11)	(5)	5	3	36	22	41	26
Gem stones	(12)	(4)	(12)	(4)	(12)	18	(12)	(4)
Gold (recoverable content of ores, etc.) troy ounces	215,467	7,541	186,435	6,525	178,918	6,262	168,197	5,887
Lead (recoverable content of ores, etc.) short tons	9	3	2	(5)			23	5
Mercury 76-pound flasks	5,461	1,349	3,380	774	3,743	852	4,459	940
Natural gas million cubic feet			50	6	133	16	246	30
Peat short tons							376	(4)
Petroleum (crude) thousand 42-gallon barrels			29	(4)	187	295	[6] 558	[6] 1,228
Sand and gravel thousand short tons	6,096	8,799	4,255	3,871	5,859	5,265	6,013	5,483
Silver (recoverable content of ores, etc.) thousand troy ounces	29	26	24	22	21	19	26	23
Stone thousand short tons	528	1,953	615	2,065	89	377	275	852
Value of items that cannot be disclosed: Platinum-group metals, uranium ore, and values indicated by footnote 4		1,394		1,253		1,499		1,056
Total Alaska		28,792		21,450		20,495		21,858

ARIZONA

Beryllium concentrate	short tons, gross weight	5	$2	18	$10			(11)	(5)
Clays [3]	thousand short tons	118	177	119	179	120	$179	173	$260
Columbium-tantalum concentrate	pounds	2,435	7						
Coal	thousand short tons	9	62	8	54	7	63	6	58
Copper (recoverable content of ores, etc.)	short tons	515,854	310,544	485,839	255,551	430,297	264,202	538,605	345,784
Gem stones		(12)	75	(12)	86	(12)	88	(12)	120
Gold (recoverable content of ores, etc.)	troy ounces	152,449	5,336	142,979	5,004	124,627	4,362	143,064	5,007
Lead (recoverable content of ores, etc.)	short tons	12,441	3,558	11,800	2,782	9,999	2,300	8,495	1,988
Lime	thousand short tons	138	2,127	126	1,817	123	1,666	148	2,430
Manganese ore (35 percent or more Mn)	short tons, gross weight	79,505	6,626	62,279	5,220	68,183	5,727	1,626	40
Manganiferous ore (5 to 35 percent Mn)	do			1,455	32	10,693	234	8,677	190
Mercury	76-pound flasks	28	7	53	12	(4)	(4)	(4)	(4)
Mica (scrap)	short tons	1,650	17	1,717	25	3,069	55	(4)	(4)
Molybdenum (content of concentrate)	thousand pounds	2,385	3,071	2,320	2,827	3,181	4,019	4,359	5,211
Natural gas	million cubic feet	22	3						
Perlite	short tons	15,646	114	(4)	(4)	(5)	(4)	(4)	(4)
Petroleum (crude)	thousand 42-gallon barrels			12	(4)	25	(4)	[6] 73	(4)
Pumice	thousand short tons	397	640	401	1,025	487	1,153	703	1,164
Sand and gravel	do	10,287	9,222	12,208	9,526	13,458	11,966	14,490	14,235
Silver (recoverable content of ores, etc.)	thousand troy ounces	5,279	4,778	4,685	4,240	3,898	3,528	4,775	4,322
Stone	thousand short tons	2,101	2,982	1,528	2,731	2,468	3,998	4,249	5,107
Tungsten concentrate	short tons, 60-percent WO_3 basis	5	9			(11)	(4)	(4)	(4)
Uranium ore	short tons	286,037	6,277	257,756	7,049	253,390	6,309	283,684	6,219
Vanadium (recoverable in ore and concentrate)	do	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.)	do	33,905	7,866	28,532	5,821	37,325	8,585	35,811	9,239
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite 1958–60), feldspar, fluorspar (1957–58), gypsum, nitrogen compounds (1957–58), pyrites, and values indicated by footnote 4			10,441		11,734		[8] 9,811		16,115
Total Arizona [9]			372,641		314,520		[8] 326,862		415,776

ARKANSAS

Barite	short tons	477,327	$4,537	182,779	$1,668	338,539	$3,097	277,851	$2,578
Bauxite	long tons, dried equivalent	1,356,898	12,314	1,257,916	[8] 12,311	1,631,643	17,048	1,932,071	20,469
Clays	thousand short tons	617	1,586	578	1,578	782	2,406	815	2,456
Coal	do	508	3,976	364	2,744	441	3,482	409	3,116
Gem stones		(12)	(4)	(12)	23	(12)	18	(12)	38
Gypsum	thousand short tons	(4)	(4)	(4)	(4)	(4)	(4)	67	208
Iron ore (usable)	thousand long tons, gross weight	7	35	(4)	(4)				
Lead (recoverable content of ores, etc.)	short tons					38	9		
Manganese ore (35 percent or more Mn)	short tons, gross weight	23,261	1,726	22,221	1,737	17,742	1,398		
Natural gas	million cubic feet	31,327	2,256	32,890	2,664	40,674	3,539	55,451	6,599
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	39,869	2,313	37,197	2,574	40,730	2,523	34,558	2,148
LP gases	do	54,034	2,097	53,518	2,743	55,731	3,048	73,252	3,735
Petroleum (crude)	thousand 42-gallon barrels	31,047	90,657	28,700	80,934	26,329	72,931	[6] 28,953	[6] 80,200
Sand and gravel	thousand short tons	8,599	6,949	8,644	7,039	11,696	11,857	8,192	10,262
Stone	do	7,278	8,378	8,461	10,178	8,824	10,424	10,939	13,555
Zinc (recoverable content of ores, etc.)	short tons					49	11	50	13
Value of items that cannot be disclosed: Abrasive stones, bromine, cement, lime, slate (1957), soapstone, and values indicated by footnote 4			6,933		7,241		10,042		10,918
Total Arkansas [9]			142,685		[8] 132,520		[8] 140,594		155,039

See footnotes at end of table.

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

CALIFORNIA

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	(4)	(4)	24,812	$272	28,143	$326	16,157	$181
Boron minerals—do	541,124	$38,041	528,209	38,310	619,946	46,150	640,591	47,550
Cement [2]—thousand 376-pound barrels	37,731	117,852	39,583	124,367	43,635	138,506	39,712	128,826
Chromite—short tons, gross weight	34,901	2,789	20,588	1,646	(5)	(5)		
Clays—thousand short tons	[3] 2,729	[3] 5,740	2,394	5,012	2,726	5,646	2,899	5,663
Copper (recoverable content of ores, etc.)—short tons	945	569	749	394	663	407	1,087	698
Feldspar—long tons	67,869	581	71,193	624	76,489	[3] 824	76,010	886
Gem stones	(12)	100	(12)	150	(12)	150	(12)	150
Gold (recoverable content of ores, etc.)—troy ounces	170,885	5,981	135,385	6,489	[3] 145,270	[3] 5,084	123,713	4,330
Gypsum—thousand short tons	1,268	2,995	1,423	3,184	1,686	3,788	1,616	3,687
Lead (recoverable content of ores, etc.)—short tons	3,458	989	140	33	227	52	440	103
Lime—thousand short tons	325	5,408	262	4,470	358	5,817	345	5,628
Magnesium compounds from sea water and bitterns (partly estimated) short tons, MgO equivalent	74,295	5,077	74,132	4,854	87,968	6,336	86,532	6,233
Manganese ore (35 percent or more Mn)—short tons, gross weight	9,009	802	17,644	1,516	19,354	1,663		
Manganiferous ore (5 to 35 percent Mn)—do					129	(4)	96	(4)
Mercury—76-pound flasks	16,511	4,078	22,365	5,123	17,100	3,890	18,764	3,955
Natural gas—million cubic feet	492,338	116,684	465,582	108,481	485,655	119,471	517,535	138,182
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	843,378	81,355	853,045	68,485	834,258	68,023	794,657	62,496
LP gases—do	390,743	20,421	342,992	18,678	396,331	21,260	408,378	21,482
Peat—short tons	35,916	424	28,617	374	34,604	449	33,091	481
Perlite—do	15,109	113	14,883	114	(4)	(4)	(4)	(4)
Petroleum (crude)—thousand 42-gallon barrels	339,646	1,035,920	313,672	909,649	308,946	787,812	[6] 304,356	[6] 748,716
Pumice—thousand short tons	459	1,510	377	1,670	574	2,162	427	1,895
Salt—do	1,330	8,721	1,297	(4)	1,388	(4)	1,443	(4)
Sand and gravel—do	78,983	87,030	84,137	95,340	87,945	108,909	87,679	107,503
Silver (recoverable content of ores, etc.)—thousand troy ounces	522	473	188	170	173	156	180	163
Stone—thousand short tons	41,351	53,591	32,423	48,345	32,134	49,090	33,075	49,842
Talc, pyrophyllite and soapstone—short tons	133,915	1,526	129,638	1,339	[3] 144,816	[3] 1,490	130,539	1,396
Tungsten concentrate—short tons, 60-percent WO_3 basis	1,750	2,735	(4)	(4)	(4)	(4)	(4)	(4)
Wollastonite—short tons			1,652	17	(4)	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.)—do	2,969	689	51	10	78	18	465	120
Value of items that cannot be disclosed: Asbestos, bromine, calcium-magnesium chloride, carbon dioxide (1957, 1959–60), masonry cement, clay (kaolin 1957), coal (lignite), diatomite, fluorspar (1957–58, 1960), iodine, iron ore, lithium minerals (1958–60), magnesite (1958–60), mica (1958, 1960), molybdenum, platinum-group metals (crude), potassium salts, pyrites, rare-earth metal concentrates, slate (1957), sodium carbonates and sulfates, strontium minerals (1957, 1959), sulfur ore, uranium ore, and values indicated by footnote 4		65,352		68,564		[3] 73,397		79,470
Total California [9]		1,650,035		1,500,367		[3] 1,433,626		1,402,214

Beryllium concentrate	short tons, gross weight	182	$91	[8] 176	[8] $63	[8] 221	[8] $67	304	$53
Carbon dioxide, natural	thousand cubic feet	(4)	(4)	(4)	(4)	175,223	(4)	155,871	20
Clays	thousand short tons	403	978	449	1,111	417	1,160	490	1,424
Coal	do	3,594	21,831	2,974	19,305	3,294	21,034	3,607	21,090
Columbium-tantalum concentrate [13]	pounds	103	(5)	2,280	7				
Copper (recoverable content of ores, etc.)	short tons	5,115	3,079	4,193	2,206	2,940	1,805	3,247	2,085
Feldspar	long tons	43,818	307	34,648	237	(4)	(4)	(4)	(4)
Gem stones		(12)	35	(12)	38	(12)	43	(12)	45
Gold (recoverable content of ores, etc.)	troy ounces	87,928	3,078	79,539	2,784	61,097	2,138	61,269	2,144
Gypsum	thousand short tons	(4)	(4)	103	341	106	385	82	296
Iron ore (usable)	thousand long tons, gross weight	(4)	(4)	(4)	(4)	11	78	11	80
Lead (recoverable content of ores, etc.)	short tons	21,003	6,007	14,112	3,302	12,907	2,969	18,080	4,231
Lime	thousand short tons	2	45	(4)	(4)	(4)	(4)	(4)	(4)
Manganese ore (35 percent or more Mn)	short tons, gross weight	175	14	210	17	1,218	102		
Mica:									
Scrap	short tons	312	6	387	6	68	1	340	4
Sheet	pounds	14	(5)						
Natural gas	million cubic feet	95,259	9,526	82,464	8,659	99,899	10,989	107,404	12,781
Natural gas liquids:									
Natural gasoline	thousand gallons	(4)	(4)	49,505	3,410	47,424	2,811	73,179	4,138
LP gases	do	(4)	(4)	68,027	3,343	77,637	3,671	104,275	4,938
Peat	short tons	3,559	(4)	7,143	41	6,674	35	9,384	37
Petroleum (crude)	thousand 42-gallon barrels	54,982	166,046	48,736	145,721	46,440	134,676	[6] 47,165	[6] 136,779
Pumice	thousand short tons	25	53	34	65	40	66	32	70
Pyrites	thousand long tons	62	(4)	67	359	(4)	(4)	(4)	(4)
Rare-earth and thorium concentrates	short tons	749	24	650	35	9	1	(11)	(5)
Sand and gravel	thousand short tons	16,400	13,994	20,626	17,842	20,897	18,817	19,053	16,882
Silver (recoverable content of ores, etc.)	thousand troy ounces	2,788	2,523	2,056	1,860	1,341	1,213	1,659	1,502
Stone	thousand short tons	2,438	4,168	2,930	4,943	2,824	5,537	2,442	4,651
Tin (content of ore and concentrate)	long tons					50	60	10	12
Tungsten concentrate	short tons, 60-percent WO_3 basis	45	55	(4)	(4)	(4)	(4)	(4)	(4)
Uranium ore	short tons	740,055	15,605	939,706	22,486	1,044,089	22,546	1,149,583	23,462
Vanadium	do	3,132	(4)	2,396	(4)	2,949	(4)	4,026	(4)
Zinc (recoverable content of ores, etc.)	do	47,000	10,904	37,132	7,575	35,388	8,139	31,278	8,070
Value of items that cannot be disclosed: Cement, fluorspar, molybdenum, perlite, salt, and values indicated by footnote 4			81,907		62,855		79,229		99,743
Total Colorado [9]			338,504		[8] 306,566		[8] 314,677		342,223

See footnotes at end of table.

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

CONNECTICUT

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate—short tons, gross weight	(4)	(4)	(4)	(4)	13	$8	16	$9
Clays—thousand short tons	308	$409	199	$299	280	368	207	308
Gem stones	(12)	(4)	(12)	3	(12)	5	(12)	7
Lime—thousand short tons	30	503	29	464	(4)	(4)	35	616
Peat—short tons	2,004	11	1,764	11	2,090	13	(4)	(4)
Sand and gravel—thousand short tons	4,777	5,042	5,019	5,479	4,749	4,912	6,575	5,960
Stone—do	6,199	10,040	4,223	6,863	4,462	7,088	5,057	8,313
Value of items that cannot be disclosed: Feldspar, sheet mica (1957–58, 1960), and values indicated by footnote 4		119		89		636		140
Total Connecticut [14]		16,055		13,128		12,930		15,255

DELAWARE

Sand and gravel—thousand short tons	974	$860	1,090	$962	1,241	$1,071	1,084	$907
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4		182		180		213		82
Total Delaware		1,042		1,142		1,284		989

FLORIDA

Clays—thousand short tons	422	$6,067	450	$5,808	[3] 245	[3] $6,171	[3] 252	[3] $6,357
Gem stones					(12)	3	(12)	(5)
Lime—thousand short tons	(4)	(4)	(4)	(4)	111	1,238	151	2,611
Natural gas—million cubic feet	34	4	35	5	34	5	30	5
Peat—short tons	37,844	195	36,438	165	34,446	158	39,275	162
Petroleum (crude)—thousand 42-gallon barrels	461	(4)	449	(4)	424	(4)	[4] 368	(4)
Phosphate rock—thousand long tons	10,191	64,789	10,851	68,951	11,564	71,208	12,321	82,530
Sand and gravel—thousand short tons	6,753	6,148	5,490	4,389	6,674	5,177	6,757	5,559
Stone—do	21,786	30,467	[7] 23,549	[7] 30,983	[7] 26,917	[7] 35,940	[7] 27,629	[7] 37,419
Titanium concentrates—thousand short tons, gross weight	263	10,643	190	5,495	262	7,196	286	7,489
Zirconium concentrate—short tons	56,802	1,976	30,302	1,018	(4)	(4)	(4)	(4)
Value of items that cannot be disclosed: Cement, clays (kaolin and miscellaneous clay 1959–60), magnesium compounds (1959–60), rare-earth metals concentrates (1957–59), staurolite, stone (dimension limestone 1958–59, calcareous marl 1960), and values indicated by footnote 4		22,514		28,510		40,034		38,151
Total Florida [6]		140,467		142,114		[8] 163,446		176,920

GEORGIA

Clays	thousand short tons	2,707	$30,120	2,942	$31,253	3,352	$36,232	3,519	$40,160
Coal	do	13	63	9	44	7	34	4	21
Iron ore (usable)	thousand long tons, gross weight	443	2,109	209	1,008	186	945	128	613
Manganese ore (35 percent or more Mn)	short tons, gross weight	(4)	(4)	(4)	(4)	1,547	(4)	----	----
Manganiferous ore (5 to 35 percent Mn)	do	2,203	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Mica (sheet)	pounds	16,933	158	15,102	82	18,461	119	10,218	89
Peat	short tons	4,690	45	4,491	(4)	4,288	(4)	6,904	73
Sand and gravel	thousand short tons	2,127	2,096	2,631	2,693	2,909	2,982	3,338	3,047
Stone	do	r 9,065	r 15,833	12,129	31,108	13,771	35,973	14,297	37,033
Talc and soapstone	short tons	49,372	106	(4)	(4)	53,692	107	40,200	88
Value of items that cannot be disclosed: Barite, bauxite, beryllium concentrate (1957), cement, feldspar, gem stones, iron ore (pigment material), scrap mica, slate (1957), stone (dimension and crushed marble and crushed sandstone 1957), and values indicated by footnote 4		----	20,081	----	10,145	----	10,979	----	11,181
Total Georgia [9]		----	69,799	----	75,106	----	86,262	----	91,203

HAWAII

Cement	thousand 376-pound barrels	----	----	----	----	----	----	113	$571
Clays	thousand short tons	2	$3	(4)	(4)	(4)	(4)	(4)	(4)
Lime	do	8	271	8	$260	(4)	(4)	(4)	(4)
Pumice	do	266	493	260	481	276	$548	361	676
Salt	do	(10)	15	(10)	(4)	----	----	----	----
Sand and gravel	do	286	538	438	1,112	463	1,253	490	1,324
Stone	do	2,585	4,632	2,377	4,446	3,034	5,480	3,535	6,443
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 4		----	----	----	13	----	363	----	353
Total Hawaii [10]		----	5,930	----	6,298	----	7,630	----	9,254

See footnotes at end of table.

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

IDAHO

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate—short tons, antimony content	664	(4)	677	(4)	678	(4)	635	(4)
Beryllium concentrate—short tons, gross weight	1	(5)						
Clays [3]—thousand short tons	23	$16	27	$20	39	$33	36	$29
Cobalt (content of concentrate)—thousand pounds	2,618	(4)	3,078	(4)	1,141	(4)		
Columbium-tantalum concentrate—pounds	364,768	(4)	422,612	(4)	189,263	(4)		
Copper (recoverable content of ores, etc.)—short tons	7,912	4,763	9,846	5,179	8,713	5,350	4,208	2,702
Gold (recoverable content of ores, etc.)—troy ounces	12,301	431	15,896	556	10,479	367	6,135	215
Iron ore (usable)—thousand long tons	(4)	(4)	1	14	6	56	9	(4)
Lead (recoverable content of ores, etc.)—short tons	71,637	20,488	53,603	12,543	62,395	14,351	42,907	10,040
Mercury—76-pound flasks	2,260	558	2,625	601	1,961	446	1,538	324
Mica:								
Scrap—short tons			1	(6)				
Sheet—pounds	1,240	9	1,968	14	(4)	(4)	(4)	(4)
Nickel (content of ore and concentrate)—short tons	37	55	29	(4)	(4)	(4)		
Phosphate rock—thousand long tons	1,307	5,684	1,291	5,652	1,610	7,412	2,177	11,044
Pumice—thousand short tons	100	168	108	172	93	137	56	88
Rare-earth metals concentrates—short tons	366	(4)	692	(4)	522	80		
Sand and gravel—thousand short tons	6,665	5,274	6,879	6,404	9,184	8,080	7,088	6,594
Silver (recoverable content of ores, etc.)—thousand troy ounces	15,067	13,637	15,953	14,438	16,637	15,057	13,647	12,351
Stone—thousand short tons	1,542	2,759	1,391	1,794	1,079	1,931	1,318	2,141
Titanium concentrate—short tons, gross weight	28,397	(4)	2,223	(4)	(4)	(4)	2,014	30
Tungsten concentrate—short tons, 60-percent WO_3 basis	35	(4)	(4)	(4)				
Uranium ore—short tons	(4)	(4)	(4)	(4)	3,374	30	(4)	(4)
Zinc (recoverable content of ores, etc.)—do	57,831	13,417	49,725	10,144	55,699	12,811	36,801	9,495
Value of items that cannot be disclosed: Barite, cement, clays (fire clay, bentonite 1958, 1960), abrasive garnet, gemstones, gypsum (1958–59), peat, zirconium concentrate (1958), and values indicated by footnote 4. Excludes values of raw materials used in manufacturing cement		6,243		7,117		4,068		2,388
Total Idaho		73,502		64,648		70,209		57,441

ILLINOIS

Cement—thousand 376-pound barrels	8,575	$26,356	9,618	$30,858	9,925	$31,794	9,139	$30,732
Clays—thousand short tons	1,917	5,155	2,335	5,910	2,229	4,950	2,356	5,479
Coal—do	46,993	187,908	43,912	176,614	45,466	184,412	45,977	184,087
Fluorspar—short tons	169,939	8,827	152,087	7,931	112,469	5,908	134,529	6,936
Gem stones	(12)	2	(12)	1	(12)	1	(12)	(4)
Lead (recoverable content of ores, etc.)—short tons	2,970	849	1,610	377	2,570	591	3,000	702

Natural gas—million cubic feet	9,647	1,495	12,983	1,921	13,739	1,910	11,666	1,458
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	(4)	(4)	22,380	1,645	(4)	(4)	16,496	1,313
LP gases—do	(4)	(4)	353,129	20,866	(4)	(4)	358,366	19,941
Peat—short tons	11,480	106	11,588	72	9,117	72	6,179	28
Petroleum (crude)—thousand 42-gallon barrels	77,083	240,499	80,275	240,825	76,727	229,414	[6] 78,840	[6] 233,366
Sand and gravel—thousand short tons	30,151	32,572	29,866	33,453	30,241	33,717	33,138	36,255
Stone—do	31,861	41,835	35,016	44,245	35,294	45,081	41,721	55,593
Zinc (recoverable content of ores, etc.)—short tons	22,185	5,147	24,940	5,088	26,815	6,167	29,550	7,624
Value of items that cannot be disclosed: Lime, tripoli, and values indicated by footnote 4		27,898		9,573		30,897		10,796
Total Illinois [9]		576,324		576,862		[8] 572,275		590,800
INDIANA								
Abrasive stones—short tons	4	$8	10	$10	5	$13	(4)	(4)
Cement—thousand 376-pound barrels	[3] 12,598	[3] 40,742	[3] 14,730	[3] 48,858	14,245	47,231	14,052	$48,310
Clays—thousand short tons	1,475	2,569	1,370	2,477	1,692	2,915	1,822	3,396
Coal—do	15,841	62,055	15,022	58,506	14,804	59,954	15,538	61,570
Natural gas—million cubic feet	671	88	378	59	484	92	342	61
Peat—short tons	13,805	130	12,106	145	15,393	202	27,486	290
Petroleum (crude)—thousand 42-gallon barrels	12,662	39,632	11,864	35,711	11,554	34,315	[6] 11,590	[6] 34,075
Sand and gravel—thousand short tons	16,750	14,206	16,862	15,045	20,357	17,924	20,752	18,377
Stone—do	14,460	33,094	15,394	31,974	18,544	37,682	18,956	34,920
Value of items that cannot be disclosed: Cement (masonry and natural cement 1957–58), gypsum, and values indicated by footnote 4		7,675		7,539		[8] 8,817		8,569
Total Indiana [9]		198,034		197,677		[8] 206,359		206,882
IOWA								
Cement—thousand 376-pound barrels	10,823	$34,881	12,675	$41,741	13,170	$44,048	12,517	$44,204
Clays—thousand short tons	[3] 752	[3] 944	[3] 837	[3] 1,054	912	1,168	1,022	1,345
Coal—do	1,312	4,543	1,179	4,147	1,180	4,214	1,068	3,845
Gypsum—do	1,123	3,773	1,230	4,491	1,318	5,587	1,283	5,428
Sand and gravel—do	12,042	8,927	12,411	10,965	13,484	11,658	14,692	13,516
Stone—do	15,214	18,768	21,045	26,138	20,501	25,759	23,185	30,321
Value of items that cannot be disclosed: Fire clay (1956–58), gem stones (1960), lime, and peat (1957–58, 1960)		614		633		520		660
Total Iowa [9]		68,986		85,356		88,557		95,030

See footnotes at end of table.

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

KANSAS

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement[2] thousand 376-pound barrels	8,178	$24,814	9,600	$30,047	10,405	$32,282	8,162	$26,373
Clays thousand short tons	909	1,240	875	1,145	1,021	1,271	894	1,224
Coal do	749	3,331	823	3,711	772	3,607	888	4,197
Gem stones					(12)	1	(12)	(5)
Helium thousand cubic feet	36,743	570	27,888	432	21,643	343	21,696	350
Lead (recoverable content of ores, etc.) short tons	4,257	1,217	1,299	304	481	111	781	183
Natural gas million cubic feet	586,690	66,883	561,816	64,047	604,410	72,529	634,410	74,226
Natural gas liquids:								
Natural gasoline thousand gallons	119,247	6,569	110,293	6,229	107,814	5,576	115,868	6,694
LP gases do	103,494	4,042	115,175	5,193	124,874	6,658	127,270	6,343
Petroleum (crude) thousand 42-gallon barrels	123,614	372,078	119,942	359,826	119,543	347,870	[6] 113,455	[6] 329,020
Salt thousand short tons	1,018	10,353	1,073	11,348	1,123	13,670	1,213	14,109
Sand and gravel do	9,345	6,175	10,317	6,769	11,334	7,937	9,710	6,808
Stone[7] do	10,412	11,926	12,424	15,036	13,999	17,108	11,814	15,031
Zinc (recoverable content of ores, etc.) short tons	15,859	3,679	4,421	902	1,017	234	2,117	546
Value of items that cannot be disclosed: Natural cement, gypsum, pumice, stone (dimension 1957–59 and crushed sandstone), and values indicated by footnote 4		1,191		1,627		2,012		1,436
Total Kansas[9]		511,513		503,788		[8] 508,077		483,958

KENTUCKY

Barite short tons					26,598	$335	(4)	(4)
Clays thousand short tons	894	$3,915	737	$2,957	984	3,595	[5] 951	[5] $2,646
Coal do	74,667	338,109	66,312	289,385	62,810	270,139	66,846	282,395
Fluorspar short tons	20,626	979	25,861	1,201	18,579	887	25,855	1,173
Lead (recoverable content of ores, etc.) do	411	118	516	121	409	94	558	131
Natural gas million cubic feet	70,024	16,666	72,248	17,412	73,504	17,420	75,329	18,380
Natural gas liquids:								
Natural gasoline thousand gallons	34,956	1,935	37,926	2,165	35,868	2,133	(4)	(4)
LP gases do	176,033	7,403	150,655	8,491	213,171	12,267	(4)	(4)
Petroleum (crude) thousand 42-gallon barrels	17,029	53,301	17,509	51,652	27,272	76,634	[6] 21,144	[6] 60,260
Sand and gravel thousand short tons	4,482	4,556	4,685	4,835	5,081	5,568	5,113	5,763
Stone do	12,718	16,714	12,597	17,360	[7] 16,063	[7] 22,215	[7] 15,810	21,493
Zinc (recoverable content of ores, etc.) short tons	837	194	1,258	257	673	155	869	224
Value of items that cannot be disclosed: Native asphalt (1957), cement, ball clay (1960), gem stones (1960), stone (crushed sandstone 1960), silver, and values indicated by footnote 4		6,211		7,059		8,202		22,080
Total Kentucky[9]		449,390		402,121		[8] 418,821		413,517

LOUISIANA

Clays	thousand short tons	[3] 642	[3] $642	[3] 755	[3] $755	[3] 904	[3] $904	749	$749
Natural gas	million cubic feet	2,078,901	232,837	2,451,587	316,255	2,670,271	411,222	2,988,414	511,019
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	775,009	63,956	783,099	50,371	846,110	60,295	875,567	66,214
LP gases	do	335,142	14,888	410,869	21,435	540,046	25,877	606,023	28,147
Petroleum (crude)	thousand 42-gallon barrels	329,896	1,094,402	313,891	1,023,517	362,666	1,145,569	[3] 394,360	[3] 1,237,823
Salt	thousand short tons	3,461	18,944	3,442	18,960	4,807	20,918	4,792	21,959
Sand and gravel	do	12,579	14,730	15,061	17,119	16,052	20,111	14,319	19,106
Stone	do	4,383	7,152	5,453	9,532	5,670	10,874	[7] 4,691	[7] 8,882
Sulfur (Frasch-process)	thousand long tons	2,156	52,690	2,028	47,651	2,252	52,779	2,256	52,639
Value of items that cannot be disclosed: Cement, clay (bentonite 1957–59), gypsum, lime, stone (crushed miscellaneous 1960), and values indicated by footnote 4			18,966		20,475		20,286		24,042
Total Louisiana [15]			1,517,522		1,523,370		[8] 1,766,269		1,967,652

MAINE

Beryllium concentrate	short tons, gross weight	4	$2	(11)	(9)	3	$2	(4)	(4)
Clays	thousand short tons	30	28	23	$26	25	26	41	$50
Feldspar	long tons	14,330	92	13,034	83	(4)	(4)	(4)	(4)
Gem stones		(12)	1	(12)	5	(12)	10	(12)	15
Mica:									
Scrap	short tons	6	(5)	104	3	157	4	171	6
Sheet	pounds	25,453	202	20,097	278	22,360	237	26,842	275
Peat	short tons	3,770	175	(4)	(4)	(4)	(4)		
Sand and gravel	thousand short tons	8,037	3,099	8,941	3,746	9,452	3,644	9,833	3,892
Stone	do	889	3,076	880	2,760	819	2,766	1,012	3,851
Value of items that cannot be disclosed: Cement, lime (1957–58), slate (1957), and values indicated by footnote 4			6,617		6,363		7,050		5,990
Total Maine [15]			12,711		12,574		13,278		13,648

MARYLAND

Clays [3]	thousand short tons	631	$963	605	$815	661	$944	612	$853
Coal	do	748	3,082	838	3,161	842	3,188	748	2,799
Gem stones		(13)	(4)	(12)	2	(12)	2	(12)	2
Natural gas	million cubic feet	4,649	1,218	4,266	1,148	4,373	1,181	4,065	1,081
Sand and gravel	thousand short tons	8,679	11,594	8,513	11,368	10,034	12,983	10,076	13,221
Stone	do	6,140	13,392	6,721	14,387	7,445	15,476	7,944	16,962
Value of items that cannot be disclosed: Beryllium concentrate (1957), cement, ball clay, greensand marl, mica (1957), lime, potassium salts, talc and soapstone, and values indicated by footnote 4			10,664		16,224		21,416		22,779
Total Maryland [9]			39,625		45,735		[8] 53,189		55,527

See footnotes at end of table.

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

MASSACHUSETTS

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	78	$98	85	$111	101	$229	83	$71
Gem stones			(12)	(5)	(12)	1	(12)	1
Lime—thousand short tons	137	2,233	139	2,121	144	2,289	154	2,870
Peat—short tons	600	(4)	1,014	(4)	773	(4)	(4)	(4)
Sand and gravel—thousand short tons	9,900	9,691	10,620	10,035	13,210	11,786	14,789	13,013
Stone—do	4,877	13,165	4,649	12,354	5,102	12,375	5,247	12,782
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4		6		9		6		8
Total Massachusetts [13]		24,789		23,887		25,916		27,588

MICHIGAN

Cement—thousand 376-pound barrels	22,045	$71,606	20,912	$70,432	23,026	$77,324	22,361	$77,694
Clays—thousand short tons	1,842	1,982	1,663	1,813	1,771	1,937	1,738	1,904
Copper (recoverable content of ores, etc.)—short tons	58,400	35,157	58,005	30,511	55,300	33,954	56,385	36,199
Gypsum—thousand short tons	1,386	4,823	1,331	4,824	1,721	6,595	1,463	5,609
Iron ore (usable)—thousand long tons, gross weight	13,123	111,484	8,111	69,845	7,247	62,921	10,792	95,791
Lime—thousand short tons	(4)	(4)	(4)	(4)	862	11,748	1,177	15,730
Manganiferous ore (5 to 35 percent Mn)—short tons, gross weight	123,547	(4)	112,536	(4)			180,460	(4)
Natural gas—million cubic feet	9,122	1,715	14,243	2,649	18,916	4,350	20,790	4,449
Peat—short tons	80,271	1,406	107,342	1,684	191,661	2,357	214,402	2,755
Petroleum (crude)—thousand 42-gallon barrels	10,169	31,117	9,308	27,366	10,439	30,691	[6] 15,665	[6] 45,585
Salt—thousand short tons	5,225	41,073	4,267	33,018	4,485	35,725	4,088	33,759
Sand and gravel—do	41,838	35,144	39,871	34,616	48,052	41,193	46,910	39,304
Silver (recoverable content of ores, etc.)—thousand troy ounces	430	389						
Stone—thousand short tons	34,495	34,176	27,188	26,846	30,095	30,379	31,256	32,274
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones, magnesium compounds, natural gas liquids, potassium salts, and values indicated by footnote 4		40,324		45,558		49,371		45,864
Total Michigan [9]		404,673		343,487		[6] 381,297		429,055

MINNESOTA

Clays—thousand short tons	[3] 97	[3] $113	92	$150	153	$267	[3] 125	[3] $163
Gem stones	(12)	(4)	(12)	(4)	(12)	(4)	(12)	2
Iron ore (usable)—thousand long tons, gross weight	67,656	541,474	42,503	354,528	36,109	306,920	54,723	470,874
Manganiferous ore (5 to 35 percent Mn)—short tons, gross weight	692,295	(4)	370,603	(4)	429,102	(4)	441,028	(4)
Peat—short tons	1,300	(4)	(4)	(4)			1,465	72
Sand and gravel—thousand short tons	28,493	19,385	29,634	21,680	28,486	20,726	30,302	24,611

Stone—do	[12] 2,968	[13] 8,175	3,519	9,560	3,639	9,461	4,234	10,034
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1957, 1960), lime, manganese ore (1957), stone (crushed sandstone, 1957, calcareous marl, 1957), and values indicated by footnote 4		15,107		10,154		9,993		9,765
Total Minnesota [18]		584,038		395,880		347,178		515,255
MISSISSIPPI								
Clays—thousand short tons	616	$3,635	576	$3,338	747	$4,064	1,017	$4,786
Iron ore (usable)—thousand long tons	(16)	1	(16)	(4)				
Natural gas—million cubic feet	169,967	17,507	160,143	22,260	162,095	25,125	172,478	32,426
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	25,152	1,469	25,738	1,658	23,207	1,495	23,648	1,552
LP gases—do	10,044	472	9,208	503	8,141	465	10,151	564
Petroleum (crude)—thousand 42-gallon barrels	38,922	113,263	39,512	113,004	49,620	140,921	[6] 51,819	[6] 146,648
Sand and gravel—thousand short tons	5,172	4,344	6,545	6,240	7,520	7,743	6,181	5,568
Stone—do	[7] 60	[7] 54	[7] 102	[7] 92	[7] 126	[7] 114	807	808
Value of items that cannot be disclosed: Certain metals and nonmetals		4,694		4,820		6,751		7,271
Total Mississippi [15]		144,950		151,411		[8] 186,116		198,862
MISSOURI								
Barite—short tons	317,350	$3,938	199,268	$2,666	296,093	$3,924	180,702	$2,588
Cement—thousand 376-pound barrels	[2] 10,794	[2] 34,307	12,116	40,657	13,947	46,974	12,183	42,330
Clays—thousand short tons	2,648	7,648	2,060	5,986	2,635	6,898	2,540	7,207
Coal—do	2,976	12,691	2,592	11,111	2,748	11,937	2,890	12,450
Copper (recoverable content of ores, etc.)—short tons	1,604	966	1,429	752	1,065	654	1,087	698
Iron ore (usable)—thousand long tons, gross weight	530	4,625	387	3,820	349	3,278	365	3,760
Lead (recoverable content of ores, etc.)—short tons	126,345	36,135	113,123	26,471	105,165	24,188	111,948	26,196
Lime—thousand short tons	1,393	16,475	1,173	14,136	1,324	15,714	1,254	14,701
Natural gas—million cubic feet	12	2					75	19
Nickel (content of ore and concentrate)—short tons	(4)	(4)	763	(4)	(4)	(4)	(4)	(4)
Petroleum (crude)—thousand 42-gallon barrels	65	(4)	84	(4)	75	(4)	[6] 72	(4)
Sand and gravel—thousand short tons	8,480	8,942	8,972	9,728	10,279	11,406	10,207	11,601
Silver (recoverable content of ores, etc.)—thousand troy ounces	184	166	251	227	340	308	16	14
Stone—thousand short tons	22,098	29,836	24,276	32,878	26,939	36,435	27,180	37,878
Zinc (recoverable content of ores, etc.)—short tons	2,951	685	362	74	92	21	2,821	728
Value of items that cannot be disclosed: Native asphalt, masonry cement (1957), cobalt, gem stones, manganese ore (1957–58), and values indicated by footnote 4		2,793		2,037		[8] 2,288		2,066
Total Missouri [9]		152,913		144,120		[8] 157,189		156,033

See footnotes at end of table.

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

MONTANA

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Chromite—short tons, gross weight	119,149	$3,921	119,057	(4)	[17] 105,000	[17] $3,765	[17] 107,000	[17] $3,813
Clay [3]—thousand short tons	32	24	23	$19	46	48	63	77
Coal: Bituminous and lignite—do	413	2,161	305	1,475	345	1,478	313	1,188
Copper (recoverable content of ores, etc.)—short tons	91,512	55,090	90,683	47,699	65,911	40,469	91,972	59,046
Fluorspar—do	64,339	(4)	53,654	(4)	18,542	(4)	31,273	(4)
Gold (recoverable content of ores, etc.)—troy ounces	32,766	1,147	26,003	910	28,551	999	45,922	1,607
Iron ore (usable)—thousand long tons, gross weight	36	(4)	14	(4)	50	254	55	293
Lead (recoverable content of ores, etc.)—short tons	13,300	3,804	8,434	1,974	7,672	1,765	4,879	1,142
Manganese ore (35 percent or more Mn)—short tons, gross weight	68,298	(4)	53,123	4,036	21,604	1,520	29,036	1,996
Manganiferous ore (5 to 35 percent Mn)—do	4,547	(4)	(4)	(4)	2,415	34	676	11
Mica, sheet—pounds	13	(5)	(4)	(4)	(4)	(5)	(4)	(4)
Natural gas—million cubic feet	28,638	2,062	27,989	1,903	30,743	2,306	33,418	2,373
Petroleum (crude)—thousand 42-gallon barrels	27,172	73,364	27,957	74,086	29,857	76,434	[6] 30,240	[6] 72,878
Phosphate rock—thousand long tons	534	3,825	(4)	(4)	(4)	(4)	(4)	(4)
Sand and gravel—thousand short tons	11,403	8,732	13,432	12,593	10,930	12,587	12,589	11,657
Silver (recoverable content of ores, etc.)—thousand troy ounces	5,558	5,030	3,630	3,286	3,420	3,096	3,607	3,265
Stone—thousand short tons	2,567	3,654	1,786	2,468	1,186	1,691	1,183	1,576
Tungsten ore and concentrate—short tons, 60-percent WO_3 basis	661	(4)					(4)	(4)
Uranium ore—short tons	(4)	(4)	689	20	2,890	(4)	1,726	29
Zinc (recoverable content of ores, etc.)—do	50,520	11,721	33,238	6,781	27,848	6,405	12,551	3,238
Value of items that cannot be disclosed: Barite, cement, clays (bentonite 1957–59, fire clay), gem stones, gypsum, lime, natural gas liquids, pyrites (1957–59), rare-earth metal concentrates (1958–59), talc, vanadium (1957), vermiculite, and values indicated by footnote 4		17,951		20,318		15,248		15,217
Total Montana [18]		191,750		176,728		[8] 167,328		178,854

NEBRASKA

Clays—thousand short tons	134	$135	108	$110	131	$133	108	$109
Gem stones	(12)	2	(12)	2	(12)	3	(12)	4
Natural gas—million cubic feet	14,249	2,280	11,405	1,711	13,128	2,087	15,258	2,670
Natural gas liquids:								
Natural gasoline—thousand gallons	(4)	(4)	10,870	727	(4)	(4)	(4)	(4)
LP gases—do	(4)	(4)	31,178	1,565	(4)	(4)	(4)	(4)
Petroleum (crude)—thousand 42-gallon barrels	19,586	58,366	20,373	59,897	22,881	65,897	[6] 24,428	[6] 70,108
Sand and gravel—thousand short tons	7,944	5,889	10,441	7,945	11,202	8,301	10,876	8,746
Stone—do	3,065	3,749	3,555	4,747	3,236	5,235	3,336	5,651

Value of items that cannot be disclosed: Cement, pumice, and values indicated by footnote 4		13,670		14,603		17,679		18,384
Total Nebraska [9]		82,928		90,047		[8] 97,130		103,687

NEVADA

Antimony ore and concentrate	short tons, antimony content	29	$9	39	$8	10	$2	
Barite	short tons	109,663	721	59,407	[8] 403	91,298	623	85,711	$580
Clays	thousand short tons	12	20	(4)	(4)	(4)	(4)	(4)	(4)
Copper (recoverable content of ores, etc.)	short tons	77,750	46,806	66,137	34,788	57,375	35,228	77,485	49,745
Fluorspar	do	(4)	(4)	12,338	340	16,743	407	18,505	388
Gem stones		(12)	100	(12)	100	(12)	100	(12)	100
Gold (recoverable content of ores, etc.)	troy ounces	76,752	2,686	105,087	3,678	113,443	3,971	58,187	2,037
Gypsum	thousand short tons	674	(4)	686	2,306	818	2,738	802	2,721
Iron ore (usable)	thousand long tons, gross weight	904	5,341	594	3,149	698	3,712	734	3,648
Lead (recoverable content of ores, etc.)	short tons	5,979	1,710	4,150	971	1,357	312	987	231
Manganese ore (35 percent or more Mn)	short tons, gross weight	129,046	(4)	127,322	7,566	[8] 56,611	[8] 3,918	49,076	3,301
Manganiferous ore (5 to 35 percent Mn)	do					200	(4)	(4)	(4)
Mercury	76-pound flasks	6,313	1,559	7,336	1,681	7,156	1,628	7,821	1,648
Petroleum (crude)	thousand 42-gallon barrels	44	76	40	69	32	(4)	[8] 25	(4)
Sand and gravel	thousand short tons	5,233	5,190	5,503	5,311	6,436	7,522	4,085	5,224
Silver (recoverable content of ores, etc.)	thousand troy ounces	959	868	933	844	611	553	707	640
Stone	thousand short tons	925	1,585	813	1,335	840	1,587	579	1,350
Talc and soapstone	short tons	7,467	57	5,391	41	5,824	50	4,882	30
Tungsten concentrate	short tons, 60-percent WO_3 basis	1,196	1,676	(4)	(4)	(4)	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.)	short tons	5,292	1,228	91	19	217	50	420	108
Value of items that cannot be disclosed: Brucite (1957–59), diatomite, lime, magnesite, molybdenum, perlite, pumice, salt, sulfur ore, uranium ore, and values indicated by footnote 4			16,756		6,020		8,458		9,091
Total Nevada [13]			86,023		[8] 68,291		[8] 70,164		80,285

NEW HAMPSHIRE

Beryllium concentrate	short tons, gross weight	4	$2	14	$8	20	$12	14	$8
Clays	thousand short tons	37	51	26	26	26	26	27	27
Gem stones		(12)	(5)	(12)	5	(12)	10	(12)	15
Mica:									
Sheet	pounds	53,554	460	81,472	646	119,163	1,133	80,065	904
Scrap	short tons	522	17	314	12	(4)	(4)	415	14
Peat	do	85	(4)	100	(4)	25	(4)	23	(4)
Sand and gravel	thousand short tons	4,505	1,970	4,940	2,620	5,124	2,887	6,621	3,687
Stone	do	(4)	(4)	(4)	(4)	82	488	104	594
Value of items that cannot be disclosed: Abrasive stones (1957), feldspar, and values indicated by footnote 4			831		602		166		68
Total New Hampshire			3,331		3,919		4,722		5,317

See footnotes at end of table.

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

NEW JERSEY

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons	[3] 593	[3] $1,872	684	$2,181	700	$1,895	664	$1,597
Gem stones	(12)	(4)	(12)	4	(12)	6	(12)	7
Iron ore (usable).....thousand long tons, gross weight	877	16,668	(4)	(4)	(4)	(4)	(4)	(4)
Peat.....short tons	(4)	(4)	18,397	185	28,300	278	25,100	192
Sand and gravel.....thousand short tons	10,323	17,619	9,877	16,145	11,033	18,620	11,594	19,511
Stone.....do	8,792	21,222	8,229	19,193	10,079	22,133	10,202	22,814
Zinc (recoverable content of ores, etc.)[18].....short tons	12,530	2,857	607	125				
Value of items that cannot be disclosed: Ball clay (1957), lime, magnesium compounds, manganiferous residuum, greensand marl, uranium ore (1960), and values indicated by footnote 4. Excludes limestone used in manufacturing lime		4,404		12,547		16,547		12,288
Total New Jersey		64,642		50,380		59,479		56,409

NEW MEXICO

Barite.....short tons	4,441	$98	(4)	(4)	320	$6	492	$10
Beryllium concentrate.....short tons, gross weight	29	15	27	$16	11	6		
Carbon dioxide, natural.....thousand cubic feet	(4)	(4)	(4)	(4)	(4)	(4)	230,115	(4)
Clays [2].....thousand short tons	33	83	40	73	45	77	56	132
Coal.....do	137	829	117	719	149	837	295	1,747
Columbium-tantalum concentrate.....pounds	866	1						
Copper (recoverable content of ores, etc.).....short tons	67,472	40,618	55,540	29,214	39,688	24,369	67,288	43,199
Fluorspar.....do					200	7		
Gem stones	(12)	30	(12)	28	(12)	39	(12)	40
Gold (recoverable content of ores, etc.).....troy ounces	3,212	112	3,378	118	3,155	110	5,423	190
Gypsum.....thousand short tons							55	193
Helium.....thousand cubic feet	69,336	1,189	29,793	502	16,903	264	43,494	684
Iron ore (usable).....thousand long tons, gross weight	(16)	1	(16)	(4)	(16)	(4)	1	27
Lead (recoverable content of ores, etc.).....short tons	5,294	1,514	1,117	261	829	191	1,996	467
Lime.....thousand short tons	24	290	21	260	16	209	36	496
Manganese ore (35 percent or more Mn).....short tons, gross weight	25,459	2,114	28,866	2,333	27,528	2,248		
Manganiferous ore (5 to 35 percent Mn).....do	42,535	152	(4)	(4)	(4)	(4)	(4)	(4)
Mica:								
Scrap.....short tons	1,347	47	787	24	210	7	235	7
Sheet.....pounds	2,134	16	1,791	18	247	2	(4)	(4)
Natural gas.....million cubic feet	723,004	67,962	761,446	79,190	739,660	73,966	798,928	85,485

Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	309,010	19,941	258,312	15,131	264,133	16,859	321,667	20,412
LP gases—do	375,930	13,046	458,178	17,331	552,257	22,320	645,116	28,788
Perlite—short tons	187,259	1,568	202,046	1,790	240,642	2,121	240,593	2,119
Petroleum (crude)—thousand 42-gallon barrels	94,759	283,128	98,515	293,974	105,692	301,394	[6] 107,940	[6] 307,491
Potassium salts—thousand short tons, K_2O equivalent	2,080	77,197	1,978	69,106	2,189	74,117	2,440	80,023
Pumice—thousand short tons	321	756	507	959	493	1,023	365	827
Salt—do	53	429	31	275	36	322	39	331
Sand and gravel—do	7,991	7,803	13,205	11,413	12,460	13,332	7,419	7,459
Silver (recoverable content of ores, etc.)—thousand troy ounces	309	280	159	144	159	144	304	275
Stone—thousand short tons	1,348	1,618	1,730	1,507	461	542	1,277	1,692
Uranium ore—short tons	1,175,742	20,538	1,888,499	32,264	3,269,826	53,463	3,793,494	61,827
Zinc (recoverable content of ores, etc.)—do	32,680	7,582	9,034	1,843	4,636	1,066	13,770	3,553
Value of items that cannot be disclosed: Cement (1960), fire clay, molybdenum, magnesium compounds, vanadium, and values indicated by footnote 4		2,276		1,345		3,771		5,266
Total New Mexico [18]		551,155		559,777		[8] 592,535		652,200
NEW YORK								
Clays—thousand short tons	1,002	$1,270	1,085	$1,419	1,309	$1,714	1,172	$1,717
Emery—short tons	11,893	184	7,687	126	8,555	150	8,169	142
Gem stones	[12]	5	[12]	8	[12]	8	[12]	9
Gypsum—thousand short tons	864	3,749	834	3,869	919	4,663	755	3,928
Iron ore (usable)—thousand long tons, gross weight	3,329	44,567	1,944	25,683	2,044	28,050	2,484	32,377
Lead (recoverable content of ores, etc.)—short tons	1,667	477	579	135	481	111	775	181
Natural gas—million cubic feet	2,869	815	2,808	859	2,915	889	4,990	1,542
Peat—short tons	[4]	[4]	13,606	117	12,875	138	10,042	146
Petroleum (crude)—thousand 42-gallon barrels	2,677	12,662	1,763	7,457	1,970	8,353	[6] 1,801	[6] 8,357
Salt—thousand short tons	3,691	28,002	3,896	30,609	4,011	30,958	4,008	30,763
Sand and gravel—do	25,640	26,480	24,730	27,541	27,943	31,415	30,687	35,152
Silver (recoverable content of ores, etc.)—thousand troy ounces	64	58	67	60	52	47	49	45
Slate—thousand short tons	59	961	[19]	[19]	[19]	[19]	[19]	[19]
Stone—do	24,265	43,276	22,598	38,219	28,640	46,556	29,802	46,955
Zinc (recoverable content of ores, etc.)—short tons	64,659	15,001	53,014	10,815	43,464	9,997	66,364	17,122
Value of items that cannot be disclosed: Beryllium concentrate (1960), cement, abrasive garnet, iron oxide pigments (1957–58), lime, talc, titanium concentrate, wollastonite, and values indicated by footnote 4		70,699		61,859		76,904		81,831
Total New York [9]		244,114		205,338		[8] 234,642		254,713

See footnotes at end of table.

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

NORTH CAROLINA

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones—short tons	(12)	[20] $5	(12)	[20] $2	[21] 191	[21] $5	(12)	[20] $2
Beryllium concentrate—short tons, gross weight	1	1	(11)	(5)				
Clays [3]—thousand short tons	2,392	1,407	2,046	1,187	2,524	1,522	2,476	1,548
Feldspar—long tons	233,439	2,728	(4)	(4)	(4)	(4)	270,761	2,781
Gem stones	(12)	(5)	(12)	1	(12)	9	(12)	4
Gold (recoverable content of ores, etc.)—troy ounces	1,373	48	876	31	965	34	1,826	64
Lead (recoverable content of ores, etc.)—short tons	9	3					424	99
Mica:								
Scrap—do	53,452	1,173	50,897	1,041	47,736	1,212	47,281	1,100
Sheet—pounds	577,607	1,575	521,701	1,722	505,623	1,755	430,193	1,411
Sand and gravel—thousand short tons	6,829	5,724	7,044	5,880	8,580	7,426	8,801	7,453
Silver (recoverable content of ores, etc.)—thousand troy ounces	12	11	15	14	16	15	212	192
Stone—thousand short tons	[7] 9,455	[7] 12,839	12,385	19,132	12,859	20,302	14,721	23,296
Talc and pyrophyllite—short tons	120,905	558	126,158	614	127,296	647	100,593	549
Tungsten concentrate—short tons, 60-percent WO_3 basis	1,828	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.)—short tons	2	(5)						
Value of items that cannot be disclosed: Abrasive stone (grinding pebbles and tube-mill liners, 1957–58, millstones 1959), asbestos, clay (bentonite 1957, kaolin 1958–60), copper, iron ore (1959–60), lithium minerals, olivine, slate (1957), stone (dimension granite, crushed basalt, dimension and crushed marble, crushed limestone, and crushed sandstone 1957), and values indicated by footnote 4		11,498		10,267		7,862		6,469
Total North Carolina		37,570		39,891		40,789		44,968

NORTH DAKOTA

Clays [3]—thousand short tons	54	$67	54	$66	61	$79	102	$129
Coal (lignite)—do	2,561	5,947	2,314	5,409	2,413	5,426	2,525	5,790
Gem stones	(12)	(5)	(12)	1	(12)	1	(12)	1
Natural gas—million cubic feet	15,450	1,468	17,325	1,672	17,915	1,774	19,483	2,221
Petroleum (crude)—thousand 42-gallon barrels	13,259	41,501	14,259	42,634	17,824	49,907	[6] 21,954	[6] 59,495
Pumice—thousand short tons	2	2	11	11				
Sand and gravel—do	7,048	4,967	11,464	6,605	9,883	6,516	8,648	6,904
Stone—do	29	52	23	35	48	84	28	44
Value of items that cannot be disclosed: Clays (bentonite, fire clay, 1960), natural gas liquids, salt (1960), and values indicated by footnote 4		2,698		3,012		3,555		3,691
Total North Dakota		56,702		59,445		[8] 67,342		78,275

OHIO

Abrasive stones, grindstones and pulpstones—short tons	1,505	$132	852	$83	1,081	$101	(4)	(4)
Cement—thousand 376-pound barrels	16,238	52,184	15,700	53,043	18,994	63,935	17,480	$61,478
Clays—thousand short tons	6,136	16,073	5,220	13,082	5,478	15,346	5,165	14,325
Coal—do	36,862	146,134	32,028	126,241	35,112	135,729	33,957	130,877
Gem stones			(12)	(5)	(12)	2	(12)	3
Lime—thousand short tons	2,763	38,383	2,411	32,471	3,190	45,121	3,117	44,403
Natural gas—million cubic feet	30,38[7]	7,201	31,786	6,802	34,664	8,042	36,074	8,477
Peat—short tons	5,478	102	5,660	104	5,813	73	6,755	93
Petroleum (crude)—thousand 42-gallon barrels	5,478	17,694	6,260	18,091	5,978	17,157	[6] 4,960	[6] 14,731
Salt—thousand short tons	2,825	16,936	2.443	17,443	2,858	20,486	3.108	24.149
Sand and gravel—do	30,596	37,503	29,624	36,619	38,604	45,139	[23] 37,943	[23] 44,979
Stone—do	[7] 37.451	[7] 61,847	29.122	49,782	[7] 36,155	[7] 59,326	[7] 35,856	[7] 59,479
Value of items that cannot be disclosed: Gypsum, natural gasoline (1957–58), stone (dimension limestone 1957, 1960, and calcareous marl, 1957, 1959–60), and values indicated by footnote 4		2,453		1,905		[8] 2,027		1,826
Total Ohio[9]		383,000		344,856		[8] 397,326		389,828

OKLAHOMA

Clays [3]—thousand short tons	641	$642	576	$579	966	$970	734	$739
Coal—do	2,195	14,165	1,629	10,858	1,525	10,272	1,342	9,113
Helium—thousand cubic feet					98,749	1,619	289,068	4,691
Lead (recoverable content of ores, etc.)—short tons	7,183	2,054	3,692	864	601	138	936	219
Natural gas—million cubic feet	719,794	59,743	696,504	70,347	811,508	81,151	824,266	98,088
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	460,644	25,329	440,798	26,029	448,353	29,443	531,995	33,074
LP gases—do	587,140	21,824	657,114	25,822	675,869	27,070	762,258	32,409
Petroleum (crude)—thousand 42-gallon barrels	214,661	650,423	200,699	594,069	198,090	578,423	[6] 192,288	[6] 561,481
Salt—thousand short tons	7	63	4	41	(4)	(4)	3	16
Sand and gravel—do	4,960	4,507	7,232	5,859	6,002	5,927	6,424	7,468
Stone—do	12,016	14,064	10,794	12,232	12,683	14,980	[7] 14,054	[7] 16,098
Tripoli—short tons	22,236	67	(4)	(4)	(4)	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.)—do	14,951	3,469	5,267	1,074	1,049	241	2,332	602
Value of items that cannot be disclosed: Native asphalt, clay (bentonite), cement, gemstones (1959–60), gypsum, lime, manganese ore (1957), pumice, stone, (crushed granite 1960), and values indicated by footnote 4		14,573		16,022		18,156		16,756
Total Oklahoma 4		809,004		761,936		[8] 765,439		779,116

See footnotes at end of table.

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

OREGON

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Chromite—short tons, gross weight	7,900	$675	4,133	[4]				
Clays—thousand short tons	240	266	252	$293	294	$308	318	$370
Copper (recoverable content of ores, etc.)—short tons	23	14	10	5			6	4
Gold (recoverable content of ores, etc.)—troy ounces	3,381	118	1,423	50	686	24	835	29
Lead (recoverable content of ores, etc.)—short tons	5	1	1	[5]				
Mercury—76-pound flasks	3,993	986	2,276	521	1,224	278	513	108
Nickel (content of ore and concentrate)—short tons	12,276	[4]	12,697	[4]	12,374	[4]	13,115	5,246
Pumice—thousand short tons	123	294	138	331	[4]	[4]	[4]	[4]
Sand and gravel—do	12,843	13,481	10,464	10,265	18,087	15,506	17,673	16,170
Silver (recoverable content of ores, etc.)—thousand troy ounces	16	14	3	2	[22]	[5]	[22]	[5]
Stone—thousand short tons	10,583	11,745	15,077	15,621	13,341	16,126	16,864	19,620
Value of items that cannot be disclosed: Asbestos (1959–60), carbon dioxide, cement, diatomite, gem stones, iron ore (pigment material, 1957, 1959), lime (1957–58, 1960), tungsten concentrate (1957), uranium ore (1957, 1960), and values indicated by footnote 4		16,154		19,311		[8] 18,607		14,124
Total Oregon [9]		42,820		45,190		[8] 49,842		54,419

PENNSYLVANIA

Cement—thousand 376-pound barrels	44,680	$148,130	42,115	$142,399	43,356	$150,918	38,320	$131,763
Clays—thousand short tons	4,074	22,012	[3] 3,318	[3] 17,051	3,466	17,196	[3] 3,557	[3] 16,536
Coal:								
Anthracite—do	25,338	227,754	21,171	187,898	20,649	172,320	18,817	147,116
Bituminous—do	85,365	492,539	67,771	373,812	65,347	345,332	65,425	345,971
Cobalt (content of concentrate)—thousand pounds	599	[4]	564	[4]	280	[4]	[4]	[4]
Gem stones	[12]	[4]	[12]	2	[12]	3	[12]	4
Lime—thousand short tons	1,298	18,406	1,003	14,161	1,263	18,261	1,120	16,277
Natural gas—million cubic feet	101,801	31,660	95,869	27,131	99,366	29,015	113,928	36,229
Natural gas liquids:								
Natural gasoline—thousand gallons	3,106	192	1,608	107	2,884	184	1,399	85
LP gases—do	1,211	106	1,363	123	1,484	36	1,580	138
Peat—short tons	26,086	236	23,623	203	26,948	262	30,837	325
Petroleum (crude)—thousand 42-gallon barrels	8,179	38,687	6,472	26,535	6,160	25,872	[6] 6,258	[6] 28,474
Sand and gravel—thousand short tons	12,406	19,570	11,825	19,180	14,257	23,233	13,011	21,204
Slate—do	139	4,005	[19]	[19]	[19]	[19]	[19]	[19]
Stone—do	43,258	73,090	40,049	69,694	43,682	77,421	42,136	74,168
Zinc (recoverable content of ores, etc.)[18]—short tons			10,812	2,229	16,718	3,828	13,746	3,559
Value of items that cannot be disclosed: Clays (kaolin 1958, 1960), copper, gold, graphite (1959–60), iron ore, mica, pyrites, pyrophyllite and soapstone, silver, tripoli, and values indicated by footnote 4		16,613		15,960		15,812		17,430
Total Pennsylvania [9]		1,077,157		882,040		[8] 862,150		824,493

RHODE ISLAND								
Sand and gravel	thousand short tons	1,058	$1,060	2,038	$1,883	1,740	$1,588	1,535	$1,355
Stone	do	[7] 4	[7] 14	[7] 3	[7] 8	(4)	(4)	1,810	4,372
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4			295		358		745		
Total Rhode Island			1,369		2,249		2,333		5,727
SOUTH CAROLINA									
Clays	thousand short tons	937	$5,161	929	$5,157	1,160	$5,920	1,297	$6,201
Mica (sheet)	pounds	2,278	12	1,144	8	251	3	101	1
Peat	short tons			4,865	(4)	4,194	(4)	(4)	(4)
Sand and gravel	thousand short tons	2,647	2,571	2,946	2,858	3,104	3,077	3,029	3,048
Stone [7]	do	3,413	4,581	3,637	5,229	6,248	8,647	5,994	8,178
Zirconium concentrate	short tons	(4)	(4)	141	5				
Value of items that cannot be disclosed: Barite, cement, feldspar (1959–60), gem stones (1958), kyanite, scrap mica, pyrites (1960), rare-earth metal concentrates (1957–58), staurolite (1957–58), stone (dimension granite 1957, 1960 crushed limestone, crushed sandstone 1959–60 calcareous marl 1957–59) titanium (1957–58), vermiculite, and values indicated by footnote 4			10,491		9,586		13,640		13,559
Total South Carolina [15]			22,168		22,412		30,598		30,001
SOUTH DAKOTA									
Beryllium concentrate	short tons, gross weight	268	$145	240	$129	156	$84	167	$88
Clays [8]	thousand short tons	176	176	155	155	227	227	202	202
Coal (lignite)	do	21	79	20	78	22	88	20	83
Columbium-tantalum concentrate	pounds	2,311	6	4,294	10				
Copper (recoverable content of ores, etc.)	short tons							1	1
Feldspar	long tons	41,316	267	23,229	145	30,825	196	45,588	292
Gem stones		(12)	15	(12)	16	(12)	20	(12)	20
Gold (recoverable content of ores, etc.)	troy ounces	568,130	19,885	570,830	19,979	577,730	20,221	554,771	19,417
Gypsum	thousand short tons	13	53	12	49	19	78	22	89
Mica:									
Scrap	short tons	1,626	43	1,003	24	158	5	205	10
Sheet	pounds	9,093	46	16,772	68	38,775	158	30,887	145
Petroleum (crude)	thousand 42-gallon barrels	54	(4)	58	(4)	151	(4)	[9] 281	(4)
Sand and gravel	thousand short tons	14,758	8,001	14,705	9,179	17,775	11,058	13,548	9,359
Silver (recoverable content of ores, etc.)	thousand troy ounces	135	122	153	138	124	113	108	98
Stone	thousand short tons	1,718	5,068	1,395	4,095	2,721	7,243	3,149	7,909
Uranium ore	short tons	69,800	760	35,489	530	45,734	606	41,104	586
Value of items that cannot be disclosed: Cement, clays (bentonite), iron ore (1957, 1960), lime, lithium minerals (1958–60), vanadium (1960), and values indicated by footnote 4			6,090		7,555		[8] 9,401		9,376
Total South Dakota [9]			39,997		41,534		[8] 48,553		46,780

See footnotes at end of table.

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

TENNESSEE

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand 376-pound barrels	7,415	$22,806	8,375	$26,408	9,153	$28,934	8,246	$27,384
Clays—thousand short tons	1,154	4,228	935	4,210	1,146	4,952	1,270	4,537
Coal—do	7,955	31,147	6,785	25,969	5,913	23,581	5,930	21,154
Copper (recoverable content of ores, etc.)—short tons	9,790	5,894	9,109	4,791	11,490	7,055	12,723	8,168
Gem stones			[12]	1	[12]	[5]	[12]	1
Gold (recoverable content of ores, etc.)—troy ounces	172	6	124	4	99	3	123	4
Iron ore (usable)—thousand long tons, gross weight	[4]	[4]	[4]	[4]	21	111	[4]	[4]
Lime—thousand short tons	94	1,134	[4]	[4]	[4]	[4]	[4]	[4]
Manganese ore (35 percent or more Mn)—short tons, gross weight	12,938	1,007	5,935	452	7,586	589	283	15
Manganiferous ore (5 to 35 percent Mn)—do					56	1	[4]	[4]
Natural gas—million cubic feet	38	6	54	9	52	9	63	11
Petroleum (crude)—thousand 42-gallon barrels	7	[4]	7	[4]	[7] 6	[4]	[6] 6	[4]
Phosphate rock—thousand long tons	1,812	12,514	1,903	13,041	1,755	13,255	1,939	15,424
Sand and gravel—thousand short tons	5,617	6,641	5,612	6,671	6,221	7,570	6,293	7,655
Silver (recoverable content of ores, etc.)—thousand troy ounces	54	49	44	40	60	54	65	58
Stone—thousand short tons	[7] 15,354	[7] 24,155	[7] 16,850	[7] 26,814	18,767	29,094	20,074	29,942
Zinc (recoverable content of ores, etc.)—short tons	58,063	13,470	59,130	12,062	89,932	20,684	91,394	23,579
Value of items that cannot be disclosed: Barite, fluorspar (1957), scrap mica, pyrites, stone (crushed sandstone 1957–58, crushed granite 1957, dimension limestone 1958) and values indicated by footnote 4		8,029		6,884		7,392		7,570
Total Tennessee [9]		128,739		124,934		[8] 140,738		143,439

TEXAS

Cement—thousand 376-pound barrels	22,144	$68,541	25,875	$79,756	27,991	$88,067	23,365	$76,577
Clays [3]—thousand short tons	2,992	4,934	3,720	5,424	3,870	5,703	3,302	5,058
Gem stones	[12]	100	[12]	100	[12]	100	[12]	100
Gypsum—thousand short tons	1,043	3,343	1,240	4,120	1,351	4,770	1,131	3,960
Helium—thousand cubic feet	204,286	3,353	294,452	4,807	238,113	3,918	120,921	2,044
Lime—thousand short tons	796	7,499	691	7,146	809	8,530	821	9,087
Natural gas—million cubic feet	5,156,215	500,153	5,178,073	517,807	5,718,993	617,651	5,892,704	665,876
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	2,944,381	201,423	2,871,589	204,501	2,790,155	209,238	2,880,906	207,583
LP gases—do	3,831,664	147,618	3,786,575	151,896	4,353,368	181,148	4,476,142	200,478
Petroleum (crude)—thousand 42-gallon barrels	1,073,867	3,338,119	940,166	2,872,389	971,978	2,893,146	[6] 933,632	[6] 2,766,972
Salt—thousand short tons	4,612	17,104	3,843	15,115	4,519	17,498	4,756	18,222
Sand and gravel—do	23,685	23,427	32,871	30,808	35,295	34,726	29,844	30,754
Stone—do	31,248	36,153	36,076	40,912	42,172	47,787	39,029	45,088

Sulfur (Frasch-process)—thousand long tons	2,879	70,226	2,616	61,621	2,970	68,998	2,747	62,855
Talc and soapstone—short tons	47,780	199	60,827	168	60,945	283	67,031	336
Value of items that cannot be disclosed: Abrasive stones (1957, 1959), native asphalt, bromine, clay (fuller's earth), coal (lignite), feldspar, graphite, iron ore, magnesium chloride (for metal), magnesium compounds (except for metal), mercury, pumice (1957–58), sodium sulfate, and uranium ore		71,510		46,891		48,544		49,666
Total Texas [9]		4,484,538		4,033,311		[8] 4,219,757		4,134,901
UTAH								
Asphalt and related bitumens, native: Gilsonite—short tons	207,704	$4,259	317,280	$4,864	379,362	$9,385	383,037	$10,020
Carbon dioxide, natural—thousand cubic feet	(4)	(4)	90,207	6	69,625	5	60,425	4
Clays [3]—thousand short tons	164	473	157	488	185	484	143	416
Coal—do	6,858	40,263	5,328	30,340	4,545	27,982	4,955	31,458
Copper (recoverable content of ores, etc.)—short tons	237,857	143,190	189,184	99,511	144,715	88,855	218,049	139,987
Fluorspar—do	11,087	387	16,109	564	(4)	(4)	1,912	51
Gem stones	(12)	12	(12)	40	(12)	134	(12)	72
Gold (recoverable content of ores, etc.)—troy ounces	378,438	13,245	307,824	10,774	239,517	8,383	368,255	12,889
Iron ore (usable)—thousand long tons, gross weight	4,156	30,383	3,514	25,202	2,842	19,979	3,334	23,862
Lead (recoverable content of ores, etc.)—short tons	44,471	12,719	40,355	9,443	36,630	8,425	39,398	9,219
Lime—thousand short tons	53	821	80	1,513	90	1,773	127	2,672
Manganese ore (35 percent or more Mn)—short tons, gross weight	142	12	1,043	84	1,511	124		
Mica (sheet)—pounds			12	(5)				
Natural gas—million cubic feet	16,824	2,473	19,247	2,829	38,921	5,527	51,040	9,187
Natural gasoline—thousand gallons	(4)	(4)	240	15	(4)	(4)	(4)	(4)
Petroleum (crude)—thousand 42-gallon barrels	4,367	9,913	24,811	74,185	39,959	114,283	[6] 37,599	[6] 103,021
Phosphate rock—thousand long tons	114	756	(4)	(4)	(4)	(4)	(4)	(4)
Pumice—thousand short tons	36	148	41	84	39	81	60	134
Salt—do	221	2,013	184	2,275	209	2,453	231	3,092
Sand and gravel—do	26,958	15,485	25,304	14,379	8,843	6,436	6,848	6,182
Silver (recoverable content of ores, etc.)—thousand troy ounces	6,199	5,610	5,278	4,777	3,734	3,380	4,783	4,329
Stone—thousand short tons	7,854	8,540	13,126	13,949	3,338	4,048	1,837	3,087
Uranium ore—short tons	1,075,759	32,501	1,239,767	38,583	1,210,654	37,310	1,089,757	27,843
Vanadium—do	509	(4)	376	(4)	536	(4)	462	(4)
Zinc (recoverable content of ores, etc.)—do	40,846	9,476	44,982	9,176	35,223	8,101	35,476	9,153
Value of items that cannot be disclosed: Barite (1959–60), cement, clay (kaolin), gypsum, molybdenum, LP-gases (1959–60), perlite, potassium salts, pyrites (1959–60), and values indicated by footnote 4		27,651		25,214		27,396		36,047
Total Utah [15]		359,335		367,232		[8] 373,515		431,396

See footnotes at end of table.

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

VERMONT

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Copper (recoverable content of ores, etc.)—short tons	3,405	$2,050	475	$250				
Gem stones			[12]	1	[12]	$1	[12]	$1
Gold (recoverable content of ores, etc.)—troy ounces	62	2						
Pyrites—thousand long tons	10	56						
Sand and gravel—thousand short tons	2,216	1,051	1,882	1,316	2,320	1,590	1,809	1,218
Silver (recoverable content of ores, etc.)—thousand troy ounces	37	33	5	5				
Slate—thousand short tons	[4]	3,269	[19]	[19]	[19]	[19]	[19]	[19]
Stone—do	557	11,404	808	15,789	944	17,372	2,114	17,444
Value of items that cannot be disclosed: Asbestos, clays, lime, talc, and values indicated by footnote 4		4,058		4,106		4,420		4,240
Total Vermont [18]		21,893		21,443		23,359		22,879

VIRGINIA

Clays—thousand short tons	803	$986	1,153	$1,143	1,346	$1,396	1,348	$1,395
Coal—do	29,506	153,959	26,826	130,319	29,769	139,224	27,838	122,723
Gem stones			[12]	3	[12]	4	[12]	5
Lead (recoverable content of ores, etc.)—short tons	3,143	899	2,934	687	2,770	637	2,152	504
Lime—thousand short tons	510	6,029	471	5,533	765	8,168	711	8,028
Manganese ore (35 percent or more Mn)—short tons, gross weight	12,655	1,058	8,128	647	6,232	499		
Manganiferous ore (5 to 35 percent Mn)—do			56	1	[4]	[4]		
Mica, sheet—pounds	529	6	147	2	108	1	103	1
Natural gas—million cubic feet	2,465	661	2,521	681	2,280	597	2,227	604
Petroleum (crude)—thousand 42-gallon barrels	5	[4]	4	[4]	6	[4]	[6] 6	[4]
Sand and gravel—thousand short tons	7,047	9,877	7,158	10,834	8,452	12,369	7,666	11,432
Silver (recoverable content of ores, etc.)—thousand troy ounces	[4]	[4]	2	2	1	1		
Slate—thousand short tons	[4]	1,003	[19]	[19]	[19]	[19]	[19]	[19]
Stone—do	[7] 14,244	[7] 21,158	15,413	27,504	17,787	31,447	[23] 19,358	[23] 33,019
Zinc (recoverable content of ores, etc.) [18]—short tons	23,080	5,277	18,472	3,808	20,334	4,662	19,885	5,142
Value of items that cannot be disclosed: Aplite, cement, feldspar, gypsum, iron oxide pigment materials (1957, 1960), kyanite, pyrites, salt, stone (dimension miscellaneous, dimension sandstone and calcareous marl 1957), talc and soapstone, titanium concentrate, and values indicated by footnote 4		29,746		25,471		28,848		25,958
Total Virginia [9]		227,108		203,277		[8] 222,501		203,819

WASHINGTON

Abrasive stone: Pebbles (grinding)	short tons	25	(5)	18	(5)	(4)	(5)	(4)	(5)
Chromite	short tons, gross weight			17	$2				
Clays	thousand short tons	298	$488	[3] 196	[3] 183	[3] 180	[3] $171	[3] 169	[3] $162
Coal	do	360	2,761	252	1,968	242	1,841	228	1,721
Copper (recoverable content of ores, etc.)	short tons	1,700	1,023	52	27	49	30	78	50
Gem stones		(12)	75	(12)	75	(12)	(4)	(12)	(4)
Gypsum	thousand short tons	6	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Iron ore (usable)	thousand long tons	4	(4)	4	(4)	4	5		
Lead (recoverable content of ores, etc.)	short tons	12,734	3,642	9,020	2,111	10,310	2,371	7,725	1,808
Manganese ore (35 percent or more Mn)	short tons, gross weight					83	(4)		
Peat	short tons	39,364	153	34,642	116	32,884	124	27,770	121
Petroleum (crude)	thousand 42-gallon barrels	5	(4)	4	(4)	1	(4)	[6] 1	(4)
Pumice	thousand short tons	(4)	(4)	(4)	(4)	9	112	(4)	(4)
Sand and gravel	do	20,415	17,510	24,389	20,086	21,360	18,576	25,297	18,979
Stone	do	8,897	11,645	7,837	9,991	12,278	13,587	13,897	15,796
Talc and soapstone	short tons	4,065	25	4,000	21	4,073	23	2,406	12
Uranium ore	do	(4)	(4)	(4)	(4)	152,336	(4)	171,255	3,223
Zinc (recoverable content of ores, etc.)	do	24,000	5,568	18,797	3,835	17,111	3,936	21,317	5,500
Value of items that cannot be disclosed: Barite, carbon dioxide, cement, fire clay (1958-60), diatomite, epsomite (1957), gold, lime (1957), magnesite, mercury (1957-58), olivine, silver, strontium minerals (1957-59), tungsten (1957), and values indicated by footnote 4			18,959		24,128		25,054		24,552
Total Washington [9]			60,471		60,896		63,894		70,005

WEST VIRGINIA

Clays	thousand short tons	708	$2,691	510	$1,960	596	$2,492	626	$2,639
Coal	do	156,842	875,587	119,468	635,201	119,692	621,003	118,944	597,222
Gem stones						(12)	1	(12)	1
Natural gas	million cubic feet	202,440	48,181	204,581	50,734	204,633	53,205	208,757	54,694
Natural gas liquids:									
Natural gasoline	thousand gallons	30,435	2,185	27,917	5,643	29,242	1,808	23,211	1,513
LP gases	do	235,881	6,543	235,524	12,806	308,316	15,534	329,874	16,527
Petroleum (crude)	thousand 42-gallon barrels	2,215	9,436	2,186	7,629	2,184	7,862	[6] 2,318	[6] 9,434
Salt	thousand short tons	648	2,642	627	2,784	811	3,305	920	3,673
Sand and gravel	do	5,354	9,893	5,253	11,729	4,854	10,513	4,506	9,802
Stone	do	6,989	11,934	[7] 5,599	[7] 9,990	[7] 5,923	[7] 10,482	[7] 8,001	[7] 14,001
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, cement, lime, manganese ore (1957), stone (crushed sandstone 1958, dimension sandstone 1959-60, calcareous marl 1959)			14,938		13,067		13,318		13,195
Total West Virginia [9]			981,654		749,747		[8] 737,616		720,674

See footnotes at end of table.

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

WISCONSIN

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones—short tons	1,790	$43	858	$26	770	$27	397	$12
Clays—thousand short tons	131	136	154	167	178	192	144	156
Iron ore (usable)—thousand long tons, gross weight	1,576	(4)	867	(4)	701	(4)	1,502	(4)
Lead (recoverable content of ores, etc.)—short tons	1,900	543	800	187	745	171	1,165	273
Lime—thousand short tons	(4)	(4)	141	2,193	(4)	(4)	(4)	(4)
Peat—short tons	400	(4)	(4)	(4)	7,500	(4)	8,500	(4)
Sand and gravel—thousand short tons	29,394	18,694	39,383	25,845	41,999	27,535	35,681	25,648
Stone—do	12,434	22,455	13,722	23,334	13,522	23,782	16,486	22,302
Zinc (recoverable content of ores, etc.)—short tons	21,575	5,006	12,140	2,477	11,635	2,676	18,410	4,750
Value of items that cannot be disclosed: Cement, gem stones, and values indicated by footnote 4		22,590		18,083		18,541		25,619
Total Wisconsin [9]		68,644		71,334		71,959		77,171

WYOMING

Beryllium concentrate—short tons, gross weight	5	$3	17	$9	1	(5)	5	$2
Clays [3]—thousand short tons	1,069	11,973	1,075	9,968	764	$9,449	788	9,571
Coal—do	2,117	7,777	1,629	5,820	1,977	6,669	2,024	6,992
Copper (recoverable content of ores, etc.)—short tons	4	2	(11)	(5)				
Gem stones	(12)	55	(12)	52	(12)	76	(12)	68
Gold (recoverable content of ores, etc.)—troy ounces	573	20	117	4			40	1
Gypsum—thousand short tons	(4)	(4)	6	19	9	31	13	46
Iron ore (usable)—thousand long tons, gross weight	736	(4)	557	(4)	503	2,923	(4)	(4)
Natural gas—million cubic feet	117,256	10,201	121,682	10,221	156,978	12,715	181,610	21,793
Natural gas liquids:								
Natural gasoline—thousand gallons	47,709	2,866	49,451	3,052	64,586	4,003	72,195	4,535
LP gases—do	57,805	2,566	54,496	2,614	90,314	3,951	120,693	5,279
Petroleum (crude)—thousand 42-gallon barrels	109,584	291,493	115,572	301,643	126,050	315,125	[6] 135,521	[6] 340,158
Phosphate rock—thousand long tons	18	121	124	937	(4)	(4)	(4)	(4)
Pumice—thousand short tons	49	41	45	40	94	77	33	30
Rare-earth metals concentrates—short tons	2	5						
Sand and gravel—thousand short tons	2,425	1,905	5,333	4,760	4,692	3,982	5,928	5,356
Stone—do	1,291	2,266	1,099	1,472	1,317	1,791	1,401	2,302

Uranium ore----------short tons--	274,699	4,669	651,790	13,286	864,582	17,610	1,357,225	27,387
Value of items that cannot be disclosed: Cement, clays (fire clay 1957–59, miscellaneous clay 1959–60), feldspar (1957–58), sheet mica (1959–60), silver (1957–58, 1960), sodium carbonates and sulfates, vanadium (1957–58), and values indicated by footnote 4----------	----------	17,527	----------	16,760	----------	15,970	----------	19,741
Total Wyoming [9]----------	----------	352,532	----------	369,938	----------	[8]393,841	----------	442,738

[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] Figure withheld to avoid disclosing individual company confidential data.
[5] Less than $1,000.
[6] Preliminary figure.
[7] Excludes certain stone, included with "Value of items that cannot be disclosed."
[8] Revised figure.
[9] Total adjusted to eliminate duplicating value of clays and stone.
[10] Less than 1,000 short tons.
[11] Less than 1 ton.
[12] Weight not recorded.
[13] Total weight of columbite-tantalite plus $(Cb\text{-}Ta)_2O_5$ content of euxenite
[14] Total value adjusted to eliminate duplicating value of stone.
[15] Total has been adjusted to eliminate duplicating value of raw materials used in manufacturing cement and/or lime.
[16] Less than 1,000 long tons.
[17] Excludes quantity consumed by American Chrome Co.
[18] 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.
[19] Beginning with 1958 slate included with stone.
[20] Millstones only.
[21] Grinding pebbles and tube-mill liners.
[22] Less than 1,000 troy ounces.
[23] Final figure; supersedes figure given in commodity chapter.

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

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
American Samoa:								
Stone—thousand short tons	34	$37	30	$59	178	$219	523	$261
Canal Zone:								
Sand and gravel—do			41	34	14	21	65	68
Stone (crushed)—do	59	99	140	237	223	270	203	306
Total Canal Zone		99		271		291		374
Canton:								
Sand and gravel—thousand short tons					[3]	[4]		
Stone (crushed)—do					[3]	1		
Guam:								
Sand and gravel—do	1	1	9	23	28	20	1	1
Stone—do	1,034	1,132	684	751	568	1,109	962	2,194
Total Guam		1,133		774		1,129		2,195
Johnston:								
Sand and gravel—thousand short tons							1	4
Stone—do							2	5
Total Johnston								9
Midway: Stone (crushed)—thousand short tons	3,875	6,700	175	476				
Virgin Islands: Stone (crushed)—do	11	31	25	81	14	51	15	51
Wake: Stone (crushed)—do	5	6	10	37	32	34	36	49

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

[2] Production data for Canton and Wake furnished by the U.S. Department of Commerce, Civil Aeronautics Administration; Midway and Johnston, by the U.S. Department of the Navy; Guam by the Government of Guam; American Samoa, by the Government of American Samoa.

[3] Less than 1,000 short tons.

[4] Less than $1,000.

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

Mineral	1957		1958		1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement.....thousand 376-pound barrels	5,552	$17,232	4,748	$15,175	5,392	$16,982	5,441	$14,546
Clays.....thousand short tons	159	140	165	83	167	83	160	102
Lime.....do	(2)	(2)	(2)	(2)	10	321	1	15
Salt.....do	10	104	1	14	3	38		
Sand and gravel.....do	497	754	476	763	530	888	8,996	8,669
Stone.....do	2,452	3,505	1,986	2,768	2,063	2,878	4,219	7,661
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 2		180		272				
Total Puerto Rico [3]		20,265		17,689		19,700		29,530

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

[2] Figure withheld to avoid disclosing individual company confidential data.

[3] Total adjusted to eliminate duplicating value of stone.

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Metal—short tons	[1] 239,976	$111,259	154,706	$75,808
Scrap—do	10,919	3,299	5,042	1,598
Plates, sheets, bars, etc—do	[1] 50,628	[1] 34,869	36,677	25,872
Antimony:				
Ore (antimony content)—do	6,466	1,236	6,455	1,214
Needle or liquated—do	177	79	24	11
Metal—do	4,422	2,039	5,437	2,495
Oxide—do	2,056	825	2,368	972
Arsenic: White—do	19,386	1,342	12,825	1,046
Bauxite: Crude—thousand long tons	[1] [2] 8,149	[1] 73,549	8,744	78,065
Beryllium ore—short tons	8,038	2,345	[2] 8,943	2,864
Bismuth (general imports)—pounds	457,163	825	1,167,019	2,131
Boron carbide—do	81,459	144	85,965	172
Cadmium:				
Metal—thousand pounds	1,638	1,744	942	1,157
Flue dust (cadmium content)—do	1,544	584	1,861	778
Calcium:				
Metal—pounds	7,425	8	12,618	15
Chloride—short tons	1,756	66	1,570	62
Chromate:				
Ore and concentrates (Cr_2O_3 content)—do	665,463	[1] 31,926	570,639	24,239
Ferrochrome (chromium content)—do	64,066	29,750	34,186	14,313
Metal—do	2,865	5,179	908	1,645
Cobalt:				
Metal—thousand pounds	20,087	35,926	10,801	17,093
Oxide (gross weight)—do	[1] 1,557	[1] 1,851	1,459	1,520
Salts and compounds (gross weight)—do	278	134	230	104
Columbium ore—pounds	3,395,816	2,652	5,051,800	3,687
Copper: (copper content)				
Ore—short tons	[1] 60	[1] 20	3,503	2,016
Concentrates—do	9,299	5,505	20,935	12,391
Regulus, black, coarse—do	7,113	4,260	185	80
Unrefined, black, blister—do	203	126	486	311
Refined in ingots, etc—do	237,304	146,478	171,021	109,760
Old and scrap—do	2,984	1,635	1,836	1,106
Old brass and clippings—do	1,257	698	309	184
Ferroalloys: Ferrosilicon (silicon content)—do	5,584	[1] 1,735	4,972	1,533
Gold:				
Ore and base bullion—troy ounces	444,416	15,522	460,579	16,080
Bullion—do	8,040,528	288,855	8,861,716	318,952
Iron ore:				
Ore—thousand long tons	[1] 35,617	[1] 312,447	34,585	321,693
Pyrites cinder—long tons	10,157	48	5,884	20
Iron and steel:				
Pig iron—short tons	[1] 699,593	[1] 35,493	330,847	18,351
Iron and steel products (major):				
Iron products—do	40,206	7,963	41,183	8,670
Steel products—do	4,574,745	556,253	3,528,826	485,901
Scrap—do	267,839	10,493	138,687	5,281
Tin-plate scrap—do	41,609	1,098	40,770	1,105
Lead:				
Ore, flue dust, matte (lead content)—do	[1] 136,526	[1] 27,035	137,574	27,816
Base bullion (lead content)—do	34	19	293	62
Pigs and bars (lead content)—do	262,632	54,667	213,147	45,017
Reclaimed, scrap, etc. (lead content)—do	7,897	1,304	5,598	1,034
Sheets, pipe, and shot—do	3,608	850	2,855	696
Babbitt metal and solder (lead content)—do	3,751	16,820	[3] 1,512	[3] 16,024
Type metal and antimonial lead (lead content)—short tons	5,020	1,204	3,819	956
Manufactures—do	1,398	586	2,097	710
Magnesium:				
Metallic and scrap—do	593	303	401	202
Alloys (magnesium content)—do	26	155	28	288
Sheets, tubing, ribbons, wire, and other forms (magnesium content)—do	26	121	4	61
Manganese:				
Ore (35 percent or more manganese) (manganese content)—short tons	887,681	74,648	1,082,218	82,289
Ferromanganese (manganese content)—do	70,232	14,067	92,594	19,008

See footnotes at end of table.

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Mercury:				
Compounds—pounds	40,622	$118	114,305	$302
Metal—76-pound flasks	30,141	5,992	19,488	3,510
Minor metals: Selenium and salts—pounds	273,929	1,761	[9] 175,761	[9] 972
Nickel:				
Ore and matte—short tons	4,071	1,612	184	73
Pigs, ingots, shot, cathodes—do	[1] 82,888	[1] 110,541	79,662	116,567
Scrap—do	619	731	135	113
Oxide—do	[2] 30,062	[2] 33,816	24,584	27,650
Platinum group:				
Unrefined materials:				
Ore and concentrates—troy ounces	503	27	401	30
Grains and nuggets, including crude, dust, and residues—troy ounces	77,763	5,447	30,338	2,201
Sponge and scrap—do	[2] 5,666	[2] 420	3,095	212
Osmiridium—do	2,121	76		
Refined metal:				
Platinum—do	[2] 260,524	[2] 17,241	238,307	18,917
Palladium—do	610,740	9,374	368,256	8,189
Iridium—do	7,772	402	4,253	283
Osmium—do	1,223	65	277	17
Rhodium—do	29,342	3,369	31,722	4,126
Ruthenium—do	14,679	492	3,997	156
Radium:				
Radium salts—milligrams	32,967	518	23,333	364
Radioactive substitutes	(4)	1,145	(4)	1,394
Rare earths: Ferrocerium and other cerium alloy—pounds	16,070	59	21,391	78
Silver:				
Ore and base bullion—thousand troy ounces	39,759	34,522	43,404	38,164
Bullion—do	29,329	26,558	17,253	15,797
Tantalum: Ore—pounds	652,839	1,166	709,936	1,137
Tin:				
Ore (tin content)—long tons	10,773	23,282	14,026	31,104
Blocks, pigs, grains, etc—do	[1] 43,578	[1] 96,855	39,488	86,221
Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f.—long tons	[1] 3,350	[1] 6,469	809	1,642
Tinfoil, powder, flitters, etc	(4)	1,008	(4)	839
Titanium:				
Ilmenite—short tons	371,687	7,991	265,645	5,067
Rutile—do	23,228	2,943	29,235	3,611
Metal—pounds	3,126,293	3,564	4,461,737	4,866
Ferrotitanium—do	252,436	70	166,053	41
Compounds and mixtures—do	5,722,512	1,088	12,258,035	2,413
Tungsten: (tungsten content)				
Ore and concentrates—thousand pounds	5,435	4,235	3,525	3,478
Metal—pounds	196,053	425	159,759	370
Ferrotungsten—thousand pounds	533	526	167	207
Other—pounds	93,963	105	36,666	62
Zinc:				
Ores (zinc content)—short tons	[1]424,134	[1] 37,475	382,707	38,696
Blocks, pigs, and slabs—do	164,462	33,996	120,925	29,639
Sheets—do	951	311	904	302
Old, dross, and skimmings—do	1,138	142	1,205	189
Dust—do	44	6	19	7
Manufactures	(4)	812	(4)	837
Zirconium: Ore, including zirconium sand—short tons	54,878	1,517	34,280	1,234
Nonmetals:				
Abrasives: Diamonds (industrial)—carats	[1] [3] 13,095,218	[1] [3] 62,626	[3] 13,101,110	[3] 51,727
Asbestos—short tons	713,047	65,006	669,495	63,345
Barite:				
Crude and ground—do	641,241	4,881	640,559	5,002
Witherite—do	2,552	113	7,344	59
Chemicals—do	6,045	551	4,986	576
Bromine—pounds	[1] 237,473	[1] 118	145,943	111
Cement—376-pound barrels	5,264,996	13,773	4,098,236	10,306
Clays:				
Raw—short tons	172,986	3,193	[2] 153,349	[2] 2,985
Manufactured—do	3,494	95	6,666	118
Cryolite—do	22,102	1,994	17,246	1,670
Feldspar: Crude—long tons	45	5	44	5

See footnotes at end of table.

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

Mineral		1959		1960	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued					
Fluorspar	short tons	555,750	$13,368	534,020	$14,393
Gem stones:					
Diamonds	carats	[1] 2,494,994	[1] 180,649	2,167,474	165,547
Emeralds	do	88,875	2,450	81,207	1,463
Other	do	[4]	29,421	[4]	25,470
Graphite	short tons	37,048	1,527	[2] 48,324	[2] 1,755
Gypsum:					
Crude, ground, calcined	do	[1] 6,132,650	[1] 11,908	5,306,975	9,045
Manufactures	do	[4]	1,288	[4]	1,388
Iodine, crude	thousand pounds	1,466	1,083	1,894	1,425
Kyanite	short tons	5,633	252	6,052	265
Lime:					
Hydrated	do	530	9	672	15
Other	do	26,374	442	18,445	369
Dead-burned dolomite	do	[1] 8,468	[1]496	[2] 12,932	[2] 550
Magnesium:					
Magnesite	do	155,634	9,871	118,779	7,789
Compounds	do	15,849	562	14,971	546
Mica:					
Uncut sheet and punch	pounds	[1] 3,220,412	[1] 7,305	1,088,021	2,081
Scrap	short tons	4,644	57	6,240	86
Manufactures	do	5,042	7,443	4,266	6,139
Mineral-earth pigments: Iron oxide pigments:					
Natural	do	3,161	160	2,976	132
Synthetic	do	7,776	1,144	7,516	1,100
Ocher, crude and refined	do	213	13	230	14
Siennas, crude and refined	do	1,399	95	649	64
Umber, crude and refined	do	2,078	68	2,894	98
Vandyke brown	do	202	14	195	14
Nitrogen compounds (major), including urea	do	[1 2] 1,472,507	65.265	[3] 1,214,198	[3] 55,638
Phosphate, crude	long tons	139,891	3,421	129,290	3,754
Phosphatic fertilizers	do	[1] 34,692	2,543	17.447	1,078
Pigments and salts:					
Lead pigments and salts	short tons	13,233	2.695	15,729	3,224
Zinc pigments and salts	do	19,147	3,678	15,582	3,052
Potash	do	[1 5] 432,232	[1 5] 15,737	[5] 417,521	[5] 15,461
Pumice:					
Crude or unmanufactured	do	21,721	152	6,556	58
Wholly or partly manufactured	do	3,988	92	3,916	103
Manufactures, n.s.p.f.		[4]	20	[4]	36
Quartz crystal (Brazilian pebble)	pounds	679,836	784	1,193,257	615
Salt	short tons	1,024,629	5,438	1,057,028	4,484
Sand and gravel:					
Glass sand	do	101	91	10,765	37
Other sand	do	348,331	464	379,673	516
Gravel	do	102,878	93	3,752	5
Sodium sulfate	thousand short tons	122	2,580	167	3,473
Stone, including slate		[4]	11,064	[4]	11,344
Strontium: Mineral	short tons	8,139	225	6,185	160
Sulfur and pyrites:					
Sulfur:					
Ore	long tons	11.593	255	104,708	2,272
Other forms, n.e.s.	do	630,895	13,646	634,130	13,185
Pyrites	do	280,638	868	304,789	1,071
Talc: Unmanufactured	short tons	25,351	861	23,975	849
Coal, petroleum, and related products:					
Carbon black:					
Acetylene black	pounds	7,246,932	1,335	6,785,095	1,303
Gas black and carbon black	do	346,771	69	719,164	134
Coal:					
Anthracite	short tons	2,633	22	1,476	16
Bituminous, slack, culm, and lignite	do	374,713	2,433	260.495	1,844
Briquets	do	185	3	6,676	389
Coke	do	123,265	1,441	125,160	1,483
Peat:					
Fertilizer grade	do	277,006	13,003	254,794	13,011
Poultry and stable grade	do	9,713	577	9,083	498

See footnotes at end of table.

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Coal, petroleum, and related products—Continued				
Petroleum:				
Crude—thousand barrels	[1] 384,597	[1] $872,606	400,846	$895,036
Gasoline [6]—do	[1] 21,176	[1] 73,310	18,870	62,653
Kerosine [7]—do	125	536	70	224
Distillate oil [8]—do	[1] 14,756	[1] 51,418	9,792	30,958
Residual oil [8]—do	[1] 223,414	[1] 454,476	230,396	482,112
Unfinished oils—do	[1] 23,127	[1] 65,801	20,430	55,847
Asphalt—do	6,982	17,043	6,257	14,379
Miscellaneous [7]—do	25	333	76	631

[1] Revised figure.
[2] Adjusted by Bureau of Mines.
[3] Data known to be not comparable with prior years.
[4] Weight not recorded.
[5] Data covers some quantities furnished by Potash Institute; values adjusted by Bureau of Mines.
[6] Includes naphtha but excludes benzol, 1959—1,365,152 barrels ($13,782,172); 1960—907,791 barrels ($9,182,726).
[7] Includes quantities imported free of duty for supplies of vessels and aircraft.
[8] Includes quantities imported free for manufacture in bond and export and for supplies of vessels and aircraft.
[9] Final figure; supersedes figure given in commodity chapter.

Compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Ingots, slabs, crude—short tons	[1] 121,305	[1] $53,619	284,979	$128,199
Scrap—do	[1] 32,164	[1] 10,384	79,513	26,905
Plates, sheets, bars, etc—do	9,015	9,977	18,098	16,266
Castings and forgings—do	1,216	2,842	1,190	2,849
Antimony: Metals and alloys, crude—do	9	4	59	47
Arsenic: Calcium arsenate—pounds	122,920	12	289,700	21
Bauxite, including bauxite concentrates—long tons	17,403	1,825	29,317	2,588
Aluminum sulfate—short tons	14,487	573	12,286	451
Other aluminum compounds—do	32,049	4,286	35,144	5,503
Beryllium—pounds	164,460	1,530	131,648	1,344
Bismuth: Metals and alloys—do	179,744	261	156,636	276
Cadmium—thousand pounds	900	1,024	2,448	3,014
Calcium chloride—short tons	39,929	1,377	26,792	1,068
Chrome:				
Ore and concentrates:				
Exports—do	[1] 11,080	[1] 531	5,184	320
Reexports—do	[1] 26,591	[1] 1,065	19,927	721
Chromic acid—do	596	349	982	546
Ferrochrome—do	6,127	2,096	15,588	5,249
Cobalt—pounds	694,641	543	1,798,218	1,313
Columbium metals, alloys, and other forms—short tons	15,414	21	159,309	157
Copper:				
Ores, concentrates, composition metal, and unrefined copper (copper content)—short tons	2,982	1,808	11,111	6,832
Refined copper and semimanufactures—do	196,012	128,577	512,332	327,940
Other copper manufactures—do	4,352	3,280	5,181	4,006
Copper sulfate or blue vitriol—do	2,672	675	14,841	3,377
Copper base alloys—do	37,607	30,002	130,922	69,908
Ferroalloys:				
Ferrosilicon—pounds	21,115,496	981	11,002,848	867
Ferrophosphorus—do	99,806,945	1,799	95,794,790	2,095

See footnotes at end of table.

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Gold:				
Ore and base bullion—troy ounces	20,498	$715	9,196	$322
Bullion, refined—do	29,104	1,218	37,676	1,326
Iron ore—thousand long tons	2,967	33,831	5,236	57,575
Iron and steel:				
Pig iron—short tons	[1] 10,438	[1] 547	111,773	5,174
Iron and steel products (major):				
Semimanufactures—do	[1] 1,069,886	[1] 213,318	2,332,753	444,895
Manufactured steel mill products—short tons	[1] 903,248	[1] 259,311	964,889	258,903
Advanced products	(2)	[1] 165,756	(2)	157,686
Iron and steel scrap: Ferrous scrap, including rerolling materials—short tons	[1] 4,939,043	[1] 167,716	7,189,614	241,900
Lead:				
Ore, matte, base bullion (lead content)—short tons	224	54	1,297	168
Pigs, bars, anodes—do	2,756	751	1,967	748
Scrap—do	1,141	291	2,579	361
Magnesium:				
Metal and alloys and semifabricated forms, n.e.c—short tons	2,377	2,028	5,125	3,695
Powder—do	12	32	7	23
Manganese.				
Ore and concentrates—do	5,702	819	5,139	719
Ferromanganese—do	947	388	751	202
Mercury:				
Exports—76-pound flasks	640	92	357	83
Reexports—do	553	119	317	62
Molybdenum:				
Ore and concentrates (molybdenum content)—pounds	18,852,279	24,778	30,244,496	39,847
Metals and alloys, crude and scrap—do	15,172	22	295,004	368
Wire—do	12,395	250	9,639	278
Semifabricated forms, n.e.c—do	8,921	91	4,940	74
Powder—do	11,314	36	9,620	32
Ferromolybdenum—do	248,012	280	424,819	489
Nickel:				
Ore—short tons			1	4
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc—short tons	11,818	11,967	52,468	27,128
Catalysts—do	597	1,162	761	1,240
Nickel-chrome electric resistance wire—short tons	139	598	235	969
Semifabricated forms, n.e.c—do	519	2,314	644	2,322
Platinum:				
Ore, concentrates, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap—troy ounces	18,560	1,147	49,497	3,212
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap)—troy ounces	12,845	390	15,652	504
Platinum group manufactures, except jewelry	(3)	2,306	(3)	2,978
Radium metal (radium content)—milligrams	2,207	40	712	17
Rare earths:				
Cerium ores, metals, and alloys—pounds	27,500	17	15,410	15
Lighter flints—do	13,343	50	27,517	118
Silver:				
Ore and base bullion—thousand troy ounces	103	93	291	266
Bullion, refined—do	9,077	8,381	26,302	24,236
Tantalum:				
Ore, metal, and other forms—pounds	16,478	242	49,965	555
Powder—do	1,988	76	[3] 1,174	[3] 49
Tin:				
Ingots, pigs, bars, etc.:				
Exports—long tons	943	1,890	608	1,294
Reexports—do	428	970	249	549
Tin scrap and other tin bearing material except tinplate scrap—long tons	7,713	1,231	4,397	1,355
Tin cans finished or unfinished—do	36,320	19,027	32,875	17,362

See footnotes at end of table.

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Titanium:				
Ores and concentrates—short tons	4,656	$290	1,260	$167
Sponge (including iodide titanium) and scrap—short tons	496	543	879	869
Intermediate mill shapes—do	380	2,770	359	2,038
Mill products, n.e.c—do	119	2,391	67	1,200
Ferrotitanium—do	321	146	245	157
Dioxide and pigments—do	36,282	10,558	33,655	10,001
Tungsten: Ore and concentrates:				
Exports—do	1	5	633	1,251
Reexports—do	98	119	234	357
Vanadium ore and concentrates, pentoxide, etc. (vanadium content)—pounds	2,480,343	4,668	7,379,432	14,124
Zinc:				
Ores and concentrates (zinc content)—short tons	1	(4)	13	3
Slabs, pigs, or blocks—do	11,629	2,673	75,145	18,122
Sheets, plates, strips, or other forms, n.e.c—short tons	3,529	2,708	3,324	2,443
Scrap (zinc content)—do	11,332	1,053	12,169	1,499
Dust—do	521	182	777	267
Semifabricated forms, n.e.c—do	1,071	612	2,569	1,195
Zirconium:				
Ores and concentrates—do	1,511	263	1,382	317
Metals and alloys and other forms—pounds	89,819	661	1,063,802	2,607
Nonmetals:				
Abrasives:				
Grindstones—short tons	401	52	319	56
Diamond dust and powder—carats	172,787	440	321,373	845
Diamond grinding wheels—do	249,950	1,518	264,942	1,567
Other natural and artificial metallic abrasives and products	(3)	1 21,090	(3)	24,082
Asbestos: Unmanufactured:				
Exports—short tons	4,317	763	5,461	845
Reexports—do	144	30	64	12
Boron: Boric acid, borates, crude and refined—pounds	507,347,292	21,047	601,211,757	25,576
Bromine, bromides, and bromates—do	9,171,539	2,594	10,241,178	2,898
Cement—376-pound barrels	277,267	1,595	187,304	1,135
Clay:				
Kaolin or china clay—short tons	74,734	2,206	79,965	2,044
Fire clay—do	1 137,490	1 2,484	177,578	3,305
Other clays—do	276,715	8,800	271,956	8,360
Cryolite—do	176	53	226	66
Fluorspar—do	1,144	69	458	38
Graphite:				
Amorphous—do	1,003	126	1,377	181
Crystalline flake, lump or chip—do	169	61	164	51
Natural, n.e.c—do	196	36	314	57
Gypsum:				
Crude, crushed or calcined—thousand short tons	14	641	17	687
Manufactures, n.e.c	(3)	655	(3)	606
Iodine, iodide, iodates—thousand pounds	175	249	251	353
Kyanite and allied minerals—short tons	2,734	167	3,255	210
Lime—do	52,780	1,000	61,056	992
Mica:				
Unmanufactured—pounds	1,072,894	126	701,926	113
Manufactured:				
Ground or pulverized—do	8,915,109	459	7,077,245	370
Other—do	216,040	653	243,354	828
Mineral-earth pigments: Iron oxide, natural and manufactured	4,337	1,040	3,862	1,113
Nitrogen compounds (major)—short tons	747,024	37,415	623,370	33,063
Phosphate rock—long tons	3,139,722	28,602	4,246,291	37,543
Phosphatic fertilizers—do	413,867	19,539	416,931	19,882
Pigments and salts (lead and zinc):				
Lead pigments—short tons	3,178	1,054	2,118	705
Zinc pigments—do	3,054	864	2,327	694
Lead salts—do	699	276	944	355
Potash:				
Fertilizer—do	560,001	16,502	815,521	23,508
Chemical—do	11,658	1,994	17,372	2,418
Quartz crystal (raw)	(3)	166	(3)	354
Radioactive isotopes, etc.—curie	112,204	1,283	146,983	1,286

See footnotes at end of table

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

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued				
Salt:				
Crude and refined—short tons	424,348	$2,660	421,764	$2,548
Shipments to noncontiguous Territories—short tons	13,652	1,031	14,311	1,042
Sodium and sodium compounds:				
Sodium sulfate—do	21,527	805	30,724	940
Sodium carbonate—thousand short tons	153	5,644	155	5,143
Stone:				
Limestone, crushed, ground, broken—short tons	1,085,553	1,999	920,791	1,775
Marble and other building and monumental—cubic feet	425,194	1,262	431,262	1,250
Stone, crushed, ground, broken—short tons	157,911	3,388	153,106	2,659
Manufactures of stone—do	(2)	643	(2)	477
Sulfur:				
Crude—long tons	[1] 1,612,158	[1] 39,975	1,775,526	40,880
Crushed, ground, flowers of—do	[1] 23,449	[1] 2,025	11,017	1,413
Talc:				
Crude and ground—short tons	58,751	1,532	59,457	1,801
Manufactures, n.e.c—do	197	175	158	92
Powders-talcum (face and compact)	(2)	1,276	(2)	1,378
Coal, petroleum and related products:				
Carbon black—thousand pounds	513,143	45,798	543,032	49,600
Coal:				
Anthracite—short tons	1,787,558	28,931	1,430,156	22,717
Bituminous—do	[1] 37,253,431	[1] 349,521	36,491,424	331,212
Briquets—do	33,458	495	21,126	305
Coke—do	460,222	8,674	353,016	6,885
Petroleum:				
Crude—thousand barrels	2,524	6,990	3,087	8,032
Gasoline [5]—do	15,518	108,766	12,380	82,615
Kerosine—do	934	4,926	590	3,148
Distillate oil—do	[1] 12,698	[1] 46,213	9,760	35,088
Residual oil—do	21,319	45,685	18,695	43,412
Lubricating oil—do	[1] 13,484	181,931	15,320	207,200
Asphalt—do	813	4,623	787	4,501
Liquefied petroleum gases—do	2,251	6,791	2,989	9,646
Wax—do	1,031	22,202	1,334	26,445
Coke—do	4,680	19,608	6,858	27,009
Petrolatum—do	260	6,361	258	6,182
Miscellaneous—do	563	14,656	500	14,719

[1] Revised figure.
[2] Weight not recorded.
[3] Adjusted by Bureau of Mines.
[4] Less than $1,000.
[5] Includes naphtha, but excludes benzol: 1959—173,935 barrels ($2,340,389), 1960—561,193 barrels ($8,951,625).

Compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

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

Mineral	1959			1960		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Fuels:						
Coal:						
Bituminous	1,906,658	409,248	21	2,003,135	412,766	21
Lignite	682,946	2,780	(1)	708,330	2,746	(1)
Pennsylvania anthracite	187,100	20,649	11	189,500	18,817	10
Coke (excluding breeze):						
Gashouse [2]	50,670	(3)	(3)	51,300	(3)	(3)
Oven and beehive	289,689	55,864	19	306,720	57,229	19
Fuel briquets and packaged fuel	114,600	900	(1)	118,300	769	(1)
Natural gas (marketable) million cubic feet	(4)	12,046,115	(4)	(4)	(4)	(4)
Peat	76,700	419	(1)	75,700	471	(1)
Petroleum (crude)—thousand barrels	7,133,663	2,574,590	36	7,683,752	2,574,933	34
Nonmetals:						
Asbestos	2,260	45	2	2,420	45	2
Barite	3,000	867	29	3,100	771	25
Cement [5]—thousand barrels	1,724,403	355,734	21	1,859,415	334,130	18
Corundum	8			9		
Diamonds—thousand carats	26,800			27,300		
Diatomite	960	450	47	960	450	47
Feldspar [6]—thousand long tons	1,180	548	46	1,240	502	41
Fluorspar	1,855	185	10	2,160	230	11
Graphite	410	(3)	(3)	465	(3)	(3)
Gypsum	42,790	10,900	25	41,930	9,825	23
Magnesite	6,600	593	8	7,100	499	7
Mica (including scrap) thousand pounds	345,000	203,788	59	410,000	240,437	59
Nitrogen, agricultural [5 6 7]	9,700	2,698	28	10,031	2,872	29
Phosphate rock—thousand long tons	36,960	15,869	43	40,100	17,506	44
Potash (K_2O equivalent)	9,400	2,383	25	10,000	2,639	26
Pumice	10,500	2,276	22	11,000	2,210	20
Pyrites—thousand long tons	18,300	1,057	6	18,700	1,016	5
Salt [5]	88,200	25,163	29	94,200	25,479	27
Strontium [6]	11	(3)	(3)	11		
Sulfur, elemental—thousand long tons	8,985	5,326	59	10,095	5,804	57
Talc, pyrophyllite, and soapstone	2,260	792	35	2,450	734	30
Vermiculite [6]	260	207	80	269	199	74
Metals, mine basis:						
Antimony, (content of ore and concentrate)—short tons	59,000	678	1	61,000	637	1
Arsenic [6]	47	5	11	62	(3)	(3)
Bauxite—thousand long tons	22,600	1,700	8	27,060	1,998	7
Beryllium concentrate—short tons	8,100	425	5	11,100	509	5
Bismuth—thousand pounds	5,100	(3)	(3)	5,200	(3)	(3)
Cadmium—do	19,800	8,602	43	21,700	10,180	47
Chromite	4,350	[8] 105	2	4,920	[8] 107	2
Cobalt (contained) [6]—short tons	17,300	1,165	7	16,700	(3)	(3)
Columbium-tantalum concentrate [6] thousand pounds	6,050	189	3	6,350		
Copper (content of ore and concentrate)	4,040	825	20	4,590	1,080	24
Gold—thousand troy ounces	42,700	1,635	4	45,000	1,680	4
Iron ore—thousand long tons	431,709	60,276	14	507,089	88,777	18
Lead (content of ore and concentrate)	2,530	256	10	2,560	247	10
Manganese ore (35 percent or more Mn)	14,226	229	2	14,832	80	(1)
Mercury—thousand 76-pound flasks	233	31	13	254	33	13
Molybdenum (content of ore and concentrate)—thousand pounds	70,200	50,956	73	89,400	68,237	76
Nickel (content of ore and concentrate)	314	12	4	358	13	4
Platinum groups (Pt, Pd, etc.) thousand troy ounces	1,010	15	1	1,190	24	2
Silver—do	221,200	23,000	10	239,500	36,800	15
Tin (content of ore and concentrate) long tons	161,600	50	(1)	179,700	10	(1)
Titanium concentrates:						
Ilmenite [6]	1,937	635	33	2,226	786	35
Rutile [6]	106	9	8	115	9	8
Tungsten concentrate (60 percent WO_3) short tons	58,800	3,649	6	69,600	7,325	11
Vanadium (content of ore and concentrate) [6]—short tons	5,324	3,719	70	6,980	4,971	71
Zinc (content of ore and concentrate)	3,360	425	13	3,510	435	12

See footnotes at end of table.

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

Mineral	1959			1960		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Metals, smelter basis:						
Aluminum	4,500	1,954	43	5,010	2,014	40
Copper	4,190	842	20	4,950	1,234	25
Iron, pig (incl. ferroalloys)	247,000	62,135	25	285,000	68,620	24
Lead	2,410	341	14	2,530	382	15
Magnesium	83	31	37	104	40	38
Selenium [6] thousand pounds	1,719	799	46	1,777	620	35
Steel ingots and castings	336,400	93,446	28	381,200	99,282	26
Tellurium [6] thousand pounds	357	196	55	390	260	67
Tin thousand long tons	156	[8] 11	7	194	[9] 14	7
Uranium oxide (U_3O_8) [6] short tons	43,440	16,420	38	41,140	17,760	43
Zinc	3,090	799	26	3,220	804	25

[1] Less than 1 percent.
[2] Includes low- and medium-temperature and gashouse coke.
[3] Bureau of Mines not at liberty to publish U.S. figure separately.
[4] Data not available.
[5] Including Puerto Rico.
[6] World total exclusive of U.S.S.R.
[7] Year ended June 30 of year stated (United Nations)
[8] Produced for Federal Government only; excludes quantity consumed by American Chrome Company.
[9] U.S. imports of tin concentrates (tin content).

Compiled by Augusta E. Jann, Division of Foreign Activities.

Employment and Injuries in the Mineral Industries

By John C. Machisak[1]

THIS CHAPTER of the Minerals Yearbook (Volume III) contains overall injury experience and accompanying employment data for coal mines (both bituminous and anthracite), coke plants, petroleum and natural gas, and peat; metal mines, their ore-dressing plants, and the primary nonferrous reduction plants and refineries, which, when combined, make the metallurgical plants; nonmetal mines; sand and gravel operations; nonmetal mills; stone quarries and related plants; and iron blast-furnace slag plants. Volume I of the yearbook contains a chapter showing injury experience and employment data treated separately by metal mines, nonmetal mines, and quarries, together with their milling operations and related plants. Volume II contains injury experience and employment data in the fuel industries (coal, coke, petroleum and natural gas, and peat). The canvass of mineral operations for their injury and employment experience conducted by the Bureau of Mines is on a voluntary basis for all industries except coal. The law requires coal to be reported. The text and tables in this chapter are a result of the replies to this canvass.

Preliminary figures for all mineral industries included in this chapter indicate improvement in the safety record. A decline of 14 percent in man-hours worked did not materially affect the overall combined (fatal and nonfatal) injury-frequency rate of 17.35 per million man-hours for 1960, when compared with the 17.47 rate for the preceding year. An indication of fewer men working is shown by a 15-percent decline in preliminary figures reported. The average employee worked 2,000 hours in 1960, and 1,984 hours the preceding year —an increase of approximately 1 percent.

One major disaster (a single accident in which five or more men are killed) occurred in the mineral industries in 1960. Eighteen men died of asphyxiation following a mine fire in a bituminous coal mine in West Virginia.

Work Stoppages.—The Bureau of Labor Statistics reported 158 work stoppages in 1960, totaling 751,000 man-days of work lost, a decline from the preceding year of 25 percent in work stoppages and 88 percent in man-days lost. The bituminous-coal-mining industry reported 120 work stoppages in 1960; anthracite mines had 6. Days lost were 137,000 and 9,000, respectively. The crushed and broken stone industry had 13 stoppages during the year, and lost 104,000 man-days of work. The remaining 19 work stoppages (12 percent) and the approximately 501,000 man-days lost (67 percent) occurred in the petroleum,

[1] Chief, Branch of Accident Analysis, Division of Accident Prevention and Health.

iron, copper, lead-zinc, ferroalloy metal ores, miscellaneous metal ores, dimension stone, sand and gravel, and chemical- and fertilizer-mineral-mining industries and in the hydraulic cement industry. The ferroalloy metal ores industry lost less than 1,000 man-days during the year.

TABLE 1.—Salient statistics of injury experience and employment data in the mineral industries of the United States, by industry groups

	1956	1957	1958	1959	1960 [1]
Average number of men working daily: [2]					
Coal mines	260,285	254,725	224,890	203,597	178,151
Coke plants	20,473	20,264	16,186	16,645	16,463
Petroleum and natural gas [7]	585,486	617,596	584,708	559,244	511,107
Peat [3]		139	464	467	576
Metal mines	68,273	68,457	59,608	58,557	53,656
Nonmetal mines (except stone quarries)	15,595	17,921	17,820	18,773	14,520
Sand and gravel operations [4]		31,531	51,122	59,492	26,832
Stone quarries	80,093	84,126	88,448	91,523	69,156
Slag (iron blast-furnace) [5]			1,882	1,789	1,680
Metallurgical plants	65,681	65,212	52,109	55,655	44,130
Nonmetal mills [6]	17,585	27,081	32,401	40,800	29,810
Total	1,113,471	1,187,052	1,129,638	1,106,542	946,081
Average number of active mine days:					
Coal mines	212	204	183	186	194
Coke plants	346	355	351	328	350
Petroleum and natural gas [7]	264	262	260	(8)	(8)
Peat [3]		209	171	178	169
Metal mines	264	259	229	214	254
Nonmetal mines (except stone quarries)	268	262	239	239	256
Sand and gravel operations [4]		221	211	(8)	(8)
Stone quarries	272	266	264	(8)	(8)
Slag (iron blast-furnace) [5]			248	254	(8)
Metallurgical plants	327	322	302	289	300
Nonmetal mills [6]	288	274	272	274	264
Total	258	254	244	213	224
Man-days worked, in thousands:					
Coal mines	55,286	52,077	41,121	37,773	34,531
Coke plants	7,082	7,187	5,683	5,467	5,768
Petroleum and natural gas [7]	154,444	161,716	151,965	148,143	132,917
Peat [3]		29	79	83	97
Metal mines	18,017	17,751	13,665	12,503	13,623
Nonmetal mines (except stone quarries)	4,178	4,691	4,258	4,492	3,715
Sand and gravel operations [4]		6,954	10,763	(8)	(8)
Stone quarries	21,776	22,410	23,353	(8)	(8)
Slag (iron blast-furnace) [5]			467	455	(8)
Metallurgical plants	21,470	21,003	15,733	16,095	13,257
Nonmetal mills [6]	5,056	7,415	8,809	11,195	7,874
Total [9]	287,311	301,232	275,895	236,207	211,782
Man-hours worked, in thousands:					
Coal mines	433,662	408,207	322,229	296,031	272,042
Coke plants	56,557	57,337	45,486	43,626	46,066
Petroleum and natural gas [7]	1,235,555	1,293,725	1,215,722	1,185,146	1,063,332
Peat [3]		231	704	738	866
Metal mines	144,407	142,181	109,523	100,576	109,260
Nonmetal mines (except stone quarries)	33,963	37,877	34,648	36,625	30,259
Sand and gravel operations [4]		59,764	92,456	109,830	49,300
Stone quarries	178,281	183,394	186,821	199,321	147,620
Slag (iron blast-furnace) [5]			3,776	3,681	3,613
Metallurgical plants	171,578	167,489	125,773	128,913	106,067
Nonmetal mills [6]	40,675	59,765	71,161	90,706	63,854
Total [9]	2,294,678	2,409,970	2,208,298	2,195,193	1,892,280

See footnotes at end of table.

TABLE 1.—Salient statistics of injury experience and employment data in the mineral industries of the United States, by industry groups—Continued

	1956	1957	1958	1959	1960 [1]
Number of injuries:					
Fatal:					
Coal mines	448	478	358	293	326
Coke plants	10	12	5	3	3
Petroleum and natural gas [7]	147	121	116	120	82
Peat [3]				1	
Metal mines	89	71	70	65	73
Nonmetal mines (except stone quarries)	17	9	15	12	19
Sand and gravel operations [4]		35	25	21	23
Stone quarries	50	53	45	52	38
Slag (iron blast-furnace) [5]			1	1	
Metallurgical plants	20	21	12	11	11
Nonmetal mills [6]	7	10	9	11	13
Total	788	810	656	590	588
Nonfatal:					
Coal mines	19,816	18,792	14,160	12,163	11,851
Coke plants	301	244	210	222	223
Petroleum and natural gas [7]	11,372	11,426	11,588	10,543	9,110
Peat [3]		5	12	14	24
Metal mines	5,475	4,554	3,499	3,281	3,392
Nonmetal mines (except stone quarries)	1,036	1,112	955	1,072	889
Sand and gravel operations [4]		1,763	1,698	2,161	1,004
Stone quarries	3,754	4,210	4,572	4,790	3,223
Slag (iron blast-furnace) [5]			43	43	34
Metallurgical plants	2,543	2,280	1,698	1,305	1,251
Nonmetal mills [6]	1,157	1,512	1,490	2,156	1,246
Total	45,454	45,898	39,925	37,750	32,247
Injury rates per million man-hours:					
Fatal:					
Coal mines	1.03	1.17	1.11	0.99	1.20
Coke plants	.18	.21	.11	.07	.07
Petroleum and natural gas [7]	.12	.09	.10	.10	.08
Peat [3]				1.36	
Metal mines	.62	.50	.64	.65	.67
Nonmetal mines (except stone quarries)	.50	.24	.43	.33	.63
Sand and gravel operations [4]		.59	.27	.19	.47
Stone quarries	.28	.29	.24	.26	.26
Slag (iron blast-furnace) [5]			.26	.27	
Metallurgical plants	.12	.13	.10	.09	.10
Nonmetal mills [6]	.17	.17	.13	.12	.20
Total	.34	.34	.30	.27	.31
Nonfatal:					
Coal mines	45.69	46.04	43.94	41.09	43.56
Coke plants	5.32	4.26	4.62	5.09	4.84
Petroleum and natural gas [7]	9.20	8.83	9.53	8.90	8.57
Peat [3]		21.68	17.05	18.97	27.72
Metal mines	37.91	32.03	31.95	32.62	31.05
Nonmetal mines (except stone quarries)	30.50	29.36	27.56	29.27	29.38
Sand and gravel operations [4]		29.50	18.37	19.68	20.37
Stone quarries	21.06	22.96	24.47	24.03	21.83
Slag (iron blast-furnace) [5]			11.39	11.68	9.41
Metallurgical plants	14.82	13.61	13.50	10.12	11.79
Nonmetal mills [6]	28.44	25.30	20.94	23.77	19.51
Total	19.81	19.05	18.08	17.20	17.04

[1] Preliminary figures, except anthracite, coke, petroleum and natural gas, and slag.
[2] Men at work each day mine was active.
[3] Peat canvass included beginning 1957.
[4] Sand and gravel canvass included beginning 1957.
[5] Slag (iron blast-furnace) canvass included beginning 1958.
[6] Clay included with nonmetal mills beginning 1956.
[7] Includes officeworkers as separate data are not available.
[8] Data not available.
[9] Data will not necessarily add to total due to rounding.

TABLE 2.—Work stoppages in certain mineral industries in the United States[1]

Industry and year	Work stoppages	
	Number	Man-days lost (thousands)
Coal mining:		
Anthracite:		
1956	18	56.3
1957	3	2.6
1958	8	2.1
1959	1	1.2
1960	6	9.3
Bituminous:		
1956	266	377.0
1957	161	136.0
1958	136	102.0
1959	146	[2] 1,560.0
1960	120	[2] 137.0
Coke and byproducts:		
Coke only:		
1956	3	56.0
1957	5	25.1
1958	(3)	(3)
1959	(3)	(3)
1960	(3)	(3)
Petroleum refining:		
1956	9	90.4
1957	9	200.0
1958	8	124.0
1959	13	543.0
1960	2	[2] 48.2
Metal mining:		
Iron:		
1956	5	679.0
1957	4	18.6
1958	1	9.7
1959	8	2,120.0
1960	2	15.2
Copper:		
1956	3	7.0
1957	3	31.5
1958	2	22.0
1959	9	1,800.0
1960	1	[2] 361.0
Lead-zinc:		
1956	3	[4] [2] 94.1
1957	5	7.1
1958		
1959	5	28.0
1960	3	58.8
Gold-silver:		
1956	1	25.3
1957	1	[5] 1.5
1958		
1959		
1960		
Bauxite and other aluminum ores:		
1956	1	5.3
1957		
1958		
1959		
1960		
Ferroalloy metal ores:		
1956		
1957		
1958	2	84.2
1959	1	(6)
1960	1	(6)
Metal mining services:		
1956	2	(6)
1957		
1958		
1959	1	(6)
1960		
Metal mining—Con.		
Miscellaneous metal ores:		
1956	1	(6)
1957	1	2.0
1958	2	1.5
1959	2	2.0
1960	2	2.3
Mining and quarrying of nonmetallic minerals (except fuels):		
Dimension stone:		
1956	2	25.1
1957	3	18.0
1958	2	14.3
1959		
1960	1	2.5
Crushed and broken stone:		
1956	15	45.2
1957	4	8.2
1958	7	5.7
1959	8	76.9
1960	13	104.0
Sand and gravel:		
1956	3	2.0
1957	2	(6)
1958	2	25.2
1959	3	[2] 11.1
1960	3	1.8
Clay, ceramic and refractory minerals:		
1956		
1957	1	(6)
1958	(2)	(6)
1959	2	1.2
1960		
Chemical and fertilizer mineral mining:		
1956	1	1.5
1957	4	4.6
1958	5	32.5
1959	3	45.5
1960	2	7.3
Nonmetallic minerals (except fuels) services:		
1956		
1957	1	1.1
1958		
1959		
1960		
Miscellaneous nonmetallic minerals (except fuels):		
1956	2	(6)
1957		
1958	1	2.5
1959		
1960		
Cement, hydraulic:		
1956	14	68.4
1957	6	436.0
1958	6	38.6
1959	8	74.8
1960	2	[2] 3.6

[1] Compiled by U.S. Department of Labor, Bureau of Labor Statistics, revised data.
[2] Includes idleness from stoppages which began in previous year.
[3] Data not available.
[4] Includes some silver.
[5] Includes some lead, copper, zinc, and silver.
[6] Less than 1,000 man-days.

NATIONAL SAFETY COMPETITION

The National Safety Competitions, sponsored and conducted annually by the Bureau of Mines, stimulated great interest among the Nation's mineral-extractive industries and encouraged the development of more effective accident-prevention programs by according national recognition to operations achieving outstanding safety records. Of the 1,127 operations participating in the 1960 competitions, 519 (46 percent) were injury-free—the greatest number in any single year. These 519 injury-free operations worked almost 38 million man-hours (23 percent) of the total exposure to occupational hazards.

Of the five competitions conducted by the Bureau of Mines, two were sponsored by the Bureau. They were the National Safety and National Sand and Gravel Competitions. In these 2 contests, 401 operations (46 percent) finished the competition year free of disabling work injuries. These 401 operations accounted for 29,886,425 man-hours (22 percent) of the total man-hours worked (136,622,630) by all participating operations in these 2 Bureau-conducted competitions.

In addition, the Bureau of Mines conducted three other annual competitions, cosponsored by national associations connected with the mineral industries—the National Crushed Stone Association, National Lime Association and National Slag Association. During 1960, 264 plants participated in the association-sponsored contests, of which 118 (45 percent) attained injury-free records during an aggregate worktime of almost 8 million man-hours. These injury-free man-hours accounted for 30 percent of the total man-hours worked by all plants participating in these competitions.

Trophy awards for the best safety records in each of the six groups in the 1960 National Safety Competition were made to the following:

Anthracite Underground Mines.—The Huber Colliery of Glen Alden Corporation, Ashley, Pa.

Bituminous-Coal Underground Mines.—The Columbia mine of Columbia-Geneva Steel Division, U.S. Steel Corp., Columbia, Utah.

Metal Underground Mines.—Jefferson City mine of Tennessee Coal and Iron Division, U.S. Steel Corp., Jefferson City, Tenn.

Nonmetal Underground Mines.—Jonathan mine of Columbia Cement Corporation, Zanesville, Ohio.

Open-Pit Mines.—Monroe No. 12 mine of Oliver Iron Mining Division, U.S. Steel Corp., Chisholm, Minn.

Quarries.—Calcite quarry of Michigan Limestone Division, U.S. Steel Corp., Rogers City, Mich.

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

Year	Men working	Man-hours worked	Number of injuries		Injury rate per million man-hours	
			Fatal	Nonfatal	Fatal	Nonfatal
1931	784,347	1,288,135,808	1,707	94,021	1.33	72.99
1932	671,343	962,924,915	1,368	66,028	1.42	68.57
1933	677,722	1,058,245,650	1,242	70,158	1.17	66.30
1934	739,817	1,167,723,543	1,429	79,211	1.22	67.83
1935	783,139	1,215,316,764	1,495	80,070	1.23	65.88
1936	824,514	1,426,233,543	1,686	90,608	1.18	63.53
1937	859,951	1,482,241,908	1,759	94.466	1.19	63.73
1938	774,894	1,144,137,296	1,369	69,940	1.20	61.13
1939	788,925	1,251,169,210	1,334	73.253	1.07	58.55
1940	801.926	1,385,128,234	1,716	80,856	1.24	58.37
1941	835,095	1,541,335,277	1,621	87,911	1.05	57.04
1942 [1]	1,120,450	2,319,213,897	1,970	100,861	.85	43.49
1943	1,144,831	2,555,619,729	1,953	101,164	.76	39.58
1944	1,086,103	2,573,452,816	1,751	98,066	.68	38.11
1945	1,033,035	2,363,783,323	1,414	87.578	.60	37.05
1946	1,108.517	2,275,960,528	1,336	86,291	.59	37.91
1947	1,179,835	2,469,256,565	1,556	91,311	.63	36.98
1948	1,242,241	2,530,418,226	1,383	86.295	.55	34.10
1949	1,240,330	2,256,418,166	898	65,909	.40	29.21
1950	1,237,649	2,340,954,733	952	66,729	.41	28.51
1951	1,223,639	2,418,090,394	1,122	67,285	.46	27.83
1952	1,230,692	2,383,608,034	927	61,296	.39	25.72
1953	1,193,182	2,357,970,591	817	53,992	.35	22.90
1954	1,096,423	2,138,687,112	671	43,130	.31	20.17
1955 [2]	1,122,393	2,290,057,680	729	46,197	.32	20.17
1956 [3]	1,113,471	2,294,678,414	788	45,454	.34	19.81
1957 [4]	1,187,052	2,409,969,589	810	45,898	.34	19.05
1958 [5]	1,129,638	2,208,298,487	656	39,925	.30	18.08
1959	1,106,542	2,195,192,674	590	37,750	.27	17.20
1960 [6]	946.081	1,892,279,928	588	32,247	.31	17.04

[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.
[6] Preliminary figures.

The Mineral Industry of Alabama

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Alabama.

By Avery H. Reed, Jr.[1] and P. E. Lamoreaux [2]

RECORD production of crushed limestone, crude petroleum, marble, miscellaneous clay, salt, scrap mica, kaolin, and talc occurred in Alabama in 1960. Among the States, Alabama ranked second in production of bauxite and third in output of iron ore and native asphalt, and fourth in scrap mica.

Alabama's mineral industry was dominated by the mining and processing of coal and iron ore, which furnished 53 percent of the total value of production, compared with 51 percent in 1959. Other important industries were cement manufacturing, crude petroleum production, and stone quarrying. Leading companies were Tennessee Coal & Iron (coal, iron ore, crushed limestone, and lime), Southern Cement Co. (cement, lime, crushed limestone, and miscellaneous clay), Woodward Iron Co. (coal and iron ore), Alabama By-Products Corp. (coal), Southeastern Electric Generating Co. (coal), and Alabama Power Co. (coal).

TABLE 1.—Mineral production in Alabama [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand 376-pound barrels	1,820	$6,967	1,576	$6,564
Portland do	12,998	39,672	11,355	36,142
Clays [2] thousand short tons	1,786	2,089	1,840	2,170
Coal do	11,947	78,212	13,011	92,439
Gem stones	(3)	(4)		
Iron ore (usable) thousand long tons, gross weight	4,165	23,922	4,068	23,511
Lime thousand short tons	579	6,847	564	6,912
Mica (sheet) pounds	818	7	(5)	(4)
Natural gas million cubic feet	172	17	57	4
Petroleum (crude) thousand 42-gallon barrels	5,524	(5)	[6] 7,257	(5)
Sand and gravel thousand short tons	4,352	4,594	4,359	4,759
Stone [7] do	11,886	18,728	13,503	19,970
Value of items that cannot be disclosed: Asphalt (native), bauxite, slag cement, clay (kaolin), mica (scrap), salt, stone (dimension limestone, dimension marble, oystershell, and crushed sandstone), talc, and values indicated by footnote 5		25,401		29,441
Total, Alabama [8]		200,847		217,617

[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] Less than $1,000.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Preliminary figure.
[7] Excludes certain stone; included with "Value of items that cannot be disclosed."
[8] Total adjusted to eliminate duplicating value of clays and stone.

[1] Chief, Field Office, Division of Mineral Resources, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, Alabama Geological Survey, Tuscaloosa, Ala.

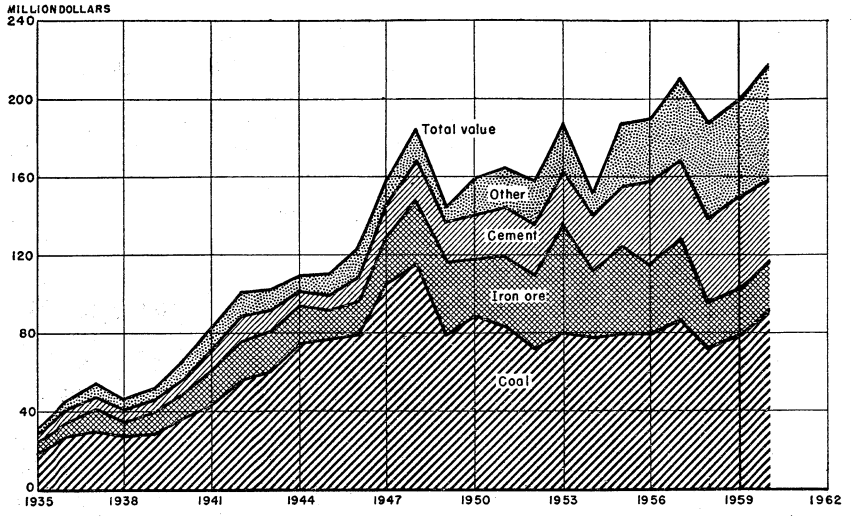

FIGURE 1.—Value of coal, iron ore, cement, and total value of mineral production in Alabama, 1935–60.

Value of mineral production increased 8 percent over 1959 and was 4 percent above 1957, the previous record year. The gain was due to substantial increases in the production of coal, petroleum, and stone.

Employment and Injuries.—Total employment in the mineral industries increased 2 percent over 1959, owing mainly to increases of 7 percent in employment at coal mines, and 8 percent at metal mines. Employment at quarries and mills decreased 13 percent because output of cement and lime was smaller.

Injury-frequency rate improved to a record low of 12 injuries per million man-hours. There were 18 fatalities, compared with 9 in 1959.

Trends and Developments.—Construction was nearing completion on two new steam units and on the first units in two new hydroelectric plants, all scheduled to begin operation in 1961; these units were: Crist Steam Plant, Unit No. 5, 75,000 kilowatts, Gulf Power Co.; The SEGCO Steam Plant, Unit No. 3, 250,000 kilowatts, Southern Electric Generating Co.; the Weiss Dam, Units No. 1 and No. 2, 58,500 kilowatts, Alabama Power Co.; and the Smith Dam, Unit No. 1, 78,750 kilowatts, Alabama Power Co.

Imports of foreign iron ore exceeded production of red iron ore for the second consecutive year.

Legislation and Government Programs.—The National System of Interstate and Defense Highways Program was again responsible for increased production of crushed limestone.

The Bureau of Mines Tuscaloosa Metallurgy Research Center continued work on various research projects of national and regional importance.

TABLE 2.—Employment and injuries in the mineral industries

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man hours
1959:							
Coal mines[1]	208	6,693	206	11,033,532	9	145	14
Quarries and mills	56	3,361	283	7,610,298	----------	107	14
Coke ovens	7	1,544	361	4,461,826	----------	33	7
Metal mines	43	2,861	183	4,195,424	----------	34	8
Nonmetal mines	44	937	234	1,754,532	----------	53	30
Sand and gravel mines	37	502	275	1,104,259	----------	27	24
Total	395	15,898	237	30,159,871	9	399	14
1960:[2]							
Coal mines[1]	203	7,400	200	11,851,822	11	154	14
Quarries and mills	55	2,958	294	6,960,601	2	75	11
Coke ovens	7	1,537	363	4,470,073	1	34	8
Metal mines	39	2,706	210	4,535,944	2	29	7
Nonmetal mines	33	879	277	1,951,047	----------	37	19
Sand and gravel mines	36	529	270	1,141,455	2	31	29
Total	373	16,009	241	30,910,942	18	360	12

[1] Excludes office workers.
[2] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt (Native).—Alabama Asphaltic Limestone Co. (Margerum quarry) crushed bituminous limestone in Colbert County for roadstone; production decreased 12 percent. Among the States, Alabama ranked third in output of native asphalt.

Coal.—Bituminous coal was mined at 177 mines in 10 counties, compared with 187 mines in 10 counties in 1959. Leading counties were Jefferson, Walker, and Tuscaloosa. Leading companies were Tennessee Coal & Iron, Alabama By-Products Corp., Southeastern Electric Generating Co., Alabama Power Co., and Woodward Iron Co., which together supplied 61 percent of the State's total. Production increased 9 percent above 1959 but was 38 percent below 1926, the record year. Average output per mine increased from 63,900 tons in 1959 to 73,500 tons in 1960.

Underground mines produced 79 percent of the total, strip mines, 10 percent, and auger mines, 1 percent. Eighty-four percent of the coal was shipped by rail or water, 11 percent by conveyor belt, and 5 percent by truck. Captive tonnage was 45 percent of the total, compared with 56 percent in 1959.

Equipment used at 135 underground mines included 237 cutting machines, which cut 71 percent of the tonnage; 250 power drills, which drilled 72 percent; 297 locomotives; 220 shuttle cars; 23 rope hoists; and 79 mother conveyors.

Equipment used at 39 strip mines included 77 power shovels, 16 draglines, 7 carryall scrapers, 57 bulldozers, 37 power drills, and 117 trucks. An estimated 39,700,000 cubic yards of overburden was excavated.

Three coal-recovery augers and two trucks were used at three auger mines.

TABLE 3.—Coal production by counties

County	1959		1960	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Bibb	28,232	$119	19,839	$91
Blount	224,687	1,309	160,688	996
Cullman	75,353	403	66,936	415
Jackson	14,901	77	8,122	41
Jefferson	7,513,267	51,451	7,944,694	60,600
Marion	187,961	1,248	208,238	1,240
Shelby	65,772	429	57,546	387
Tuscaloosa	664,180	3,004	701,323	2,988
Walker	3,060,250	19,590	3,715,407	25,106
Winston	112,537	582	127,854	575
Total	11,947,140	78,212	13,010,647	92,439
Earliest record to date	946,634,000	(1)	959,645,000	(1)

[1] Data not available.

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

Natural Gas.—Marketed production of natural gas from Marion County decreased substantially compared with 1959.

Petroleum.—Production of crude petroleum increased 31 percent and was 23 percent above 1958, the previous record year. Leading counties were Mobile and Escambia. During the year, 40 new producing wells were drilled. The 384 producing wells were in the following counties: Baldwin 6, Choctaw 69, Clarke 13, Escambia 36, and Mobile 260.

Jett Drilling Co., Inc., entered into a multimillion-dollar drilling deal with Ancora Corp., involving at least 100 new holes in the Citronelle oilfield. More than 4,000 acres were involved, much of it on the undeveloped east flank of the field.

TABLE 4.—Crude petroleum production, by counties

(Barrels)

County	1959	1960 [1]
Baldwin	48,941	41,188
Choctaw	308,299	302,332
Clarke	87,309	13,153
Escambia	698,150	627,775
Mobile	[2] 4,381,301	6,272,552
Total	[2] 5,524,000	7,257,000
Earliest record to date	[2] 26,470,000	33,727,000

[1] Preliminary figures.
[2] Revised figure.

Source: State Oil & Gas Board.

NONMETALS

Cement.—Seven companies produced masonry cement at eight plants in four counties. Leading producers were Southern Cement Co. and National Cement Co. Shipments decreased 13 percent and were 19

percent below 1955, the record year. Consumption of masonry cement in Alabama amounted to 21 percent of shipments. Out-of-State shipments were made to Georgia (30 percent), South Carolina (12 percent), North Carolina (9 percent), Florida (8 percent), Louisiana (8 percent), Mississippi (7 percent), Tennessee (3 percent), and other States (2 percent).

Seven companies produced portland cement at eight plants in five counties. Leading producers were Southern Cement Co. (Calera plant) and Ideal Cement Co. (Mobile plant). Shipments decreased 13 percent below 1959, the record year. Shipments of portland cement to Alabama consumers amounted to 40 percent. The remaining shipments were made to Georgia (21 percent), Florida (15 percent), Mississippi (9 percent), South Carolina (7 percent), Louisiana (3 percent), North Carolina (2 percent), Tennessee (2 percent), and other States (1 percent). Raw materials used in manufacturing portland cement included limestone and oystershell (46 percent), cement rock (34 percent), clay and shale (13 percent), and other materials (7 percent).

End uses of portland cement were as follows: Ready-mixed concrete (53 percent), concrete-products manufacturers (20 percent), highway contractors (13 percent), building-materials dealers (8 percent), and other uses (6 percent).

Southern Cement Co. and Cheney Lime & Cement Co. produced slag cement. Shipments were 12 percent below 1959 and 74 percent below 1952, the record year.

Annual capacity of portland cement plants increased from 16,273,000 to 16,340,000 barrels.

Clays.—Twenty-one companies mined 1,549,000 tons of miscellaneous clay at 23 mines in 12 counties for portland cement and heavy clay products. Leading producers were Southern Cement Co. and Jenkins Brick Co. Production increased 3 percent over 1959, the previous record year.

Nine companies mined fire clay at 10 mines in 7 counties. Leading producers were Donoho Clay Co. and Russell Coal & Clay Co. Production increased 5 percent but was 4 percent below 1956, the record year. Dixie Fire Brick Co., subsidiary of A. P. Greene Fire Brick Co., completed a $100,000 modernization program at Kimberley; the main products of the plant were ladle brick and fire clay brick.

Harbison-Walker Refractories Co. and Thomas Alabama Kaolin Co. mined kaolin for floor and wall tile, firebrick and block, paper filling, fertilizer, and insecticides. Production increased 39 percent above 1959, the previous record year.

Lime.—Six companies produced quicklime and hydrated lime at seven plants in Jefferson and Shelby Counties for building, agricultural, refractory, chemical, and industrial uses. Leading producers were Southern Cement Co. (Roberta and Keystone limekilns) and Longview Lime Corp. Production decreased 3 percent below 1959, the record year. Shipments of lime to consumers in Alabama amounted to 57 percent. The remaining shipments were made to Florida (17 percent), Georgia (13 percent), Mississippi (4 percent),

615629—61——5

TABLE 5.—Fire clay sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Firebrick and block	(1)	(1)	(1)	105,602	$278,755	$2.64
Foundries and steelworks	26,444	$51,746	$1.96	35,477	79,804	2.25
Fire-clay mortar	81,564	210,455	2.58	(1)	(1)	(1)
Other [2]	169,636	474,901	2.80	150,165	394,812	2.63
Total	277,644	737,102	2.65	291,244	753,371	2.59

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes saggers, pins, stilts and wads, heavy clay products, clay crucibles, bauxite high-alumina brick, other refractories, and uses indicated by footnote 1.

TABLE 6.—Lime sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Chemical and industrial	453,830	$5,334,726	$11.75	432,934	$5,222,194	$12.06
Other [1]	125,252	1,512,603	12.08	131,336	1,690,170	12.87
Total	579,082	6,847,329	11.82	564,270	6,912,364	12.25

[1] Includes construction, agriculture, and refractory lime.

Tennessee (4 percent), Louisiana (2 percent), North Carolina (1 percent), and other States and exports (2 percent).

Magnesium Compounds.—Tennessee Coal & Iron produced dead-burned dolomite for refractory use.

Mica.—Dixie Mines, Inc., mined scrap mica at the Dixie mine; production increased 3 percent over 1959, the previous record year. Among the States, Alabama ranked fourth in production of scrap mica. J. J. New mined a small quantity of sheet mica.

Phosphate Rock.—Armour Chemical Co., Victor Chemical Co., and Virginia-Carolina Chemical Co. were prospecting for phosphate rock on the Elk River in the Veto-Alabama area. The Tennessee Valley Authority planned a new and larger phosphorus furnace at Mussel Shoals for producing phosphatic fertilizer.

Salt.—Olin Mathieson Chemical Corp., the only salt producer in the State had increased production each year since 1952, the first year. Output increased 1 percent over 1959, the previous record year.

Sand and Gravel.—Thirty companies mined sand and gravel at 35 mines in 22 counties. Leading producers were Birmingham Slag Co., Radcliff Materials Corp., and Alabama Gravel Co. Leading counties were Montgomery, Mobile, and Elmore. Production was about the same as in 1959 but was 14 percent below 1957, the record year. Of the total production, more than 99 percent was washed. Forty-eight percent was shipped by truck, 47 percent by rail, and 5 percent by water.

TABLE 7.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Autauga			148,300	$119,550
Baldwin	10,400	$10,400	8,505	8,505
Barbour	258,007	281,875	23,932	32,835
Calhoun	173,693	199,461	218,164	258,539
Cherokee	(1)	(1)	2,294	5,416
Chilton	(1)	(1)	202,000	164,700
Clarke	11,119	12,432	12,000	12,000
Dallas	374,908	377,203	256,224	274,681
Elmore	(1)	(1)	(1)	(1)
Escambia	(1)	(1)	(1)	(1)
Etowah	(1)	(1)		
Franklin	(1)	(1)	(1)	(1)
Greene	(1)	(1)	(1)	(1)
Houston	40,500	34,425	(1)	(1)
Jefferson	181,591	203,110	214,473	229,274
Macon	83,380	104,990	110,836	188,178
Mobile	(1)	(1)	(1)	(1)
Monroe	21,842	20,605	24,488	23,102
Montgomery	591,086	592,295	1,301,694	1,271,168
Morgan	(1)	(1)	(1)	(1)
Russell	(1)	(1)	147,161	152,208
St. Clair	1,297	2,918	1,498	3,373
Tuscaloosa	228,228	250,900	(1)	(1)
Undistributed	2,375,674	2,502,922	1,687,067	2,015,575
Total	4,351,725	4,593,536	4,358,636	4,759,104

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

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

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,479,254	$1,288,768	$0.87	1,369,685	$1,189,845	$0.87
Paving	462,278	410,114	.89	541,388	432,132	.80
Molding	130,341	214,635	1.65	94,950	217,821	2.29
Railroad ballast	9,859	5,172	.52	12,746	6,919	.54
Fill	7,912	4,641	.59	3,998	1,880	.47
Engine	52,624	34,206	.65			
Gravel:						
Paving	782,966	940,790	1.20	1,071,127	1,281,962	1.20
Structural	1,209,746	1,447,027	1.20	1,007,166	1,342,796	1.33
Fill	2,034	2,179	1.07			
Other sand and gravel [1]	214,711	246,004	1.15	257,576	285,749	1.11
Total	4,351,725	4,593,536	1.06	4,358,636	4,759,104	1.09

[1] Includes railroad ballast and other gravel.

Stone.—Thirty-five companies crushed limestone at 40 quarries in 18 counties. Leading counties were Shelby, Jefferson, and Madison. Leading producers were Birmingham Slag Co., Lone Star Cement Corp., and Southern Cement Co. Production increased 14 percent over 1959, the previous record year. Of the total production, 60 percent was shipped by truck, 26 percent by rail, 9 percent by conveyor belt, and 5 percent by water.

Alabama Limestone Co. quarried dimension limestone in Franklin County for rubble, rough architectural, sawed and cut dressed building stone, and for curbing and flagging. Production decreased 4 percent and was 39 percent below 1956, the record year.

Thompson-Weinman & Co., Moretti-Harrah Marble Co., and Alabama Marble Co. crushed marble at Sylacauga for whiting, terrazzo, and other uses. Production increased 2 percent over 1959, the previous record year.

Moretti-Harrah Marble Co. and Alabama Marble Co. quarried dimension marble for rough interior, sawed interior, and cut exterior and interior dressed building stone, and for cut dressed monumental stone. Production was about the same as in 1958, the previous record year.

Southern Oystershell Milling Corp. and Bay Towing & Dredging Co., Inc., crushed oystershell from Mobile Bay for poultry grit and for roadstone. Production increased 5 percent but was 50 percent below 1957, the record year.

Universal Atlas Cement Co. and Sam P. Acton crushed sandstone for cement and refractories. Production decreased 11 percent and was 87 percent below 1956, the record year.

TABLE 9.—Crushed limestone sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Blount	(1)	(1)		
Cherokee			(1)	(1)
Colbert	555,842	$673,162	797,283	$951,256
Conecuh	(1)	(1)	(1)	(1)
Covington	(1)	(1)	(1)	(1)
De Kalb	(1)	(1)	(1)	(1)
Etowah	(1)	(1)	(1)	(1)
Franklin	(1)	(1)	(1)	(1)
Henry	20,000	51,000	20,000	60,000
Jackson	133,646	165,570	58,104	72,630
Jefferson	3,218,261	3,412,566	3,213,149	3,541,744
Lawrence	(1)	(1)		
Lee	(1)	(1)		
Limestone	49,235	73,853	44,720	67,080
Madison	(1)	(1)	(1)	(1)
Marengo	(1)	(1)	(1)	(1)
Marshall	(1)	(1)	(1)	(1)
Morgan	(1)	(1)	(1)	(1)
St. Clair	(1)	(1)	(1)	(1)
Shelby	3,305,836	4,615,918	4,085,804	5,765,021
Washington	(1)	(1)	(1)	(1)
Undistributed	4,295,473	5,100,743	4,970,404	5,185,867
Total	11,578,293	14,092,812	13,189,464	15,643,598

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

A. O. Brown quarried dimension sandstone for rough architectural building stone. Production increased 10 percent but was 90 percent below 1954, the record year.

Talc.—American Talc Co. mined and ground talc in Winterboro for insecticides, paint, textiles, and toilet preparations. Production increased 12 percent over 1959, the previous record year.

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

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	4,929,833	$6,395,036	$1.30	5,731,089	$6,990,419	$1.22
Cement manufacture	3,580,832	3,066,724	.86	2,909,122	2,093,221	.72
Fluxing stone	1,267,422	1,788,673	1.41	1,548,053	2,444,560	1.58
Agstone	604,757	918,015	1.52	1,058,304	1,416,650	1.34
Lime manufacture	833,375	1,113,160	1.34	941,018	1,095,819	1.16
Riprap	(1)	(1)	(1)	625,483	883,046	1.41
Stone sand	(1)	(1)	(1)	66,507	82,548	1.24
Asphalt filler	57,078	167,295	2.93	44,295	199,328	4.50
Rock dust for coal mines	67,256	285,754	4.25	(1)	(1)	(1)
Railroad ballast	(1)	(1)	(1)	19,328	25,550	1.32
Other uses [2]	237,740	358,155	1.51	246,265	412,457	1.67
Total	11,578,293	14,092,812	1.22	13,189,464	15,643,598	1.19

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes alkali, paper, refractory, other uses, and uses indicated by footnote 1.

Vermiculite.—Zonolite Co. exfoliated vermiculite at its plant in Birmingham, using vermiculite from out of State.

METALS

Aluminum.—Reynolds Metals Co. operated the Listerhill aluminum reduction plant in Sheffield.

Bauxite.—R. E. Wilson Mining Co., D. M. Wilson Bauxite Co., and Harbison-Walker Refractories Co. mined crude bauxite in Barbour and Henry Counties. Production decreased 4 percent. Alabama ranked second in bauxite production.

Ferroalloys.—Shipments of ferromanganese, silicomanganese, ferrosilicon, and ferrophosphorus totaled 156,000 short tons valued at $28,710,000.

Gold and Silver.—There had been no production of gold and silver in Alabama since 1946. Table 11 shows the production of gold and silver, 1830–1960. The history of gold mining in Alabama has involved mainly the working of the small streams in the gold-bearing area and the operation of one large gold mine. The greatest period of activity was from the discovery of gold in 1830 through 1849, when gold was discovered in California and the Alabama gold miners dropped their picks and joined the gold rush. There was sporadic placer mining at various times after that, but the production was small. In 1905, the Hog Mountain mine in Tallapoosa County opened, a cyanide mill was constructed, and several hundred feet of sinking and drifting were done. The mine operated until 1914, was idle from 1915 to 1934, and again operated from 1934 through 1937. This one mine furnished about half of the total gold and silver production of the State. Production since 1937, all from placer operations, has been very small.

TABLE 11.—Mine production of gold and silver, 1830–1960

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1830-80	18,052	$373,075			18,052	$373,075
1881	48	1,000			48	1,000
1882	169	3,500			169	3,500
1883	290	6,000			290	6,000
1884	242	5,000			242	5,000
1885	290	6,000			290	6,000
1886	194	4,000			194	4,000
1887	121	2,500			121	2,500
1888	271	5,600			271	5,600
1889	123	2,539	77	$100	200	2,639
1890	105	2,170			105	2,170
1891	109	2,245			109	2,245
1892	117	2,419	20	26	137	2,445
1893	308	6,362			308	6,362
1894	198	4,092	66	85	264	4,177
1895	236	4,878			236	4,878
1896	275	5,700			275	5,700
1897	358	7,400	100	129	458	7,529
1898	242	5,000	100	129	342	5,129
1899	208	4,300	100	129	308	4,429
1900	92	1,900	100	129	192	2,029
1901	150	3,100	100	129	250	3,229
1902	119	2,500	100	129	219	2,629
1903	213	4,400	49	63	262	4,463
1904	1,417	29,300	200	116	1,617	29,416
1905	2,008	41,500	300	183	2,308	41,683
1906	1,137	23,500	100	68	1,237	23,568
1907	1,325	27,400	600	400	1,925	27,800
1908	1,993	41,200	400	200	2,393	41,400
1909	1,413	29,200	200	100	1,613	29,300
1910	1,592	32,900	300	200	1,892	33,100
1911	915	18,916	171	91	1,086	19,007
1912	809	16,724	168	103	977	16,827
1913	537	11,094	117	72	654	11,166
1914	579	11,970	119	73	698	12,043
1915	254	5,243	12	6	266	5,249
1916	418	8,650	53	35	471	8,685
1917	109	2,262			109	2,262
1918	39	797			39	797
1919						
1920	14	296	9	10	23	306
1921-22						
1923	6	114	1	1	7	115
1924-28						
1929	10	203	1	1	11	204
1930	22	450	3	1	25	451
1931	20	407	3	1	23	408
1932	69	1,423	10	3	79	1,426
1933	4	101			4	101
1934	2,781	97,186	361	233	3,142	97,419
1935	2,227	77,953	401	288	2,628	78,241
1936	4,726	165,410	869	673	5,595	166,083
1937	2,460	86,096	457	353	2,917	86,449
1938	41	1,435	4	3	45	1,438
1939	3	105			3	105
1940	5	175	3	2	8	177
1941	30	1,050	3	2	33	1,052
1942	1	35			1	35
1943-44						
1945	5	175	1	1	6	176
1946	1	35			1	35
1947-60						
Total	49,500	1,198,985	5,678	4,267	55,178	1,203,252

TABLE 12.—Mine production of gold and silver, 1830–1960, by counties

County	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
Chilton	24	$504	14	$13	38	$517
Clay	55	1,465	250	165	305	1,630
Cleburne	137	2,845	11	5	148	2,850
Randolph	100	2,666	14	7	114	2,673
Talladega	1,325	28,414	110	63	1,435	28,477
Tallapoosa	23,916	668,222	4,286	2,860	28,202	671,082
Undistributed	23,943	494,869	993	1,154	24,936	496,023
Total	49,500	1,198,985	5,678	4,267	55,178	1,203,252

Iron Ore.—Shipments of iron ore decreased 2 percent and were 54 percent below 1942, the record year. Of the total shipments, 52 percent were direct-shipping ore, compared with 50 percent in 1959. The number of active mines decreased from 35 to 31, and average usable production per mine increased from 119,000 to 137,000 tons. Alabama ranked third among the States in iron ore production. Cumulative shipments since 1840 totaled 358,180,000 long tons valued at $927,255,000.

Four companies mined red iron ore (hematite) at four mines in Jefferson and Tuscaloosa Counties. Leading producers were Tennessee Coal & Iron (Wenonah mine) and Woodward Iron Co. (Pyne mine). Production increased 14 percent but was 58 percent below 1942, the record year.

Twenty operators mined brown iron ore (limonite) for iron and steel at 27 mines in 10 counties. Leading counties were Franklin and Pike. Leading producers were Shook & Fletcher Supply Co. (Taits Gap, Blackburn, and Adkins mines), U.S. Pipe & Foundry Co. (Russellville No. 15 mine), and Glenwood Mining Co., Inc. (Greenville, Glenwood, and Springhill mines). Shipments decreased 36 percent and were 56 percent below 1942, the record year.

Magnesium.—Alabama Metallurgical Corp. manufactured magnesium from dolomite at Selma.

TABLE 13.—Usable iron ore shipments, by counties

County	1959		1960	
	Long tons	Value	Long tons	Value
Barbour	52,617	$252,373	77,068	$398,914
Blount	(1)	(1)	(1)	(1)
Butler	273,463	1,439,200	188,873	1,209,393
Calhoun	10,423	63,311	(1)	(1)
Cherokee			(1)	(1)
Crenshaw	(1)	(1)	39,633	299,553
Franklin	(1)	(1)	(1)	(1)
Jefferson	2,970,839	17,399,630	(1)	(1)
Pike	232,146	1,128,638	203,770	1,724,410
Shelby	(1)	(1)	5,066	30,401
Tuscaloosa	(1)	(1)	(1)	(1)
Undistributed	625,836	3,638,643	3,553,274	19,848,556
Total	4,165,324	23,921,795	4,067,684	23,511,227

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 14.—Mine production and shipments of crude iron ore

	1959		1960	
	Number of mines	Long tons	Number of mines	Long tons
Mine production:				
By varieties:				
Hematite	6	3,194,835	4	3,317,487
Limonite	29	4,251,353	27	3,851,000
By mining methods:				
Open pit	31	4,383,792	28	4,014,369
Underground	4	3,062,396	3	3,154,118
Shipments from mines:				
Direct to consumers	6	2,088,390	4	2,097,317
To beneficiation plants	29	5,351,140	27	5,060,966

TABLE 15.—Usable iron ore production and shipments

	1959		1960	
	Long tons	Iron content, natural (percent)	Long tons	Iron content, natural (percent)
Production:				
Hematite	2,803,278	36	3,206,911	37
Limonite	1,362,046	46	1,028,548	45
Shipments:				
Direct shipping ore	2,088,390	36	2,097,317	37
Concentrates and sinter	2,076,934	42	1,970,367	45

Pig Iron and Steel.—Tennessee Coal & Iron, U.S. Pipe & Foundry Co., Republic Steel Corp., and Woodward Iron Co. produced 3,545,000 tons of foundry, basic, low-phosphorus, direct-casting, and malleable pig iron, compared with 3,658,000 tons in 1959. Value of shipments was $200,366,000, compared with $206,450,000 in 1959. Iron ore consumed in blast furnaces, steel mills, and agglomerating plants was 68 percent domestic and 32 percent imported. Imports of iron ore, mainly from Venezuela and Chile, decreased 29 percent below 1959, the record year.

Woodward Iron Co. announced plans to build an ore sintering plant in Woodward, Ala., as part of a $2 million program.

REVIEW BY COUNTIES

Mineral production was reported from 47 of the State's 67 counties, compared with 51 in 1959. Leading counties were Jefferson, Mobile, Walker, and Shelby, which together supplied 83 percent of the total value.

Autauga.—Dallas Sand & Gravel Co. mined building sand and fluxing gravel.

Baldwin.—Production of crude petroleum from 6 oil wells was 16 percent less than in 1959; one new producing well was drilled during the year. Hinote Sand Supply Co. produced a small quantity of building sand and gravel. Fairhope Clay Products Co. mined miscellaneous clay for heavy clay products.

Barbour.—H. D. Loflin, Rucker Mining Co., Davis Bros., and Glenwood Mining Co., Inc., mined brown iron ore for iron and steel. R. E.

Wilson Mining Co. and D. M. Wilson Bauxite Co. mined bauxite for chemicals and refractories. Harbison-Walker Refractories Co. mined refractory kaolin for firebrick and block; production was nearly double that of 1959. The company planned to construct a plant at Eufaula to eliminate the long haul to Bessemer. McKenzie Construction Co. mined building, paving, railroad ballast, and fill sand, and building gravel.

TABLE 16.—Value of mineral production in Alabama, by counties [1]

County	1959	1960	Minerals produced in 1960 in order of value
Autauga	----------	$119,550	Sand and gravel.
Baldwin	(2)	(2)	Petroleum, sand and gravel, miscellaneous clay.
Barbour	(2)	(2)	Iron ore, bauxite, kaolin, sand and gravel.
Bibb	$118,856	90,664	Coal.
Blount	2,342,146	1,626,264	Coal, iron ore, cement, fire clay, sandstone.
Butler	1,439,200	1,209,393	Iron ore.
Calhoun	482,619	568,509	Sand and gravel, fire clay, iron ore, miscellaneous clay.
Cherokee	(2)	(2)	Limestone, iron ore, sand and gravel.
Chilton	(2)	164,700	Sand and gravel.
Choctaw	(2)	(2)	Petroleum.
Clarke	(2)	(2)	Petroleum, sand and gravel.
Clay	(2)	----------	
Cleburne	(2)	----------	
Colbert	(2)	(2)	Limestone, native asphalt.
Conecuh	(2)	(2)	Limestone.
Coosa	(2)	----------	
Covington	(2)	(2)	Limestone.
Crenshaw	(2)	299,553	Iron ore.
Cullman	403,329	415,249	Coal.
Dallas	377,203	274,681	Sand and gravel.
De Kalb	(2)	(2)	Limestone.
Elmore	(2)	(2)	Sand and gravel, miscellaneous clay.
Escambia	(2)	(2)	Petroleum, sand and gravel, miscellaneous clay.
Etowah	(2)	(2)	Limestone.
Franklin	2,267,346	2,326,542	Limestone, iron ore, sand and gravel, fire clay.
Greene	(2)	(2)	Sand and gravel.
Henry	(2)	(2)	Bauxite, limestone.
Houston	34,425	(2)	Sand and gravel.
Jackson	243,204	113,300	Limestone, coal.
Jefferson	99,192,275	106,485,039	Coal, cement, iron ore, limestone, lime, miscellaneous clay, sand and gravel, fire clay, sandstone.
Lawrence	(2)	----------	
Lee	(2)	----------	
Limestone	73,853	67,080	Limestone.
Macon	104,990	188,178	Sand and gravel.
Madison	(2)	(2)	Limestone, miscellaneous clay.
Marengo	(2)	(2)	Cement, limestone.
Marion	(2)	(2)	Coal, kaolin, natural gas.
Marshall	(2)	(2)	Limestone.
Mobile	(2)	(2)	Petroleum, cement, oystershell, sand and gravel, miscellaneous clay.
Monroe	20,605	23,102	Sand and gravel.
Montgomery	720,657	1,410,668	Sand and gravel, miscellaneous clay.
Morgan	(2)	(2)	Limestone, sand and gravel.
Pike	1,128,638	1,724,410	Iron ore.
Randolph	(2)	(2)	Mica.
Russell	(2)	497,251	Miscellaneous clay, sand and gravel
St. Clair	(2)	(2)	Cement, limestone, miscellaneous clay, fire clay, sand and gravel.
Shelby	17,255,700	19,571,650	Cement, lime, limestone, coal, miscellaneous clay, iron ore, fire clay.
Talladega	(2)	(2)	Marble, talc.
Tuscaloosa	5,080,279	4,443,740	Coal, iron ore, sand and gravel.
Walker	19,953,360	25,482,624	Coal, fire clay.
Washington	(2)	(2)	Salt, limestone, miscellaneous clay.
Winston	581,816	575,343	Coal.
Undistributed	[3] 49,026,499	49,939,501	
Total	[3] 200,847,000	217,617,000	

[1] The following counties are not listed because no production was reported: Bullock, Chambers, Coffee, Dale, Fayette, Geneva, Hale, Lamar, Lauderdale, Lowndes, Perry, Pickens, Sumter, Tallapoosa, and Wilcox.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[3] Revised figure.

Bibb.—Four mines produced coal; the leading producers were W. E. Meacham Coal Co. (Belle Ellen No. 11 mine) and Blocton Coal Co. (Belle Ellen No. 9 mine).

Blount.—Five mines produced coal; leading producers were Alabama Coal & Ore Co., Inc. (Hopewell strip mine), and Robbins Coal Co., Inc. (Southview strip mine). Shook & Fletcher Supply Co. (Taits Gap mine) mined brown iron ore for iron and steel. Cheney Lime & Cement Co. produced masonry and slag cements at the Graystone mill. Harbison-Walker Refractories Co. (Thermal mine) and Lehigh Coal Co. (Lehigh mine) produced fire clay for firebrick and block and for other refractories. A. O. Brown quarried a small quantity of dimension sandstone for rough architectural building stone.

Butler.—Six companies mined brown iron ore for iron and steel; leading producers were Pigeon Creek Mining Co. and Woodward-Acree Mining Co. Total production of brown iron ore, 1929–60, was 1,194,000 tons.

Calhoun.—Wade Sand & Gravel Co., Inc., and John B. Lagarde, Inc., mined building sand and gravel. Donoho Foundry Co. mined fire clay for fire-clay mortar. J. E. and F. D. Brown, and Pope & Sublett mined brown iron ore for iron and steel; total production, 1906–60, was 1,355,000 tons. Agricola Brick Co. mined miscellaneous clay for heavy clay products.

Cherokee.—A. E. Burgess Co., Inc. and W. S. Fowler Equipment Rental Co. opened new quarries and crushed limestone for riprap and fill. Arrington Mining Co. reopened the Sidhart mine and produced brown iron ore for iron and steel. Wolf Creek Sand Co. mined a small quantity of molding sand.

Chilton.—Southeastern Sand-Gravel Co. mined building and paving sand and building and fluxing gravel.

Choctaw.—Crude petroleum production from 69 oil wells was 2 percent less than in 1959. One new producing well was drilled during the year.

Clarke.—Crude petroleum production from 13 oil wells declined 85 percent; one new producing well was drilled during the year. Paul Sand & Gravel Co. mined a small quantity of building sand and gravel.

Colbert.—Tri-State Limestone, Inc., Ralph Rogers & Co., Inc., and Alabama Asphaltic Limestone Co. (Maloney quarry) crushed limestone for roadstone, agstone, railroad ballast, and stone sand. Alabama Asphaltic Limestone (Margerum quarry) mined native asphalt for roadstone.

Conecuh.—Conecuh Lime Co., Inc. (Evergreen quarry), crushed limestone for agstone.

Covington.—Miller Lime Pit (Florala quarry) crushed limestone for roadstone and agstone.

Crenshaw.—McGhee & Merrill Co., Glenwood Mining Co., Inc., and Davis Bros. Mining Co. mined brown iron ore for pig iron and steel; total production, 1939–60, was 779,000 tons.

Cullman.—Six mines produced coal; leading producers were Marigold Coal, Inc. (No. 2 Strip mine), and H. E. Drummond Coal Co., Inc. (Drummond Strip mine).

Dallas.—C. Pierson Cosby and Dallas Sand & Gravel Co., Inc., mined building, paving, molding, railroad ballast, and fill sand, and building, paving, filter, railroad ballast, and fluxing gravel.

De Kalb.—Pearsall Limestone, Inc., crushed limestone for concrete and roads.

Elmore.—Alabama Gravel Co. and Birmingham Slag Co. mined building and paving sand and building and fluxing gravel. Jenkins Brick Co. mined miscellaneous clay for heavy clay products.

Escambia.—Crude petroleum production from 36 oil wells decreased 10 percent below 1959; no new producing wells were drilled during the year. Dixie Sand & Gravel Co. and Flomaton Gravel Co. mined building and paving sand and gravel. Keego Clay Products Co. mined miscellaneous clay for heavy clay products.

Etowah.—Alabama Aggregate Co. and Double R. Co. crushed limestone for concrete and roads, raprap, agstone, and fluxing stone.

Franklin.—Alabama Limestone Co. quarried dimension limestone for rubble, rought architectural, and sawed and cut building stone. U.S. Pipe & Foundry Co. (Russellville No. 15 mine), Shook & Fletcher Supply Co. (Blackburn mine), and Hester & Farned mined brown iron ore for pig iron and steel; total production, 1902–60, was 7,241,000 tons. Tennessee Valley Sand & Gravel Co. mined building and paving sand and gravel and produced fire clay for fire-clay mortar.

Greene.—Akron Sand Co. mined building and paving sand and gravel.

Henry.—Harbison-Walker Refractories Co. mined bauxite for refractories. Abbeville Lime Co. crushed limestone for agstone.

Houston.—L. C. Smith Sand & Gravel Co. and Speigner Concrete Block Co. mined building and fill sand.

Jackson.—The State highway department crushed limestone for concrete and roads. Widows Creek Mining Corp. (Sewannee strip mine) and Reames Coal Co. mined coal.

Jefferson.—Seventy-four mines produced coal; leading mines were the Concord No. 1 mine (Tennessee Coal & Iron), the Maxine mine (Alabama By-Products Corp.), and the Edgewater mine (Tennessee Coal & Iron).

Four companies produced portland cement; five companies produced masonry cement, and Southern Cement Co. produced slag cement. Leading producers of portland cement were Universal Atlas Cement Co. (Leeds mill) and Lone Star Cement Corp. (Birmingham mill). Leading producers of masonry cement were Southern Cement Co. (North Birmingham mill) and Lone Star Cement Corp. (Birmingham mill).

Tennessee Coal & Iron (Wenonah mine), Woodward Iron Co. (Pyne mine), and Republic Steel Corp. (Edwards mine) mined red iron ore for pig iron and steel. Total production of red iron ore, 1863–1960, was 298,692,000 tons.

Eight quarries crushed limestone for cement, roadstone, agstone, fluxing stone, rock dust for coal mines, lime, railroad ballast, stone sand, and refractories. Leading producers were Tennessee Coal & Iron (Dolonah quarry), Dolcito Quarry Co. (Dolcito quarry), and Universal Atlas Cement Co. (Leeds quarry).

Tennessee Coal & Iron (Ensley works) produced quicklime for chemical, industrial, and refractory use.

Seven companies mined miscellaneous clay for cement and for heavy clay products. Leading producers were Natco Corp., Universal Atlas Cement Co., and Lehigh Portland Cement Co.

Wade & Vance Sand & Gravel Co., Inc., mined building sand and gravel.

Dixie Fire Brick Co., Inc., Bibby Coal, Shale & Clay Co., and W. S. Dickey Clay Co., mined fire clay for firebrick and block, fire-clay mortar, and heavy clay products.

Universal Atlas Cement Co. and Sam P. Acton crushed sandstone for cement and refractories.

Zonolite Co. exfoliated vermiculite at its plant in Birmingham, using materials from out of State.

Limestone.—Limestone County Board of Revenue crushed limestone for concrete and roads.

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

Madison.—Madison Limestone Co. (Pluski Pike & Airport quarries) and Alabama Rock Co. crushed limestone for roadstone and agstone. Alabama Brick & Tile Co. and Huntsville Brick & Tile Co., Inc., mined miscellaneous clay for heavy clay products.

Marengo.—Lone Star Cement Corp. produced portland cement at the Demopolis mill and crushed limestone for use in making cement.

Marion.—Twenty-eight mines produced coal; leading producers were Brookside-Pratt Mining Co. (New River strip mine), Webb Excavating Co. (Brilliant strip mine), and Self & Fowler Coal Co. (No. 3 mine). Thomas Alabama Kaolin Co. (Hackelburg mine) mined kaolin for floor and wall tile, firebrick and block, fillers, and insecticides. Production of natural gas declined 67 percent.

Marshall.—C. A. Langford crushed limestone for concrete and roads.

Mobile.—Production of crude petroleum from 260 oil wells expanded 43 percent; during the year, 37 new producing wells were drilled. Ideal Cement Co. produced portland cement at the Mobile mill, using oystershell dredged from Mobile Bay, and mined miscellaneous clay for use in making cement. Bay Towing & Dredging Co. and Southern Oystershell Milling Co. dredged oystershell from Mobile Bay for cement, roadstone, and poultry grit. Radcliff Gravel Co., Inc., mined building and paving sand and gravel.

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

Montgomery.—Five companies mined building and paving sand, and building, paving, and railroad ballast gravel; the leading producer was Birmingham Slag Co. (Conley and Cooks Station mines). Jenkins Brick Co. and Excelsior Brick Co. mined miscellaneous clay for heavy clay products.

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

Pike.—Five mines produced brown iron ore for sale to iron and steel plants. Leading producers were Glenwood Mining Co., Inc. (Spring Hill mine), and Arrington Mining Co. (Brundidge mine).

Randolph.—Dixie Mines, Inc. (Dixie mine), mined scrap mica; part of the mica was shipped to Texas, and part was ground by the company and shipped to consumers. J. J. New (New mine) mined a small quantity of sheet mica.

Russell.—Bickerstaff Brick Co., Dixie Brick Co., and Bickerstaff Co., Inc., mined miscellaneous clay for heavy clay products. Con-

solidated Gravel Co., Inc., mined building, paving, and railroad ballast sand, and building and paving gravel.

St. Clair.—National Cement Co. produced masonry and portland cement at the Ragland mill. National Cement Co. and Birmingham Slag Co. crushed limestone for cement, agstone, and roadstone. National Cement Co. and Ragland Brick Co. mined miscellaneous clay for cement and heavy clay products. Riverside Clay Co. (Riverside and Pell City mines) mined fire clay for foundries and steelworks. Wolf Creek Sand Co. mined a small quantity of molding sand.

Shelby.—Southern Cement Co. produced masonry and portland cements at the Calera mill. Six limekilns produced quicklime and hydrated lime for agricultural, building, chemical, and industrial uses; leading producers were Southern Cement Co. (Roberta limekiln) and Longview Lime Corp. (Saginaw limekiln). Eight quarries crushed limestone for concrete and roads, agstone, papermills, cement, lime, riprap, fluxing stone, railroad ballast, asphalt filler, rock dust for coal mines, chemicals, and stone sand; leading producers were Birmingham Slag Co. (Calera quarry), Southern Cement Co. (Roberta quarry), and Alabama Aggregates Co. (Pelham quarry). Six mines produced coal; leading producers were River Valley Coal Co. (River Valley No. 8 mine) and Alabama Red Ash Coal Co. (No. 2 mine). Southern Cement Co. mined miscellaneous clay for cement. Shelby Sand & Ore Co. mined brown iron ore for iron and steel; total production, 1890–1960, was 1,592,000 tons. Montevallo Clay Co. mined fire clay for foundries and steelworks.

Talladega.—Thompson-Weinman & Co. (Hill quarry), Moretti-Harrah Marble Co., and Alabama Marble Co. crushed marble for terrazzo and other uses. Moretti-Harrah Marble Co. and Alabama Marble Co. quarried dimension marble for rough interior; cut, sawed, and dressed interior; cut and dressed exterior; and cut, dressed monumental stone. American Talc Co. (Winterboro mine) mined a small quantity of talc, and ground it for insecticides, paint, textiles, toilet preparations, and other uses.

Tuscaloosa.—Six mines produced coal; leading producers were Twin Seam Mining Co. (Kellerman No. 4 strip mine) and Debardeleben Coal Corp. (River Bank strip mine). Southeastern Coal & Iron Co. mined red iron ore at the Dudley mine, and Shook & Fletcher Supply Co. mined brown iron ore at the Adkins mine for pig iron and steel; total production of iron ore, 1890–1960, was 12,534,000 tons. Yazoo Gravel Co., Inc., Tuscaloosa Sand & Gravel Co., and Shackelford Construction Co. mined building and molding sand, and building gravel.

Walker.—Forty-three mines produced coal; leading producers were Southern Electric Generating Co. (Segco No. 1 mine), Alabama Power Co. (Gorgas mine), and Debardeleben Coal Corp. (Waterside strip mine). Russell Coal & Clay Co., Natco Corp., and Aaron Clay Co. mined fire clay for firebrick and block.

Washington.—Mathieson Chemical Corp. recovered salt from brine at its plant near McIntosh. Lone Star Cement Corp. crushed limestone and mined miscellaneous clay, which were shipped to Louisiana for use in making cement.

Winston.—McCoy Coal Co. mined coal at the Winston strip mine.

The Mineral Industry of Alaska

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Department of Natural Resources, State of Alaska.

By Kevin Malone,[1] Phil R. Holdsworth,[2] and Ruth Robotham[3]

DEVELOPMENTS in the oil and gas fields on Kenai Peninsula in Alaska were the outstanding features of the mineral industry of the State in 1960. Systematic drilling in the Swanson River and Soldatna Creek units by Standard Oil Co. of California resulted in 13 new oil wells and 1 gas well. Union Oil Co. of California and Ohio Oil Co. brought in an additional gas well in their Kenai unit (Kalifonsky Beach). In the first significant discovery by an independent

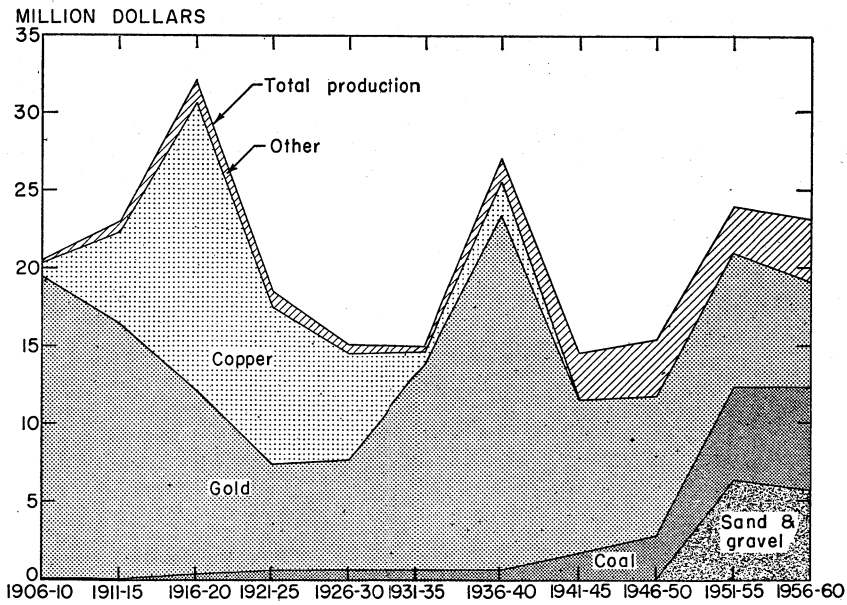

FIGURE 1.—Cumulative values of mineral production in Alaska, by major commodities, 1906–60 (five year averages).

[1] Commodity-industry analyst, Bureau of Mines, Juneau, Alaska.
[2] Commissioner, Department of Natural Resources, State of Alaska, Juneau, Alaska.
[3] Statistical clerk, Bureau of Mines, Juneau, Alaska.

in Alaska in almost 60 years, Halbouty Alaska Oil Co. and King Oil, Inc., brought in gas-discovery well No. 1B at West Fork, some 6 miles south of Soldatna Creek and 16 miles northeast of the Union-Ohio Kenai unit. In October, Standard of California and Richfield Oil Corp. began operating a 20-mile crude-oil line from the Swanson River field to tidewater at Nikiski.

The Anchorage Natural Gas Corp. gasline from the Kenai unit to Anchorage was partly laid; unusual difficulties in crossing Turnagain Arm forced a delay in completing this section until 1961.

Value of mineral production in Alaska increased 7 percent over 1959. The substantial gain in value of petroleum and natural gas, coupled with increases in value of output of coal, sand and gravel, stone, and mercury, more than offset a sizable decrease in gold production.

Coal replaced gold as the leading mineral commodity with 29 percent of total value. Gold, with 27 percent, and sand and gravel, with 25 percent, were next. Value of petroleum and natural gas increased from less than 2 percent of total mineral production in 1959 to almost 6 percent in 1960. These four commodities supplied 87 percent of mineral production in the State; mercury output, almost entirely from the Red Devil mine, Kuskokwim River region, supplied 4 percent. The Red Devil mine furnished 13 percent of the Nation's domestic mercury, placing Alaska third among the mercury-producing States. Goodnews Bay Mining Co., operating placers near Platinum in the southwestern part of the Kuskokwim River region, maintained its position as the only producer of primary platinum in the United States.

TABLE 1.—Mineral production in Alaska [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clay—short tons	180	$1	1,150	$10
Coal, bituminous—thousand short tons	660	5,869	722	6,318
Copper (recoverable content of ores, etc.)—short tons	36	22	41	26
Gold (recoverable content of ores, etc.)—troy ounces	178,918	6,262	168,197	5,887
Mercury—76-pound flasks	3,743	852	4,459	940
Natural gas—million cubic feet	133	16	246	30
Petroleum (crude)—thousand 42-gallon barrels	187	295	[2] 558	[2] 1,228
Sand and gravel—thousand short tons	5,859	5,265	6,013	5,483
Silver (recoverable content of ores, etc.) thousand troy ounces	21	19	26	23
Stone—thousand short tons	89	377	275	852
Value of items that cannot be disclosed: Gem stones, platinum-group metals, and uranium; lead (1960), and peat	----------	1,517	----------	1,061
Total Alaska	----------	20,495	----------	21,858

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

Exploration expenditures for metals and nonmetals increased 63 percent over 1959. Activities in Southeastern Alaska, where iron, copper, nickel, and limestone deposits were being investigated, supplied a large part of the increase. Work on the Ruby Creek copper

TABLE 2.—Expenditures by major companies for exploration and prospecting

(Thousand dollars)

Type and region	Expenditures	
	1959	1960
Metals exploration:		
Southeastern Alaska	$750	$1,300
Copper River and Prince William Sound	45	25
Kuskokwim River and Yukon River	225	85
Northwestern Alaska	260	400
Other	5	290
Oil and gas exploration and development: [1]		
All areas	30,798	35,000
Total	32,083	37,100

[1] Includes production expenditures.

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

TABLE 3.—Coastwise receipts and foreign mineral trade

Commodity	1958			1959		
	Coastwise receipts	Imports	Exports	Coastwise receipts	Imports	Exports
Anthracite, bituminous coal and lignite, coal and coke briquettes, and coke—short tons	798	140	----	857	30	----
Motor fuel and gasoline—thousand barrels	1,790	----	----	2,328	7	----
Gas, oil, distillate, and residual fuel oil—do	4,089	----	(1)	4,373	----	----
Petroleum asphalt—short tons	11,980	----	----	4,429	----	----
Lubricating oil and greases—thousand barrels	55	----	----	30	----	----
Petroleum products, not elsewhere classified—thousand barrels	266	----	----	146	13	----
Building cement—376-pound barrels	226,605	1,477	----	302,426	154	----
Building, monument, and other stone mfgrs., not elsewhere classified—short tons	2,953	----	----	3,499	----	----
Clays and earths—do	1,849	----	----	1,340	784	----
Brick and tile—do	1,220	----	----	1,910	----	----
Sulfur—do	----	5,233	----	----	8,110	----
Sand, gravel, and crushed rock, including limestone—short tons	83,737	----	----	739	----	----
Iron ore and concentrates—do	194	----	----	153	----	----
Iron and steel scrap—do	427	----	9,525	524	----	6,257
Iron and steel products—do	26,505	1,497	----	31,370	----	----
Aluminum metal and alloys in crude and semifabricated forms—short tons	312	----	----	307	----	----
Copper semifabricated forms—do	814	----	----	532	----	----
Lead and lead-base alloys in crude and semifabricated forms—short tons	54	----	----	20	----	----
Other nonferrous ores, concentrates, metals and scrap, except precious, in crude and semifabricated forms—short tons	5	----	----	16	----	----
Fertilizer materials—do	1,240	1,598	----	1,417	956	----

[1] Less than 1,000 barrels.

Source: Waterborne Commerce of the United States, Part 4, Pacific Coast, Alaska, and Pacific Islands, calendar years, 1958-59, by the U.S. Army Corps of Engineers.

deposit, Northwestern Alaska region, also was at a higher pace than in 1959.

Employment.—Activity at 181 mining and milling operations furnished employment for 1,715 men in 1960, compared with 253 operations and 1,733 men in 1959. Also there were 41 purely prospecting or exploration operations, employing 130 men.

Injuries.—No fatalities occurred in the mineral industry in 1960. Lost-time accidents increased from 79 in 1959 to 86. Time lost, not including allowance for two open cases, was 1,459 days.

Wages and Hours.—Mines in Alaska operated an average of 159 days. The short working period resulted from the seasonal nature of Alaska operations; in many instances severe climatic conditions restricted work to 6 or 7 months a year. Some operators worked 6 to 7 days a week and 10 hours or more a day to take advantage of favorable weather conditions.

For the mineral industries covered by the Employment Security Act (companies having at least four employees working not less than 20 weeks during the year), average monthly earnings were $747. Earnings for all mining operations except fuels were $620 per month. Coal mining monthly earnings averaged $926. In oil and gas exploration and development the figure was $806 per month.

TABLE 4.—Number of establishments in the mineral industries in 1960, classified by number of employees

Type of operation	Number of establishments employing—			
	1-9	10-19	20-29	30 and over [1]
Metal mines [2]	167	7	2	5
Nonmetal mines	63			
Quarries and mills [2]	10			
Coal mines	1		4	3
Total	241	7	6	8

[1] Includes 5 operations employing 30-39; 1 operation, 40-49; 1 operation, 60-69; 1, over 100.
[2] Includes assessment, exploration and development operations.

TABLE 5.—Employment and injuries in the mineral industries in 1960 [1]

Type of operation	Number of men working (average)	Average number of days worked	Man-days	Injuries (number)	
				Fatal	Nonfatal
Metal:					
Lode	108	117	12,672		14
Mills	6	264	1,582		
Placer:					
Dredge	390	216	84,172		22
Nonfloat	176	128	22,612		1
Hydraulic	12	115	1,385		
Small-scale hand	6	68	405		
Assessment, exploration, development, and/or prospecting [2]	262	97	25,399		4
Nonmetal mines [3]	474	139	65,685		1
Quarries and mills	109	81	8,799		
Coal	302	177	53,512		44
Total	1,845	150	276,223		86

[1] Excludes officeworkers.
[2] Includes 142 men in placer assessment, exploration, development and/or prospecting; 95 in lode; and 25 in limestone exploration.
[3] Includes sand and gravel and clay operations.

Legislation and Government Programs.—Three new wildlife ranges, totaling more than 11 million acres, were established by administrative action of the Secretary of the Interior. This action affected 9 million acres in Northern Alaska, 1.8 million acres in the Yukon-

Kuskokwim delta, and 400,000 acres in the Alaska Peninsula. Congress had failed to act on a bill to create the new ranges. Lands within the Kuskokwim National Wildlife Range were withdrawn from all forms of appropriation under the land laws except mining location and mineral leasing (PLO 22–13); the Arctic National Wildlife Range (PLO 22–14) and the Izembek National Wildlife Range (Alaska Peninsula) (PLO 22–16), were closed to mining location but open to mineral leasing.

Lease rentals on Government oil and gas lands were set at 50 cents per acre, the minimum annual rate under the amended Mineral Leasing Act passed by Congress in 1960. Under the new regulations, lessees in Alaska may hold up to 600,000 acres but not more than 300,000 in either of two zones into which the Yukon-Tanana River system divides the State. Granting of new leases was suspended from September to mid-December pending completion of the revised regulations.

Some highlights of the Battelle Memorial Institute study of economic growth in Alaska and the Canadian Northwest over the next two decades were released toward the end of the year. Made for the Alaska International Rail and Highway Commission, the study declared that oil and tourism probably would provide the stimuli for growth, projected at a 39-percent increase in population and $1.4-billion increase in annual revenue in 20 years. Construction of a rail link from Fairbanks to Central British Columbia was considered not feasible. Such a line would need an estimated $34 million annual subsidy by 1980. Instead, $240 million highway construction program of five major road projects was advocated as a necessity for developing the northwest area. Also, provision for a ferry system for passengers, automobiles, and freight along the Inside Passage from Juneau-Haines to Prince Rupert was considered vitally important. Such a system was virtually assured when voters approved the sale of $18 million in general obligation bonds to finance construction of ferry and docking facilities.

Investigations of the scientific and technical factors involved in the proposed nuclear construction of a harbor at Cape Thompson—Project Chariot—continued during the year. A non-nuclear blast to test ground characteristics was set off at Cape Thompson in November.

Port Whittier, the U.S. Army's deep-water port serving military installations in Alaska, was deactivated in September. Power, heating, firefighting, and communication facilities were kept operational and private interests and other Government agencies took over operation of some facilities. Whittier was built during World War II at a cost of $55 million.

State legislation of interest to the mining industry included the following bills: Cancelling the State uranium bonus ($10,000); permitting geophysical, geochemical, and geological work to qualify as assessment work on mining claims; authorizing (with a $1 million appropriation) the construction and maintenance of pioneer access roads into and within areas rich in natural resources; changing the due date on assessment work from July 1 to September 1; and authorizing the Department of Natural Resources to make safety and con-

servation regulations governing mining operations. An amendment to the Fish and Game Code regulations required notification to the Commissioner, Fish and Game, of any hydraulic project on a river, lake, or stream, including crossings by wheeled or track-laying equipment or by dragging supplies or gear across or through such bodies of water. The State legislature commissioned Arthur D. Little, Inc., Cambridge, Mass., to make an economic feasibility study on the use of Alaska's major natural resources. A preliminary report was scheduled for delivery to the 1961 session of the legislature.

Transportation.—Approval of higher waterborne freight rates, increased 10 percent on an interim basis early in January, was still under consideration by the Federal Maritime Board at yearend. The State, working through the Governor's Office, was fighting the increased rates. Coastwise Lines abandoned its shipping service from West Coast ports to Alaska. Puget Sound-Alaska Van Lines, Inc., began weekly barge service from Seattle and bi-weekly service from San Francisco. Puget Sound had been operating as a contract carrier for Coastwise Lines. The new service employed 3 barges, each capable of carrying 300 24-foot vans.

Trans-Pacific Freight Conference, a 27-member group including 2 U.S. lines, set up rates between Japan and 8 Alaska ports. Rates averaged 30 percent higher than those to West Coast ports because of low volume, port problems, and higher insurance rates. Some allowances were made on shipments to Anchorage. Except for minor items, the Port of Anchorage facility was completed at yearend, and schedules of rates and charges were being drawn up. The $8.2 million installation was city-owned.

In May, the first shipment of steel to be imported directly from Japan arrived at Anchorage. Other Japanese shipments included cement, pipe, construction materials, chemicals, and foodstuffs. Pipe for the Anchorage Natural Gas Corp. Kenai-Anchorage line was hauled by Danish and German freighters from mills in Scotland.

TABLE 6.—Freight rates,[1] Seattle to selected Alaskan cities

(Cents per hundred pounds)

Commodity	Seattle to—					
	Seward		Anchorage via Seward		Fairbanks via Seward	
	1959	1960	1959	1960	1959	1960
Machinery	153	161	239	257	282	300
Groceries	163	170				
Do 24,000 pound minimum			248	260	332	344
Do 60,000 pound minimum			221	233	280	292
Diesel oil	136	150				
Do 30,000 pound minimum			191	210	289	308
Ores and concentrates (Southbound only) [2]	78	86				
Do [2] 20,000 pound minimum			117½	125½	153	161

[1] Effective June 1, 1959, rates include all-risk insurance.
[2] Value not to exceed $60 per ton. Rate increases 25 percent for each additional $60 (or fraction) per ton valuation.

Source: Alaska Steamship Company.

Federal appropriations for road construction in the fiscal year ending June 30, 1961 were $35.9 million. National Forest Service highway funds and National Park Service road funds totaled $4 million. Funds available from all sources for roadbuilding, including State matching funds and pioneer access road funds, totaled $44.9 million. The Federal Government administered approximately one-third of the road construction projects in 1960. By the close of the 1960 construction season, the Federal Bureau of Public Roads had almost completed administration of highway construction involving Federal aid funds; Bureau of Public Roads activity in this field was expected to end in 1961, after which the agency will handle contracts for and supervise construction of roads in national parks and forests and perform its normal functions with respect to Federal aid projects.

Work on the Livengood-Eureka Highway was completed; bridges were built at Baker Creek, Hot Springs Slough, and the Hutlinana River. In the Nome area, a bridge moved from the Chena Slough (Fairbanks) was erected across the Kuzitrin River. On the Nome-Kougarok Highway (State Route 141), work on the 7.7-mile section from the Kuzitrin River to Coffee Creek was about two-thirds complete. The Coffee Creek-Neva Creek section of State Route 141 had been surveyed and the design for construction completed. At Fairbanks, the new four-lane bridge across Chena Slough was opened. The Alaska Highway was paved from Midway Lake to the Canadian border, thus completing the paving of the Alaska section of the highway.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—No antimony ore was mined or shipped. Small stocks produced in previous years remained at a few properties.

Beryllium.—Prospectors and representatives of mining companies showed some interest in beryl possibilities of the Seward Peninsula. The Federal Bureau of Mines investigated beryllium prospects in Southeastern Alaska and the Seward Peninsula.

Copper.—Bear Creek Mining Co., a subsidiary of Kennecott Copper Corp., proceeded with exploration of the Ruby Creek copper deposit, northwest of Shungnak, Northwestern Alaska region. Five diamond drills were used to core the deposit. Admirality Alaska Gold Mining Co. continued underground exploration of the Mertie Lode copper-nickel deposit at Funter Bay, Admiralty Island. Newmont Exploration, Ltd. (Newmont Mining Co. subsidiary), explored the Nunatak deposit at Glacier Bay by diamond drilling. The deposit has showings of copper, nickel, and cobalt.

Gold.—Output of gold dropped sharply despite a 1 percent rise in total yards washed; value was 7 percent less than that for 1959. More than 99 percent of gold produced came from placer mines. Decreased output and value were attributed to a substantial decline in the grade of gravel washed by dredging operations and in the yardage washed by nonfloat operations. Dredges handled 4 percent more gravel, but the value of gold was 6 percent less than in 1959.

For nonfloat operations, gravel washed decreased 22 percent, and value of output declined 12 percent. Dredges supplied 82 percent of the total gold output; nonfloat operations, 16 percent; and hydraulic, small-scale hand, and lode mines, 2 percent.

Of 14.3 million yards washed by all methods, dredges accounted for 13 million yards (12.5 in 1959) or 91 percent; nonfloat operations washed 1.2 million yards (1.6 in 1959) or 9 percent. Yardage of hydraulic and small-scale hand operations was only a fraction of 1 percent. Average value per yard washed for all methods decreased from 44.3 cents in 1959 to 40.9 cents. For dredging, the decrease was from 41.2 cents to 37.4 cents. Value per yard washed for nonfloat operations increased from 67.2 cents to 75.8 cents.

TABLE 7.—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)
1951–55 (average)	5	139	9,887	246,356	$8,622
1956	3	120	265	209,296	7,325
1957	4	87	11,626	215,467	7,541
1958	3	108	55	186,435	6,525
1959	2	94	617	178,918	6,262
1960	6	92	234	168,197	5,887

Year	Silver (lode and placer)		Other		Total value (thousands)
	Troy	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	33,727	$31	8	$3	$8,656
1956	28,360	26	1	(4)	7,351
1957	28,862	26	9	3	7,570
1958	23,507	22	7	3	6,550
1959	21,358	19	36	22	6,303
1960	25,934	23	64	32	5,942

[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.
[4] Less than $1,000

TABLE 8.—Fifteen leading gold-producing mines in 1960, in order of output

Rank in 1960	Rank in 1959	Mine	District	Region	Operator	Source of gold
1	1	Fairbanks Unit	Fairbanks	Yukon River	United States Smelting, Refining & Mining Co.	Dredge (4).
2	2	Nome Unit	Nome	Seward Peninsula.	do	Dredge (3).
3	4	Nyac	Aniak	Kuskokwim River.	New York-Alaska Gold Dredging Corp.	Do.
4	(1)	Chicken Creek	Fortymile	Yukon River	United States Smelting, Refining & Mining Co.	Dredge (1).
5	3	Hogatza River	Hughes	do	do	Do.
6	7	Otter Creek	Iditarod	do	Otter Dredging Co	Do.
7	5	Woodchopper Creek.	Circle	do	Alluvial Golds, Inc	Do.
8	6	Candle Creek	Fairhaven	Seward Peninsula.	Far North Development Co.	Nonfloat.
9	13	Flat Creek	Iditarod	Yukon River	Flat Creek Placers	Do.
10	12	Eureka Creek	Hot Springs	do	Strandberg & Sons	Do.
11	8	Inmachuk River	Fairhaven	Seward Peninsula.	Inmachuk Mining Co	Dredge (1).
12	(1)	Fish Creek	Fairbanks	Yukon River	Wolf Creek Mining Co	Nonfloat.
13	14	Prince Creek	Iditarod	do	Prince Creek Mining Co	Do.
14	(1)	Solomon River	Nome	Seward Peninsula.	Lee Bros. Dredging Co	Dredge (1).
15	10	Colorado Creek	Innoko	Yukon River	Strandberg & Sons	Nonfloat.

[1] Not among the 15 highest in 1959.

TABLE 9.—Gold produced at placer mines, by classes of mines and methods of recovery

Class and method	Mines producing [1]	Washing plants	Material treated (thousand cubic yards)	Gold recovered		
				Troy ounces	Value	Average value per cubic yard
Surface placers:						
Gravel mechanically handled:						
Bucketline dredges:						
1951–55 (average)	13	22	13,015	194,720	$6,815,200	$0.524
1956	13	22	12,350	161,410	5,649,350	.457
1957	12	21	14,287	177,563	6,214,705	.435
1958	13	22	16,043	150,342	5,261,970	.328
1959	13	22	12,478	146,886	5,141,010	.412
1960	15	22	12,988	138,620	4,851,700	.374
Nonfloating washing plants: [2]						
1951–55 (average)	85	85	2,930	48,160	1,685,593	.575
1956	76	76	2,295	44,533	1,558,655	.679
1957	70	70	2,224	36,211	1,267,385	.570
1958	78	78	2,077	34,664	1,213,240	.584
1959	64	64	1,578	30,307	1,060,745	.672
1960	60	60	1,229	26,602	931,070	.758
Gravel hydraulically handled:						
1951–55 (average)	14	----------	80	1,333	46,669	.583
1956	14	----------	24	866	30,310	1.258
1957	3	----------	116	974	34,090	.295
1958	9	----------	34	567	19,845	.587
1959	8	----------	25	522	18,270	.729
1960	11	----------	43	1,447	50,645	1.178
Small-scale hand:						
1951–55 (average)	25	----------	23	811	28,392	1.234
1956	17	----------	22	724	25,340	1.152
1957	2	----------	19	314	10,990	.575
1958	8	----------	14	662	23,170	1.657
1959	9	----------	11	585	20,475	1.895
1960	6	----------	1	153	5,355	5.366
Underground placers (drift):						
1951–55 (average)	2	----------	[3]	64	2,254	6.629
1956–60	----------	----------	----------	----------	----------	----------
Grand total placers:						
1951–55 (average)	139	----------	16,049	245,089	8,578,108	.534
1956	120	----------	14,692	207,533	7,263,655	.494
1957	87	----------	16,645	215,062	7,527,170	.452
1958	108	----------	18,168	186,235	6,518,225	.359
1959	94	----------	14,092	178,300	6,240,500	.443
1960	92	----------	14,261	166,822	5,838,770	.409

[1] Excludes itinerant prospectors, "snipers," "high-graders," and others, who gave no evidence of legal right to property.
[2] Includes all placer mines, using both power excavator and washing plant on dry land; when washing plant is movable, outfit is termed "dry-land dredge."
[3] Less than 1,000 cubic yards.

TABLE 10.—Mine production of gold and silver in 1960, by months, in terms of recoverable metals [1]

Month	Gold (troy ounces)	Silver (troy ounces)	Month	Gold (troy ounces)	Silver (troy ounces)
January	----------	----------	August	37,985	6,927
February	----------	----------	September	33,480	3,818
March	540	69	October	16,922	2,186
April	2,869	460	November	6,679	3,005
May	9,723	1,281	December	1,318	138
June	24,480	3,427			
July	34,201	4,623	Total	168,197	25,934

[1] Derived from mint and smelter receipts and producers' reports.

TABLE 11.—Production of gold and silver at placer mines in 1960, by regions and districts

Region and district	Mines producing	Gold (troy ounces)	Silver (troy ounces)	Total value
Cook Inlet-Susitna:				
Yentna	1	111	15	$3,899
Seward Peninsula:				
Fairhaven	8	4,933	660	173,252
Kougarok	4	1,568	158	55,023
Koyuk	3	276	24	9,682
Nome	3	39,029	4,439	1,370,033
Port Clarence	2	167	22	5,865
Yukon River:				
Circle	7	3,085	318	108,263
Fairbanks	10	80,447	12,111	2,826,606
Fortymile	8	5,335	1,191	187,803
Hot Springs	4	2,074	521	73,062
Iditarod	5	7,576	1,093	266,149
Innoko	10	4,773	608	167,605
Kantishna	3	575	150	20,261
Koyukuk	3	203	20	7,123
Melozitna	1	448	40	15,716
Rampart	4	547	37	19,178
Ruby	3	2,088	337	73,385
Other districts [1]	13	13,587	1,146	476,582
Total	92	166,822	22,890	5,859,487

[1] Includes 4 districts for which production was unreported by producer and the following districts for which quantities and values cannot be shown separately: 3 in Aniak, 1 in McGrath, Kuskokwim River region; 1 in Council, Seward Peninsula region; 2 in Chandalar, and 1 each in Hughes and Tolovana, Yukon River region.

TABLE 12.—Production of gold, silver, and other metals [1] at lode mines, in terms of recoverable metals

Year	Mines producing	Gold		Silver		Other		Total value (thousands)
		Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	5	1,268	$44	847	$1	8	$3	$48
1956	3	1,763	62	566	1	1	(2)	63
1957	4	405	14	1,836	2	9	3	19
1958	3	200	7	587	1	7	3	11
1959	2	618	22	869	1	36	22	45
1960	6	1,375	48	3,044	3	64	32	83

[1] Includes copper, lead, and zinc.
[2] Less than $1,000.

Twenty-two dredges (excluding Goodnews Bay dredging operations where gold is a byproduct of platinum placers) mined gold during the year. United States Smelting, Refining and Mining Co. in the Yukon River and Seward Peninsula regions and New York-Alaska Gold Dredging Corp. in the Kuskokwim River region were the leading producers. United States Smelting, Refining and Mining Co. operated four boats in the Fairbanks district, one at Chicken (Fortymile district), and one on the Hogatza River (Hughes district), in the Yukon River region; and three in the Nome fields, Seward Peninsula region. Reduction of operations in the Fairbanks dredge fields—only four boats digging compared with six in 1959—foreshadowed the end of an industry which contributed importantly to the opening and development of Alaska. The company had sus-

TABLE 13.—Equipment used at placer mines in 1960, by regions

Region	Number of operations [1]	Gravel washed (thousand cubic yards) [2]	Equipment used (number)				
			Bulldozers	Draglines	Hydraulic giants	Dredges	Other [3]
Bristol Bay	1						
Cook Inlet-Susitna	5	9	3		5		
Copper River	4	6	4		3		
Kuskokwim River	5	1,363	5	2	6	4	
Northwestern Alaska	3	6	3			1	
Seward Peninsula	30	3,593	24	3	10	8	3
Southeastern Alaska	1						
Yukon River	83	9,284	96	29	87	11	6
Total	132	14,261	135	34	111	24	9

[1] Includes equipment at 1 operation from which gold is a byproduct of platinum-group metals recovery, and at 39 operations, which conducted assessment, maintenance or preparatory work but made no valuable mineral recovery.
[2] Partly estimated.
[3] Includes hydraulic elevators, power units, screen stackers, suction and diesel pumps.

pended thawing operations, except on a few remnants, by the close of the 1960 season; some placer ground was being leased or subleased to other operators. Estimates were that dredging at Fairbanks would be finished by 1963 or 1964. Of the three boats digging in the Nome fields, one was hung up when the season ended. Here too, thawing was confined to remnants; operations were not expected to run beyond the 1962 season.

The number of nonfloat operations (where gravel is delivered to washing plants by bulldozer or dragline) decreased to 60 from 64 in 1959 and 78 in 1958. The increase in grade of gravel washed, already noted, was not enough to offset the decrease in yardage handled; value of output decreased 12 percent. Leading nonfloat producers were Strandberg and Sons (Hot Springs and Innoko districts, Yukon River region); Far North Development Co. (Fairhaven district, Seward Peninsula region); and Flat Creek Placers (Iditarod district, Yukon River region). Both in volume of material handled and in value of gold recovered, nonfloat operations in Alaska had decreased steadily for 5 years. To counter rising costs, operators were forced to bypass marginal ground or abandon areas formerly workable. Output in 1960 was only 55 percent of the 1951–55 average.

The Fairbanks district, Yukon River, was again the major gold-producing district in Alaska; the Nome district, Seward Peninsula region, and the Iditarod district, Yukon River region followed in value of output. The Aniak district, Kuskokwim River region, ranked fourth; the New York-Alaska Gold Dredging Corp. Nyac operation contributed most of the output.

Activity in lode gold mining continued on the low scale of recent years. Two operations in the Fairbanks district, two at Hyder (Southeastern Alaska region), one at Willow Creek and one at Valdez Creek (both Cook Inlet-Susitna region) reported small production. Rehabilitation of the Mikado and other claims in the Chandalar, north of the Arctic Circle, continued; some exploration also was done at this camp.

Placer miners sold 825 ounces of natural gold (nuggets, grains, and dust, not melted or amalgamated) to buyers and jewelers, a decline of 432 ounces from 1959.

Iron Ore.—Interest in the iron resources of Alaska remained high. Exploration and assessment work was reported on 11 deposits; 10 of which were in the Southeastern Alaska region. One company examining a Southeastern iron-ore deposit also was exploring a limestone prospect. Humble Oil and Refining Co. continued to explore its deposit near Kemuk Mountain, Bristol Bay region.

Mercury.—Output of mercury increased 19 percent in quantity and 10 percent in value over the 1959 figures. The average price per flask at New York decreased from $227.48 to $210.76. Alaska Mines and Minerals, Inc., operating the Red Devil mine, Kuskokwim River region, contributed almost the entire output. Alaska ranked third among mercury-producing States. Representatives of Japanese firms made preliminary field investigations and held exploratory talks relative to Japanese operation of mercury deposits in the Kuskokwim. The Federal Bureau of Mines continued examination of the White Mountain prospect, Kuskokwim River region. Field work in the 1960 season gave promise of an important deposit.

TABLE 14.—Mercury production

Year	Number of producing mines	Flasks	Value [1]
1951–55 (average) [2]	1	231	$60,351
1956	2	3,280	852,538
1957	2	5,461	1,348,758
1958	2	3,380	774,223
1959	2	3,743	851,458
1960	3	4,459	939,779

[1] Value calculated at average New York price.
[2] No production in 1951.

Molybdenum.—Molybdenum showings in the Hayes Glacier area, discovered in 1959, were examined to determine the extent and grade of the deposit. Preliminary tests indicated a sizable deposit. Further work was deferred until power is available in the area. The deposit is 80 miles northwest of Anchorage, Cook Inlet-Susitna region.

Nickel.—Examination of nickel deposits in Southeastern Alaska continued. At Funter Bay, Admiralty Alaska Gold Mining Co. extended the 200-level toward the Mertie Lode; some diamond drilling was done. Newmont Mining Co. continued its diamond-drilling program at Brady Glacier.

Platinum-Group Metals.—Goodnews Bay Mining Co., again the only producer of primary platinum in the United States, mined at a slightly higher rate at its dredging operations 10 miles south of Platinum, Kuskokwim River region.

Scrap Metals.—Small shipments of ferrous and nonferrous scrap were shipped from the States. Most of the ferrous scrap was exported from Anchorage to Japan.

Silver.—Small quantities of silver were produced as a byproduct of gold ores, copper ore (Nizina district, Copper River region), and lead-silver ores (Hyder district, southeastern Alaska region).

Tungsten.—Activity at Alaska tungsten deposits was limited to assessment work. Weakness in tungsten prices since the close of the General Services Administration purchasing program discouraged interest in tungsten mining.

Uranium.—Jott Mining Co. of Oklahoma City shipped uranium ore from the Ross-Adams deposit at Bokan Mountain, Prince of Wales Island, Southeastern Alaska region. Uranium production credited to the State came from ores mined in previous years and withdrawn from stockpile in 1960 when shipped for processing.

Construction of the U.S. Army Corps of Engineers nuclear power-plant (APPR–1) at Fort Greely, Yukon River region, was almost complete at yearend. The 2,000-kilowatt plant, developed for use at isolated or remote locations, was scheduled for testing in the spring of 1961.

MINERAL FUELS

Coal.—Tonnage of coal mined increased 9 percent over that of 1959; value increased 8 percent. Larger military coal contracts, 516,000 tons in fiscal 1961 compared with 456,000 in 1960, furnished the increase.

Strip mines produced 91 percent of the coal in 1960 compared with 82 percent in 1959, continued the trend away from underground coal mining. The Suntrana Mining Co. Nenana (Healy River) deposit, where 9 percent of the coal was mined, was the only underground producer credited with more than 1,000 tons. Usibelli Coal Mine, Inc., also operating in the Nenana field, bought the Suntrana properties in October, and operated the mine on a small scale at yearend.

An estimated 72 percent of the coal produced was sold for heat and power at Fort Wainwright (formerly Ladd Field) and Eielson Air Force Base near Fairbanks, at Fort Richardson and Elmendorf Air-Force Base near Anchorage, and at other military sites in Alaska. Additional quantities were sold to local utility companies for heat and power and to consumers for heating and cooking. Matanuska coal, f.o.b. mine, was priced at $13.10 per ton for steam, $13.50 for lump, and $20.00 or above for lump, home delivery; military steam coal sold at $11.00–12.00 per ton. At Fairbanks, prices were $15.40 for lump, $14.35 for chestnut No. 1, and $13.35 for chestnut No. 2, with an average $4.00 per ton delivery charge. Contract prices on large orders were appreciably lower.

One underground and six strip mines were operated compared with two and six, respectively, in 1959. Evan Jones' underground mine at Jonesville was on a maintenance basis only during 1960. Coal output continued to come from the Matanuska field, Cook Inlet-Susitna region, and the Nenana (Healy River) field, Yukon River region; only a small quantity came from the Barrow field, Northern Alaska region. Matanuska field mines (all strip) yielded 42 percent of all coal mined; Nenana mines (including Suntrana's underground operation) supplied the remaining 58 percent. Price for Matanuska coal at the tipple averaged $11.43 per ton, for Nenana coal, $6.83 per ton. All

Alaska coal averaged $8.75 per ton, compared with $8.89 in 1959. Of total tonnage mined, 47 percent was cleaned, compared with 38 percent in 1959.

TABLE 15.—Coal production by fields

(Thousand short tons and thousand dollars)

Year	Field						Total	
	Matanuska		Nenana		Barrow			
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1955	258	$3,055	381	$2,690	1	$14	640	$5,759
1956	269	3,273	457	3,055	1	46	727	6,374
1957	237	2,947	604	4,337	1	12	842	7,296
1958	290	3,532	468	3,392	1	7	759	6,931
1959	251	2,977	409	2,892	----------	----------	660	5,869
1960	300	3,434	422	2,884	----------	----------	722	6,318

No fieldwork was conducted on the Bering River coalfield. Jewell Ridge Coal Co. of Tazewell, Va., continued laboratory testing and other studies in connection with possible shipments of Bering River coals to the Orient.

Regulations for leasing State-owned coal lands became effective April 15. Lands classified by the State as coal-bearing are leased only by competitive bid. Lands upon which a coal-bearing classification is denied by State officials are open to prospecting permits; a successful prospector may convert his permit into a noncompetitive lease.

Petroleum and Natural Gas.—Systematic development of the Swanson River and Soldatna Creek units (the two units together are called the Swanson River field) on the Kenai Peninsula and completion of the Swanson River-Nikiski pipeline and terminal port facilities resulted in a four-fold increase in the value of crude petroleum produced. The first tanker of crude oil from Alaska left Nikiski for the Richmond, Calif. refinery of Standard Oil Co. of California late in October. At yearend the Nikiski line was flowing at the rate of more than 6,000 barrels per day.

Of 26 wells spudded during the year (not including 1 Swanson River well that was drilled for salt water injection), 20 were completed and 6 were drilling at yearend. Five wells spudded in 1959 were completed. The 25 field completions showed 13 productive or producible oil wells (all in the Swanson River field), 3 gas wells, and 9 dry holes. The Standard-Richfield Soldatna Creek unit, with eight producers in eight tries, was outstanding. Except for the important Halbouty-King West Fork gas discovery, exploration drilling was not successful. Seven other wildcats in various parts of the State were dry holes. Exploration and development footage drilled in 1960 was 278,045 feet compared with 141,933 feet in 1959.

Petroleum exploration continued strong in 1960. In addition to Standard-Richfield's exploration and development drilling in the Swanson River field, Colorado Oil and Gas Corp. (Dangerous River unit), Benedum and Associates (Nulato unit), Richfield Oil Corp.

TABLE 16.—Exploration and development drilling for petroleum in 1960

Unit	Location	Company	Wells							
			Drilling, start of year	Spudded [1]	Completions	Drilling, end of year	Oil productive	Gas	Dry holes	Feet drilled
Swanson River.[2]	Kenai Peninsula.	Standard-Richfield.	2	7	8	1	5	1	2	86,095
Soldatna Creek.[2]	do	do	1	9	8	2	8	------	------	99,346
Falls Creek	do	do	------	1	------	1	------	------	------	6,474
Kenai	do	Union-Ohio	------	2	1	1	------	1	------	8,737
West Fork	do	Halbouty-King.	------	1	1	------	------	1	------	14,019
Bishop Creek	do	do	------	1	1	------	------	------	1	9,034
Dangerous River.	Yakutat	Colorado Oil & Gas.	------	1	1	------	------	------	1	8,634
Kaliakh River	Yakataga	Richfield	1	2	2	1	------	------	2	29,313
Knik Arm	Cook Inlet	Union-Ohio	------	2	2	------	------	------	2	6,228
Nulato	Yukon River	Benedum Associates.	1	------	1	------	------	------	1	10,165
Total			5	26	25	6	13	3	9	278,045

[1] One Swanson River well, drilled for salt water injection, not included.
[2] The two units, together, are the Swanson River field.

Source: Alaska Division of Mines and Minerals.

TABLE 17.—Acreage under oil and gas lease

Year	Thousand acres	Year	Thousand acres
1954	1,833	1958	27,900
1955	2,519	1959	34,265
1956	2,815	1960	33,287
1957	6,516		

Source: (1954-58) Bureau of Land Management; (1959-60) Geological Survey, U.S. Department of the Interior.

(Kaliakh River unit), Union Oil Co. of California (Knik Arm unit), Pan American Oil Corp. (Napatuk Creek unit), Halbouty Alaska Oil Co. (West Fork unit), and Standard-Richfield (Falls Creek unit) had crews drilling. Field parties worked the Kandik-Yukon Flats area, Copper River basin, Alaska Peninsula, Arctic Slope, Bethel basin, and the Cook Inlet-Susitna region.

Union Oil Co. and Ohio Oil Co., joint bidders, acquired 20 of the 27 tracts offered for competitive bidding by the State at the mid-July sale. Pure Oil Co., Sunray-Midcontinental Oil Co., and L. H. Hines submitted other winning bids. The tracts, on the Kenai Peninsula and in the Nushagak area, Bristol Bay region, contain 16,506 acres.

Of 26 tracts containing 73,048 acres offered at the December sale, bids were made on 9, covering 22,867 acres. El Paso Natural Gas Products Co. acquired 15,758 acres in 5 tracts at Herendeen Bay, Alaska Peninsula region. Union-Ohio, with an offshore bid on 1,852 acres at Kalifonsky Beach, Kenai Peninsula region, and Richfield Oil Corp., with an offshore bid on 5,778 acres at Katalla, Copper River region, acquired the remaining acreage.

Anchorage Natural Gas Corp. through its subsidiary, Alaska Pipeline Co., made significant progress on the overland section of the gasline from the Union-Ohio Kenai unit (Kalifonsky Beach) to Anchorage. Attempts to lay the 8.5-mile section across Turnagain Arm were thwarted by heavy winds, strong tides, and two deep channels. Heavier gear was to be brought from the Gulf of Mexico in the spring of 1961 to complete the Turnagain crossing.

At West Fork on the Kenai Peninsula, Halbouty Alaska Oil Co. and King Oil Co. brought in an important gas discovery on a tract subleased from Alaska Oil and Mineral Co., Inc. The discovery well, 16 miles northeast of the Kenai unit and 6 miles south of Soldatna Creek, tested at 80 million cubic feet per day on open flow from a depth of 5,000 feet. Union-Ohio announced that three additional wells would be drilled in the Kenai unit; one, completed late in the year, flowed 4,100,000 cubic feet per day through 3/8-inch choke from a depth of 4,300 feet. The three Kenai unit wells drilled in 1959 had capacity enough to fulfill the Union-Ohio 20-year contract to supply Anchorage Natural Gas Corp. The new wells would permit better regulation of gas flow and provide additional information on the extent of reserves. Union-Ohio continued feasibility studies on liquefaction of Kenai gas for shipment to the Orient.

In a competitive bid lease sale of 16 tracts covering 9,105 acres of Federal lands in the Gubic gasfield, Hunt Oil Co. and allied interests were high bidders on 10 tracts, totaling 5,640 acres. Colorado Oil and Gas Corp. was high bidder on the remaining six tracts of 3,465 acres. Gubic, north of the Brooks Range on the Arctic Slope, was discovered in 1951 during the U.S. Navy program of oil exploration in Northern Alaska; it is 2 miles south of Naval Petroleum Reserve No. 4 in an area recently restored to the public domain.

NONMETALS

Clays.—Atlas Brick and Tile Co. erected a plant with a capacity of 50,000 to 60,000 brick per day a few miles from Anchorage. The company planned to use local common clay, blended with a better grade clay from Sheep Mountain, to make common, Norman, and commercial building brick for the Anchorage market. Basic Building Products, Inc., did not operate its Anchorage plant in 1960.

Gem Stones.—Raw jade for sale to lapidaries and collectors was mined on Dahl Creek, Shungnak district, Northwestern Alaska region. Shungnak Jade project continued to purchase jade produced on the Shungnak and Kobuk Rivers and Dahl Creek from Eskimo claim owners. The project, operated by Eskimos under the sponsorship of the Indian Arts and Crafts Board, supervised cutting, processing, and polishing jade into shapes for jewelry and souvenirs. Other jade miners in the Shungnak district produced jade for domestic sale and for export to Germany. Small quantities of mineral specimens, including jasper, agate, garnet, petrified wood, and metallic nuggets, were collected and sold to mineral dealers and gem collectors.

Sand and Gravel.—Tonnage of sand and gravel increased 3 percent, and value increased 4 percent over the 1959 figures. Military construction was less than in 1959, but increases in highway, commercial,

and industrial construction more than offset the decrease in military use.

TABLE 18.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1959		1960	
	Quantity	Value	Quantity	Value
Sand:				
Structural	88	$283	288	$932
Paving	378	908	633	985
Railroad ballast	(1)	(1)	47	16
Fill	(1)	(1)	194	419
Gravel:				
Structural	879	1,040	330	110
Paving	4,166	2,611	958	694
Railroad ballast	170	133	120	113
Fill	(1)	(1)	3,374	2,032
Other sand and gravel [2]	178	290	69	182
Total	5,859	5,265	6,013	5,483

[1] Included with "Other sand and gravel."
[2] Includes (1959) fill and "Other construction" sand and "Other construction" gravel; (1960) "Other construction" and "Industrial" sand, and "Other construction" and "Miscellaneous" gravel.

Average value per ton of all sand and gravel was $0.91 compared with $0.90 in 1959. Material used for State and Federal projects supplied 84 percent of total tonnage and 69 percent of total value. Of the output, 1.33 million tons (22 percent) with a value of $1.88 per ton was washed, compared with 1.26 million tons (22 percent) and $2.60 per ton in 1959. Value of unwashed sand and gravel was $0.64 per ton ($0.43 in 1959). Ten commercial operators and nine State and Federal agencies or their contractors produced sand and gravel, compared with 11 commercial and 6 Government producers in 1959. Commercial producers included the Alaska Railroad, an agency of the Department of the Interior, which is considered as a commercial producer for purposes of comparability with data published for other States.

Commercial producers accounted for 987,000 tons, or 16 percent of the output, with an average value of $1.72 per ton. Seventy-two percent of the commercial output with a unit value of $2.08, was washed; the value of unwashed material was $0.77 per ton. Twelve percent of the output by State and Federal agencies, with a value of $1.65 per ton, was washed; unwashed material was valued at $0.63 per ton.

TABLE 19.—Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1959		1960	
	Quantity	Value	Quantity	Value
Crushed and broken:				
Riprap	77	$85	83	$149
Concrete and roadstone	12	292	192	703
Total	89	377	275	852

The Alaska Division of Highways, the U.S. Bureau of Public Roads, and the U.S. Army Corps of Engineers were the major producers. Alaska Division of Highways, reflecting the takeover of road construction and maintenance from the Bureau of Public Roads, furnished 53 percent of the tonnage credited to State and Federal agencies and 54 percent of the value.

Stone.—Tonnage of stone produced increased more than three times, and value was more than twice that of 1959. The increase resulted from greater use of stone in military construction and roadwork. The entire output came from quarries operated by Government agencies or their contractors. The U.S. Army Corps of Engineers was the leading producer with 70 percent of the total tonnage and 82 percent of the value. The Alaska Railroad, owned and operated by the Federal Government, was the only producer classified as commercial.

REVIEW BY REGIONS

The Yukon River region, with placer gold from the dredge fields of Fairbanks and coal from the Nenana field as the leading mineral commodities, again led in the value of mineral production. Cook Inlet-Susitna region, with coal (Matanuska field) and sand and gravel ranked second. The Kuskokwim River region ranked third with output of mercury, platinum-group metals, and gold. There was no mineral production from the Alaska Peninsula or the Bering Sea region.

TABLE 20.—Value of mineral production in Alaska, by regions[1]

(Thousand dollars)

Region	1959	1960	Minerals produced in 1960 in order of value
Aleutian Islands	$564	$76	Sand and gravel, stone.
Bristol Bay	98	28	Sand and gravel, gold.
Cook Inlet-Susitna	5,084	5,506	Coal, sand and gravel, stone, clay, gold, silver.
Copper River	184	165	Sand and gravel, stone, copper, gold, silver, lead.
Kenai Peninsula	745	1,898	Crude petroleum, sand and gravel, natural gas.
Kodiak Island	44	89	Sand and gravel.
Kuskokwim River	1,994	2,111	Mercury, platinum-group metals, gold, silver, gem stones.
Northern Alaska	16	21	Natural gas.
Northwestern Alaska	19	33	Gem stones, gold, silver.
Seward Peninsula	1,231	1,676	Gold, stone, silver.
Southeastern Alaska	1,928	932	Sand and gravel, uranium, stone, lead, gem stones, silver, gold, copper.
Yukon River	8,588	9,323	Gold, coal, sand and gravel, stone, peat, silver.
Total	20,495	21,858	

[1] No mineral production from Alaska Peninsula and Bering Sea regions.

Alaska Peninsula.—El Paso Natural Gas Products Co. was high bidder on oil lands at Herendeen Bay (Moller subdistrict) leased by the State at the December sale. The company acquired 15,758 acres at an average bid of $1.23 per acre.

Aleutian Islands.—Sand and gravel and stone were the only mineral commodities produced. Value was only one-third of 1 percent of the total for the State.

Bristol Bay.—Humble Oil and Refining Co. reported assessment work on its iron deposits near Kemuk Mountain, Nushagak subdistrict.

No drilling for petroleum was reported for the region. Three companies reported 10 man-weeks spent on geophysical work for oil.

Cook Inlet-Susitna.—Coal and sand and gravel were the leading mineral commodities of the region, supplying almost all of the $5.5 million value of production. Small quantities of stone, clay, gold, and silver were produced.

Value of coal production, all from the Matanuska field, increased 15 percent compared with 1959; tonnage rose 20 percent. Value per ton averaged $11.43, compared with $11.84 per ton in 1959. Military contracts for Matanuska coal, which increased from 201,000 tons in 1959 to 228,000 tons in 1960, furnished the increase in the region's coal value. An estimated 76 percent of the coal mined was sold to the military. All coal in the region was strip mined. Evan Jones' underground mine at Jonesville was on a maintenance basis only for the entire year. High labor costs were given as the reason for closing the mine.

The Bureau of Mines continued to explore the Beluga River coal field. No reports were published in 1960, but an open-file report, bringing engineering and other data up to date, was being prepared for release early in 1961. Additional work on the Beluga River deposits was scheduled for 1961. Beluga River, with a large indicated reserve of coal and only 50 miles northwest of Anchorage, was a possible site for a coal-fired, mine-mouth, powerplant to serve the city's increasing power needs.

Cook Inlet-Susitna again led in production of sand and gravel in Alaska. Four commercial operations and five Government agencies or their contractors produced 2.1 million short tons valued at $2 million. The Alaska Division of Highways was the leading producer in both tonnage and value.

Construction of a cement mill in the Railbelt area moved closer to reality when Permanente Cement Co. announced plans for a $5 million plant to be built either in Anchorage or in Sutton, 50 miles northeast of Anchorage on the Glenn Highway. According to estimates, the proposed plant, with a capacity of 500,000 barrels a year would reduce cement costs in the Anchorage area 13 percent. Permanente located claims covering 240 acres of limestone deposits on the East Fork of Kings River in the Castle Mountain area (Willow Creek district). Preliminary work was to be done during 1961; plant construction, depending on results of preliminary work, was scheduled for 1962.

Tentative plans for a second cement plant, to be located in the Cantwell-Windy area 165 miles north of Anchorage on the Alaska Railroad, were also announced. Alaska Portland Cement, Ltd., purchased limestone deposits in the Windy area; plant feasibility studies were reported underway.

In petroleum activities, Union Oil Co. of California and Ohio Oil Co. drilled Knik Arm Nos. 1 and 2 in the Big Lake area 20 miles north of Anchorage. Both of the wells, drilled to depths slightly below 3,000 feet, were dry holes. Anchorage Gas and Oil Development Co. (Rosetta unit) drilled unsuccessfully north of the Knik Arm site from 1954 to 1959.

Glacier Mining Co. completed a preliminary exploration program on molybdenum showings in the Hayes Glacier area 80 miles northwest of Anchorage. Some of the major United States mining com-

panies were reported to be interested in the deposit. At the close of the 1960 field season, a spokesman for Glacier announced that work had disclosed a sizable molybdenum deposit. Because of the high development costs in the isolated area and the lack of inexpensive power, there were no immediate plans to exploit the deposit.

Gold lodes in the Willow Creek district received only a little attention. After the wide publicity given the Nation's gold problems, the small interest shown was disappointing to mining men. Lode-gold activities in the Cook Inlet-Susitna region, as elsewhere in the State, had been dormant for years.

Copper River.—Value of mineral production was less than 1 percent of the total for the State. Sand and gravel and stone supplied 73 percent of value of output; copper, gold, silver, and lead made up the remainder.

Richfield Oil Corp. continued wildcat operations on its Kaliakh River unit near Yakataga. Kaliakh No. 1 was deepened 9,206 feet to a total depth of 14,699 feet. The well was temporarily abandoned, pending results of subsequent drilling. Kaliakh No. 2, 2 miles north of No. 1 was drilled to 9,575 feet; it was a dry hole. Kaliakh No. 2 RD, a directional redrill at 4,975 feet in No. 2, was drilling at 10,532 feet at yearend. Richfield's wells are 50 miles from those drilled by Phillips Petroleum Corp. and 75 miles east of the old Katalla field, which produced 154,000 barrels of oil from shallow depths from 1903 to 1933. At the December sale of State oil lands leases, Richfield was high bidder on 5,257 acres offshore at Katalla. The company bid $1.09 per acre.

No fieldwork was reported on the coal deposits in the Bering River field. Jewell Ridge Coal Co. (Tazewell, Va.) continued laboratory and other studies in connection with future exploitation of Bering River coal.

Kenai Peninsula.—Development of the Peninsula's Swanson River field into a major oil producer during 1960 was the outstanding event in the mineral industry of the region as well as of the entire State. The Swanson River field is made up of the Swanson River and Soldatna Creek units. From 17 producing or producible wells at the end of the year, Swanson River was pumping more than 6,000 barrels per day through the newly constructed Nikiski pipeline. Plans to increase the capacity of the line from 10,000 to 30,000 barrels per day were reported underway.

During the year, of seven wells (not including one drilled for salt water injection) spudded in the Swanson River unit, four were brought in as producing oil wells and one as a gas well; one was a dry hole, and one was drilling at yearend. Of two wells spudded in 1959 and completed in 1960, one was a producing oil well and one, a dry hole. In the Soldatna Creek unit, nine wells were spudded in 1960 and one well was drilling as the year began. Of the 10 wells, 8 were completed as producing oil wells and 2 were drilling at yearend. Thus, the two units of Swanson River field showed 16 wells spudded in 1960 and 3 wells drilling as the year began; 3 of the 19 were drilling at the close of the year. Of the 16 completions, 13 were producing or producible oil wells and 1 was a gas well. Two of the wells, both in the Swanson River unit, were dry holes. Development drilling in

the two units (not including one salt water injection well) totaled 185,441 feet for the year. The Soldatna Creek unit was developed almost entirely in 1960; of 99,597 feet drilled in the unit, all but 251 feet was drilled in 1960.

Since Richfield's 1957 discovery well at Swanson River, 26 wells (including discovery well No. 34–10 but excluding 1 well drilled for salt water injection) have been spudded. Of 23 completions at the end of 1960, 17 were producing or producible oil wells; 1 was a gas well; 4 were dry holes, and 1 well was shut in when flow dropped after 8 months of production. Soldatna Creek had eight producing oil wells in eight completions. Unit productivity of Soldatna Creek wells ranged from 700 to 800 barrels per day of 38° (API) oil.

In exploratory drilling elsewhere on the Peninsula, Halbouty-Alaska Oil Co. and King Oil Co. spudded and completed two wells. On the Bishop Creek unit (north of the Kenai unit and west of Soldatna Creek unit) No. 11 was drilled to 9,034 feet, plugged, and abandoned as a dry hole. At West Fork, the company brought in a significant gas discovery, Halbouty-King No. 1B. Drilled to 14,019 feet, the well showed no oil; gas flow (free) was measured at 80 million cubic feet per day from a depth of 5,000 feet. West Fork is 6 miles south of the Soldatna Creek unit and 16 miles northeast of the Union-Ohio Kenai unit (Kalifonsky Beach). Alaska Oil and Mineral Co., leaseholder, had an interest, along with Halbouty-King, in West Fork. At yearend, no plans to exploit the new discovery had been announced.

Union-Ohio completed one of three additional wells announced for the Kenai unit; a second well was drilling at yearend. Kenai unit 14–4, completed late in November, tested at 4.1 million cubic feet per day on a 3/8-inch choke from 4,300 feet.

Early in December, Standard-Richfield spudded Falls Creek No. 1, 2 miles south of Clam Gulch and 20 miles south of the Union-Ohio Kenai unit. Falls Creek No. 1 was a directional well to tap offshore formations under Cook Inlet. Depth at yearend was 6,474 feet.

The proposed $45.8 million Bradley Lake hydropower project (Kachemak Bay) received initial approval of the U.S. Army Corps of Engineers. A 60,000-kilowatt tidewater plant at Battle River, 25 miles northeast of Homer, was proposed to relieve an anticipated power shortage in the Anchorage area.

Kodiak.—A small quantity of sand and gravel by the U.S. Navy was the only mineral output reported for the region.

Two tidelands tracts on Kodiak, near Ugak, were offered at the State's competitive oil lease sale in December. There were no bidders.

Kuskokwim River.—The region ranked third in value of mineral output. Mercury, platinum-group metals, and gold contributed almost the entire output; a small quantity of silver was produced as a by-product of gold and platinum dredging operations.

Operations at the Red Devil mine, Aniak district, Georgetown subdistrict, were the second highest in the history of the mine. The 1960 output was exceeded only by that of 1957. Red Devil, supplying almost all of Alaska's mercury, produced an estimated 13 percent of the U.S. output. Alaska Mines and Minerals, Inc., operator of Red Devil, continued its program of surface and underground explora-

tion in the search for new ore bodies. The company used an 8-inch, tractor-mounted auger equipped with tungsten-carbide cutting tips in surface prospecting. Borings were made through as much as 40 feet of overburden to obtain bedrock samples. Underground exploration, employing both crosscutting and longholing, successfully located the faulted segment of the Dolly series above the 450 level. The Dolly discovery substantially increased ore reserves at Red Devil. At the close of the year, Red Devil was sinking the main shaft (incline) from the 450 to the 600 level.

The Goodnews Bay Mining Co. platinum dredging operations 10 miles south of Platinum contributed substantially to the value of mineral output in the region. Value per yard was somewhat higher than in 1959, and the quantity produced also increased over 1959.

The New York-Alaska Gold Dredging Corp. gold dredging operations at Nyac in the southeastern part of the region contributed appreciably to the value of the mineral output of the Kuskokwim; Nyac was the third-ranking gold producer in the State, after the Fairbanks and Nome operations of the United States Smelting, Refining and Mining Co. The company had a 6½-foot dredge digging 8,000 cubic yards per day and a 1½-foot dredge digging 1,500 yards per day. The latter was used for prospecting and to determine the over-run factor—the factor by which dredge recovery exceeds the values found in drilling the ground. The over-run factor was appreciable at Nyac. A third dredge of 4 cubic feet was to be rebuilt to 6-feet boat for use in the 1961 season, bringing estimated capacity to 3 million cubic yards per year. Nyac operated 7 months in 1960.

Pan American Petroleum Corp. completed core-drilling tests in the Napatuk Creek area, Bethel district. The company was building a road to the site of the first exploratory well as the year closed.

Shell Oil Co. received a 5-year development contract on 450,000 acres 90 miles southwest of Bethel on Kuskokwim Bay. Shell held 105,928 acres in the area. The contract called for at least three exploratory wells in the 5-year period and a minimum expenditure of $950,000. Shell must also relinquish one-half the acreage before January 1, 1964.

Northern Alaska.—Value of mineral output was small, only a fraction of 1 percent of the total for the State. A small quantity of coal (less than 1,000 tons) was produced at Meade River for consumption at Barrow. Gas wells on Naval Petroleum Reserve No. 4 supplied 172 million cubic feet of natural gas, valued at $20,699, to Government agencies and to the Puget Sound and Drake powerplant at Barrow.

At the Federal Bureau of Land Management February sale, Hunt Oil Co. and Colorado Oil and Gas Corp. were successful bidders on the 16 tracts offered on the Gubic structure. The tracts are near the Colville River, northeast of Umiat and east of and adjacent to Naval Petroleum Reserve No. 4.

Field crews of 6 companies reported 92 crew-weeks on geological and geophysical work along the Arctic Slope in the 1960 season.

Northwestern Alaska.—Gem stones and gold and silver were the only mineral commodities produced. Value was only a fraction of 1 percent of the total value of mineral output in the State.

At the Ruby Creek copper deposit, Shungnak district (north of the Arctic Circle), Bear Creek Mining Co. proceeded with exploration work, chiefly diamond drilling. No progress reports were made public during the year. Bear Creek had been examining the deposits since 1957.

Seward Peninsula.—Gold, as in past years, was the leading mineral commodity produced, enabling Seward Peninsula to retain fifth rank in value of production in the State. Countering the trend in other regions, value of the Peninsula's gold production increased 35 percent over 1959. Small quantities of stone and silver, the only other mineral commodities of record, were produced.

In the Nome district, the United States Smelting, Refining and Mining Co. No. 6 dredge continued digging on the submarine beach deposit. Bedrock on this deposit is 27 feet below sea level. Dredge No. 5, floated in 1959 from the No. 3 beach, was digging naturally thawed stream gravels on Dry Creek. The No. 1 dredge, retired in 1959, was put back in service to dig a remnant between Nos. 2 and 3 beaches.

Other firms operating dredges on the Peninsula were Lee Brothers Dredging Co., Inmachuk Mining Co., Lucky Syndicate, and Nugget Mining Co. Lee Brothers worked bench gravels on the Solomon River, Nome district; Inmachuk Mining was dredging stream gravels on the Inmachuk River, Fairhaven district; Lucky Syndicate worked ground on the Kougarok River, Kougarok district; and Nugget Mining was digging bench gravels and old tailings on the Niukluk River, Council district. Nonfloat plants were operated by Far North Development Co. (Candle Creek, Fairhaven district), N. B. Tweet and Sons (Kougarok River, Kougarok district), S. W. Mining Co. (Jump Creek, Fairhaven district), and others.

General Services Administration sold, by sealed bid, the Lost River Tin mine, including patented lode and placer claims, purchase options on additional claims, plant equipment, and personal property. Lenhart J. Grothe of Red Devil was the successful bidder at $21,777. The Lost River mine is in the York Mountains 27 miles northwest of Teller and 6 miles inland.

Some fieldwork by private interests on beryllium prospects and the Esch iron property in the Sinuk River area was reported. There was no report of activity, except for assessment work, on the bismuth, graphite, or lead deposits on Seward Peninsula.

Southeastern Alaska.—The region ranked sixth in value of mineral production. Sand and gravel and uranium were the leading mineral commodities; small quantities of stone, gold, silver, copper, lead, and gem stones also were mined. The uranium production credited to the region was from ores mined previously and processed in 1960. Credits in uranium accountability are made in the year processed rather than when mined.

Output of sand and gravel was 966,000 tons valued at $816,000, compared with 736,000 tons and $1.04 million in 1959. The Alaska Division of Highways and the Bureau of Public Roads were the major producers.

Exploration activity on the iron deposits of the region remained high. Nine companies or individuals were engaged in exploring or

prospecting for iron in 1960. Columbia Iron Mining Co. continued work on a deposit at Union Bay, Cleveland Peninsula, and on the Klukwan deposit, Juneau district, Skagway subdistrict. Mt. Andrew Mining Co., a subsidiary of Utah Construction and Mining Co., diamond-drilled at Vixen Inlet, Cleveland Peninsula, and at Mt. Andrew, Kasaan Peninsula. The Poorman Group, also on Kasaan Peninsula, was explored by Prince of Wales Mining Co. W. S. Pekovich did work on deposits at Port Snettisham and Point Astley, both in the Juneau district.

Columbia Iron Mining Co. drilled or examined limestone deposits on Heceta and Wadleigh Islands. A Dahl Island limestone deposit was drilled by Ideal Cement Co.

Exploration on the Brady Glacier copper-nickel deposit north of Dundas Bay, Juneau district, continued. Fremont Mining Co. and Newmont Mining Co. had interests in the area. Moneta Porcupine Mines, Ltd., had a 10-man field party prospecting for copper near Endicott Arm and in other parts of the region. Admiralty-Alaska Gold Mining Co. did work on the Mertie Lode at Funter Bay. Mineral Basin Mining Co. drifted and diamond drilled on its gold-copper property in the Hyder district.

Colorado Oil and Gas Corp. spudded and drilled to 8,634 feet, Dangerous River No. 1, 15 miles southeast of Yakutat; the well was a dry hole. Colorado announced that British Petroleum Exploration Co. (Alaska), Inc., and Sinclair Oil and Gas Corp. had taken an interest in the 1-million-acre development contract at Yakutat. Other interests with Colorado were Frankfort Oil Co. and Continental Oil Co.

Yukon River.—Mines of the Yukon River region supplied 43 percent of the value of mineral production in Alaska. Gold, coal, sand and gravel, and stone were the leading mineral commodities. Value of gold produced declined 13 percent; value of coal was unchanged; the combined value of sand and gravel and stone, attributable largely to military construction, increased 113 percent. Total value of mineral production for the region increased 8 percent, about the same rate as that for the State.

Ten dredges, two less than in 1959, were active. United States Smelting, Refining and Mining Co. continued as the leading gold producer. It operated four dredges in the Fairbanks district (down from six in 1959); one on the Hogatza River, Hughes district; and one at Chicken, Fortymile district. Others mining by dredge were Alluvial Golds, Inc., on Woodchopper Creek, and JAK Mining Co., on Crooked Creek, both in the Circle district; Minalaska, Inc., on Ganes Creek, Ophir district; and Miscovich Brothers, on Otter Creek, Iditarod district. Miscovich Brothers took over the Otter Dredging Co. operation on Flat Creek part way through the dredge season. Dredging furnished 80 percent of the gold output of the region.

Nonfloat plants contributed 18 percent of the value of gold production in the region. Strandberg and Sons (Eureka Creek, Hot Springs district and Colorado Creek, Innoko district), Flat Creek Placers (Flat Creek, Iditarod district), Wolf Creek Mining Co. (Fish Creek and Wolf Creek, Fairbanks district), Prince Creek Mining Co.

(Prince Creek, Iditarod district), and Ruby Mining Co. (Long Creek, Ruby district) were among the leading nonfloat producers.

Lode-gold mining attracted only a little attention. Little Squaw Mining Co. continued its program of reopening and exploring some of the Chandalar lodes. Arctic Alaska Fisheries and Enterprises, Inc., worked its vein on the old Homestake property in the Fairbanks district. Ore was treated at the Cleary Hill mill. The Lookout mine at Ester Dome reported a small production.

Three strip mines and one underground mine produced coal during the year. Usibelli Coal Mine, Inc., Cripple Creek Coal Co., and Arctic Coal Co. operated strip mines in the Nenana (Healy River) field. The Suntrana Mining Co. underground mine produced coal in the early months of the year. The mine was sold to Usibelli in October, and Usibelli was working the mine on a reduced scale at yearend. A small quantity of coal was produced at Meade River for consumption at Barrow. Alaska Resources, Inc., mined a small quantity of peat from the Fox Pit, 10 miles north of Fairbanks, for use as a soil conditioner. Pit-run material sold at $3 per yard and shredded peat sold at $4.50 per yard, both f.o.b. pit.

Benedum and Associate's Nulato unit wildcat in the Anvik district was a dry hole. The well was drilled to 12,015 feet, plugged, and abandoned. Twelve companies reported 75 crew-weeks in geological or geophysical work on oil.

Chatanika Power Co. announced plans for constructing an ice dam for power development on the Chatanika River at Shovel Creek, 22 miles below Olnes. Construction by buildup spraying in winter was being studied; moss and decomposed vegetation locally available would be used to insulate in warm weather. The company's Chatanika Syphon powerplant continued in operation throughout the 1960 season.

Preliminary studies of the Rampart Dam project by the U.S. Army Corps of Engineers were underway. Planned to harness the entire flow of the Yukon, the project would create a lake 10,850 square miles in area (larger than Lake Erie) and 200 miles long. Estimates were that it would take 20 years after completion of the dam to fill the lake. Potential capacity, at 4.8 million kilowatts, would make Rampart the largest hydroelectric installation in the Western Hemisphere—2½ times the capacity of Grand Coulee. At yearend preparations were being made to move drilling equipment to the damsite.

The U.S. Army Corps of Engineers nuclear powerplant (APPR–1) at Fort Greely was still under construction at yearend.

The Mineral Industry of Arizona

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except minerals fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Arizona Bureau of Mines.

By William H. Kerns,[1] F. J. Kelly,[1] and D. H. Mullen [1]

ARIZONA'S COPPER INDUSTRY in 1960 again dominated the mineral industries of the State. One-half of the Nation's copper came from Arizona, and the metal represented $345.8 million, or 83 percent of the State's $415.8 million total value of all minerals produced. An $81.6 million increase in the value of copper was primarily responsible for the $88.9 million, or 27-percent advance in the State's total output. Resumption of copper production in January 1960 from several of the principal producing mines, which had been closed by a strike during the last 5 months of 1959, a full-year's output from these and one new major mine, and increased output from a number of the important mines accounted for the significant increase in copper production in 1960.

Output of metals (mainly copper, but including byproduct gold, silver, and molybdenum from copper-ore treatment; lead; zinc; uranium ore; and byproduct vanadium from uranium-ore treatment) furnished $379.7 million or 91.3 percent of the total value of mineral production. Nonmetals (primarily sand and gravel, cement, stone, lime, and pumice) supplied $35.8 million or 8.6 percent of the total, and fuels (coal and petroleum) accounted for the remaining $0.3 million or 0.1 percent.

Employment and Injuries.—Preliminary data compiled by the Bureau of Mines for employment and injuries in the mineral industries in Arizona in 1960, excluding the petroleum industry, are shown in table 2. Copper mines alone accounted for two-thirds of the total man-hours worked and fatal and nonfatal injuries. However, the frequency rate (injuries per million man-hours) for copper mines was lower than that of the total.

Legislation and Government Programs.—No Office of Mineral Exploration (OME) contracts were executed in Arizona in 1960. Following an announcement late in 1959 by the Office of Civil and Defense Mobilization (OCDM), the General Services Administration (GSA) called for bids to supply nonferrous soft asbestos of domestic origin for the national stockpile. The initial bids opened on April 29 were rejected, but new bids opened on June 7 were acceptable for No. 2

[1] Commodity-industry analyst, Bureau of Mines, Denver, Colo.

fiber from three apparent low bidders. Initial shipments to GSA by two operators were rejected, and no purchases had been made by the close of the year. Arizona's manganese industry was at a near standstill throughout the year as a result of completion of the Government carlot purchase program in 1959.

TABLE 1.—Mineral production in Arizona [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	120	$179	173	$260
Coal do	7	63	6	58
Copper (recoverable content of ores, etc.) short tons	430,297	264,202	538,605	345,784
Gem stones	(3)	88	(3)	120
Gold (recoverable content of ores, etc.) troy ounces	124,627	4,362	143,064	5,007
Lead (recoverable content of ores, etc.) short tons	9,999	2,300	8,495	1,988
Lime thousand short tons	123	1,666	148	2,430
Manganese ore and concentrate (35 percent or more Mn) short tons, gross weight	68,183	5,727	1,626	40
Manganiferous ore and concentrate (5 to 35 percent Mn) short tons, gross weight	10,693	234	8,677	190
Mica (scrap) short tons	3,069	55	(4)	(4)
Molybdenum (content of concentrate) thousand pounds	3,181	4,019	4,359	5,211
Petroleum (crude) thousand 42-gallon barrels	25	(4)	[5] 73	(4)
Pumice thousand short tons	487	1,153	703	1,164
Sand and gravel do	13,458	11,966	14,490	14,235
Silver (recoverable content of ores, etc.) thousand troy ounces	3,898	3,528	4,775	4,322
Stone thousand short tons	2,468	3,998	4,249	5,107
Uranium ore short tons	253,390	6,309	283,684	6,219
Zinc (recoverable content of ores, etc.) do	37,325	8,585	35,811	9,239
Value of items that cannot be disclosed: Asbestos, beryllium concentrate (1960), cement, clays (bentonite), feldspar, gypsum, mercury, perlite, pyrites, tungsten concentrate, vanadium, and values indicated by footnote 4	----------	[6] 9,811	----------	16,115
Total Arizona [7]	----------	[6] 326,862	----------	415,776

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Preliminary figure.
[6] Revised figure.
[7] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

TABLE 2.—Employment and injuries in the mineral industries [1] in 1960 [2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
Copper mines	100	9,901	23,542,174	11	476	20.7
Uranium mines	38	445	939,240	1	43	46.8
Metal mines (other)	33	528	1,102,403	3	115	107.0
Nonmetal mines	34	397	809,432	--------	9	11.1
Quarries	48	570	1,286,203	--------	24	18.7
Sand and gravel plants	70	1,438	2,602,949	1	31	12.3
Nonferrous smelters and reduction plants	9	2,516	5,705,176	1	92	16.3
Coal mines	2	18	21,680	--------	----------	----------
Total	334	15,813	36,009,257	17	790	22.4

[1] Excludes petroleum industry.
[2] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—A small quantity of 10 percent BeO ore was recovered from the Homestead lode, Yavapai County, by Earl Anderson. The hand-cobbed ore was shipped to the Beryl Ores Co., Arvada, Colo.

Copper.—Arizona again ranked first in the United States in output of copper and accounted for 50 percent of the Nation's production. Arizona copper output increased 25 percent in quantity (108,308 short tons) and 31 percent ($81.6 million) in value from 1959. Copper supplied 91 percent of the value of metals and 83 percent of the State value of all minerals produced.

TABLE 3.—Fifteen leading copper-producing mines in 1960, in order of output

Rank in 1960	Rank in 1959	Mine	District	County	Operator	Source of copper in 1960
1	1	Morenci	Copper Mountain.	Greenlee	Phelps Dodge Corp.	Gold-silver ore, copper ore, copper precipitates.
2	3	San Manuel	Old Hat	Pinal	San Manuel Copper Corp.	Copper ore.
3	2	New Cornelia	Ajo	Pima	Phelps Dodge Corp.	Gold-silver tailings, gold-silver ore, copper ore.
4	5	Lavender pit Copper Queen.	Warren	Cochise	do	Copper ore, copper precipitates.
5	6	Ray pit	Mineral Creek	Pinal	Kennecott Copper Corp.	Do.
6	4	Inspiration	Globe-Miami	Gila	Inspiration Consolidated Copper Co.	Do.
7	9	Esperanza	Pima	Pima	Duval Sulphur & Potash Co.	Copper ore.
8	8	Silver Bell Unit.	Silver Bell	do	American Smelting and Refining Co.	Copper ore, copper precipitates.
9	11	Magma	Pioneer	Pinal	Magma Copper Co.	Gold-silver ore, copper ore.
10	7	Copper Cities	Globe-Miami	Gila	Tennessee Corp.[1] Copper Cities Division.	Copper ore.
11	10	Pima	Pima	Pima	Pima Mining Co.	Do.
12	12	Bagdad	Eureka	Yavapai	Bagdad Copper Corp.	Do.
13	13	Miami	Globe-Miami	Gila	Tennessee Corp.[1] Miami Copper Co. Div.	Copper precipitates.
14	16	Old Dick	Eureka	Yavapai	Cyprus Mines Corp.	Copper-zinc ore.
15	14	Castle Dome dump.	Globe-Miami	Gila	Tennessee Corp.[1] Miami Copper Co. Div.	Copper precipitates.

[1] On June 10, 1960, Tennessee Corp. obtained lease with option to purchase all mining properties in Gila County formerly owned by Miami Copper Co.

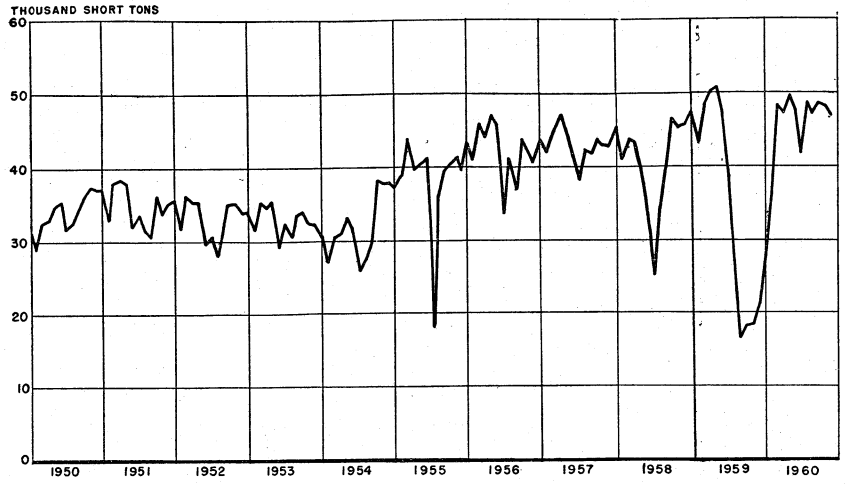

FIGURE 1.—Mine production of copper in Arizona, 1950–60, by months, in terms of recoverable metal.

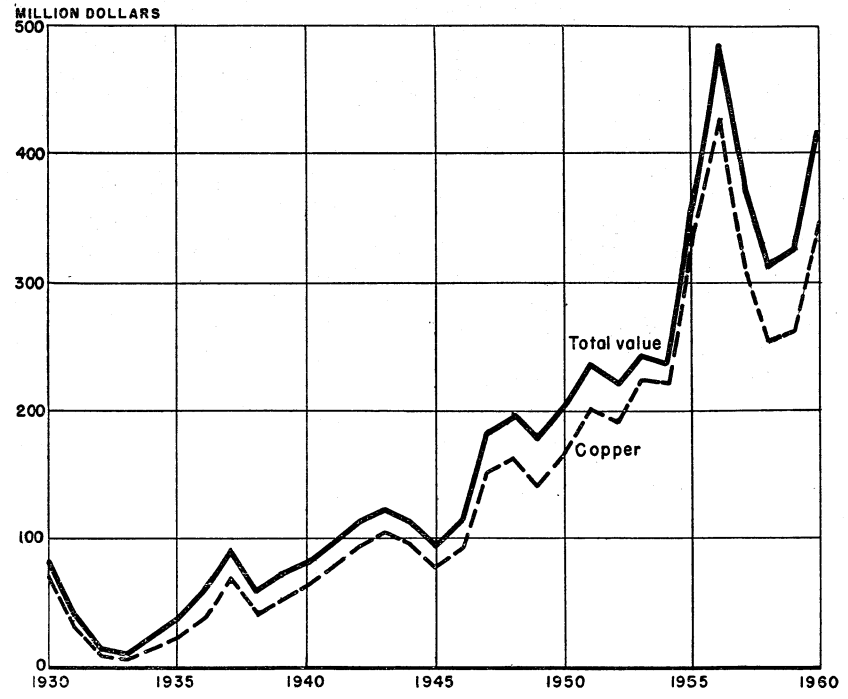

FIGURE 2.—Value of mine production of copper and total value of mineral production in Arizona, 1930–60.

TABLE 4.—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]	
	1959	1960	1959	1960	1959	1960
Open pit:						
Morenci	10,513,000	14,500,000	18,930,000	21,200,000	74,997	105,640
New Cornelia	9,823,000	9,066,000	15,060,000	14,700,000	70,949	66,693
Inspiration	5,378,848	5,314,770	3,993,262	4,105,835	47,012	46,400
Ray	2,998,888	6,523,814	[2] 7,419,324	[2] 14,467,527	29,084	58,799
Lavender	3,170,000	4,245,000	4,773,000	11,588,900	25,551	33,248
Copper Cities	3,060,575	[2] 3,058,372	[2] 1,809,488	[2] 1,666,149	18,470	16,551
Silver Bell [3]	2,776,400	2,723,200	1,602,610	1,788,470	(3)	(3)
Esperanza [3]	[4] 3,216,383	4,366,856	6,545,400	9,648,961	(3)	(3)
Pima	1,200,606	1,327,473	[2 5] 2,618,804	[2 5] 4,027,316	(3)	(3)
Bagdad	[2] 1,770,138	[2] 1,821,402	[2] 6,440,208	[2 5] 5,988,379	[6] 11,975	[6] 11,931
Castle Dome dump					[7] 2,451	[7] 2,654
Mission [3]			1,654,650	29,669,400		
Underground:						
San Manuel	7,595,867	12,261,220			46,170	81,724
Copper Queen	373,395	509,668			19,556	25,575
Magma	276,387	386,636			13,009	18,917
Miami	[8] 998,568	(9)			10,615	9,390
Daisy [10]	83,322	48,872			2,281	1,324

[1] Includes copper recovered from leaching of material in place and in dumps.
[2] Mining World Catalogue and Directory Number, Apr. 25, 1961, p. 99.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Wet weight.
[5] Cubic yards.
[6] Gross metal in concentrate shipped.
[7] Water leaching of mine dumps only.
[8] Cessation of underground mining July 1, 1959, and conversion to in-place leaching.
[9] All production from in-place leaching.
[10] Daisy-Mineral Hill in 1959—Daisy only in 1960.

Source: Company published annual reports except where otherwise specified.

Production of copper advanced from 28,000 short tons produced in January to 37,000 tons in February, and then rose to 48,000 tons in March. Slight increases and decreases were recorded above and below the March output, but the remaining 9 months averaged 47,000 tons a month. The significant increase in the first quarter resulted primarily from the resumption of output from several of the principal producing mines, which had been forced to stop operations during the last 5 months of 1959 because of a labor strike. Operations that resumed activity in the first quarter of 1960 after the strike ended included the Copper Queen and Morenci Branches of the Phelps Dodge Corp., Ray Division of Kennecott Copper Corp., and Magma and San Manuel properties of Magma Copper Co. Other major as well as smaller copper mining and milling operations and custom shippers that were not idled by the labor strike had been forced to stockpile ore or concentrate at the mines or mills or to curtail production during the strike because the smelters to which they had shipped were closed.

The 5 leading copper producers furnished 368,500 short tons, or 68 percent of the copper output, and the top 15 accounted for 530,500 tons or 98 percent. Of the five leading mines, three were operated

by Phelps Dodge Corp.; one by San Manuel Copper Corp., a subsidiary of Magma Copper Co.; and one by a division of the Kennecott Copper Corp.

The Duval Sulphur & Potash Co. Esperanza open-pit copper mine and 12,000-ton-per-day mill, which began operating in March 1959, had its first full year of operation in 1960. Maximum production was maintained. At the close of the year mine development was well advanced with six mining levels available for producing ore and three additional levels advancing in waste overburden to develop additional ore. A drilling program to evaluate a porphyry copper deposit in northwestern Arizona, begun in 1959 by Duval, was still in progress at yearend.

The $43.5 million program of American Smelting and Refining Co. (Asarco) to bring its Mission Project open-pit copper mine into scheduled production by 1962 was well advanced by the close of the year. Construction work begun in March on its $17 million 15,000-ton-per-day concentration plant and scheduled for completion in September 1961, progressed on schedule. Stripping of the 200 feet of overburden continued throughout the year; 31.3 million tons, well over half of the total preoperation stripping required, was removed by the end of the year. Principal service buildings, including the

TABLE 5.—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)
1951-55 (average)	190	9	46,215	116,739	$4,086	4,621	$4,183
1956	194	5	61,044	146,110	5,114	5,179	4,687
1957	141	8	60,166	152,449	5,336	5,279	4,778
1958	100	4	56,773	142,979	5,004	4,685	4,240
1959	101	3	53,732	124,627	4,362	3,898	3,528
1960	106	5	66,800	143,064	5,007	4,775	4,322
1860-1960			[3]	12,593,738	328,276	359,314	277,565

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951-55 (average)	407,429	$236,086	12,309	$3,806	34,363	$10,298	$258,459
1956	505,908	430,022	11,999	3,768	25,580	7,009	450,600
1957	515,854	310,544	12,441	3,558	33,905	7,866	332,082
1958	485,839	255,551	11,890	2,782	28,532	5,821	273,398
1959	430,297	264,202	9,999	2,300	37,325	8,585	282,977
1960	538,605	345,784	8,495	1,988	35,811	9,239	366,340
1860-1960	17,195,391	6,721,649	608,841	118,450	850,700	205,798	7,651,738

[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.
[3] Data not available.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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		Troyounces	Value	Troyounces	Value
Cochise	6	----	4,890,867	40,011	$1,400,385	699,941	$633,482
Gila	16	1	8,448,895	1,229	43,015	147,054	133,091
Graham	2	----	(3)	(3)	(3)	(3)	(3)
Greenlee	1	----	14,499,830	8,224	287,840	645,637	584,334
Maricopa	6	1	12,741	44	1,540	6,460	5,847
Mohave	5	----	3,309	50	1,750	26,698	24,163
Navajo	----	----	(4)	10	350	3,068	2,777
Pima	16	----	17,450,054	34,289	1,200,115	1,083,186	980,338
Pinal	19	----	19,230,448	33,962	1,188,670	1,122,464	1,015,887
Santa Cruz	3	----	[3] 32,693	[3] 40	[3] 1,400	[3] 76,494	[3] 69,231
Yavapai	24	1	2,230,986	25,090	878,150	963,540	872,052
Yuma	8	2	492	115	4,025	450	407
Total: 1960	106	5	66,800,315	143,064	5,007,240	4,774,992	4,321,609
1959	101	3	53,732,150	124,627	4,361,945	3,898,336	3,528,191

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Cochise	60,639	$38,929,853	76	$17,749	2,613	$674,089	$41,655,558
Gila	71,098	45,645,269	19	4,411	1	374	45,826,160
Graham	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Greenlee	105,640	67,820,880	----	----	----	----	68,693,054
Maricopa	5	2,953	----	----	----	----	10,340
Mohave	19	11,845	85	19,773	35	9,069	66,600
Navajo	215	138,287	(5)	94	3	877	142,385
Pima	128,838	82,714,253	1	222	3,687	951,156	85,846,084
Pinal	155,814	100,032,780	29	6,728	1	310	102,244,375
Santa Cruz	[3] 63	[3] 40,253	[3] 1,254	[3] 293,506	[3] 1,581	[3] 407,743	[3] 812,133
Yavapai	16,259	10,438,471	7,020	1,642,703	27,890	7,195,517	21,026,893
Yuma	15	9,566	11	2,644	(5)	103	16,745
Total: 1960	538,605	345,784,410	8,495	1,987,830	35,811	9,239,238	366,340,327
1959	430,297	264,202,358	9,999	2,299,770	37,325	8,584,750	282,977,014

[1] Operations at miscellaneous cleanups not counted as a producing mine.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Production of Graham County combined with Santa Cruz County to avoid disclosing individual company confidential data.
[4] Byproduct of uranium ore.
[5] Less than 1 ton.

machine shop, warehouse, and changehouse, and a 7-mile railroad spur, were completed. Development operations at Mission were described.[2]

In April, Inspiration Consolidated Copper Co. purchased and began operating the International Smelting and Refining Co. Miami copper smelter adjacent to International's concentrating plant. Concentrate and cement copper from the operation at Inspiration and material from other producers were treated at the smelter. In addition, the Inspiration refinery was expanded and placed in operation in February. The purchase of the smelter and expansion of the refinery were undertaken to anticipate the increased output expected when the Christmas mine of the company begins producing in late 1961 or early 1962 and to reduce smelting and refining costs. The purchase gave the company an integrated mining, milling, smelting, and re-

[2] Mining World, Fast Start at Mission: American Smelting Now Stripping 2,500,000 Tons a Month: Vol. 22, No. 9, August 1960, pp. 26–27.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	21	4,476	883	9,520	32,100		
Dry gold-silver	7	121,761	700	33,210	2,786,200	1,500	1,400
Dry silver	14	92,263	1	14,073	1,145,700	1,900	100
Total	42	218,500	1,584	56,803	3,964,000	3,400	1,500
Copper	44	66,032,439	115,602	3,689,622	993,370,700	800	300,500
Copper-zinc	4	147,541	92	50,555	8,454,400	31,600	17,270,500
Lead	9	4,202	128	33,738	7,200	495,400	24,200
Lead-zinc	4	337,070	24,493	919,054	837,500	16,423,600	46,930,200
Zinc	1	19,370		1,027	62,600		7,073,200
Total	65	66,540,622	140,315	4,693,996	1,002,732,400	16,951,400	71,598,600
Other "lode" material:							
Gold tailings	1	15,240	740	11,898	29,100		
Gold-silver and silver tailings	2	15,542	10	779	77,400		
Copper cleanup	[2]	10,215	56	7,237	3,284,600		
Copper precipitates	11	44,929			66,691,000		
Lead cleanup	[2]	8		184		9,100	400
Lead tailings	1	70		123		13,500	400
Lead-zinc mill cleanup	[2]	32	5	392	400	5,600	3,300
Zinc cleanup	[2]	86	217	503	300	6,200	11,000
Uranium ore			10	3,068	430,800	800	6,800
Total		86,122	1,038	24,184	70,513,600	35,200	21,900
Total "lode" material	106	66,845,244	142,937	4,774,983	1,077,210,000	16,990,000	71,622,000
Gravel (placer operations)	5		127	9			
Total, all sources	111	66,845,244	143,064	4,774,992	1,077,210,000	16,990,000	71,622,000

[1] Detail will not necessarily add to totals because some mines produce more than 1 class of material.
[2] From properties not classed as mines.

fining operation, and placed it in a position to ship the full copper output of its Inspiration and Christmas mines in the form of refined copper cathodes.

The McDonald 18-foot circular shaft at the Christmas mine, 12 miles north of Winkelman, had been sunk to 1,576 feet, 204 feet short of final depth, by the close of the year. In addition, 1,431 feet of development drifts, raises, and station excavation were driven in 1960. A circular concreted air shaft, 12 feet in diameter, with a planned depth of 1,205 feet, was completed to a depth of 462 feet. Final determination of the mill flowsheet and layout was made, equipment ordered, and construction begun. Construction of the miscellaneous service building and facilities was continued. The operation was designed for a production and milling capacity of 4,000 tons of ore per day; copper output was expected to approximate 36 million pounds per year. Christmas mine development was described.[3]

Following 3 years of deep diamond drilling and geological and geophysical surveying by its exploration subsidiary (Bear Creek

[3] Bogert, John R., Christmas Mine Development Proceeds at Fast Pace: Min. World, vol. 22, No. 8, July 1960, pp. 28–29.

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	4	1			
Cyanidation: Ore	4,211	35,145			
Total recoverable in bullion	4,215	35,146			
Concentration and smelting of concentrates:					
Ore [1]	110,446	4,216,819	[2] 963,239,600	16,706.900	71,589,000
Old tailings		123		13,500	400
Total	110,446	4,216,942	963,239,600	16,720,400	71,589,400
Direct-smelting:					
Ore	27,248	501,902	43,748,400	248,700	17,900
Copper precipitates			66,691,000		
Smelter cleanings, etc	1,028	20,993	3,391,800	20,900	14,700
Total	28,276	522,895	113,831,200	269,600	32,600
Other: Leaching of copper ore			[3] 139,200		
Placer	127	9			
Grand total	143,064	4,774,992	1,077,210,000	16,990,000	71,622,000

[1] Includes uranium-ore concentrate.
[2] Includes copper recovered from leaching of ore at one operation that employs dual-process treatment of leaching followed by flotation concentration; combined to avoid disclosing individual company confidential data.
[3] All other copper recovered by leaching was from one operation and is included with "Lode: Concentration and smelting of concentrates: Ore" as indicated in footnote reference 2.

Mining Co.) on a copper mineralized area northeast of Safford, Kennecott Copper Corp. purchased 120 mining claims in the area in 1959 and applied for patent on 53 of the claims in 1960. In addition, at the close of the year a contract was awarded to Boyles Bros. Drilling Co. for a 795-foot vertical two-compartment shaft on the property with inside dimensions of 9 feet 2 inches by 5 feet 6 inches. Another contract was to be let for drifting, crosscutting, and raising from the 3,900-foot level to be cut at a distance of 754 feet from the collar.

Phelps Dodge Corp. started exercising options to buy approximately 300 mining claims 10 miles north of Safford and 2 miles west of the property purchased by Kennecott in December. In a drilling program conducted by the company on the claims in 1959, copper mineralization reportedly was found in one hole at a depth of 1,000 feet. No immediate plans for further exploration and development of the claims, on which the options to buy were exercised, were announced. American Metal Climax, Inc., terminated its option on claims on Turtle Mountain north of the Phelps Dodge property at yearend in 1959.

By midyear 1960, three major mining companies and others had located extensive holdings of mining claims in the Twin Buttes mining area 6½ miles south of Banner Mining Co., Pima Mining Co., and American Smelting and Refining Co. (Mission Project) operations south of Tucson. Reportedly, American Metal Climax, Inc., located approximately 300 claims in the 10-square-mile area and drilled four test holes ranging in depth from 1,250 to 1,500 feet. Bear Creek Mining Co. staked claims and started drilling test holes. Asarco filed on 162 claims north of those located by American Metal Climax, Inc.

Transarizona Resources, Inc., completed a plant and development of an open-pit mine south of Casa Grande and began copper production in July. This plant was the first commercial application in the United States of the salt-coke-segregation process to recover copper from copper-silicate ore. It had a rated capacity of 250 tons of ore per day with provisions for enlargement. Salt (30 to 50 tons per week) for the chloridizing furnace was trucked from Carlsbad, N. Mex. Mining and milling operations were described.[4]

Banner Mining Co. five-compartment Palo Verde shaft was completed by Centennial Development Co. at a depth of 960 feet, short of the 1,020-foot intended mark, because an excessive quantity of water was encountered. Banner then took over development of the mine and began cutting stations and ore and waste pockets on the 700, 800, and 900 levels. By yearend 100 tons of ore per day was being produced from development work and treated in the company mill. Development work on an around-the-clock basis was continuing to bring the mine into full production of 1,000 tons per day in late 1961. Banner Mining Co. and Pima Mining Co. reached an agreement under which Pima would mine 1.8 million tons of Banner's Daisy mine ores from Pima's open pit over a 7-year period starting in 1962. Preparatory stripping to enlarge Pima's open pit, by Pima, was ahead of schedule. The ore was to be milled by Pima. Underground mining in the Daisy workings was halted by Banner. Revisions were completed at the Pima mill by Pima Mining Co., resulting in an increase in daily mill capacity from 3,000 to 3,800 tons per day.

The 500-foot Copper Queen shaft of Cyprus Mines Corp., located near its producing Old Dick mine, was completed by Centennial Development Co.; stations were cut at the 300- and 450-foot levels to intersect the vein; and a small tonnage of development copper-zinc ore was produced and treated in the Old Dick mill.

Ground-breaking ceremonies in July officially marked the start of construction of the Bagdad Copper Corp. $2 million leaching plant and auxiliary sulfuric acid plant at its Bagdad open-pit copper operation. The plant, scheduled for completion in June 1961, was designed to recover 20 tons of copper per day from low-grade oxide ore stockpiled during stripping and mining operations to produce ore for the company concentration plant.

As part of a $40 million expansion program by Kennecott Copper Corp. at its Ray operation a new water reclamation plant was completed and placed in operation in June. The new plant will recover additional water from the mill tailings using a radioactive isotope gamma ray source coupled with a detection unit to control automatically the density of the solids in the thickener. This is believed to be the first application of such a device in the copper industry. The limitations of the company water rights from the Gila River had controlled the quantity of ore that could be treated. Therefore, the availability of the additional water reclaimed was an important factor that enabled the company to increase the capacity of the Ray Mines Division from 15,000 to 22,500 tons of ore per day.

[4] Engineering and Mining Journal, Arizona Copper Silicates Respond to Segregation: Vol. 161, No. 11, November 1960, pp. 86–87.

The operating mines and plants of Miami Copper Co. in Arizona were acquired by the Tennessee Corp. on June 10, except for a royalty interest in the copper reserves which were to be sold by Miami to institutional investors for a reported $15 million. The Miami Copper Co. was to be liquidated. The transaction involved leaching operations at the Miami and Castle Dome properties and open-pit mining and milling at the Copper Cities property.

A $5 million expansion program started in 1959 by the Phelps Dodge Corp. on the Lavender open-pit mine of its Copper Queen Branch to extend the life of the mine by 7 years or more to about 14 years continued in 1960. Buildings were relocated to permit enlargement of the open pit to the southeast. Stripping in this area was started, a new diesel powerplant was completed, and four 35-ton capacity dump trucks were purchased.

Gold.—Gold output increased 15 percent and directly reflected the advance in production of copper as 81 percent of the gold was recovered from copper ore. Of the remainder, 17 percent came from lead-zinc ore, and 2 percent was recovered from miscellaneous material and other classes of ore.

Three mining operations—Copper Queen Branch and New Cornelia Branch (Phelps Dodge Corp.) and Iron King Branch (Shattuck Denn Mining Corp.), in descending order of output—furnished 69 percent of the State's gold output. San Manuel (San Manuel Copper Corp.), Magma (Magma Copper Co.), and Morenci (Morenci Branch of Phelps Dodge Corp.) supplied 28 percent.

Iron.—Ray Mines Division, Kennecott Copper Corp., continued to produce sinter (sponge iron) from pyrite recovered by the company as a byproduct of the treatment of copper ore at Hayden and from pyrite purchased from Magma Copper Co. The sinter and sulfuric acid, both produced from pyrite, were used in the leach-precipitation-flotation (L-P-F) process in the Ray concentrator.

Phelps Dodge Corp. started constructing a small plant at the company smelter at Douglas for the manufacture of sponge iron from iron oxides produced in smelting operations. The sponge iron produced will be used in the precipitation of copper from solution in the company leaching operation at Bisbee in place of detinned cans presently obtained principally from outside the State.

Southwest Iron and Steel Co. combined with the Arkota Steel Co. and broke ground near Coolidge for the construction of a plant to produce pig iron. Raw material for the plant was to come from Southwest's magnetite-bearing alluvial deposit 40 miles north of Tucson. The plant, being built by Arkota with a planned initial capacity of 75 tons of pig iron daily, will employ a sponge-iron-electric furnace process reported developed by Julius D. Madaras. The magnetite was to be mined by open-pit methods and concentrated by the magnetic separation process, then trucked to the plant.

The Colorado Fuel and Iron Corp. submitted the successful—and only—bid for an exclusive prospecting permit for iron and other minerals, including uranium, on 120,200 acres, 188 square miles, in the northwestern section of the Fort Apache Indian Reservation in Arizona. The permit was for 2 years with the right to extend it for an additional 2 years if desired. The company had made geologic

studies in the area during the past 2 years and announced that substantial reserves of iron ore had been indicated by this work.

Webb & Knapp, Inc., signed a contract in October with U.S. Bonneville Power Administration to provide power for a steel plant at Anaconda, Mont. However, a company spokesman stated this action did not mean abandonment of plans for a similar steel plant at Clarkdale. The company had announced plans in June for tripling the capacity of the projected steel mill at Clarkdale from 100,000 tons per year to 350,000 tons and for raising the cost of the mill from $15 million to $40 million. The steel would be produced from copper slag, owned by the company, remaining from the Clarkdale copper smelter (last operated in 1950).

Lead.—Lead production (8,495 short tons) dropped 15 percent compared with 1959 (9,999 short tons), and was far below the 5-year average for 1949–53 of 20,659 short tons. Two producers, Shattuck Denn Mining Corp. (Iron King mine) and Nash & McFarland (Flux mine) accounted for the bulk of the output.

Operations at the Iron King mine at Humboldt continued throughout the year without interruption. Test-drilling on the main ore structure to depths below the presently developed levels was conducted and, according to the company, confirmed the continuation of the mineralized structure. Metallurgical research was continued toward the development of new products, such as soil conditioners and plant-food supplements, which could be made from the sulfur and iron contained in the mill tailings. Ore from the Flux mine was treated in the Nash & McFarland Trench mill. In addition, some custom ore was treated in the Trench mill.

Manganese Ore and Concentrate.—When the quota was reached on the Government manganese ore and concentrate carlot-purchase program on August 5, 1959, the manganese industry in Arizona came to a near standstill, and this condition continued throughout 1960. Two operators produced manganese concentrate by treating manganese mill tailings and marketed their products commercially. Shipments of manganiferous ore and concentrate to the plant of Kaiser Steel Corp., Fontana, Calif., by Mohave Mining and Milling Co. of Wickenburg, ended in June, and Mohave liquidated all company assets by the close of the year.

Mercury.—Mercury production increased fivefold compared with 1959. All output came from three mines in the Mazatzal Mountains in Gila and Maricopa Counties, the State's principal mercury-producing area. The Turn Bull mine in Maricopa County operated by Bacon, Grimes & Brunson, partners, was the largest producer followed by the Lola Lee mine operated by Jack Ralston and the Oneida mine operated by the Oneida Mining Co.

Molybdenum.—Molybdenum was produced as a byproduct of copper mining and milling at six of the State's leading copper mines in 1960, compared with seven in 1959. Miami Copper Co. had discontinued its Miami operation in 1959, but despite the drop of one producer, output of molybdenum increased 37 percent in quantity and 30 percent in value in 1960. This substantial gain was the direct result of increased copper production. Part of the increased output was recorded by Duval Sulphur & Potash Co. at its Esperanza operation. Duval

began producing in 1959 and had its first full-year's output in 1960. The five other mines with molybdenum byproduct production were Inspiration, Morenci, Silver Bell, San Manuel, and Bagdad.

Silver.—A 22-percent increase ($794,000) in silver production directly reflected the advance in copper output, because 77 percent of the silver was recovered as a byproduct of copper ore. Most of the remainder came from lead-zinc ores, but some came from copper-zinc, lead, and gold-silver ores and miscellaneous materials treated.

Uranium.—Production of uranium ore from 64 operations in five counties was 12 percent greater than in 1959. The mine value of the ore, however, decreased 1 percent because of a decline in grade from 0.30 percent (6.0 pounds) U_3O_8 per ton in 1959 to 0.26 percent (5.2 pounds) in 1960. Major production continued to be from Apache, Coconino, and Navajo Counties. Virtually all of the ore mined in Coconino and Gila Counties was processed at the Rare Metals Corporation of America mill at Tuba City which operated the entire year. Ores from Apache and Navajo Counties were processed at mills in Colorado, New Mexico, and Utah.

TABLE 9.—Mine production of uranium ore, by counties [1]

County	1959				1960			
	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]
Apache	16	85,384	445,808	$1,846,018	19	108,835	544,279	$2,272,187
Cochise	1	22	80	285	1	15	42	118
Coconino	37	53,956	406,261	1,755,640	30	90,931	522,602	2,211,835
Gila					4	2,103	14,966	65,448
Navajo	11	[3] 114,028	[3] 661,260	[3] 2,707,429	10	81,800	405,528	1,669,840
Yavapai	1	(3)	(3)	(3)				
Total	66	253,390	1,513,409	6,309,372	64	283,684	1,487,417	6,219,428

[1] Based on data supplied to the Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowance.
[3] Production of Yavapai County combined with that of Navajo County to avoid disclosing individual company confidential data.

Vanadium.—Uranium ores in Apache County, and to a lesser extent in Navajo County, contained vanadium in sufficient quantity to warrant its recovery. Vanadium was recovered from those ores that were processed at mills equipped with vanadium-recovery units in southwestern Colorado (Climax Uranium Co. at Grand Junction and Vanadium Corporation of America [VCA] at Durango) and northwestern New Mexico (Kerr-McGee Oil Industries, Inc., at Shiprock). The quantity of vanadium recovered from ores of Arizona origin was more than double that of 1959.

Zinc.—A 4-percent decrease in quantity and 8-percent increase in value of zinc production were recorded in 1960. The increased value of output despite a drop in production reflected the rise in the weighted annual average price for zinc from 11.5 cents per pound in 1959 to 12.9 cents in 1960. The Iron King mine, operated by Shattuck Denn Mining Corp., was again by far the principal zinc producer in the State, followed by the Old Dick mine (Cyprus Mines Corp.),

Atlas mine (B. S. & K. Mining Co.), Johnson Camp mine, Moore shaft (McFarland & Hullinger), and the Flux mine (Nash & McFarland). These five producers accounted for 99 percent of the State's zinc output.

NONMETALS

Asbestos.—Shipments of asbestos from mines near Globe, Gila County, continued to decline, dropping 9 percent below 1959. However, as a result of a higher average price for fiber sold, the total value for 1960 output was 11 percent above 1959. Except for a small quantity of grades 1, 2, and 3, shipments during the year were restricted to shorts and filter fiber. Producers in order of output were: Jaquays Mining Corp. (Regal and Chrysotile mines), Metate Asbestos Corp. (Metate), Kyle Asbestos Mines of Arizona (Sloan Creek), and LeTourneau Asbestos Corp. (Asbestos Peak).

A new mill was constructed about 2 miles east of Globe by LeTourneau Asbestos Corp. The mill processed ore from the Asbestos Peak and Bore Tree Saddle properties. GSA, pursuant to an announcement late in 1959 by OCDM, called for bids to supply nonferrous, soft asbestos of domestic origin for the national stockpile. The initial bids opened on April 29 were rejected, but new bids opened on June 7 indicated the following acceptable low bidders for No. 2 fiber: Jaquays Mining Corp., 450 tons at $918 per ton; Metate Asbestos Corp., 40 tons at $920; and Kyle Asbestos Mines of Arizona, 10 tons at $925. An initial shipment of 130 tons of No. 2 crude submitted to the Government on July 20 by two operators was rejected. No purchases were made by GSA during the year. A description of the Arizona asbestos industry was published.[5]

Barite.—A report was published discussing all known barite occurrences in Arizona as well as history, ownership, and production for most of the deposits.[6]

Cement.—On June 17 ceremonies were held at the Glen Canyon damsite observing the pouring of the first load of concrete. The cement for this concrete came from the Clarkdale plant of Phoenix Cement Co. Division, American Cement Corp.

Cement requirements for the construction of the dam and a gain in consumption of cement in industrial and residential construction boosted Arizona's cement sales 61 percent above the 1959 figure. All of the portland and masonry cements produced was consumed in Arizona, except for a small quantity exported.

Plans to expand operations at the two cement plants in the State were of major importance to the industrial growth of Arizona. A building permit was issued to Arizona Portland Cement Co. to construct five new storage silos, a new finishing mill, and loading facilities for both truck and rail shipments and to lengthen the Southern Pacific spur track to reach the new loading docks at the company Rillito plant. The plant had a daily capacity of 8,000 barrels with three kilns operating on a three-shift basis. In the latter part of 1960,

[5] Mining World, Arizona Asbestos Industry Is Growing Steadily Around Globe: Vol. 22, No. 10, September 1960, pp. 44–45.

[6] Stewart, L. A., and Pfister, A. J., Barite Deposits of Arizona: Bureau of Mines Rept. of Investigations 5651, 1960, 89 pp.

Phoenix Cement Co. announced plans to increase the capacity of its Clarkdale plant by 800,000 barrels annually by constructing an additional kiln. The new kiln will bring the plant capacity to 2.6 million barrels. Details and information about the new plant at Clarkdale were published.[7]

Clays.—Despite a 58-percent drop in the production of bentonite in Apache County, the overall output of all types of clay increased 18 percent over 1959. Gains in the production of miscellaneous clay and shale in Maricopa and Pinal Counties were responsible for the increase. The addition of the Phoenix Brick Yard to the list of active quarry operations accounted for the bulk of the increased production of miscellaneous clay and shale. Gila Pottery Co., operator of the Weary Lode in Gila County, went out of business during 1960.

Feldspar.—International Minerals & Chemical Corp. (IMC) continued to be the only producer of crude and ground feldspar. Sena Mining Co. was the mine operator, and all crude output was shipped to the Kingman mill of IMC for grinding. The bulk of the ground feldspar was shipped to consumers in California, although some shipments were reported to Ohio, Texas, Washington, Utah, and Mexico.

Gem Stones.—Interest in the collection of gem or ornamental stones by individuals, societies, and dealers resulted in the collection of an estimated $120,000 worth of material in 1960. This compared with a value of $88,000 in 1959. The collection of turquois and copper specimens in Gila County and petrified wood and various mineral specimens in Yavapai County accounted for 45 percent of the total value of all gem stones collected in 1960.

Gypsum.—The gypsum industry of Arizona continued to consist of three mining operations in Pinal County, and output was 16 percent above 1959. Arizona Gypsum Corp. mined gypsum near Winkelman and sold its uncalcined output for use as a portland-cement retarder and for agricultural purposes. Garcia & Peters Gypsum Co. sold crude gypsum from its Mammoth property for agricultural uses. Union Gypsum Co., with a wallboard and lathe plant at Phoenix, was acquired by National Gypsum Co. of Buffalo, N.Y., during 1960. The mining operation supplying crude gypsum was centered at the old Harless mines near Feldman. The crude ore was trucked to Winkelman for rail shipments to the Phoenix wallboard plant.

Lime.—Production (sold or used) of lime in Arizona rose 20 percent above comparable 1959 data. The same five lime-burning operations reporting in 1959 were active in 1960. Although the bulk of the lime sold or used in 1960 was consumed within the State, some shipments were made to California, Mexico, and New Mexico. The use of lime in the concentration of metallic ores (principally copper) accounted for 88 percent of all the lime sold or used. Other smaller uses included alkalies, sand-lime and slag brick, coke and gas, glass, open-hearth furnaces, and water purification. Kennecott Copper Corp. constructed a lime plant at its Ray copper concentrator at Hayden. The plant had five vertical kilns and was to supply lime for use as a conditioning

[7] Pit and Quarry, Modern Phoenix Plant Near Clarkdale Supplying 3 Million-Bbl. Glen Canyon Dam Contract: Vol. 52, No. 8, February 1960, pp. 90–95.
Rock Products, Glen Canyon Dam Spawns Phoenix Cement: Vol. 63, No. 5, May 1960, pp. 115–134.

agent in copper flotation. No production was reported in 1960 for the new plant.

Mica.—An increase in the demand for ground mica by roofing paper and paint manufacturers resulted in a substantial gain in the mine production of scrap mica. The Buckeye Mica Co., with a mill at Buckeye and mines near Quartzite and Buckeye, accounted for nearly all of the production. James Stewart Co. produced a small quantity of ground mica from a gougelike material recovered from the Charleston mine near Tombstone. During 1960 the Tombstone Mica Co., Inc., leased the Charleston mine and laid out a development program.

Nitrogen Compounds.—Randall Mills Corp., operator of Bat Cave 600 feet above the Colorado River in Grand Canyon, did not produce or sell any guano during 1960.

Perlite.—Although Tucson Perlite, Inc., did not mine any perlite in 1960, output for the State was 5 percent above that of 1959. Increased production from the Superior operation of Harborlite Corp. was responsible for the gain. Arizona Perlite Roofs, Inc., new name for Perlite Industries of Arizona, Inc., Pinal County mining operation, produced less perlite in 1960 than in 1959. Expanding plants were operated at Phoenix by Perlite Industries of Arizona and at Tucson by Tucson Perlite, Inc. The latter plant used crude perlite mined in 1959. Building plaster, loose-fill insulation, concrete aggregate, and block manufacturing consumed all of the expanded perlite produced in 1960. Harborlite Corp. shipped its crude output to a company-owned plant in California.

Pumice.—Production and sales of pumice (scoria) continued to climb, reaching 703,000 tons, 44 percent above 1959. All six mining operations in the State recorded gains in output. The Atchison, Topeka and Santa Fe Railway Co. operated its Darling pit near Winona and was the largest producer; all the output was used for railroad ballast. The need for scoria in the manufacture of building block and for fill consumed all of the mine production of Superlite Builders Supply Co. and Paul Zanzucchi (supplying crude material to Harenberg Block Co., Inc., of Flagstaff). San Xavier Rock & Sand Co. continued to quarry scoria from its Douglas pit as did Gila Cinder Co. from its Graham County operation. Yavapai Block Co. near Ashfork began mining in 1960, at the Cruice cinder pit.

Pyrites.—Production of pyrites was slightly more than double the 1959 total. Kennecott Copper Corp., at Hayden, accounted for the bulk of the output. Magma Copper Co. shipped a small quantity to Kennecott; all the pyrite was consumed at the sulfuric acid plant of Kennecott at Hayden. Crude sulfur from Texas was used in the manufacture of sulfuric acid at plants near Benson, Chandler, and Inspiration. A contact sulfuric acid plant was under construction by Bagdad Copper Corp. at Bagdad. Crude sulfur will be used as the raw material.

Sand and Gravel.—An 8-percent increase in the production and use of sand and gravel raised the State total to 14.5 million tons valued at $14.2 million. Commercial output accounted for 44 percent, and Government-and-contractor production accounted for 56 percent of the total production. Maricopa County was the center of production

activity, with an output of nearly 6 million tons. A report [8] showed that from July 1956 to January 1961 Arizona completed, to full or acceptable interstate standards, 201.9 miles of road plus 312.4 miles of highway adequate for present traffic, for a total of 514.3 miles open to traffic. On the basis of completed mileage, Arizona ranked sixth in the Nation. However, in terms of work in progress on the interstate system, Arizona ranked 33d, with 167.5 miles in construction, engineering, or right-of-way status.

TABLE 10.—Sand and gravel production in 1960, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Apache	459	$331	Pima	975	$1,237
Cochise	1,020	747	Pinal	1,278	1,116
Coconino	2,863	3,261	Santa Cruz	5	8
Gila	277	235	Yavapai	363	307
Graham	121	130	Yuma	595	549
Maricopa	5,980	5,813	Undistributed	100	60
Mohave	139	114			
Navajo	315	327	Total	14,490	14,235

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,325	$1,672	1,448	$1,821
Paving	179	157	519	488
Engine	(1)	(1)	(1)	(1)
Oil (hydrafrac)			(1)	(1)
Fill	322	166	131	77
Other	27	17	46	172
Gravel:				
Building	1,197	1,454	1,548	1,951
Paving	1,200	1,309	2,086	2,049
Railroad ballast	(1)	(1)		
Fill	674	336	392	212
Other	192	197	201	205
Total sand and gravel	5,116	5,308	6,371	6,975
Government-and-contractor operations:				
Sand:				
Building	1	3	113	113
Paving	1,226	839	1,058	976
Fill			74	19
Gravel:				
Building	2	3	29	38
Paving	7,113	5,813	6,833	6,108
Fill			12	6
Total sand and gravel	8,342	6,658	8,119	7,260
Grand total	13,458	11,966	14,490	14,235

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."

[8] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program: Dec. 31, 1960, press release BPR 61–6, Feb. 22, 1961.

Stone.—Production of all types of stone rose to 4.2 million tons valued at $5.1 million, compared with 2.5 million tons and $4 million in 1959. Sixty-seven percent of the tonnage increase was accounted for by the Federal Bureaus of Indian Affairs and Public Roads which quarried basalt, limestone, and miscellaneous stone. A gain in the output of limestone used in the manufacture of cement and lime was largely responsible for an increase in commercial stone production.

Vermiculite.—Crude vermiculite from Montana was exfoliated at the Glendale plant of Ari-Zonolite Co. Output of finished product was 45 percent greater and was used as insulation, and in plaster and concrete aggregate, agriculture, and acoustical products.

TABLE 12.—Stone production in 1960, by counties

County	Short tons	Value	County	Short tons	Value
Apache	641,620	$646,024	Navajo	34,157	$25,618
Cochise	(1)	(1)	Pima	(1)	(1)
Coconino	1,165,056	1,081,152	Pinal	(1)	(1)
Gila	42,888	48,152	Yavapai	(1)	(1)
Greenlee	(1)	(1)	Undistributed	2,361,727	3,303,767
Maricopa	3,859	2,195			
Mohave	(1)	(1)	Total	4,249,307	5,106,908

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

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

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1956	90,899	$135,102	640	$640	1,810	$30,605	1,066,920	$1,326,602
1957	(1)	(1)	800	800	1,700	29,500	1,138,200	1,504,000
1958	(1)	(1)	(1)	(1)	3,600	62,800	1,122,800	1,399,540
1959	87,968	58,762	(1)	(1)	(1)	(1)	1,345,200	1,678,900
1960	(1)	(1)	647,441	651,845	(1)	(1)	1,782,967	2,079,263

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956	367,760	$934,070	95,000	$47,500	1,623,029	$2,474,519
1957	903,053	1,410,087	56,806	37,296	2,100,559	2,981,683
1958	322,747	1,194,746	78,831	73,483	1,527,978	2,730,569
1959	238,101	820,146	796,416	1,440,647	2,467,685	3,998,455
1960	490,339	1,175,090	1,328,560	1,200,710	4,249,307	5,106,908

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other stone."

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

Use		1959		1960	
		Quantity	Value	Quantity	Value
Dimension stone:					
Rough construction	short tons	13,229	$128,360	12,479	$91,607
Rubble	do.	634	3,238	(1)	(1)
Architectural:					
Rough	cubic feet	(1)	(1)	(1)	(1)
Approximate equivalent in short tons		(1)		(1)	
Dressed	cubic feet	(1)	(1)	(1)	(1)
Approximate equivalent in short tons		(1)		(1)	
Flagging	cubic feet	22,386	17,403	77,918	133,486
Approximate equivalent in short tons		1,681		5,844	
Other (quantity approximate in short tons)		1,857	81,345	3,356	67,047
Total dimension stone (approximate, in short tons)		17,401	230,346	21,679	292,140
Crushed and broken stone:					
Riprap	short tons	563,300	1,127,900	20,717	26,154
Metallurgical	do.	314,000	630,000	373,303	743,266
Concrete and roadstone	do.	400,668	420,362	2,292,231	2,147,404
Other	do.	[2] 1,172,316	[2] 1,589,847	[3] 1,541,377	[3] 1,897,944
Total crushed and broken stone	do.	2,450,284	3,768,109	4,227,628	4,814,768
Grand total (approximate, in short tons)		2,467,685	3,998,455	4,249,307	5,106,908

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes cement, lime, abrasives, roof granules, pottery, porcelain, tile, terrazzo, agriculture, and mineral food.
[3] Includes cement, lime, abrasives, roof granules, pottery, porcelain, tile, terrazzo, and agriculture.

MINERAL FUELS

Coal.—Coal production, from the Cow Spring No. 3 mine in Coconino County and the Keams Canyon No. 4 mine in Navajo County, was 14 percent below that of 1959.

Petroleum and Natural Gas.—Petroleum production which came from three fields in Apache County, was 73,000 barrels, nearly three times that of 1959. During the year 39 wells were completed—20 exploratory and 19 development. Of the 20 exploratory wells, 1 was listed as a discovery. The discovery well was in the southern portion of the Paradox Basin 2.5 miles northwest of the Bita Peak field. Initial production was 8 barrels of oil a day, on pump, from the McCracken (Devonian) formation at a depth of 6,758 to 6,794 feet. Two successful development wells were completed in the Dry Mesa field. Additional drilling was done in the Pinta Dome area, primarily for the development of shallow helium gas reserves. Drilling activity was uneventful; however, an increased interest in the possibility of substantial production was evidenced by a rise in leasing, which reached 2 million acres during the year.

REVIEW BY COUNTIES

Apache.—Output of uranium ore and byproduct vanadium from uranium-ore milling accounted for three-quarters of the $5.2 million value of mineral production in the county. Apache County led the State in the production of these two commodities. Uranium ore,

nearly all of which was processed at mills in Colorado and New Mexico, was produced at 19 operations. Principal producers were Kerr-McGee Oil Industries, Inc., at the Mesa group mines and VCA at the Monument No. 2 mine. Most of the uranium ores mined contained a significant quantity of vanadium which was recovered from those ores processed at mills equipped with vanadium-recovery units, in Colorado and New Mexico. The quantity of vanadium recovered was substantially greater than in 1959.

Petroleum production from three fields nearly tripled that of 1959. Of the 39 wells drilled in the State, 34 were in Apache County. Drilling totaled 81,763 feet. Three of the wells completed (one exploratory and two development) were successful.

The production of nonswelling bentonite by Alba Mining Co. in the Sanders area continued to decline. A shift in highway construction resulted in a substantial drop in output of sand and gravel, but because of road construction by the Federal Bureaus of Indian Affairs, Forest Service, and Public Roads, output of stone rose from 35,700 tons in 1959 to 641,600 in 1960.

TABLE 15.—Value of mineral production in Arizona, by counties

County	1959	1960	Minerals produced in 1960, in order of value
Apache	[1] $4,253,943	[2] $5,212,471	Uranium ore, vanadium, stone, sand and gravel, petroleum, clays, gem stones.
Cochise	31,963,199	44,255,697	Copper, gold, lime, stone, sand and gravel, zinc, silver, pumice, lead, gem stones, mica (scrap), uranium ore.
Coconino	4,884,107	7,622,708	Sand and gravel, uranium ore, stone, pumice, coal, gem stones.
Gila	50,239,827	47,186,532	Copper, molybdenum, asbestos, sand and gravel, silver, lime, uranium ore, stone, gold, gem stones, lead, mercury, zinc.
Graham	153,582	150,596	Sand and gravel, pumice, lead, gem stones, copper, zinc, silver, gold.
Greenlee	48,084,455	70,413,650	Copper, molybdenum, lime, silver, gold, stone, gem stones.
Maricopa	6,698,542	6,384,838	Sand and gravel, mica (scrap), clays, manganese ore and concentrate, manganiferous ore and concentrate, mercury, gem stones, silver, copper, stone, gold.
Mohave	982,759	346,651	Sand and gravel, stone, feldspar, silver, manganiferous ore and concentrate, lead, copper, zinc, gem stones, gold.
Navajo	3,170,572	2,220,445	Uranium ore, sand and gravel, copper, coal, stone, vanadium, gem stones, silver, zinc, gold, lead.
Pima	[1] 91,325,129	98,271,821	Copper, cement, molybdenum, sand and gravel, gold, silver, zinc, stone, clays, gem stones, manganiferous ore and concentrate, lead.
Pinal	61,236,788	106,722,094	Copper, molybdenum, gold, sand and gravel, silver, gypsum, lime, pyrites, stone, perlite, manganiferous ore and concentrate, clays, lead, gem stones, zinc.
Santa Cruz	1,130,477	816,087	Zinc, lead, silver, copper, sand and gravel, gold, gem stones.
Yavapai	21,643,699	26,710,885	Copper, zinc, cement, lead, gold, silver, stone, lime, sand and gravel, molybdenum, gypsum, gem stones, pumice, beryllium concentrate.
Yuma	1,794,254	584,511	Sand and gravel, gem stones, copper, gold, manganiferous ore and concentrate, lead, silver, mica (scrap), zinc.
Undistributed [3]	[1] 683,649	589,255	
Total [4]	[1] 326,862,000	415,776,000	

[1] Revised figure.
[2] Petroleum value is preliminary.
[3] Includes tungsten concentrate (1960) and some manganese ore and concentrate (1959), stone (1960), manganiferous ore and concentrate (1960), sand and gravel (1960), and gem stones that cannot be assigned to specific counties.
[4] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

Cochise.—Copper accounted for 88 percent ($38.9 million) of the $44.3 million value of mineral production in the county. Gold and silver output, recovered primarily as byproducts of copper ore, supplied 3 percent and 1 percent, respectively, of the total value. Other metals produced included lead, zinc, and uranium ore.

Copper Queen Branch, Phelps Dodge Corp., accounted for most of the copper and gold from its Copper Queen underground mine and Lavender open-pit mine at Bisbee. This operation was the State's fourth-largest copper producer. According to the company annual report, 509,700 tons of ore was produced from the Copper Queen mine, from which 25,575 tons of copper was recovered, and 4,245,000 tons of ore was produced from the Lavender mine, which yielded 33,248 tons of copper. The ratio of waste and leach material to ore mined at the Lavender pit increased to 2.73 to 1, compared with 1.51 to 1 in 1959, because of the increased stripping requirements in connection with the pit expansion program. Part of the ore from the Copper Queen mine was shipped to the company smelter at Douglas, and part was treated at the concentrator at Bisbee. All of the ore from the Lavender pit went to the concentrator. The concentrate and the precipitates from leaching were shipped to the Douglas smelter.

Johnson Camp—Burro and Chocora claims operated by Strong & Harris, Inc., and Moore shaft operated by McFarland & Hullinger—the county's second largest copper producer, was the principal zinc producer. Some lead and zinc was recovered from ores produced from the Burrito De Fierro and March mines, and a small quantity of copper came from the Paramount mine. A small quantity of uranium ore was produced at the Star No. 1 mine and shipped to the mill at Tuba City for processing.

Increased output of lime, pumice (scoria), sand and gravel, and stone resulted in nonmetallic production valued at $2.6 million, compared with $2.1 million in 1959. The Paul Lime Plant at Paul Spur was responsible for all the lime output and a portion of the increased production of limestone. San Xavier Rock & Sand Co. mined a larger quantity of scoria from its Bernardino scoria deposit for use at its Douglas building-block plant. Quarrying of sandstone used for smelter flux and crushed marble for terrazzo also increased. Crews of the State highway department produced all of the sand and gravel for road maintenance and construction. The Charleston mine of James Stewart Co. was active for only a short time during the year, and thus output of sericite mica was drastically reduced.

Coconino.—Nonmetallic mineral output in Coconino County was $5.4 million or 71 percent of the total value. Sand and gravel was the most important product in terms of value; crews of the State highway department produced the bulk of this material. The Federal Bureaus of Public Roads, Indian Affairs, and the Forest Service accounted for a large portion of the total stone quarried. Road construction and maintenance were the major uses. Dimension sandstone quarries in the county yielded 13,810 tons of flagging, rough construction and architectural stone, and rubble. The county was the principal source of pumice (scoria) in Arizona, with mining operations conducted by Atchison, Topeka & Santa Fe Railway Co., Paul Zanzucchi (Harenberg Block Co., Inc.), and Superlite Builders Supply Co.

Uranium ore production accounted for $2.2 million (29 percent) of the county's total value of mineral production. The county ranked second in the State in production of uranium ore. Except for a small quantity shipped to a mill in New Mexico, the entire output was processed at the Rare Metals Corporation of America mill at Tuba City. The leading producers were Western Gold & Uranium, Inc., operating the Orphan mine on the rim of the Grand Canyon, and Rare Metals Corp. at the Huskon group and other mines in the Cameron district. A number of independent operators in the Cameron district also produced uranium ore. The contract for the purchase of uranium oxide concentrate from the Tuba City mill by the AEC will terminate on March 31, 1962, and extension of the contract was largely dependent on the quantity and grade of ore that could be allocated to the Orphan mine, the principal mining operation in the State. Legislation was introduced in the Congress that would permit Western Gold & Uranium, Inc., to mine all uranium ore in the Orphan claim and in adjacent Grand Canyon National Park lands over a period of years; in exchange Western Gold & Uranium, Inc., would deed title to company-owned land in Grand Canyon National Park to the National Park Service. No action was taken on the proposed legislation, and the problem remained unsolved at the end of the year.

Coal was produced at the Cow Springs No. 3 mine by Lawrence Isaac Coal Co.

Gila.—Copper accounted for 97 percent ($45.6 million) of the value of all minerals produced in Gila County ($47.2 million). Most of the copper came from four principal producers—Inspiration, Copper Cities, Miami (in-place leaching), and Castle Dome (dump leaching).

The Inspiration mine, leaching plant, concentrator, smelter, and refinery of Inspiration Consolidated Copper Co., the sixth largest copper producer in the State, were operated at capacity throughout the year. Operations at the mine were scheduled to meet the ore demand for the metallurgical plants, partly on a 6-day-per-week and partly on a 7-day-per-week basis during the year. The leaching plant, concentrator, and refinery operated on a 7-day-per-week three shifts-per-day basis. The smelter operation was varied as necessary to handle the tonnage from the Inspiration mill and outside shippers. According to the company annual report, 5.3 million tons of ore was mined with a copper content of 0.396 percent in the oxide minerals and 0.482 percent in the sulfide minerals. A total of 4.1 million tons of waste was removed of which 1.2 million tons was segregated and placed on a dump for leaching to recover the contained copper. A total of 75.7 million pounds of copper or 15.89 pounds per ton of ore treated was recovered from Inspiration ore, and 5.1 million pounds was recovered from the leaching of dumps and ore in place. The Inspiration refinery was expanded during the year. Inspiration purchased the International Smelting and Refining Co. copper smelter at Inspiration and assumed operation of the plant on April 1. The company continued International's policy of buying and treating custom ores and concentrates. It also enlarged the refinery and purchased the smelter to anticipate increased production expected

from its Christmas mine and to reduce the costs of smelting and refining.

Development and construction activities at the Christmas underground copper mine by Inspiration continued throughout the year. Surface plant construction was on schedule, but a greater-than-expected inflow of water caused delays in the mine development schedule that possibly could defer the beginning of production until sometime in the first half of 1962.

The Copper Cities mining and milling operation, Miami leaching-in-place operation, and Castle Dome dump-leaching operation, the county's second, third, and fourth largest producers of copper, respectively, were acquired by the Tennessee Corp. from Miami Copper Co. on June 10 except for a royalty interest in the copper reserves, which was to be sold by Miami to institutional investors.

Most of the gold and silver production of the county was recovered as a byproduct of the treatment of copper ores by the leading producers. All of the molybdenum production was recovered from the Inspiration copper ore. Most of the lead was recovered from ore produced from the 79 Mine by Charles E. Goetz. Mercury output came from the Lola Lee mine operated by Jack Ralston.

Although there was a 9-percent decrease in the sales of asbestos fiber in 1960, the value rose 11 percent because of a higher average price for material sold. Mines in the vicinity of Globe were the source of all the asbestos produced in Arizona and the western United States.

Uranium ore from the Hope group of claims and the Little Joe mine was produced by H. C. Smith and Arizona Continental Uranium Co., respectively. All output was shipped to the mill at Tuba City for processing.

Graham.—Gem stones, pumice, and sand and gravel accounted for 97 percent of the total value of mineral production. Gila Cinder Co. continued to mine scoria from its deposit near Safford for use at the Gila Valley Block Co. plant. Contractors for the State highway department produced 120,700 tons of paving sand and gravel. Metals output (gold, silver, copper, lead, and zinc) came from copper and lead ores from the Coronado mine (L. Parcher) and Sein Fein mine (Holiday Mining Co.), respectively.

Greenlee.—The Morenci open-pit mine, operated by the Morenci Branch, Phelps Dodge Corp., was again the State's leading copper producer. It was the third largest molybdenum and silver producer and ranked sixth in output of gold, all recoverd as byproducts of copper ore. According to the company annual report, 35.7 million tons of material was handled, of which 14.5 million tons was ore. The ratio of waste and leach material to ore mined was 1.46 to 1. A total of 105,640 tons of copper was recovered from milling and leaching operations. In extending the pit mining area to include additional ore indicated by drilling, the company relocated former mine shop buildings. Two electric shovels with 9-cubic-yard dippers were purchased to replace two older shovels with 6-cubic-yard dippers. The company continued to operate a limekiln at the property to supply lime for metallurgical purposes.

Maricopa.—Mainly because of a substantial drop in the shipment of manganese ore and concentrates (35 percent or more Mn) and an equally significant gain in the consumption of sand and gravel, the contribution of nonmetallic production to the total value of all minerals produced rose to 98 percent compared with 81 percent in 1959. Maricopa County was the leading producer of sand and gravel in the State with output reaching nearly 6 million tons, a 27-percent increase over 1959. Fourteen commercial operations produced 4.7 million tons, and Government-and-contractor operations produced the remainder. Union Rock & Materials Co. and Superior Sand & Gravel Division, Fisher Contracting Co., were the principal commercial producers. Wallapai Brick & Clay Products, Inc., and Phoenix Brick Yard operated brick and heavy clay products plants using miscellaneous clay and shale mined within the county. The grinding mill of Buckeye Mica Co. operated on an accelerated basis during the year, and sales were considerably higher than in 1959.

The decline in manganese ore and concentrate production (shipments) resulted from the completion of the Government carlot-purchase program in 1959. The small quantities of manganese concentrate shipped in 1960 were recovered by treating manganese mill tailings. Some manganiferous ore was shipped from the Black Rock mine to the Kaiser Steel Corp., Fontana, Calif., by Mohave Mining and Milling Co. Mercury was produced from the Turn Bull mine by Bacon, Grimes & Brunson and from the Oneida mine by the Oneida Mining Co. Small quantities of gold, silver, and copper came from six lode mines and one placer mine.

Mohave.—Sand and gravel, stone, feldspar, and gem stones accounted for three-fourths of the total value of the county's mineral production. IMC continued to mine and mill feldspar at its Kingman mill. This mill also ground quartzite which accounted for the bulk of the stone production.

Five mines accounted for the small output of gold, silver, copper, lead, and zinc. The Antlers and McCracken mines were the principal producers.

Navajo.—Uranium ore accounted for three-quarters of the total value of mineral production and the county ranked third in the output of this mineral commodity. The major producer was Industrial Uranium Co., operating the Big Chief, Moonlight, Starlight No. 1, and Sunlight mines. A portion of the uranium ore mined contained sufficient vanadium oxide to warrant recovery. Ores containing vanadium were shipped to southwestern Colorado mills where the vanadium was recovered and the value credited to Arizona. Other uranium ores contained significant quantities of copper, which was recovered at the Mexican Hat, Utah, plant of Texas Zinc Minerals Corp.

Two exploratory oil wells were drilled. Both were dry and were abandoned. The Hopi Indian Agency operated the Keams Canyon No. 4 coal mine.

Pima.—Copper furnished 84 percent of the value of mineral production. Five mines, New Cornelia (3d largest copper producer in the State), Esperanza (7th), Silver Bell (8th), Pima (11th), and Daisy (19th), supplied 99.7 percent of the county's and 24 percent of the State's copper output. Most of the gold and silver were recovered as

byproducts of copper ore. All of the molybdenum produced came from copper ore treated at the Esperanza and Silver Bell operations.

In its annual report, Phelps Dodge Corp. reported that 23,721,000 tons of material was handled from the Ajo open-pit mine by the New Cornelia Branch operation; 9,066,000 tons was ore and 14,655,000 tons was waste material. From the ore milled, 66,693 tons of copper was produced.

Duval Sulphur & Potash Co. completed the first full year of operation at its Esperanza copper property. Production was maintained at the maximum level throughout the year, and the average milling rate was 11,600 tons of ore per day. The marketed products were copper concentrate and molybdic trioxide.

At the Silver Bell mine, the Silver Bell Unit of Asarco continued to mine copper ore from the Oxide and El Tiro open-pit mines. A substantial quantity of exploration and development diamond drilling was conducted.

Cyprus Mines Corp., which owned 50 percent of the Pima Mining Co., stated in its annual report that 1,327,473 tons of ore containing 1.14 percent copper was produced from the Pima mine and was concentrated at the company mill in 1960. Mill alterations to increase the capacity from 3,000 to 3,800 tons per day were completed. An agreement was reached with Banner Mining Co. under which Pima would mine and mill an estimated 1.8 million tons of Banner's ore. Stripping was ahead of schedule at the close of the year. Mining of Banner's ore by Pima was to begin in 1962. Banner decided to stop production from the Daisy underground mine because of the proximity of the Pima open-pit operation.

The Banner Mining Co. Palo Verde shaft was completed to its final depth of 960 feet by October. The company started cutting stations and ore and waste pockets on the 700, 800, and 900 levels. By yearend, 100 tons of ore per day was being mined from development work on the Palo Verde mine.

The Atlas mine, operated by B. S. & K. Mining Co., was the principal producer of zinc in the county.

Cement was the second-ranking commodity in terms of value, and shipments of portland and masonry cement from the Rillito plant of Arizona Portland Cement Co. were 15 percent greater than in 1959. Except for a small quantity of limestone used for roofing granules, all of the limestone quarried in 1960 was used in manufacturing cement. Crushed marble, used as roofing granules, and crushed sandstone, used as riprap and smelter flux, were also quarried. Devry Brick Co., Inc., Grabe Brick Co., and Tucson Pressed Brick Co. produced miscellaneous clay and shale for use at their respective plants in manufacturing brick and other heavy clay products. Tucson Perlite Co. did not mine any crude perlite in 1960, and its Tucson expanding plant operated on crude material mined in 1959.

Pinal.—Copper supplied $100 million (94 percent) of the $106.7 million value of mineral production. Output from three mines, San Manuel (second-largest copper producer in the State), Ray (fifth), and Magma (ninth) accounted for 99.8 percent of the county's and 29 percent of the State's copper production. Most of the gold and silver from the county was recovered as a byproduct of copper.

615629—61——9

All of the molybdenum was recovered as a byproduct of copper ore milling at San Manuel.

Magma Copper Co., sole owner of the San Manuel Copper Corp., announced in its annual report that 12,261,220 tons of ore with 0.71-percent copper in the sulfide minerals was mined from San Manuel in 1960. The copper contained in the oxide minerals in the ore was not recovered. Tons of ore mined per operating day averaged 34,249 for the year, compared with 32,741 in 1959 and 32,175 in 1958. Metal recovered from the ore milled included 81,724 tons of copper, 2.8 million pounds of molybdenum sulfide, 18,010 ounces of gold, and 290,617 ounces of silver. A cyanide plant for the recovery of gold from the molybdenum sulfide concentrate was completed and placed in operation in July. During the year, 296,804 tons of copper concentrate was processed at the smelter, an average of 847 tons per day of operation, and anode copper was produced.

According to the Kennecott Copper Corp. annual report, 6.5 million tons of ore was mined by the Ray Mines Division in 1960, compared with 3.0 million tons in 1959. Copper production from all Ray operations, mining and milling of ore and leaching of waste dumps and ore in place, was 58,799 tons of copper, compared with 29,084 tons in 1959. Expansion of productive capacity at the Ray Division was completed by the middle of the year. The $35 million program included enlargement of the pit, which necessitated the relocation of certain surface facilities to permit the mining of additional ore reserves; and increased mine equipment and mill capacity to make possible the mining and milling of 22,500 tons of ore a day compared with 15,000 tons formerly. The expansion enabled Ray Mines to produce 20,000 additional tons of copper a year, an increase of 40 percent.

Magma Copper Co., according to its annual report, produced 386,636 tons of ore assaying 5.10 percent copper, 0.04 ounces gold, and 1.73 ounces silver in 1960, compared with 276,387 tons assaying 5.23 percent copper, 0.04 ounces gold, and 1.50 ounces silver in 1959. In addition, 440 tons of custom ore was purchased and treated, compared with 106 tons in 1959. Mine production was resumed on January 19 after the strike settlement, and smelter operation was resumed on February 11 after repairs interrupted by the strike had been completed. Development work at the Magma mine during the year comprised 11,789 feet of drifts and crosscuts, 5,849 feet of raises, and 5,995 feet of diamond drilling.

All of the molybdenum and most of the gold and silver output in the county were recovered as byproducts from copper ore. Molybdenum, gold, and silver accounted for 4 percent of the county's value of mineral production.

Although nonmetals contributed only 2 percent of the total value of all mineral production, a number of the commodities in this group were necessary for the production of the more valuable metals. Some of the pyrite recovered from base-metal milling was roasted to produce sulfuric acid for copper leaching and sponge iron for precipitation. Lime produced by San Manuel Copper Corp. was used in its San Manuel concentrator, and quartzite quarried by the same company was used as flux in the treatment of copper ores. A portion of the

gypsum mined by Arizona Gypsum Co., Garcia & Peters, and National Gypsum was shipped to wallboard and cement plants but returned to the county as cement, wallboard, and other building products consumed by the mineral industry; some of the gypsum was used locally for agricultural purposes. Miscellaneous clay or shale mined by Phoenix Brick Yard was used in the manufacture of building brick and other clay products, and the crude perlite mined by Arizona Perlite Roofs, Inc., and Harborlite Corp. was expanded at Tucson and California expanding plants for use in building plaster and other construction applications. Four commercial and two Government-and-contractor producers mined 1.3 million tons of sand and gravel valued at $1.1 million. This material was used for building and paving construction, mostly in Pinal County. San Manuel Copper Corp. mined all of the crushed limestone and sandstone for use as smelter flux and in the manufacture of lime at its San Manuel Copper operation. A small quantity of crushed marble was quarried and used as roofing granules.

Santa Cruz.—Production of gold, silver, copper, lead, and zinc came from ore from three mines and cleanup at two mines. The Flux mine operated by Nash & McFarland was the principal producer. An average of 2,500 tons of ore per month from the Flux mine was treated in the Trench mill; in addition some custom ore was milled. In mid-year a crew of 38 men was employed: 29 in the mine and 7 in the mill, working 2 shifts per day, 6 days per week; and 2 in the shops, working 1 shift.

Yavapai.—Gold, silver, copper, lead, and zinc accounted for 79 percent of the value of mineral production. The Iron King mine at Humbolt, operated by the Iron King Branch of Shattuck Denn Mining Corp., was the State's leading silver, lead, and zinc producer and the third largest gold producer. According to the company report, operations continued throughout the year without interruption, and 304,735 tons of ore was mined.

The Bagdad Copper Corp. mine at Bagdad continued to be the principal producer of copper in the county and was the 12th largest producer in the State. Byproduct gold, silver, and molybdenum also were recovered. Production of copper nearly equaled that of 1959. Construction of a plant to produce copper by leaching stockpiled oxidized copper material was on schedule at the close of the year. The section to produce sulfuric acid from sulfur was completed and tested. The launders where copper is precipitated from copper solutions on detinned cans were completed. The final item, the piping and irrigation system to circulate the acid solution over the dumps, was nearly completed. The plant was expected to add 20 tons per day to the copper output of the operation.

The Old Dick mine, wholly owned and operated by Cyprus Mines Corp., was one of the county's leading copper (14th in the State) and zinc (2d in the State) producers. The company reported that 80,940 tons of ore, including a small tonnage of development ore from the adjacent Copper Queen mine, was mined and milled in 1960, compared with 76,111 tons in 1959. Plans were announced to increase the processing capacity of the property from 240 to 300 tons per day by

installing a heavy-medium separation plant to remove barren and low-grade material from the ore before grinding.

Other important metal producers in the county included Big Hole Mining Co., which produced copper ore from the United Verde open-pit mine (formerly operated by Phelps Dodge Corp.), and Fred D. Schemmer, who operated the Commercial mine under lease from Phelps Dodge Corp. and produced fluxing copper ore for the Phelps Dodge smelter at Douglas. Earl Anderson recovered a small quantity of hand-cobbed beryl concentrate from the Homestead Lode.

The first full year's operation of the Phoenix Cement Co. plant at Clarkdale resulted in a substantial increase in the value of cement sold in the county; cement ranked third in terms of value. Phoenix Cement Co. also operated the Redwall and Lakebed quarries to supply cement rock to its Clarkdale plant. Arizona Gypsum Co. mined gypsum from the Camp Verde deposit for use in manufacturing cement. The Flintkote Co. reduced the output of lime from its Nelson plant 12 percent. Scoria was added to the list of nonmetals produced in the county and was produced by Yavapai Block Co. from its Cruice cinder pit near Ashfork.

Yuma.—The county highway department and contractors for the State highway department and the Federal Bureaus of Public Roads and Reclamation produced 594,600 tons of structural and paving sand and gravel. Buckeye Mica Co. mined sericite mica from its property near Quartzite.

Gold, silver, and copper were recovered from small lots of ore produced from seven lode mines; silver, lead, and zinc were recovered from tailings and cleanup material from two operations; and copper was recovered from copper precipitates at one operation.

The Mineral Industry of Arkansas

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 Arkansas Geological and Conservation Commission, Norman F. Williams, Director and State Geologist, Little Rock, Ark.

By Harry F. Robertson [1] and Raymond B. Stroud [2]

VALUE of mineral production in Arkansas in 1960 increased 9 percent over 1959. The record value of $155 million reflects the continued growth of the mineral industry and represents a 16 percent increase since 1955. In 1960, gains were reported in the value of bauxite, clays, gem stones, natural gas, natural gas liquids, crude petroleum, and stone; decreases were noted in the value of barite, coal, and sand and gravel. Emphasis continued on development of new industries.

Construction began on Beaver Dam, the fourth major project in the upper White River basin for control and development of the river and its tributaries. The dam will be located 8 miles west of Eureka Springs and will consist of a concrete barrier 1,333 feet long and 228 feet above the stream bed, supplemented by all-earth structures where needed on the reservoir rim. In addition to flood control and hydroelectric power, the dam will create a reservoir extending upstream to the vicinity of Fayetteville. Construction of the dam, embankment, and dikes will require an estimated 539,000 cubic yards of excavation, 1,327,000 cubic yards of fill, 754,000 cubic yards of concrete, and 1,400 tons of reinforcing steel. Aggregate for the concrete will be obtained from a limestone quarry near the damsite.

Dardanelle Lock and Dam project continued on schedule during the year and, at yearend, was 12 percent complete. Future work includes relocation of cemeteries, powerlines, gaslines, and highways, and procurement and installation of four turbines and four generators.

Greers Ferry Dam, a multiple-purpose project on the Little Red River near Heber Springs, was 41 percent complete. Construction of the powerhouse was scheduled to start about mid–1961 and will complete the $56 million project.

Other new and expanded markets for the State's mineral resources resulted from construction projects such as the $10 million plant of Norge Division of Borg-Warner Corp. at Fort Smith, the Crane Co. $6.5 million installation at Jonesboro, and the Seiberling Rubber Corp.

[1] Commodity-industry analyst, Bureau of Mines, Bartlesville, Okla.
[2] Geologist (Mineral Deposits), Bureau of Mines, Bartlesville, Okla.

TABLE 1.—Mineral production in Arkansas [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	338,539	$3,097	277,851	$2,578
Bauxite—long tons, dried equivalent	1,631,643	17,048	1,932,071	20,469
Clays—thousand short tons	782	2,406	815	2,456
Coal—do	441	3,482	409	3,116
Gem stones		18		38
Gypsum—thousand short tons	[2]	[3]	[2]	208
Lead (recoverable content of ores, etc.)—short tons	38	9	67	
Manganese ore (35 percent or more Mn) short tons, gross weight	17,742	1,398		
Natural gas—million cubic feet	40,674	3,539	55,451	6,599
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	40,730	2,523	34,558	2,148
LP gases—do	55,731	3,048	73,252	3,735
Petroleum (crude)—thousand 42-gallon barrels	26,329	72,931	[4] 28,953	[4] 80,200
Sand and gravel—thousand short tons	11,696	11,857	8,192	10,262
Stone—do	8,824	10,424	10,939	13,555
Zinc (recoverable content of ores, etc.)—short tons	49	11	50	13
Value of items that cannot be disclosed: Abrasive stones, bromine, cement, lime, soapstone, and values indicated by footnote 3		10,042		10,918
Total Arkansas [5]		140,594		155,039

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.
[5] Total adjusted to eliminate duplicating value of clays and stone.

plant at Batesville. Two major projects at Helena—the Mississippi River bridge and the Arkansas Power and Light Co. generating plant—were completed during the year.

Employment and Injuries.—Employment in all categories of the mining industry dropped sharply and was 10 percent lower than that reported in 1959. The mining industry annual payroll decreased 9.5 percent; however, the overall average of weekly wage rates increased 1 percent. Average weekly wages were: $115.92 in the metal mining industry, a gain of 8 percent over 1959; $93.35 in the coal industry, a gain of 3 percent; $91.59 in the crude petroleum and natural gas industry, essentially unchanged; and $76.31 in the nonmetal mining and quarrying industries, a decrease of 1 percent.

TABLE 2.—Average annual employment for selected minerals

Industry	1959		1960	
	Employing units	Employment	Employing units	Employment
Metal mining	39	701	25	619
Bituminous coal mining	25	394	22	285
Crude petroleum and natural gas	372	3,349	377	3,065
Nonmetallic mining and quarrying	108	1,632	105	1,484
Total	544	6,076	529	5,453

Source: Arkansas Department of Labor, Employment Security Division, Little Rock, Ark.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal.—The number of bituminous coal mines operated during the year was unchanged from 1959—10 underground and 10 strip-mines. Output from underground mines accounted for 27 percent; that from open-pit mines for 73 percent of the total production of 409,199 short tons of coal. Total production decreased 7 percent in quantity and 10 in value, compared with 1959, because of a significant decrease in output from underground mines.

TABLE 3.—Coal production

(Thousand short tons and thousand dollars)

Year	Short tons	Value	Year	Short tons	Value
1951–55 (average)	762	$5,916	1958	364	$2,744
1956	590	4,601	1959	441	3,482
1957	508	3,976	1960	409	3,116

At the 10 strip mines, 6 million cubic yards of overburden was excavated and 296,425 tons of coal loaded—a stripping ratio of 20 cubic yards of overburden to 1 ton of coal mined.

Oil and Gas Exploration and Development.—Drilling activity in 86 fields in 21 counties resulted in completion of 285 oil wells, 39 gas wells, and 257 dry holes. The total number of holes drilled decreased 23 percent. The reduced drilling activity was attributed mainly to loss of part of the State's crude oil market. Significant decreases in development drilling were noted in Union, Ouachita, Nevada, and Columbia Counties.

During 1960, 56 percent of the wells drilled were completed as producers of oil or gas; 35 wells were successfully completed as new sources of supply, establishing 8 new fields (3 oil and 5 gas) and 27 new pools (19 oil and 8 gas). Successful outpost wells established significant lateral extensions of at least 15 fields during the year.

The deepest well drilled in 1960 was in Lafayette County and was completed as a producer in the Smackover formation at a total depth of 11,509 feet. The record producing depth, about 11,015 feet, was established in 1960 in the newly discovered Lake Erling oilfield in Lafayette County.

In north Arkansas, dry natural gas was produced from relatively shallow sands of Pennsylvanian, Mississippian, and Devonian ages. Drilling activity in this part of the State resulted in discovery of four new gasfields and five new sources of gas supply. At yearend, there were 50 gasfields in the north Arkansas area.

In south Arkansas, oil and gas production came from Cretaceous and Jurassic formations. Exploratory and development drilling, conducted in 10 counties and 63 fields, totaled 528 wells. Of the wells drilled, 127 were wildcat and resulted in the discovery of 4 new fields (3 oil and 1 gas) and 20 new pools (19 oil and 1 gas). Development drilling resulted in significant extensions of fields in Union, Lafayette,

TABLE 4.—Oil and gas well drilling and total crew-weeks spent in geophysical prospecting in 1960, by counties

County	Drilling						Total	Crew-weeks
	Proved field wells			Exploratory wells				Reflection seismograph
	Oil	Gas	Dry	Oil	Gas	Dry		
Bradley	4			1			5	2
Calhoun	15		11			8	34	
Columbia	14		7			8	29	17
Conway			2			1	3	(1)
Crawford	1	1	1			1	4	(1)
Faulkner						1	1	(1)
Franklin		16	1		1		18	(1)
Grant						1	1	
Hempstead						2	2	7
Howard								1
Johnson		1	2		1		4	(1)
Lafayette	57	1	28	2	1	34	123	9
Lee								5
Little River						1	1	
Logan		7	1				8	(1)
Lonoke								(1)
Miller	32		31	2		19	84	25
Nevada	7	1	3			5	16	1
Ouachita	20		3			5	28	
Pope	1	2	2		1	1	7	(1)
Searcy						2	2	
Scott								(1)
Sebastian		3	1				4	(1)
Union	129	2	36		1	38	206	14
Van Buren						1	1	
White								(1)
Yell								(1)
Various North Arkansas Counties								145
Total: 1960	280	34	129	5	5	128	581	226
1959	413	49	141	9	8	139	759	230

[1] Breakdown in number of crew-weeks unavailable; included in total crew-weeks for "Various North Arkansas counties."

Source: Arkansas Oil and Gas Statistical Bulletin, vol. 18, No. 12, December 1959 through vol. 21, No. 4, April 1961.
National Oil Scouts & Landmen's Associations, Oil- and Gas-Field Development in the United States: Vol. 31, 1960.

and Miller Counties. Of 173 fields found to date, 146 remained active producers of oil, condensate, or gas. Almost all the fields in southern Arkansas produced from multiple sources.

Pressure maintenance and secondary recovery projects were carried out in several southern Arkansas fields during 1960. Pool unitization followed by water or gas injection successfully prolonged the productive life of fields in Columbia, Lafayette, Ouachita, Miller, and Union Counties.

Pipeline Construction.—Arkansas Public Service Commission approved construction of new natural gaslines by Arkansas Western Gas Co. The planned facilities included transmission lines from Coal Hill, Altus, and Rock Creek gasfields and additional compressor facilities. Arkansas-Louisiana Gas Co. completed a 125-mile, 18-inch gas-transmission line from Perla to Helena. The new line terminated at the Arkansas Power and Light Co. generating plant, that used up to 75 million cubic feet daily.

Natural Gas.—Production of natural gas continued an upward trend for the fourth consecutive year, increasing 36 percent over 1959 output. North-Arkansas gasfields again accounted for more than half of the gas produced. Gas output in south Arkansas gained 44 percent compared with 1959. Proved natural gas reserves at yearend had increased in both sections of the State. Fifteen counties reported natural gas production. The leaders, in order of production value, were Franklin, Columbia, Lafayette, Pope, and Miller Counties.

Natural Gas Liquids.—Overall quantity and value of natural gas liquids gained 12 and 6 percent, respectively, over 1959. A decrease in total value of natural gasoline and cycle products was more than offset by an increase in the value of liquid petroleum gas production. Four natural-gasoline plants and two cycling plants operated throughout the year. A fifth natural-gasoline plant, operated by Shell Oil Co. at Magnolia, discontinued production in mid-1960.

TABLE 5.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

	Proved reserves Dec. 1, 1959	Changes in proved reserves, due to extensions and new discoveries in 1960	Proved reserves, Dec. 31, 1960 (production was deducted)	Change from 1959, percent
Crude oil—thousand barrels	312,911	15,236	301,997	−3
Natural gas liquids [1]—do	32,017	2,625	27,497	−14
Natural gas—million cubic feet	1,422,817	119,475	1,459,710	+3

[1] Includes condensate, natural gasoline, and LP gases.

Source: American Gas Association, and American Petroleum Institute, Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas: Vol. 15, Dec. 31, 1960, pp. 11, 12, 21.

TABLE 6.—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] Quantity	Marketed production [2] Value (thousands)	Repressuring	Vented and wasted [3]
1951–55 (average)	34,112	28,050	62,162	38,817	$1,872	19,240	4,105
1956	16,000	37,000	53,000	30,162	1,810	16,269	6,569
1957	18,000	36,000	54,000	31,327	2,256	16,045	6,628
1958	23,000	45,000	68,000	32,890	2,664	28,180	6,930
1959	32,000	40,800	72,800	40,674	3,539	27,488	4,638
1960 [4]	45,700	41,100	86,800	55,451	6,599	27,640	3,709

[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.
[4] Preliminary figure.

TABLE 7.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951-55 (average)	55,335	$3,885	52,057	$2,187	107,392	$6,072
1956	41,529	2,541	56,146	2,293	97,675	4,834
1957	39,869	2,313	54,034	2,097	93,903	4,410
1958	37,197	2,574	53,518	2,743	90,715	5,317
1959	40,730	2,523	55,731	3,048	96,461	5,571
1960	34,558	2,148	73,252	3,735	107,810	5,883

TABLE 8.—Crude petroleum production, by fields

(Thousand barrels and thousand dollars)

Field	1959		1960 [1]	
	Barrels	Value	Barrels	Value
Atlanta	148	$409	290	$803
Buckner	332	920	309	856
Dorcheat-Macedonia	314	870	617	1,709
El Dorado	646	1,789	456	1,263
Fouke	855	2,369	1,088	3,014
Magnolia	4,439	12,296	5,032	13,938
McKamie	755	2,091	950	2,632
Midway	2,196	6,083	2,211	6,124
Schuler	1,849	5,122	1,510	4,183
Smackover	4,363	12,085	4,057	11,238
Stephens	1,472	4,077	1,182	3,274
Village	398	1,103	626	1,734
Wesson	1,525	4,224	1,717	4,756
Other fields [2]	7,037	19,493	8,908	24,676
Total	26,329	72,931	28,953	80,200

[1] Preliminary figures.
[2] Includes oil consumed on leases and net change in stocks held on leases for the State.

TABLE 9.—Crude petroleum production, indicated demand, and stocks in 1960, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Arkansas	Month	Production	Indicated demand	Stocks originating in Arkansas
January	2,184	2,098	2,121	August	2,428	2,619	1,552
February	2,368	2,540	1,949	September	2,397	2,364	1,585
March	2,400	2,408	1,941	October	2,539	2,422	1,702
April	2,372	2,296	2,017	November	2,446	2,565	1,583
May	2,585	2,754	1,848	December	2,468	2,265	1,786
June	2,323	2,267	1,904				
July	2,443	2,604	1,743	Total	28,953	29,202	----------

Petroleum.—Crude petroleum continued to be the State's most important mineral commodity. Estimated production was 29 million barrels valued at $80.2 million, increases of 10 percent in both quantity and value above production in 1959.

NONMETALS

Abrasive Stone.—Novaculite, quarried in Garland County, was processed into grinding pebbles and oilstones. Production decreased 15 percent in quantity and 13 percent in value compared with 1959.

Barite.—Arkansas barite sold or used by producers was 18 percent less than that reported in 1959. The decline was attributed to a significant decrease in oil well drilling. Nearly all the barite was processed for use in drilling muds.

U.S. Glass and Chemical Corp. continued construction of a $700,000 barite and gravel plant at Dierks. Additional flotation circuits, added to the original mill design, increased the capacity to about 42,000 tons of finished barite per year. Completion of the plant was scheduled for June 1961.

TABLE 10.—Primary barite sold or used by producers

Year	Short tons	Value (thousands)	Year	Short tons	Value (thousands)
1951–55 (average)	409,995	$3,784	1958	182,779	$1,668
1956	486,254	4,256	1959	338,539	3,097
1957	477,327	4,537	1960	277,851	2,578

Bromine.—Michigan Chemical Corp. recovered bromine from oil well brines pumped to its El Dorado plant. Expansion during 1960 brought the capacity of the plant to 10 million pounds of elemental bromine a year.

Arkansas Chemicals, Inc., announced plans to build a $1.5 million bromine-recovery plant near El Dorado. Completion was scheduled for mid–1961. Well brines from nearby fields were to be processed.

Cement.—Total output of portland and masonry cements at the State's two plants gained substantially compared with 1959. Cement shipments were up significantly in quantity and value. Increased residential and nonresidential construction during the year contributed to the gains.

Clays.—An overall gain of 4 percent was reported for clay sold and used. Major uses were unchanged. Fire clay gained 7 percent, and miscellaneous clay, including that used in manufacture of cement, increased only 1 percent.

Acme Brick Co. completed expansion of facilities at its Malvern plant. New installations included clay storage, screening, and blending equipment, a modern vacuum pug mill and brick machine, a tunnel kiln with attached dryer, and a structure to house the kiln.

Gem Stones.—Quartz crystals and specimen grade samples of various minerals contributed the major part of the reported value of Arkansas gem stones. The Crater of Diamonds at Murfreesboro accounted for almost half the value of the 1960 production.

Gypsum.—Output of gypsum, all from Pike County, increased 15 percent over 1959. All Arkansas gypsum was utilized in the manufacture of cement. Dulin Bauxite Co., operator of the gypsum mine and mill near Murphreesboro, rebuilt the plant to allow better quality control of the calcined product.

TABLE 11.—Shipments of portland cement to Arkansas consumers

Year	Arkansas (thousand barrels)	Change, percent	
		In Arkansas	In United States
1951-55 (average)	1,997		
1956	1,843	−27	+6
1957	1,694	−8	−6
1958	2,129	+26	+6
1959	2,624	+23	+9
1960	2,590	−1	−7

TABLE 12.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Miscellaneous clay [1]		Fire clay		Total clay	
	Quantity	Value	Quantity	Value	Quantity	Value
1951-55 (average)	201	$283	385	$1,594	586	$1,877
1956	444	447	275	1,189	719	1,636
1957	226	226	390	1,360	616	1,586
1958	265	264	313	1,313	578	1,577
1959	383	383	399	2,023	782	2,406
1960	388	387	427	2,069	815	2,456

[1] Includes clay used for cement.

Lime.—Production of lime increased 9 percent over 1959. The aluminum industry was the major consumer; lesser amounts were used for water purification and by the paper, petroleum, sugar-refining, and other industries.

Sand and Gravel.—Sand and gravel was produced in 39 of the 75 counties. Production was off 30 percent, and value decreased 13 percent compared with 1959. The decrease in output was attributed to completion of the Freeway Bridge at Little Rock—about 4 million tons of sand and gravel was used in the project in 1959 and none in 1960.

Stone.—A record value of $13.6 million from production of 10.9 million short tons of stone (including slate) reflected continued growth of the Arkansas stone industry for the ninth consecutive year. Significant gains were reported in production of crushed granite, dimension marble, and crushed sandstone.

Sulfur (Recovered Elemental).—Recovery of byproduct sulfur, from gas cycle plants in Columbia, Lafayette, and Union Counties, increased 36 percent compared with 1959. Four sulfur-recovery units were in operation at yearend.

The initial run from the new sulfur-recovery unit at the El Dorado refinery of Lion Oil Co. was shipped in September. The product from the unit, which has a capacity of 15 tons daily, was used at the nearby Monsanto Chemical Co. plant.

Arkansas-Louisiana Chemical Corp. placed a sulfur-recovery unit in operation at the Hamilton plant at midyear and the plant was altered to handle gas from the Magnolia field.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,374	$1,355	1,348	$1,324
Paving	1,203	1,121	1,001	903
Gravel:				
Building	1,630	1,866	1,503	1,889
Paving	2,105	2,232	1,376	1,652
Other	12	17		
Undistributed [1]	649	944	707	964
Total sand and gravel	6,973	7,535	5,935	6,732
Government-and-contractor operations:				
Sand:				
Paving	2,300	1,862	699	1,071
Gravel:				
Paving	2,423	2,460	1,558	2,459
Total sand and gravel	4,723	4,322	2,257	3,530
Grand total	11,696	11,857	8,192	10,262

[1] Includes glass, molding, filtering, and other construction, industrial, and ground sands; railroad ballast and miscellaneous gravels, which the Bureau of Mines is not at liberty to publish separately.

TABLE 14.—Stone sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1956	6,325	$8,113	1959	8,824	$10,424
1957	7,336	8,871	1960	10,939	13,555
1958	8,461	10,178			

METALS

Aluminum.—Production of primary aluminum declined sharply in 1960, reflecting the lack of demand for the product. In January, Reynolds Metals Co. cut production of the Arkadelphia plant to 25 percent of capacity.

Bauxite.—Production of crude bauxite increased 18 percent over 1959 output and accounted for 97 percent of all U.S. production. About 88 percent of the bauxite was mined in Saline County and 12 percent in Pulaski County compared with 98 percent in Saline County and 2 percent in Pulaski County in 1959. The outstanding production gain in Pulaski County came mainly from the Berry-Mayhan, Heckler, and Bierman Tract open-pit mines.

Reynolds Mining Corp., with open-pit and underground mines in Saline and Pulaski Counties, was the leading bauxite producer. Aluminum Company of America, with strip mining in Saline County, ranked second.

Manganese.—Manganese production terminated in August 1959, the closing date of the Government manganese-purchasing program. Mining economics prevented the Arkansas manganese producers from competing for the remaining markets.

TABLE 15.—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
1951-55 (average)	2,041	1,724	$13,098	1,891	1,681	$14,241
1956	1,966	1,669	14,444	1,817	1,567	14,643
1957	1,625	1,357	12,314	2,004	1,696	16,476
1958	1,516	1,258	[1] 12,311	1,586	1,341	[1] 14,373
1959	1,940	1,632	17,048	1,827	1,580	17,960
1960	2,327	1,932	20,469	1,876	1,604	18,982

[1] Revised figure.

TABLE 16.—Manganese ore shipped from mines[1]

Year	Short tons		Value (thousands)
	Gross weight	Mn content	
1951-55 (average)	9,912	4,471	[2]
1956	29,485	12,525	$2,066
1957	23,261	10,000	1,726
1958	22,221	9,440	1,737
1959	17,742	6,714	1,398
1960[3]			

[1] Containing 35 percent or more manganese (natural).
[2] Data not available.
[3] No production in 1960.

The Federal Bureau of Mines continued sampling, mapping, and correlation of manganese and manganiferous limestone deposits in Arkansas.

Zinc.—Rush Creek Mining Co. produced and milled zinc ore at the Monte Cristo mine near Yellville, Marion County, and shipped a small quantity of concentrate to the La Salle Smelter of Matthiessen & Hegeler Zinc Co. at La Salle, Ill. A company-owned churn drill was used in a limited exploration program during the year.

REVIEW BY COUNTIES

Mineral production was reported in 56 of the 75 counties; 11 counties reported production valued at more than $3 million. Five counties—Columbia, Union, Saline, Lafayette, and Ouachita—contributed 65 percent of the total mineral-production value.

Ashley.—Washed sand and gravel for building and road construction was produced by St. Francis Material Co.

Benton.—White River Sand & Gravel Co. produced building and paving sand and gravel; Paul Davis mined pit-run gravel for fill. Independent Gravel Co. quarried and crushed limestone for soil conditioning, mineral food, glass, asphalt filler, and other purposes.

Bradley.—An outstanding increase in the value of mineral production resulted from large gains in output of petroleum and sand and

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

County	1959	1960	Minerals produced in 1960 in order of value
Ashley	(2)	(2)	Sand and gravel.
Baxter	(2)	$2,882	Do.
Benton	(2)	(2)	Stone, sand and gravel.
Boone	(2)	4,890	Sand and gravel.
Bradley	$37,499	631,110	Petroleum, sand and gravel.
Calhoun	639,632	863,256	Sand and gravel, petroleum.
Carroll	(2)	(2)	Sand and gravel, stone.
Chicot	156,128	351,786	Sand and gravel.
Clark	46,166	32,416	Sand and gravel, clays.
Clay	24,389	17,368	Sand and gravel.
Cleburne	50,750	1,520,824	Stone, natural gas.
Columbia	26,455,412	29,487,180	Petroleum, natural gas liquids, natural gas, sand and gravel.
Conway	57,901	208,340	Natural gas, sand and gravel.
Craighead	115,879	174,528	Sand and gravel, clays.
Crawford	660,525	911,404	Stone, sand and gravel, natural gas.
Cross	241,272	116,065	Sand and gravel.
Drew	23,117	13,117	Do.
Faulkner	4,505	----------	
Franklin	1,941,679	3,097,663	Natural gas, coal, stone.
Garland	68,263	246,090	Stone, oilstones, sand and gravel, grinding pebbles, gem stones.
Grant	(2)	(2)	Sand and gravel, clays.
Greene	128,999	108,878	Sand and gravel.
Hempstead	(2)	(2)	Clays.
Hot Springs	4,350,604	3,845,481	Barite, clays, stone, sand and gravel, gem stones.
Howard	(2)	(2)	Cement, stone, sand and gravel, clays.
Independence	2,336,941	1,313,433	Stone, lime, sand and gravel.
Izard	1,659,100	(2)	Stone, sand and gravel.
Jackson	(2)	(2)	Sand and gravel.
Jefferson	(2)	49,996	Do.
Johnson	1,301,046	1,261,368	Coal, natural gas, clays, stone.
Lafayette	14,145,465	16,488,131	Petroleum, natural gas liquids, natural gas, sand and gravel.
Lawrence	(2)	(2)	Stone, sand and gravel.
Lincoln	(2)	49,537	Sand and gravel.
Little River	(2)	(2)	Cement, stone, sand and gravel, clays.
Logan	303,925	353,084	Coal, stone, natural gas.
Lonoke	70,083	40,000	Clays.
Madison	(2)	(2)	Stone.
Marion	40,560	44,090	Sand and gravel, zinc, stone.
Miller	5,341,146	6,793,164	Petroleum, sand and gravel, natural gas, clays.
Mississippi	(2)	(2)	Sand and gravel.
Montgomery	671,290	612,681	Slate, barite, gem stones.
Nevada	2,058,895	1,764,561	Petroleum, natural gas.
Ouachita	13,430,991	12,534,509	Petroleum, sand and gravel, natural gas, clays.
Perry	----------	22,600	Stone.
Phillips	(2)	46,900	Sand and gravel.
Pike	168,741	227,153	Gypsum, gem stones.
Poinsett	(2)	(2)	Sand and gravel.
Polk	188,655	30,854	Clays, slate.
Pope	1,337,484	1,601,940	Stone, coal, natural gas, sand and gravel.
Pulaski	8,991,126	5,796,729	Stone, bauxite, clays, sand and gravel.
St. Francis	(2)	(2)	Sand and gravel.
Saline	17,503,092	20,144,360	Bauxite, lime, sand and gravel, soapstone, clays, slate.
Sebastian	1,783,879	1,470,268	Coal, natural gas, stone, clays.
Stone	(2)	(2)	Stone.
Union	20,198,567	21,888,470	Petroleum, bromine, natural gas liquids, natural gas, clays.
Washington	304,868	536,044	Stone, natural gas.
White	(2)	(2)	Stone.
Undistributed	13,755,426	20,285,850	
Total	140,594,000	155,039,000	

[1] The following counties are not listed because no mineral production was reported: Arkansas, Cleveland, Crittenden, Dallas, Desha, Lee, Monroe, Newton, Prairie, Randolph, Scott, Searcy, Sevier, Sharp, Van Buren, Woodruff, and Yell.
[2] Figure withheld to avoid disclosing individual confidential data; included with "Undistributed."

gravel. Moro Gravel Co. and Carter Lyon supplied the sand and gravel.

Development-well drilling in the Lick Creek field was extremely successful inasmuch as all wells produced oil. Exploratory drilling

by Olin Oil and Gas Corp. resulted in discovery of one new oilfield, Careyville Landing, on the southwestern edge of the county.

Calhoun.—Washed sand and gravel for construction and paving accounted for about half the total value of mineral production. Contributing to total production were Reynolds and Williams, St. Francis Material Co., Pine Bluff Sand and Gravel Co., Twin City Gravel Co., Ouachita Aggregate Co., and W. W. Grant. Development-well drilling added 15 new producers to existing oilfields, considerably increasing petroleum output.

Carroll.—Southeast Construction Co. and Garrett Gravel Co. produced construction and paving sand and gravel. U.S. Corps of Engineers used a substantial quantity of crushed limestone for road building.

Chicot.—Value of sand and gravel production for building and paving was more than double that reported in 1959. Producers were Greenville Gravel Co. and Linwood Smith Construction Co.

Cleburne.—U.S. Corps of Engineers contracted for 975,000 tons of crushed sandstone which was used as drainage blanket, riprap, and concrete aggregate in the Greers Ferry Dam project. A small amount of natural gas was produced from the Quitman field in the southwest corner of the county.

Columbia.—The value of mineral production increased substantially compared with 1959. The county again led in total value of minerals and the quantities of petroleum and natural gas liquid produced. It ranked second in natural gas production. Arkansas-Louisiana Chemical Corp. added a sulfur-recovery unit to its Hamilton gas-processing plant at Magnolia. Shell Oil Co. discontinued operating its gas-processing plant in July. Lion Oil Co., Division of Monsanto Chemical Corp., recovered sulfur from sour gas at its Magnolia plant until mid-year, then moved the operation to Union County. Development-well drilling in the Stephens oilfield added 14 new producers. Columbia County Highway Department mined bank-run gravel for road construction and maintenance. Commercial producers of building, paving, and fill gravel were Columbia Sand & Gravel Co., Jennie F. Lovell, and Lambert & Barr, Inc.

Conway.—An outstanding gain in natural gas production resulted from increased output of the Jerusalem and Old Hickory gasfields. Southeast Construction Co. produced building and paving sand and gravel.

Craighead.—Gains were reported in output of sand and gravel for construction and roadwork. Major producers were St. Francis Material Co., Southeast Construction Co., Ralph Cox Gravel Co., Hugh Findley, and R. D. Davenport. Wheeler Brick Co., Inc., mined red clay for use in making face brick at its plant near Jonesboro.

Crawford.—Arkhola Sand & Gravel Co. reported production of considerable quantities of sand and gravel and crushed sandstone. The materials were used for building, paving, and fill. Ben M. Hogan & Co. mined and crushed sandstone for concrete aggregate and road construction. Jim Brewer Service & Supply quarried and crushed limestone. Exploratory drilling resulted in discovery of one new gasfield, Hollis Lake; two additional producing zones were discovered by subsequent development drilling.

Cross.—Production of sand and gravel was of major importance to the economy of Cross County. Commercial producers were Humphries and Kail, McGeorge Contracting Co., and Cross County Gravel Co.

Franklin.—Increases in production of natural gas and coal were sufficient to rank the county first in natural gas production and third in coal production. Exploratory drilling resulted in discovery of the new Altus gasfield. Development-well drilling was markedly successful; 16 of 17 field wells drilled were gas producers. Athletic Mining and Smelting Co. reported a quadruple completion in the Aetna gasfield. Additional reserves were reported for Cecil, Aetna, Rock Creek, Ozark, White Oak, and Lone Elm gasfields. Increased coal production from the Quality Excelsior Coal Co. strip mine added considerably to total value of mineral production in the county.

Garland.—Crushed sandstone, produced by Ben M. Hogan & Co., accounted for a substantial increase in mineral production value. Norton Pike Co. purchased novaculite, mined near Hot Springs, for shipment to its plant in New Hampshire. Oilstones and grinding pebbles were made from novaculite by Arkansas Abrasives, Inc., Arkansas Oilstone Co., and Jackson Whetstone Co. Pit-run gravel for various purposes was produced by Smith Bros. Construction and Materials Co.

Grant.—Southwest Concrete Material Corp., near Poyen, used clay from a nearby pit as raw material in its lightweight-aggregate plant. Sand and gravel overlying the clay was processed and used mostly as aggregate in concrete pipe.

Greene.—Arkansas Gravel Co. and B&S Gravel Co. produced building and paving sand and gravel. Ted Cline mined pit-run gravel for fill.

Hempstead.—Miscellaneous clay for building brick and other heavy clay products was mined by Hope Brick Works. Exploratory drilling for oil was unsuccessful during the year. Seven crew-weeks of geophysical exploration were reported.

Hot Springs.—Crude barite, the county's most important mineral, was mined and ground by Baroid Division of National Lead Co. and Magnet Cove Barium Corp. Acme Brick Co. (Perla plant) and Malvern Brick & Tile Co. mined fire clay for refractories and heavy clay products. Acme Brick Co. (Malvern plant) used miscellaneous clay for building brick and tile. Coogan Gravel Co. and Harbison-Walker Refractories Co. mined and processed rock for use in silica refractories. Malvern Minerals Co. produced finely ground silica sand for use in a liquid grinding operation especially useful for finishing small, cast-metal parts. Freshour Bros. and Malvern Gravel Co. produced building and paving sand and gravel. The Jones Mill aluminum-reduction plant of Reynolds Metals Co. operated throughout the year.

Howard.—Ideal Cement Co. mined chalk, marl, sand, and limestone for cement manufacture at its plant near Okay.

Independence.—Total value of mineral production in 1960 decreased considerably due to cessation of the Government manganese program. Hydrated lime and quicklime for industrial, chemical, and building uses were produced by Batesville White Lime Co.; the company also quarried and crushed limestone for soil conditioner, metallurgical

flux, asphalt filler, mineral food, concrete aggregate, and other purposes. Batesville Marble Co. quarried marble for processing at its Little Rock plant. Stone Products Co. quarried marble at pits near Batesville. Sandstone for building purposes was quarried and sawed by Varnell Sandstone Quarry, Oran McBride Stone Quarries, Salado Stone Co., and Bristow Stone Co. Sand and gravel for building and fill was produced by Galloway Sand & Gravel Co. at Batesville.

Izard.—Izard County ranked third in value of stone production and first in value of sand output. Aluminum Company of America and Arkansas Limestone Co. mined and crushed limestone for metallurgical flux and soil conditioner. A substantial contribution to total mineral production value resulted from high-grade silica sand mined and ground by Silica Products Co., Inc., at Guion. The finished material was used in making glass, foundry molds, pottery, and other products.

Jackson.—Sand and gravel for structural use and paving was produced by Mobley Construction Co., Inc.

Johnson.—Johnson County ranked first in value of coal mined. Open-pit and underground mines were operated to furnish coal for steel mills and other uses. Eureka Brick & Tile Co. mined clay for heavy clay products. Exploratory drilling resulted in discovery of the new Ludwig gasfield. Development-well drilling located additional reserves in the Union City, Spadra, and Coal Hill gasfields.

Lafayette.—The petroleum and natural gas industries contributed the major part of mineral production value. The county led in output of byproduct elemental sulfur, and ranked second in production of natural gas liquids, and third in production of crude petroleum and natural gas. Exploratory and development drilling resulted in discovery of one new gas-condensate field, Lake Erling, and new oil pools in the Lewisville, New Garland City, and Stamps fields. A new producing depth record (11,005 to 11,025 feet) was established by a gas-condensate producer in the new Lake Erling field.

Sand and gravel for building and paving was mined and processed by Meriwether Gravel Co., Inc.; Lambert & Barr, Inc., furnished pit-run gravel for fill. Olin-Mathiesen Chemical Corp. recovered elemental sulfur from natural gas at its McKamie plant.

Lawrence.—Ben M. Hogan & Co. and Verkler Limestone Co. quarried and crushed limestone for roadstone, riprap, and soil conditioner. L. F. Parker furnished pit-run gravel for county road construction; Ben M. Hogan & Co. mined sand and gravel for use by the Arkansas State Highway Department as road base and surfacing.

Little River.—Increased cement output by Arkansas Cement Corp. caused a corresponding gain in marl and limestone production in the county. Ark-La Limestone Corp. quarried and processed limestone for agricultural use. Braswell Sand & Gravel Co., Inc., produced building and paving sand and gravel at a stationary plant near Wilton.

Logan.—Dimension sandstone was quarried and processed by Logan County Building Stone Co., River Mountain Stone Co., and Spicer Stone Co. Stone was quarried and sawed by Schwartz Quarry.

Two underground bituminous coal mines utilized cutting machines to produce high-grade coal for shipment to northern markets.

A substantial increase in natural gas production was reported in 1960. Development well drilling resulted in extensions of the Chismville, Booneville, and Aetna gasfields.

Madison.—Ozark Construction Co. quarried and crushed limestone for road construction; War Eagle Lime Co. produced agricultural limestone at a quarry near Huntsville.

Marion.—Rush Creek Mining Co., near Yellville, shipped zinc concentrate. Sand and gravel for road construction was produced by Freshour Corp. and Kenneth D. McDowell.

Miller.—Petroleum production contributed 84 percent of the total value of mineral output. The county ranked second in value of sand and gravel production and fourth in value of clay production. Gifford-Hill Co., Inc., furnished sand and gravel for building, paving, fill, and other purposes. W. S. Dickey Clay Manufacturing Co. mined fire clay and miscellaneous clay at pits in Texarkana.

Exploratory and development drilling resulted in rediscovery of the small Lenz field and extensions of the Genoa, Fouke North, Kiblah, and Christmas fields.

Mississippi.—Elliott Sartain & Co. furnished gravel for county road construction and maintenance.

Montgomery.—Slate was quarried and processed to slate flour and roofing granules by Bird & Son, Inc. Crude barite was shipped from stock by Baroid Division of National Lead Co. Specimen-grade quartz crystals were found near Mount Ida by Coy Drain and Ocus Stanley.

Nevada.—Crude petroleum contributed essentially all the 1960 mineral production value. Development drilling established additional reserves in the Troy oilfield. Berry Asphalt Co. operated an oil refinery at Waterloo.

Ouachita.—Crude petroleum and sand and gravel accounted for most of the value of mineral production in the county. The productive Smackover field received the major part of development well drilling and accounted for over 90 percent of the petroleum produced. Successful completion of a new pay in the Cotton Valley formation created considerable interest and activity in the Smackover field. Pool unitization and water-injection programs facilitated recovery of petroleum from Wesson, Stephens, and Center oilfields. Berry Asphalt Co. operated an oil refinery at Stephens.

Building and paving sand and gravel was mined and processed by Pine Bluff Sand & Gravel Co., Standard Gravel Co., and Henry Garner. Hope Brick Works mined miscellaneous clay for brick and tile manufacture at its Chidester plant.

Pike.—Dulin Bauxite Co. produced gypsum for use as a retarder in portland cement. The company completed new facilities at the plant near Highland to allow better quality control of the finished product. Several diamonds were found in the Murfreesboro area; three outstanding finds at the Crater of Diamonds weighed from 4.5 to 6.5 carats.

Poinsett.—St. Francis Material Co. and Crowder Construction Co. mined and processed sand and gravel for building and paving purposes. Arkansas State Highway Department used part of the aggregate for road construction.

Pope.—Mid-Continent Stone and Construction Co. quarried and crushed limestone, for riprap in the Arkansas River. U.S. Army Corps of Engineers contracted for a substantial quantity of sandstone to be used as riprap and concrete aggregate. Texas Ledgestone Co. produced dimension sandstone and flagging.

P&M Coal Mining Co. operated a strip mine near Russellville and produced coal for smelter consumption.

Exploratory and development drilling resulted in discovery of the Scottsville gasfield and additional gas reserves in the Dover field.

Pulaski.—Stone requirements for riprap, concrete aggregate, road construction, and railroad ballast made Pulaski County the leading supplier of crushed sandstone. Producers were Jeffrey Stone Co. and Ben M. Hogan & Co. Limestone was quarried and crushed by D. F. Jones Construction Co. and Reynolds & Williams. U.S. Army Corps of Engineers contracted for both sandstone and granite to use as riprap. Big Rock Stone & Materials Co. quarried and crushed syenite for use as riprap, concrete aggregate, roadstone, railroad ballast, and roofing granules. Big Rock Stone & Materials Co. and Jeffrey Stone Co. supplied sand for building and paving; John D. Ott furnished pit-run gravel for use as fill.

A. P. Green Fire Brick Co. and Consolidated Chemical Industries Division, Stauffer Chemical Co. processed high-alumina clays from deposits near Little Rock.

Bauxite was mined or shipped from stock by American Cyanamid Co., Campbell Bauxite Co., Dickinson-McGeorge, Inc., Porocel Corp., Reynolds Mining Corp., and Consolidated Chemical Industries Division, Stauffer Chemical Co. Three companies operated drying, and activating plants to process bauxite for abrasives, chemicals, and other industrial uses.

St. Francis.—St. Francis Material Co. and J. J. Crisp Gravel Sales produced sand and gravel for construction, paving, and fill.

Saline.—Total value of mineral production reached a new high, mainly due to a substantial increase in bauxite production. Bauxite, the county's leading commodity, was produced by Reynolds Mining Corp., Aluminum Company of America, and American Cyanamid Co. Aluminum Company of America also made lime from Izard County limestone.

Milwhite Co., Inc., quarried and processed soapstone and slate for filler in asphalt, insecticides, roofing, and rubber. Structural and paving sand and gravel were produced by East Arkansas Materials Co., Richards Equipment Co., and others.

Sebastian.—Coal mined from six underground and three strip mines was the county's most important mineral industry. Total production of coal dropped considerably from 1959, almost entirely because of less output from the underground mines of Peerless Coal Co. and Quality Excelsior Coal Co. A major part of the coal mined was used by steel mills. Crushed sandstone, for use as riprap on the Arkansas River, was produced for U.S. Army Corps of Engineers. Acme Brick Co. mined miscellaneous clay for brick and tile. Rescolite Co. made lightweight aggregate from locally mined shale.

Development drilling during the year discovered additional natural gas reserves in the Gragg, Massard Prairie, and Cecil fields.

Union.—Union County ranked second in total value of minerals produced, second in petroleum, and third in natural gas liquids. Crude petroleum production accounted for 94 percent of the mineral value. Exploratory drilling resulted in finding the Cypress Creek oilfield. Development-well drilling increased known oil reserves in the Camp Creek, Cypress Creek, Lick Creek, and Smackover fields, as well as gas-condensate reserves in the Olin Forest field. Pressure maintenance and secondary recovery projects were carried out in several of the older gas-condensate and oilfields. According to the Arkansas Oil & Gas Commission, the operations will permit recovery of an additional 40 million barrels of oil from the fields.

Michigan Chemical Co. increased the annual capacity of its plant near El Dorado to 10 million pounds of elemental bromine. Value of bromine, recovered from oil-well brines, contributed substantially to the county's economy.

Lion Oil Co., Denton Corp. (formerly Mobil Oil Co. plant), and J. R. Querles Oil Co. operated cycling and natural-gasoline plants.

Washington.—Ben M. Hogan & Co. quarried and crushed sandstone for State road construction; McClinton Bros. and Ozark Construction Co. mined and crushed limestone for concrete aggregate, roadstone, and soil conditioner. McClinton Bros. completed plant improvements which included installation of natural gas engines to drive a 175-kw power plant. Considerable savings in fuel costs were reported by the company.

White.—Acme Materials Co. quarried and crushed a substantial quantity of sandstone for riprap, concrete aggregate, roadstone, and railroad ballast. Arkansas State Highway Department used part of the material for road construction and maintenance.

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.

By L. E. Davis,[1] R. Y. Ashizawa,[2] and L. Giorgetti[2]

MINERAL production in California declined in value for the third consecutive year decreasing to $1,402,214,000, 2 percent below 1959. The value of mineral fuels as a group continued the downward trend begun in 1958 despite an increase in the value of natural gas. Production of nonmetals reversed an 8-year trend, declining 2 percent in value below 1959. Increases in the values of natural saline minerals were noteworthy exceptions to this general

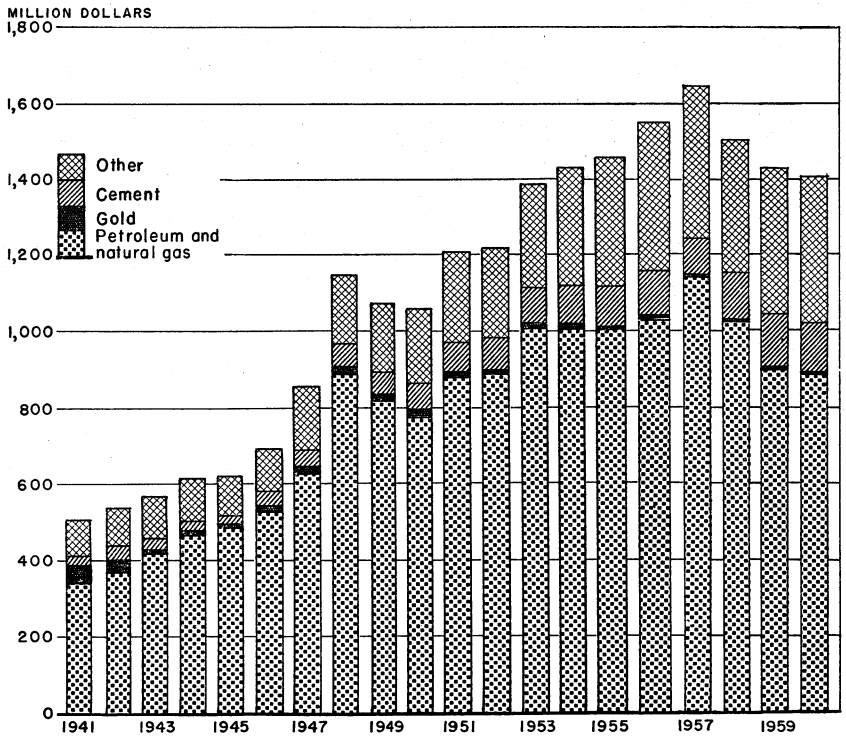

FIGURE 1.—Value of petroleum and natural gas, gold, cement, and total value of mineral production in California, 1941–60.

[1] Commodity-industry analyst, Bureau of Mines, San Francisco, Calif.
[2] Statistical assistant, Bureau of Mines, San Francisco, Calif.

decline. Metals as a group rose 4 percent in value over 1959, largely because Union Carbide Nuclear Co. attained full-scale production at its Pine Creek ammonium-paratungstate plant in Inyo County. Only gold and molybdenum decreased both in quantity and value. Uranium output remained virtually unchanged from 1959. For the first time in several years neither manganese nor chromite ores were produced or shipped.

TABLE 1.—Mineral production in California [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	28,143	$326	16,157	$181
Boron minerals—do	619,946	46,150	640,591	47,550
Cement [2]—thousand 376-pound barrels	43,635	138,506	39,712	128,826
Clays—thousand short tons	2,726	5,646	2,899	5,663
Copper (recoverable content of ores, etc.)—short tons	663	407	1,087	698
Feldspar—long tons	76,489	[3] 824	76,010	886
Gem stones	[4]	150	[4]	150
Gold (recoverable content of ores, etc.)—troy ounces	[3] 145,270	[3] 5,084	123,713	4,330
Gypsum—thousand short tons	1,686	3,788	1,616	3,687
Lead (recoverable content of ores, etc.)—short tons	227	52	440	103
Lime—thousand short tons	358	5,817	345	5,628
Magnesium compounds from sea water and bitterns (partly estimated)—short tons M_gO equivalent	87,968	6,336	86,532	6,233
Manganese ore and concentrates (35 percent or more Mn)—short tons, gross weight [5]	19,354	1,663	----------	----------
Manganiferous ores (5 to 35 percent Mn) short tons, gross weight	129	[6]	96	[6]
Mercury—76-pound flasks	17,100	3,890	18,764	3,955
Natural gas—million cubic feet	485,655	119,471	517,535	138,182
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	834,258	68,023	794,657	62,496
LP gases—do	396,331	21,260	408,378	21,482
Peat—short tons	34,604	449	33,091	481
Petroleum (crude)—thousand 42-gallon barrels	308,946	787,812	[7] 304,356	[7] 748,716
Pumice—thousand short tons	574	2,162	427	1,895
Salt—do	1,388	[6]	1,443	[6]
Sand and gravel—do	87,945	108,909	87,679	107,503
Silver (recoverable content of ores, etc.) thousand troy ounces	173	156	180	163
Stone [8]—thousand short tons	32,134	49,090	33,075	49,842
Talc, soapstone, and pyrophyllite—short tons	[3] 144,816	[3] 1,490	130,539	1,396
Zinc (recoverable content of ores, etc.)—do	78	18	465	120
Value of items that cannot be disclosed: Asbestos, bromine, calcium chloride, carbon dioxide, chromite (1959), masonry cement, coal (lignite), diatomite, fluorspar (1960), iodine, iron ore, lithium minerals, magnesite, mica, molybdenum, perlite, platinum-group metals, potassium salts, pyrites, rare-earth metals concentrates, sodium carbonate, sodium sulfate, strontium minerals (1959), sulfur ore, tungsten concentrate, uranium ore, wollastonite, and values indicated by footnote 6	----------	[3] 73,397	----------	79,470
Total California [9]	----------	[3] 1,433,626	----------	1,402,214

[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] Revised figure.
[4] Weight not recorded.
[5] Quantity and value of low-grade shipments to custom mills not included.
[6] Figure withheld to avoid disclosing individual company confidential data.
[7] Preliminary figure.
[8] Includes slate.
[9] Total adjusted to eliminate duplicating the value of clays and stone used in manufacturing cement and lime.

Employment and Injuries.—Preliminary 1960 data compiled by the Federal Bureau of Mines for the mineral industries other than mineral fuels, indicated a decline from 1959 in employment approximately 3 percent. Employment reflected production fluctuations with about a 14 percent rise in employment at metal mines and mills, and a 5 percent decrease at nonmetal mines, quarries and plants. Nonfatal injuries were lower in both categories; however, fatalities rose from 1 to 2 at metal mines whereas those attributed to the nonmetals group were unchanged from the preceding year at 9. Injuries per thousand workers were appreciably below 1959.

California participants in the Bureau of Mines 1960 National Safety Competition reporting no lost-time injuries during the year included 1 cement plant, 1 nonmetal open pit, 8 quarries, 13 sand and gravel operations, and 1 lime producer.

TABLE 2.—Employment and injuries in the mineral industries [1]

Industry	1959 [2]				1960 [3]			
	Employees	Injuries			Employees	Injuries		
		Fatal	Nonfatal	Total		Fatal	Nonfatal	Total
Metal mines and mills [4]	2,150	1	99	100	2,457	2	97	99
Nonmetallic mines, quarries, and plants [4]	16,220	9	717	726	15,386	9	537	546
Total	18,370	10	816	826	17,843	11	634	[645

[1] Excludes the mineral fuels industry.
[2] Final figures.
[3] Preliminary figures.
[4] Includes officeworkers.

Consumption, Trade, and Markets.—California led all States in diversity of mineral commodities produced and in the value of mineral raw materials consumed. Consumption exceeded production except for those commodities where the State was the sole or principal domestic source. Despite the abundance of its mineral resources, California was dependent on out-of-State producers to supply some mineral requirements. This was particularly true of mineral fuels. Consumption of major petroleum products was up 4 percent from 1959. Foreign imports of crude oil rose 18 percent above 1959 and natural gas receipts by pipeline were up almost 100 billion cubic feet. California ranked third, after Texas and Louisiana, in output of mineral fuels; however, with population second only to New York, the State led in liquid petroleum consumption and ranked second in natural gas utilization. In 1960, the State had over 8.5 million motor vehicle registrations and more than 20,000 gasoline service stations, exceeding all other States. Tax revenue from fuel, transportation, and vehicle taxes was one-fifth the total tax revenue in California for 1960.

The diversity of metal and mineral commodities produced, nearly 50 percent more than the second ranking State, necessitated a wide variety of marketing practices. As the sole domestic source of boron and iodine and virtually all the rare-earth minerals, all or most

of these commodities went to out-of-State markets. The same was also true in those instances where sources within the State yielded more than 50 percent of total domestic production (diatomite, sodium compounds, mercury, and tungsten). As its own best market, California used a tonnage of sand and gravel that was nearly double the output of the next leading State. The State led all others in production of gypsum and yet imported a large tonnage from Mexico. Deposits in neighboring States supplied many nonmetallic raw materials processed in California to meet local requirements. Some processors were also producers; others purchased or custom-milled the minerals for customers. Metal ores and concentrates were processed out-of-State, except for the American Smelting & Refining Co. Selby smelter, treating primary nonferrous material, ores and concentrates; the Kaiser Steel Co. integrated steel plant at Fontana, utilizing iron ores and concentrates; and the Union Carbide Nuclear Co. Pine Creek processing plant for tungsten ores and concentrates.

TABLE 3.—Principal custom mills, commercial grinding plants, and primary smelters in 1960

Company	County	Nearest city or town	Minerals processed	Remarks
Industrial Minerals & Chemical Co.	Alameda	Berkeley	Nonmetals	Contract grinding.
Metals Disintegrating Co., Inc.	do	Emeryville	do	Do.
American Smelting & Refining Co.	Contra Costa	Selby	Lead, zinc, silver, gold.	Smelter, refinery, and fuming plant.
Fresno Agricultural Chemical Co.	Fresno	Fresno	Nonmetals	Custom mill.
Huntley Industrial Minerals, Inc.	Inyo	Bishop	do	Do.
Union Carbide Nuclear Co.	do	do	Tungsten ore and concentrates.	1,000 ton-a-day flotation and chemical plant.
Butte Lode Mining Co	Kern	Randsburg	Gold and silver	Stamp mill, amalgamation and gravity concentrator.
American Minerals Co	Los Angeles	Los Angeles	Nonmetals	Commercial grinding.
Kennedy Minerals Co	do	do	do	Do.
Western Talc Co	do	do	do	Contract grinding.
Industrial Minerals & Chemical Co.	Sacramento	Florin	do	Do.
New Idria Mining & Chemical Co.	San Benito	Idria	Mercury	Custom mill.
Kaiser Steel Corp	San Bernardino.	Fontana	Iron ore	Blast furnaces, steel plants, and fabricating plants.
Wildberg Bros. Smelting & Refining Co.	San Francisco	San Francisco	Gold, silver, and platinum.	Smelting, refining, and manufacturing.

TABLE 4.—Sand and gravel, crushed stone, and portland cement sold or used in 1960, by methods of transportation

(Thousand short tons)

Material	Railroad	Motortruck	Waterway	Not stated[1]	Total
Sand and gravel (commercial)	2,943	69,998	(2)	92	73,033
Crushed stone (commercial)	3,806	22,396	1,548	(3)	27,750
Portland cement	1,449	5,904	(2)	113	7,466

[1] Includes interplant transfers to batching units, etc.
[2] Included with "Not stated" to avoid disclosing individual company confidential data.
[3] Included with "Motortruck" to avoid disclosing individual company confidential data.

Trends and Developments.—Although the predicted planned industrial and residential expansion did not occur in 1960, a number of important developments were of special significance in the mineral industries.

In December, the largest California gas discovery in several years was made in the Los Medanos area, Contra Costa County. Initial measured tests through a restricted orifice indicated 8 million cubic feet, with an unrestricted flow exceeding 100 million cubic feet per day. Oil production was recorded for the first time in Solano County after a light gravity oil source was discovered in the Winters gas field by Texaco Co. Pacific Gas & Electric Co. had under development the Nation's largest underground natural gas storage, the depleted McDonald Island gasfield in the San Joaquin River delta. The project was scheduled for completion in 1961. Shell Oil Co. announced plans to construct a new plant at Martinez for refining lubricating oils by catalytic hydrogenation. The plant, first of its kind in the West, will have a 500-barrel daily capacity.

The $5 million white cement plant under construction at Crestmore by Riverside Cement Co. was expected to be in production in 1961. New Pacific Rolling Mills, Inc., placed a 150,000-ton stainless-steel plant in production at Cucamonga, San Bernardino County, first of its kind on the West Coast. The first fully automatic aluminum extrusion plant in the western United States was placed in operation at San Jose by American International Aluminum Corp.

Westinghouse Electric Corp. submitted the low bid for the Pt. Loma (San Diego) plant for converting sea water to fresh water. Plans called for production of 1 million gallons of fresh water per day for 20 years, using the multistage flash-distillation process. Union Carbide Nuclear Co. expanded its tungsten refinery to include two new company-developed processing steps and produced high-purity amonium paratungstate throughout the year. Celtor Chemical Corp. began operating its mill near Hoopa, Humboldt County, early in the year. The company treated copper ores from its Copper Bluff mine and shipped most of the copper concentrate produced to out-of-State smelters. Southern Pacific Pipe Lines, Inc., began constructing a $2 million, 8-inch, 70-mile underground pipeline from the Port of Stockton ore dock to two jet fuel storage tanks three miles from Castle Air Force Base. The pipeline was planned for completion before mid-1961. Before yearend, two Canadian provinces, Alberta and British Columbia, and four States, Idaho, Washington, Oregon, and California, were the scenes of right-of-way clearing and ground preparation for the 1,400-mile pipeline that will transport natural gas from Alberta fields to northern and central California. The project was expected to be finished late in 1961.

About midyear Pacific Gas & Electric Co. placed its Sonoma County steam-generating plant under test. Late in the year this 12,500-kilowatt turbine generator, operating on natural steam from wells at "The Geysers," was dedicated by the company at the plant site.

Legislation and Government Programs.—Public Land Orders, which had withdrawn land in California in connection with the prosecution of World War II, were revoked. Involved were 5,920 acres on the

northern edge of the Avawatz Mountain Range and 1,360 acres east of U.S. Highway 395 about 6 miles south of the junction with U.S. Highway 466 in San Bernardino County.

Four Defense Minerals Exploration Administration (DMEA) contracts, under the supervision of the Office of Minerals Exploration (OME), for mineral exploration in California, were still in effect at the beginning of 1960. Two OME contracts for mercury, one each in Yolo and Lake County, were let in May and July, respectively, and one for copper in Inyo County, in September. Of the seven contracts in effect all or part of the year, only one for mercury was active at yearend.

Bureau of Mines resources work conducted in 1960 encompassed the collection and dissemination of mineral production statistics in California, in cooperation with the California Division of Mines. Resources investigations included: The mercury potential of California (as a part of the total domestic potential); beryllium and other rare-metals studies; and the beginning of surveys of chemical (mineral) raw materials and clay resources in California. The Bureau of Mines completed a reconnaissance sampling of a beryllium deposit near Lone Pine, Inyo County. The property was subsequently optioned to a Nevada mining company that conducted an intensive drilling program. Under a cooperative agreement with the California Division of Mines, reconnaissance sampling of two northern California nickeliferous laterite areas was completed by the Bureau and plans were made for a similar project at fire clay deposits in central California. Other projects under the cooperative agreement comprised slope stability studies at Boron, Kern County, recovery of tungsten and molybdenum from California scheelite ores, and the recovery of alumina from a large deposit of anorthosite in southern California.

In cooperation with the University of California Lawrence Radiation Laboratory, work on pure metals development was conducted at the Boulder City Research Laboratory, Nevada. The Bureau's Berk-

TABLE 5.—Office of Minerals Exploration contracts active during 1960

County and contractor	Property	Commodity	Contract		
			Date	Total amount	Government participation (percent)
Inyo:					
William R. Noack	Loretta	Copper	Sept. 27, 1960	$29,600	50
Lake:					
C.O.G. Minerals Corp.	Abbott	Mercury	July 14, 1960	35,060	50
Napa:					
H.L.M. Mining Co.	Aetna Springs	do.	Feb. 17, 1958	16,520	75
San Benito:					
New Idria Mining and Chemical Co.	Sulphur-Springs	Mercury	Nov. 12, 1957	96,980	75
Shasta:					
Shasta Minerals & Chemical Co. (Shasta-Phelps Dodge Joint Venture).	Balaklala	Copper-zinc	Aug. 3, 1956	[1] 89,620	50
Yolo:					
Trans-Pacific Metals, Inc.	Reed	Mercury	June 16, 1958	78,770	50
Do.	do.	do.	May 15, 1960	34,340	50

[1] Amended 1960.

eley Thermodynamics Laboratory in California conducted thermochemical studies of the rare and precious metals as a joint effort with the Reno Metallurgy Research Center, Nevada, of which the Berkeley Laboratory is a part. The San Francisco Petroleum Research Laboratory continued its basic and applied research in the broad field of petroleum production, including evaluation of methods of predicting oil-reservoir performance with particular reference to oil-recovery efficiencies, well completion studies, and the application of secondary recovery techniques.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—The Pittsburg (Contra Costa County) plant of Shell Chemical Corp. produced a carbon (furnace) black from natural gas as a byproduct of ammonia-fertilizer manufacture. The carbon product, a thermal black, was sold for use in open-hearth steelmaking. Although no pigment black was produced, the company planned to produce a rubber-grade black by the end of 1961.

At yearend, two more California carbon black plants had been planned. The first was a joint effort of Witco Chemical Corp. and Continental Carbon Co., to be located in Bakersfield. The feed stock for this plant was expected to be heavy fuel oil. United Carbon Co. purchased a site near Mojave for the second plant, which will produce a black of the furnace variety from fuel oil. Output from this plant will be consumed by the rubber, paint, and ink industries.

Carbon Dioxide.—The Honolulu Oil Company carbon dioxide separation process at its natural gasoline plant in Taft, Kern County, was operated throughout the year. As a result carbon dioxide output greatly increased over 1959, the year the plant was built. The product was used in manufacturing "dry ice," and was sold to aircraft companies for "freezing" rivets and to bottlers for carbonated beverages. Demand for carbon dioxide could increase appreciably in view of its potential use in carbonated-water secondary-oil-field recovery programs. Experimentation conducted elsewhere in the Nation could find application in some California fields.

Coal (Lignite).—All commercial lignite mining in California was done near Ione, Amador County, at a strip mine in the West Belt district. The lignite was mined chiefly for the montan wax content, not for fuel. The wax was consumed in manufacturing carbon paper, phonograph records, polishes, and rubber products. More lignite was mined in 1960 than in 1959, to meet the demand for the wax.

Coke.—Coke production in California was relatively small in comparison with that of some other States, but was important in metallurgical uses. Coke for metallurgy had been produced since 1943. Most of the California coke was produced at the Kaiser Company Fontana steel plant from coal mined in Utah and Arkansas. Most local coals are unsuitable for coking because of their high ash content, which results in structural weakness of the produced coke. Coke production had materially increased during the past few years, and production in 1960 was 11 percent above that of 1959.

Natural Gas.—Net withdrawals of natural gas reached 517,535 million cubic feet, up 7 percent from 1959. The volume obtained from dry gas zones represented one-third the total; oil zones yielded two-thirds. Less than 1 percent of the total withdrawals was vented or wasted (blown to air). During the year, 112 new gas wells were completed in dry gasfields, 32 more than in 1959. The great interest in gas exploration in the Sacramento Valley resulted in the discovery of 13 new dry gasfields. In addition, there were 15 new pool discoveries in oil fields and 14 new outposts or extensions, making a total of 42 finds out of 189 wildcats drilled for gas. The Trico area led all others with 13 new development wells, followed by the Arbuckle and McMullin Ranch areas with 10 each. The total injected gas used for repressure and pressure maintenance operations increased 2 percent over 1959 to 235,819 million cubic feet.

At yearend the depleted McDonald Island gasfield was being prepared for storage of out-of-State gas with a maximum capacity of 124,500 million cubic feet, largest in the world. An injection

TABLE 6.—Natural gas, natural gas liquids, and petroleum produced in 1960, by counties

County	Natural gas [1] (million cubic feet)	Natural gas liquids		Petroleum [1] (thousand barrels)
		Natural gasoline and cycle products (thousand gallons)	LP gases (thousand gallons)	
Butte	11,701			
Colusa	9,203			
Contra Costa	2,437			
Fresno	27,587	19,739	33,963	28,308
Glenn	30,502			
Humboldt	928			
Kern	117,716	213,865	157,339	94,299
Kings	8,852	(2)	(2)	1,748
Los Angeles	56,412	232,489	51,051	68,933
Madera	2,304			
Monterey	3,546			11,589
Orange	27,587	95,851	24,163	33,002
Riverside				3
Sacramento	46,215			
San Benito	2,701			557
San Bernardino	100			101
San Joaquin	13,268			
San Luis Obispo	1,058	(2)	(2)	1,505
San Mateo	33			174
Santa Barbara	20,179	34,074	45,881	24,092
Santa Clara				(3)
Solano	39,769			10
Sonoma	78			
Sutter	2,183			
Tehama	1,021			
Tulare	6,255			48
Ventura	87,290	160,428	62,792	40,983
Yolo	1,459			
Undistributed		38,211	33,189	
Total	[4] 516,637	794,657	408,378	305,352
Value (thousands)	[5] $138,182	$62,496	$21,482	[5] $748,716

[1] Quantity figures for natural gas and petroleum by courtesy of California Department of Natural Resources, Division of Oil and Gas.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Less than 1,000 barrels.
[4] Less natural gas vented and wasted.
[5] Preliminary figure.

pumping and control center was nearing completion. The continued increase in gas well completions was indicative of the constantly increasing demand for gas coupled with the comparatively fast payout for gas wells as compared with oil wells in California. The new 1,400-mile, 415-million-cubic-foot, Alberta-to-San Francisco gasline, designed to supplement local gas, will have its high load factor much enhanced by connection to the McDonald Island field. The Alberta line was expected to be completed in 1962.

As of December 31, 1960, California natural gas reserves in million cubic feet were estimated at: 6,182,656, "residue" oil well; 2,569,684, dry gas; and 69,598, underground storage. The total was up 3 percent from 1959.

Natural Gas Liquids.—Processing plant capacity rose 19 percent and the number of plants, including one fractionator, increased from 68 to 70. Three plants were built, and one was dismantled during the year. Despite a slight increase in volume of gas processed, total products declined 2 percent below 1959 figures as a 3-percent rise in LP gas output did not offset a 5-percent decline in yield of natural gasoline and cyclic products. Much of this change took place in Kern and Fresno Counties. Price changes in the petroleum industry lowered the dollar value of all natural gas liquids 3 percent from the 1959 level. Natural gasoline and cycle products constituted two-thirds and LP gases, one-third of the total production.

LP gas production roughly paralleled the national average of 11 percent, but producer estimates indicated total California reserves declined 4 percent. California sales were expected to increase further in 1961 if consumption at a planned tire plant materializes. In California alone, LP gas sales had risen about 4,000 percent since 1922. Presumably much of the projected increase through 1970 will be in commercial-industrial sales including internal combustion, chemical, and synthetic uses. Daily shortages in supply probably will occur, possibly aggravated by lack of sufficient storage, since California has no salt domes or mined caverns suitable for storage. Maximum LP gas withdrawal rates from water-sand storage reservoirs were low as reported by one company using this type of storage. Generally, LP gas supply was expected to increase because of the freeing of local source gas by entry of new methane lines from out-of-State. Two of these lines were either being built or planned, and a third was under consideration.

Peat.—Production and sales of peat were about 4 percent below 1959 figures. Two operators in Contra Costa County and one each in Modoc, Orange, and Riverside Counties furnished the State output. Reed-sedge peat from Contra Costa and Riverside Counties represented 73 percent of the tonnage sold; moss peat from Modoc County, 24 percent; and Orange County peat humus, the remaining 3 percent. Soil improvement uses consumed 90 percent of the output; 95 percent of the tonnage sold was prepared (shredded), and 42 percent was packaged. Approximately 97 percent of the total shipments went to California consumers; the remaining 3 percent was consigned to Nevada, Arizona, Oregon, Washington, Texas, and Utah customers.

Petroleum.—Crude petroleum production was 1 percent under the 1959 figure. Shut-in capacity was virtually nonexistent at yearend,

having declined from about 6,000 barrels a day in January. The lower yield was a continuation of a decline begun in 1955. The wider gap between consumption and production was made up chiefly by an 18-percent increase in imports over 1959. However, pipeline receipts from New Mexico and Utah declined 3 percent for the same period. Imports totaled nearly 24 percent of the refinery input.

In 1960, 1,880 notices to drill were filed, 338 more than in 1959. During the year, 1,259 new producing wells were completed, including 29 service wells. Of the total, 657 were heavy-gravity producers (below 20°) and 602 were light-gravity. Development completions by region were as follows: San Joaquin Valley, 877 wells; Coastal, 188; and Los Angeles, 194. A total of 1,218 oil wells was drilled in California during 1960, of which 28 were exploratory. There were 4 new field discoveries and 13 successful new pool finds. At yearend 37,394 wells were producing crude oil, 856 more than in 1959. The increase was largely the result of an accelerated heavy-oil developmental-drilling program. Of 211 wildcats drilled for new fields in 1960, the discovery ratio was 1 new field for 11 dry holes drilled. In comparison, the ratio for the United States was 1 for 8.

Average crude-oil input to California refineries rose 3 percent, more than 30,000 barrels a day above 1959. The number of physical refining plants remained unchanged at 37, and refinery capacity increased less than 1 percent. Significant gains were noted in hydrogen treatment and vacuum distillation. "Hydrofining," "unifining", or other similar process was under consideration by one company. No new coking facilities were added, but one new plant was planned for construction in 1961. Some California refiners processed foreign crudes for the first time.

The year was marked by increased use of secondary recovery processes. Overall, 20 new injection projects were begun. Of all projects in progress, only those using gas injection remained constant. The total water injected into all oil sands in California increased 5 percent to 707,744 barrels a day. The number of such projects rose from 83 to 98, but average rate of production was down from 8,139 barrels a day in 1959 to 7,149 barrels a day. The Wilmington field alone represented 48 percent of the State's waterflood total. At one pool of the Midway field, preliminary work on a slug-type miscible-phase displacement program was in progress using liquid propane. Plans for separating the injected propane from produced liquids were being considered. In a secondary program at Coalinga field, steam was being injected to reduce high oil viscosity and to promote production. One injection, two producing, and four temperature-observation wells were used in a pattern with the observation wells on a circle 90 feet from the injector. The producing wells are 180 feet from the injector, which received 60 tons of steam a day at 600 pounds pressure.

NONMETALS

Asbestos.—Production and sales of chrysotile asbestos declined 63 percent in 1960. The Phoenix mine, operated by Asbestos Bonding Co., Division of Clute Corp., was the principal producer. During the year the company converted its pilot plant to commercial opera-

tion. Shipments were made to consumers in the San Francisco Bay area for use in cement, stucco, and various insulation products. Small quantities were shipped to State highway agencies in California and Colorado for testing as a component in various paving mixes.

Exploration and development activity was stepped up by several companies at known deposits in the Santa Rita Mountain area, Fresno County. Union Carbide Nuclear Co. and Coalinga Asbestos Co., Inc. (a joint venture of Johns Manville Corp. and Kern County Land Co.), acquired extensive holdings that were explored by bulldozer stripping and trenching and by auger and bucket drilling. Shipments of crude ore were made to company-owned plants for experimental testing by both operators. National Mill and Mining Co. explored deposits in the same area and completed test runs at its mill in Coalinga. Jefferson Lake Asbestos Co. continued its exploration program at an asbestos deposit in Calaveras County by diamond-drilling and trenching. Rawhide Asbestos Co., Tuolumne County, mined a relatively small tonnage of asbestos for test purposes. Minor activity was in progress at several asbestos prospects in Shasta, Siskiyou, Trinity, and Monterey Counties. An occurrence of chrysotile asbestos was reported on Mount Diablo, Contra Costa County, but the find was not expected to be of commercial importance.

Barite.—Production of crude barite dropped 61 percent from 1959. The quantity sold or used declined nearly 43 percent, and end stocks were reduced by about the same percentage. Despite an apparent increase in well-drilling activity by the oil and gas industry, the tonnage of California-produced crude barite, prepared for use in well-drilling fluids, dropped more than 12 percent. Three mines, one near Yermo in San Bernardino County, and two in the 9-mile Canyon area of Tulare County, were the source of 97 percent of the crude barite sold or used by California producers. Two barite properties in Nevada County and one in Kern County contributed the remainder. Crude barite mined in Nevada was processed by one producer in a Stanislaus County chemical plant and ground by another at Merced. Relatively small quantities of ground barite were consumed in uses other than as a component of well-drilling muds.

Boron Minerals and Compounds.—Total U.S. production (and most of the world supply) of boron minerals came from bedded deposits in Inyo and Kern Counties and brines of Searles Lake, San Bernardino County. Total production and value increased 3 percent, compared with 1959. Refined boron compounds were produced from the Kern County borates at refineries both at the deposit and in Wilmington, Los Angeles County. A San Francisco Bay area chemical plant also used Kern County crude borates to manufacture high-purity boron compounds. During 1960 Kern County Land Corp. acquired two borax mining claims, totaling 39 acres, in Death Valley from U.S. Borax & Chemical Corp. An exploratory hole, which permitted a geologist to be lowered inside for direct subsurface work, was drilled near the open pit mine of U.S. Borax & Chemical Co. at Boron. Also, plans were made to replace 2½ miles of truck haulage with a 1,300-foot conveyor system. The conveyor, which will be located in the 315-foot-deep pit, will move up a slope of 18° from the primary crusher.

615629—61——11

Although the use of boron in missile and rocket fuel had been deemphasized, an accelerated program, costing an estimated $10 million a year, was being directed toward other new developments and applications such as in brake fluids, plastics, metal alloys, paper coatings, and electrodes. The canceled Government contract for boron as a high-energy fuel accounted for only 1,000 tons per year loss to the industry. On the other hand, the Federal and State forest services used nearly 9,000 tons of boron products in a fire-extinguishing solution for fighting forest fires in 1960.

Bromine and Bromine Compounds.—Elemental bromine was recovered in processing Searles Lake brines at the Trona plant, San Bernardino County, by American Potash & Chemical Corp. The plant product was sold to chemical and pharmaceutical companies for use in compounding a wide variety of products. Production at this plant increased slightly above that of 1959, but the unit value was unchanged. Mineral Products Division, Food Machinery Corp., recovered bromine from saltworks bitterns in the company plant at Newark, Alameda County. The liquid bromine was converted to ethylene dibromide, chiefly for use as a fumigant in treating soils and seeds. Output increased 77 percent over 1959. Much of the ethylene dibromide used with tetraethyl lead as an antiknock fluid in gasoline was produced at plants in other States.

Calcium Chloride.—Less liquid calcium chloride was recovered by California Rock Salt Co. and National Chloride Co. from brines collected at Bristol Lake, San Bernardino County, than in 1959. Hill Bros. Chemical Co. purchased crude liquid and operated a third plant in the area to produce both a flake product and a refined liquid. Output of flake calcium chloride was higher than in 1959. The products of all three plants were marketed in Arizona, Nevada, and southern California, mainly in fireproofing materials and as hygroscopic agents. Unit values were higher than in 1959.

Cement.—Production and shipments of portland cement declined 8 percent and 9 percent, respectively, compared with 1959. Bulk shipments declined to 32,993,000 barrels from 36,382,000, and paper bag shipments totaled 6,719,000 barrels compared with 7,253,000 in 1959. Eight southern California cement plants in Kern, Los Angeles, Riverside, and San Bernardino Counties produced and shipped over 2 million barrels less than in 1959. Average value per barrel of southern California cement was $3.22. Five northern California plants in Calaveras, San Benito, San Mateo, Santa Clara, and Santa Cruz Counties produced and shipped about 16 million barrels, compared with 18 million barrels in 1959. Average value per barrel of northern California cement was $3.28.

Southern California plants shipped 21,601,000 barrels to southern California, 539,000 to northern California, 539,000 to Nevada, 828,000 to Arizona, and the remainder to Utah, Oregon, and Colorado. Northern California plants shipped 12,676,000 barrels to northern California, 306,000 to southern California, 284,000 to Nevada, and the remainder to Hawaii, Washington, Oregon, Alaska, and foreign destinations. Shipments of masonry cement were made from plants in Santa Clara and San Bernardino Counties.

Calaveras Cement Co. began constructing its new $14-million cement plant, designed for an annual capacity of 1.5 million barrels, 10 miles north of Redding in Shasta County. The company opened a new bulk cement transfer plant at Springfield, Oreg., to handle cement from its plant at San Andreas, Calif., until its Redding plant is completed. A $5-million, 250,000-barrel capacity, white cement plant was under construction at the Crestmore facility of Riverside Cement Co. The plant will be the first of its kind west of the Rocky Mountains devoted solely to producing white cement. The Permanente Cement Co. new 3,000-barrel bulk cement distribution plant at Eureka, Calif., was completed late in 1960 and began receiving cement from Permanente, Calif.

TABLE 7.—Finished portland cement

(Thousand barrels and thousand dollars)

Year	Active plants	Estimated capacity	Production	Shipments from mills			Estimated consumption	Stocks at mills, Dec. 31
				Quantity	Value			
					Total	Average per barrel		
1951-55 (average)	11	35,196	31,939	31,718	$90,026	$2.84	27,738	1,714
1956	12	42,882	39,547	39,290	120,511	3.07	35,872	2,180
1957	13	50,150	38,371	37,731	117,852	3.12	33,388	2,956
1958	13	49,505	39,056	39,583	124,367	3.14	34,232	2,483
1959	13	51,555	43,635	43,635	138,506	3.17	38,648	2,480
1960	13	51,755	39,892	39,712	128,826	3.24	35,330	2,663

Clays.—Production of clays and shale gained 6 percent in quantity (2,899,000 tons in 1960) chiefly because of the increased tonnage of miscellaneous clays and shale produced and stockpiled for use in manufacturing portland cement. Forty-three percent of the total output was used for brick, tile, and sewer pipe; 28 percent for cement; 21 percent for lightweight aggregate; and the remainder for industrial uses, principally refractories. More than 2.4 million tons of miscellaneous clay and shale was produced in 25 counties. Los Angeles, San Mateo, Solano, Ventura, and Riverside Counties yielded 1.4 million tons. Eight counties, led by Amador, Placer, and Riverside, were the source of 415,000 tons of fire clay used in heavy clay products and refractories. Kaolin production of 14,000 tons in Mono and Orange Counties was virtually unchanged from 1959. Ball clay was mined in San Bernardino and Stanislaus Counties for tile, whiteware, and pottery. Two producers in Inyo County mined fuller's earth for filler, filter, and absorbent uses. Inyo, San Benito, and San Bernardino Counties were sources of an increased quantity of bentonite produced for various industrial applications. Nearly 2,300 tons of bentonite was used with borates in a fire-retardant mixture by Federal and State forest services to fight California's forest fires during 1960. Fresno Agricultural Chemical Co. announced that as a result of a Bureau of Mines publication [3] the company began mining and processing bentonite for use in oil-well drilling muds.

[3] Aune, Q. A., Caraway, W. H., Morris, F. C., and Gates, G. L., Evaluation of a California Bentonitic Clay for Use in Oil-Well Drilling Muds: Bureau of Mines Rept. of Investigations 5487, 1959, 44 pp.

The search for new deposits of high-grade clays continued. Exploration was in progress in the Castle Mountains, San Bernardino County, to locate a possible extension of the Hart clay deposit. Extensive clay deposits of possible commercial interest were discovered on the north slope of the San Gabriel Mountains in Los Angeles County. An exploration project was begun on the southern extension of the Ione clay formation in the Cooperstown area in Stanislaus and Tuolumne Counties under a cooperative research study agreement between the Bureau of Mines and the California State Division of Mines.

TABLE 8.—Clays production, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Alameda	33,887	$76,280	(1)	$69,661
Amador	84,591	321,889	78,327	159,161
Contra Costa	69,531	104,035	64,076	95,365
Inyo	(1)	(1)	8,452	45,307
Kern	64,879	158,414	65,469	122,541
Los Angeles	401,097	492,762	388,002	477,753
Madera	(1)	(1)	7,500	9,375
Mono	2,100	5,985	(1)	(1)
Orange	34,796	256,580	49,367	276,720
Riverside	385,230	1,037,237	370,677	1,027,511
San Bernardino	126,273	362,230	139,073	440,212
San Diego	29,600	30,900	27,100	28,650
San Joaquin	50,500	93,793	56,000	96,879
San Luis Obispo	9,750	12,187	(1)	(1)
Santa Barbara	16,428	16,428		
Santa Clara	44,744	53,360	31,080	39,684
Sonoma	19,500	7,800	(1)	(1)
Stanislaus	(1)	(1)	(1)	38,673
Tulare	6,750	6,750	5,400	5,000
Undistributed [2]	1,346,338	2,609,080	1,608,054	2,730,106
Total	2,725,994	5,645,710	2,898,577	5,662,598

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes Calaveras, Fresno, Marin, Placer, Sacramento, San Benito, San Mateo, Santa Cruz, Solano, Sutter, Ventura, and Yuba Counties, and counties indicated by footnote 1.

Diatomite.—Output of diatomite came principally from open-pit operations in Santa Barbara County. Lesser but important tonnages were mined in Kern and Napa Counties. In most instances, the material was processed in mills at the pit sites. More than half the diatomite was sold for filter aid, but appreciable tonnages were used for insulation, fillers, absorbents, pozzolan, lightweight aggregate, and admixture material. Despite a slight decrease in sales of diatomite, compared with 1959, the total value increased because of relatively higher unit prices for insulation and filter aid products.

Feldspar.—Dune sands of the Monterey peninsula were mined for their feldspar content by Owens-Illinois and Del Monte Properties Co. The former removed heavy minerals by magnetic separation and used the feldspathic sand in glass manufacture. The latter used froth flotation to remove heavy minerals and to produce feldspar and silica concentrates. The plant products were blended and ground to consumer specifications and sold for a variety of uses. The major consuming industries were glass, sanitary ware, pottery, tile, and other ceramic products. Crude feldspar produced from the Beck open-pit

mine in San Bernardino County was custom ground in Los Angeles and used by Gladding, McBean & Co. in manufacturing ceramic products.

Fluorspar.—Production of fluorspar was limited to one operation in the Clark Mountain area, San Bernardino County. Open-pit mining yielded a relatively small tonnage of crude ore that was concentrated to ceramic-grade fluorspar in the company's flotation plant. The plant product was shipped to glass manufacturers in Ohio and the Los Angeles area. Fluorspar mined in other States continued to supply the requirements of most California fluorspar consuming industries, particularly for metallurgical-grade material.

Gem Stones.—Commercial and amateur collectors, mineralogical societies, and gem dealers collected a variety of gem materials and mineral specimens in 41 counties. Agate, jasper, obsidian, petrified wood, onyx, and jade were the principal gem materials gathered. San Bernardino County was the source of the greatest variety, followed by Kern and Riverside Counties. More than 30,000 pounds of agate and jasper was collected in San Bernardino County. The Davis Creek and Lassen Creek areas of Modoc County yielded small quantities of obsidian. Lapis lazuli, a deep blue gem stone also known as the "sapphire of the ancients," was mined in the San Antonio Canyon area of San Bernardino County. Other varieties of gem materials and specimens collected included significant quantities of chalcedony, colemanite, garnet, howlite, idocrase, kyanite, lepidolite, lithiophillite, marcasite, opal, quartz crystal, rhodonite, verd antique, and vesuvianite.

Gypsum.—Mine production of crude gypsum and gypsite declined 4 percent from the 1959 record high of 1,686,000 tons, to 1,616,000 tons. Output was adversely affected by early rains and a period of foggy weather in the San Joaquin Valley farm areas and to a lesser degree by a decline in residential construction. Production and sales of California-produced agricultural gypsite were 892,000 tons and 878,000 tons, respectively, a 7-percent decrease compared with 1959. Sales of agricultural gypsite, including material from out-of-State sources, rose from 1,010,000 tons in 1959 to 1,086,000 tons, according to preliminary figures released by the California Department of Agriculture. Mines in Kern County alone yielded 730,000 tons during the year; gypsite deposits also were worked in Kings, Merced, San Luis Obispo, and Santa Barbara Counties, solely for agricultural use.

Rock gypsum was mined in Imperial and Riverside Counties for use in manufacturing building products, and in Ventura County for use as a retardant in portland cement. A plant in Alameda County recovered gypsum as a byproduct of magnesia produced from saltworks bitterns and sold most of the product as a cement-retardant and for agricultural use. Calcining plants were operated at plaster and board mills in Alameda, Contra Costa, Imperial, Los Angeles, and Riverside Counties.

Iodine.—One producer in California, Dow Chemical Co., produced virtually all the domestic crude iodine. The company recovered iodine from waste oil well brines of the Los Angeles basin in its Seal Beach plant, Orange County. The Deepwater Chemical Co., Ltd.,

recovered a few hundred pounds of iodine from well brines of the Dominques field in its Compton plant, Los Angeles County, early in 1960, and produced iodine products the remainder of the year from purchased crude iodine. The quantities of crude iodine produced and used by the producer in other products were 30 and 20 percent lower, respectively, than in 1959. However, consumer demand rose sharply and sales increased 86 percent above 1959, reducing yearend stocks nearly 71 percent.

Lime.—The total output of lime declined from 358,000 tons in 1959 to 345,000 tons, because of lower demand for refractory quicklime and lime for chemical, industrial, and construction uses. Although output of hydrated agricultural lime was the least of the major use categories, sales more than doubled those of 1959. Seven plants in California operated nine rotary kilns and three shaft-type kilns with a reported annual lime-burning capacity of 440,515 tons. Hydrators were usually continuous types. Fuel used at the plants were predominantly natural gas; however, several used fuel oil and one used coke. Some plants using natural gas maintained fuel oil on a standby basis. The Natividad operation in Monterey County was the largest lime-producing plant in the State. Other plants were operated in Alameda, El Dorado, San Bernadino, San Diego, and Tuolumne Counties. During 1960, the city of San Diego installed a 25-ton-per-day calcining plant at its Alvarado filtration facility. Lime used for water purification and softening was recovered from the sludge of treated water, the city's new and sole source. Lime produced in excess of needs was made available to the San Diego Miramar filtration plant.

Lithium Minerals.—The American Potash and Chemical Company extracted crude dilithium-sodium phosphate from brines in Searles Lake, San Bernardino County. The company converted the recovered product to lithium carbonate before it was marketed. Consumption and value increased slightly, compared with 1959, as wider uses for lithium and lithium chemicals were developed.

Magnesite and Magnesium Compounds.—The Western Quarry near Livermore continued to be the State's only active magnesite property. Although tonnages were comparatively small, production and shipments were more than five times the 1959 figures. Late in the year, operation of the deposit was assumed by Mother Lode Rock Industries, Inc. Production and sales of magnesium compounds declined from 1959. Magnesium carbonate led the decline with a 10-percent decrease in both quantity and value. The Mineral Products Division, Food Machinery Corp., plants in Alameda and San Diego Counties extracted mangnesium hydroxide and mangnesium chloride, respectively, from saltworks bitterns obtained from nearby salt producers. In Monterey and San Mateo Counties, extraction plants operated by Kaiser Aluminum and Chemical Corp. and Merck & Co., Inc., respectively, recovered magnesium compounds from sea water, using calcined dolomite and limestone.

Mica.—The State's entire production of crude mica (sericite schist) was obtained from a deposit near Ogilby, Imperial County. The output was ground by the producer and sold for use in manufacturing

roofing material. Crude scrap mica purchased from South Dakota and imported from India and Mexico was dry-ground at a Los Angeles County processing plant. The plant output was sold to paint and roofing material manufacturers.

Perlite.—Crude perlite output was limited to two operations—one each in Inyo and Napa Counties. The tonnage of crude perlite produced and sold declined slightly compared with 1959. Average unit values increased slightly. Twelve plants in California expanded perlite—7 in Los Angeles County, and 1 each in Contra Costa, Fresno, Marin, Napa, and San Diego Counties. More than half the crude perlite processed by expanding plants in California was supplied by out-of-State producers. Expanded perlite was sold for consumption in building plaster, wallboard, and paint products, and for use as loose-fill insulation, concrete aggregate, soil conditioner, filler, and filter aid.

Potassium Salts.—Although production of potassium compounds increased slightly compared with 1959, sales of potassium chloride and potassium sulfate declined 14 percent. The average unit value increased. Stocks were reduced appreciably below 1959. Except for the relatively small quantity of potassium sulfate contained in cement plant flue dust obtained near Davenport and used as a soil aid, the entire California production was extracted by American Potash and Chemical Corp. as muriate of potash (potassium chloride) at Trona, from Searles Lake brines. Some of the muriate was converted to potassium sulfate. The company reported expansion of its Trona operations as part of a $25 million capital improvement plan. A $7 million evaporation plant was under construction to replace obsolete borax, potash, soda ash, and salt cake producing units.

Pumice.—The tonnage of pumice, including pumicite and volcanic cinder, produced for sale or use, dropped from 574,000 tons in 1959 to 427,000 tons, chiefly because of a decline of 148,000 tons in the quantity of cinder and scoria used as railroad ballast. The tonnage of cinder consumed in road construction was substantially the same as

TABLE 9.—Pumice[1] sold or used by producers in 1960, by counties

County	Crude		Prepared		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Fresno	579	$1,938	456	$2,664	1,035	$4,602
Inyo	1,284	2,568	31,648	146,763	32,932	149,331
Lake	12,100	38,680	(2)	(2)	(2)	(2)
Lassen	10,887	21,774	(2)	(2)	(2)	(2)
Madera	----------	----------	7,432	77,429	7,432	77,429
Modoc	25,529	51,058	4,362	12,248	29,891	63,306
Plumas	8,707	17,414	----------	----------	8,707	17,414
Shasta	5,197	10,394	----------	----------	5,197	10,394
Siskiyou	110,068	219,614	47,620	114,535	157,688	334,149
Tehama	8,738	17,450	----------	----------	8,738	17,450
Trinity	2,525	5,050	----------	----------	2,525	5,050
Other counties[3]	85,338	363,956	64,319	791,540	172,644	1,215,950
Total	270,952	749,896	155,837	1,145,179	426,789	1,895,075

[1] Includes pumicite and volcanic cinder.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."
[3] Includes Imperial, Kern, Mono, San Bernardino Counties and counties indicated by footnote 2.

in 1959. Included in total output was 103,000 tons of pumice and cinder produced for use as concrete aggregate and nearly 20,000 tons marketed for use in landscape gardening. Lesser quantities of pumice and related volcanic materials were produced for a wide variety of uses such as carrier in pesticides, diluent in fumigants, soil conditioner, insulation, plaster aggregate, abrasive, oil and grease absorbent, cleaning compound, and filler in paints.

Pyrite.—The Mountain Copper Co. of California Iron Mountain (Hornet) mine, Shasta County, was the only pyrite producer. Production and sales decreased appreciably below 1959. The output was shipped to two chemical plants in Contra Costa County. Most of the pyrite cinder produced at these plants was sold for use in manufacturing quick-setting cements. A small quantity was used as a soil supplement.

Salt.—Production and shipments of salt from 11 plants in 7 counties rose 4 percent, compared with 1959. Most of the output was solar salt, harvested and processed in the San Francisco Bay area. Leslie Salt Co., the leading producer, operated four plants in the area and planned to harvest a first crop in 1961 from ponds in the San Pablo Bay area. Solar evaporation of sea water and brines, was the major method of salt production; however, a rock salt (halite) deposit in San Bernardino County contributed significantly to the total output. More than 50 percent of California's salt production was consumed in the State. The remainder was shipped to Nevada, Washington, Arizona, Oregon, Hawaii, several other States, various Pacific islands, and Canada and Mexico. The salt was used chiefly as a food preservative, in the manufacture of chlorine and caustic soda, and as a water softener. Other uses that required relatively small quantities were in manufacturing paper, ceramics, and rubber; in processing oils and metals; and for deicing roads and streets.

Sand and Gravel.—Despite a decline in residential construction, the quantity and value of sand and gravel output remained relatively high because of increased activity in commercial building and highway construction. Total value of these materials declined $1.4 million from the record high of $108.9 million established in 1959. Approximately 92 percent of the 87.7 million tons of sand and gravel produced

TABLE 10.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Sand		Gravel		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	22,435	$21,689	36,327	$32,930	58,762	$54,619
1956	30,564	35,492	55,883	61,034	86,447	96,526
1957	32,789	34,134	46,194	52,896	78,983	87,030
1958	30,810	34,710	53,327	60,630	84,137	95,340
1959	34,101	41,583	53,844	67,326	87,945	108,909
1960	36,524	46,000	51,155	61,503	87,679	107,503

was used for building and paving. Output of special industrial sands rose 15 percent above 1959; glass and molding sands increased the most. Production of ground sand declined mainly because a lower tonnage was prepared for foundry use. Los Angeles County again led in sand and gravel output by a wide margin, producing 18.8 million tons, 21 percent of the State total. Several large producers sought more favorable marketing positions during 1960 by acquiring existing commercial preparation plants and potential deposits.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	499	$1,958	(1)	(1)
Molding	50	224	(1)	(1)
Building	17,430	21,848	19,458	$23,622
Paving	8,881	9,932	8,225	9,455
Blast	202	796	185	771
Engine	55	177	63	210
Filter			8	62
Other	4,650	4,316	3,366	6,060
Total	31,767	39,251	31,305	40,180
Gravel:				
Building	20,091	29,463	20,667	26,844
Paving	20,061	24,739	18,304	23,545
Railroad ballast	297	318	387	327
Other	3,795	3,669	2,370	2,414
Total	44,244	58,189	41,728	53,130
Total sand and gravel	76,011	97,440	73,033	93,310
Government-and-contractor operations: [2]				
Sand:				
Building	14	15	21	29
Paving	2,320	2,317	4,497	5,159
Fill			701	632
Total	2,334	2,332	5,219	5,820
Gravel:				
Building	87	63	22	31
Paving	9,513	9,074	9,284	8,215
Fill			39	45
Other			82	82
Total	9,600	9,137	9,427	8,373
Total sand and gravel	11,934	11,469	14,646	14,193
All operations:				
Sand	34,101	41,583	36,524	46,000
Gravel	53,844	67,326	51,155	61,503
Grand total	87,945	108,909	87,679	107,503

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes figures for States, counties, municipalities, and other Government agencies.

TABLE 12.—Sand and gravel production in 1960, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	7,317	$11,369	Placer	450	$574
Alpine	28	28	Plumas	184	176
Butte	1,667	1,673	Riverside	1,849	3,489
Colusa	262	252	Sacramento	4,406	6,926
Contra Costa	185	191	San Benito	310	273
Del Norte	225	216	San Bernardino	5,506	4,863
El Dorado	64	97	San Diego	5,712	9,422
Fresno	2,566	2,987	San Joaquin	1,840	2,206
Glenn	425	394	San Luis Obispo	686	827
Humboldt	1,964	1,701	Santa Barbara	1,346	1,728
Imperial	469	494	Santa Clara	3,782	3,342
Inyo	366	321	Santa Cruz	699	960
Kern	3,046	4,332	Shasta	1,152	1,451
Kings	611	608	Siskiyou	912	861
Lake	295	360	Sonoma	2,014	1,921
Lassen	189	189	Stanislaus	769	760
Los Angeles	18,794	20,162	Sutter	58	56
Madera	57	43	Tehama	637	1,047
Marin	332	293	Trinity	208	235
Mariposa	63	106	Tulare	906	1,413
Mendocino	496	511	Tuolumne	32	33
Merced	1,278	1,199	Ventura	2,236	2,972
Modoc	446	432	Yolo	2,061	2,605
Mono	43	36	Yuba	354	409
Monterey	832	1,928	Other counties [1]	690	2,006
Napa	50	48			
Nevada	272	397	Total	87,679	107,503
Orange	6,538	6,581			

[1] Includes Amador, Calaveras, San Francisco, San Mateo, Sierra, and Solano Counties, combined to avoid disclosing individual company confidential data.

Slag (Iron-Blast Furnace).—Kaiser Steel Corp. purchased North Hollywood Tile Co. in a long-range program aimed at productive use of the large quantity of blast-furnace slag generated at its Fontana steel plant. The slag will be expanded for lightweight aggregate. The new acquisition was to be operated as the North Hollywood Block Division, Kaiser Steel Corp.

Sodium Compounds.—Tonnage and value of sodium compounds increased 9 percent, compared with 1959. Pittsburgh Plate Glass Co., Chemical Division (formerly Columbia Southern Chemical Corp.) produced anhydrous sodium carbonate and sodium sesqui-carbonate from Owens Lake brines, Inyo County. U.S. Borax and Chemical Corp. produced anhydrous sodium sulfate in its Wilmington refinery, Los Angeles County, from borates mined and partly refined in Kern County. Stauffer Chemical Co. purchased borates from the same source and recovered byproduct sodium sulfate in its San Francisco plant. American Potash and Chemical Corp and West End Chemical Co. (Division, Stauffer Chemical Co.) recovered sodium carbonate (soda ash and trona) and sodium sulfate (salt cake) through processing Searles Lake brines in plants at Trona and West End, respectively. Glauber's salt also was produced at the latter plant.

Stone.—Stone production rose to 33.1 million tons, valued at $49.8 million, owing to the increased quantity of riprap material quarried for dam construction and road relocation, notably in Tulare County. Although a major decline was reported in the production of limestone used in manufacturing cement, output of limestone and dolomite rose for such industrial uses as metallurgical flux, whiting, refractories,

TABLE 13.—Stone sold or used by producers, by uses

Use	1959		1960	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble—short tons	48,042	$576,338	45,270	$842,795
Rough architectural—cubic feet	[1] 37,992	[1] 267,742	[1] 74,607	[1] 504,239
Approximate equivalent in—short tons	3,160		6,240	
Monuments and mausoleums—cubic feet	45,939	368,276	22,728	289,431
Approximate equivalent in—short tons	3,871		1,959	
Flagging—cubic feet	41,130	75,443	19,667	50,716
Approximate equivalent in—short tons	3,384		1,657	
Total dimension stone approximate, in short tons	58,457	1,287,799	55,126	1,687,181
Crushed and broken stone:				
Riprap—short tons	2,988,354	4,791,958	4,942,054	6,611,511
Metallurgical—do	[2]	[2]	[2]	[2]
Concrete and roadstone—do	10,508,699	13,458,238	10,659,927	13,153,995
Railroad ballast—do	[2]	[2]	[2]	[2]
Agricultural—do	[2]	[2]	[2]	[2]
Chemical—do	[2]	[2]	[2]	[2]
Miscellaneous [3]—do	[4] 18,578,372	[4] 29,551,832	[5] 17,417,742	[5] 28,389,377
Total crushed and broken stone—do	32,075,425	47,802,028	33,019,723	48,154,883
Grand total approximate, in short tons	32,133,882	49,089,827	33,074,849	49,842,064

[1] Includes dressed architectural and roofing slate.
[2] Included with "Miscellaneous" to avoid disclosing individual company confidential data.
[3] Includes whiting substitute, filler, mineral food, poultry grit, stucco, roofing granules, filter beds, terrazzo metallurgical, railroad ballast, agricultural, chemical, and miscellaneous uses.
[4] Includes 12,886,476 short tons of limestone and oystershell used in cement valued at $14,485,668 and 776,884 tons of limestone used in lime valued at $2,142,830.
[5] Includes 11,878,047 short tons of limestone and oystershell used in cement valued at $14,670,521 and 736,876 tons of limestone used in lime valued at $1,974,004.

TABLE 14.—Stone [1] production in 1960, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	1,701	$1,179	Riverside	1,200	$3,193
Alpine	1	[3]	San Bernardino	4,954	6,859
Amador	4	65	San Diego	1,018	1,380
Butte	92	94	San Joaquin	[3]	[3]
Contra Costa	1,783	2,513	San Luis Obispo	544	1,274
Del Norte	36	32	San Mateo	2,177	2,513
El Dorado	774	1,407	Santa Barbara	[4]	499
Fresno	67	171	Santa Clara	3,641	4,101
Glenn	19	23	Santa Cruz	1,928	2,742
Humboldt	179	147	Shasta	39	39
Imperial	40	42	Sierra	11	19
Inyo	[4]	414	Siskiyou	3	5
Kings	50	55	Solano	139	214
Lake	10	17	Sonoma	229	322
Lassen	118	122	Sutter	28	29
Los Angeles	2,355	4,614	Tehama	26	20
Madera	14	[4]	Trinity	694	743
Mariposa	1	24	Tulare	1,400	825
Mendocino	34	58	Tuolumne	312	1,036
Modoc	2	2	Ventura	438	973
Nevada	33	32	Yuba	14	29
Orange	55	150	Other counties [5]	6,835	11,811
Placer	24	[4]			
Plumas	53	55	Total	33,075	49,842

[1] Includes stone used in cement and lime.
[2] Less than $1,000.
[3] Less than 1,000 short tons.
[4] Included with "Other counties" to avoid disclosing individual company confidential data.
[5] Includes Calaveras, Kern, Marin, Monterey, Napa, San Benito, San Francisco, Stanislaus, and counties indicated by footnote 4.

poultry grit, filler in paper, and mineral feed for animals. The increased tonnages of road material quarried from sandstone and miscellaneous stone deposits offset to some extent the lower quantity of granitic rock produced for the same use. Marble quarry operators experienced a year of high demand for blocks and slabs for interior use and crushed marble for roofing, terrazzo, and exposed aggregate in precast panels. Dimension granite quarried for architectural stone and industrial purposes increased by nearly 10,000 cubic feet compared with 1959. Output gains also were noted in the volume of dimension limestone prepared for building, and of limestone and slate for flagging. The tonnage of natural and artificially colored roofing granules prepared from crushed stone and gravel during the year rose from 328,000 tons in 1959 to about 404,000 tons.

TABLE 15.—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
1956	3,899	$5,155	1,967	$2,339	14,115	$22,118
1957	12,744	10,565	1,953	2,432	14,102	22,512
1958	3,649	5,348	1,499	1,738	14,409	22.584
1959	4,343	5,433	1,772	2,728	16,137	24,384
1960	4,208	5,409	1,941	2,748	15,054	23,311

Year	Sandstone		Other stone [2]		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1956	2,818	$4,834	9,684	$11,662	32,583	$46,108
1957	4,222	6,680	8,330	11.402	41,351	53,591
1958	3,933	5,688	8,933	12,987	32,423	48,345
1959	2,758	4,506	7,124	12,039	32,134	49,090
1960	3,541	5,626	8,331	12,748	33,075	49,842

[1] Includes limestone and oystershell used in cement and lime as follows (in thousand short tons and thousand dollars): 1956, 12,260 tons, $17,355; 1957, 11,861 tons, $16,489; 1958, 12,352 tons, $16,422; 1959, 13,663 tons, $16,628; 1960, 12,605 tons, $16,645.

[2] Includes light-colored volcanics, schist, serpentine, river boulders, and such other stone as cannot properly be classed in any main group; also marble (1956-60) and slate (1958-60).

Sulfur.—Recovery of elemental sulfur as a byproduct of oil refining increased 7 percent over 1959. Total production from all major California refineries reached 88,936 long tons. The Modified Claus or Simon-Carves method generally was used for elemental sulfur recovery at refineries concerned, most of which were in the Los Angeles area. Refineries producing hydrogen sulfide reported a 16 percent increase in output. Recovery from stack exhaust gases at the Selby smelter in Contra Costa County was 31 percent greater than in 1959.

Production and shipments of sulfur ore increased 15 and 19 percent, respectively, compared with 1959. A high percentage of the total output was mined at the Leviathan sulfur deposit, Alpine County, by The Anaconda Company. Four other mines, New Elgin, Colusa County; Crater Sulphur, Inyo County; and the S Bar S and Sulphur Bank, Lake County, yielded sulfur ores used to treat soils. Output

from the Leviathan mine was consumed in the producer's sulfuric acid plant in Nevada.

Talc, Soapstone, and Pyrophyllite.—Production and shipments of these minerals dropped 10 and 12 percent, respectively, below 1959 figures, and direct sales to consumers declined 7 percent. Approximately 87 percent of the combined outputs were mined from deposits in Inyo and San Bernardino Counties. These two counties were the source of all the talc produced. The soapstone production came principally from one deposit each in Amador, El Dorado, and Los Angeles Counties. Pyrophyllite was shipped mainly from one property each in Mono and San Bernardino Counties, and three in San Diego County. The ceramic industry consumed 50 percent of the total shipments. In descending order of quantity consumed, insecticides, paint, paper, rubber, toilet preparations, rice polishing, asphalt, and textiles used the remainder. Only talc was reported to have been exported.

Vermiculite.—California Zonolite Co. exfoliated crude vermiculite received from company mines in Montana at plants in Sacramento and Los Angeles Counties. In Orange County, Lahabralite Co. exfoliated crude vermiculite imported from Africa. The plant products were used principally for thermal and acoustical insulation, and as lightweight aggregate in plaster and concrete; however, some of the plant output was sold for use by nurseries for rooting cuttings and tubers, sprouting seedlings, and as a soil conditioner. The quantity of vermiculite exfoliated was virtually unchanged from 1959, but unit values rose appreciably owing to increased sales for specialized uses.

Water.—Pacific Gas and Electric Co. constructed and placed in service the first geothermal-electric power generating station in North America. The Geysers Tower Plant, Sonoma County, had a capacity of 12,500 kilowatts. Source of its power is natural steam recovered through a series of wells that provide the plant with 348° F. steam at the rate of 265,000 pounds an hour. Adequate steam has been developed to permit constructing a second plant of similar capacity.

Possible sources of geothermal power for generating electricity were investigated by the Magma Power Co. at Casa Diablo Hot Springs, Mono County, northwest of Bishop, and in the Sulphur Bank area, Lake County. A geothermal area in Napa County was explored by the Calistoga Power Co.

Westinghouse Electric Corp. was awarded the contract for constructing a 1 million gallon-per-day sea water conversion demonstration plant at Point Loma, San Diego County. The plant represented a cooperative effort of the Office of Saline Water, U.S. Department of the Interior, and the State of California Department of Water Resources, and was expected to produce fresh water for about $1 per thousand gallons. It will use a multistage flash distillation process incorporating several features designed to permit flexibility for testing and for further improvements in economy.

The Southern California Edison Co. completed an experimental seawater conversion plant near Oxnard, Ventura County. The pilot plant consisted of a 26-stage flash evaporation unit that used nearly spent steam from the generating station turbines. It will supply technical and cost data for use in designing larger scale commercial units.

Other Nonmetals.—Some exploratory and assessment work was done at the Desert Rat claims, an aluminum silicate (abrasives) prospect a few miles southeast of Daggett, San Bernardino County, on the Camp Rock road. An amorphous silica property in the Castle Mountains southeast of Ivanpah was idle throughout the year.

Sunray Mid-Continent Oil Co. carried out an extensive exploratory program in a relatively unexplored section of the Mojave Desert. The intensive search included core drilling in an attempt to find commercial saline deposits and other minerals. A laboratory trailer, equipped to conduct wet chemical analysis and with a petrographic microscope and a Geiger counter, accompanied the specially adapted shorthole drill-rig. The results of this search had not been reported at yearend.

C. K. Williams Co., the only producer of iron oxide pigments in California, operated a plant at Emeryville, Alameda County. Most of the output was manufactured brown, red, and yellow iron oxides made from steel scrap, using acids and caustics; however, small tonnages of hematite from Arizona and limonite from Oregon were used to produce natural brown iron oxide, venetian red, and ocher pigments.

No strontium minerals were produced. The Pan Chemical Co. celestite property in the Fish Creek Mountains, San Diego County, was idle throughout 1960; it had reported production in 1959.

Several California chemical companies purchased phosphate rock from out-of-State producers and used the mineral chiefly in manufacturing various grades of fertilizers.

Wollastonite float was gathered near Midland, Riverside County, and shipped for use as ornamental and building stone.

METALS

Beryllium.—The Sorenson beryllium prospect in the Inyo Mountains, about 8 miles east of Lone Pine, Inyo County, was investigated by the Bureau of Mines to obtain information on the beryllium mineralization in the area. The Bureau excavated 1,000 feet of trenches and took 200 channel samples. Results of this work indicated that beryl occurred disseminated and in widely separated, discontinuous, narrow stringers. The White Caps Gold Mining Co. of Nevada obtained a lease and option to purchase the property. The company continued the investigations by core drilling and underground exploration.

Chromite.—No chromite ore was mined or shipped in 1960. Chromite was eligible for Government assistance under the OME program, but the lack of a market for domestic ore discouraged exploration or development at California mines.

Copper.—The output of recoverable copper was the highest since 1947 and had the greatest total value since that date except for 1956. This high quantity and value resulted because the metal-mining industry was strike-free and the unit price for the metal averaged 32.1 cents per pound for 1960. Three mines yielded 94 percent of the near-record production. The major producer was Union Carbide Nuclear Co. at its Pine Creek mine (byproduct copper from tungsten ore),

Inyo County; followed by Celtor Chemical Corp. at its Copper Bluff mine (copper ore), Humboldt County; and Mountain Copper Co. at its Iron Mountain mine (copper precipitates from mine water of a pyrite ore-body), Shasta County. Although 11 other properties contributed to the total copper output, only 3 mines (copper), 1 each in Madera, Plumas, and Siskiyou Counties yielded more than 10 tons of recoverable metal.

TABLE 16.—Mine production of gold, silver, copper, lead, and zinc in 1960, by counties, in terms of recoverable metals

County	Mines producing [1]		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value	Troy ounces	Value
Alpine	1		78	$2,730	3,182	$2,880
Amador	3	1	74	2,590	21	19
Butte	2	2	57	1,995	18	16
Calaveras	1	[2]	30	1,050	8	8
Fresno		5	421	14,735	51	46
Inyo	11	[2]	233	8,155	98,404	89,061
Kern	8	1	259	9,065	[3]	[3]
Los Angeles		2	146	5,110	19	17
Mono	2		25	875	649	587
Nevada	4	5	1,448	50,680	[3]	[3]
Placer		5	140	4,900	14	12
Plumas	2	5	102	3,570	[3]	[3]
San Bernardino	8	1	26	910		
Shasta	6	1	602	21,070	3,056	2,766
Sierra	7	4	16,528	578,480	3,231	2,924
Siskiyou	7	8	7,881	275,835	25,141	22,754
Stanislaus		1	8	280	1	1
Tuolumne	2		14	490	4	4
Undistributed [4]	19	9	95,641	3,347,435	45,981	41,615
Total	83	50	123,713	4,329,955	179,780	162,710

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Alpine			200	$23	200	$25	$5,658
Amador							2,609
Butte			[3]	[3]	[3]	[3]	2,011
Calaveras							1,058
Fresno							14,781
Inyo	[3]	[3]	811,600	94,957	308,100	39,745	231,918
Kern							9,065
Los Angeles							5,127
Mono			5,500	644			2,106
Nevada	[3]	[3]	[3]	[3]	[3]	[3]	50,680
Placer							4,912
Plumas	[3]	[3]					3,570
San Bernardino	4,300	$1,380	[3]	[3]	[3]	[3]	2,290
Shasta	160,000	51,360	3,200	374			75,570
Sierra					300	39	581,443
Siskiyou	[3]	[3]					298,589
Stanislaus							281
Tuolumne							494
Undistributed [4]	2,009,700	645,114	59,500	6,962	621,400	80,161	4,121,287
Total	2,174,000	697,854	880,000	102,960	930,000	119,970	5,413,449

[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] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes Del Norte, El Dorado, Humboldt, Madera, Mariposa, Merced, Riverside, Sacramento, San Diego, Trinity, and Yuba Counties and counties indicated by footnote 3.

Gold.—Total recoverable gold produced was 15 percent below the 1959 figure. The decline was most pronounced in placer operations, in which 3.5 million cubic yards less material was washed. One of the two major placer gold operations treated 45 percent less material; the other washed about the same quantity as in 1959. There were eight more active placer properties in 1960, seven of which were dragline operations.

Approximately 10,000 less ounces of gold was obtained from lode gold ores, but increased activity at copper, lead, and zinc mines that recovered gold as a byproduct more than offset that loss.

Iron Ore.—Less iron ore was mined than in 1959. Only one mine produced direct-shipping-grade ore, and only three mines were active. Shipments of usable iron ore were 8 percent above 1959, and the entire increase was credited to exported concentrate. Concentrate was produced only at the Eagle Mountain mine, Riverside County, and the Iron Age mine, San Bernardino County. Neither property yielded direct-shipping-grade ore. The Rusty Ridge open-pit iron mine near Paradise, Butte County, explored in 1959 by Standard Slag Co., yielded direct-shipping-grade ore in 1960 that was shipped for export. The company reported that economic grades of ore were exhausted in November, and the mine was abandoned. The blast furnaces of Kaiser Steel Corp., Fontana, consumed most of the Eagle Mountain output and iron ore from Nevada mines. Approximately one-third of the concentrate produced from Iron Age ore, by hand-sorting and magnetic separation, was sold for use in cement; the remaining tonnage was consumed in open-hearth furnaces. The Port of Stockton received 678,710 long tons of iron ore from California and Nevada producers for export to Japan.

Iron and Steel.—Production, shipments, and consumption of pig iron rose 24, 21, and 20 percent, respectively, above 1959 figures. Although California pig iron was produced only at the Kaiser Steel Corp. integrated steel plant in Fontana, Columbia-Geneva Division, U.S. Steel Corp., received pig iron at its Pittsburg works in Contra Costa County and its Torrance works, Los Angeles County, from company blast furnaces in Utah. At Niles, Pacific States Steel Corp. completed new fabricating facilities in July but the planned completion of a blast furnace was delayed until mid-1962 or later. Bethlehem Steel Corp. completed an H-iron plant at Los Angeles for direct reduction of iron ore. The plant operated experimentally late in the year, but results of the test runs were not available at yearend. The American Steel Rolling Mills, Inc., in Long Beach, was acquired by Texas interests. The new owner planned early completion of an automated plant to make reinforcing rod and expected to be in operation early in 1961. The New Pacific Rolling Mills, Inc., placed the West Coast's first stainless-steel plant in production at Cucamonga. Design capacity of this plant was 150,000 tons of rolled steel (bars, squares, flats, channel, and angles) per year. During the year National Steel Supply at Torrance added an experimental furnace for extremely high-temperature work.

TABLE 17.—Gold produced at placer mines, by classes of mines and methods of recovery [1]

Class and method	Mines producing [2]	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:						
1951–55 (average)	6	16	49,969	140,668	$4,923,394	$0.099
1956	3	10	36,357	130,631	4,572,085	.126
1957	3	9	31,043	117,832	4,124,120	.133
1958	3	7	27,513	135,540	4,743,900	.172
1959	2	7	24,528	103,023	3,605,805	.147
1960	2	5	21,020	89,562	3,134,670	.149
Dragline dredges: [3]						
1951–55 (average)	9	8	685	3,259	114,079	.167
1956	7	7	328	871	20,485	.093
1957	4	4	261	759	26,565	.102
1958	6	6	83	467	16,345	.197
1959	6	6	119	1,405	49,175	.413
1960	13	14	111	1,081	37,835	.340
Suction dredges:						
1951–55 (average)	7	7	70	292	10,234	.147
1956	2	2	24	27	945	.040
1957						
1958	2	2	2	14	490	.223
1959	3	3	7	68	2,380	.359
1960	2	2	[4]	5	175	.583
Nonfloating washing plants: [3 5]						
1951–55 (average)	20	20	48	1,796	62,846	1.302
1956	18	22	2	1,624	56,840	1.583
1957	4	21	12	1,549	54,215	.970
1958	4	15	1	872	30,520	.523
1959	3	11	2	1,201	42,035	.326
1960	2	6	8	365	12,775	.376
Gravel hydraulically handled:						
1951–55 (average)	11	----------	97	357	12,481	.129
1956	6	----------	9	101	3,535	.389
1957	6	----------	11	85	2,975	.271
1958	6	----------	7	166	5,810	.824
1959	3	----------	4	50	1,750	.417
1960	4	----------	1	11	385	.396
Small-scale hand method: [6]						
1951–55 (average)	43	----------	80	1,469	51,408	.640
1956	26	----------	79	1,029	36,015	.459
1957	32	----------	36	1,283	44,905	1.246
1958 [7]	39	----------	49	1,177	41,195	.841
1959 [7]	22	----------	[8] 30	[8] 1,146	[8] 40,110	1.405
1960 [7]	26	----------	59	1,111	38,885	.617
Underground placers:						
Drift:						
1951–55 (average)	13	----------	4	183	6,419	1.515
1956	11	----------	4	164	5,740	1.481
1957	6	----------	3	109	3,815	1.240
1958	5	----------	[4]	27	945	2.796
1959	3	----------	[4]	9	315	1.432
1960	1	----------	1	44	1,540	1.750
Grand total placers:						
1951–55 (average)	109	----------	50,953	148,024	5,180,861	.102
1956	73	----------	36,803	134,447	4,705,645	.126
1957	55	----------	31,366	121,617	4,256,595	.133
1958	65	----------	27,655	138,263	4,839,205	.173
1959	42	----------	[8] 24,691	[8] 106,902	[8] 3,741,570	[8] .152
1960	50	----------	21,201	92,179	3,226,265	.152
1848–1960	----------	----------	[9]	67,963,270	1,514,452,096	[9]

[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 "dry-land 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.
[8] Revised figure.
[9] Data not available.

TABLE 18.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing [2]		Material sold or treated [3] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousand dollars)	Troy ounces	Value (thousand dollars)
1951-55 (average)	145	109	369	264,424	$9,255	909,001	$823
1956	116	73	281	193,816	6,784	938,139	849
1957	118	55	204	170,885	5,981	522,288	472
1958	107	65	139	185,385	6,489	188,260	170
1959	73	42	142	[4] 145,270	[4] 5,084	[4] 172,810	156
1960	83	50	157	123,713	4,330	179,780	163
1848-1960	-------	-------	[5]	105,704,647	2,401,766	118,924,380	96,847

Year	Copper		Lead		Zinc		Total value (thousand dollars)
	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	
1951-55 (average)	616	$344	8,953	$2,781	6,526	$1,968	$15,171
1956	859	730	9,296	2,919	8,049	2,205	13,487
1957	945	569	3,458	989	2,969	689	8,700
1958	749	394	140	33	51	10	7,096
1959	663	407	227	52	78	18	[4] 5,717
1960	1,087	698	440	103	465	120	5,414
1848-1960	637,388	207,559	263,318	52,341	149,949	35,402	2,793,915

[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 itenerant prospectors, "snipers", "high-graders", and others who gave no evidence of legal right to property.
[3] Does not include gravel washed.
[4] Revised figure.
[5] Data not available.

TABLE 19.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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 [1] [2]	[3] 15,368	2,852	-------	-------	-------
Cyanidation:					
Ore	7,604	24,415	-------	-------	-------
Old tailings	8	9	-------	-------	-------
Total	7,612	24,424	-------	-------	-------
Total recoverable in bullion	22,980	27,276	-------	-------	-------
Concentration and smelting of concentrates: Ore [2] [4]	7,811	110,403	1,934,400	60,100	623,900
Direct smelting:					
Ore	321	33,042	79,600	816,700	306,100
Copper precipitates	71	2,907	160,000	3,200	-------
Old tailings	351	563	-------	-------	-------
Total	743	36,492	239,600	819,900	306,100
Placer	92,179	5,609	-------	-------	-------
Grand total	123,713	179,780	2,174,000	880,000	930,000

[1] Includes tungsten ore.
[2] Combined to avoid disclosing individual company confidential data.
[3] Includes gold recovered as "natural gold."
[4] Includes tungsten ore concentrate.

TABLE 20.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	53	133,875	27,559	29,384	500	5,100	1,700
Silver	3	177	78	3,700	----------	200	200
Copper and tungsten ore [2]	14	[3] 17,292	3,418	105,769	2,001,900	24,500	621,500
Lead	10	2,294	20	13,355	800	285,000	7,000
Lead-zinc	2	3,087	29	18,484	10,800	562,000	299,600
Total	82	156,725	31,104	170,692	2,014,000	876,800	930,000
Other lode material:							
Copper precipitates	1	158	71	2,907	160,000	3,200	----------
Old tailings	([4])	398	359	572	----------	----------	----------
Total	1	556	430	3,479	160,000	3,200	----------
Total lode material	83	157,281	31,534	174,171	2,174,000	880,000	930,000
Gravel (placer operations)	50	([5])	92,179	5,609	----------	----------	----------
Total all sources	133	----------	123,713	179,780	2,174,000	880,000	930,000

[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] Tungsten-ore tonnage not included.
[4] From property not classed as a mine.
[5] 21,200,670 cubic yards. Does not include material washed at commercial gravel plants to produce 278 ounces of byproduct gold and 21 ounces of byproduct silver included in placer totals.

Iron and Steel Scrap.—Consumption of ferrous scrap in California dropped 10 percent below 1959; in contrast, pig iron consumption rose 20 percent. Except for the Fontana plant of Kaiser Steel Corp., California steel mills used scrap (home-generated and purchased) for 80 to 100 percent of their iron requirements. Home-generated ferrous scrap increased 11 percent over 1959 to 1,194,690 short tons, whereas purchased scrap declined 32 percent to 1,043,720 short tons. Exports were high for the year, particularly for the 4th quarter when Japanese interests contracted for 95 cargoes of iron and steel scrap. This was 30 cargoes above the previous quarter and the highest for any 3-month period since export was opened in 1953. Los Angeles No. 1 heavy-melting scrap closed the year at $29 to $30 per long ton; San Francisco, at $32. No. 2 bundles, the major product at most scrap yards, closed at $17 per long ton in Los Angeles and $18, in San Francisco.

TABLE 21.—Ferrous scrap and pig iron consumption

(Thousand short tons)

Year	Ferrous scrap	Pig iron	Year	Ferrous scrap	Pig iron
1951–55 (average)	2,529	1,203	1958	2,127	1,280
1956	2,789	1,431	1959	2,280	1,379
1957	2,656	1,437	1960	2,054	1,650

TABLE 22.—Ferrous scrap and pig iron, consumption by types of furnaces and miscellaneous uses

(Thousand short tons)

	1959	1960		1959	1960
Ferrous scrap and pig iron charged to—			Ferrous scrap and pig iron charged to—		
Steel furnaces: [1]			Miscellaneous uses: [3]		
Scrap	1,868	1,670	Scrap	53	47
Pig iron	1,171	1,340			
Total	3,039	3,010	Total scrap	2,280	2,054
			Total pig iron	1,379	1,650
Iron furnaces: [2]			Grand total	3,659	3,704
Scrap	359	337			
Pig iron	208	310			
Total	567	647			

[1] Includes open-hearth, electric furnaces, and basic oxygen process.
[2] Includes cupola, air, and blast furnaces; also direct castings.
[3] Includes rerolling, copper precipitation, nonferrous, and chemical uses.

Lead.—The output of recoverable lead nearly doubled that of 1959. Lead and lead-zinc ores mined in Inyo County, principally at the Defense (lead) and the Santa Rosa (lead-zinc) mines in the Modoc and Lee districts, respectively, furnished 87 percent of the increase. Of the total recoverable lead produced, less than 4 percent was derived from sources other than lead and lead-zinc ores.

Manganese.—Ore shipments were limited to low-grade manganese ores obtained from two mines in Stanislaus County and one in Tehama County. All shipments were consigned to an Arizona mill for upgrading. Ultimate consumption, as concentrate, was in iron and steel.

Mercury.—Activity at mercury mines increased compared with 1959, despite a lower average unit price for the metal. The tonnages of ore mined and treated rose more than 4 percent above 1959, and production and shipments were up 10 and 9 percent, respectively. Although 56 operators at 41 properties contributed to the total, over 82 percent of the output came from three operations—the New Idria mine, San Benito County; the Mt. Jackson, Sonoma County; and the Buena Vista, San Luis Obispo County. Six mines—one each in Kings, Lake, Santa Barbara, and Sonoma Counties, and two in Santa Clara County—produced 200 or more flasks. The remaining 32 mines and prospects yielded less than 200 flasks each.

TABLE 23.—Mercury production, by methods of recovery

Year	Operating mines	Furnaced [1]		Retorted		Unclassified [2] flasks	Total	
		Ore (short tons)	Flasks	Ore (short tons)	Flasks		Flasks	Value [3]
1951–55 (average)	33	93,091	7,780	4,063	503	107	8,390	$1,995,895
1956	71	76,801	6,991	9,312	1,971	55	9,017	2,343,699
1957	57	115,134	13,722	10,806	2,228	561	16,511	4,077,887
1958	48	130,560	20,307	10,471	1,594	464	22,365	5,122,927
1959	37	107,072	15,685	12,034	1,271	144	17,100	3,889,908
1960	41	120,714	17,862	4,334	785	117	18,764	3,954,701

[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.—Production and shipments of molybdenite and powellite (combined) concentrates decreased 52 and 43 percent, respectively, below 1959. Both minerals were obtained as byproducts in the treatment of tungsten ores of the Pine Creek mine, Inyo County. All the molybdenite produced and about 10 percent of the molybdenum recovered as powellite was shipped for export. The remaining molybdenum recovered from powellite was sold for domestic consumption. Shipments were 46 percent above 1959, and yearend stocks were reduced about 68 percent.

Platinum-Group Metals.—Two major dredging operations, on the American and Yuba Rivers in Sacramento and Yuba Counties, respectively, obtained platinum as a byproduct in gold recovery.

Rare-Earth Minerals.—The Molybdenum Corp. of America Mountain Pass barite-bastnasite mine in the Ivanpah Mountains, San Bernardino County, was active during the year. The extensive deposit was further explored by churndrilling, and the open pit was developed by stripping. Production of bastnasite concentrate, averaging 68 percent rare-earth oxides, declined slightly from 1959, but shipments were more than three times those of 1959. The concentrate was processed at company plants in Washington and York, Pa. The Desert Dominion Mining and Milling Co. xenotime property in northern Riverside County was idle.

Secondary Nonferrous Metals.—An estimated 300 million pounds of nonferrous scrap valued at $30 million was consumed in California, a slight decline from the 1959 consumption. Lead, copper, and aluminum scrap comprised 85 percent of the total consumption, or 44, 27, and 14 percent, respectively; the remaining 15 percent included zinc, antimony, magnesium, nickel, and tin. In 1960 California rated as a "plus" area with respect to aluminum, copper, and lead scrap, and a "minus" area with respect to zinc scrap.

Plants in the Los Angeles area used most of the nonferrous scrap produced in consuming an estimated 85 percent of the copper and lead, and 97 percent of the aluminum scrap.

Silver.—The 4-percent increase in silver output over 1959 was due chiefly to increased activity at lead and lead-zinc mines from which silver ores was recovered as a byproduct. Placer silver production represented only 3 percent of the total and was recovered as a coproduct in placer gold mining. Approximately 76 percent of the lode silver was derived from copper ores mined in Humboldt and Siskiyou Counties, and tungsten, lead, and lead-zinc ores mined in Inyo County.

Tungsten.—Four tungsten mines were active. The Pine Creek mine and mill, Inyo County, of Union Carbide Nuclear Co. was the major tungsten operation in the State. Late in 1959 the company added additional processing steps that resulted in production of high-purity ammonium paratungstate in 1960. New Idria Mining and Chemical Co. reactivated its Strawberry mine in Madera County, and operated about 3 months for rehabilitation. The concentrate produced was sold mostly to a New York buyer; a relatively small quantity was purchased by Union Carbide Nuclear Co. for its Pine Creek plant. The other two operators of tungsten properties, the Nichols mine in Inyo County and the Little Dutchman in Fresno County, also sold concen-

trates to the Pine Creek operation. The Atolia tungsten mine, San Bernardino County, was inactive but stockpiled concentrate was sold to a New Jersey buyer. Late in the year, tungsten placer ground in the Atolia area was acquired by Metals and Petroleum Corp., Los Angeles.

Uranium.—Commercial uranium ore was shipped from two properties, one each in Lassen and Sierra Counties. The tonnage shipped was 19 percent below that in 1959, but the average U_3O_8 content was higher, and the total value remained substantially the same. The Lassen County ore was processed in Utah; the Sierra County ore was consigned to an Oregon plant.

Zinc.—Recoverable zinc output increased nearly sixfold over that in 1959. Most of the increase was credited to byproduct recovery from copper ore of the Copper Bluff mine, Humboldt County; however, production at the Santa Rosa mine, Inyo County, was more than double that in 1959. Copper and lead-zinc ores were the source of 99 percent of the total zinc output. Lead, tungsten, gold, and silver ores combined furnished the remaining 1 percent.

Other Metals.—Activity at cobalt-nickel properties and prospects was confined principally to routine assessment and maintenance work. A limited drilling program was completed by the Federal Bureau of Mines at the Diamond Flat and Pine Flat prospects near Smith River, Del Norte County, and considerable sampling, blasting, and road work was completed at claims in the Coyote Mountains, Imperial County. Some exploratory work was done on the Friday property near Julian, San Diego County.

Except for assessment work completed at the Live Oak mine near Saugus, Los Angeles County, and the Chloride-Globe group of claims near Weaverville, Trinity County, ilmenite-rutile prospects were idle.

A zircon prospect a few miles north of Mojave, Kern County, was idle except for annual assessment work. A Sacramento minerals company completed limited drilling projects in Amador, Butte, Calaveras, Mariposa, Merced, and Placer Counties in a search for zircon, titanium minerals, gold, and other heavy minerals. Another company prospected in the Barstow area, San Bernardino County, where drilling and testing revealed free zircon in black sands. Recovery would require a dredging operation, using water not presently available.

No activity of any kind was reported in 1960 from the Santa Ana tin prospect in Trabuco Canyon, Orange County.

REVIEW BY COUNTIES

Alameda.—Increased sand and gravel requirements for paving projects, particularly MacArthur Boulevard and Nimitz Freeway, offset to a large extent the reduction in sales of aggregate for building construction. The capacities of the major producers—Henry J. Kaiser Co., Pacific Cement & Aggregates, Inc., and Rhodes & Jamieson, Ltd.—were more than 1 million tons a year each. These companies worked alluvial deposits near Pleasanton, Fremont, and Niles. Concrete aggregate obtained near Pleasanton was used in the massive estuary tube under construction between Alameda and Oakland.

Pits in the Irvington, Livermore, and Sunol areas and a sand dredge operation near Alameda were additional sources of sand and gravel. Nearly 500,000 tons of crushed basalt was quarried by Gallagher & Burk, Inc., at its Leona operation near Mountain Boulevard, Oakland, and used principally for road base and fill. Sandstone and miscellaneous stone were produced from quarries in the San Leandro and Hayward areas for the same uses by Castro Valley Rock Co., East Bay Excavating Co., Inc., La Vista Quarries, and San Leandro Rock Co. Lowrie Paving Co. mined fire clay for foundry use at the underground workings of the Tesla deposit near Livermore until the end of July, when the operation was shut down indefinitely. Miscellaneous clay was dug from a deposit 3 miles west of Livermore by E. H. Metcalf Materials, from open pits near Fremont by California Pottery Co. and Interlocking Roof Tile Co., and from the workings of Kraftile Co. 2 miles from Niles on the Niles-Alvarado road. The clays were sold or used for stoneware, heavy clay products, and architectural terra cotta.

TABLE 24.—Value of mineral production in California, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Alameda	$20,527,931	$19,720,317	Sand and gravel, salt magnesium compounds, stone, lime, bromine, clays, gem stones.
Alpine	(1)	(1)	Sulfur ore, sand and gravel, silver, gold, stone, zinc, lead.
Amador	1,396,203	1,656,175	Sand and gravel, coal (lignite), clays, stone, soapstone, gold, silver.
Butte	[2] 3,277,509	4,945,328	Natural gas, sand and gravel, stone, iron ore, gold, zinc, gem stones, silver, lead.
Calaveras	15,094,715	13,583,617	Cement, stone, sand and gravel, clays, gold, gem stones, silver.
Colusa	[2] 1,646,107	2,716,275	Natural gas, sand and gravel, sulfur ore.
Contra Costa	[2] 3,694,333	3,654,402	Stone, natural gas, peat, sand and gravel, clays.
Del Norte	410,731	248,870	Sand and gravel, stone, copper, silver.
El Dorado	3,148,051	1,991,850	Stone, lime, sand and gravel, soapstone, gem stones, gold, lead, silver, zinc.
Fresno	[2] 97,445,828	88,206,896	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays, gold, tungsten, pumice, mercury, asbestos, silver.
Glenn	[2] 8,397,127	8,560,622	Natural gas, sand and gravel, stone.
Humboldt	[2] 1,734,595	2,565,884	Sand and gravel, copper, natural gas, stone, gold, zinc, silver, lead, gem stones.
Imperial	[2] 3,368,440	2,302,673	Gypsum, sand and gravel, pumice, stone, mica (scrap), gem stones.
Inyo	8,710,106	10,956,725	Tungsten, sodium carbonate, molybdenum, talc, pyrophyllite and soapstone, boron minerals, stone, copper, sand and gravel, pumice, pumicite and volcanic cinder, perlite, lead, silver, clays, zinc, sulfur ore, gold, gem stones.
Kern	[2] 343,221,896	350,477,295	Petroleum, boron minerals, natural gas, natural-gas liquids, cement, stone, sand and gravel, gypsum, sodium sulfate, salt, clays, pumice, carbon dioxide, gold, gem stones, mercury, diatomite, barite, silver.
Kings	[2] 13,755,413	12,728,648	Petroleum, natural-gas liquids, natural gas, sand and gravel, gypsum, mercury, stone.
Lake	945,993	681,830	Sand and gravel, mercury, pumice, pumicite and volcanic cinder, sulfur ore, stone, gem stones.
Lassen	278,481	367,885	Sand and gravel, stone, volcanic cinder, uranium, gem stones.
Los Angeles	[2] 243,342,097	236,758,913	Petroleum, natural gas liquids, sand and gravel, natural gas, stone, cement, clays, iodine, soapstone, gold, gem stones, silver.
Madera	[2] 1,518,324	1,307,374	Natural gas, stone, tungsten, pumice and pumicite, sand and gravel, copper, clays, gold, silver.
Marin	1,478,499	2,006,568	Stone, sand and gravel, clays, mercury, gem stones.
Mariposa	158,926	169,745	Sand and gravel, gold, stone, silver, gem stones.
Mendocino	769,465	571,974	Sand and gravel, stone, mercury, gem stones.
Merced	1,387,326	1,201,528	Sand and gravel, gypsum, gold, silver.
Modoc	899,699	683,649	Sand and gravel, peat, pumice and volcanic cinder, gem stones, stone.

See footnotes at end of table.

TABLE 24.—Value of mineral production in California, by counties—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Mono	$1,009,385	$819,621	Pumice and volcanic cinder, sand and gravel, pyrophyllite, clays, gold, lead, silver, gem stones.
Monterey	[2] 28,003,049	28,636,583	Petroleum, magnesium compounds, lime, sand and gravel, stone, natural gas, feldspar, salt, gem stones.
Napa	861,769	839,321	Stone, sand and gravel, diatomite, mercury, asbestos, perlite, gem stones.
Nevada	1,247,906	484,466	Sand and gravel, gold, stone, barite, silver, lead, zinc, copper.
Orange	[2] 113,430,116	104,894,772	Petroleum, natural gas liquids, natural gas, sand and gravel, clays, stone, salt, iodine, peat, gem stones.
Placer	1,140,315	1,187,301	Sand and gravel, clays, stone, gold, silver.
Plumas	218,818	262,806	Sand and gravel, stone, volcanic cinder, copper, gold, silver.
Riverside	[2] 37,408,359	36,692,145	Iron ore, cement, sand and gravel, stone, clays, gypsum, peat, wollastonite, petroleum, gem stones, gold, copper, silver.
Sacramento	[2] 17,962,684	19,763,249	Natural gas, sand and gravel, gold, clays, platinum, silver.
San Benito	[2] 8,624,419	8,116,650	Cement, mercury, petroleum, stone, natural gas, sand and gravel, clays, gem stones.
San Bernardino	[2] 85,216,308	83,089,092	Cement, boron minerals, sodium carbonate, stone, sodium sulfate, potassium salts, sand and gravel, salt, talc and pyrophyllite, lithium, clays, calcium chloride, lime, bromine, iron ore, petroleum, volcanic cinder, tungsten, rare earths, barite, natural gas, gem stones, silver, lead, fluorspar, copper, feldspar, gold, zinc, masonry cement.
San Diego	[2] 14,479,254	11,584,204	Sand and gravel, stone, magnesium compounds, salt, lime, clays, pyrophyllite, gem stones, gold, silver.
San Francisco	280,062	[1]	Stone, sand and gravel.
San Joaquin	[2] 4,049,507	5,844,513	Natural gas, sand and gravel, clays, stone.
San Luis Obispo	[2] 9,819,791	8,174,877	Petroleum, stone, sand and gravel, natural-gas liquids, mercury, natural gas, gypsum, clays, gem stones.
San Mateo	[2] 13,142,472	11,683,004	Cement, stone, salt, magnesium compounds, petroleum, clays, sand and gravel, natural gas.
Santa Barbara	[2] 89,876,893	90,098,632	Petroleum, diatomite, natural gas, natural-gas liquids, sand and gravel, stone, mercury, gypsum, gem stones.
Santa Clara	[2] 29,425,051	27,226,555	Cement, stone, sand and gravel, mercury, clays, magnesite, masonry cement, petroleum, gem stones.
Santa Cruz	10,069,197	10,610,852	Cement, stone, sand and gravel, clays, potassium salts.
Shasta	2,137,663	2,242,136	Sand and gravel, pyrites, copper, stone, gold, volcanic cinder, silver, lead.
Sierra	979,641	771,051	Gold, sand and gravel, stone, silver, uranium, zinc.
Siskiyou	1,363,752	1,508,718	Sand and gravel, pumice and volcanic cinder, gold, silver, copper, stone, gem stones.
Solano	[2] 9,178,305	11,974,518	Natural gas, clays, stone, sand and gravel, petroleum, mercury.
Sonoma	[2] 2,676,569	3,073,831	Sand and gravel, mercury, stone, natural gas, clays, gem stones.
Stanislaus	[2] 797,095	801,042	Sand and gravel, clays, manganiferous ores, stone, gold, mercury, silver.
Sutter	[2] 690,532	698,533	Natural gas, sand and gravel, clays, stone.
Tehama	[2] 611,063	1,356,970	Sand and gravel, natural gas, stone, volcanic cinder, gem stones, manganiferous ores.
Trinity	1,366,674	997,898	Stone, sand and gravel, mercury, gold, volcanic cinder, silver.
Tulare	[2] 3,189,521	4,150,293	Natural gas, sand and gravel, stone, barite, petroleum, clays, gem stones.
Tuolumne	1,257,348	1,632,817	Stone, lime, sand and gravel, gold, gem stones, silver.
Ventura	[2] 158,179,134	148,935,824	Petroleum, natural gas, natural-gas liquids, sand and gravel, stone, clays, gypsum.
Yolo	[1]	[1]	Sand and gravel, natural gas, mercury.
Yuba	[2] 3,617,599	3,199,535	Gold, sand and gravel, stone, clays, platinum, silver, copper.
Undistributed [3]	[2] 4,707,954	2,797,148	
Total [4]	[2]1,433,626,000	1,402,214,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Revised figure.
[3] Includes gem stones, gold, mercury, and silver that cannot be assigned to specific counties and value indicated by footnote 1.
[4] Total adjusted to eliminate duplicating value of clays and stone used in manufacturin cement and lime.

Crude salt was harvested from several thousand acres of ponds by solar evaporation, and washed and refined at four plants in the county. Leslie Salt Co. operated two plants at Newark, and one at Mt. Eden, and sold crude salt to another Newark refinery. Oliver Bros. Salt Co. also operated a plant at Mt. Eden. Salt-works bitterns from the Newark plants were piped to the nearby chemical plant of Mineral Products Division, Food Machinery Corp., and processed to yield magnesia, synthetic gypsum, and byproduct ethylene dibromide. Dolomite from the company quarry in San Benito County was burned and used to precipitate the magnesium hydroxide. Fibreboard Paper Products Corp. in Emeryville used purchased magnesium hydroxide for manufacturing insulation. The company also calcined crude gypsum from Nevada at Newark for use in wallboard and other gypsum products. At Berkeley, Philadelphia Quartz Co. used purchased magnesite and brucite in producing hydrous magnesium sulfate.

Judson Steel Corp. in Emeryville and Pacific States Steel Corp. in Union City operated open-hearth furnaces, using iron and steel scrap as the source of metal. The latter company's planned completion of a blast furnace was delayed until mid-1962, but new fabricating facilities were completed in July. Brush Beryllium Co. placed its new fabrication plant in operation at Hayward, using eastern beryllium metal to produce machined components for atmospheric and space vehicles and nuclear applications.

Custom grinding plants (nonmetallic minerals) were operated in Berkeley by Industrial Minerals & Chemical Co. and Yuba Milling Co., Division of Metals Disintegrating Co., Inc. The Chemical & Pigment Co. ground purchased metallic and nonmetallic minerals in Oakland. In Emeryville, C. K. Williams Co. produced synthetic and natural iron oxide pigments. Raw materials for the natural pigments were obtained from out-of-State sources.

Alpine.—A high percentage of the sulfur ore produced in California during 1960 was obtained from the Leviathan mine near Markleeville by The Anaconda Co. The crude ore was trucked to the producer's copper-leaching plant in Nevada and was used in making sulfuric acid. Virtually the entire sand and gravel and decomposed granite output was used by contractors for the U.S. Forest Service on agency roads or in constructing new sections of State Highway 89 near Picketts.

Claude B. Lovestedt worked the Zaca mine, 6 miles southeast of Markleeville, near Highway 89. The silver ore was shipped to the Selby smelter, Contra Costa County, for recovery of silver, gold, and lead. Some recoverable zinc was contained in the ore. About 485 feet of tunnel was rehabilitated during the year, yielding 100 tons of development work.

Amador.—Sand produced near Ione by Owens-Illinois and Ione Clay & Sand Co. was used in glass, firebrick, and flue lining. Paving sand and gravel was produced by crews of the Amador County Road Department and by a contractor for the State on Highway 88. Harbison-Walker Refractories Co. worked the Custer quarry south of Ione for quartzite used in silica brick. More than 1,000 tons of dimension building stone and roofing granules was produced by Sierra

Madre Stone Co. from its quarry near Volcano. State highway maintenance crews mined granite for fill.

Lignite mined near Ione by American Lignite Products Co., Inc., was processed in the company's Buena Vista plant to recover montan wax and various byproducts. Fire clay was shipped from deposits in the Ione area and from stockpiles by Gladding, McBean & Co., Pacific Clay Products Co., Ione Clay & Sand Co., and Harbison-Walker Refractories Co. This last company planned to acquire the Winter clay pit 3 miles northwest of Ione, effective January 1, 1961. Most of the clays mined in the Ione area were used in refractories and heavy clay products, but one company sold clays for use in pottery, as a carrier in insecticides, and for filler uses. Soapstone mined on the Rancheria property, near Sutter Creek, by Industrial Minerals & Chemical Co. was ground in the producer's Sacramento County mill for consumption in insecticides and rubber.

Three lode gold prospects, two near Pioneer and one near Enterprise, were the sources of gold ore mined and treated to recover gold and silver. Cleanup operations at two gold properties, one each near Jackson and Pine Grove, yielded a few ounces of gold and silver. A relatively small quantity of gold was produced from bench gravel worked by hydraulic methods on the Lancha Plana placer claims in Jackson Valley.

Butte.—Although the number of producing dry-gas wells was virtually unchanged from 1959, gas production rose 29 percent. The number of proved productive areas increased slightly and all gas fields in the county except the Llano Seco field had increased output. The greatest percentage increase in production occurred at the Schohr Ranch field (three wells). The Wild Goose field was the fifth largest dry-gas producer in the State.

Increased quantities of sand and gravel were needed to meet requirements of public works projects conducted in preparation for constructing the Oroville Dam and for highway reconstruction and resurfacing near Gridley, Chico, and Oroville. Producers in the area reclaimed these materials from old dredge and hydraulic tailings and from stream bed gravels in Dry Creek and the Feather and Sacramento Rivers. Output was used mostly for structural and paving purposes. Basalt rock and miscellaneous stone were quarried and prepared by State and County road crews for highway maintenance.

The extensive exploration and development carried on by Standard Slag Co. in 1959 at the Rusty Ridge iron property in the Table Mountain area yielded more than 10,000 tons of shipping grade ore in 1960. The output was exported. The deposit proved to be a pocket that was exhausted of economic-grade ore during the year, and the mine was abandoned. Stream gravels near the junction of the south fork and middle fork of the Feather River yielded gold and silver. Gold ore from the Hungry Jack mine near Big Bend contained recoverable gold and silver. The Silver King & Queen lead-zinc claims in the Philbrook Reservoir area were the source of small quantities of gold, silver, lead, and zinc.

Calaveras.—General use, moderate heat, high-early-strength, and plastic cements were produced in the five-kiln wet-process plant of Calaveras Cement Co. at Kentucky House, south of San Andreas.

Bulk and bag shipments were made by truck and rail to California markets and to distributors in Nevada and Oregon. Considerable development was conducted at two quarries near San Andreas where the company obtained limestone used in cement. Rough dimension stone was quarried near Mokelumne Hill by Harley H. Kreth. Altaville Aggregates worked the Peirano quarry to produce roofing granules. County road crews obtained stone from the Amelia Meuli quarry near Vallecito and the Elma Clark quarry south of Wilseyville. State highway maintenance crews quarried decomposed granite for fill.

Silica sand was prepared for the glass industry by Pacific Clay Products Co. at Camanche; flotation was used to control the feldspar content. Sand and gravel was produced and prepared for building and paving at the Neilsen Gravel Plant, San Andreas, and by crews and contractors of the County and the U.S. Forest Service. The largest clay and shale operation in the county was southeast of San Andreas, where these materials were mined for use in portland cement. Fire clay and miscellaneous clay were hauled from stockpiles maintained by Pacific Clay Products Co. at its Camanche, Snyder (Buena Vista), and Valley Springs operations, and by California Pottery Co. from Valley Springs. The clays were used in manufacturing heavy clay products. Cleanup operations at placers in the Angels Camp and Campo Seco areas yielded a few ounces of gold and silver. Gold ore shipped from the Tom Smith prospect near Sheep Ranch contained recoverable gold and silver.

Colusa.—Dry-gas production rose 78 percent above 1959. Several new discoveries were made during the year: By Western Gulf Oil Co. (Buckeye field) on January 1, Universal Consolidated Oil Co. (new pool in Compton Landing field) on September 26, Cameron Oil Co. (Forbes pool in Grimes field) on January 11, Occidental Petroleum Corp. (Grimes West field) on December 5, and Gulf Oil Corp. (Kirk field) on October 18. The Grimes West field appeared to be the most productive of these discoveries with an initial flow on December 7 of 17,250,000 cubic feet. Total depth of the well was 8,263 feet with perforations at 7,645–7,656 feet. The productive zone was Upper Cretaceous sands. The Arbuckle field was the most active gasfield with 10 new well completions; Kirkwood had three new completions; Grimes, five and Buckeye, six.

Sand and gravel was produced principally by crews and contractors of the county highway agency and the California Division of Highways. The material was used in reconstructing and resurfacing roads in the Grimes, Maxwell, and Williams areas. Commercial concrete batch plants were operated in the Williams area by Goforth Bros. and Cortena Rock Products Co., who obtained sand and gravel from nearby pits, creek beds, and river bars. A small tonnage of sulfur ore was mined at a property near Wilbur Springs and was used as a soil-conditioner.

Contra Costa.—Basalt was obtained from the Tunnel Rock quarry near Orinda; sandstone and quartzite, from surface and underground workings near Richmond and Pacheco; and miscellaneous stone, from a large quarry near Clayton. Major producers of stone were Pacific Cement & Aggregates, Inc., and Henry J. Kaiser Co. in the Clayton

area, and Blake Bros. Co. in Richmond. Most of the stone was used for riprap, concrete aggregate, and road base material. Sand was dug from pits near Cowell and Antioch and dredged from San Francisco Bay, chiefly for building, paving, and railroad ballast. Clays were mined by Port Costa Brick Works and United Materials & Richmond Brick Co. in the Port Costa and Richmond areas, respectively, and used in manufacturing brick. Kaiser Gypsum Co. in Antioch calcined crude gypsum imported from Mexico for use in manufacturing various gypsum products. The crude mineral was also consumed as a retarder in portland cement and as a filler. In the same plant the company expanded crude perlite purchased from a Nevada producer.

One of the State's outstanding dry-gas finds was the McCulloch-Duarte No. 1 about one-half mile south of production in the Los Medanos field in a new fault block. Discovery was made between 3,890 and 4,235 feet with a calculated free flow of 170 million cubic feet. The initial measured flow was 7,900,000 cubic feet through ½-inch bean. Production came from sands of Eocene age. Petroleum coke from refineries at Avon and Rodeo increased substantially above 1959. At yearend, new hydrogen-treating facilities were under consideration at major company refineries. Recovery of hydrogen sulfide at these refineries increased 19 percent over 1959, and elemental sulfur production rose 18 percent. Peat dredging in the San Joaquin River delta yielded a relatively large tonnage of reed-sedge peat, about half of which was packaged and sold as a soil conditioner. The value was up 27 percent from 1959.

Del Norte.—Sand and gravel for building and paving was obtained from stream-bed deposits along the Smith and Klamath Rivers, and was prepared by crews and contractors for Government agencies for road construction and maintenance from sources in the same areas. Miscellaneous stone quarried near Crescent City and in other places in the county was used as riprap and roadstone in State and county projects.

A few tons of ore from the Hiouchi prospect in the Myrtle Creek area, east of Crescent City, contained small quantities of recoverable copper and silver.

El Dorado.—An appreciable quantity of granite was quarried and much of the output was used in the Upper American River Project of the Sacramento Municipal Utility District; however, road improvements on Highways 50 and 89 and in the Georgetown and Pilot Hill areas also required impressive tonnages. Limestone was produced at two surface and two underground operations for consumption in glass and lime manufacture, sugar refining, metallurgical processes, for concrete and asphalt aggregate, as a filler in fertilizer, and for whiting and roofing granules. California Rock & Gravel Co. quarried limestone near Cool. Diamond Springs Lime Co. produced quicklime and hydrated lime, using an oil-fired rotary kiln and continuous hydrator and stone from its Mountain and Diamond Springs quarries. The Mountain underground quarry near Auburn was mined by room and pillar. El Dorado Limestone Co. also worked an underground limestone quarry near Shingle Springs by shrinkage stoping. Dimension building stone was quarried southeast of Placerville by Sierra Placerite Corp. At its underground workings in Chili Bar, Placer-

ville Slate Products Co. mined a substantial tonnage of slate, which was crushed for granules or ground for rock flour. Mine development included about 200 feet of tunneling. Sand and gravel for building, paving, and fill was produced by commercial operators near Placerville and by crews and contractors for Government agencies. The quantity of lightweight aggregate required for construction projects, principally in the Lake Tahoe area, was obtained in neighboring California and Nevada Counties. Pacific Clay Products Co. mined soapstone at its Shrub deposit south of Shingle Springs and shipped the crude mineral to grinders in the San Francisco Bay area.

Cleanup at the Hazel Creek lode-gold mine near Pollock Pines yielded relatively small quantities of gold, silver, lead, and zinc. The Hazel Creek mill, burned early in 1959, was not rebuilt. Development was carried on at the Yellow Jacket gold property near Kelsey, but no production was reported. Prospectors recovered a few ounces of gold and silver from stream gravels along the American River.

Fresno.—Crude oil production declined 6 percent from 1959. In 1960, 18 dry holes with a total footage of 122,554 feet were drilled, compared with 25 dry holes and 202,755 feet in 1959. Although a new pool wildcat was brought in by Leda Petroleum on June 27 in the Guijarral Hills field, oil-well completions were comparatively few. At the southeast end of the Helm field, oil was obtained 1,700 feet west of the nearest producer at a depth of 6,853 feet with an initial flow of 144 barrels daily. The southeast Burrel area was extended 2,100 feet northeast when Arrowhead Exploration Co. completed two producers. Shell Oil Co. drilled 30 comparatively shallow holes on its leases in the Coalinga field emphasizing the increased trend toward developing heavy oil with the aid of bottom-hole heaters. Such heaters use electric heating elements to raise the temperature of oil adjacent to the hole walls and thus to increase flow.

Although oil zone natural gas production was down 8 percent, dry-gas output was more than double that of 1959. Socony Mobil Oil Co., Inc., processed wet gas in one plant at Burrel and one near Avenal. Wet gas also was processed in two plants at Coalinga, one each by Standard Oil Co. and Union Oil Co. Production from these four plants was down 30 percent in total natural gas liquids, but LP-gas output increased 24 percent. Union Oil Co. increased plant capacity for butane-propane mixture 7 percent during the year.

Sand and gravel was produced from pits near Coalinga, Fresno, Friant, Pinedale, and Sanger for structural and paving uses by commercial operators, and for maintenance of roads by crews and contractors for Government agencies. Paving requirements were lower than in 1959 as road construction and resurfacing operations were limited to relatively small projects near Mendota, Fresno, and Academy. Dimension stone for monumental use was quarried near Academy by Superior Academy Granite Co. Decomposed granite and miscellaneous stone obtained near Sanger were used as roadstone and fill. Maintenance crews of the U.S. Forest Service produced some stone for riprap. Miscellaneous clay was dug from deposits near Fresno and used in manufacturing heavy clay products by Craycroft Brick Co. The South Dome pumice deposit east of Friant yielded over 1,000 tons of the material for lightweight aggregate. In March,

Fresno Perlite Corp. began operating a new perlite-expanding plant to replace one that burned in 1958. Johns-Manville Corp., National Milling & Mining, and Union Carbide Nuclear Co. explored chrysotile asbestos deposits in the same general area northwest of Coalinga. The first two shipped small tonnages to company mills for testing; the third shipped to an out-of-State processing plant.

Several sand and gravel producers, who worked deposits by dragline along the San Joaquin River, recovered notable quantities of gold and silver. Old bricks from the furnace at the Archer mine northwest of Coalinga were furnaced at New Idria, San Benito County, to yield a few flasks of mercury.

Glenn.—Humble Oil Co. made a new gasfield discovery (Angel Slough) about 3½ miles east of Princeton. Initial flow was 2,350,000 cubic feet at 800 pounds pressure from a 13-foot interval between 2,383 and 2,396 feet. Total depth was 7,019 feet, and the hole was plugged at 3,710 feet. The well was completed on June 18. Five new wells were completed during the year. The Beehive Bend gasfield again was a leading producer in the State. Although the main area of this field had a production loss of 8 percent, output from the Willows area was up 84 percent compared with 1959. The total dry-gas yield for the county was 5 percent below 1959.

Nearly 144,000 tons of gravel was produced from the Wyo pit for use as railroad ballast by Southern Pacific Co. Commercial sand and gravel plants were operated near Orland by Mack Rock & Sand Corp. and Orland Sand & Gravel Co. Both companies worked the Stony Creek stream bed. The Willow Creek deposits were worked by Willows Ready Mix Sand & Gravel Co. and by County road maintenance crews. Miscellaneous stone was quarried and prepared for a road project by a contractor for the U.S. Army Corps of Engineers.

Humboldt.—Highway and bridge construction near Dyerville, Bridgeville, Weitchpec, and between Eureka and Fortuna, required large tonnages of stone and sand and gravel compared with 1959 demands for these materials. Virtually all the stone quarried was used for riprap in embankments. Sand and gravel was produced principally from stream-bed deposits along the Eel, Van Dusen, and Mad Rivers. Major commercial producers operated established preparation plants near Arcata and Fortuna. Permanente Cement Co. established a bulk-cement-distribution facility at Eureka to serve consumers from Garberville north into Oregon with cement shipped by rail from the company plant at Permanente.

A new gasfield discovery (Table Bluff) was made June 7 by Zephyr Oil Co. about 2 miles north of Loleta. Total depth was 5,652 feet; production came from the 62-foot interval immediately above bottom. Initial flow was only 800,000 cubic feet, but on June 10 the flow increased to 1,200,000 cubic feet at 1,500 to 1,800 pounds per square inch pressure through a one-eighth inch bean. Total gas production, chiefly from the Eureka gasfield, decreased 6 percent from 1959.

The Copper Bluff mine near Hoopa was the only active lode mine in the county. Celtor Chemical Corp. mined copper ore from this property and processed it in the company mill beginning in April. Concentrate was shipped to smelters in Montana, Washington, Idaho, and California. The Copper Bluff mine supplied a high percentage

of the State's recoverable zinc, in addition to important quantities of copper, gold, and silver and several tons of lead. At the mine the company carried on development that included longhole drilling, drifts, and raises, and resulted in more than 8,500 tons of stockpiled development rock. A token quantity of gold was recovered from a few thousand pounds of ore at a prospect near the Klamath River northeast of Orleans.

Imperial.—U.S. Gypsum Co. worked its multiple bench gypsum mine in the Fish Creek Mountains and hauled the crude mineral to the company's gypsum products plant in Plaster City.

Crews and contractors of State and county road agencies produced more than half the county sand and gravel output. Deposits along the New and Alamo Rivers near Brawley, El Centro, and Holtville supplied commercial plants with sand and gravel for aggregate used chiefly in building construction and irrigation systems. Basalt rock from the Navajo quarry near Coyote Wells was prepared for roofing granules. Granite produced at the Mt. Signal quarry and the Pilot Knob quarry (near Winterhaven) was used as riprap by the Imperial Irrigation District and the Bureau of Reclamation. Decomposed granite quarried near Plaster City was used in building streets and driveways.

Pumice mined near Calipatria was used as lightweight aggregate and for landscaping. An open-pit deposit near Ogilby yielded mica (sericite schist), which was ground by the producer for use in manufacturing roofing materials.

Inyo.—The Union Carbide Nuclear Co. Pine Creek operations were enlarged to permit production of ammonium paratungstate and as a result, the quantity and value of tungsten production increased over 1959. The Pine Creek tungsten ores yielded a high percentage of the tungsten, all of the molybdenum, and much of the lode gold and silver produced in California, and was the State's leading source of copper. The Augusta prospect in the Cerro Gordo area was the only copper property in the county that reported any activity during the year. Although eight lead and lead-zinc mines contributed to the lead and zinc production, the lead-zinc ore from the Santa Rosa mine southwest of Keeler and lead ore from the Defense mine east of Darwin supplied 96 percent of the lead output and nearly 99 percent of the zinc. The ores from these two mines also contained more than 27 percent of the silver recovered from all lode mines in the county.

The Chemical Division (formerly Columbia-Southern Chemical Corp.), Pittsburgh Plate Glass Co., recovered sodium compounds from brines of Owens Lake in a plant at Bartlett. Principal products of the processing plant were anhydrous sodium carbonate and sodium sesqui-carbonate. The Gold Hill and Sugar Loaf areas at the Panamint Range and the areas near Big Pine, Big Springs, Keeler, and Tecopa yielded 60 percent of the State's (nearly 18 percent of the Nation's) talc production and shipments. About 1,500 feet of exploratory diamond drilling was done on the Warm Springs (Big Talc) property at Gold Hill, California's leading talc producer. Some of the crude mineral was ground in plants at Laws and Keeler. The Death Valley talc property, west of Shoshone, was operated by Multi Mines, Inc., the first half of 1960 and by Kennedy Minerals Co., Inc.,

the remainder of the year. The Holliday (Branson) mine east of Keeler was the source of some steatite talc. U.S. Borax and Chemical Co. mined crude borate minerals from underground mines in Corkscrew Canyon (colemanite) and near Shoshone (ulexite), which were refined or further processed in its mill and refinery in Kern County.

Greatly increased tonnages of sand, gravel and stone were required for highway construction near Independence and Shoshone, and for various road and structural projects of State and County road agencies, Los Angeles Aqueduct, Death Valley National Monument, and the U.S. Forest Service. County crews operated a portable crushing and screening plant southwest of Fish Springs to process granite used in road maintenance. Limestone, obtained from the West End quarry north of Searles Lake, was burned chiefly as a source of carbon dioxide used to produce soda ash in a Kern County plant. Quartzite from the Lakeview quarry near Lone Pine was used in manufacturing silica brick by Gladding, McBean & Co. The Iron Mask and Deep Spring quartzite deposits northeast of Big Pine were worked by R. K. Hatch to produce rough construction stone. Miscellaneous stone was quarried near Ballarat by Stutterite Stone Co. and near Death Valley Junction by Harry W. Amey for dimension building stone and terrazzo. Premier Marble Products worked the underground Inyo marble quarry southeast of Lone Pine and prepared building stone, roofing granules, and aggregate used in precast concrete products. Commercial plants prepared sand and gravel for concrete aggregate near Bishop.

Bentonite was mined at the Side Hill open pit and underground property near Death Valley Junction during the latter half of 1960 and was prepared for use in cosmetics and pharmaceuticals. The Ibex bentonite pit southwest of Tecopa was operated by Multi Mines, Inc., until June, at which time it was acquired and worked by Kennedy Minerals Co., Inc. The Ibex clay was used as a component in enameling. Fuller's earth was produced and prepared for filler, filter aid, and absorbent uses by Sierra Talc Co., from the Olancha deposit south of Keeler, and by David Jones, from the Little Joe No. 1 claim east of Olancha. Pumice mined near Little Lake and pumicite from the Van Loon deposit north of Bishop were prepared for use as lightweight aggregate. A relatively small tonnage of volcanic cinder was mined on U.S. Forest Service property and used in road construction. Crude perlite mined near Big Pine was shipped to expanding plants outside the county. Sulfur ore was produced at the Crater mine in the Last Chance Range by Inyo Soil Sulphur Co. and prepared for agricultural use.

Kern.—Crude petroleum production was the highest since 1956; the total value was slightly above 1959 despite a lower unit price. Exploratory drilling led to three new oilfield discoveries, none of which was considered of great importance. Of the two significant oil pool discoveries in California during 1960, one which extended the Belgian Anticline field of the McKittrick group, was made in the county by Shell Oil Co. The find was believed to be in a new fault block. The well was completed January 11, and by February 8 the flow of 34° API gravity oil had increased from 474 to 972 barrels per day at a

pressure of 920 pounds per square inch. The most active oil fields were the Kern River and Belridge South. The number of active wells slightly exceeded the 1959 figure.

Natural gas output from oil zones rose 9 percent above 1959 and was processed in 18 Kern County plants. Total value of all plant products declined 3 percent chiefly because of a 5-percent production decline in natural gasoline and cyclic products that was not offset by an 18-percent rise in LP-gas output. Dry-gas output rose slightly from 1959 chiefly as the result of a new field (Shale Flats) discovery and a successful shallower pool (in Canal field) test, both by Shell Oil Co.

U.S. Borax and Chemical Co., the Nation's leading producer of borates and boron compounds, mined crude borates from an open-pit mine near Boron. The crude minerals, including those from company deposits in Inyo County, were processed in nearby facilities. Some of the partly refined minerals were shipped to the company refinery near Los Angeles for further processing. Sodium sulfate was produced as a byproduct in the boron processing plant. A relatively small tonnage of crude borates and some partially refined boron minerals were sold to chemical companies outside the county. Western Salt Co. harvested crude salt from Koehm dry-lake brines by solar evaporation at its Saltdale plant and shipped the crude mineral to Los Angeles consumers for various applications.

Portland cement was manufactured in the Mojave dry-process plant of California Portland Cement Co. and in the Monolith wet-process plant of Monolith Cement Co. Both producers used limestone and sandstone from quarries near their plant sites. Monolith obtained clay and shale for its process from a pit near Tehachapi. Production and shipments of cement declined below 1959 figures at Mojave; output and sales at the Monolith plant both increased. Shipments were made by truck and rail to all nearby States. Major highway construction projects near Lerdo, Bakersfield, and Grapevine required nearly 500,000 tons more sand and gravel than had been produced in the entire county during 1959. Much of the demand was met by plants working deposits along the Kern River near Bakersfield. Other preparation plants were operated in the Lebec, Maricopa, and Inyokern areas. Limestone was obtained from the Castle Butte quarry near Mojave for use as decorative stone. Mojave Rock Products and N. W. Sweetser quarried colored sandstone and quartz northwest of Rosamond and prepared the materials for use as roofing granules and exposed aggregate. Desert Rock Milling Co. quarried building stone and roofing granules near Tehachapi and Rosamond. Nearly 730,000 tons of gypsite was mined for agricultural use near Lost Hills, Maricopa, and Taft. H. M. Holloway, Inc., leading producer of agricultural gypsite in California, conducted an exploratory program that included 83,000 feet of rotary drilling. Other major producers were C. L. Fanning near Lost Hills and Temblor Gypsum Co. near Taft.

Clays used in rotary drilling were mined (or hauled from a company stockpile) by Mojave Corp. at Rodgers Dry Lake near Boron and by McKittrick Mud Co., near McKittrick. Sericite was mined northwest of McKittrick by Excel Minerals Co. for use in absorbents. Macco Corp. hauled drilling clays from stockpiles at a property at

615629—61——13

Buckhorn Lake which had been purchased by the Federal Government and made a part of Edwards Air Force Base. American Minerals Co. mined clay from its White Rock deposit near Cantil for use in whiteware. A property between Mojave and Inyokern was the source of pumice prepared and sold for use in absorbents, abrasives, and cleaning and scouring compounds. Diatomite was mined in open pits about 10 miles northwest of McKittrick. The material was processed by the producer for use as an absorbent. The Progressive Mining & Drilling Corp. of Nevada reactivated the Ritter barite property near Loraine and shipped the output to a grinding plant at Terminal Island, Los Angeles County.

Six lode-gold mines in the Randsburg area, including cleanup operations at two, yielded most of the gold and silver produced. The Wegman group of claims south of Mojave and the Uncle Sam prospect near the Havilah Ranger Station contributed to the lode gold and silver output in the county. A few ounces of gold and silver were recovered from ores of the Gwynne tungsten mine south of Claraville. Cinnabar ore, mined from the Fickert-Durnal open pits near Keene while completing exploration and development work, was retorted to yield several flasks of mercury. The Travertine uranium prospect near Lake Isabella was active most of 1960 although no ore was shipped. While extending a drift, some development rock was produced and stockpiled.

Kings.—Petroleum production declined 4 percent below 1959 despite two new oil pool discoveries, both in the Guijarral Hills field of the Coalinga Group. The first discovery was in the Main Area on May 30 by Union Oil Co. and the second in the Northwest Area on June 27 by Leda Petroleum Co. Crude petroleum was processed in a cracking and skimming plant at Hanford operated by Caminol Co. Gas output from oil zones dropped 23 percent from 1959. The wet gas was processed in four plants near Avenal, three operated by Standard Oil Co. and one by Socony Mobile Oil Co. The quantity of natural gasoline and cyclic products produced in these plants was nearly 11 percent lower, but the volume of LP-gas was slightly higher than in 1959. Dry-gas production rose 17 percent. The Trico gas area, which lies partly within the county, was the most productive, with 13 new development wells completed during 1960.

Construction of facilities, including extensive hangar aprons at Lemoore Naval Air Station and road widening north of Hanford, required appreciably larger tonnages of stone and sand and gravel than were produced in 1959. The additional quantities of these materials needed as base coarse and concrete aggregate at these projects were obtained from preparation plants in Fresno and Tulare Counties. McPhaill Gypsum Co. mined agricultural gypsite from deposits southeast of Avenal in the Kettleman Hills area.

Cinnabar ore mined at the Little King (Fredanna) claims near Parkfield was furnaced, and ore from the Dawson pit near Avenal was retorted to recover mercury. Exploration and development work completed during the year at the Little King mine included tunnels, crosscuts, and rotary drilling.

Lake.—Output of sand and gravel at both commercial and Government and contractor operations was substantially below 1959. Much

of the decline was attributed to reduced need for paving aggregate in major State highway projects, some of which had been completed during 1959. Virtually all sand and gravel produced came from stream-bed deposits near Clear Lake. Miscellaneous stone was quarried by Government contractors and obtained from local farms for use as riprap in road and levee construction. The Clear Lake area also was the source of large tonnages of pumice, pumicite, and volcanic cinder sold for lightweight aggregate, roofing material, ornamental rock, and fill. Two prospects near Kelsyville and Clearlake Oaks yielded sulfur ore that was sold for use as a soil aid.

Ore from the Abbott underground mercury mine in Grizzly Canyon near the Colusa County line was furnaced and yielded several hundred flasks of the metal. Exploration and development at this property included raises, winzes, crosscuts, and diamond drilling. A few pounds of mercury was recovered from development rock produced in sinking a shaft at the Juanita property near Middletown, but no metal was shipped.

Lassen.—Essentially all the sand and gravel was produced by crews and contractors for Federal, State and county agencies. Crews from the Sierra Ordnance Depot obtained granite for fill 2 miles west of the Skedaddle Creek bridge. A contractor supplied the same agency with miscellaneous stone for use as railroad ballast. Susanville Marble & Granite Works prepared granite for curbing at its quarry 5 miles south of Susanville. Volcanic cinder production declined substantially from 1959 chiefly because of lesser requirements in road construction and maintenance by Government agencies. The material was mined near Susanville for lightweight aggregate used locally.

The Cornelia C No. 2 mine near Hallelujah Junction was the source of uranium ore shipped to a Utah processing plant. In 1959 and 1957, this mine had yielded ore that was consigned to the same processor.

Los Angeles.—Crude oil production was slightly higher than in 1959, however, average unit value declined 12 cents per barrel, resulting in a total value that was $7.3 million less than in 1959. More exploratory wells were drilled for oil in Los Angeles County than in any other except Kern. However, there were only three successful completions. Two of these were made when Union Oil Co. discovered the Las Cienegas field with a well completion on June 20 and made a new pool discovery in this field on October 12. The other discovery was a successful deeper-pool test by Standard Oil Co. in the Inglewood field when the Marlow-Burns 306 well was completed May 12. In the Wilmington subsidence area, the California Oil and Gas supervisor approved new operating agreements for unitization of an area encompassing 450 producing wells south of Anaheim Street and north of Seaside Boulevard. Such unitization would permit multiple producer ownership to operate as a single property. Most of California's cracking and reforming capacity, 17 of 38 active refineries and 21 of 70 natural gasoline plants, were in the county. Nearly 6 percent less wet gas was produced and processed than in 1959. Output of natural gas liquids was 9 percent less for natural gasoline and cyclic products and 2 percent more for LP-gases. One natural gasoline plant (the East Los Angeles plant of Richfield Oil

Corp.) was dismantled, leaving 19 active plants at yearend. Richfield Oil Corp. completed a successful shallower pool test adjacent to the Bandini oilfield with a gas well on June 12. A 61-foot perforation interval between 3,888 and 3,949 feet gave an initial flow of 927 thousand cubic feet at 1,360 pounds pressure. Production came from Pliocene gas sands. The 96-percent increase in dry-gas production over 1959 was attributed principally to this discovery.

Nearly 18.8 million tons of sand and gravel was produced by commercial plants and Government crews and contractors, an 8-percent increase over 1959. A 7-percent gain was reported for structural use and a 9-percent rise for road construction. A substantial tonnage was consumed as aggregate in additional Los Angeles freeway interchanges and extensions. Preparation plants in the Azusa, El Monte, Irwindale, and Sun Valley areas produced more than 1 million tons each for a combined output of nearly 9.5 million tons. Specialty sands for molding, grinding, blast, and engine uses were obtained from deposits near El Segundo, Huntington Park, Torrance, and Walteria. Approximately 1.1 million tons of granite and decomposed granite was quarried, principally for use as riprap and road base. Decorative dimension stone was produced in Palos Verdes and in the Saugus area for building construction, flagging, and rubble. Two producers on Santa Catalina Island operated quarries to supply crushed and broken stone for harbor and breakwater improvements at Long Beach, San Pedro, and Port Hueneme. Blue Diamond Co., Division of The Flintkote Co., manufactured portland cement at Los Angeles, using clinker purchased from California Portland Cement Co. and gypsum shipped from the producer's property in Nevada. The plant output was consumed in Blue Diamond's extensive ready-mixed concrete facilities in southern California. Miscellaneous clay was dug from pits in or near Castaic, Compton, Reseda, Whittier, Monterey Park, Van Nuys, and Torrance and used in manufacturing brick, structural tile, and sewer pipe. Pacific Clay Products Co. announced the closing of its Corona plant, Riverside County, and the transfer of all the machinery and equipment to its Santa Fe Springs plant, which was reported to be the largest vitrified sewer-pipe facility in the United States. The encroaching Los Angeles freeway system forced relocation of the Higgins Brick Co. Monterey Park plant. Soapstone from the Katz property near the Hauser Ranch in Sierra Pelona Valley was ground for asphalt filler and stucco.

Crude vermiculite mined in Montana was exfoliated in the Los Angeles plant of California Zonolite Co. and used for plaster aggregate, thermal and acoustical insulation, and soil additive at nurseries. Seven companies expanded crude perlite received from mines in California, Colorado, Nevada, and New Mexico. Six grinders of talc, soapstone, and pyrophyllite operated Los Angeles plants, principally with crude materials mined in California and Nevada. Calada Materials Co. and Oil Base, Inc., ground crude barite received from company operations, in plants at Terminal Island and Compton, respectively. Southern California Minerals Co. custom-ground feldspar and other crude nonmetals. Gypsum lath, plaster, and wallboard plants were operated by Fibreboard Paper Products Corp., at South Gate, and by Kaiser Gypsum Co., Inc., at Long Beach. The

former used crude gypsum from its property in Nevada; the latter imported gypsum from Mexico. At Los Nietos, Sunshine Mica Co. ground crude mica received from South Dakota and imported from India and Mexico. The plant products were used in manufacturing paint and roofing materials.

Waste oil-well brine from the Los Angeles Basin was pumped to the Dow Chemical Co. Orange County plant to recover crude iodine. U.S. Borax and Chemical Co. operated a refinery at Wilmington with crude and partly refined borates received from its operations in Kern County. Some byproduct sodium sulfate also was recovered.

At the Azusa Gravel plant byproduct gold and silver were recovered in washing gravel from the nearby San Gabriel River channel. Stream gravel in the Gold Creek area north of Sunland was worked by small-scale hand methods to yield a few ounces of gold. Steel ingots and finished steel products were produced from ferrous scrap in electric furnaces by Bethlehem Pacific Coast Steel Corp. at Vernon, Southwest Steel Rolling Mills at Los Angeles, and National Supply Co. at Torrance. National Supply added an experimental extremely high-temperature furnace during the year. Columbia-Geneva Steel Division, U.S. Steel Corp., operated open-hearth instead of electric furnaces in Torrance. At Cucamonga, New Pacific Rolling Mills, Inc., began operating a stainless steel rolling mill late in the year.

Madera.—Solar Drilling Co. made a gas discovery 1.5 miles south of the Moffat Ranch field, with a well completion on November 9. This successful new-pool wildcat had an initial flow of 4,060,000 cubic feet daily from four intervals beginning at 3,936 feet. Despite this discovery, dry-gas production dropped 10 percent below 1959; no new development wells were added during the year. The county had 12 active gas wells at its three gasfields, compared with 15 in 1959.

Commercial preparation plants near Madera and Chowchilla produced sand and gravel for local aggregate requirements in building construction. The tonnages of sand and gravel and stone produced by Government crews and contractors for road construction and maintenance were appreciably below 1959. At the site of the Mammouth Pool power tunnel project, Bechtel Corp. crushed granite for use as concrete aggregate. Dimension granite was quarried and dressed at the Raymond quarry for use as architectural and monument stone. Pumice and volcanic cinder were dug from deposits a few miles south of Belleview and were prepared for use as lightweight aggregate and as a carrier in pesticides. Hans Sumpf Co. worked a clay deposit near Madera to obtain clayey soil, which was molded and stabilized with emulsified asphalt for use in making adobe brick.

The Strawberry tungsten mine, on the west fork of Granite Creek, was worked by New Idria Mining & Chemical Co. Ore was milled for a 3-month period, and although some concentrate was sold to Union Carbide Nuclear Co., most of the product was consigned to a New York buyer. Part of the shipments came from concentrate held in stock from previous years. The operator did some rehabilitation work at the mine during the year. A relatively small tonnage of development rock was produced in driving raises, drifts, and crosscuts. Exploration work included diamond drilling. The only other active metal mine in the county was the Jessee Belle copper property

near Madera. Fresno County Land Development Co. operated the mine and mill about half the year. Flotation concentrate produced was shipped to an Arizona smelter for recovery of copper, gold, and silver. The company completed about 500 feet of diamond drilling as part of an exploratory program.

Marin.—An increased tonnage of sand and gravel was required to meet demands for construction of the Nicasio Dam, highway interchanges, and general road improvements. Sand and gravel requirements for public works projects were supplied by Government crews and contractors from various stream-bed deposits, supplemented by aggregate produced at basalt and sandstone quarries near San Rafael and Novato by Basalt Rock Co. and near Greenbrae by Hutchinson Co. A substantial tonnage of crushed stone was used for taxiway and hardstand construction at Hamilton Air Force Base. Nearly 40 percent of the sandstone produced at McNear quarry near San Rafael was barged up the Sacramento River for use as riprap in levee embankments.

Shale quarried from a deposit in San Pedro hill west of San Rafael was used by L.P. McNear Brick Co. in manufacturing brick and by The McNear Co. to produce lightweight (Haydite) aggregate. The Haydite plant used oil-fired rotary kilns to expand the shale, some of which was subsequently crushed and sized for use in manufacturing concrete products. The expanded product was sold bagged and in bulk. Perlite Products Co. began operating its Sausalito expanding plant, using crude ore from California and Nevada mines.

Mercury was recovered by retorting cinnabar ore produced at the Edwards mine on the Bently Ranch east of Marshall.

Mariposa.—Crews and contractors of Federal, State and county agencies used most of the sand and gravel output for road construction and maintenance. Substantial quantities were supplied by the Mariposa Sand and Gravel Co. for paving in Yosemite National Park. Harms Bros. operated a portable crusher in El Portal and stockpiled material for a Federal agency. Slate deposits in the Aqua Fria area were worked by four operators to produce roofing granules, flagging, and dimension slate for walks and walls. Nearly 40,000 square feet of slate flagging, ranging from ½ to 2 inches in thickness, was quarried. Mariposite building stone was obtained from the Haigh's quarry and the Old Mary Harrison mine near Coulterville.

Six lode gold mines were active; however, the Red Bank mine near Bagby and the Hasloe mine west of Dogtown were the chief gold and silver producers. At the Red Bank property, exploration and development work included a shaft, raises, drifts, and tunnels. More than 1,000 tons of development rock was stockpiled. Except for a few itinerant prospectors who worked stream gravels in various parts of the county, placer gold and silver output was confined to the Lucky Seven claims on Blacks Creeks west of Coulterville.

Mendocino.—Sand and gravel output from commercial plants at Ukiah, Willits, Covelo, Fort Bragg, and Point Arena, plus that of Government crews and contractors, totaled nearly 500,000 tons. Much of the production was prepared for road construction and resurfacing projects in the Boonville, Willits, Longvale, and Dos Rios

areas. Stone was quarried near Rockport and at other places in the county, for road base and for riprap in embankments.

A new mercury prospect, the Empress property on the Crawford Ranch east of Ukiah, was worked, and cinnabar ore was retorted to recover the metal.

Merced.—A marked reduction in highway projects, compared with 1959, resulted in a decline in sand and gravel production for building and paving. Most of the 1960 demand for paving material was for county roads, particularly the Lander Avenue extension between Stevinson and Los Banos. The major sand and gravel preparation plants were in the Snelling and Los Banos areas. Agricultural Minerals & Fertilizer Co. mined agricultural gypsite at the Little Panoche property south of Los Banos. The mineral was used locally.

A relatively small quantity of byproduct gold and silver was recovered at the River Rock, Inc., sand and gravel preparation plant on the Merced River near Snelling.

Modoc.—Moyer Gravel Co. used a diesel shovel, scraper, and bulldozers to produce sand and gravel from an alluvial terrace on the north fork of the Pit River northeast of Alturas. The material was hauled to a nearby plant and prepared for asphalt and concrete aggregate. Crews and contractors for the City of Alturas, and county and State road agencies, prepared sand and gravel for base course, surfacing and surface-sealing in road construction and maintenance. A substantial tonnage of aggregate was consumed in the realignment and widening of U.S. Highway 395 between Alturas and Likely.

Volcanic cinder was mined on National Forest land for use in road construction and from a deposit at East Sand Butte (Ainshea-Butte) for railroad ballast by Great Northern Railway Co. From a deposit near Tionesta, H. P. Free mined pumice, which was prepared and marketed for lightweight aggregate.

Jeffery & Associates used a dragline, clamshell, bulldozer, and bucket loader to mine peat moss from a bog in Jess Valley, east of Likely. Most of the output was packaged and sold for soil improvement. Although shipments were made to buyers in Arizona, Oregon, Nevada, Washington, Texas, and Utah, California consumers received most of the production.

Mono.—Pumice was mined from deposits near Chalfont, Benton, and Lee Vining. Some of the material was prepared and marketed for use in acoustical plaster, as roofing granules, lightweight aggregate, and scouring blocks. The remainder was sold crude as landscaping material. A relatively small tonnage of volcanic cinder mined on National Forest land was used in road construction by the U.S. Forest Service. Sand and gravel was produced and prepared by Government crews and contractors for use in the construction and maintenance of roads. Pyrophyllite mined at the Pacific property near White Mountain by Huntley Industrial Minerals, Inc., was ground in the producer's Laws plant for use in manufacturing ceramics, paint, and gypsum board. The company dug kaolin from the Little Antelope clay deposit near Casa Diablo from May through December. The mineral was prepared for use in whiteware, paint, paper, plaster, and a variety of other uses.

A comparatively small tonnage of gold-silver ore from the Chemung gold mine near Bridgeport was shipped to the Selby smelter, Contra Costa County. Claude B. Lovestedt worked the Topaz silver-lead mine near Topaz Lake and shipped ore containing lead, silver, and gold to the same smelter. Some trenching and stripping of overburden was done at a uranium prospect near the junction of State Highway 108 and U.S. Highway 395 while completing assessment work, but no ore was produced or shipped.

Monterey.—A total of 721 oil wells were in active production during the year, 49 of which were new development wells. The activity, mostly in the San Ardo oil pool, raised production about 500 barrels a day. Much of the increase came from the Lombardi sand of the Campbell area, with peak production occurring in 1960. Forty-five of the new producing wells were added in the San Ardo pool. Several wells in the Monroe Swell area were abandoned. Crude petroleum output was 5 percent above 1959, and natural gas from oil zones rose 15 percent. Virtually the entire output of petroleum and wet gas was processed in Contra Costa and Los Angeles Counties.

Kaiser Aluminum & Chemical Corp. produced quicklime and hydrated lime at a plant in Natividad from limestone and dolomite quarried nearby. The company used three gas-fired rotary kilns and a continuous hydrator to prepare lime for chemical, agricultural, and industrial uses; refractories manufacture; and building uses. Most of the dolomitic lime produced was consumed in the producer's sea-water processing plant at Moss Landing to extract magnesium hydroxide, which was calcined to various grades of magnesia. Much of the magnesia was used with chromite from the Philippine Islands in manufacturing refractories. Near Moss Landing, evaporating ponds, covering about 400 acres, were used for the solar harvesting of salt by Monterey Salt Works.

Sand and gravel output declined from 1,047,000 tons in 1959 to 832,000 tons. The decrease was attributed to reduced requirements for paving materials by county, State, and Federal agencies. Specialty sands were prepared from dune deposits in the Pacific Grove-Pebble Beach area, for blast, engine, and foundry uses, and by Owens-Illinois and Del Monte Properties Co. to produce glass sand. Del Monte operated a flotation plant and produced both feldspar and silica concentrates. The sands and concentrates were blended to supply specialty products, ground and unground, that were used in pottery, pipe, brick, sanitary ware, and for foundry and filler uses. The Kaiser Natividad quarry near Salinas yielded dolomite for such nonlime uses as filler in fertilizers and roofing granules. Roofing granules also were prepared by W. M. Barnes Co. from dolomitic limestone quarried on the Hurt Ranch south of Salinas. Dormody Equipment & Supply Co. worked the Carmel quarry for stone used in building construction. Decomposed granite was stripped from deposits near Monterey, Pebble Beach, and Salinas for use as road base.

Napa.—Sand and gravel was produced near Angwin for building and paving use and near Napa as a source for fill material. Basalt Rock Co., Inc., supplied most of the locally produced aggregate, rip-

rap, and base material from basalt quarried from its Juarez and Pedrotti operations near Napa. Some of the material was used to improve the road to the producer's new shale deposit at Oakville. County crews worked the Parker Hill pit east of Yountville and produced materials used in road maintenance and repair.

Diatomaceous silica from deposits near Napa was processed for use in pozzolanic cements. From its Alvo quarry, Perlite Aggregates, Inc., mined crude perlite, which was expanded in the company plant near St. Helena. Leslie Salt Co. reported that a first harvest (requiring a 3-year cycle through solar evaporation) was expected in 1961 from an operation along the Napa River near San Pablo Bay that had been in preparation since 1953.

Asbestos Bonding Co. produced chrysotile asbestos at the Phoenix mine near Napa. Four operators worked the James Creek gravels by placer methods to recover mercury that had been washed into the creek bottom from the Oat Hill mined dump. Some of the dump material was retorted by another operator. Ores from the Oat Hill and Oat Hill Extension mines also were processed to yield mercury.

Nevada.—The tonnages of sand and gravel and stone produced were limited chiefly to that material needed to pave roads from Truckee north to Hobart Mills and southeast to the Placer County line. Small quantities were produced and used locally in the Truckee and Grass Valley areas for building construction. Heavy grading projects underway over Donner Summit for a 10.5-mile section of the Highway 40 freeway were forerunners of expected major requirements for aggregate. At its Spanish mine near Washington, Industrial Minerals & Chemical Co. mined crude barite that was shipped to company grinding facilities in Alameda and Sacramento Counties. The Sacramento County plant also received some crude ore from the reactivated Democrat barite property in Slump Canyon near the Placer County line.

Although relatively small tonnages of gold ore were mined at the Indiana mine near Grass Valley, the Orleans near Bloomfield, and the Red Ledge near Washington, a high percentage of the lode gold and silver credited to the county was recovered in cleanup operations at the Brunswick-Idaho Maryland, Empire Star, and Lava Cap properties in the Grass Valley-Nevada City area. Cleanup material shipped from the Willow Valley mine, east of Nevada City, to the Selby smelter also contained recoverable copper, lead, and zinc. Except for the output from a dragline operation on Wolf Creek near the Limekiln Ranch, virtually all placer gold and silver was recovered from small-scale stream-gravel operations by itinerant prospectors. Gold and silver recovered by Yuba Mining Co., on the north fork of the Yuba River north of Columbia Hill, in 1958 and 1959, was sold to various buyers in 1960.

Orange.—The number of producing oil wells in the county declined from 3,862 to 3,816. This decrease was associated with a corresponding 5-percent decline in crude petroleum production. Despite the production loss, Orange County was again fourth in petroleum output. Socal Oil & Refining Co. operated the only oil refinery in the county, a thermal-cracking plant at Huntington Beach. The volume of wet gas produced was 4 percent below 1959; however, the total natural

gas liquids recovered at seven plants (three near Huntington Beach, two near Brea, and one each near La Habra and Placentia) increased. Natural gasoline and cyclic products increased 5 percent in quantity above 1959, and LP-gas output rose 3 percent. Dow Chemical Co. operated the Nation's only iodine extraction plant at Seal Beach, where crude iodine was recovered from waste oil-well brines of the Los Angeles Basin. Western Salt Co. harvested crude salt from 6 ponds of the Newport Bay salt Works at Corona Del Mar. The unscreened product was sold in bulk and in bags to local consumers. Some of the extracted salt-works bitterns was sold for use as a weed killer. Peat humus was dug from the R. W. McClellan & Sons peat pit near Huntington Beach and sold in bulk for use as a soil conditioner. The tonnage marketed was 31 percent under the 1959 figure.

The quantity of sand and gravel produced for building construction increased from 3.4 million tons in 1959 to 4 million tons. The increase for paving projects was 100,000 tons. Preparation plants in the Anaheim, Orange, El Modeno, and San Juan Capistrano areas supplied a substantial part of the production. Specialty sands were obtained from pits near Huntington Beach, Trabuco Canyon, and El Toro and prepared for blast, foundry, and pottery uses. Decomposed granite and miscellaneous stone were quarried by Government contractors for road base and use as rip-rap in flood-control embankments. Kaolin was mined for use in whiteware and foundry ganister by California Nonmetallics, on the Robinson ranch east of Trabuco Canyon Road, and by W. A. Schoeppe Clay Co., from its deposit about 13 miles northwest of El Toro. Miscellaneous clay was dug near Anaheim, Corona, and Huntington Beach and used in manufacturing brick, sewer pipe, and other heavy clay products. The Lahabralite Co. imported crude vermiculite from Transvaal, South Africa, and exfoliated it in a plant in Anaheim for use in premixed plaster, as insulation, and for lightweight aggregate.

Placer.—Sand and gravel production declined from 547,000 tons in 1959 to 450,000 tons. A substantial decrease in the output of paving sand and gravel was partly offset by an increase in the tonnage used for structural purposes. Road construction projects were mainly road surface improvements near Roseville and Soda Springs and grading operations near Baxter. Commercial preparation plants were operated near Sheridan, Auburn, Colfax, and Tahoe City. Joe Chevreaux in Auburn, one of the major producers of building and paving sand and gravel, also prepared appreciable quantities of blast sands and of quartz gravels for use as landscape and exposed aggregate. Teichert Aggregates established a new plant near Blackwood Creek, south of Tahoe City, to supply sand and gravel for resort developments and paving projects. Granite was quarried near Rocklin by Union Granite Co. for use as building and monument stone, and crushed for nursery, poultry, and roofing granules. Granite and decomposed granite deposits near Rocklin and Auburn furnished stone used principally for road base and fill. Sierra Nevada Milling Corp., Inc., mined quartz near Colfax and ground it for silica flour and foundry use. The company installed an additional pulverizer at its plant during 1960. Fire clay was mined by

Gladding, McBean & Co. and Lincoln Clay Products Co., Inc., from deposits in the Lincoln area, for use in manufacturing brick, structural tile, and sewer pipe.

Except for a few ounces of gold recovered by a dragline operation at Canada Hill and a suction dredge near Colfax, gold and silver production was from one-man operations (itinerant prospectors, snipers, etc.) which recovered placer gold and silver from streambed gravels, using small-scale hand methods.

In 1959 a development program was begun at the Dairy Farm mine, near McCourtney Crossing on the Bear River. The operator constructed ponds to handle copper-bearing mine water, from which cement copper would be recovered. The water was to be pumped from an open pit to an upper pond in the mine dump, percolated down into a series of lower ponds, and then through wooden tanks containing iron scrap. No precipitate had been shipped by the end of 1960.

Plumas.—Sand and gravel production increased chiefly because of aggregate needed by Government contractors for road construction and realinement projects near Canyon Dam, Blairsden, and Beckwourth. Producers near Quincy, including Plumas Ready-Mix Concrete and the Bellamy Corp., obtained sand and gravel from the Spanish Creek stream bed for building, paving, filtration sand, and drain rock. The Tobin quarry was worked intermittently by maintenance crews of the Western Pacific Railroad Co. for stone used as riprap. Over 8,000 tons of volcanic cinder was produced from deposits in the National Forest and used by crews of the U.S. Forest Service in road construction.

Copper ore from the Engels mine northeast of Greenville was shipped to the Tacoma, Wash. smelter for recovery of contained copper and silver. The only other active lode mine was the Gold Stripe gold mine west of Greenville. Ore from this property was smelted at Selby, Contra Costa County, to recover a few ounces of gold and silver. Virtually all the placer gold and silver recovered was obtained from stream gravels by prospectors.

Riverside.—Kaiser Steel Corp. operated its Eagle Mountain iron mine, the State's major metal mine and one of three active iron mines in 1960. Production and shipments of mine-run ore were 9 and 12 percent, respectively, below 1959 figures. No direct-shipping-grade ore was produced during the year. The run-of-mine ore was upgraded in a nearby plant, and the concentrate was shipped to the company-owned integrated steel plant at Fontana, San Bernardino County, or exported. Less than 200 long tons of the iron concentrate produced were sold to domestic consumers. During the year Kaiser Steel Corp. completed about 5,000 feet of diamond drilling at the mine site as a part of its exploration program. Ores containing gold, silver, and copper from two lode mines, the La Escondida in the Maria Mountains a few miles northeast of Mineral Switch and the Mountaineer about 1 mile east of U.S. Highway 95 near the San Bernardino County line, were shipped to out-of-State copper smelters. At the Ram uranium claims near Twentynine Palms development consisting of trenching, shaft sinking, and raising was completed, but no ore was produced or shipped.

Riverside Cement Co. produced portland cement in its 13-kiln dry-process plant at Crestmore for shipment to customers in California, Arizona, and Nevada. The company purchased nearly 73 million kilowatt-hours of electrical energy to operate the plant in 1960. An automatic system for palletizing bagged cement was installed in the newly modernized bagging plant. A new dry-process white-cement plant with capacity to produce 250,000 barrels a year was under construction adjacent to the existing plant. Full-scale production of white cement was expected by June 1961. Sand and gravel production declined to 1.8 million tons. About two-thirds of the 300,000-ton decline was attributed to a decrease in paving requirements and one-third, to a lesser demand for structural uses. Major producers operated fixed plants in Corona, Indio, and Desert Hot Springs areas. The tonnage of glass sand produced near Corona by Owens-Illinois was moderately greater than in 1959. Granite and decomposed granite were quarried and prepared for road base, fill, riprap, and poultry grit. Limestone was mined underground near Crestmore by Riverside Cement Co. and consumed in the producer's cement plant or sold for flux and filler. Limestone quarries were operated near West Riverside and Nightingale as a source of stone used as roofing granules and concrete aggregate. Quarries were worked by Minnesota Mining & Manufacturing Co. and Hugh Seeger Corp. near Corona, and Kenneth J. MacKenzie near White Water to obtain stone used for rubble, riprap, roofing granules, and sand-blasting material.

Clay deposits in the Alberhill, Corona, and Elsinore areas were sources of fire and miscellaneous clay used in manfacturing refractories, heavy clay products, stoneware, and pottery. Pacific Clay Products Co. worked the largest clay deposit in the county north of Terra Cotta. The deposit covered nearly five sections of land. Pacific Clay began unifying its facilities by dismantling its Corona plant and moving the equipment and machinery to Santa Fe Springs in Los Angeles County. The Crestmore shale pit was the source of material used by Riverside Cement Co. in cement manufacture. U.S. Gypsum Co. mined crude gypsum southwest of the Little Maria Mountains and used most of the production in its nearby Midland plaster and wallboard plant. Some float wollastonite was collected in the same area and shipped for ornamental use. Morongo Corp. mined reed-sedge peat near Banning, using a dragline. The air-dried peat was ground and sold in bulk for soil conditioning, a fertilizer mix, and as an ingredient in potting soils. Production was slightly above that in 1959. Several companies continued to explore for oil in the western part of the county, but no significant finds were reported. Output from the single producing well in the Pardo Dam area was down 11 percent from 1959.

Sacramento.—The volume of natural gas produced rose more than 15 percent above the 1959 figure, partly because of three gas discoveries. Amerada Petroleum Corp. made a new-field discovery (Grand Island) at a depth of 4,677 feet about 3 miles north of the River Island gasfield. The well was completed August 3 with an initial flow of 2,782 thousand cubic feet. Two new-pool wildcat discoveries were made during the year, one by Brazos Oil & Gas Co., in the Walnut Grove field at a depth of 4,386 with a well completion on March 10,

and one by Texaco, Inc. in the River Island field at 3,566 feet on December 4. Initial flow at both wells exceeded 1 million cubic feet.

Reduced sales of aggregate used in building construction were offset somewhat by increased demand for sand and gravel used in paving U.S. Highways 40, 50, and 99, and State Highway 24. McClellan Air Force Base projects, as well as those of City and county agencies, required appreciable quantities of these materials. Pits and stream-bed deposits in the Sacramento, Del Paso, Perkins, and Fair Oaks areas were the principal sources for sand and gravel. The G. R. McDonell clay pit near Sacramento was worked by R. J. Robideaux, and the clay was sold for use in making refractory brick. Sacramento Brick Co. dredged clay near the southwest city limits of Sacramento. Cannon & Co. obtained clay used to manufacture brick near Sloughhouse from April through November. Crude vermiculite received from a Montana mine was exfoliated in the Sacramento plant of California Zonolite Co. and sold for use as lightweight plaster and concrete aggregate, acoustical and thermal insulation, and a soil aid.

Most of the placer gold and silver recovered in the county, and all the platinum, came from the bucketline dredging operation of the Natomas Co. on the American River. Four sand and gravel preparation plants recovered byproduct gold and silver.

San Benito.—General purpose, moderate heat, high sulfate resistance, and plastic portland cements were produced by Ideal Cement Co. at San Juan Bautista and shipped by truck to consumers in northern and southern California. A comparatively small tonnage of cement was shipped to Oregon. The company operated four 150-foot kilns to produce clinker for its wet-process plant. Sand and gravel obtained from deposits along the San Benito River near Hollister was prepared by Don L. Rider and Hollister Sand & Gravel Co. for concrete aggregate and road base. Hollister Sand shipped these materials by rail to the San Jose and Redwood City areas. At Logan, crushed and broken stone from the State's largest granite quarry was shipped by rail and truck for riprap, roadstone, aggregate, and railroad ballast. Quarries near San Juan Bautista and Hollister yielded limestone and dolomite used in manufacturing cement and magnesium compounds, respectively. Two producers mined bentonitic clays for enameling, foundry use, fillers, drilling mud ingredient, and other uses. San Benito Clay & Mineral Co. mined clay near Tres Pinos, and Fresno Agricultural & Chemical Co. operated the Vallecitos, Ashurst, and Buckhorn clay deposits near Idria.

Ten mercury mines and prospects were active. The New Idria mine was the Nation's major mercury producer and the only mine in San Benito County that yielded more than 50 flasks of metal. Exploration and development completed at the New Idria included over 200 feet of shafts and raises; more than 2,000 feet of tunnels, drifts, and crosscuts; and more than 5,000 feet of diamond and long-hole drilling. Some exploration and development work also was done at the nearby Elkafajo property, a new mercury prospect. Among the other active mercury mines, the most productive were the San Carlos, Santa Margarita, and Camp No. 2, in the Idria area, and the Juniper near Panoche. The number of producing oil wells remained about the

same, but overall production dropped 36 percent below 1959. Most of the decrease was attributed to the Vallecitos field. Despite the appreciable decline in crude petroleum output, wet-gas production rose 2 percent. Dry-gas output was reported for the first time in several years; production came from the Lamerias gas area of the Hollister field. This area was first discovered in 1950 as an oil find and later classified as a dry-gas area. The potential producing wells had been shutin for several years.

San Bernardino.—Mineral and natural saline deposits comprising an area larger than Connecticut, Massachusetts, and Rhode Island combined, yielded 30 metal and mineral commodities with a total value greater than the value of mineral output in Nevada. Plants at Colton, Cushenbury, Oro Grande, and Victorville produced 13 million barrels and shipped over 12 million barrels of portland cement during the year. Shipments were made by truck and rail to consumers in California, Nevada, Arizona, Utah, and Colorado. Dry-process manufacture was used at the California Portland Cement Co. nine-kiln Colton plant and the Riverside Cement Co. seven-kiln Oro Grande plant. The Permanente Cement Co. two-kiln Cushenbury plant and the Southwestern Portland Cement Co. nine-kiln Victorville plant used the wet process. More than 288 million kilowatt-hours of electrical energy was consumed by the four plants. Southwestern installed a new baghouse at its Victorville plant during the year to remove cement dust from the kiln smoke.

Saline materials, including sodium borates, boric acid, potassium chloride and sulfate, soda ash, salt cake, elemental bromine, and crude dilithium-sodium phosphate (converted to lithium carborate) were produced from Searles Lake brines by American Potash and Chemical Company. West End Chemical Company operated a plant on the opposite side of this playa to produce sodium borate, soda ash, salt cake and glauber's salt by entirely different processes. The bromine was used mostly by chemical plants in the Los Angeles area; potassium salts were mainly used in preparing fertilizers. The entire output of calcium chloride in California was obtained from Bristol Lake by two plants and refined at a third plant to liquid and flake forms. Crude salt, obtained from Searles, Bristol, and Danby dry-lake brines, was recovered by solar evaporation. Halite was mined with a dragline near Amboy and sold for use in manufacturing chlorine. American Potash and Chemical Company installed a $7 million evaporation plant at its Trona operation to replace older facilities and increase production. Salt was produced by California Salt Company both by solar evaporation and conventional mining and processed for many uses. Pacific Salt Co. recovered salt from holdings of the American Potash & Chemical Corp. on Searles Lake by bulldozer, scraping thin surface layers. The salt was hauled 4 miles to Argus, a rail loading point. Salt harvested near Rice by Metropolitan Water District of Southern California was used entirely in water softening.

Reduced output of limestone quarried near Oro Grande, Colton, Cushenbury, and Victorville for use in cement resulted in a decline in total stone production of about 300,000 tons below 1959. Increased shipments of limestone were made from the Cushenbury quarry for use as flux at the Fontana steel plant. Limestone was also quarried for

use in glass, paper, whiting, poultry grit, and roofing granules. Marble-Wite Dolomite, Inc., opened a large dolomite deposit about 7 miles south of Lucerne Valley and produced roofing granules, terrazzo chips, and decorative rock. Granite and decomposed granite were quarried near Colton, Big Bear Lake, and Twentynine Palms, and adjacent to several Government project sites, for use as riprap, roadstone, and fill. Marble quarried in the Victorville and Yucca Valley areas was used for rough and dressed building stone and terrazzo. Sandstone, quartz, and quartzite were quarried near Oro Grande, Hinkley, Baldwin Lake, and Twentynine Palms for cement, filler, rock wool, and building uses, and in foundries and oil refineries. Stone quarried in the Barstow, Baker, and Old Woman Springs areas was used for dimension building stone and roofing and decorative granules. Sand and gravel production declined from 6.3 million tons in 1959 to 5.5 million tons, chiefly because demand for paving aggregate dropped from 2.4 million to 1.7 million tons. Large tonnages of sand and gravel produced from pits and plants between Upland and Redlands were consumed in building and paving.

Four producers supplied more than one-third the State talc output from 14 deposits. Most of the active talc mines were in the Tecopa and Silver Lake-Yucca Grove areas. Western Talc Co. was the county's major producer. Southern California Minerals Co. carried out exploration and development work at its Excelsior and Monarch properties near Tecopa and stockpiled some development rock. Mineral Materials Co. did not mine any pyrophyllite at its Victorite deposit during year, but shipments were made to grinders from stocks. Ball clay was dug at the Hart mine in the Castle Mountains near Ivanpah by Gladding, McBean & Co. and Southern California Minerals Co. for use in pottery and stoneware, floor and wall tile, and refractories. Exploration was in progress at the mine site in an attempt to locate an extension of the deposit. Bentonitic clay mined or withdrawn from stockpiles at the Honey Brown property near Vidal, the Geyser View No. 3 claim near Newberry, and the Hector deposit near Dagget was used to supply trace minerals in animal feeds, as a filter aid, and for many other applications. Miscellaneous clay was obtained from pits near Chino and Highgrove for use in brick manufacture. Shale-Lite Corp. mined shale near Chino and used it to produce expanded lightweight aggregate. Clay and shale from the Cushenbury pit south of Lucerne Valley was used by Permanente Cement Co. Quicklime and hydrated lime was produced by California Portland Cement Co. at its Colton plant for sale to the building trades. West End Chemical Co. produced byproduct quicklime and hydrated lime in its plant at Searles Lake. The output was sold for chemical, industrial, building, and agricultural uses.

Volcanic cinder from a property near Ludlow was used for railroad ballast. Deposits near Cima and north of Hinkley yielded volcanic cinder prepared for use as lightweight aggregate, soil conditioner, and landscaping material. Crude fluorspar from the Pacific Fluorite mine in the Clark Mountain area was purchased by an Ohio company for use in glass manufacture. Oil Base, Inc. shipped crude barite from its Leviathan mine near Yermo to the company processing plant at Compton, Los Angeles County. Crude feldspar produced at the Beck

mine near Four Corners was custom-ground in a Los Angeles plant. The average number of producing oil wells rose from 14 in 1959 to 22. Petroleum production dropped 15 percent; wet gas output increased 6 percent. One of three wells drilled during the year was abandoned as dry, and two were suspended. The total footage drilled was only 4,652 feet.

Iron Age Mines Co., at its open-pit magnetite iron mine south of Danby Lake, hand-sorted and ran the crude ore over a magnetic pulley to upgrade the ore for sale to cement and iron and steel producers. Kaiser Steel Corp. operated its integrated steel plant at Fontana, the State's major steel plant and only producer of pig iron. Late in the year Metals and Petroleum Corp. of Los Angeles acquired tungsten placer properties in the Atolia area near Randsburg. Before World War II this area yielded both gold and tungsten. Molybdenum Corp. of America operated its Mountain Pass mine and mill but processed a lower tonnage of barite-bastnasite ore in producing rare-earth concentrate than in 1959. However, shipments of concentrate were more than three times the 1959 tonnage. During the year, the producer reached an agreement with American Potash & Chemical Corp. whereby the latter company would exclusively develop and distribute the rare-earth products in the glass industry. Most of the county's silver, lead, and zinc output was recovered in smelting lead ores, which also contained recoverable gold and copper, from the Bonanza King mine in the Providence Mountains a few miles southeast of Kelso. Ore mined at the Silver Bow property near Calico also yielded silver and lead. Nearly 50 percent of the credited copper output was derived from ore of the Best Yet mine, a few miles west of Needles, which also yielded silver and zinc. Copper ores from the Consolation and Master claims near Spangler, the Copper Queen and Joseph claims north of Barstow, and the Mary Elizabeth mine in the Avawatz Mountains north of Baker, were shipped to an Arizona smelter for recovery of copper and silver. Ore from the Mary Elizabeth mine contained most of the gold output reported in the county. C & C Drilling Co. shipped silver ore from the Good Pay mine near Ord Mountain to the Selby smelter, Contra Costa County. The company completed considerable development work at the mine including shafts, raises, and tunnels. About 1,000 tons of waste was removed to the mine dump and over 3,000 tons of development rock was stockpiled.

San Diego.—Sand and gravel production decreased 1.5 million tons from 1959. Paving sand and gravel decreased 1 million tons; sand and gravel for structural uses decreased 500,000 tons. Nearly 3.4 million tons of sand and gravel was produced for construction purposes, and the remainder was used mostly for paving of roads, streets, and airport runways. The principal producers operated pits and plants in the San Diego, El Cajon, and Oceanside areas. Silica sand obtained and prepared near Oceanside was sold for industrial uses, including glass, molding, sand blasting, engine, and filtration. The Escondido and Congo Black quarries near Escondido, the Western Black quarry near Vista, and the Suncrest quarry near El Cajon, were sources of rough and dressed dimension granite quarried for architectural and monumental uses. Operators at the Congo Black and Western Black quarries made surface-bearing plates for equipment in laboratory

use. Granite, decomposed granite, and miscellaneous stone quarried in the same general areas were used as riprap, roadstone, and fill material. Basaltic rock was quarried from the Volcan No. 1 and No. 2 claims about 3 miles northeast of Jacumba and prepared for use as roofing granules.

Western Salt Co. harvested crude salt from ponds at South Bay by solar evaporation of sea water and processed the material at Fruitdale for a wide variety of uses. The salt-works bitterns were pumped to the nearby chemical plant of Mineral Products Division, Food Machinery and Chemical Corp., where magnesium chloride was extracted. A limekiln was installed at the Alvarado water treatment plant of the San Diego City Water Department for the calcination of calcium carbonate sludge removed in water treatment. The installation supplied lime for the city's Alvarado and Miramar filtration plants. Miscellaneous clay dug near Del Mar and the Linda Vista Station was used by Sorrento Brick & Clay Products and by Hazard Block Co., respectively. Union Brick Co. mined shale north of Pacific Beach near Highway 101 and consumed it in the company plant. Three pyrophyllite deposits were operated in the San Diequito area during the year. Except for a relatively small tonnage shipped to a Los Angeles chemical plant, the output was consigned to grinders in Escondido and Campo and one in Los Angeles County. Harborlite Corp., in Escondido, expanded crude perlite received from Inyo County and Arizona. Delwin R. Curry worked two gold properties near Pine Valley. Ores of the Eagle Nest group and the Ross Quartz mine were amalgamated to recover gold and silver.

San Francisco.—Franciscan chert (red rock) quarried and crushed at Candlestick Point was used for base material in State highway projects and in extending runways at San Francisco International Airport, San Mateo County. Sand was dredged from the bay bordering the city and county, and obtained from ocean-beach dune deposits for use in asphaltic and concrete surfacing and as fill in the Golden Gateway project.

Commercial Minerals Co. purchased limestone and soapstone from El Dorado County, talc from Inyo County, and bentonite from San Benito County. The ores were ground or otherwise processed by the company for resale. Stauffer Chemical Co. processed partly refined borates purchased from a Kern County producer and converted them to various boron and sodium compounds.

San Joaquin.—The volume of natural gas produced was more than one and a half times that in 1959. The increased output was attributed mainly to a successful new-field wildcat, two successful new-pool wildcats, and an average of 13 more producing gas wells. Great Basins Petroleum Co. had a successful new-field discovery in the McMullin Ranch area with a well completion on May 4 that had an initial flow of 2,740,000 cubic feet from two producing intervals between 5,925 and 5,970 feet. The company also made a new-pool discovery in the Vernalis field with a successful well completion on May 21. The other successful new-pool wildcat was made by E. C. Brown when his H. D. Towne Unit 2 came in at 3,526 feet on March 31 with an initial flow of more than 2 million cubic feet near the southern boundary of the Thornton gasfield. At yearend the depleted Mac-

Donald gasfield was nearly ready for the planned gas storage by Pacific Gas & Electric Co.

Sand and gravel production, principally in the Tracy, Escalon and Clements areas, was moderately lower than in 1959. Requirements for these materials for constructing and surfacing highways north of Clements and south of Lodi and local street and road projects offset somewhat a decline in the quantity used in building construction. A comparatively small tonnage of stone was quarried and crushed near a road project under construction for a military installation. Clays were mined near Stockton and Tracy for use by California Clay Products Co., Stockton Building Materials Co., and Pacific Clay Products Co. Pacific Clay was modernizing its vitrified clay pipe plant at Stockton.

San Luis Obispo.—An average of four more producing oil wells yielded 34 percent less petroleum than in 1959. Production came from five fields—Arroyo Grande, Guadalupe, Morales Canyon, Russell Ranch, and Taylor Canyon. There were no new-field or new-pool discoveries during the year. In addition to four new producing wells, two unsuccessful wells were drilled in the Cuyama Valley area; one reached granite at 9,002 feet on August 20, and the other was abandoned as dry at 1,805 feet. Two dry wells, one drilled to 5,200 feet in the Chimney Rock area and the other to 3,303 feet at Midway Sunset, were reported. Natural gas output came from oil zones only and was 15 percent below 1959. Union Oil Company operated a coking and thermal-cracking plant at Arroyo Grande and Richfield Oil Corp. treated wet gas in its natural gasoline and cycle plant near Cuyama. The quantities of natural gasoline and cyclic products credited to the county decreased 17 percent, and the volume of LP-gas produced was 2 percent less than 1959 figures. Reduced output of these materials at commercial plants and by Government crews and contractors was attributed to lesser requirements for sand and gravel in both building and road construction projects. Virtually all the production came from deposits near Cambria, Atascadero, Pismo Beach, and Arroyo Grande. Quarries in the Adelaide, Morro Bay, San Luis Obispo, and Nipomo areas supplied building stone, rubble, riprap, flagging, and road base material. A substantial tonnage of riprap was quarried for embankment use in projects of the U.S. Army Corps of Engineers, State Division of Highways, and the Whale Rock Dam project. The latter was a joint venture of the State Division of Water Resources and the City of San Luis Obispo. San Luis Brick, Inc., dug and used miscellaneous clay from a deposit near the city limits of San Luis Obispo. Superior Gypsum Co. mined agricultural gypsite at the Carisso property several miles east of Simmler.

Although six mercury mines were active, only the Buena Vista, near Klau, yielded more than a few flasks of the metal. Exploration and development completed at this open-pit property included 5,000 feet of rotary drilling and the stripping of about 100,000 cubic yards of waste. Some rotary drilling and stripping was done at the Rinconda mine a few miles southeast of Santa Margarita.

San Mateo.—Oystershell and clay, dredged together from San Francisco Bay, were used as basic raw materials to produce portland

cement at the Redwood City wet-process plant of Ideal Cement Co., where 235-foot rotary kilns were operated. Shipments of finished cement were made by truck, rail, and water, principally to northern California markets; however, cement also was shipped to customers in southern California, Nevada, and Oregon. Some of the oyster-shell was processed outside the county for use as poultry grit and as a mineral filler in animal feeds. Sand output was limited to the tonnage produced commercially at Pilarchitos Creek near Half Moon Bay, and the quantity produced and used by Government contractors in road projects. Sandstone, limestone, basalt, decomposed granite, and miscellaneous stone were quarried in the Brisbane, Belmont, Redwood City, Rockaway Beach, Woodside, and Pescadero areas. These quarries furnished most of the concrete aggregate, riprap, roadstone, and fill material produced in the county. Stone output increased and was used principally in widening the Bayshore Freeway.

At Redwood City, Leslie Salt Co., with operations extending into Alameda and Santa Clara Counties, harvested a large tonnage of crude salt by solar evaporation of sea water in ponds along San Francisco Bay. Virtually all salt produced at the Redwood City plant was exported or shipped to other States. In south San Francisco, Merck & Co. operated a chemical plant and used a purchased limestone-dolomite mixture in recovering magnesium hydroxide from sea water.

Petroleum and natural (wet) gas production, from an average of twice as many wells, rose 62 and 27 percent, respectively, compared with 1959 figures. The south area of La Honda field, which was discovered in 1959, was the chief producing area. Only one well produced in the Oil Creek area.

Santa Barbara.—A new drilling platform was erected for Texaco, Inc., about 1.5 miles offshore, 5 miles west of Gaviota. The double-deck production platform was near a well completion made by Texaco in 1959. This well had been drilled to 6,751 feet, and a formation test reportedly flowed 1,393 barrels daily of 35° API gravity oil and a large amount of gas, but no production was reported in 1960. During the year two notable offshore gas discoveries were made. Standard Oil Co. of California completed a gas well in the Gaviota offshore field on June 16 at a depth of 9,007 feet, and Phillips Petroleum Co. made a gas-well completion September 28 in the Naples offshore field. Standard Oil also began erecting a second platform in the Summerland offshore area. On September 10 Socony Mobil Oil Co., Inc., had a successful shallower pool test in the Cat Canyon field from Pliocene gas sands. The perforation interval was 3,412–3,501 feet with an initial flow of 477,000 cubic feet daily. The volume of dry gas produced was 4.5 times the total for 1959. Crude oil and wet gas output increased 4 and 3 percent, respectively, whereas production of natural gasoline and cyclic products and LP-gas from six plants rose 10 and 9 percent. Two new cycling plants of Standard Oil Co. at Carpenteria and Gaviota contributed substantially to the increase in natural gas liquids.

Open-pit operations at Lompoc supplied a high percentage of California's diatomite output. The crude material was prepared for a wide variety of uses in the nearby processing plants of Great Lakes

Carbon Corp., Johns-Manville Products Corp., and Wyandotte Chemical Corp. Much of the finished diatomite was consumed as a filter aid and filler or carrier in various products, and for thermal and acoustic insulation. Near Santa Maria, The Airox Co. mined and prepared diatomite for use as lightweight aggregate and as an ingredient in pozzolan cement.

The peak construction period for facilities at Vandenberg Air Force Base had ended, and demand for aggregate was appreciably less than in 1959. However, much of the sand and gravel and stone production was used in constructing related projects at the base, for roads and buildings at the Naval Missile Facility at Point Arguello, and for improvements to U.S. Highway 101, west of Santa Barbara. The principal producers of sand and gravel operated fixed and portable plants along the Sisquoc River in the Santa Maria-Garey-Sisquoc area and along the Santa Ynez River in the Lompoc-Buellton-Solvang area. Missile City Rock Corp. quarried dolomite in Miguelito Canyon, near Lompoc, and produced dimension and crushed stone used in structures and roads. Rough and dressed building stone, riprap, and flagging were quarried near Santa Maria, Lompoc, and Santa Barbara. In June, Rincon Rock Corp. installed equipment at its quarry near Carpenteria for preparing stone used in building and paving. De Weese Spreaders, Inc., mined agricultural gypsite one-half mile south of Ventucopa during the first half of 1960. The company ceased mining in July when the deposit was depleted of salable mineral.

The Gibraltar mine northeast of Santa Barbara, was the only active mercury property. Some underground development rock was furnaced, but most of the recovered metal came from ore mined at the producer's open-pit operation.

Santa Clara.—The 6-kiln wet-process cement plant of Permanente Cement Co. at Permanente was the State's largest cement-producing facility. The plant used over 143 million kilowatt-hours of electrical energy during the year. Shipments of virtually all types of cement, including some white and masonry cements, were made to consumers in California, Nevada, Oregon, Washington, Hawaii, and foreign countries. The construction of interchanges and extensions along U.S. Highway 101 Bypass and State Highway 17 to provide continuous freeway routes through the county placed heavy demands on many sand and gravel producers. Virtually all the sand and gravel used for building and road construction was obtained from streambed deposits in Coyote, Guadalupe, Los Gatos, and Uvas Creeks, and bench gravels along Stevens Creek Road west of San Jose. The county's largest stone quarry was at Permanente, where limestone for cement and road base was processed at two crushing plants. Other stone quarries were worked near Milpitas, Palo Alto, Los Altos, San Jose, Saratoga, Morgan Hill, and Gilroy for rubble, aggregate, roadstone, roofing granules, and fill. Road base material was obtained from the Alum Rock Park and Saratoga quarries by crews of the City of San Jose and Santa Clara County, respectively. Oystershell dredged from San Francisco Bay near Dumbarton Bridge was used as poultry grit and mineral filler in animal feeds. The Western quarry near Livermore was the source of magnesite used by an

Alameda County chemical plant in producing hydrous magnesium sulfate. Late in the year Mother Lode Rock Industries, Inc., took over operation of the quarry. Remillard-Dandini Co. and Gladding Bros. Manufacturing Co. mined miscellaneous clay near San Jose for use in making brick and flue lining.

The Guadalupe and New Almaden mines were the only producing mercury properties. Dump material was worked at the New Almaden by 10 lessees, only half the number working in 1959. One of the lessees recovered nearly 700 flasks of mercury. As in 1959, only two oil wells were active. The wells, in the old Moody Gulch field, yielded 33 percent less crude oil than in 1959.

Santa Cruz.—Pacific Cement & Aggregates, Inc., operated a 9-kiln dry-process cement plant at Davenport and produced general purpose and moderate heat portland cements for northern California customers. Nearly 60 million kilowatt-hours of electrical energy was used. Shipments were made of both bulk and bagged cement by truck and rail. Pacific Cement mined shale from its nearby quarry, and Ideal Cement Co. operated the Chittenden shale quarry, for raw material used in manufacturing cement. Flue dust from the Davenport cement plant was sold for fertilizer because of its potash content. Sand and gravel was mined principally from the unconsolidated Santa Margarita formation. At Felton, sand was blended with crushed stone and used as concrete aggregate. Several producers worked sand deposits in the Santa Cruz and Scott Valley areas. Sandstone quarried at Davenport and hauled to San Mateo County for constructing the 7,000-foot L-shaped breakwater at Half Moon Bay chiefly accounted for the increase in stone production compared with 1959. Limestone quarried at Davenport and Santa Cruz was used in manufacturing cement, as rubble, and for poultry grit. Stone was quarried near Felton and Soquel by crews and contractors for State and county road agencies.

Union Oil Co. of California terminated its research project for recovering hydrocarbon from bituminous sandstone near Santa Cruz. The project was begun in 1955 by Husky Oil Co. High recovery cost was the principal factor in the decision to abandon the project.

Shasta.—Sand and gravel was produced principally by dragline along the Sacramento River and from stream-bed deposits on Churn and Clear Creeks near Redding. Demand was high for concrete aggregate and base material for water-tunnel linings, powerplant construction, and road relocation in preparation for the proposed Whiskeytown Dam and adjacent saddle dams. By yearend, the Clear Creek tunnel had been holed through and work begun on the Spring Creek tunnel, the Whiskeytown Dam and two of three major powerplants. Basalt and miscellaneous stone were quarried by Government crews and contractors for use as riprap and roadstone. Calaveras Cement Co. was building a new $14 million, 1.5-million-barrel annual capacity, automated cement plant about 10 miles north of Redding. Development of the limestone deposit in the Grey Rocks Hills northeast of the plant site began in December, with plans for a belt conveyor adit and a vertical shaft for use as an ore pass. All volcanic cinder produced in the county was used for road construction. Most of the material came from deposits near Glenburn and Fall River

Mills, although crews and contractors for the State Division of Highways produced some for their own use from deposits in the Shasta National Forest.

Mountain Copper Co., Ltd., mined pyrite from its Iron Mountain pit west of Matheson Station and recovered cement copper from underground mine water. The pyrite was crushed and shipped to Contra Costa County chemical plants, where the mineral was roasted to recover sulfur used in making sulfuric acid. The resulting cinder was used in manufacturing special cements and as a soil supplement. The cement, copper, and solution-residues from the company's chemical plant were shipped to the copper smelter in Tacoma, Wash., for extraction of copper, gold, silver, and lead. During the year the company stripped and removed nearly 1 million tons of waste at its Iron Mountain property and completed over 1,750 feet of diamond drilling. A few miles north, about 5,000 feet of diamond drilling was done in exploring the Balaklala copper mine, but no ore was mined or shipped. Five lode gold mines were active; the Yankee John about 6.5 miles southwest of Redding on the Igo road, Washington near French Gulch, and the El Dorado near Towerhouse were the most productive.

Sierra.—Seven lode gold mines were active; however, only three—the Brush Creek south of Goodyears Bar, the Original 16 to 1 at Alleghany, and the El Dorado (El Dorado-Plumbago) east of Alleghany—yielded appreciable quantities of gold and silver. The El Dorado ore also contained recoverable zinc. Considerable exploration and development work was done at these mines and the Plumbago southeast of Alleghany. The work consisted of shaft, drifts, tunnels, raises, and drilling. Gold and silver, recovered by dragline dredging in 1958 and 1959 on the Espy Placer property near Pike, were sold in 1960. Placer gold and silver were recovered by small-scale hand equipment in stream and ancient river bed gravels in the Poker Flat, Pike, and Alleghany areas. Old tailings were washed at the Two Bills site on Illinois Creek north of Downieville; relatively small quantities of gold and silver were recovered. Test work at the Desert Hill prospect south of Pike yielded some placer gold. Uranium ore was shipped from the Silver Streak mine in Dog Valley to a processing plant at Lakeview, Oreg. The mine had yielded shipping-grade ore in 1958.

All the sand and gravel and most of the stone produced was used in road construction by crews and contractors for Federal, State, and county agencies. The commercial requirements for building and paving sand and gravel were supplied by producers in neighboring counties. Reno Silica Co. quarried quartz (July through September) several miles north of Crystal Peak and shipped it to an Oregon silicon manufacturer.

Siskiyou.—A substantial tonnage of sand and gravel was produced by county, State, and Federal crews and contractors for constructing bridges and roads in the Weed, Yreka, Seiad Valley, Clear Creek, and Callahan areas. Commercial preparation plants were operated by Mt. Shasta Gravel Co., Inc., at an alluvial deposit 2 miles northwest of Mt. Shasta, and by A. Young of Yreka, who obtained gravel from the Greenhorn Creek stream bed and sand from Whitney Creek.

The materials were used for building and paving. Basalt and miscellaneous stone were used for riprap and roadstone by contractors for the U.S. Forest Service and Bureau of Reclamation. Siskiyou Stone Co., Inc., of Yreka quarried ornamental building stone near Montague, where the company was building a plant. More than half the output of volcanic cinder, all used for railroad ballast, came from the Kegg cinder pit. Deposits near the Modoc County line yielded pumice and volcanic cinder for lightweight aggregate, landscaping material, road base, and fill. Lesser quantities of volcanic cinder were used in the maintenance and repair of county, State, and Federal roads.

Five lode gold mines were active. The Siskon mine near Happy Camp yielded a high percentage of the lode gold and silver produced. Ore from this mine was cyanided to recover the precious metals. The operator stripped about 50,000 tons of waste from the open pit deposit and completed 300 feet of exploratory diamond drilling. Copper ores from the Cornucopia mine west of Callahan and a prospect on the Fay property southeast of Etna were shipped to the Tacoma (Washington) smelter for recovery of copper, gold, and silver. Except for two dragline operations near Happy Camp and one at Deadwood west of Yreka, placer gold and silver was produced by small-scale hand methods on the Klamath, Scott, and Salmon Rivers.

Solano.—A nearly 25-percent increase in volume of dry gas over 1959 was due largely to an average of 24 more producing wells and three new gas discoveries. G. E. Kadane & Sons made a new field (Bunker) discovery June 4 with a gas well completion 2.5 miles northwest of the Maine Prairie gasfield. Initial flow was 3,425,000 cubic feet from a depth of 6,831 feet. On July 16 Standard Oil Co. of California made a new gas pool discovery in the Cache Slough gasfield. Production came from a 2-foot interval at 5,341 feet with an initial flow of 3,850,000 cubic feet daily. Reserve Gas & Oil Co. completed a gas well on December 15 about 2.5 miles north of the Cache Slough gasfield reported as a new gasfield (Liberty Island). Initial flow from three producing intervals was reported at 3,900,000 cubic feet daily through a three-eighth-inch bean with a pressure of 1,400 pounds per square inch. The first crude oil production in the Sacramento Valley was recorded in the Winters gasfield by Texaco, Inc. The well was originally completed as a gas well near the 5,000-foot depth in Cretaceous sands but later began producing oil at an average rate of 79 barrels daily. A second test of the same zone found gas that flowed at an initial daily rate of 2,970,000 cubic feet. The Rio Vista gasfield in Solano and Sacramento Counties had the largest production in the State, yielding 187 million cubic feet per day, 19 million cubic feet more than in 1959.

Basalt Rock Co., Inc., the leading producer of expanded shale in the State, mined raw material from the Chabot pit near Vallejo and furnaced it for use as lightweight aggregate. Basalt Rock obtained some raw material in excavating a road to a new shale source in Napa County. The tonnage of stone quarried near Benicia, Vallejo, Suisun, and Thomasson was substantially above that of 1959 because of extensive requirements for 4- and 6-lane highways near the quarry

sites. Sand and gravel was produced near Vacaville and Winters; however, much of the material for paving projects, particularly sand, was supplied by producers outside the county.

A comparatively small quantity of mercury was recovered from ore mined at the Brownlie property near Vallejo.

Sonoma.—Sand and gravel production for building and road construction increased about 500,000 tons over 1959. An appreciable part of the total output came from stream-bed deposits along the Russian River in the Cloverdale, Healdsburg, Windsor, and Mirabel Park areas. Basalt Rock Co., Inc., the county's major sand and gravel producer, supplied most of the aggregate used in freeway construction near Healdsburg. Road projects near Santa Rosa, Jenner, and Monte Rio, and school and residential construction were major markets for sand and gravel and stone. Stone quarries in the southern part of the county near Forestville, Occidental, Petaluma, and Sonoma were the principal sources for riprap in levee embankments and base material in roads. Dimension stone was quarried near Glen Ellen for building and wall rock, and flagging. Shale from the Mark West quarry near Santa Rosa was used as fill.

Three mercury mines were worked during the year; the Mt. Jackson, near Guerneville; the Culver-Baer (Buckman), in the Geyser area; and the Mercury Bank, near Healdsburg. The Mount Jackson mine was the State's second largest mercury producer. The Buckman mine was sold in April to Alex Rorabaugh and Swen Gummer of Cloverdale by Buckman Laboratories, Inc.

Although one potential producing well was added to the Petaluma gas field in 1960, as in 1959 an average of only three gas wells produced during the year. However, dry-gas output rose 30 percent.

Stanislaus.—The tonnage output of sand and gravel increased compared with 1959, chiefly to supply aggregate for building and paving projects in Stanislaus County and adjacent counties. Production came mainly from fixed and portable plants along the Tuolumne River near Modesto, Hughson, and Waterford; the Stanislaus River near Riverbank, Oakdale, and Knights Ferry; and Orestimba Creek near Newman. Dimension stone for building construction was quarried near Knights Ferry. Ball clay, fire clay, and miscellaneous clay were mined by E. H. Metcalf near Oakdale, Western States Minerals Co. and Clayton & Lester Raggio in the Knights Ferry area, and Kraftile Co. near LaGrange. The clays were used in sanitary ware, pottery, stoneware, heavy clay products, and rotary drilling muds.

Manganiferous ore from the Buckeye mine in the Mount Oso area was shipped to an Arizona mill for upgrading and eventual consumption by a California steel producer. Cinnabar ore from the Adobe underground mercury mine near Patterson was retorted to yield a small quantity of the metal. Virtually all the gold and silver were recovered as byproducts at a sand and gravel dragline operation on the Tuolumne River southeast of Waterford.

Sutter.—A slight increase in natural gas output over 1959 was attributed to two new gas discoveries late in the year. Buttes Gas & Oil Co. discovered the Natomas gasfield near the Sacramento County line with a well completion on December 1. Production was reported from Cretaceous sands at 3,240 feet with an initial flow of 800,000

cubic feet daily. On November 21, Atlantic Oil Co. made a new gas pool discovery in the Grimes field. The well was drilled to a depth of 8,020 feet with production at 6,760 feet, also in Cretaceous sands. Daily initial flow was reported at 5,250,000 cubic feet. Despite these discoveries the average number of producing gas wells was one less than in 1959 although the number of potential producers increased by two.

Most of the sand and gravel required for use in the county that had to meet State specifications was obtained from neighboring counties, principally from producers along the Yuba River in Yuba County. Output in Sutter County was limited chiefly to sand and gravel produced from volcanic detritus deposits near Sutter Buttes. Lesser quantities of these materials were obtained at Shanghai Bend on the Feather River near Yuba City and from stream bed gravels of the Bear River near Nicolaus. Stone for road base was quarried near Sutter Buttes by county road crews. Gladding, McBean & Co. dug clay near Nicolaus and used it in manufacturing vitrified sewer pipe.

Tehama.—Public works projects, including roads and structures for the Bureau of Reclamation and the U.S. Army Corps of Engineers, required more than 650,000 tons of sand and gravel. Much of the production was supplied by operators along the Sacramento River near Red Bluff, at Elder Creek near Gerber, and on Thomas Creek near Richfield. Miscellaneous stone was quarried and prepared for use as riprap and roadstone by crews and contractors for the U.S. Forest Service. Crews of State and Federal agencies mined volcanic cinder used in road construction.

On April 2, Buttes Gas & Oil Co. made a new shallower pool gas discovery in the northeast part of the Corning gas field. The well, the shallowest ever drilled in the area, produced from the 1,086 to 1,101 interval in Tehama B sands of Pliocene age. This sand had been noted previously in nearby wells but had never been opened to production. Initial flow from the discovery well was 8 million cubic feet of 720 B.t.u. gas through a 1-inch bean. Later, Superior Oil Co. recompleted two wells in the same pool. An average of one less producing well yielded 6 percent less natural gas than in 1959, yet the number of potential producers at yearend 1960 had been increased by five.

A relatively small tonnage of maganiferous ore was upgraded in an Arizona mill and sold to a California steel plant.

Trinity.—Most of the sand and gravel and stone produced was utilized in realinement of highways and as riprap and surface rock at the Trinity Dam. The dam reached its ultimate height of 537 feet during the year, making it the highest earthfill dam in the world. Other construction features of the $257 million project, such as powerplants and tunnel linings, also required substantial tonnages of concrete aggregate. These materials were supplied by Government contractors and a commercial preparation plant at Weaverville. Riprap was produced from a stone quarry near Island Mountain for railroad embankments. Volcanic cinder was mined in the National Forest for use in road construction.

Although the Altoona mine in the Castle Creek area was the major source of mercury, ore from the nearby Hub property was retorted

to recover a small quantity of the metal. Ores from prospects near Junction City and southeast of Hayfork yielded a few ounces of gold and silver. A suction dredge was operated on the north fork of the Trinity River upstream from Helena, and stream-bed gravels of Crow Creek in Cinnabar Gulch were worked by hydraulicking; however, a high percentage of the placer gold and silver was recovered by prospectors, using small-scale hand methods.

Tulare.—The output of natural (dry) gas was down 1 percent and that of petroleum was up 2 percent compared with 1959. An average of five more gas wells were producing in 1960, but the average number of producing oil wells remained unchanged. Production came from the Trico gasfield, lying partly in Kern and Kings Counties, and the Deer Creek oilfield.

Substantial tonnages of sand and gravel and stone were used in constructing the Terminus Dam near Lemon Cove and the Success Dam near Porterville, and related construction projects including relocation of roads. Virtually the entire stone output used for riprap, fill, and road base was quarried by Government contractors from deposits near the projects sites. Commercial sand and gravel preparation plants in the Lemon Cove, Porterville, and Woodlake areas supplied a large percentage of the asphalt and concrete aggregate used in roads and structures at the dams, as well as material for highway construction in the Visalia and Strathmore areas. S. P. Brick Co. dug miscellaneous clay near Exeter for use in its Fresno County brick plant.

Barite was mined from the Macco Corp. property in 9-mile Canyon and the nearby deposit of Southwest Minerals, Inc. Most of the crude mineral from both mines was processed at the Macco plant at Rosamond, Kern County. A lesser tonnage of the raw mineral was upgraded before shipment by jigging by Macco Corp. at Linnie Station, Inyo County.

Tuolumne.—A relatively large tonnage of granite was excavated from the Cherry Reservoir tunnel and crushed for concrete aggregate and road base by contractors for the Hetch Hetchy water and power project. Quarries near Twain Harte, Strawberry, and Buck Meadows supplied stone used for riprap, aggregate, roadstone, and roofing granules. Several stone quarries near road projects of Federal agencies were worked by Government crews and contractors for riprap and other road construction uses. Limestone from the Sonora quarry was used in sugar refining, animal feeds, manufacture of paper and lime, and for various other purposes. The Columbia limestone quarry was idle. Marble quarried in the Sonora area was crushed for terrazzo. Portable plants along the Tuolumne River prepared sand and gravel for use in paving sections on State Highways 108 and 120. U.S. Lime Products Division, The Flintkote Co., operated three shaft-type kilns, one rotary kiln, and a batch hydrator at Sonora and produced quicklime and hydrated lime for various chemical and industrial uses, including agriculture and the building trades.

The Fenton group of claims and the Toughnut prospect near Big Oak Flat yielded comparatively small tonnages of gold ore containing recoverable gold and silver.

Ventura.—Crude oil and natural (wet) gas production declined 6 and 5 percent, respectively, despite a rise in average number of producing oil wells from 3,020 in 1959 to 3,079. Two new oil pool discoveries were made during the year, both by Texaco, Inc. The first resulted from a well completion on July 4 in the Bardsdale oilfield with an initial daily flow of 258 barrels of 32.4° API gravity and 202,000 cubic feet of wet gas. The second was made in the Shields Canyon oilfield on October 3 when the Shields No. 202 well was brought in. This well produced from a 123-foot interval beginning at 7,171 feet. The initial daily flow was 565 barrels of 31.8° API gravity oil and 243 thousand cubic feet of wet gas. In the Saticoy oilfield, Shell Oil Co. extended production limits about 2,000 feet to the northeast, and Union Oil Co. extended the productive limits of the Bardsdale oilfield 700 feet to the west when it completed a 140-barrel-a-day pumper. Richfield Oil Corp. completed a development drilling program on its offshore man-made island in the Rincon oilfield, with 46 directionally drilled wells. A unitized waterflooding program was begun in the Oligocene zone of the Shields Canyon field. The number of refineries remained unchanged, with two asphalt and one skimming and asphalt at Oxnard, and one skimming plant at Ventura. The number of natural gasoline and cycle plants increased by one when Richfield Oil Corp. completed its Rincon Island No. 24 near Ventura. Output of natural gas liquids from these plants was virtually unchanged for natural gasoline and cyclic products but declined 26 percent for LP-gas from 1959. Dry-gas production, from one less producing well, decreased 13 percent. Near the beginning of the year a 10-inch, 12-mile, cement-lined waste-water line was completed between the Saticoy oilfield and the City of Oxnard industrial waste plant. The cost was approximately $475,000; brine capacity was 6,000 barrels daily. The participating companies were Shell Oil Co., Socony Mobil Oil Co., Inc., and The Superior Oil Co.

Stone was quarried near Camarillo and Oxnard for riprap used principally in the construction of a breakwater near Ventura, material in levees and enbankments along the Santa Clara River, and base material in road construction. Explosives, a ripper, and a tractor were used to mine decomposed oystershell at the Tapo Alto quarry near Santa Susana. The material was prepared for use as an ingredient in fertilizers, a mineral filler in animal feeds, and poultry grit. Dimension sandstone was quarried near Ojai for rubble and flagging. Sand and gravel preparation plants in the El Rio, Saticoy, and Santa Paula areas, supplied much of the concrete aggregate used at the Naval Missile Center, Point Mugu for runways, streets, and roads. Ridgelite Products, Inc., and Rocklite Products, Inc., produced lightweight aggregate shale from shale mined near Frazier Park and Ventura, respectively. Monolith Portland Cement Co. quarried gypsum from its Cuyama deposit 25 miles south of Maricopa and consumed the crude mineral in its Kern County cement plant.

Yolo.—Most of the sand and gravel produced was used in constructing and maintaining State and county roads, and city streets. The major producers operated fixed preparation plants along Cache Creek in the Madison and Woodland areas, near most of the paving projects.

Some of the sand and gravel was used by crews and contractors for Solano and Sutter County road agencies.

A more than 12–percent volume increase in natural (dry) gas output compared with 1959, was attributed to an average of four more producing wells, and to a new pool discovery by Artnell Co. in the Dunnigan Hills gasfield. The discovery resulted from a well completion on May 4 that produced from two intervals: The Sub-Hermle pool at 3,064 to 3,065 feet and the Forbes pool at 3,077 to 3,087 feet. Initial daily flow from the Sub-Hermle pool was 1,690,000 cubic feet and that from the Forbes pool, 2,250,000 cubic feet.

The Reed mine, near the county line west of Rumsey, yielded cinnabar ore that was retorted to recover more than 100 flasks of mercury. Activity at this mine had been limited to exploration in 1959.

Yuba.—California's major placer-gold operation was that of Yuba Gold Fields Division, Yuba Consolidated Industries, Inc., which operated four bucketline dredges on the Yuba River near Marysville. A high percentage of the placer gold, silver, and platinum recovered in the State was credited to this operation. Electrosonic Mining & Equipment Co. operated an electrostatic unit in the same area on dredge tailings and recovered gold and silver. Henry M. Michael operated a nonfloat washing plant on placer tailings at Rock Island Bar, 10 miles east of Challenge, and recovered a few ounces of gold and silver. Numerous prospectors worked stream gravels by small-scale hand methods in the Brownsville, Camptonville, and Smartville areas and produced relatively small quantities of placer gold and silver. Virtually all lode gold and silver produced in the county was recovered by amalgamation and flotation from ores of the Browns Valley group of claims (Dannebroge mine), in Browns Valley. The flotation concentrate also contained recoverable copper.

Sand and gravel produced from stream-bed gravels and dredge tailings along the Yuba River near Marysville was prepared in portable and fixed plants, principally for concrete aggregate and road base. Some river sand was prepared for blast, engine, filtration, and stock car uses. A contractor supplied the U.S. Army Corps of Engineers with riprap for levees and embankments. Gladding, McBean & Co. mined miscellaneous clay near Wheatland that was used by the producer in manufacturing sewer pipe.

The Mineral Industry of Colorado

By M. H Howes [1]

A HIGHER output of petroleum—Colorado's major mineral product—together with a substantial increase in metals production offset a decrease in nonmetals yield; the overall mineral value for the State reached a new record in 1960. Minerals produced were valued at $342.2 million, 9 percent above the $314.7 million value in 1959 and $3.7 million greater than the 1957 record of $338.5 million. The principal commodities in the metals group again were molybdenum and uranium; the primary nonmetals were cement and sand and gravel.

Mineral fuels represented 52 percent of the value of mineral production—3 percent more than in 1959. Petroleum, which supplied 40 percent of the total value, increased 2 percent both in quantity and value of production as the result of an extensive secondary-recovery program at several Colorado fields and new production from the Denver-Julesburg basin. Coal production rose 10 percent because of an increase in electric power generation and a greater demand for Colorado coal in the Utah steel industry. The $21.1 million value for coal represented 6 percent of the value of the State's mineral production.

Metals furnished 36 percent of the value of minerals production—26 percent more than in 1959—and increased in value from $97.3 million in 1959 to $122.5 million in 1960.

Prices of copper, lead, and zinc were higher than in 1959. A decrease in zinc production was offset by a substantial increase in output of copper, lead, and silver, and a slightly higher output of gold. The total value of these five metals was $18 million, a gain of 11 percent over 1959, compared with an 8-percent decrease from 1958 to 1959.

The most significant declines in output and value among the 14 nonmetals produced in Colorado were in commodities most important to the construction industry, specifically cement, sand and gravel, and stone. Nonmetals production, 10 percent below the 1959 value, supplied 12 percent of the value of all minerals produced.

Production started at the Camp Bird mine and mill in Ouray County during October 1960 after 4 years of development and construction.

American Smelting and Refining Co. (Asarco) announced that its Arkansas Valley lead smelter at Leadville would be shut down early in 1961 because of a decreasing ore supply.

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

TABLE 1.—Mineral production in Colorado [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate—short tons, gross weight	[2] 221	[2] $67	304	$53
Carbon dioxide (natural)—thousand cubic feet	175,223	13	155,871	20
Clays—thousand short tons	417	1,160	490	1,424
Coal—do	3,294	21,034	3,607	21,090
Copper (recoverable content of ores, etc.)—short tons	2,940	1,805	3,247	2,085
Gem stones	([3])	43	([3])	45
Gold (recoverable content of ores, etc.)—troy ounces	61,097	2,138	61,269	2,144
Gypsum—thousand short tons	106	385	82	296
Iron ore (usable)—thousand long tons, gross weight	11	78	11	80
Lead (recoverable content of ores, etc.)—short tons	12,907	2,969	18,080	4,231
Manganese ore and concentrate (35 percent or more Mn)—short tons, gross weight	1,218	102	----------	----------
Mica: Scrap—short tons	68	1	340	4
Natural gas—million cubic feet	99,899	10,989	107,404	12,781
Natural-gas liquids:				
Natural gasoline—thousand gallons	47,424	2,811	73,179	4,138
LP gases—do	77,637	3,671	104,275	4,938
Peat—short tons	6,674	35	9,384	37
Petroleum (crude)—thousand 42-gallon barrels	46,440	134,676	[4] 47,165	[4] 136,779
Pumice—thousand short tons	40	66	32	70
Rare-earth metals and thorium concentrates—short tons	9	1	----------	----------
Sand and gravel—thousand short tons	20,897	18,817	19,053	16,882
Silver (recoverable content of ores, etc.)—thousand troy ounces	1,341	1,213	1,659	1,502
Stone—thousand short tons	2,824	5,537	2,442	4,651
Tin (content of concentrate)—long tons	50	60	10	12
Uranium ore—short tons	1,044,089	22,546	1,149,583	23,462
Vanadium—thousand pounds	5,897	([5])	8,053	([5])
Zinc (recoverable content of ores, etc.)—short tons	35,388	8,139	31,278	8,070
Value of items that cannot be disclosed: Cement, feldspar, fluorspar, lime, molybdenum, perlite, pyrites, salt, tungsten concentrate, and values indicated by footnote 5	----------	[2] 79,216	----------	99,743
Total Colorado [6]	----------	[2] 314,677	----------	342,223

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Revised figure.
[3] Weight not recorded.
[4] Preliminary figure.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime

To replace or expand existing equipment, the Colorado Fuel and Iron Corp. (CF&I) started installation of new oxygen steelmaking facilities at Pueblo capable of producing 600,000 tons of steel per year.

American Gilsonite Co. announced plans to double its plant capacity at Fruita.

An application by Public Service Co. of Colorado (PSC) for permission to store natural gas in the abandoned Leyden coal mine near Denver, to relieve peak loads in the Denver metropolitan area, was approved by the Oil and Gas Conservation Commission of Colorado September 30, 1960.

Research in rock mechanics as applied to ground control was conducted at the Denver Mining Research Center of the Federal Bureau of Mines. A report [2] on geologic factors related to block caving was published.

[2] Wilson, E. D., Geologic Factors Related to Block Caving at San Manuel Copper Mine, Pinal Couty, Ariz., 2. Progress Report, April 1956–March 1958: Bureau of Mines Rept. of Investigations 5561, 1960, 43 pp.

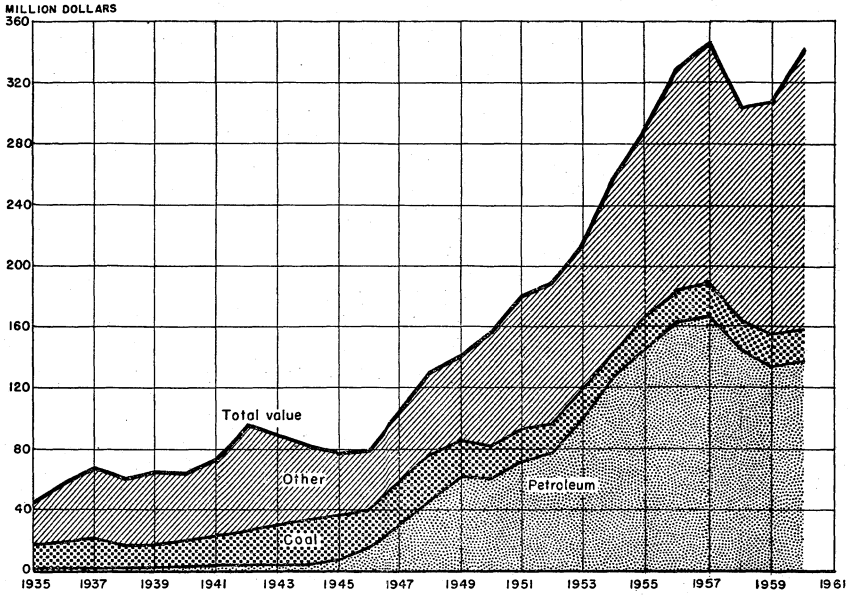

FIGURE 1.—Value of petroleum and coal and total value of all minerals produced in Colorado, 1935–60 (excludes uranium 1941–55).

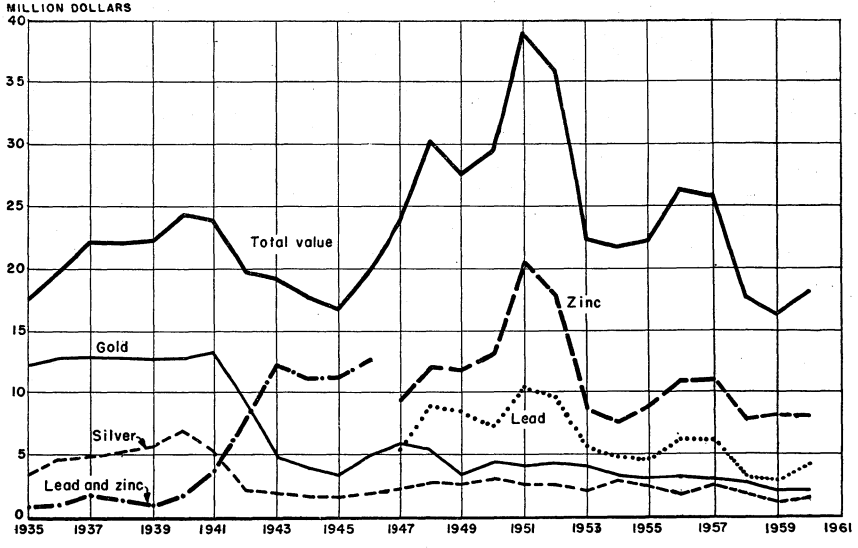

FIGURE 2.—Value of mine production of gold, silver, lead, and zinc and total value of these minerals (including copper) in Colorado, 1935–60.

Employment and Injuries.—Preliminary employment and injuries data (excluding the petroleum industry) are shown in table 2. The coal and coke industry contributed 30 percent of the total man-hours worked and 2 of the 10 fatal injuries in Colorado's mineral industry.

TABLE 2.—Employment and injuries in the mineral industries [1] in 1960 [2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
Nonferrous mines and smelters (excluding uranium)	91	1,707	2,944,928		196	66.6
Uranium	422	3,065	5,893,272	6	218	38.0
Ferrous	5	1,268	3,608,008		70	19.4
Sand and gravel	207	1,366	2,058,209		27	13.1
Stone	89	621	1,204,219		26	21.6
Other nonmetals	121	599	923,568	2	42	47.6
Coal and coke	120	2,838	7,038,004	2	152	21.9
Total	1,055	11,464	23,670,208	10	731	31.3

[1] Excludes petroleum.
[2] Preliminary figures.

The uranium industry accounted for 25 percent of the total man-hours worked and 6 of the 10 fatalities.

Legislation and Government Programs.—Exploration for copper-lead-zinc was continued by Clear Creek Mining Co. at Idaho Springs, Clear Creek County, under an Office of Minerals Exploration (OME) contract executed in 1959. No OME contracts were executed in Colorado in 1960.

A small quantity of high-grade beryllium concentrate mined in the State was shipped to the Government purchase depot at Custer, S. Dak.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt and Related Bitumens.—Gilsonite from Utah continued to be processed by American Gilsonite Co. at its plant near Fruita. The company announced plans to double the plant capacity by installing additional dewatering facilities, another coking furnace and steam boiler, tanks, flotation cells, increased power facilities, and an additional railroad spur. A fuel oil equal to or superior to similar oils derived from crude petroleum, for use in diesel-powered locomotives, was developed by the company. The use of this oil in locomotives between Denver and Salt Lake City, Utah, was particularly economical to the Denver & Rio Grande Western Railroad because the plant, approximately halfway between the cities, relieved the railroad of providing large diesel-fuel storage facilities at these terminals.

Carbon Dioxide.—Carbon dioxide production, from wells in Las Animas and Montezuma Counties, decreased 11 percent. The gas was transported through pipelines to plants in Bent and Montezuma Counties where it was processed into dry ice and liquid carbon dioxide. In Jackson County the carbon dioxide from oil wells was vented.

Coal.—An increase of 10 percent in the production of coal resulted from greater electric power generation and larger consumption of Colorado coal in the Utah steel industry. In December, CF&I permanently closed its Frederick mine and curtailed production from its Allen mine (both in Las Animas County). Two basic oxygen con-

TABLE 3.—Coal production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1959		1960	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Delta	69,548	$5.18	69,893	$5.37
El Paso	4,392	7.51	[2] 667,106	[2] 7.25
Fremont	280,113	3.57	299,027	3.55
Garfield	16,767	6.19	14,798	7.50
Gunnison	262,931	5.73	270,640	5.51
Huerfano	59,744	5.98	60,352	6.36
Jackson	119,759	2.18	169,903	[3]
La Plata	28,015	4.61	30,646	4.17
Las Animas	693,406	11.91	697,598	9.25
Mesa	[4] 88,677	5.95	107,197	5.46
Moffat	[4] 480,860	[4] 7.19	[2]	[2]
Montrose	[4]	[4]	[2]	[2]
Pitkin	[4]	[4]	[2]	[2]
Rio Blanco	10,840	6.14	11,106	4.99
Routt	397,279	3.75	467,515	4.03
Weld	781,811	4.45	741,505	4.34
Total	3,294,142	6.39	3,607,286	5.85

[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 El Paso County to avoid disclosing individual company confidential data.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Production of Montrose and Pitkin Counties combined with Moffat County to avoid disclosing individual company confidential data.

verters were being installed at the CF&I Pueblo plant. A new technique in blast-furnace operation was started wherein natural gas was used as a supplemental fuel to lower the quantity of coke required to reduce iron from the ore. Several power companies planned to use coal as a fuel in reported expansion of their power generating capacity.

The Federal Bureau of Mines continued its long-range investigations of coal use at its Denver Coal Research Laboratory. Studies included entrained-state carbonization of bituminous coal and lignites; coking properties of selected western coals; binderless briquetting of lignite; and staticbed, pressurized, and swept-bed carbonization assays. The research effort was concerned partly with the investigation of the yields and properties of low-temperature tar. A report [3] by a coal as a fuel in reported expansion of their power-generating staff member of the Denver Coal Research Laboratory was published.

Natural Gas.—The value of marketed natural gas from well in 16 counties and residual gas from natural gasoline plants in 8 counties increased 16 percent. New gas discoveries were made in 14 fields in 9 counties. The gas was piped to consumers.

On September 30, the Oil and Gas Conservation Commission of Colorado granted approval to Public Service Co. of Colorado (PSC) to use the abandoned Leyden coal mine 7 miles northwest of Arvada for natural gas storage—a measure to augment the supply of gas dur-

[3] Gomez, Manuel, Pyrolysis of Coal: Ind. and Eng. Chem., vol. 52, August 1960, pp. 717–720.

ing the peak-use consumer demand from the Denver metropolitan area. In its testing program, PSC theorized that 3 billion feet of gas could be stored safely in the cavity at a pressure of 300 pounds per square inch. As of September 30, testing, in progress since September 1959, continued with the injection of 350 million cubic feet of gas at a pressure between 100 and 200 pounds per square inch.

Natural Gas Liquids.—Natural gasoline, propane, and butane were recovered from wet petroleum gases at plants in Adams, La Plata, Logan, Moffat, Morgan, Rio Blanco, Washington, and Weld Counties. The quantity of natural gasoline recovered was 54 percent greater than in 1959; the quantity of propane and butane recovered increased 34 percent.

Peat.—Peat humus production, from Boulder, Gilpin, and Teller Counties, increased 41 percent. The peat was used as an admixture in fertilizers and as a soil conditioner.

Petroleum.—Production of petroleum, from 237 fields in 18 counties, increased 2 percent, thus reversing a downward trend. Waterflood projects together with new production from the Denver-Julesburg basin supplied the increase. The extensive secondary-recovery program by waterflooding and gas injection at the Rangely field continued as planned. Although production was 3 percent less than in 1959, the output of 17 million barrels from the field furnished 36 percent of the petroleum produced in the State. The Adena field in Morgan County, second only to Rangely, produced 7.6 million barrels, a gain of 16 percent. The gain was attributed mainly to waterflooding. More than 40 million barrels of petroleum had been produced from the Adena field since its discovery in 1953. Increased production from other fields was attributed largely to secondary recovery. Waterflooding was being conducted at 18 eastern Colorado fields at yearend and had been approved, but not started, at 6 other fields.

TABLE 4.—Crude petroleum production, by counties[1]

(Thousand barrels)

County	1959	1960[2]	Principal fields in 1960 in order of production
Adams	672	936	Badger Creek, Middlemist, Beacon.
Archuleta	113	102	Price Gramps.
Bent	1	8	McClave.
Boulder	2	2	Boulder.
Fremont	39	27	Florence-Canon City.
Jackson	934	848	McCallum, South McCallum, Battleship.
Jefferson	1	----	
Kiowa	2	8	Brandon.
La Plata	20	21	Red Mesa.
Larimer	192	191	Fort Collins, Wellington.
Logan	5,259	4,554	Cliff, Northwest Graylin, Yenter, Lewis Creek, Dune Ridge.
Moffat	1,292	1,810	Powder Wash, Danforth Hills, Iles.
Montezuma	106	79	Towaoc. Flodine Park.
Morgan	8,628	9,241	Adena, Bijou, Sand River, Zorichak, West Bijou.
Prowers	1	----	
Rio Blanco	20,499	19,676	Rangely, Wilson Creek.
Routt	113	106	Tow Creek, Sage Creek.
Washington	6,798	7,980	Little Beaver, Plum Bush Creek, Big Beaver.
Weld	1,768	1,574	Pierce, Black Hollow, New Windsor.
Yuma	----	2	Laird.
Total	46,440	47,165	

[1] Based on Colorado Oil and Gas Conservation Commission county data adjusted to Bureau of Mines total.
[2] Preliminary figures.

TABLE 5.—Wildcat- and development-well completions in 1960, by counties

County	Crude	Gas	Dry	Total	Footage	County	Crude	Gas	Dry	Total	Footage
Wildcat:						San Miguel	[1] 1	2	6	9	86,300
Adams	[1] 2	2	10	14	82,200	Washington	5	1	51	57	279,600
Alamosa	----	----	1	1	6,100	Weld	1	1	9	11	63,100
Arapahoe	----	----	1	1	5,700	Yuma	1	----	4	5	27,700
Archuleta	----	----	2	2	1,400						
Baca	----	1	7	8	45,800	Total	[2] 24	23	311	358	1,755,200
Bent	1	----	11	12	62,100						
Boulder	1	----	2	3	16,200	Development:					
Cheyenne	----	----	1	1	5,300	Adams	3	----	11	14	84,100
Crowley	----	----	1	1	6,300	Archuleta	2	----	----	2	2,200
Dolores	----	----	2	2	15,300	Baca	----	----	4	4	14,300
Fremont	----	----	3	3	1,800	Bent	----	----	2	2	10,100
Garfield	----	4	9	13	57,500	Fremont	----	----	8	8	21,400
Grand	----	----	2	2	5,400	Garfield	----	2	3	5	22,100
Gunnison	----	----	1	1	5,100	Jackson	[3] 10	----	1	11	65,800
Huerfano	----	----	2	2	5,000	Kiowa	----	7	4	11	54,600
Jackson	----	----	3	3	16,900	La Plata	----	49	7	56	326,900
Kiowa	----	----	5	5	26,800	Larimer	2	----	----	2	9,600
La Plata	----	2	8	10	53,100	Logan	16	4	11	31	158,700
Larimer	1	----	----	1	3,200	Mesa	----	4	2	6	34,200
Las Animas	----	----	2	2	5,600	Moffat	8	4	6	18	89,700
Logan	1	----	38	39	204,100	Montezuma	----	1	7	8	30,700
Mesa	----	1	2	3	18,800	Morgan	14	1	23	38	227,600
Moffat	2	2	17	21	131,300	Prowers	----	----	1	1	5,100
Montezuma	1	----	32	33	64,900	Rio Blanco	19	18	19	56	192,600
Montrose	----	----	3	3	11,200	Routt	4	----	2	6	26,000
Morgan	[1] 4	----	30	34	190,900	Sedgwick	----	1	1	2	7,500
Otero	----	----	1	1	5,900	Washington	24	2	35	61	298,400
Ouray	----	----	1	1	4,400	Weld	1	----	4	5	32,700
Pitkin	----	----	1	1	5,000	Yuma	1	----	----	1	5,700
Prowers	----	----	2	2	10,400						
Pueblo	----	----	1	1	2,200	Total	[3] 104	93	151	348	1,720,000
Rio Blanco	2	7	30	39	175,000						
Routt	1	----	9	10	37,300	Total all drilling	[4] 128	116	462	706	3,475,200
Saguache	----	----	1	1	10,300						

[1] Includes 1 condensate-well completion.
[2] Includes 3 condensate-well completions.
[3] Includes 6 condensate-well completions.
[4] Includes 9 condensate-well completions (3 wildcat, 6 development).

Source: Oil and Gas Journal.

Total drilling declined from 809 completions and 4.2 million feet in 1959 to 706 completions and 3.5 million feet. During 1960 there were 24 oil and 23 gas-well discoveries. Development drilling resulted in 104 oil and 93 gas wells. More than half of the successful exploratory and development wells were drilled within the Denver-Julesburg basin.

Shale Oil.—Two publications [4] describing investigations of oil shale were released.

METALS

Beryllium.—Increasing interest in beryllium resulted in a 38-percent increase in sales of beryllium concentrate. A 21-percent decline in the value of production was caused by a decrease from 7.73 to 5.66 percent in the average BeO content of the concentrate. All of the concentrate containing plus-8-percent BeO came from pegmatites in

[4] Matzick, Arthur, Dannenberg, R. O., and Guthrie, Boyd, Experiments in Crushing Green River Oil Shale: Bureau of Mines Rept. of Investigations 5563, 1960, 64 pp.
Stanfield, K. E., Smith, J. W., Smith, H. N., and Robb, W. A., Oil Yields of Sections of Green River Oil Shale in Colorado, 1954–57: Bureau of Mines Rept. of Investigations 5614, 1960, 186 pp.

Larimer, Chaffee, Fremont, Mesa, Park, Gunnison, and Jefferson Counties. Virtually all the minus-8-percent concentrate was produced by U.S. Beryllium Corp. from its Boomer Lode and Redskin mine, both in the Badger Flats area, Park County. In the past the Government purchase depot at Custer, S. Dak., was the principal market for beryl with a minimum BeO content of 8 percent. In 1959, the purchase depot received 123 tons of the 221 tons of concentrate produced. Output for 1960 was 265 tons of minus-8-percent BeO and 39 tons of plus-8-percent BeO concentrates. Of the 1960 production, only 14 tons of plus-8-percent BeO material was shipped to Custer; the remainder was purchased by Mineral Concentrates & Chemical Co., Inc. (Mincon), Loveland, and Beryl Ores Co., Arvada. Both of these companies were equipped to process beryllium ore or concentrate, even in small lots.

A beryllium occurrence in Larimer County was described.[5]

Cadmium, Indium, and Thallium.—Asarco recovered cadmium, indium, and thallium from flue dust, dross, and other byproduct material shipped from other company smelters to its Globe smelter at Denver.

Copper.—Production of copper increased 10 percent, and its value increased 16 percent compared with that of 1959. The principal copper producer in the State was the Idarado Mining Co. that operated

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)
1951–55 (average)	146	19	1,243	109,008	$3,815	2,798	$2,533
1956	124	18	1,156	97,668	3,418	2,285	2,068
1957	115	16	1,111	87,928	3,078	2,788	2,523
1958	91	17	869	79,539	2,784	2,056	1,860
1959	65	16	769	61,097	2,138	1,341	1,213
1960	70	15	809	61,269	2,144	1,659	1,502
1858–1960			(3)	40,546,571	913,007	766,501	600,220

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	3,721	$2,176	23,157	$7,094	43,445	$12,586	$28,204
1956	4,228	3,594	19,856	6,235	40,246	11,027	26,342
1957	5,115	3,079	21,003	6,007	47,000	10,904	25,591
1958	4,193	2,206	14,112	3,302	37,132	7,575	17,727
1959	2,940	1,805	12,907	2,969	35,388	8,139	16,264
1960	3,247	2,085	18,080	4,231	31,278	8,070	18,031
1858–1960	299,031	94,089	2,761,323	327,289	1,924,856	358,124	2,292,729

[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.
[3] Data not available.

[5] Gilkey, M. M., Hyatt Ranch Pegmatite, Larimer County, Colo.: Bureau of Mines Rept. of Investigations 5643, 1960, 18 pp.

the Treasury Tunnel-Black Bear-Smuggler Union group of mines in the *Upper San Miguel* district, San Miguel County; production exceeded that of 1959 by 14 percent. The New Jersey Zinc Co., Empire Zinc Division, second to Idarado in output of copper, produced gold- and silver-bearing copper and lead-zinc ores from its

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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		6		1,225	$42,875	171	$155
Boulder	2	1	183	27	945	9,452	8,555
Clear Creek	7		6,165	694	24,290	13,347	12,080
Dolores	1		14,681	84	2,940	81,593	73,846
Eagle	1		187,758	4,616	161,560	579,144	524,155
El Paso			2	5	175	1	1
Gilpin	1	2	18	47	1,645	137	124
Gunnison	5		6,101	72	2,520	8,183	7,406
Hinsdale	2		5,002	39	1,365	8,547	7,735
Jefferson		3		716	25,060	123	111
Lake	6		7,962	329	11,515	14,151	12,807
Mineral	3		38,541	833	29,155	237,364	214,826
Moffat		1		5	175		
Montrose	1		1			7	6
Ouray	7		16,010	185	6,475	17,763	16,076
Park	4		177	16	560	804	728
Pitkin	1		56			427	386
Saguache	4		203	3	105	2,261	2,046
San Juan	5		39,861	1,206	42,210	50,284	45,510
San Miguel	3		432,953	19,576	685,160	631,193	571,262
Summit	5	2	273	62	2,170	1,041	942
Teller	12		52,797	31,529	1,103,515	3,044	2,755
Total:							
1960	70	15	808,744	61,269	2,144,415	1,659,037	1,501,512
1959	65	16	769,323	61,097	2,138,395	1,340,732	1,213,430

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Adams							$43,030
Boulder	1	$321	1	$269			10,090
Clear Creek	11	7,351	144	33,755	3	$877	78,353
Dolores	10	6,388	1,377	322,183	961	248,041	653,398
Eagle	448	287,873	4,477	1,047,688	16,022	4,133,715	6,154,991
El Paso							176
Gilpin	[3]	32	[3]	70			1,871
Gunnison	6	3,595	98	22,932	137	35,230	71,683
Hinsdale	[3]	257	3	655			10,012
Jefferson							25,171
Lake	22	14,381	188	43,898			82,601
Mineral	158	101,308	2,177	509,336	1,918	494,908	1,349,533
Moffat							175
Montrose	[3]	64					70
Ouray	35	22,181	260	60,758	222	57,173	162,663
Park	3	1,926	7	1,732	9	2,219	7,165
Pitkin	[3]	160	7	1,615	5	1,264	3,425
Saguache	2	1,124	10	2,235	10	2,696	8,206
San Juan	161	103,394	389	91,026	42	10,707	292,847
San Miguel	2,390	1,534,187	8,936	2,091,094	11,949	3,082,894	7,964,597
Summit	[3]	32	6	1,474			4,618
Teller							1,106,270
Total:							
1960	3,247	2,084,574	18,080	4,230,720	31,278	8,069,724	18,030,945
1959	2,940	1,805,160	12,907	2,968,610	35,388	8,139,240	16,264,835

[1] Operations at slag dumps and old mill or miscellaneous cleanups not counted as producing mines.
[2] Does not include gravel washed.
[3] Less than 1 ton.

Eagle mine in the *Red Cliff* district, Eagle County. Output decreased 36 percent below that of 1959 because of a strike at the mine that lasted from August 5 to November 25.

Gold.—Production of gold was 61,269 troy ounces valued of $2.1 million, about the same as in 1959. The leading producer was The Golden Cycle Corp. at its Ajax mine in *Cripple Creek* district, Teller County, followed by the Idarado Mining Co., at its Treasury Tunnel-Black Bear-Smuggler Union group of mines in *Upper San Miguel* district, San Miguel County. Other leading producers were The New Jersey Zinc Co. at its Eagle mine in *Red Cliff* district, Eagle County; and The United Gold Mines Co. at its United Gold mine and Deadwood Leasing Co. at its Free Coinage mine, both in *Cripple Creek* district, Teller County. Although gold was mined in 20 counties, 51 percent of the output came from 12 mines in Teller County.

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	18	53,465	31,829	5,770	8,900	7,100	1,300
Dry gold-silver	4	1,220	66	1,714	800	9,900	2,400
Dry silver	6	7,400	43	24,048	3,900	128,800	----------
Total	28	62,085	31,938	31,532	13,600	145,800	3,700
Copper	3	9,649	3,597	312,186	525,000	55,300	9,700
Copper-lead	3	37,999	954	42,006	311,000	684,700	56,700
Copper-lead-zinc	3	433,890	19,560	634,406	4,798,100	17,951,800	23,946,200
Lead	25	8,595	921	28,140	29,300	515,100	12,300
Lead-zinc	10	251,003	2,090	603,248	779,700	16,549,800	38,525,000
Total	42	741,136	27,122	1,619,986	6,443,100	35,756,700	62,549,900
Other "lode" material:							
Gold cleanings and mill cleanings	[2]	42	22	57	100	----------	----------
Gold tailings	1	201	32	153	----------	1,500	200
Lead cleanings and mill cleanings	[2]	23	7	295	500	8,200	----------
Lead slag	[2]	5,246	95	6,601	36,400	245,600	----------
Lead-zinc mill cleanings	[2]	11	2	95	300	2,200	2,200
Total	1	5,523	158	7,201	37,300	257,500	2,400
Total "lode" material	70	808,744	59,218	1,658,719	6,494,000	36,160,000	62,556,000
Gravel (placer operations)	15	----------	2,051	318	----------	----------	----------
Total, all sources	85	808,744	61,269	1,659,037	6,494,000	36,160,000	62,556,000

[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.

Iron Ore.—Brown iron ore (limonite) production remained virtually the same as in 1959. Brown ore for use in paint was mined at three properties: The Geneva mine in Clear Creek County by Stony Point Development, Inc., the South Mineral Placer in San Juan County by A. A. McCluskey, and the Iron Springs Placer in San Miguel County by C. K. Williams & Co. A small quantity was produced for use as a soil conditioner from Iron Lode No. 3 in San Miguel County by Theresa B. Robinson.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	5,591	1,883			
Old tailings	5	2			
Total	5,596	1,885			
Cyanidation:					
Ore	31,214	2,955			
Cleanings	5				
Total	31,219	2,955			
Total recoverable in bullion	36,815	4,840			
Concentration, and smelting of concentrates:					
Ore	18,290	1,312,128	5,917,600	35,580,800	62,542,600
Old tailings	27,	151		1,500	200
Total	18,317	1,312,279	5,917,600	35,582,300	62,542,800
Direct-smelting:					
Ore	3,965	334,552	539,100	321,700	11,000
Cleanings	26	447	900	10,400	2,200
Old slag	95	6,601	36,400	245,600	
Total	4,086	341,600	576,400	577,700	13,200
Placer	2,051	318			
Grand total	61,269	1,659,037	6,494,000	36,160,000	62,556,000

Company mines in Utah and Wyoming supplied iron ore for the Pueblo plant of CF&I. The corporation annual report for 1960 reported an operating loss, the first since 1946, owing to a sharp reduction in sales to the petroleum, railroad, and automobile industries, and other basic users of heavy-tonnage products, together with particularly strong foreign competition. New oxygen-steel converters capable of producing 600,000 tons of ingots annually were being installed at the Pueblo plant to improve productive efficiency.

Pitkin Iron Corp. produced iron ore from its property above Ashcroft in Pitkin County for testing at Columbia Iron Mining Co. (U.S. Steel) at Geneva, Utah.

Titaniferous iron deposits in Gunnison County were described.[6]

Lead.—The quantity and value of lead produced increased 40 and 43 percent, respectively. The weighted annual average price for lead was 11.7 cents compared with 11.5 cents in 1959. Lead was mined in 16 counties. Ninety-four percent of the Colorado lead output was supplied by the Treasury Tunnel-Black Bear-Smuggler Union group of mines of the Idarado Mining Co. in *Upper San Miguel* district, San Miguel County; the Eagle mine of The New Jersey Zinc Co. in *Red Cliff* district, Eagle County; the Emperius mine of Emperius Mining Co. in *Creede* district, Mineral County; and the Rico

[6] Rose, Charles K., and Shannon, Spencer S., Jr., Cebolla Creek Titaniferous Iron Deposits, Gunnison County, Colo.: Bureau of Mines Rept. of Investigations 5679, 1960, 30 pp.

Argentine mine of Rico Argentine Mining Co. in *Pioneer* district, Dolores County.

During October, Camp Bird Colorado, Inc., began treating ores at its new 500-ton-per-day flotation mill at the Camp Bird mine in Ouray County. Flotation products included silver-bearing copper-lead-zinc sulfide and zinc sulfide concentrates. In addition, free gold was recovered by jigging.

Asarco announced that it would suspend operations at its Leadville smelter early in 1961 because of a declining ore supply. The smelter had been in operation for 81 years. Ore-buying was to be continued and ores and concentrates were to be treated at company smelters at El Paso and Amarillo, Tex. The Asarco cadmium-producing Globe plant in Denver would not be affected.

Molybdenum.—Molybdenum was produced at the Climax mine in Lake County by Climax Molybdenum Co., Climax Division, American Metal Climax, Inc. The company annual report cited an output of 11,684,000 tons of ore, 28 percent above that of 1959, from which a record quantity of molybdenum was recovered. Byproducts recovered in treating molybdenum ore were tungsten, tin, and pyrite.

During the year, progress was made on the beginning phases of opening a new (third) level, 300 feet below the Storke level, for future ore development. The arrangement by which John W. Galbreath & Co. purchased company houses at Climax and Leadville for resale to company employees progressed during the year. It was estimated that it would take two more summers to move all the houses from Climax to Leadville.

Silver.—Silver production increased 24 percent, from 1.3 million troy ounces in 1959 to 1.7 million troy ounces. Leading producers, supplying 89 percent of the State's production, were Idarado Mining Co. from the Treasury Tunnel-Black Bear-Smuggler Union group of mines in *Upper San Miquel* district, San Miguel County; The New Jersey Zinc Co. from the Eagle mine in *Red Cliff* district, Eagle County; Emperius Mining Co. from the Emperius mine in *Creede* district, Mineral County; and Standard Metals Corp. from the Shenandoah mine in *Animas* district, San Juan County.

Tin.—Climax Molybdenum Co. marketed 10 long tons of tin concentrate produced from molybdenum flotation tailing at its Climax mill, compared with 50 long tons in 1959. However, the concentrate marketed in 1959 was the accumulation of production from 1956 through 1959.

Tungsten.—Tungsten was recovered by treating molybdenum flotation tailing from the Climax mill of Climax Molybdenum Co. Twenty-five percent less tungsten concentrate was marketed than in 1959, but the value decreased only 5 percent.

Tungsten mining and milling in Boulder County was described.[7]

Uranium.—Uranium ore production increased 10 percent over that of 1959. Because of a drop in the grade of the ore from 0.26 percent uranium oxide in 1959 to 0.25 percent in 1960, the value of production increased only 4 percent. Uranium ore was produced from 522 operations in 18 counties. Leading counties, all having a value of

[7] Belser, Carl, Tungsten Mining and Milling in Boulder County, Colo.: Bureau of Mines Inf. Circ. 7936, 1960, 54 pp.

output of over $1 million, in order of importance, were as follows: Montrose, San Miguel, Mesa, Moffat, Saguache, and Jefferson.

The upgrading plant at Slick Rock and processing mills in Gunnison, Grand Junction, Durango, Rifle, Uravan, Maybell, and Canon City continued to operate during the year. The Atomic Energy Commission (AEC) contract with Climax Uranium Co., Climax Division, American Metal Climax, Inc., for the purchase of concentrate was extended to December 31, 1966, or to a date determined by an earlier delivery of the maximum quantity provided by the contract. Early in 1960 the Cotter Corp. began expanding its Canon City mill to the 200-ton daily capacity authorized by AEC. AEC authorization also provided for processing of appropriate quantities of crude ore from qualified independent producers. A substantial part of the expanded plant was used in processing uranium ore mined by Denver-Golden Corp. from its Schwartzwalder mine in Jefferson County.

Two papers [8] on uranium in Colorado were published.

TABLE 10.— Mine production of uranium ore, by counties [1]

County	1959				1960			
	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	3	(3)	(3)	(3)	2	4,131	52,181	$238,088
Clear Creek					1	6	12	24
Fremont	13	13,826	73,394	$308,078	16	23,995	112,086	454,272
Gilpin	2	(3)	(3)	(3)	1	(3)	(3)	(3)
Gunnison	1	(3)	(3)	(3)	1	126	896	3,931
Huerfano	1	(3)	(3)	(3)				
Jackson					1	(3)	(3)	(3)
Jefferson	7	20,045	332,520	1,554,420	10	24,732	323,380	1,489,648
Las Animas					1	(3)	(3)	(3)
Mesa	80	145,205	826,660	3,490,693	80	120,438	723,380	3,054,964
Moffat	20	(3)	(3)	(3)	17	(3)	(3)	(3)
Montezuma					1	12	46	173
Montrose	260	449,422	2,415,038	9,986,967	285	509,338	2,595,272	10,710,253
Park	1	(3)	(3)	(3)	1	(3)	(3)	(3)
Pitkin					1	37	88	213
Pueblo	2	(3)	(3)	(3)	2	(3)	(3)	(3)
Rio Blanco	8	3,593	19,323	81,563	11	3,804	17,098	69,481
Saguache	8	134,547	462,586	1,554,929	6	172,468	534,349	1,621,188
San Juan	3	(3)	(3)	(3)				
San Miguel	99	161,756	833,327	3,445,449	85	182,776	894,968	3,686,954
Undistributed		115,695	526,499	2,123,523		107,720	517,240	2,133,111
Total	508	1,044,089	5,489,347	22,545,622	522	1,149,583	5,770,996	23,462,300

[1] Based on data supplied to the Bureau of Mines by the AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowance.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Vanadium.—Recovery of vanadium from uranium ores containing enough vanadium to cover the cost of treatment was made at four Colorado uranium-processing mills operated by the following: Climax Uranium Co., Grand Junction; Union Carbide Corp., Union Carbide Nuclear Co. Division, Rifle and Uravan; and Vanadium Corp. of America (VCA), Durango. Crude ore from mines in Colorado, New

[8] Redmon, D. E., Exploratory Drilling Practices and Costs at Western Uranium Deposits: Bureau of Mines Inf. Circ. 7944, 1960, 68 pp.
Soulé, J. H., Mining Methods and Costs, Schwartzwalder Uranium Mine, Jefferson County, Colo.: Bureau of Mines Inf. Circ. 7963, 1960, 24 pp.

Mexico, Arizona, Utah, and Wyoming was processed at these mills; the vanadium oxide recovered was credited to the State of origin. The quantity recovered from ores of Colorado was 37 percent greater than in 1959.

As high bidder for vanadium oxide offered for sale at Grand Junction by AEC, VCA purchased 1.6 million pounds for $1 per pound. In November AEC offered an additional 1.5 million pounds for sale; sealed bids were to be opened on January 25, 1961.

Zinc.—Zinc production declined 12 percent in quantity but only 1 percent in value. The weighted annual average price increased from 11.5 cents per pound in 1959 to 12.9 cents per pound. Of the zinc mined in Colorado, 99 percent was produced by the following companies: The New Jersey Zinc Co. from its Eagle mine in *Red Cliff* district, Eagle County; Idarado Mining Co. from the Treasury Tunnel-Black Bear-Smuggler Union group of mines in *Upper San Miguel* district, San Miguel County; Emperius Mining Co. from the Emperius mine in *Creede* district, Mineral County; and Rico Argentine Mining Co. from the Rico Argentine mine in *Pioneer* district, Dolores County.

NONMETALS

Cement.—Because of less construction in the areas served by Ideal Cement Co., the production of types I, II, III, and V portland and masonry cements was 15 percent under that of 1959. Four kilns, two at the Portland plant at Portland in Fremont County and two at the Boettcher plant at La Porte in Larimer County, were operated during the year. Seventy-two percent of the finished cement sold was transported by truck and the remainder by rail to purchasers in Kansas, Montana, Nebraska, New Mexico, Utah, and Wyoming, as well as to consumers in Colorado.

Clays.—A 7-percent increase in output of fire clay plus a 35-percent increase in output of miscellaneous clays resulted in an overall 18-percent advance in production of all types of clays mined. Of the total, fire clay amounted to 291,000 tons (59 percent); the remainder was comprised of miscellaneous clays and 1,000 tons of bentonite. Jefferson County continued to be the leading producer of fire clay and miscellaneous clays, followed by Boulder, Douglas, and Pueblo. The 300,000-cubic-yard-per-year shale-processing (lightweight aggregate) plant of Great Western Aggregates, Inc., subsidiary of Ideal Cement Co., was 75 percent complete at yearend.

Denver Fire Clay Co., producer of refractory products, completed a $335,000 modernization program at its Denver plant. A major part of the program was the construction of a shuttle-type kiln, the first step in remodeling the entire brick-firing system.

Feldspar.—Feldspar production continued to decline. M. & S., Inc., the one remaining producer in the State, continued to operate its Homestake Strip mine and ship to the Salida mill of Western Feldspar Milling Co.

Fluorspar.—The General Chemical Division, Allied Chemical Corp., operating its Burlington mine and Valmont mill in Boulder County, was the only fluorspar producer.

TABLE 11.—Clay production, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Boulder	(1)	(1)	(1)	(1)
Custer			2,082	$7,513
Douglas	70,715	$183,910	78,140	196,083
El Paso	8,286	23,941	10,833	42,868
Fremont	14,801	62,346	23,671	105,417
Huerfano	7,590	41,745	3,720	(1)
Jefferson	231,389	558,765	212,843	607,152
Las Animas	7,298	18,975	8,685	19,975
Mesa	(1)	(1)	(1)	(1)
Pueblo	64,467	239,878	64,738	266,465
Undistributed	12,935	30,449	85,050	178,766
Total	417,481	1,160,009	489,762	1,424,239

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Gem Stones.—Gem stones and specimens valued at $45,000 (5 percent above that of 1959) were produced and collected from widely distributed areas in over one-third of the counties. Turquoise worth $16,360, mined from the Villa Grove Turquoise Lode in Saguache County, again made Villa Grove the richest gem-stone-producing locality. Specimens collected from unidentified areas were valued at $15,000, only slightly less than in 1959.

Gypsum.—Four mines in Fremont and Larimer Counties produced 82,000 tons of crude gypsum, 23 percent below that of 1959. The U.S. Soil Conditioning Co. mined agricultural gypsum from its Fremont County pit near Salida. The Pabco Building Materials Division of Fibreboard Paper Products Corp. produced gypsum from its Fremont County deposit for use in manufacturing cement at the Portland plant of Ideal Cement Co. and for its own plaster plant at Florence. In Larimer County, gypsum for the Boettcher plant of Ideal Cement Co. was supplied by E. W. Munroe from his mine near Fort Collins. The United States Gypsum Co. mined gypsum from a deposit near its Loveland plant.

Lime.—Production of quicklime and hydrated lime for building, agricultural, chemical, and industrial uses was more than double the 1959 output. Two plants—one near Colorado Springs and the other at Glenwood Springs—supplied a small part of the lime used in Colorado.

Mica.—Scrap-mica production increased from 68 to 340 tons and came from two properties in Larimer County: the Langston mine of Jolex Mica Co. and the H. L. Mattox property. All the scrap was ground by Jolex Mica Co. at its plant at Fort Collins.

Perlite.—The only source of crude perlite in Colorado continued to be the Rosita mine of Persolite Products, Inc.; output decreased 18 percent below that of 1959. Grinding and expanding was done at the Persolite perlite plant at Florence. New Mexico mines continued to supply perlite to Western Mineral Products Co. of Denver.

Pumice.—Production of 32,000 tons of pumice from Costilla, Eagle, and Routt Counties declined 20 percent but the average value per ton increased 6 percent. Volcanic scoria, used principally as railroad

ballast, was also used as concrete admixture, concrete aggregate, insulation, roofing aggregate, and in highway cindering.

Pyrites.—A 9-percent decrease in overall production of pyrite was due largely to a smaller tonnage of pyrite recovered as a byproduct of molybdenum-ore processing by Climax Molybdenum Co. The pyrite was shipped to the acid plant of General Chemical at Denver. On January 30 a fire destroyed the pyrite crushing plant, pyrite storage, and accessory equipment of the sulfuric acid plant of Rico Argentine Mining Co. at Rico. Consequently, acid production at the plant virtually stopped for 2 months. However, despite this interuption, Rico produced more acid in 1960 than in 1959. The Rico Argentine Mining Co. annual report stated that 36,426 tons of pyrite, almost entirely mined from the Mountain Springs area, was used to produce 28,859 tons of 100-percent-basis sulfuric acid during the 1960 fiscal year.

Salt.—Union Carbide Nuclear Co. continued to pump brine from its Montrose County well for use in treating uranium ores.

Sand and Gravel.—A 9-percent decline in production of sand and gravel resulted chiefly from reduced consumption for paving and building. Sand and gravel was produced in 59 of Colorado's 63 counties. Adams County, again the leading producer, was followed by Jefferson, El Paso, Arapahoe, Weld, and Pueblo; each had an output exceeding 1 million tons. The leading commercial producers were Brannan Sand & Gravel Co.; Cooley Gravel Co.; Western Paving Construction Co.; Rio Grande Gravel Co.; Nielsons, Inc.; Herren & Strong Gravel Co., Inc.; and Whitewater Sand & Gravel Co. A

TABLE 12.—Sand and gravel production in 1960, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	3,344	$3,531	Larimer	833	$768
Alamosa	5	6	Las Animas	190	176
Arapahoe	1,288	1,418	Lincoln	181	147
Archuleta	6	6	Logan	301	186
Baca	147	59	Mesa	873	703
Bent	120	56	Mineral	42	47
Boulder	527	478	Moffat	235	148
Chaffee	101	104	Montezuma	605	811
Cheyenne	196	142	Montrose	4	3
Clear Creek	161	141	Morgan	65	48
Conejos	2	2	Otero	326	188
Crowley	187	92	Ouray	6	6
Custer	6	8	Park	2	1
Delta	140	153	Pitkin	35	34
Dolores	30	25	Prowers	60	87
Douglas	288	368	Pueblo	1,042	796
Eagle	252	143	Rio Blanco	48	40
Elbert	312	336	Rio Grande	(1)	1
El Paso	1,377	957	Routt	226	153
Fremont	36	44	Saguache	2	4
Garfield	77	59	San Juan	4	6
Gilpin	2	1	San Miguel	24	24
Grand	177	162	Sedgwick	64	32
Gunnison	32	29	Summit	336	587
Huerfano	3	4	Teller	2	1
Jackson	34	12	Washington	164	66
Jefferson	2,044	1,777	Weld	1,102	592
Kiowa	303	198	Yuma	100	133
Kit Carson	41	21	Undistributed	727	562
Lake	55	59			
La Plata	161	141	Total	19,053	16,882

[1] Less than 1,000 short tons.

report[9] showed that from July 1, 1956, to December 31, 1960, Colorado completed to full or acceptable interstate highway standards 128 miles of road plus 100.7 miles of highway adequate for present traffic for a total of 228.7 miles open to traffic. With this mileage, the State ranked 17th in the United States.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	1,914	$2,128	1,725	$2,026
Paving	322	281	860	742
Railroad ballast	(1)	(1)	(1)	(1)
Fill	60	31	50	37
Other	16	16	70	168
Industrial sand:				
Blast	(1)	(1)	1	8
Engine	(1)	(1)	(1)	(1)
Filtration	(1)	(1)	2	21
Other	11	32	16	50
Ground sand: Foundry			8	11
Total sand	2,323	2,488	2,732	3,063
Construction gravel:				
Building	2,494	3,092	2,180	2,623
Paving	5,113	4,876	5,041	4,686
Railroad ballast	(1)	(1)		
Fill	311	322	104	75
Other	39	48	96	249
Miscellaneous gravel	22	31	140	191
Total gravel	7,979	8,369	7,561	7,824
Total sand and gravel	10,302	10,857	10,293	10,887
Government-and-contractor operations:				
Sand:				
Building	26	15	2	7
Paving	257	166	811	637
Fill	29	16		
Total sand	312	197	813	644
Gravel:				
Building	125	83	196	149
Paving	9,916	7,545	7,715	5,166
Fill	234	126	36	36
Other	8	9		
Total gravel	10,283	7,763	7,947	5,351
Total sand and gravel	10,595	7,960	8,760	5,995
All operations:				
Sand	2,635	2,685	3,545	3,707
Gravel	18,262	16,132	15,508	13,175
Grand total	20,897	18,817	19,053	16,882

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."

Stone.—Lower consumption of crushed limestone in the cement industry caused a 14-percent decrease in production of stone. In addition to use in the cement industry, crushed limestone was used for flux in

[9] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960, press release BPR 61–6, Feb. 22, 1961.

manufacturing steel, making concrete, refining sugar, making quicklime and hydrated lime, and road construction. A greater need for crushed sandstone, principally in concrete and road construction, more than offset the lesser need for dimensional sandstone, resulting in a 41-percent increase in the quantity of sandstone quarried.

Dimensional granite and marble were used chiefly for monumental stone. The principal use for crushed granite was in road construction; a small quantity was used as ornamental aggregate.

Vermiculite.—Crude vermiculite produced in Montana was exfoliated by the Western Mineral Products Co. at its Denver plant for use as insulation and lightweight aggregate.

TABLE 14.—Stone production in 1960, by counties

County	Short tons	Value	County	Short tons	Value
Adams	22,543	$24,566	La Plata	2,800	$11,200
Archuleta	750	3,000	Larimer	791,660	1,676,314
Baca	1,925	2,238	Las Animas	2,076	4,532
Bent	22,756	35,333	Lincoln	25	50
Boulder	4,324	41,446	Mesa	1,000	18,000
Chaffee	146,971	370,114	Moffat	3,200	8,000
Delta	113,912	113,912	Montrose	2,470	10,351
Douglas	3,241	91,803	Otero	3,753	9,631
Elbert	62	558	Park	500	1,750
El Paso	(1)	(1)	Pueblo	12,495	25,890
Fremont	922,230	1,395,822	Routt	14,800	22,200
Garfield	(1)	(1)	San Miguel	4,959	11,393
Grand	13,600	27,000	Teller	2,836	95,771
Gunnison	(1)	(1)	Washington	595	6,548
Jefferson	4,669	6,872	Weld	4,000	3,255
Kit Carson	5,858	8,501	Undistributed	331,926	624,730
Lake	(1)	(1)	Total	2,441,936	4,650,780

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 15.—Stone sold or used by producers, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1956	36,135	$155,169	----	----	(1)	(1)	2,036,486	$2,951,737
1957	18,367	111,425	3,500	$65,000	679	$28,782	2,290,500	3,238,900
1958	10,837	82,060	----	----	2,058	186,012	2,701,750	4,004,500
1959	136,439	229,460	(1)	(1)	(1)	(1)	2,482,700	4,344,000
1960	145,944	532,041	16,400	25,700	4,075	124,026	2,123,194	3,484,757

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956	153,371	$1,994,599	24,176	$115,136	2,250,168	$5,216,641
1957	121,619	721,595	3,800	2,600	2,438,465	4,168,302
1958	37,641	342,412	177,984	328,063	2,930,270	4,943,047
1959	43,381	294,015	161,149	669,043	2,823,669	5,536,518
1960	61,371	298,447	90,952	185,809	2,441,936	4,650,780

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other stone."

TABLE 16.—Stone sold or used by producers, by uses

Use	1959		1960	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble—short tons	6,968	$88,155	4,095	$70,510
Rough architectural—cubic feet	41,387	80,395	46,500	87,582
Approximate equivalent in short tons	3,269		3,647	
Dressed architectural—cubic feet	12,612	28,420	5,429	21,891
Approximate equivalent in short tons	984		429	
Rough monumental—cubic feet	12,250	29,400	11,045	35,485
Approximate equivalent in short tons	1,029		953	
Dressed monumental—cubic feet	925	26,000	4,656	101,400
Approximate equivalent in short tons	78		414	
Flagging—cubic feet	30,084	29,087	33,690	39,374
Approximate equivalent in short tons	2,347		2,628	
Total dimension stone (approximate in short tons)	14,675	281,457	12,166	356,242
Crushed and broken stone:				
Riprap—short tons	279,203	612,905	31,075	58,319
Metallurgical—do	281,900	620,100	335,704	710,682
Concrete and roadstone—do	366,127	871,205	515,826	735,726
Chemical—do	47,400	125,800	50,181	119,676
Miscellaneous—do	[1] 1,834,364	[1] 3,025,051	[2] 1,496,984	[2] 2,670,135
Total crushed and broken stone—do	2,808,994	5,255,061	2,429,770	4,294,538
Grand total (approximate in short tons)	2,823,669	5,536,518	2,441,936	4,650,780

[1] Includes asphalt filler, coal dust, filter beds, cement, lime, marble whiting, block filler, plaster and cleaning sands, terrazzo, and roofing chips.
[2] Includes asphalt filler, cement, lime, marble whiting, plaster sand, terrazzo, roofing chips, ornamental aggregate, stucco, agriculture, and poultry grits.

REVIEW BY COUNTIES

Adams.—Production of sand and gravel at 15 operations was 3.3 million tons, furnishing 56 percent of the total value of all minerals produced. Brannan Sand & Gravel Co., Western Paving Construction Co., Boise Cascade Sand & Gravel Co., and Cooley Gravel Co. were the principal producers. Stone output consisted of crushed miscellaneous stone quarried by contractors for the Colorado Department of Highways; the stone was used as riprap and road metal.

Petroleum production, supplying 43 percent of the value of the county's mineral output, all from 94 wells in 17 fields, was 39 percent above that of 1959. Three new fields were discovered. In June, B. F. Allison discovered the Beryl field when he completed the No. 1 Dawson-Dinnsen well. Initial production was 1.2 million cubic feet of gas from the J sandstone at a depth of 5,715 to 5,721 feet. In July, Delhi-Taylor Oil Corp. completed the No. 1 Cowell, which flowed 300 barrels of oil a day from the J sandstone at a depth of 6,332 to 6,333 feet. The field was named the Deer Trail. In August, Delhi-Taylor Oil Corp. completed the No. 1 State-Plains well, 3.5 miles to the northwest of the Deer Trail discovery. The well flowed 1.9 million cubic feet of gas a day from the J sandstone. Offset wells to the west and southeast and a stepout well to the southeast were failures. The throughput of natural gas at the plant operated by N. C. Ginther at the Leader field was 205.2 million cubic feet of gas with the recovery of 9,3900 barrels of natural gas liquids.

TABLE 17.—Value of mineral production in Colorado, by counties [1]

County	1959	1960 [2]	Minerals produced in 1960 in order of value
Adams	$5,767,688	[3] $6,312,996	Sand and gravel, petroleum, gold, stone, silver.
Alamosa	28,389	6,500	Sand and gravel.
Arapahoe	1,939,016	1,417,700	Do.
Archuleta	638,927	305,000	Petroleum, sand and gravel, stone.
Baca [4]	11,946	61,338	Sand and gravel, stone.
Bent [4]	257,931	114,033	Sand and gravel, stone, petroleum.
Boulder	1,877,445	1,805,373	Fluorspar, sand and gravel, uranium ore, clays, stone, peat, silver, petroleum, gem stones, gold, copper, lead.
Chaffee	604,925	606,838	Stone, feldspar, sand and gravel, beryllium concentrate, gem stones.
Cheyenne	119,500	141,800	Sand and gravel.
Clear Creek	186,672	240,291	Sand and gravel, lead, gold, iron ore, silver, copper, zinc, uranium ore.
Conejos	250,188	2,650	Sand and gravel, gem stones.
Costilla	(5)	(5)	Pumice.
Crowley	600	91,800	Sand and gravel.
Custer	(5)	(5)	Perlite, sand and gravel, clays.
Delta	531,119	641,801	Coal, sand and gravel, stone.
Dolores	508,877	(5)	Pyrites, lead, zinc, silver, sand and gravel, copper, gold.
Douglas	439,006	657,405	Sand and gravel, clays, stone, gem stones.
Eagle	7,088,270	6,306,750	Zinc, lead, silver, copper, gold, sand and gravel, pumice, gem stones.
Elbert	8,000	337,058	Sand and gravel, stone.
El Paso	2,021,915	1,645,542	Sand and gravel, stone, lime, clays, coal, gold, silver.
Fremont	13,654,429	11,115,959	Cement, stone, coal, uranium ore, gypsum, clays, petroleum, sand and gravel, beryllium concentrate, gem stones.
Garfield [4]	191,838	288,050	Coal, lime, sand and gravel, stone, gem stones.
Gilpin	12,322	15,713	Peat, gold, sand and gravel, silver, lead, copper, uranium ore.
Grand	66,832	188,500	Sand and gravel, stone.
Gunnison	1,607,274	1,642,084	Coal, stone, zinc, sand and gravel, lead, silver, uranium ore, copper, gold, beryllium concentrate, gem stones.
Hinsdale	7,725	10,012	Silver, gold, lead, copper.
Huerfano	446,764	(5)	Coal, clays, sand and gravel.
Jackson	3,090,447	[6] 3,004,214	Petroleum, coal, fluorspar, sand and gravel, uranium ore.
Jefferson	3,474,806	3,906,002	Sand and gravel, uranium ore, clays, gold, stone, beryllium concentrate, silver, gem stones.
Kiowa	[4] 61,500	221,100	Sand and gravel, petroleum.
Kit Carson	14,300	29,801	Sand and gravel, stone, gem stones.
Lake	47,740,170	66,676,115	Molybdenum, tungsten concentrate, pyrites, sand and gravel, lead, copper, silver, tin, gold, stone.
La Plata [4]	271,799	[3] 341,274	Sand and gravel, coal, petroleum, stone.
Larimer [4]	12,375,638	12,614,445	Cement, stone, sand and gravel, petroleum, gypsum, mica (scrap), beryllium concentrate.
Las Animas	9,049,697	6,662,062	Coal, sand and gravel, clays, carbon dioxide, stone, uranium ore.
Lincoln	53,200	146,650	Sand and gravel, stone.
Logan [7]	[8] 15,397,550	13,393,100	Petroleum, sand and gravel.
Mesa [9]	4,875,734	4,364,110	Uranium ore, sand and gravel, coal, stone, clays, gem stones, beryllium concentrate.
Mineral	1,020,577	1,398,533	Lead, zinc, silver, copper, sand and gravel, gold, gem stones.
Moffat [10]	6,614,921	8,134,815	Petroleum, uranium ore, coal, sand and gravel, stone, gold.
Montezuma [4]	1,395,644	[6] 1,049,607	Sand and gravel, petroleum, carbon dioxide, uranium ore, gem stones.
Montrose [6]	10,903,704	[4] 11,125,164	Uranium ore, coal, salt, stone, sand and gravel, gem stones, copper, silver.
Morgan [7]	[8] 25,449,473	26,847,000	Petroleum, sand and gravel.
Otero	116,479	197,831	Sand and gravel, stone.
Ouray	4,030	168,663	Lead, zinc, copper, silver, gold, sand and gravel.
Park	[8] 372,898	53,042	Beryllium concentrate, zinc, copper, stone, lead, sand and gravel, gem stones, silver, gold, uranium ore.
Phillips	1,545	(4)	
Pitkin	(5)	(5)	Coal, sand and gravel, lead, zinc, silver, uranium ore, copper.
Prowers	86,183	86,600	Sand and gravel.
Pueblo	(5)	(5)	Sand and gravel, clays, stone, uranium ore.
Rio Blanco [10]	[8] 59,818,637	57,225,660	Petroleum, uranium ore, coal, sand and gravel, gem stones.
Rio Grande	10,000	1,150	Sand and gravel, gem stones.
Routt	1,865,003	2,390,019	Coal, petroleum, sand and gravel, pumice, stone.

See footnotes at the end of table.

TABLE 17.—Value of mineral production in Colorado, by counties [1]—Continued

County	1959	1960 [2]	Minerals produced in 1960 in order of value
Saguache	$1,776,590	$1,650,855	Uranium ore, gem stones, sand and gravel, zinc, lead, silver, copper, gold.
San Juan	[6] 92,816	300,772	Copper, lead, silver, gold, zinc, sand and gravel, iron ore, gem stones.
San Miguel [6]	10,042,933	11,745,179	Uranium ore, zinc, lead, copper, gold, silver, iron ore, sand and gravel, stone, gem stones.
Sedgwick [4]	60,900	31,860	Sand and gravel, gem stones.
Summit	72,015	591,718	Sand and gravel, gold, lead, silver, copper.
Teller	1,165,950	1,219,496	Gold, stone, peat, silver, gem stones, sand and gravel.
Washington [7]	[8] 19,727,350	23,215,048	Petroleum, sand and gravel, stone.
Weld [4]	9,507,101	[8] 8,380,730	Petroleum, coal, sand and gravel, stone, gem stones.
Yuma	574,967	138,900	Sand and gravel, petroleum, gem stones.
Undistributed [11]	[8] 32,219,751	43,269,672	
Total [12]	[8] 314,677,000	342,223,000	

[1] Denver County is not listed because no production was reported.
[2] Petroleum value is preliminary.
[3] Excludes natural gas liquids.
[4] Excludes natural gas.
[5] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[6] Excludes vanadium.
[7] Excludes natural gas and natural-gas liquids.
[8] Revised figure.
[9] Excludes natural gas and vanadium.
[10] Excludes natural gas, natural gas liquids, and vanadium.
[11] Includes vanadium, natural gas, natural gas liquids, some sand and gravel and gem stones and values indicated by footnote 5.
[12] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

The entire output of gold and silver was recovered as a byproduct of the washing and screening of sand and gravel at six operations. Kerkling & Slensker recovered gold and silver from gravel sluiced from the Boise Cascade Sand & Gravel pit, F. S. Rizzuto Gravel pit, and Brannan Pits Nos. 8 and 10; Robert B. Ray from Clear Creek Rock Products Co. gravel pit; and Cooley Gravel Co. from its North Plant pit.

A public purchase depot and plant maintained in Arvada by Beryl Ores Co. for beryl and other beryllium-bearing ores was equipped to inspect and analyze beryllium-bearing ores and to crush and grind these ores for the varied requirements of the ceramic industry. The Beryl Ores Co. also was equipped to produce beryllium basic acetate, an important compound of high-purity beryllium, to make other beryllium compounds on order, and to grind mica for the roofing and paint industries.

Alamosa.—Oriental Refining Co. operated its 1,100-barrel-a-day refinery at Alamosa. Throughput was 274,000 barrels of crude oil, a slight decline from that of 1959.

Arapahoe.—Sand and gravel continued to dominate the mineral industry of the county. Nine commercial and Government-and-contractor operations produced 13 million tons of aggregate valued at $1.4 million. Cooley Gravel Co., with plants at Englewood and Littleton, was the major mine operator. Other important producers were Colorado Materials Co. and Herbertson Sand & Gravel Co.

Archuleta.—Petroleum production from 35 wells in 2 fields was 10 percent below that of 1959.

Baca.—Natural gas was produced at the Greenwood and Prairie Dog fields. One new field (Midway) was discovered when Horizon

Oil & Gas Co. completed the No. 1–22 Cogburn well in October. The well flowed 8.4 million cubic feet of gas a day from the Topeka at a depth of 3,031 to 3,056 feet and from the Morrow at a depth of 4,674 feet.

Bent.—Petroleum production from that part of the McClave field lying within the county increased sixteenfold over that of 1959. Carbon dioxide from wells in Las Animas County was processed at Ninaview.

Boulder.—Although nonmetals continued to supply most of the total value of mineral production, their contribution decreased to 85 percent as a result of reduction in the output of sand and gravel and stone plus an increase in mine shipments of uranium ore. General Chemical operated its Burlington fluorspar mine and Valmont mill at about the same rate as that reported in 1959. Colorado Brick Co. and Eldorado Clay Co. mined fire clay and miscellaneous clay at their Valmont, Longmont, and Nos. 1 and 2 claypits at an increased rate. Boulder Gravel Products, Inc., Golden Transfer Co., Pendleton Construction Co., and C & M Sand & Gravel Co. produced nearly all the 526,900 tons of sand and gravel reported.

Boulder Gravel Products, Inc., recovered small quantities of gold and silver as byproducts of the washing and screening of sand and gravel at its Geo. Sawhill Ranch pit. Silver ore containing, in addition to silver, small quantities of gold, copper, and lead was produced and marketed from the Blue Bird mine. No tungsten ore or concentrate was produced or shipped from Boulder County tungsten deposits during the year; however, rejects from the Climax mill (Lake County) were re-treated by Earl Sweeney in the Marion mill, and the resultant tungsten concentrate was marketed.

Petroleum production from the Boulder field was approximately the same as in 1959. Uranium ore produced by La Salle Mining Co. at the Fair Day mine was shipped to Salt Lake City, Utah, for processing. Peat humus was mined for use as a soil conditioner.

Chaffee.—The chemical and construction materials—feldspar, stone, and sand and gravel—provided most of the value of mineral output. M. & S., Inc., operated its Homestake feldspar mine, shipping the crude ore to the Salida mill of Western Feldspar Milling Co. The Monarch quarry of CF&I contributed most of the stone output. Colorado Granite Co. quarried a small quantity of monumental granite, and Bailey Manufacturing Co. produced crushed granite for use as poultry grit. Construction crews of the State and county highway departments and the Hart Rok Redi Mixt Concrete Co. produced the 100,800 tons of sand and gravel recorded.

The Double R Mines worked the Mine Site Lode during the year and shipped 11,519 pounds of beryl concentrate to the Government purchase depot at Custer, S. Dak.

Clear Creek.—Most of the gold, silver, copper, lead, and zinc output in the county was recovered from lead ore produced from the Jackpot Oil Co. Bald Eagle mine by P. G. Leavitt and Milton George, lessees. These metals also were recovered from cleanup material from the Eagle mill and from ore produced from six other active mines—Ashland, Burleigh Tunnel, Dixie, Drummond, Franklin Claim No. 73, and Kitty Clyde.

Stony Point Development, Inc., produced and shipped brown iron ore (limonite) from the Geneva mine to Columbia Carbon, Monmouth, N.J., for use in manufacturing paint.

Uranium ore produced at the Little Warrior mine by Seacol, Inc., was shipped to Canon City for processing.

Costilla.—Increased shipments of pumice (scoria) by Colorado Aggregate Co., Inc., reversed the downward trend of the past few years. The Mesita Hill deposit near Mesita was the source of the scoria. Concrete admixture, insulation, and roofing aggregate were the end uses for 1960 shipments.

Custer.—The Rosita perlite mine, leased by Persolite Products, Inc., was operated at relatively the same rate as in 1959. Crude material was trucked to Florence for expanding; building plaster, insulation, concrete, and aggregate were the principal uses for the finished product. Ralph J. Pierce reported production of 2,000 tons of fire clay from the Lawson Place deposit.

Delta.—Coal production from seven underground mines was slightly above that of 1959. The major producer was the Juanita Coal & Coke Co. at the King mine.

Denver.—Five petroleum refineries in the Denver area operated throughout the year. Throughput was 11.7 million barrels, a 1-percent increase over that of 1959. Continental Oil Co. completed the addition of 2,000 barrels a day of vacuum capacity at its 18,000-barrel-a-day plant at Denver.

Dolores.—The Rico Argentine Mining Co. reported to stockholders that 14,653 tons of lead-zinc ore was mined and milled during the fiscal year ending June 30, 1960. Of this quantity, 8,465 tons was produced from the Mountain Springs area and the remainder from the Argentine area of the mine. The mill was operated at about 40 percent capacity. From the ore milled, 2,270 tons of lead and zinc concentrates containing 53 ounces of gold, 50,200 ounces of silver, 905 tons of lead, and 641 tons of zinc was shipped to smelters. Development work in the mine included 1,823 feet of drifts and crosscuts, 984 feet of raises, and 113 feet of long-hole drilling.

Rico Argentine also mined 36,426 tons of pyrite, virtually all from the Mountain Springs area of the mine. From this pyrite, 28,859 tons of 100-percent-basis commercial sulfuric acid was produced in the company plant at Rico. Ore storage bins, the crushing plant, and miscellaneous buildings, destroyed by fire January 30, were rebuilt during the year.

Douglas.—Increased value of the output of sand and gravel, stone, and clay boosted the total value of mineral production to $657,000, a gain of 50 percent. Hall Sand & Gravel Co. and Garfield Gravel, Inc., produced most of the aggregate quarried during the year. Robinson Brick & Tile Co. operated its Diamond, Ute, and Hogback mines. Denver Brick & Pipe Co. produced fire clay from the Ringenberg deposit, and Helmer Bros. and Stroud A. Whisenhunt mined fire clay from the Helmer and Stevens mines. Colonna Co. of Colorado, Inc., quarried and crushed granite for use as exposed aggregate in buildings, and Helmer Bros. reported the production of a small quantity of crushed limestone used as flux and for agricultural purposes.

Eagle.—Empire Zinc's Eagle mine led in output of zinc; ranked second in production of copper, lead, and silver; and ranked third in gold output in the State. It was closed by a labor strike for 4 months during the year. Production of direct-shipping copper-silver ore was below that of 1959 because this type of ore did not occur in the new area of the mine opened. Exploration and development on lower levels continued throughout the year.

Mine production of scoria was only half that of 1959 and resulted from cutbacks at the Dotsero and Carbondale deposits of Lava Products, Inc., and Roaring Fork Pumice Co. The Lava Products plant was shut down part of the year to complete an expansion program.

El Paso.—Although the value of output dropped 19 percent from 1959, mineral-production activity again was dominated by the sand and gravel and stone industries. The county ranked third in the State in the quantity of sand and gravel produced. Government-and-contractor production amounted to 54 percent of the 1.4 million tons output; seven commercial operators quarried 635,000 tons of building and paving sand and gravel. Castle Concrete Co., Colorado Lime Co., and Colorado Materials Co. mined crushed limestone; and Colonna Co. of Colorado, Inc., produced crushed granite. Increased shipments of clay were reported. The producers were National Clay Products Co. (National mine), Robinson Brick & Tile Co. (Apache), and Standard Fire Brick Co. (Husted). Colorado Lime Co. nearly doubled its output of quicklime and hydrated lime from its Pikeview operation.

Fremont.—The effect of cement-manufacturing activities on the mineral industry was evident again in 1960. The total value of mineral production decreased to $11.1 million, a decline of 19 percent, chiefly because of reduced shipments of cement from the Portland plant of Ideal Cement Co. Attendant to cutbacks in cement production and shipments was reduced quarry output of limestone used in manufacturing cement. Crushed limestone output was also reported by CF&I, Colorado Limestone Co., and Frank H. Norberg Co.; flux and sugar refining were the principal uses. Colonna Co. of Colorado, Inc., and Cowan Bros. produced crushed and dimension marble and granite. Fire clay production was reported by Ralph J. Pierce from the Flint, Salt Canyon, and Stage Coach Road mines; by George O. Stroup from the 8-Mile and Phantom Canyon mines; and by Irwin Clay Co. from the Irwin pit. Glen Lamberg & Sons mined 1,000 tons of bentonite from the Triangle-Lamberg group of claims. Fibreboard Paper Products Corp. operated its Florence wallboard and plaster-products plant using crude gypsum from a deposit near Cotopaxi.

Mary Lee Mining Co. recovered beryl from the Mary Lee and Mica Lodes, and Lockhart & Ellis worked the Mica Lode for beryl; all output was sold to the Government at its Custer, S. Dak., depot.

Coal production, from 20 underground and 2 strip mines, increased 7 percent over that of 1959. Major producers were The Corley Co. at the Pioneer Canon Nos. 1 and 2 and the Corley Strip mines, Vento Coal Co. at the Vento, and Beer Coal & Construction Co. at the Beer Strip. The tipple at the Vento mine was destroyed by fire in January. Fremont County ranked fifth in the State in the production of

coal. Petroleum production from 28 wells in the Florence-Canon City field was 31 percent below that of 1959. Uranium ore was produced at 16 operations and increased 74 percent in quantity and 47 percent in value over that of 1959. Major producers were Cotter Corp. at the Picnic Tree and Red Cliff mines; Gunnison Mining Co. at the Last Chance and from land leased from the State Land Board; and Juniper Oil and Mining Co. at the Snooper, Thorne, and Dickson Lease mines. The output was processed at mills in Canon City and Gunnison. The Cotter Corp. operated its uranium-processing mill at Canon City throughout the year, using crude ore mainly from the Front Range and adjoining counties.

Garfield.—Frank H. Norberg Co., operating the Glenwood Springs limestone quarry, produced all the stone in Garfield County in 1960. This limestone was used in sugar refining and road construction, as a flux, and for manufacturing lime. Basic Chemical Corp. tripled its output of quicklime and hydrated lime at its Glenwood Springs plant.

Natural gas was produced from 17 wells in 7 fields. Two discoveries were credited to the county. In December, Argo Oil Co. completed a well in the South Baxter Pass area, northeast of the South Baxter Pass field, discovered in 1959. Initial flow was 1.7 million cubic feet of gas a day from the Morrison at a depth of 6,959 to 7,182 feet. Also in December, Mountain States Drilling Co. completed the No. 1 Boulton, which flowed 850,000 cubic feet of gas a day from the Divide Creek at a depth of 7,526 to 7,886 feet. The well was 4 miles north of the northernmost producer at the Divide Creek field and 4 miles east of the Baldy Creek field, with no intervening wells. Coal production from five mines was 12 percent below that of 1959. Major producers were Bendetti Bros. at the New South Canon mine and William Haas, Jr., at the Black Raven mine. Union Carbide Nuclear Co. operated its 1,000-ton-a-day uranium mill at Rifle. Crude ore came from mines in Colorado, Utah, and Wyoming and upgraded material from a beneficiating plant at Slick Rock in San Miguel County. The purchase contract for uranium oxide with AEC, scheduled to expire on March 31, 1962, was being negotiated for the 1962–66 period.

Gilpin.—Peat humus was mined from deposits near Black Hawk for use as a soil conditioner and as a fertilizer admixture.

Gold, silver, and lead were recovered from ore produced from the Lone Star mine and treated in the Marion mill. Two gold-silver placer mines, Ralston Creek Placer and Smith Tyler, were active part of the year.

Gunnison.—Coal production from eight mines was 3 percent above that of 1959. The major producer was Minerals Development Corp. of Colorado, operating the Oliver No. 3 and Somerset mines. A part of the production from the Oliver No. 3 was transported by conveyor belt to the Western Colorado Power Co. Oliver powerplant at Somerset. Production from the Somerset mine was shipped to Utah for manufacturing coke. Bear Coal Co. operated the Bear mine, and Champion Coal Mining Co. operated the Hawk's Nest mine. Uranium ore produced by Cotter Corp. at the Big Red mine was processed at a company-owned plant at Canon City. Gunnison Mining Co. operated

its 200-ton-a-day acid-leach recovery mill at Gunnison. The uranium oxide purchase contract with AEC, which was to expire on March 31, 1962, was extended to December 31, 1962.

The leading producer of silver, copper, lead, and zinc in the county was the Standard Metals Corp. Micawber mine. The ore mined was treated in the company mill at Crested Butte, and the copper-lead, lead, and zinc concentrates produced were shipped to various smelters for recovery of the metals. Other active mines producing one or all of these metals included the Baxter Lode, Endner, Gold Links, and Little Darling.

George B. Tucker recovered a small quantity of beryl from the Monazite Lode and shipped the hand-cobbed concentrate to Custer, S. Dak.

Hinsdale.—The entire mineral output consisted of gold, silver, copper, and lead recovered from ore and mine-dump material from the Pelican mine and ore from the Never Sweat mine.

Huerfano.—Coal production from seven mines was slightly above that of 1959. Major producers were Delcarbon Coal Co. at the Calumet No. 2, Morning Glory Coal Co. at the Morning Glory, Red Ash Coal Co. at the Maitland No. 2, and Vista Coal Co. at the Gordon. Fire destroyed the tipple at the Maitland No. 2.

The Chamblin mine of Standard Fire Brick Co. continued as the only source of clay. Sand and gravel output was reduced to 3,200 tons of paving gravel that was produced by a contractor for the Colorado Department of Highways.

Jackson.—Petroleum production from 45 wells in 4 fields was 9 percent below that of 1959. Major production came from the McCallum and South McCallum fields. Carbon dioxide (77.9 billion cubic feet) produced at the McCallum and South McCallum fields was vented. Coal production at the Rosebud strip mine was 42 percent above that of 1959. The operation was abandoned in midyear. Pioneer Exploration Co. mined uranium ore at the Hume mine and shipped it to Rifle and Maybell for processing.

A small quantity of acid-grade fluorspar was shipped from stock by Ozark-Mahoning Coal Co. at Cowdrey.

Jefferson.—Jefferson County ranked second in the production of sand and gravel, the county's principal mineral product. Output was valued at $1.8 million. The leading producers were Rio Grande Gravel Co., Table Mountain, Inc., Asphalt Paving Co., Western Paving Construction Co., L. H. Kilgroe, and Brannan Sand & Gravel Co., each of which produced over 100,000 tons of aggregate.

The county was also the principal source of clays used for manufacturing building brick and other clay products. Denver Brick & Pipe Co. operated the Caldwell Nos. 4 and 71 and Strainland mines, Denver Fire Clay Co. operated the North and South Golden mines, Robinson Brick & Tile Co. operated the Lariat and Chieftain deposits, and Lakewood Brick & Tile Co. operated the Lindsay and Lakewood claypits. The following mine operators produced clay for sale to brick plants in the Denver metropolitan area: Garnett C. Bennetts (Leyden and Ramstetter pits), Duane J. Bruno (Mount Carbon mine), Wesley Conda (State and Church pits), Leland Doughty (Doughty claim), George W. Parfet Estate, Inc. (Rockwell-Apex-

Green Mountain deposits), John L. Harvey, and H. M. Rubey Clay Co.

Beryl recovered from the Beggar mine by Fred H. Olmstead was sold to Mincon at Loveland. The W. O. W. mine was worked for a short period by Ben Walz, and 333 pounds of beryl concentrate was sold to Beryl Ores Co. at Arvada.

Of the 10 operations producing uranium ore, major producers were Denver-Golden Corp. at the Schwartzwalder, Foothills Mining Co. at the Wright lease, and Yellow Queen Uranium Co. at the Ascension mine. The output was shipped to processing mills at Gunnison and Canon City; Riverton, Wyo.; and Salt Lake City, Utah.

Gold and silver were recovered as byproducts at three sand and gravel washing and screening plants: Brannan Sand & Gravel Co. Pit. No. 11, the Rio Grande Gravel Co. W. P. Kerkling placer pit by Kerkling & Slensker, and the Suburban Sand & Gravel Co. pit by Robert R. Ray.

Kiowa.—Petroleum production from the Brandon field increased fourfold over that of 1959.

Lake.—The entire molybdenum production of Colorado came from the Climax mine of Climax Molybdenum Co. Tungsten, tin, and pyrite recovered as byproducts of the molybdenum ore were marketed. Some of the pyrite produced was sold to a Denver plant for use in manufacturing sulfuric acid.

La Plata.—Petroleum production, from eight wells in the Red Mesa field, increased slightly over that of 1959. Natural gas was produced from 250 wells in the Ignacio-Blanco; producing formations were the Mesaverde (195 wells), Fruitland-Pictured Cliffs (36 wells), and Dakota (19 wells). The Barker Dome and Alkali Gulch fields, with four wells each, produced natural gas from the Paradox formation. El Paso Natural Gas Co. operated its Ignacio natural gas plant near Durango. The plant extracted natural gas liquids from products of natural gas fields in Colorado and New Mexico. Throughput of gas from Colorado wells was 67 billion cubic feet (including dry gas passed through plant compressors); 709,500 barrels of natural gas liquids was recovered. Coal production from nine mines was 9 percent above that of 1959. Major producers were Victory Coal Co. at the Victory No. 3 mine, King Coal Co. at the King, and Peacock Coal Co. at the Peacock. VCA operated its 750-ton-a-day uranium-vanadium processing plant at Durango. Crude ore came from mines in Colorado, Arizona, New Mexico, and Utah. Vanadium was recovered from those uranium ores containing significant quantities of vanadium oxide. The value of the recovered vanadium was credited to the State of origin. Negotiations continued with AEC toward extending the uranium-oxide purchase contract that was to expire March 31, 1962.

Larimer.—An increase in the output of sand and gravel and a small gain in the value of cement shipments contributed a 2-percent rise in the value of mineral production over that of 1959. Although the quantity of cement shipped from the Boettcher plant of Ideal Cement Co. declined slightly, a higher average price resulted in the small overall gain in value of shipments. Crushed limestone, used in manufacturing cement and in refining sugar, was the principal stone quar-

ried. The county was the major source of dimension sandstone in the State. Quarrying was done by Colorado Stone Co. (Berthoud, Loveland, and Rose stone quarries), Jacobson-Lyons Stone Co. (Carter Lake), Arthur Ohline (Ohline), Neal Sprague (Berthoud Pink Stone), Sterling Contracting Co. (Wild North), Weaver Stone Co. (Weaver), and Wild's Stone Quarries (Wild South). Types of building stone produced were rough construction, rubble, rough architectural, sawed, dressed, and flagging. Crude gypsum used in manufacturing cement was mined by E. W. Munroe from a pit near Fort Collins. United States Gypsum Co. mined gypsum from its property near Loveland for consumption at its Loveland wallboard plant. Scrap-mica output, 340 tons, came from the Langston mine operated by Jolex Mica Co. and from an unnamed property operated by H. L. Mattox. The crude mica was ground at the Jolex mill near Fort Collins.

A total of 48,276 pounds of beryl concentrate was recovered from Larimer County pegmatites. The ore, averaging 9.82 percent BeO, was sold to Mincon and Beryl Ores Co.

Petroleum production, from 38 wells in 5 fields, was slightly below that of 1959.

Las Animas.—Coal production from eight underground mines was slightly above that of 1959. Major production came from the Allen and Frederick mines operated by CF&I and was used for manufacturing coke at its Pueblo steel plant, from Albert Iuppa & Son Coal Co. at the Starkville No. 4 mine, from Rapson Coal Co. at the Rapson mine, and from Peacock Coal Co. at the Peacock mine. The Frederick mine at Valdez was closed late in December. Because of a limited reserve, the mine had not been mechanized as had the Allen mine, and increasing costs dictated abandonment as the developed reserve approached exhaustion. Carbon dioxide was produced at the Ninaview field and transported by pipeline to a processing plant in Bent County.

Logan.—Logan County ranked fourth in the production of petroleum. Production, from 436 wells in 66 fields, was 13 percent below that of 1959. A total of 39 exploratory wells, about one-fifth of the exploratory drilling in eastern Colorado, was drilled in Logan County. Of these, one at the Chess field was successful. B. F. Allison completed the No. 1 Bollish-Ramey well in July. The discovery well pumped 90 barrels of oil a day from the J sandstone at a depth of 4,800 to 4,818 feet. By yearend, Creslenn Oil Co. completed the workover of a previous failure that offset the discovery to the northeast. The offset well pumped 15 barrels of oil a day from the J sandstone. Development drilling resulted in 20 successful wells scattered over a number of fields. A substantial number of the successful wells were in the Little Hoot and West Padroni fields. N. C. Ginther operated natural gas plants at the Little Hoot, Padroni, Lewis Creek, and Yenter fields. Throughput of the four plants was 10.1 billion cubic feet of gas with the recovery of 486,000 barrels of natural gas liquids. Kansas-Nebraska Natural Gas Co. operated a stripper plant which recovered 49,000 barrels of natural gas liquids, at the Mount Hope-Walker compressor plant.

Mesa.—Uranium-ore production, from 80 operations, was 17 percent below that of 1959; however, the grade of ore produced increased from 0.28 percent U_3O_8 in 1959 to 0.30 percent. Major producers were Beaver Mesa Uranium Co. at the Rajah group, Mark 2, J. W. L. Fraction No. 1, and John Brown No. 14 mines; Climax Uranium Co. at the Arrowhead group, Karns Incline, the Incline group, Crow's Nest, Blue Ribbon No. 2, Mineral Channel No. 3, October Adit, and Ronnie No. 2; and Union Carbide Nuclear Co. at the Sun Spot and Sun Spot No. 2, Thunder Cloud No. 1, Trojan No. 18, Mary No. 3, Lucky Boy, and At 05–1–36 mines. The entire production was processed at mills in Grand Junction, Rifle, Uravan, and Durango. Climax Uranium Co. operated its 330-ton-a-day plant at Grand Junction. The AEC uranium-oxide purchase contract with Climax Uranium Co., approved in July 1950 and expiring on July 31, 1960, was replaced with a continuing contract, to expire on December 31, 1966. The new contract reserved part of the mill capacity for processing appropriate quantities of ore from qualified independent producers and provided for delivery of approximately 2.6 million pounds of uranium oxide, valued at $21 million, between August 1, 1960, and December 31, 1966. The mill recovered vanadium from Colorado Plateau ores containing significant quantities of vanadium oxide.

Coal production from seven underground mines was 21 percent above that of 1959. At the Cameo mine, operated by Kerr Coal Co., the major producer, the coal was delivered from the mine by conveyor belt to the 44-megawatt Cameo powerplant operated by PSC. American Gilsonite Co. operated its processing plant at Gilsonite, near Fruita, producing gasoline, diesel fuel, and metallurgical coke from gilsonite mined in Utah. Plans were announced to double the capacity of the plant to 1,600 barrels of gasoline, 1,300 barrels of diesel fuel, and 350 tons of coke a day. Natural gas production came from the Asbury Creek, Bar X, Buzzard Creek, Highline Canal, and Mack Creek fields. Four development wells were successful.

Junction Brick & Tile Co. continued to quarry miscellaneous clay from a pit near Grand Junction. All output was used at the company plant in manufacturing building brick and other heavy clay products. For the first time in the history of the county, beryl concentrate was shipped to the Government purchase depot at Custer, S. Dak. Dale W. Poe recovered beryl from the Blue Gem No. 1 claim and Frank E. Long, from the Crystal and Tantalum Lode and the Zaro No. 1 Lode.

Mineral.—Most of the gold, silver, and lead, and all of the copper and zinc output from the county came from ore produced from the Emperius mine operated by Emperius Mining Co. This mine was the third largest producer of silver, lead, and zinc in the State. Gold, silver, and lead were recovered from ore produced from the Outlet mine by Outlet Mining Co. A small quantity of silver ore was shipped from the Holy Moses dump by Sublet Mining Co.

Moffat.—Coal production from the Red Wing mine, operated by Colowyo Coal Co., was 4 percent above that of 1959. Petroleum was produced at 100 wells in 10 fields, principally at Powder Wash, Danforth Hills, and Iles. Natural gas was produced from the Ace, Hiawatha, West Hiawatha, Powder Wash, Sugar Loaf, and Thorn-

burg fields. Extensive exploration and development drilling resulted in the completion of 21 exploratory and 18 development wells. In February, Pan American Petroleum Corp. completed a well in the Four Mile Creek area, just south of the Colorado-Wyoming State line and 2 miles north of the 1959 discovery. Initial production was 11 million cubic feet of gas a day from two horizons in the Lance formation at depths of 3,612 to 3,618 and 3,624 to 3,630 feet. Intex Oil Co. completed an exploratory well at the Big Gulch field in August. The well flowed 5.8 million cubic feet of gas a day from the lower Mesaverde and 1.8 million cubic feet of gas a day from the Frontier. Texaco, Inc., completed the No. 18 Government-Knowlton in the Moffat field early in the year. The well flowed 1,098 barrels of oil a day from the Weber at a depth of 5,975 feet, the first production from the Weber in the field. A southeast offset by Texaco, Inc., flowed 205 barrels of oil a day, also from the Weber, at a depth of 6,015 to 6,200 feet. A second discovery in the Weber was made at Danforth Hills field in November when Texaco, Inc., completed the No. 7 Government-Treleaven, which pumped 445 barrels of oil a day at depths of 8,123 to 8,133 and 8,172 to 8,182 feet. Continental Oil Co. completed the No. 1 Smith well in the Elk Springs field in January. Production was 3.3 million cubic feet of gas a day from the Dakota, the first in the field, at a depth of 3,703 to 3,706 feet. Mountain Fuel Supply Co. operated natural gas refrigeration plants at the Hiawatha and Powder Wash fields. Uranium ore was produced at 17 operations. The major producer was Trace Elements Corp., a unit of Union Carbide Nuclear Co. The corporation also operated its 300-ton-a-day acid-leach uranium-processing plant at Maybell. Negotiations continued for extending the uranium-oxide purchase contract with AEC beyond the expiration date of March 31, 1962.

Montezuma.—Petroleum production from five fields was 25 percent below that of 1959. The Goodman Point field was discovered when Thomas L. Nabers & Associates completed the No. 2 Rowley well in March. Initial production was 29 barrels of oil a day from the Paradox at a depth of 5,399 to 5,419 feet. Thirty-three exploratory and eight development wells were completed. Carbon dioxide was produced from the Mississippian limestone and Shinarump formations at the McElmo field by Three States Natural Gas Co. The gas was converted to dry ice at a plant at McElmo by Colorado Carbonics Corp. Uranium ore from the Blue Eagle mine was shipped to Durango for processing.

Montrose.—Montrose County led with 44 percent of all uranium ore produced in the State. Output came from 285 operations. Major producers were Union Carbide Nuclear Co., Climax Uranium Co., Worcester Mines, and The Golden Cycle Corp. These four companies supplied 88 percent of all uranium ore produced in the county. Union Carbide Nuclear Co. operated its 1,000-ton-a-day uranium-processing plant at Uravan. The plant also recovered vanadium from the Colorado Plateau ores containing significant quantities of vanadium oxide. The vanadium recovered from out-of-State ores was credited to the State of origin. Union Carbide continued negotiations with AEC concerning revision and extension of the uranium-oxide purchase contract that was to terminate on March

31, 1962. VCA announced that a new uranium concentrator would be built at Naturita on the site of the plant that had been closed and dismantled in 1958 because of obsolescence. Coal production from the Navajo strip mine operated by Edna Coal Co. was more than double that of 1959. The coal was used at the Colorado-Ute Rural Electrification Administration (REA) steam powerplant at Nucla.

Morgan.—Petroleum production, from 296 wells in 35 fields, gained 7 percent over that of 1959. Much of the increase was from the successful secondary-recovery operation by waterflooding at the Adena field. The county was second in number of discoveries. The Hawthorne field, north of the Bijou area, was discovered when Richard F. Shaheen completed the No. 1 Loose well in June. The well pumped 50 barrels of oil a day from the D sandstone at a depth of 6,164 to 6,170 feet. An offset to the southwest was a failure. Richard F. Shaheen and Decker Drilling Co. established the Ditch field upon completion of the No. 1 Reed well in July, which pumped 100 barrels of oil a day from the D sandstone at a depth of 5,685 feet. Anschutz Drilling Co. discovered the Dike field, to the west, by completing the No. 1 Cook well in October. Initial production was 3 million cubic feet of gas and 50 barrels of condensate a day from the D sandstone at a depth of 6,259 feet. Kimbark Exploration Co. completed the No. 1 McVey well in the San Arroya Creek field near the southern edge of the county in November. The well pumped 13 barrels of oil a day from the D sandstone at a depth of 5,744 to 5,748 feet. Offset wells to the east and north were failures. In December, Ambassador Oil Co. completed the No. 1 Parachini well at the Track field a mile north of the North Bijou field. Initial production was 240 barrels of oil and 430,000 cubic feet of gas a day from the D sandstone at a depth of 6,050 to 6,055 feet. Stuarco Oil Co., Carver-Dodge, and HLM Drilling Co. completed a workover well near the Ashley field in December. The well, nearly a mile north of the Ashley field, pumped 126 barrels of oil a day from the D sandstone at a depth of 5,878 to 5,881 feet and was believed to be an outpost to the Ashley field. Development drilling was concentrated in the Bijou, North Bijou, and West Bijou fields where there were 11 new producers from the D sandstone. These fields, discovered in 1958, have yielded nearly 2 million barrels of oil through 1960. N. C. Ginther operated natural gas plants at the Bijou and Vallery fields, Pure Oil Co. at the Adena, and Loffland Co. at the Fort Morgan. Throughput at the plants was 12.3 billion cubic feet of gas, and 1.3 million barrels of natural gas liquids was recovered.

Ouray.—Culminating a 4-year deveolpment and construction program costing $2.5 million, the Camp Bird mine and new 500-ton-a-day flotation mill, owned by Camp Bird Colorado, Inc., began production October 10. Output of gold, silver, copper, lead, and zinc from this mine furnished a large part of the county's mineral production and accounted for the substantial increase in the total as compared with that of 1959. In addition, small quantities of these metals were recovered from ores produced from the Mountain Monarch, Bachelor, Dexter No. 3, Frances, Little Balm of Gilead, and Nancy Cleo mines.

Park.—Output of gold, silver, copper, lead, and zinc, valued at $7,165, was recovered from small lots of ore produced from four ac-

tive mines—the Betty, Evening Star, Little Star & Twinkle Lode, and Sweet Home.

The 265 tons of beryl and beryllium-bearing material mined and sold came from four mines. The Boomer and Redskin Lodes of the U.S. Beryllium Corp. were the major producers. The 530,000 pounds of concentrate recovered from these deposits contained 1,335 short-ton units of BeO. CYWYD Mining Co. from the J & S Lode and the Globe Hill Mining Co. from the Big Sheep Horn mine recovered beryl. Except for small quantities of beryl sold to the Government at Custer, S. Dak., and to Beryl Ores Co. at Arvada, all output was sold to Mincon at Loveland.

Uranium ore mined at the Last Chance mine was shipped to Canon City for processing.

Pitkin.—Coal production from five underground mines was 42 percent above that of 1959. Thompson Creek Coal and Coke Corp. operated the Thompson Creek Nos. 1, 2, 3, and 5 mines, and Mid-Continent Coal and Coke Co. operated the Dutch Creek mine. Uranium ore mined by Aspen Mines, Inc., at the Frying Pan group was shipped to Salt Lake City, Utah, for processing. Utex Exploration Co. recovered natural gas from a well 5 miles east of the Divide Creek field in Mesa County. Drillstem tests flowed at the rate of 3.1 to 3.4 million cubic feet of gas a day through open 2-inch tubing from the Cozette member of the Mesaverde.

Montezuma Industries, Inc., shipped a small quantity of silver-copper-bearing lead-zinc ore from the Tam O'Shanter mine near Ashcroft to the United States Smelting Refining and Mining Co. Midvale (Utah) mill for treatment.

Prowers.—Petroleum was produced at the Barrel Springs field. The No. 1 Kern well was drilled about midway between the Barrel Springs field and the McClave field to the northwest by Keith L. Rising; drillstem tests in the Morrow recovered gas-cut mud at a depth of 4,406 to 4,430 feet. As operator, Frankfort Oil Co. ran casing to 4,665 feet and swabbed 70 barrels of oil from the Morrow at a depth of 4,553 feet. Total depth of the well was 4,801 feet and testing was continuing at yearend.

Pueblo.—Uranium ore mined by Cliff & Creek Uranium Co. at the George Avery and Avery Ranch mines was shipped to Canon City for processing.

Fire clay was mined by General Refractories Co. (Turkey Creek), Harbison-Walker Refractories Co. (Miller and Blunt), Standard Fire Brick Co. (Rock Creek), Colorado Fire Clay Co. (Nellie-Helen), and Summit Pressed Brick & Tile Co. Output in 1960, only slightly above that of 1959, was used mainly in manufacturing refractory products.

Rio Blanco.—Petroleum production, from 498 wells in 7 fields, was 4 percent below that of 1959; however, the county continued to lead with 42 percent of the State output. Natural gas was produced at five fields and three oilfields. The secondary-recovery program at the Weber reservoir of the Rangely field unit operated by The California Co. continued as planned. Production of the unit was 16.4 million barrels, a daily average of 44,800 compared with 17.2 million barrels and a daily average of 47,100 in 1959. As of December 31, 30.5 million barrels of water had been injected into the reservoir, by means of 56

water-injection wells. In addition, approximately 100 million cubic feet of natural gas was being injected into the reservoir daily. Additional injection wells will be used as needed, and installation of additional pumps at the central water injection plant will increase injection capacity to 140,000 barrels of water a day.

Exploration was largely in the Douglas Creek, Fawn Creek, and Piceance Creek areas. In May, west of the Douglas Creek field, Gulf Oil Co. completed the No. 1 Dragon Trail-Government well, which flowed 1.2 million cubic feet of gas a day from the Emery. Three additional discoveries were made in the Emery at depths of 2,200 to 3,500 feet. J. H. Page completed the No. 13–1 Federal well in June with a flow of 224,000 cubic feet of gas a day; Beardmore Drilling Co. completed the No. 18–3 Government well in June with a flow of 2.1 million cubic feet of gas a day; and Utex Exploration Co. completed the No. 1–A Cathedral well in June with a flow of 1.9 million cubic feet of gas a day. In November, Apache Corp. completed the No. 1 Government-Watson well in the Douglas Creek area, which flowed 298,000 cubic feet of gas a day from the Emery at a depth of 2,760 to 3,040 feet. To the east in the Fawn Creek area, Equity Oil Co. completed two wells (No. 1 Greeno and No. 1 Ebler) in the Green River at a depth of 2,500 feet. The No. 1 Greeno well was reported as a gas well and the No. 1 Ebler as an oil well, but no production data were released. East of the Fawn Creek area, Equity Oil Co. completed the No. 8 Piceance well in the Green River at a depth of 3,107 feet. The well was completed as an oil well, but no production data were released. South of Fawn Creek, Shannon Oil Co. completed the No. 1 Government well in the Whiskey area in October. Initial production was 500,000 cubic feet of gas a day from Tertiary formations at a depth of 6,035 to 6,053 feet. The California Co. developed new methods of natural gasoline plant design at Rangely field. Absorbers were installed between the second and third stages of six scattered compressor stations used in injecting gas into the Weber pool as part of the secondary-recovery program. The company found that absorber oil could be pumped to the compressor stations and back to the main extraction plant at a cost lower than transferring the wet gas to the extraction plant and back to the compressor stations. Throughput of the satellite compressor stations with absorbers was 28 billion cubic feet of gas with the recovery of 870,827 barrels of natural gas liquids at the main extraction plant. By December 31, approximately 220 billion cubic feet of gas had been injected into the reservoir through 17 wells on the crest of the pool. Uinta Refining Co. operated the 1,700-barrel-a-day refinery at Rangely (operated by Wesco Refining Co. in 1959). Throughput was estimated at 120,000 barrels in both 1959 and 1960.

Uranium ore produced at 11 operations was shipped to plants at Rifle and Grand Junction for processing. The major producer was McAlester Fuel Co., operating the Butter Fly mine. Coal production by Jenkins & Mathis Coal Co. at the Rienau mine and M. E. Staley at the White River Fuel mine was 2 percent above that of 1959.

Routt.—Coal production by Dry Creek Coal Co. at the Cardinal and Routt Mining Corp. at the Keystone, both underground mines; Edna

Coal Co. at the Edna strip mine; and The Pittsburg & Midway Coal Mining Co. at the Osage strip, was 18 percent above that of 1959. The county ranked third in coal production.

Petroleum production, from 20 wells in 5 fields, was slightly below that of 1959. The North Sage Creek was discovered when Caswell Silver and J. L. Cramer completed the No. 1 Featherstone in October. The well pumped 32 barrels of oil a day from the Niobrara at a depth of 5,496 to 5,593 feet. A second well, being tested one-half mile to the north, reportedly had flowed at substantial rates from the Niobrara at yearend.

McCoy Aggregate Co. of Steamboat Springs mined scoria from a nearby deposit. Crude and prepared scoria was sold to consumers for use in manufacturing cinder block and for railroad ballast.

Saguache.—Uranium ore produced at six operations was shipped to plants at Canon City and Gunnison for processing. Major producers were Gunnison Mining Co. at the Los Ochos (Thornburg No. 1 and West) and Thornburg No. 2 mines, and Pinnacle Exploration, Inc., at the Erie No. 28 mine.

Superior Mines Corp., the principal producer of base-metal ores in the county in 1959, was inactive. J. D. Blunt, who operated the Warwick mine near Bonanza, was the largest producer of gold, silver, copper, lead, and zinc. Small lots of ores containing these minerals were produced from the Cocomonga and Copper Head mines in the Bonanza area and the Monon mine in the Embargo Creek area.

San Juan.—The total value of mineral production from the county tripled. This increase resulted chiefly from the recovery of substantial quantities of gold, silver, copper, lead, and zinc from ore produced from the Shenandoah mine by Standard Metals Corp., formerly Standard Uranium Corp. The ore was concentrated in the company's newly rehabilitated Central mill near Silverton. In addition, the company continued work on extending the American tunnel 4,800 feet and raising from it 480 feet to connect with the existing workings of the Sunnyside property.

Fall River Exploration & Mining Co. produced gold-silver-copper-zinc-bearing lead ore from the Little Dora mine and concentrated it in the Pride of the West mill, formerly owned by Argyle Mining & Milling Co. Smaller quantities of ore containing these metals were produced and marketed from the Brooklyn, Longfellow, and Osceola mines.

A. A. McCluskey produced brown iron ore (limonite) from the South Mineral Placer mine and shipped it to an eastern firm for use in manufacturing paint.

San Miguel.—Two-thirds of the total value of mineral production came from gold, silver, copper, lead, and zinc recovered mainly from ores produced from the Treasury Tunnel-Black Bear-Smuggler Union group of mines operated by Idarado Mining Co. This group, the State's leading silver, copper, and lead producer, ranked second in output of gold and zinc. According to the company annual report to stockholders, 432,750 tons of ore was produced in 1960, compared with 369,050 tons in 1959. The ore milled in 1960 averaged 0.054 ounces of gold and 1.71 ounces of silver per ton, 2.45 percent lead, 0.65 percent copper, and 3.62 percent zinc. During the year the company

purchased all of the neighboring mining properties and interests of Atlas Mining Co., where some ore had been developed in past years.

Most of the State's iron-ore production (shipments) came from the Iron Springs Placer operated by C. K. Williams & Co. and was used for making paint. A small quantity of brown iron ore was produced from the Iron Lode No. 3 by Theresa B. Robinson for use as a soil additive.

Production of uranium ore from 85 operations was 13 percent above that of 1959. The county ranked second in production of uranium ore. Major output came from the Deremo lease, Burro group, H. L. Bigler, and Norther group operated by Union Carbide Nuclear Co. and the Radium and Bean Patch mines operated by Dulaney Mining Co. The ore was shipped to mills at Uravan and Durango and to an upgrading plant at Slick Rock for processing. Union Carbide Nuclear Co. operated its upgrading plant at Slick Rock. The partly concentrated material from the plant was shipped to the mill at Rifle for further processing.

Exploratory drilling in that part of the Paradox basin lying within the county resulted in nine completions, of which three were discoveries in the southeast Lisbon area. In June, Pure Oil Co. completed the No. 1 McIntyre Canyon well, which flowed 3.4 million cubic feet of gas a day from the Mississippian at a depth of 8,780 to 8,901 feet. The well also tested the Devonian. The No. 2 McIntyre Canyon, 1 mile to the southwest, completed by Pure Oil Co. in April, flowed 6.2 million cubic feet of gas a day from the Mississippian at a depth of 8,674 to 8,784 feet, 6.7 million cubic feet from the Ouray (Devonian) at a depth of 8,821 to 8,862 feet, and 149 barrels of condensate a day from both zones. Total depth of the well was 9,170 feet. A third well in the area, the No. 3 McIntyre Canyon, 1.5 miles southeast of the No. 2 well and 2 miles south and slightly east of the No. 1 well, was completed by Pure Oil Co. at a depth of 9,524 feet. Initial flow was 6.4 million cubic feet of gas and 122 barrels of oil a day from the Mississippian. A fourth well, 1 mile northwest of the No. 1 well, was a failure. Belca Petroleum Co. drilled the No. 1 Egnar unit 2.5 miles south of the Pure No. 1 unit, and although not completed at the end of the year, a calculated potential of 11.7 million cubic feet of gas a day from 5 intervals in the Mississippian was reported.

Summit.—Five active lode mines furnished $3,100 of the $4,600 value of gold, silver, copper, and lead produced. The remainder came from gold and silver recovered from two placer-mining operations.

Teller.—Gold and silver output, which supplied $1.1 million of the $1.2 million value of mineral production, came from 12 active mines in the Cripple Creek district in 1960, compared with 17 in 1959. All of the operators shipped their products, either mine ore or mine dump material, to the Carlton mill for treatment. The Ajax mine, operated by The Golden Cycle Corp., was the State's leading producer of gold. Other important producers in the district were the Deadwood mine operated by The United Gold Mines Co. and the Free Coinage mine operated by Deadwood Leasing Co.

As quoted in The Golden Cycle Corp. annual report, 47,414 tons of mine ore and 5,245 tons of dump ore, having an average value of $20.45 per ton for both company and custom material, were treated

in the company's Carlton mill. Mine and dump ore and average value of ore treated in 1959 were 61,422 and 8,755 tons and $16.17, respectively. During 1960, 21,328 tons of ore averaging $21.24 per ton and 14,872 tons of ore averaging $29.87 per ton were produced by the company and by lessees, respectively, from the Ajax mine. The mine was operated on a 2-shift-a-day basis throughout the year. The underground electrical power system was converted from 30-cycle to 60-cycle current, enabling the company to use electric instead of air-operated pumps. This change increased pumping efficiency and reduced the cost.

The United Gold Mines Co. cited in its annual report that 4,186 tons of mine ore (with an average value of $10.84 per ton) and 2,799 tons of dump ore ($6.90 per ton) were produced from its operations in the Cripple Creek district. To gain access to new ore and to new areas for exploration, the company began to rehabilitate the Theresa shaft, a project it expected to complete in February 1961.

Peat humus was mined for use as a soil conditioner and as an admixture in fertilizer.

Washington.—Petroleum production, from 387 wells in 54 fields, was 17 percent above that of 1959. The county ranked third in the State with 17 percent of the total output. With six discoveries, Washington County led all eastern Colorado counties. Anderson-Pritchard Oil Co. worked over an old well about 1 mile south of the Plum Bush Creek field. This well, No. 2 MacNeill, was completed in May and pumped 251 barrels of oil a day from the J sandstone at a depth of 5,045 to 5,047 feet; the field was named the Ring. B. F. Allison drilled a west offset that pumped 192 barrels of oil a day from the J sandstone. Anderson-Pritchard Oil Co. completed a well south of the Allison well that pumped 37 barrels of oil on an 18-hour test from the J sandstone. An offset well to the east and two stepout wells to the west were failures. In October, Plains Exploration Co. completed the No. B–1 Knight well, discovery of the Sapphire field, 6 miles northeast of the Ring. The well pumped 93 barrels of oil a day from the J sandstone at a depth of 4,917 to 4,927 feet. An offset to the south pumped 105 barrels of oil a day. Offsets to the east and west and a stepout to the south were failures. Two discoveries were made farther to the north. In August, Tipps Drilling Co. completed the No. 1 Blake (Saddle field), which pumped 105 barrels of oil a day from the J sandstone at a depth of 4,958 to 4,961 feet. An offset to the west was a failure. The Lariat field was discovered in September when Kimbark Exploration Co. completed the No. 1 McFall-State well, which pumped 26 barrels of oil a day from the D sandstone at a depth of 4,983 to 4,989 feet. In June, 15 miles east and south of the Ring field, B. F. Allison and Dow & McHugh completed the No. 1 Ben Gay, which pumped 50 barrels of oil a day from the J sandstone at a depth of 4,680 to 4,682 feet. In December, Champlin Oil & Refining Co. completed the No. 1 Loudder, 2 miles south of the Lindon field. The well pumped 90 barrels of oil a day from the J sandstone at a depth of 4,660 to 4,665 feet. Two other discoveries that had no successful offsets were completed by B. F. Allison. The Arrow field was completed in December at the No. 1 Pan American State and flowed 4.2 million cubic feet

of gas a day from the J sandstone at a depth of 4.781 to 4, 783 feet. An unnamed field was completed in October at the No. 1 Brown with an initial production of 125 barrels of oil a day on pump from the D sandstone at a depth of 4,933 to 4,940 feet. Development drilling was scattered throughout the county; major attention was directed to the Lindon field where 12 new producers were completed, and to the Ruby with 5 new oil producers and 1 gas well. Akron Gasoline Co. operated a natural gasoline plant at Akron. Natural gas came from the West Xenia and Akron fields, and Continental Oil Co. processed natural gas from the Little Beaver field at its plant at Brush. Throughput was 2.6 billion cubic feet of gas with the recovery of 521,795 barrels of natural gas liquids.

Weld.—Coal production from six underground mines was 5 percent below that of 1959. However, the county led in coal production with 21 percent of the State total. The Imperial Coal Co. operated the Eagle and Imperial mines; The Clayton Coal Co., the Lincoln and Washington; Boulder Valley Coal Co., the Boulder Valley No. 3; and McNeil Coal Corp., the Sterling. Much of the coal was used at thermal powerplants. Petroleum production, from 112 wells in 26 fields, was 11 percent below that of 1959. Two discoveries were made from 11 exploratory wells drilled. In February, Pure Oil Co. completed the No. 1 Sweigard well at the New Raymer field, north of the Jackpot field. The well pumped 42 barrels of oil a day from the D sandstone at a depth of 6,224 to 6,227 feet. In April, Wentworth Drilling Co. completed the No. 1 McEndaffer at the Mantle field. The field is west of the Battle Canyon field and the discovery well flowed 1.5 million cubic feet of gas a day with some condensate from the J sandstone at a depth of 6,222 to 6,233 feet. The well was shut in, but the operator planned to reenter and attempt completion in the D sandstone. Drillstem tests of the D sandstone had shown a flow of 6.3 million cubic feet of gas a day. In June, Clayton Oil Co. and Jack Ladmer completed a southwest offset that pumped 68 barrels of oil a day from the D sandstone. Another well nearly a mile to the north of the No. 1 Sweigard well was a failure. No development drilling except that at the New Raymer field was done. Akron Gasoline Co. operated a natural gas plant at the Battle Canyon field. Throughput was 56.6 million cubic feet of gas with the recovery of 12,088 barrels of natural gas liquids.

Yuma.—Yuma County became a producer of petroleum when the Laird field near the Colorado-Nebraska State line was discovered in April. The field is 40 miles east of the nearest Colorado field (Hyde in Morgan County) and 25 miles from the nearest producing fields in Nebraska and Kansas. S. D. Johnson completed No. 1 State, the field opener, which pumped 11 barrels of oil a day from the Lansing-Kansas City at a depth of 4,721 to 4,733 feet. Tennessee Gas & Oil Co. completed the No. 1-Nicklas-A, a northwest offset, which pumped 15 barrels of oil a day also from the Lansing-Kansas City.

615629—61——17

The Mineral Industry of Connecticut

By Stanley A. Feitler [1]

VALUE of Connecticut's mineral production in 1960 was $15.3 million, an 18-percent increase over 1959, but 5 percent below the record year of 1957. Most mineral commodities were produced in larger quantities in 1960, but the principal gain was in stone and sand and gravel production which together accounted for 94 percent of the total value. Mineral producers found that although the level of consumption was high, average prices were unchanged or lower. As costs continued to increase, many operations had a lower profit-to-sales ratio, a condition not limited to the mineral industry in 1960.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Although seven companies mined miscellaneous clay during 1960 compared with five in 1959, fewer tons were produced. Part of the output was used in the manufacture of flowerpots, but most

TABLE 1.—Mineral production in Connecticut [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate ---- short tons	13	$8	16	$9
Clays ---- do	279,937	368	207,458	308
Gem stones	(2)	5	(2)	7
Lime ---- short tons	(3)	(3)	34,664	616
Peat ---- do	2,090	13	(3)	(3)
Sand and gravel ---- thousand short tons	4,749	4,912	6,575	5,960
Stone ---- do	4,462	7,088	5,057	8,313
Value of items that cannot be disclosed: Feldspar, lime (1959), mica (1960), peat (1960), and items indicated by footnote 3	----------	[4] 636	----------	140
Total Connecticut [5]	----------	12,930	----------	15,254

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Revised figure.
[5] Total adjusted to eliminate duplicating value of stone.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.

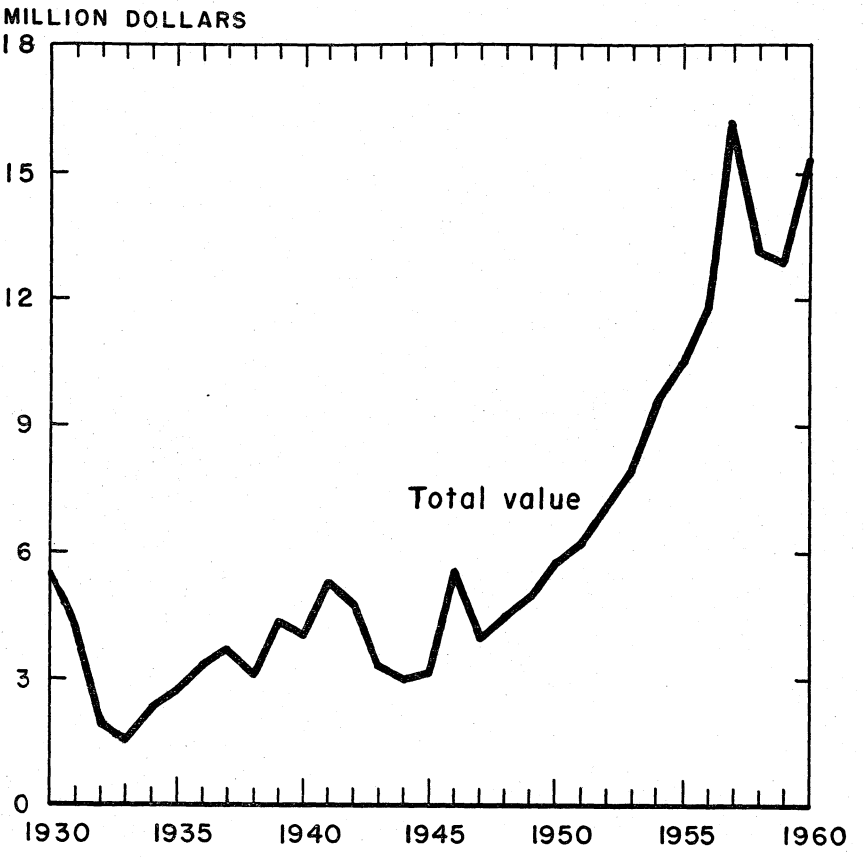

FIGURE 1.—Value of mineral production in Connecticut, 1930–60.

of the clay was used in the manufacture of building brick. The reduced production of miscellaneous clay was attributable to smaller demand for brick by the construction industry. The clay was mined by 15 men, who worked 24,000 hours and produced an average of 8.6 tons per man-hour. One lost-time injury was reported. Connecticut brick manufacturers formed the Brick Service and Development Association to assist and promote all phases of brick application.

Feldspar.—Feldspar production continued at about the same level as in 1959, with a small decrease in tonnage and a small increase in value. Grinding plants continued to obtain crude feldspar from nearby pegmatite bodies in Middlesex County. Selective mining was used to maintain uniform millfeed, and the crude material was dry ground to specifications established by consumers.

Gem Stones.—Collectors of mineral specimens and gem stones increased their activity, and the value of the material recovered was higher than in 1959. Pegmatites in the central and western counties continued to interest mineral and gem collectors as well as lapidary clubs, as they contain such a wide variety of rare minerals and gem stones.

Lime.—For the third successive year, output of lime exceeded that of the previous year. More than half the output was used in the manufacture of calcium and magnesium at Canaan; more than 40 percent was used as mason's lime. Lime was also used as a soil conditioner and in insecticides. More than 70 percent of the total tonnage was sold within the State.

Mica.—A small quantity of strategic-grade mica was recovered from two mines. It was sold to General Services Administration (GSA) at the Franklin, N.H., purchase depot.

Sand and Gravel.—Commercially produced sand and gravel increased 12 percent in tonnage and 8 percent in value, reflecting a lower price per ton for most uses. The average price per ton for gravel was down $0.12, and that for sand was up $0.01. A large increase in tonnage by Government-and-contractor operations was due in part to the expanded highway construction program and in part to improved canvassing methods. Material washed, screened, or otherwise prepared decreased from 84 percent of the total in 1959 to 78 percent. Deliveries of sand and gravel continued to be mainly by truck. Commercial producers employed 382 men, who worked 700,000 hours and produced 7.3 tons of finished product per man-hour.

TABLE 2.—Sand and gravel sold or used by producers, by class of operations and uses

Class of operation and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Molding			2,000	$1,000
Structural	1,123,080	$985,801	1,272,192	1,232,534
Paving	1,255,582	1,143,221	950,249	875,915
Other	100,924	109,818	135,749	120,548
Gravel:				
Structural	948,418	1,440,543	1,013,016	1,461,801
Paving	609,458	727,786	922,468	1,076,217
Fill	207,271	140,116	355,838	219,802
Other	171,437	205,603	86,061	58,398
Undistributed [1]	161,473	91,651	377,726	197,492
Total	4,577,643	4,844,539	5,115,299	5,243,707
Government-and-contractor operations:				
Sand: Paving	72,763	26,705	63,007	21,904
Gravel: Paving	98,313	41,219	1,396,739	694,370
Total	171,076	67,924	1,459,746	716,274
Grand total	4,748,719	4,912,463	6,575,045	5,959,981

[1] Includes filter sand, railroad ballast, and fill sand.

Stone.—Although basalt (traprock) represented most of the stone output, limestone, granite, and quartzite also contributed to the total stone produced. Increased tonnage and value was due partly to the accelerated highway construction program and partly to improved canvassing procedures. Crushed stone, mainly basalt, used principally for building and highway construction, accounted for 96 percent of the tonnage and 88 percent of the value of all stone in 1960. The average value of crushed stone was $1.61 per ton, an increase of $0.06 per ton compared with 1959.

TABLE 3.—Stone sold or used by producers, by uses

Use	1959		1960	
	Short tons	Value	Short tons	Value
Dimension stone (approximate short tons)	6,730	$174,426	6,628	$158,944
Crushed and broken stone:				
Agstone	(1)	(1)	62,441	286,000
Concrete, roadstone	4,084,999	5,916,239	4,714,944	7,076,804
Railroad ballast	58,002	70,641	47,465	59,332
Riprap	132,679	153,751	111,204	162,950
Undistributed [2]	179,727	773,415	114,781	568,709
Total	4,462,137	7,088,472	5,057,463	8,312,739

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes ground quartz, flux, other stone, and items indicated by footnote 1.

Granite was quarried for dimension stone and monuments, but most of the tonnage was crushed. Limestone, used mainly for making lime, was also ground for agricultural and other uses. A major portion of quartzite production was used in manufacturing glass.

Commercial crushed stone producers employed 347 men, who worked 736,000 hours and produced 5.9 tons of finished stone per man-hour.

METALS

Connecticut continued to be an important center for smelting and processing primary and secondary nonferrous metals, although sales were less than in 1959. Several plants were merged or purchased by others to improve operating economy or diversify products, and operations were discontinued at a few metal-processing plants. Research groups continued to work on projects aimed at improving processes and expanding uses for some of the rarer metals as well as the common nonferrous metals and alloys.

Principal yards dealing in iron and steel scrap were centered about Ansonia, Kent, Meriden, and New Haven in New Haven County and Bridgeport and Danbury in Fairfield County. Low prices and restricted demand by domestic consumers resulted in increased shipments for export, which accounted for 65 percent of all shipments from yards. The principal grades shipped, in order of decreasing tonnage, were No. 2 and all other bundles (mainly for export), No. 2 heavy-melting steel, No. 1 heavy-melting steel, and low-phosphorous scrap.

Beryllium concentrate.—Production of beryllium concentrate in the form of hand-cobbed beryl was higher than in 1959. Beryl from mines in three counties was sold at the GSA depot, Franklin, N.H. The material had an average beryllium oxide content of 11.4 percent.

MINERAL FUELS

Coke.—The Connecticut Coke Co. plant (New Haven) of Eastern Gas & Fuel Associates continued to operate 70 Koppers-Becker by-product coke ovens having an annual capacity of 410,000 tons. Part of the output was used by the market vacated by Eastern Gas & Fuel Associates' Everett, Mass., plant, which had been discontinued.

Chemical byproducts produced at the New Haven plant included ammonium sulfate, crude coal tar, crude light oil, and intermediate light oil.

Peat.—Output of peat for use as a soil conditioner was greater than in 1959, although bogs in Hartford and Tolland Counties were idle. Connecticut production (all from Middlesex County) in 1960 had a higher average value per ton than in 1959.

REVIEW BY COUNTIES

The Connecticut State Highway Department reported production of sand and gravel and crushed stone from unspecified counties. In Hartford County, the town of South Windsor and the Department of Public Works at Bristol reported production of sand and gravel by Government-and-contractor operations.

Fairfield.—With just under 1 million tons, Fairfield County was second in sand and gravel production. Ninety percent of the total output was used in building and highway construction, and the rest was used for fill and sanding roads. Among the more important producers were John Lomazzo & Sons Corp., Weston, Grasso Construction Co., Shelton, and Lambert, Inc., Brookfield. All sand and gravel produced was delivered by truck, and 85 percent was washed, screened, or otherwise prepared before shipment. The only limestone producer in the county, Connecticut Agstone Co., discontinued operations at its quarry near Danbury.

Gem and mineral specimens were collected at many localities. The Branchville pegmatite in Redding Township, long noted as the locality for a large variety of rare minerals, produced some of the rare manganese phosphates and the uranium minerals, autunite, torbernite, uraninite, and cyrtolite. Excellent specimens of clevelandite, apatite, garnet, and columbite-tantalite also were recovered.

A variety of steel products was produced at the Bridgeport plant of Carpenter Steel Co. of New England in two electric furnaces. Bridgeport Brass Co. bought the Seymour Manufacturing Co., Seymour, whose facilities and products put Bridgeport Brass Co. in such new product fields as phosphor bronze, nickel-silver alloys, nickel anodes, and bright nickel solutions.

TABLE 4.—Value of mineral production in Connecticut, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Fairfield	$1,494,730	$1,261,573	Sand and gravel, gem stones.
Hartford	3,703,447	4,474,450	Stone, sand and gravel, clays, peat, gem stones.
Litchfield	1,663,146	1,776,475	Stone, lime, sand and gravel, beryllium, gem stones.
Middlesex	553,517	497,982	Sand and gravel, clays, feldspar, peat, beryllium, mica.
New Haven	4,367,394	4,384,825	Stone, sand and gravel, clays, beryllium, gem stones.
New London	507,855	808,698	Stone, sand and gravel.
Tolland	(1)	(1)	Sand and gravel.
Windham	(1)	(1)	Sand and gravel, stone.
Undistributed [2]	639,424	2,049,911	
Total	12,930,000	15,254,000	

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes stone and sand and gravel that cannot be assigned to specific counties and values indicated by footnote 1.

H. K. Porter Co., Inc., Shelton, produced synthetic mullite for refractory uses. Kaolin from out of State with alumina added was fired at 3,250° F. in an 8- by 250-foot rotary kiln. Mullite so produced was fired in two tunnel kilns to produce high-grade refractory brick and block for use by the glass and steel industries.

Lambert, Inc., which began producing sand and gravel in 1959 with a 90-ton-per-hour plant, installed additional equipment in 1960 to increase capacity to 150 tons per hour. The sand and gravel was recovered from a glacial moraine.

Hartford.—Although output of basalt was down to 1.8 million tons, the county continued to rank second in the State in crushed stone production. Most of the crushed stone output was marketed for use in concrete and highway construction; a small quantity was sold for riprap. Six operators mined, crushed, and screened basalt during the year from three quarries near Plainville and one each near East Granby, Farmington, and Newington. Tower Hill Granite Co. and T. A. Armando, both near Glastonbury, produced granite for dimension stone.

Hartford County, with 1.6 million tons, was the leading producer of sand and gravel in the State. Most of the output was used for building and paving, but a minor tonnage was consumed in sanding roads, filtration, and as railroad ballast. Nineteen producers were active in the county, and 77 percent of their output was washed and screened.

Although more producers were active during 1960, output of miscellaneous clay was lower than in 1959. All of the output was used in the manufacture of building brick except a quantity sold by Eastern Brick Co. to the Keller-Whillden Pottery Co., Kensington, for use in making flowerpots.

Mineral collectors reported recovery of zeolites and calcite from vugs in the basalt near Farmington, and samarskite, garnet, and tourmaline from the Spinelli prospect near Glastonbury.

Litchfield.—Output of limestone increased over that of 1959 in both tonnage and value. The principal uses for limestone mined in the county were for agstone (for soil treatment) and the manufacture of lime. Smaller quantities were used for riprap, metallurgical flux, dead-burned dolomite, rubber filler, asphalt filler, pottery, stucco, and filler in plastic and paint. New England Lime Co. mined dolomitic limestone to supply its limekilns. More than half the total lime produced was quicklime used in manufacturing calcium and magnesium at the Nelco Metals, Inc., Canaan, plant of New England Lime Co. The other principal uses were for mason's lime and agricultural lime.

Seven pits produced sand and gravel for building, paving, and highway surface maintenance. Two of the operations were near New Milford; the others were near Canaan, Litchfield, Plainville, Lime Rock, and Torrington. Twenty-two percent of the output was sold as bank-run; the rest was washed and screened before shipment. Building Materials, Inc., continued to mine basalt for concrete, roadstone, and riprap at its Torrington quarry. Production was higher than in 1959.

Beryl concentrates were produced at Parker's quarry near North Woodbury and sold to GSA at the Franklin, N.H., purchase depot.

The hand-sorted material contained an average of 11.6 percent beryllium oxide. Gem and mineral collectors recovered aquamarine, tourmaline, and garnet in New Milford Township. Scovill Manufacturing Co., New Milford, produced copper tubing in newly installed tubemills.

Middlesex.—Sand and gravel production was lower than in 1959. The output, used for building, paving, fill, and ice control, was recovered from pits at East Hampton, Middletown, Madison, Clinton, Deep River, and Haddam. All deliveries were by truck, and 85 percent of the material was washed and screened before shipment.

The Michael Kane Brick Co., Middletown, reported increased production of miscellaneous clay to meet greater demand for building brick.

Crude feldspar requirements of the Eureka Feldspar Mining & Milling Co. were supplied by John W. Mance at the Hale pegmatite, where he produced the material under contract. The crude feldspar was trucked to the Eureka Co. grinding plant, where it was prepared for use by the ceramic industry. Worth Spar Co., Inc., continued to mine potash feldspar from a zoned pegmatite near Cobalt. The crude material was trucked to the company mill, where it was pulverized for use in floor-cleaning compound as an abrasive and nonskid additive.

Feldspar Corp. completed construction of its new mill south of the Connecticut River a few miles east of Middletown. This company, with several plants in the Southeast, had produced feldspar for more than 30 years. The new mill, with grinding and flotation sections through the shakedown operation, was ready at the end of 1960 to ship feldspar for use in the manufacture of glass and ceramics. Pegmatite bodies located from 500 to 1,500 feet from the millsite were developed for production. The company planned to market byproduct scrap mica and quartz.

Peat was recovered from bogs near Old Saybrook by E. C. McGuire & Son and Saybrook Peat, both of Old Saybrook. Production was maintained at a higher level than in 1959. The pegmatite dikes of Middlesex County continued to be popular with collectors as a source of a wide variety of gems and mineral specimens.

New Haven.—Almost half the stone produced in the State was mined in New Haven County from seven basalt quarries and one granite quarry. Ninety-eight percent of crushed stone sold for use as concrete aggregate and roadstone; the remainder was used for riprap and railroad ballast. Of the 2.1 million tons of crushed stone produced in 1960, 52 percent was shipped by truck, 37 percent by water, and 11 percent by rail. The rock was mined at two quarries near New Haven and one quarry each near Woodbridge, Meriden, Wallingford, and North Brandford. The New Haven quarry of the Foxon Traprock Co., Inc., was closed in July 1960. Through affiliation with the New Haven Traprock Co., New Haven, the Foxon Concrete Corp. continued to market concrete using crushed stone produced by New Haven Traprock Co. Castellucia & Sons, Inc., continued to produce rough architectural stone from its granite quarry at Brandford.

The county continued to rank third among the State's sand and gravel producing counties. The entire output was used for building, highway construction, and fill.

The Stiles Corp., North Haven, produced less miscellaneous clay for brickmaking than in 1959 because of the low level of demand in the first quarter and a strike in June. A 9- by 70-foot rotary dryer was installed to control moisture in the clay and thus to improve quality control and overall economy.

Burritt R. Curtis produced beryl at the Southford Pegmatite, Southbury, for the seventh consecutive year. The hand-sorted beryl, which contained 12.5 percent beryllium oxide, was sold to GSA at the Franklin, N.H., purchase depot. Gem and mineral collectors were active during the year, collecting specimens and gem material at many mineral localities in the county.

Chase Brass & Copper Co., Inc., Waterbury, a subsidiary of Kennecott Copper Corp., completed plans for installing new equipment to process copper tubing. Seymour Manufacturing Co., Seymour, manufacturer of phosphor bronze, nickel-silver alloys, nickel anodes, and bright nickel solutions, was acquired by Bridgeport Brass Co.

New London.—Connecticut Silica Co. increased production at its North Stonington quartzite mine to satisfy the demand for its products. The quartzite was crushed and ground to specifications for use in manufacturing glass and as foundry, abrasive, and plaster sand. The quartzite was also used for roofing granules and as a filler.

Barrett Division of Allied Chemical Corp. mined and crushed granite for use as concrete aggregate, roadstone, and riprap at its Montville quarry. The Millstone Granite Quarry, Inc., Waterford, quarried and prepared rough architectural stone, rough stone for monuments and mausoleums, and rough construction stone. Golden Pink Granite Quarry Co., New London, and E. Locarno & Sons, Niantic, produced rough monumental stone from granite quarries.

Sand and gravel was produced from five pits, two at Montville and one each at Yantic, Niantic, and Waterford. The material was used for building, paving, and fill, and for sanding roads.

Tolland.—Sand and gravel was produced by Earl L. Parker, Inc., Tolland, Myron M. Lee, Bolton, and Vernon Sand & Gravel Co., Vernon, for use in building, paving, and fill and for sanding roads. The Bonair Peat Co. of Ellington was inactive in 1960.

Windham.—Sand and gravel produced from pits near Putnam, Danielson, and Wauregan was used for building, paving, and railroad ballast. Concrete aggregate, roadstone, and railroad ballast were produced near Wauregan from crushed basalt. H. B. Marriott, Oneco, quarried granite to produce curbing and rubble.

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.

By Robert D. Thomson [1]

THE VALUE of Delaware's 1960 mineral production declined to $989,000, 23 percent below 1959. Decreased demand resulted in a lower output of sand and gravel, stone, and clay.

Employment reported by the mineral industries totaled 71 production employees working 121,400 man-hours.

TABLE 1.—Mineral production in Delaware [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel thousand short tons	1,241	$1,071	1,084	$907
Value of items that cannot be disclosed: Clays and stone		213		82
Total Delaware		1,284		989

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

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Miscellaneous clay production decreased owing mainly to a continuing decline in demand for building brick. The clay produced in New Castle County was used at a local brick plant.

Fluorspar.—The St. Lawarence Fluorspar, Inc., plant at Wilmington was idle in 1960. When operating, it used flotation to produce acid-grade fluorspar concentrate from imported crude ore.

Gypsum.—Bestwall Gypsum Co. began constructing a gypsum products plant at the Wilmington Marine Terminal. The plant was to use gypsum obtained from company mines, including mines operated in Nova Scotia and the Dominican Republic.

[1] Supervisory commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.

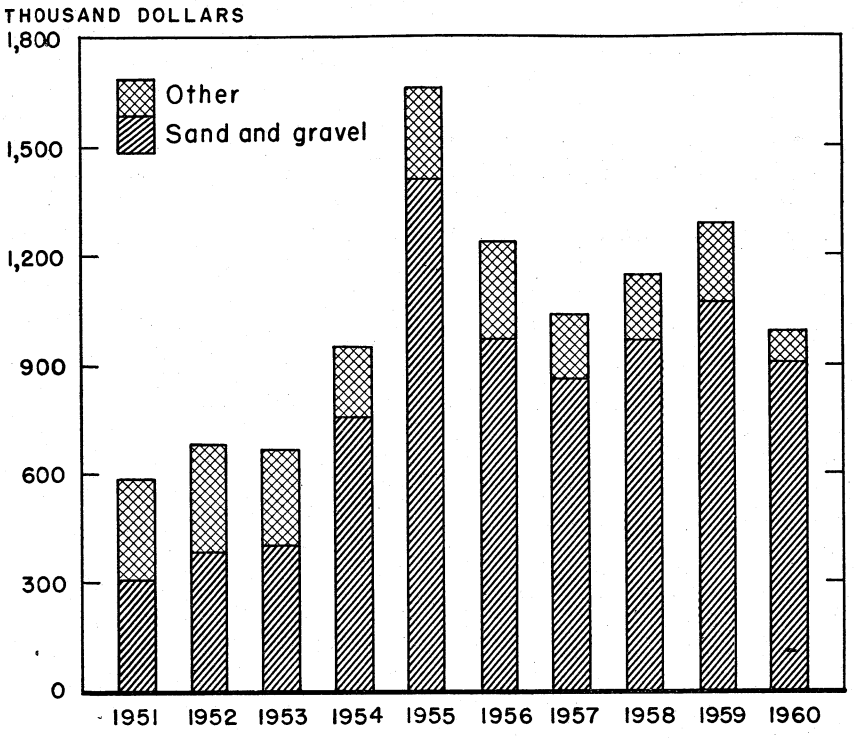

FIGURE 1.—Value of mineral production in Delaware 1951–60.

Allied Chemical Corp.'s Barrett Division began constructing a gypsum board plant at Claymont to utilize gypsum produced as a byproduct of wet-process phosphoric acid manufacture.

Sand and Gravel.—Sand and gravel continued to be the principal mineral industry in Delaware despite a drop of 13 percent in tonnage and 15 percent in value. No sand or gravel was produced by the State highway department, accounting in great measure for the decline. Commercial production of sand also decreased although gravel production increased. Sand was marketed as building, paving, and engine sand, and for fill. Gravel was marketed for building, paving, and fill. Of the total tonnage, sand and gravel for building purposes represented 12 percent and for paving purposes 79 percent. Less than half of the sand and gravel production was washed or screened, about 10 percent less than 1959. The entire output was transported by truck to consumers.

A daily average of 62 production employees worked a total of 104,000 man-hours during the year.

Stone.—Gabbro, classified as granite for statistical purposes, was the only stone produced in the State. It was crushed and shipped by truck for use as concrete aggregate and roadstone.

Sulfur.—Recovered elemental sulfur was produced by Tidewater Oil Co. at its Delaware City plant. The Claus process was used to re-

cover the sulfur from crude oil received from other States and foreign countries. Construction of a new naphthalene plant with an initial annual capacity of 100 million pounds was begun by Tidewater Oil Co. at this refinery.

METALS

Colorado Fuel and Iron Corp. sold its Claymont mill to Phoenix Steel Corp. in October 1960. The plant, with an annual ingot capacity of 506,500 short tons, consisted of seven open-hearth furnaces; two plate rolling mills of 160- and 120-inch widths with a combined annual capacity of 300,000 tons; an electric weld mill for large-diameter pipe; a fabricating shop; and a flanging, pressing, and dished and spun head department. Pig iron was supplied by the Phoenix, Chester, Pa., blast furnace, 3 miles from Claymont.

Sinter was produced at Wilmington by Pyrites Co., Inc. Raw materials for the sinter were residue from a pyrite concentrate produced in Pennsylvania, aniline sludge, and flue dust. The sinter was used in making pig iron and steel. The Delaware works of General Chemical Division, Allied Chemical Corp. at North Claymont produced cinder for use in making pig iron and steel, cement, and refractories.

Iron and steel scrap was generated in Wilmington, Dover, and Smyrna. Shipments from yards consisted primarily of Nos. 1 and 2 Heavy Melting steel, No. 2 and all other bundles, cast-iron scrap other than borings, and unprepared scrap.

The New Castle plant of American Manganese Steel Division, American Brake Shoe & Foundry Co., and the Wilmington plant of North American Smelting Co. were also active during the year. The New Castle plant produced manganese steel castings and chrome molybdenum steel castings, and the Wilmington smelter and refinery, bronze, brass, aluminum, and zinc casting alloys, solder, babbitts, and type metal.

REVIEW BY COUNTIES

Kent.—Sand and gravel was produced near Dover, Harrington, Milford, and Wyoming principally as building, paving, and fill material. Kent again ranked second as a mineral-producing county despite a 65-percent drop in sand and gravel production. St. Jones River Gravel Co. at Dover operated a stationary plant producing washed and screened materials. Fisher M. Carpenter produced bank-run gravel at Milford. Clough & Caulk Sand and Gravel marketed washed and screened sand and gravel; M. A. Hartnett produced bank-run sand. The Barber Sand and Gravel Co. dredge near Harrington produced sand for building purposes. The entire county output of sand and gravel was shipped to consumers by truck.

New Castle.—New Castle continued as the leading county in mineral production. Output of sand and gravel by commercial producers increased 27 percent over 1959. The sand and gravel produced was primarily paving and building material. Washed sand and gravel was produced from a stationary plant by Petrillo Bros., Inc., near Wilmington; Delaware Sand & Gravel Co., New Castle; and Whittington's Sand & Gravel Co., Bear. Delaware Sand & Gravel Co.

was the only one of the three that did not produce unprepared material. Parkway Gravel Co., Inc., operated the Cristine pit at Jefferson Farms, producing bank-run gravel, using a portable plant. The entire sand and gravel production in this county was shipped by truck.

Stone also was produced by the Petrillo Bros., Inc., from the multiple-bench Shellpot quarry near Wilmington. The crushed rock was transported by truck from a crushing plant to each project. Miscellaneous clay was produced by Delaware Brick Co. from an open pit near New Castle. The clay was loaded mechanically and transported to the plant—crushed, ground, and screened for use in producing building brick.

Sussex.—Output of commercial sand and gravel in Sussex county increased slightly over 1959. Bank-run sand was produced by Lewes Sand Co. for use as engine sand. The Henry G. Graves & Sons, Inc., portable plant produced paving sand. The Atkins Bros. stationary plant near Millsboro produced washed sand as building material, unprepared sand for fill material, and unprepared gravel for miscellaneous uses. The entire output of sand and gravel from this county was transported to consumers by truck.

The Mineral Industry of Florida

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Florida.

By Lawrence E. Shirley [1] and Robert O. Vernon [2]

FLORIDA produced a recordbreaking $177 million worth of mineral commodities in 1960. Production value increased 8 percent over 1959, the previous high year, and thus marked continuation of the trend of the past decade. Florida, the foremost producing State in the Nation for phosphate rock, fuller's earth, and staurolite, also led the Southeastern States in stone, peat, and oystershell output and was second only to Alabama in masonry and portland cement and lime, and second only to North Carolina in sand and gravel production. Production gains over 1959 were made in lime, peat, phosphate rock, sand and gravel, stone, titanium concentrates, magnesium compounds, staurolite, and zirconium concentrates.

Florida led the Nation in phosphate rock output for the 67th consecutive year and established a new high in the State; output increased 7 percent and value 16 percent over 1959. Leading phosphate rock producers were International Minerals & Chemical Corp., Virginia-Carolina Chemical Corp., and American Agricultural Chemical Co.

Stone output increased 3 percent and its value 4 percent over 1959 making it the second leading commodity in terms of value in the State; leading producers were Florida Rock Products Co., Camp Concrete Rock Co., and Ideal Crushed Stone Co.

Employment and Injuries.—Reports submitted to the Federal Bureau of Mines by producers in the mineral industries throughout the State indicated that 17 percent more mines, quarries, and mills were active than in 1959, an increase of 25 operations. The number of men working daily in these industries increased 3 percent, a net gain of 181 persons, over 1959. Total man-hours worked increased 1.4 million or 9 percent over 1959; there were increases in nonmetal mines and quarries and mills and decreases in metal mines and sand and gravel mines. Injuries per million man-hours decreased from 15 to 12. Fatal injuries decreased from 6 to 3 and nonfatal injuries from 240 to 223.

The University of Florida conducted its annual conference on Accident Prevention Engineering, as a public service to the employers and workers of Florida's industries. The conference, inaugurated in 1954, is held for 3 days each spring at the Florida Engineering and Industrial Experiment Station, Gainesville. Selected papers from

[1] Commodity-industry analyst, Bureau of Mines, Knoxville, Tenn.
[2] Director, Florida Geological Survey, Tallahassee, Fla.

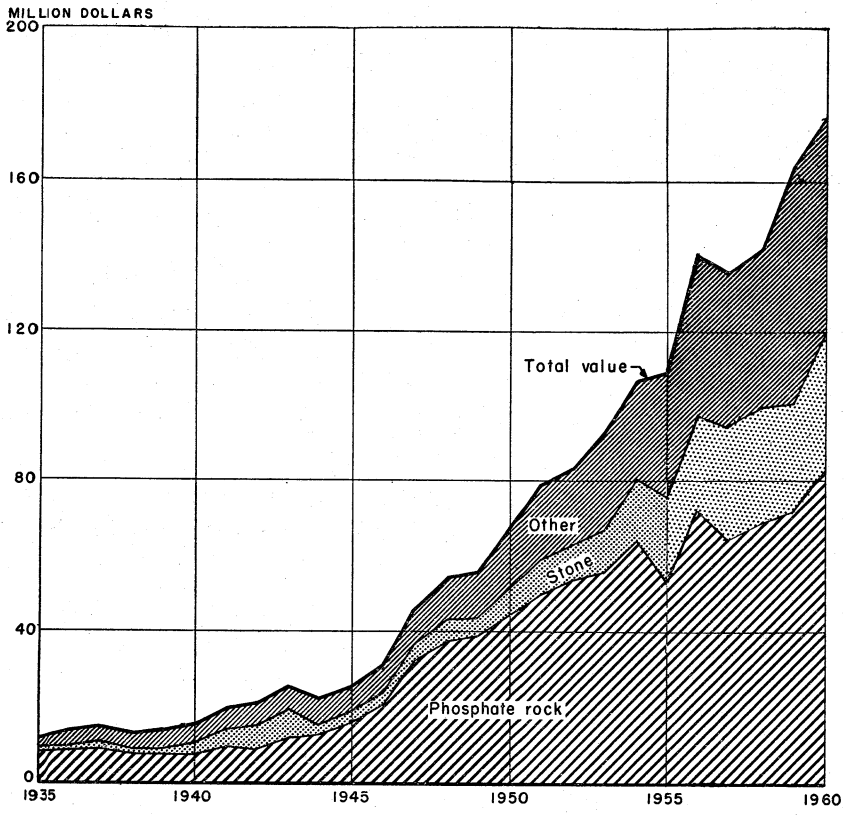

FIGURE 1.—Value of phosphate rock, stone, and total value of mineral production in Florida, 1935–60.

the conference were published,[3] and included such subjects as responsibilities of the safety engineer, industrial disaster planning and effective safety publicity.

Consumption, Trade, and Markets.—Florida's ports showed an 8-percent decline in exports and imports in 1960; the dollar volume of traffic fell from $729.8 million to $671.3 million. Exports dropped from $411.5 million to $318.3 million and imports from $379.3 million to $292 million. Port expansion and new construction highlighted port development during the year. Construction began on the new $20 million Port of Miami, implemented by the presentation by the city of Miami to the Metropolitan-Dade County Commission of property deeds for the 187-acre Dodge Island port site, the signing into law of a bill providing $3.8 million for Federal dredging on the new port, and the allocation of $2 million by the Metro Commission for initial construction. The port will offer facilities to attract shippers, using ultra-modern methods and ships designed to increase speed of ma-

[3] University of Florida, Industrial Safety Engineering, Selected Papers From Annual Conferences on Accident Prevention Engineering: Engineering Progress at the University of Florida, Bull. Ser. No. 5, vol. 14, No. 11, November 1960, 35 pp.

TABLE 1.—Mineral production in Florida [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	245	$6,171	252	$6,357
Gem stones	(3)	3	(3)	(4)
Lime thousand short tons	111	1,238	151	2,611
Natural gas million cubic feet	34	5	30	5
Peat short tons	34,446	158	39,275	162
Petroleum (crude) thousand 42-gallon barrels	424	(5)	[6] 368	(5)
Phosphate rock thousand long tons	11,564	71,208	12,321	82,530
Sand and gravel thousand short tons	6,674	5,177	6,757	5,559
Stone [7] do	26,917	35,940	27,629	37,419
Titanium concentrates thousand short tons, gross weight	262	7,196	286	7,489
Value of items that cannot be disclosed: Cement, clays (kaolin and miscellaneous clay), magnesium compounds, rare earth metal concentrates (1959), staurolite, stone (dimension limestone, 1959, and marl, 1960), zirconium concentrates, and values indicated by footnote 5		40,034		38,151
Total Florida [8]		163,446		176,920

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain clays, included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Less than $1,000.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Preliminary figure.
[7] Excludes certain stone, included with "Value of items that cannot be disclosed."
[8] Total adjusted to eliminate duplicating value of clay and stone.

terial handling. At the Port of Pensacola, a leading port for shipments of bulk fertilizer and paper, work was started on a $3.5 million project to develop a modern dock complex by bulkheading and extending present facilities; the new development, which includes new transit warehousing facilities, was expected to be completed in 2 years. At Port Everglades, near Ft. Lauderdale, work was nearly completed on major harbor improvements that included 1,475 linear feet of bulkheading for two new ship berths, with a water depth of 36 feet, and new maintenance buildings and berths for tugs.

TABLE 2.—Employment and injuries in the mineral industries [1]

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:							
Nonmetal mines	34	3,288	292	7,683,138	3	60	8
Quarries and mills	78	2,773	314	6,975,965	3	143	21
Metal mines	5	498	271	1,078,845		6	6
Sand and gravel mines	33	409	285	932,254		31	33
Total	150	6,968	299	16,670,202	6	240	15
1960: [2]							
Nonmetal mines	32	3,540	305	8,633,695	1	59	7
Quarries and mills	103	2,890	331	7,645,764	1	137	18
Metal mines	4	377	330	995,374	1	3	4
Sand and gravel mines	36	342	308	841,932		24	28
Total	175	7,149	317	18,116,765	3	223	12

[1] Excludes officeworkers.
[2] Preliminary figures.

The Atlantic Coast Line Railroad, which began piggyback service in June 1959, began scheduled piggyback train service between Florida and New York near the end of 1960. The special train, carrying truck trailers on specially constructed railway cars, will cut a day from the normal freight schedule between Lakeland, Fla., and New York City. Coast Line operated piggyback service on regular freight trains between 125 cities and carried more than 1,200 piggyback cars a month.

The volume of cement imported into Florida was of growing concern to domestic producers. Imports, which began in 1950, had increased steadily in the Florida customs district because of low freight rates, import duties, and price concessions.

Gypsum, perlite, and vermiculite were brought in from other States and processed for consumption in Florida and nearby States. National Gypsum Co. began constructing a new $6 million gypsum products plant near Port Tampa. Kaiser Gypsum Co. announced that a $3 million gypsum products plant would be built near Jacksonville.

Increased production of crushed stone and sand and gravel indicated expanding consumption of these commodities for road construction, concrete materials, and other building uses.

New developments during the year indicated increased consumption of phosphate rock in the immediate future for manufacturing ordinary superphosphate and triple superphosphate, for direct application to the soil, and for other fertilizer uses. Exports of phosphate rock increased 18 percent over 1959.

Trends and Developments.—Florida's industrial expansion and continued population growth contributed most to new developments during the year. Industry announced 839 new plants and major expansions during the year, the highest total reported since 1957, and 7 percent more than in 1959. Florida had been the third fastest growing State in the Nation since 1900, outpaced only by Arizona and California. Florida's population increase was 836 percent, from 529,000 in 1900 to 4,952,000 in 1960. The total population was expected to exceed 7 million by 1970. Brevard and Broward Counties occupied first and third places, respectively, out of 45 counties in the United States that more than doubled their population from 1950 to 1960. Florida's rate of gain in personal income last year was slightly ahead of the national average and continued to lead the South. The State ranked second in the Nation in terms of value of shipments of nonmetallic minerals, exceeded only by California.

Demand for electricity in Florida continued to increase, and new construction and expansion of power facilities continued by the State's four major power companies and municipally owned plants. Florida Power and Light Co. began an expansion program at its Riveria Beach plant to raise capacity from 140,000 to 440,000 kilowatts; and scheduled a second new unit for 1963 to add still another 300,000 kilowatts, making it the largest powerplant in the State. Tampa Electric Co. was adding 175,000 kilowatts of new capacity, Gulf Power Co. 150,000 kilowatts, and Florida Power Corp. 195,000 kilowatts. Among the municipally owned power systems, Jacksonville voted bonds to finance a 138,000-kilowatt addition and Orlando

was adding 90,000 kilowatts. Electric power generating capacity in Florida totaled 3.8 million kilowatts.

Houston Texas Gas and Oil Corp., a division of the Houston Corp., was authorized by the Federal Power Commission to build 235 miles of sales laterals in the State and to boost compressor capacity by 30,000 horsepower, at a cost of $16 million.

The Florida Development Commission announced that several sites in the northwestern part of the State were being considered for a nuclear fuel reprocessing plant that would cost between $12 and $20 million. The plant would treat fuel elements from privately owned nuclear powerplants and would require 6,000 acres of land.

Roadbuilding and bridge construction were accelerated. The interstate highway construction program in Florida ranked first in the Nation in utilization of interstate funds; of $194 million allocated to the State, all except $2.5 million had been obligated. Of Florida's total interstate mileage, 113 miles will be urban and the remainder rural. The urban mileage, 10 percent of the total, is expected to carry 50 percent of the traffic. At the end of 1960, 50.6 miles of interstate highway were open to traffic, 170.7 miles were under construction, and 183.1 miles were in the final planning state. The Florida Development Commission sold revenue bond issues totaling $47.2 million for road construction in 11 counties and authorized the financing of $26.8 million for 5 other projects in 5 counties. Output of crushed limestone, sand and gravel, and other roadbuilding materials increased for the year, and there were indications that demand would continue to increase.

Pan-American Sulphur Co. began constructing a 20,000-ton molten-sulfur storage tank in Tampa. The tank, expected to be completed in early 1961, will receive molten sulfur from Mexico in a Pan American tanker under construction in Germany. Tampa is Pan American's main U.S. shipping point and remelting facility. Freeport Sulphur Co. is also constructing a new 30,000-ton transshipment center at Tampa.

Legislation and Government Programs.—The Bureau of Sanitary Engineering, Florida State Board of Health, began a study to determine the air pollution problem. The results of the survey would guide establishment of appropriate air pollution control measures. Several of the phosphate producing companies installed new equipment or improved existing equipment to control both liquid and gas wastes from their operations.

The U.S. Department of the Interior, Office of Saline Water, awarded a contract to the Blaw-Knox Co. of Pittsburgh to erect and operate, at St. Petersburg, a freezing process pilot plant for converting salt water to fresh water. The plant will test a process developed under an Office of Saline Water contract by Cornell University. In addition, three solar-distillation pilot plants were under test at Daytona Beach.

The Bureau of Mines, at its Norris (Tenn.) Metallurgy Research Center, continued tests on Florida clay samples as part of its cooperative agreement with the Florida Geological Survey.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement output declined for the first time since 1957; output for all types of cement decreased 8 percent in quantity and 7 percent in value from 1959. Portland cement decreased 7 percent in quantity and 6 percent in value; masonry cement decreased 19 percent in quantity and 18 percent in value. The decreased production was attributed to delays in highway and general construction programs. Competition from foreign cement also had some bearing on the downturn; during 1960 about 896,000 barrels of cement was imported into the Florida customs district, more than into any other district in the Nation. Mineral commodities used in cement production, crushed limestone and clay, also decreased in output.

Lehigh Portland Cement Co. operated plants near Bunnell (Flagler County) and Miami (Broward County). Two descriptive articles on the electrical system employed in Lehigh's Miami plant were published.[4]

General Portland Cement Co. operated its Tampa and Miami plants throughout the year. The company continued its improvement and expansion program at both plants at an estimated cost of $11 million for 1960; projected expenditures for 1961 were $7 million. Construction at the Tampa plant, expected to be completed in 1961, would boost output to 7 million barrels annually. Features of this expansion were a 16½- by 600-foot kiln, said to be the largest wet-process unit in the United States, and four 12- by 36-foot compartment mills with 3,000-horsepower motors, also of record size. Hurricane Donna caused a temporary shutdown of the company's plants and interfered with construction projects and cement shipments.

Universal Atlas Cement Division of United States Steel Corp., secured options on three sites for cement distributing stations along the eastern seaboard, two of which were in Florida—at Jacksonville and Port Canaveral.

Prestressed-concrete railroad ties were tested on a one-fourth-mile section of track of Seaboard Air Line Railroad near Tampa by American Concrete Crosstie Corp. The ties, designed by the Association of American Railroads, were said to have competitive advantages over the conventional wooden ties; because of their strength, about one-third as many ties are needed per mile of track, and they are expected to last two or three times longer than wooden ties.

The volume of imported cement along the eastern seaboard, particularly in the Florida customs district, was of growing concern to domestic producers. In 1950, imported cement began to come into Florida in large quantities because it was badly needed, was of good quality, and supplied the needs of a fast-growing market that could not get its cement needs from domestic producers. When domestic cement was no longer in short supply foreign producers were able to continue to make inroads into the domestic market by offering

[4] Hower, John F., and Lordi, Anthony C., Lehigh's Miami Plant Highlights Advanced Theories: Rock Products, vol. 63, No. 5, May 1960, pp. 168, 170, 172, 174; Lehigh's Power Centers Set New Trend: Rock Products, vol. 63, No. 6, June 1960, pp. 114, 116, 119, 124.

price concessions because of low freight rates and low import duties. Domestic producers made no great effort to counteract these imports by greater exports, partly because most other countries had prohibitively high import duties. Articles were published during the year concerning cement imports.[5]

Ponce Products, Inc., Ponce, Puerto Rico, purchased a further interest in Maule Industries, Inc., a large producer of ready-mixed concrete, concrete products, and crushed limestone and other aggregates in the Miami area. Funds from the purchase were to be used by Maule Industries to build new aggregate and ready-mix plants west of Miami. Ponce owns two cement plants in Puerto Rico which ship much of their output to Florida's east coast.

Clays.—Total clay production, including fuller's earth, kaolin, and miscellaneous clay, decreased 2 percent in output but increased 2 percent in value over 1959. Florida, for the third consecutive year, ranked first in the Nation in production of fuller's earth and output reached a new record high. Tonnage and value increased 3 percent over 1959, totalling 252,000 tons valued at $6.4 million. Fuller's earth accounted for about 4 percent of the total mineral production value of Florida. Fuller's earth was mined in Gadsden County by Minerals & Chemicals Phillip Corp., Floridin Co., Inc., and Magnet Cove Barium Co.

On July 21, Minerals & Chemical Corp. of America and the Phillip companies, consisting of Phillip Brothers, Inc., and Phillip Brothers Ore Corp. merged to form Minerals & Chemicals Phillips Corp. Phillip Brothers, Inc., and its subsidiary are importers, exporters, processors, and merchants in ferrous and nonferrous ores, metals, and minerals. They operate in the United States and through subsidiaries abroad. Minerals & Chemicals, in addition to its fuller's earth operations in Florida, produces and processes kaolin, bauxite, and limestone products, with mines and plants in Georgia, Arkansas, Michigian, Ohio, and Virginia and a research center at Menlo Park, N. J.

The Floridin Co., with facilities in both Tallahassee and Quincy, celebrated its 50th anniversary by beginning research into new applications for fuller's earth; the company also opened new sales offices in New York, N. Y., St. Louis, Mo., and Dallas, Tex., in an effort to reach new markets for fuller's earth, activated bauxite, and chromatographic adsorbents.

Kaolin output decreased by 2 percent and its value by 7 percent from 1959. Putnam County was the only county in which kaolin was produced; it was mined by United Clay Mines Corp. and Edgar Plastic Kaolin Co. A deposit containing 16 million tons of kaolin was located between Leesburg and Okahumpka in the Lake County area. The material was suitable for chinaware or pottery.

Miscellaneous clay production decreased 5 percent in both quantity and value from 1959, due to an 11-percent decrease in clay used for cement manufacture. The clay was mined in Citrus County by General Portland Cement Co., in Clay County by the Solite Corp., and in Gadsden County by the Apalachee Correctional Institute.

Universal Sewer Pipe Corp., announced plans to construct a 200,000-square-foot plant near Ocala, to produce vitrified clay pipe and related

[5] Bell, Joseph N., Cement Imports Pose Threat: Rock Products, vol. 63, No. 10, October 1960, pp. 81–93. Price, Frederick C., Cement Outlook: Grim but Hopeful, Chem. Eng., vol. 67, No. 22, Oct. 31, 1960, pp. 60, 62, 64.

products; operations at the company's concrete pipe facility near the main plant on Neville Island near Pittsburgh, Pa., were being discontinued. Vulcan Materials Co., with concrete pipe plants in Jacksonville and Tampa, constructed a modern concrete pipe plant at Orlando, Fla. to replace obsolete facilities at Sanford. A new concrete pipe plant also was built by the company at Tallahassee and existing facilities there were expanded at a cost of $250,000. Plans were also announced for a new plant at Apopka. Southern Lightweight Aggregates Corp. of Richmond, Va., changed its name to Solite Corp. The company, in its second year, produced lightweight aggregate at Green Cove Springs for use in structural concrete and masonry. The company also maintained offices in Jacksonville. A description of the Solite operation was published.[6]

Gem Stones.—Gem stone output, valued at $3,000 in 1959, declined to less than $1,000. Production of agatized coral from the Tampa Bay area in Hillsborough County was reported. No collecting of selenite or shells was reported, although a certain amount of this type of collection goes on the year round.

Gypsum.—United States Gypsum Co. at Jacksonville, Duval County, calcined gypsum for use in manufacturing building products. The company completed a new plant to produce paper used in the manufacture of sheetrock, wallboard and other products manufactured in the company's plant at Jacksonville.

National Gypsum Co., started constructing a gypsum products plant estimated to cost $6 million, on a 30-acre site on Tampa Bay. The plant will process gypsum ore received by ship from National Gypsum's deposits in Nova Scotia, and manufacture gypsum wallboard, lath, sheathing, and plaster. The new plant was expected to be in production in mid-1962. In 1960, the company was supplying the growing Florida market from its recently expanded plant in Savannah, Ga.

Kaiser Gypsum Co., of Oakland, Calif., a wholly owned subsidiary of Permanente Cement Co., exercised its option to purchase 34 acres of property near Jacksonville, as a site for a $3 million gypsum products plant to be completed in 1961. Kaiser Aluminum & Chemical Corp. manufactured sodium silicate at Mulberry.

Lime.—Lime was produced in four counties by four companies; three of the operations were captive. Output of lime continued an upward trend, increasing 36 percent in quantity and 111 percent in value over 1959. Dixie Lime Products Co. (Ocala No. 1 limekiln), Marion County, the only commercial lime producer in the State, sold quicklime and hydrated lime for masonry, chemical, and industrial uses. Buckeye Cellulose Corp. (Foley limekiln), Taylor County, the largest producer of lime in the State, produced 97,000 tons of quicklime for use in its own plant for water purification and causticizing. The company announced about midyear a program for increasing capacity for bleached kraft and dissolving pulps by 33,000 tons per year—3 percent higher than the current capacity of 260,000 tons per year. This would be the company's third expansion in 3 years. In 1959, a $20-million expansion was completed when a second produc-

[6] Wright, C. E., Solite Didn't Spare the Spadework: Rock Products, vol. 63, No. 4, April 1960, pp. 144, 146.

tion line was added. It was anticipated that lime requirements would expand further as water purification needs increase. Michigan Chemical Corp. (Port St. Joe limekiln), Gulf County, produced quicklime for its own use. The city of Miami (Hialeah limekiln), Dade County, produced 23,000 tons of quicklime valued at $244,000 for municipal water purification and softening.

Chemical Lime, Inc., Brooksville, announced in September that a plant costing $2 million would be constructed to produce quicklime and hydrated lime for the chemical processing and other industries. The plant was to go on stream in the summer of 1961 with a design capacity of 200 tons per day. Raw material—Ocala limestone—will be obtained from the quarry of Camp Concrete Corp.

Magnesia.—Michigan Chemical Corp., in its second year of production of magnesia from sea water, increased output considerably. The company produced refractory and caustic-calcined magnesias for use by the plastic, refractories, fertilizer, chemical, paper, glass, rubber, insulation, and petroleum industries. During the year the company installed new equipment, including a special rotary kiln.

Perlite.—Crude perlite from Western States was processed by three companies in three counties; combined output was 9,000 tons valued at $599,000 compared with 11,000 tons valued at $786,000 in 1959, a decrease of 18 percent in tonnage and 24 percent in value. This was the first year that a decrease had been recorded since production began in 1952. Average value-per-ton of the processed material increased to $69.23 per ton from $69.09 in 1959. Airlite Processing Corp. of Florida, Indian River County, the largest producer in the State, expanded perlite for use in building plaster and concrete aggregate; Tennessee Products & Chemical Corp., Duval County, expanded perlite for use in building plaster at its Jacksonville plant; and Perlite, Inc., Dade County, expanded perlite at its Hialeah plant for use in building plaster, concrete aggregate, and soil conditioning.

Phosphate Rock.—For the 67th consecutive year, Florida led the Nation in total phosphate rock production. Seventy percent of the Nation's marketable phosphate rock was produced in Florida. Tonnage and value both reached record highs in 1960. Combined marketable production of all types of phosphate rock totaled 12.3 million tons valued at $82.5 million, an increase of 7 percent in quantity and 16 percent in value over 1959. Land-pebble phosphate which comprised 99 percent of the total phosphate rock output, established a new record for marketable production and was responsible for the total gain. Hard-rock and soft-rock phosphate both declined in output and value from 1959. The largest decline was in soft rock which decreased 10 percent in tonnage and 7 percent in value; hard-rock output decreased 1 percent in tonnage, but increased 1 percent in value from 1959.

Mine production of land-pebble crude ore, dry basis, was 47,651,000 long tons, with a P_2O_5 content of 4,980,000 long tons. A total of 12,132,000 long tons of processed materials with a P_2O_5 content of 3,984,000 long tons was sold or used during 1960. Land pebble for agricultural purposes comprised 54 percent of that sold or used and totaled 6,562,000 long tons; 63 percent went into ordinary superphosphate, 24 percent into triple superphosphate, and the remaining 13

percent was used for direct application to the soil, other fertilizer uses, and stock and poultry feed. Industrial purposes consumed 20 percent or 2,427,000 tons; 87 percent of this tonnage was used for making phosphoric acid by the wet process and the remaining 13 percent went into the manufacture of elemental phosphorus. Twenty-six percent or 3,143,000 long tons of the total was exported, an increase of 18 percent over 1959. A total tonnage of 1,137,000 long tons of processed material was sold to and purchased from mining companies, an interchange common to the industry.

Land-pebble phosphate came from 14 mines operated by 8 companies in Polk and Hillsborough Counties. In Polk County, the following companies, listed in order of output, operated: International Minerals & Chemical Corp. (Achan and Noralyn mines), Virginia-Carolina Chemical Corp. (Clear Springs and Homine mines), American Agricultural Chemical Co. (South Pierce mine), American Cyanamid Co. (Orange Park mine), Swift & Co. (Varn and Watson mines), W. R. Grace & Co., Davison Chemical Division (Bonny Lake and Clark-James mines), Armour Agricultural Chemical Co. (Armour mine), and Smith-Douglass Co., Inc. (Tenoroc mine). In Hillsborough County, American Cyanamid Co. (Sydney mine) and American Agricultural Chemical Co. (Boyette mine) operated.

Hard-rock phosphate, for use in manufacturing phosphorus and ordinary superphosphates, was produced by only one company, Kibler-Camp Phosphate Enterprise (Section 20 mine), Citrus County.

Soft-rock phosphate production came from seven mines operated by six companies in three counties. The largest single mine producer was Sun Phosphate Co. (Dunnellon mine), Citrus County; the largest producing company, with two mines, was Loncala Phosphate Co. (Mona mine in Gilchrist County, and Lake City Junction mine in Columbia County). Other producers, in order of output, were Soil Builders, Inc. (Mincoll mine), Kellogg Co. (Kellogg mine), Camp Phosphate Co. (Hernando mine), and Superior Phosphate Co., all of Citrus County. Total marketable production was 46,488 long tons

TABLE 3.—Phosphate rock sold or used by producers, by uses

Use	1959			1960		
	Long tons	Value		Long tons	Value	
		Total	Average per ton		Total	Average per ton
Ordinary superphosphate	4,293,954	$26,891,017	$6.26	4,155,626	$28,402,633	$6.83
Phosphoric acid (wet process)	(1)	(1)	(1)	2,100,706	13,094,121	6.23
Triple superphosphate	[2] 3,459,413	[2] 20,220,090	5.84	1,571,823	10,883,760	6.92
Direct application to the soil	598,227	3,778,731	6.32	556,348	3,894,853	7.00
Elemental phosphorus, ferrophosphorus, phosphoric acid	341,193	2,017,055	5.91	387,041	2,563,812	6.62
Stock and poultry feed	350,977	2,254,136	6.42	[3] 336,723	[3] 2,383,986	7.08
Other uses	[3] 50,884	[3] 320,061	[3] 6.29			
Exports	2,665,562	17,382,120	6.52	3,142,415	20,693,052	6.59
Total	11,760,210	72,863,210	6.20	12,250,682	81,916,217	6.69

[1] Included with triple superphosphate.
[2] Includes phosphoric acid (wet process).
[3] Includes nitraphosphate and other fertilizer.

TABLE 4.—Marketable production of phosphate rock

(Thousand long tons and thousand dollars)

Year	Hard rock		Soft rock		Land pebble		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	81	$637	83	$496	9,028	$54,371	9,192	$55,504
1956	96	809	59	378	11,668	73,103	11,823	74,290
1957	80	689	52	365	10,059	63,736	10,191	64,789
1958	87	737	53	414	10,711	67,800	10,851	68,951
1959	78	666	52	414	11,434	70,128	11,564	71,208
1960	77	670	47	384	12,197	81,476	12,321	82,530

valued at $384,536, a decrease of 10 percent in quantity and 7 percent in value from 1959. The phosphate was all used in stock and poultry feed and for direct application to the soil.

International Minerals & Chemical Corp., Bartow, the largest producer of phosphate rock in the State, increased output 11 percent in quantity and 21 percent in value over 1959, a record year despite damage and flooding by Hurricane Donna, a break in the impounding dam of the Noralyn mine, and labor strikes. The company signed a multi-million-dollar contract with Electric Reduction Co., Toronto, Ont., to supply calcined phosphate rock from its Noralyn mine to Port Maitland, Ont., where Electric Reduction was building a $12-million plant to produce phosphoric acid, dicalcium phosphate, triple superphosphate, and sodium tripolyphosphate. International will serve as U.S. sales agent. In the last quarter of 1960, International announced plans to build a new $1 million phosphate-calcining plant at Noralyn, adjacent to an existing plant, to handle the increased demand resulting from the Electric Reduction contract. The company placed in operation a recirculating system at its Bonnie plant designed to control both liquid and gas wastes in chemical processing of phosphates.

Virginia-Carolina Chemical Corp., Bartow, second largest producer of phosphate, increased output of marketable phosphate 49 percent in quantity and 57 percent in value over 1959, a record high. During 1960 the company tripled superphosphate capacity at its Nichols plant from 100,000 to 300,000 tons per year as part of a $10 million expansion program; completed a new diammonium phosphate plant, with potential capacity of 100,000 tons per year, adjacent to the company's concentrated superphosphate facility at Nichols; and completed a new phosphate-rock flotation plant costing more than $1 million, at the Clear Springs mine, 20 miles south of Nichols. The company sold its one-third interests in Gulfcoast Transit Co. and Mid-South Towing Co., phosphate and coal haulage companies, to Peabody Coal Co. and Tampa Electric Co., former partners in the operations. A labor dispute resulting from a company proposal to divide mining and processing into two contract units, begun in 1959, extended into 1960.

American Agricultural Chemical Co., the third largest producer of marketable phosphate, decreased output 8 percent in quantity and 4 percent in value under 1959, the first decrease by the company since 1955. The company began constructing a new phosphate washer at

Palmetto with completion scheduled for March 1961. A hydrosizer for the new plant was developed by the company's metallurgical staff. The company's new air classifiers at its Pierce plant were described.[7]

American Cyanamid Co., Brewster, the fourth largest producer of land-pebble marketable phosphate, increased output 27 percent in quantity and 45 percent in value over 1959, establishing a record year for output at its Orange Park mine. The company's phosphoric acid plant at Brewster was expanded to 200,000 tons (54 percent acid) per year; additional construction was begun at the same location to provide for a total of 400,000 tons of 54 percent phosphoric acid capacity annually. Approximately 3,500 acres of phosphate rock-bearing land in the Brewster area were purchased during 1960, in line with the company's long-range program of reserve acquisition. Planned expansion of the company's triple superphosphate facilities called for the installation of additional rock-grinding equipment, new granulation facilities, and a new quality-control laboratory at Brewster, enabling entry into the direct application market, both in the United States and abroad. The company announced plans at the end of 1960 to increase expenditures for pollution control by $2 million. A large chain mill and scrubber installation, to reduce fluorine emission from the firm's triple superphosphate curing building, was completed at a cost of $500,000 and was expected to reduce fluoride emitted to the atmosphere by about 70 percent. The company's pollution control system was described.[8]

Swift & Co., Bartow, began to double phosphoric acid capacity in the last half of 1960, to increase output of triple superphosphate. The company signed a 3-year labor contract with the International Chemical Workers Union that called for wage increases extending into 1961.

W. R. Grace & Co., Davison Chemical Division closed its Pauway No. 4 mine near Lakeland and opened the new Clark-James mine; extensive modernization and expansion of mining facilities was in progress at the close of the year. The company completed its new 400-ton-per-day sulfuric acid plant at Bartow; expansion of phosphoric acid facilities was also in progress at yearend. A wet scrubber to remove dust ejected into the air by drying plants was installed by the company at its Ridgewood plant. The new scrubber used 15 gallons of water per minute and handled 145,000 cubic feet of exhaust gas per minute. It was the first of its type to be installed in the Florida phosphate field.

Armour Agricultural Chemical Co., Fort Meade, announced that construction of a new phosphate facility to produce phosphoric acid, triple superphosphate, and sulfuric acid, estimated to cost $10 million, would begin in 1961. The new plant was part of a $60 million company expansion program set for completion in 1962.

Smith-Douglass Co., Inc., perfected a new phosphate-ore flotation process that demonstrated 30 percent savings in major equipment costs and 20 percent in operating costs, based on an 8-month test. In the new process, silica is floated first instead of phosphate. The key to the new process is an air-operated cell with no moving parts. Ground

[7] Engineering and Mining Journal, New Air Classifiers Reclaim Phosphate: Vol. 161, No. 10, October 1960, pp. 105–106.
[8] Pit and Quarry, Fluoride Pollution Control System Installed at American Cyanamid Plant: Vol. 53, No. 3, September 1960, p. 115.

phosphate rock, mixed with a chemical, enters the feed distribution box at the top of the cell and water is forced through pinholes in rubber tubes on three levels of the cell. Combined action of the water, the air bubbles, and the shape of the cell itself circulates the mineral suspension. About 10 percent more phosphate is recovered from the ore than in conventional cells, where an impeller usually stirs the suspension. Flotation starts as an amine reagent coats the silica lumps, usually about one thirty-second of an inch in diameter. Since the amine has an affinity for air bubbles, buoyant bubbles of encased silica form and float to the surface where they overflow the cell. Phosphate sinks to the bottom and is discharged through the underflow. A detailed description of the process was published.[9] Near the end of 1960, the company doubled the input rate of its flotation pilot plant at the Tenoroc mine, east of Lakeland to 100 tons per hour of phosphate rock. The pilot plant, using the Hollingsworth-Sapp system, was originally built with commercial-size equipment, and the final step in the company's expansion program will be a complete changeover to the new process. During pilot plant testing, phosphate recoveries were 95 percent; 85 percent is normal in other processes. According to the company, this increase could mean a saving of $8 million per year for Florida producers.

U.S. Phosphoric Products division, Tennessee Corp., Tampa, announced a multi-million-dollar expansion for its operations at Gibsonton. The new facilities will increase output of phosphate products 50 percent. An $11 million ammonia plant also was under construction. The new phosphate facilities were expected to be completed by late 1961 or early 1962.

National Phosphate Co., Marseilles, Ill., reported that construction of a new phosphoric acid plant was 50 percent complete; National will use Florida phosphate rock and sulfuric acid to produce phosphoric acid (54 percent) by the wet-process method.

Plymouth Cordage Co., of Plymouth, Mass., acquired Wilson & Toomer Fertilizer Co., of Jacksonville for $8.5 million; Wilson & Toomer makes fertilizers, pesticides, and poultry byproducts. Plymouth Cordage had four plants in Florida and two in Georgia; it also had rock-crushing, stevedoring, and warehousing operations in Florida.

The Tennessee Valley Authority (TVA)[10] continued prospecting in the Florida hard-rock phosphate area. TVA purchased 600 acres of phosphate land, to increase total holdings to 4,074 acres. At the 1960 rate of consumption this represented an ore reserve of about 19 years. No mining was done by TVA in Florida. TVA studies to develop more efficient methods of recovering phosphate from the Florida hard-rock field were continued, wet-screening method now in use commercially recover only about half the phosphate. High-analysis Florida land-pebble phosphate was purchased for the research and mixed with Tennessee phosphate matrix to make a suitable charge for the electric furnaces or treated with phosphoric acid or P_2O_5 to make a high-analysis fertilizer. Improvements were made in the demonstration

[9] Chemical Week, Flotation Switch Cuts Phosphate Costs: Vol. 87, No. 3, Sept. 24, 1960, pp. 75–76.

[10] Tennessee Valley Authority, Annual Report of the Tennessee Valley Authority, for fiscal year ended June 30, 1960, 83 pp.

plant placed in operation in 1959 for experimental production of nitric phosphate-type fertilizer from leach-zone ore. This ore is primarily an aluminum phosphate and is discarded with overburden in Florida phosphate mining operations. Plant improvements in 1960 increased output; 1,267 tons was produced. TVA made a total of 264,000 tons of fertilizer of all types, sold 250,000, and used the remainder in farm demonstration programs. During 1960 a new process was developed by TVA to make granular diammonium phosphate fertilizer. It was reported that the method can use low-cost wet-process phosphoric acid without a purification step. A more detailed description of the product was published.[11]

Sand and Gravel.—A new record was established in combined production of sand and gravel. Total output sold or used by producers was 6.8 million tons valued at $5.6 million, an increase of 1 percent in quantity and 7 percent in value over 1959. Individually, sand production increased 1 percent in tonnage and 8 percent in value; gravel decreased 2 percent in tonnage and increased 5 percent in value. Sand and gravel was produced by 43 mines in 12 counties, 2 counties less than in 1959. Leading sand and gravel producing counties, as in 1959, were Polk, Putnam, and Lake, listed in order of output. Leading producers of sand, all in Polk County, were Mammoth Sand Co. (Lake Wales mine), Pembroke, Standard Sand Co. (Standard mine), Davenport, and Oak Ridge Sand Co. (Achan mine), Mulberry. Eighty percent of the sand produced was sold or used as building sand, 9 percent as fill sand, 6 percent as paving sand, and the remaining 5 percent as glass, molding, blast, and filter sand and for other uses. Gravel, produced by 7 mines in 6 counties, decreased 2 percent in quantity from 1959. Sixty-one percent was used or sold as building gravel and 39 percent as paving gravel. Leading gravel producers were Florida Gravel Co. (Chattahooche mine), Chattahooche; Ward Gravel Co. (Century mine), Flomaton, Ala.; and Dade-Broward Rock Co. (Opa Locka mine), Opa Locka. Ninety-five percent of the sand and gravel was processed by washing, classifying, sorting, or other methods and the remaining 5 percent was unprocessed material. Fifty-eight percent of the sand and gravel was transported by railroad, and 42 percent by truck.

Southern Materials Co., Jacksonville, established a new sand operation in Putnam County, and spent $3.4 million for diversification and expansion. Seven ready-mixed concrete plants, a concrete block plant, and the sand operation were added in the Jacksonville area. The Florida Division of Oakland Consolidated Corp. of Michigan started construction on a new sand plant 2 miles west of Clermont, Lake County. The new plant, to be operated by Oakland Sand and Minerals Corp., was expected to be operating in the first half of 1961. The plant will have a capacity of 7,500 tons per day. A major feature of the plant will be a 100-foot-high tower for gravity stockpiling of more than 75,000 tons of finished sands. Ferro Corp., Cleveland, Ohio, a large producer of porcelain enamel frit, announced plans to build a new fiber glass plant at North Miami, Dade County, as part of Ferro Corp's. $2.8 million expansion program. Products of the

[11] Chemical Engineering, Ammoniated Phosphates Highlight Fertilizer Shift: Vol. 68, No. 10, May 15, 1960, pp. 68–72.

TABLE 5.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Bay	(1)	(1)	(1)	(1)
Broward	41,225	$25,900	(1)	(1)
Dade	(1)	(1)	712,387	$530,374
Escambia	476,405	406,239	386,515	356,812
Gadsden	229,436	382,890	222,898	364,145
Glades			(1)	(1)
Lake	793,579	573,157	882,602	585,786
Leon	56,588	75,850	78,613	110,545
Pinellas	71,316	99,407		
Polk	3,320,219	2,351,224	3,069,400	2,250,686
Putnam	1,236,084	1,006,177	958,371	832,352
St. Lucie	(1)	(1)	(1)	(1)
Volusia	(1)	(1)	(1)	(1)
Undistributed	449,196	256,114	446,157	528,478
Total	6,674,048	5,176,958	6,756,943	5,559,178

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 6.—Sand and gravel sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	5,299,862	$3,938,056	$0.74	5,054,133	$3,924,689	$0.78
Fill	201,872	110,876	.55	565,825	306,107	.54
Paving	371,132	240,841	.65	399,823	377,631	.94
Other [2]	(1)	(1)	(1)	265,687	288,054	1.08
Total	(1)	(1)	(1)	6,285,468	4,896,481	.78
Gravel:						
Structural	(1)	(1)	(1)	288,286	333,503	1.16
Paving	194,951	348,172	1.78	183,189	329,194	1.80
Total	(1)	(1)	(1)	471,475	662,697	1.41
Total sand and gravel	6,674,048	5,176,958	.78	6,756,943	5,559,178	.82

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes glass, molding, blast, filtration, and other sands.

plant will be glass mats and colored coatings for the Florida glass boat industry. Benner Glass Co., Jacksonville, announced expansion of its glassware plant; the 6-year-old company had increased employment from 12 to 175 workers, and distributed its products throughout the eastern half of the United States.

Precast and prestressed concrete bridge sections were used in constructing the 3-mile Pensacola Bay Bridge. Monolithic deck units spanned 60 feet and weighed 156 tons; some of the prestressed cylinder piles were 164 feet long, believed to be the longest of their type used in U.S. bridge construction.

Staurolite.—Staurolite output reached a new high with an increase of 5 percent in tonnage and 8 percent in value over 1959, the previous record year. E. I. du Pont de Nemours & Co., Inc., Clay County, the

only producer in the United States recovered staurolite as one of the byproducts in concentrating titanium minerals at its Highland and Trail Ridge plants. Staurolite was sold as a source of alumina and iron oxide for the manufacture of cement.

Stone.—Florida led the Southeastern States in total stone production with an output of 27.6 million tons valued at $37.4 million, increases of 3 percent in tonnage and 4 percent in value over 1959, the previous record year. Total stone production had increased each year since 1952, attesting to the rapid growth of construction in Florida. Crushed limestone, the principal stone commodity, also established a new high in 1960; output was 26 million tons valued at $34.9 million, an increase of 4 percent in quantity and 5 percent in value over 1959, the previous record year. Crushed limestone accounted for 94 percent of total stone production. Crushed limestone used in cement manufacture decreased 13 percent in tonnage and 8 percent in value below 1959, due to decreased raw-material requirements by the cement industry. Crushed oystershell production, which had been growing since 1955, decreased 16 percent in tonnage and 10 percent in value under 1959; total output was 1.6 million tons valued at $2.6 million. It was used for concrete and roadstone (97 percent) and poultry grit (3 percent). For the first time since 1951, no dimension limestone was recorded. Marl was produced for the first year since 1949, by Seminole Shell Products Co., Inc. (Dunedin quarry), Pinellas County, for use as a filler.

Crushed limestone was produced at 75 mines in 20 counties; 84 percent was used for concrete, roadstone, and screenings, and the remainder for agricultural railroad ballast, and other uses; 9 companies in 7 counties produced crushed limestone for agricultural purposes.

TABLE 7.—Crushed limestone sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Alachua	860,580	$635,126	1,201,668	$1,030,731
Broward	5,449,715	6,207,392	4,079,176	5,181,281
Citrus	(1)	(1)	(1)	(1)
Collier	453,593	607,164	(1)	(1)
Columbia			(1)	(1)
Dade	6,969,203	9,104,744	7,707,367	9,673,221
Flagler	(1)	(1)	(1)	(1)
Hendry	(1)	(1)	(1)	(1)
Hernando	4,876,899	8,333,638	5,415,406	8,893,350
Indian River			8,066	6,453
Lafayette	203,000	182,700	239,600	209,088
Lee	(1)	(1)	(1)	(1)
Levy	611,520	825,939	414,264	784,152
Manatee	(1)	(1)	(1)	(1)
Marion	1,438,731	1,585,666	1,329,792	1,223,071
Monroe	126,500	242.000	(1)	(1)
Palm Beach	188,368	151,815	(1)	(1)
Pasco	(1)	(1)	(1)	(1)
Pinellas			7,350	7,350
St. Johns			(1)	(1)
Sarasota			(1)	(1)
Sumter	(1)	(1)	(1)	(1)
Suwannee	(1)	(1)	(1)	(1)
Undistributed	3,871,407	5,217,651	5,660,110	7,842,193
Total	25,049,516	33,093,835	26,062,799	34,850,890

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 8.—Crushed limestone and oystershell sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	22,698,773	$29,103,378	$1.28	23,309,376	$30,229,203	$1.30
Agstone	564,099	1,614,607	2.86	728,340	2,125,907	2.92
Stone sand	307,837	349,797	1.14	372,186	412,356	1.11
Railroad ballast	(1)	(1)	(1)	199,341	327,970	1.65
Riprap	19,000	11,970	.63			
Other [2]	3,327,397	4,860,061	1.46	3,019,737	4,323,542	1.43
Total	26,917,106	35,939,813	1.34	27,628,980	37,418,978	1.35

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes cement, asphalt filler, poultry grit, lime, other uses, and uses indicated by footnote 1.

Leading counties in crushed limestone output were Dade, Hernando, and Broward; Broward was the second leading county in 1959. Leading State producers in order of output were Florida Rock Products Co. and Camp Concrete Rock, both of Hernando County, and Ideal Crushed Stone Co., Dade County.

Noncommercial crushed limestone was produced by six county highway departments in 1960, compared with only one of record in 1959; 395,000 tons of limestone valued at $308,000, all used for concrete, roadstone, and screenings, was produced. The leading noncommercial producer was Palm Beach County Highway Department. Crushed limestone was transported 63 percent by truck, 35 percent by railroad, and 2 percent by water. All noncommercial limestone was transported by truck.

Crushed oystershell was produced by seven companies in six counties at eight locations, mostly on leases obtained from the State of Florida. Decreases in output for the year were attributed to inclement weather and fluctuations in roadbuilding. Leading oystershell producers were, in order of output, Bay Dredging and Construction Co., Hillsborough County; Benton and Co., Pinellas County; and Bay Towing and Dredging Co., Walton County. Oystershell was transported 51 percent by truck, 47 percent by water, and 2 percent by railroad.

New limestone producers reporting for the year included the following: W. & M. Construction Co., Inc. (Norfleet quarry), Alachua County; Crystal River Quarries, Inc. (Crystal River quarry), and Colitz Mining Co. (Blue Water quarry) both in Citrus County; A. J. Capeletti, Inc. (Pennonco quarry), Joe Daniel, Inc., Division of A. J. Capeletti, Inc. (Joe quarry), Harry C. Delaney, Inc. (Peterson quarry), all of Dade County; Limestone Products, Inc. (Columbia City quarry), Columbia County; Williston Shell Rock Co. (Chauncey quarry), Lafayette County; Peacock Lime Rock Co. (Wildwood quarry), Sumter County; R. H. Wright, Inc. (HDSSF quarry), Monroe County; and Port Richey Mining Corp. (Hudson quarry), Pasco County.

Articles were published concerning crushed stone operations owned or operated by the following: Three Bays Improvement Co. (Rock-

dale quarry) near Perrine;[12] Seminole Rock Products Co., Inc. (Medley quarry) near Miami;[13]. Quality Lime Products Co. (Sumterville quarry), Sumter County;[14] and R. H. Wright, Inc., Florida Unit of Houdaille Industries, Inc., of Buffalo, N.Y.[15]

Vermiculite.—Zonolite Co. exfoliated vermiculite in plants at Jacksonville, Duval County; Tampa, Hillsborough County; and Boca Raton, Palm Beach County. Plant output increased 19 percent in quantity and 18 percent in value over 1959. The raw material supplying the plants was mined in South Carolina, Montana, and the Union of South Africa. Verlite Co., Tampa, opened a modern vermiculite-exfoliating plant, utilizing South African material, in October.

Research on new uses for vermiculite continued throughout the year; the Vermiculite Institute and the Vermiculite Association, Inc., increased research budgets for 1961. Concrete blocks, slabs, planks, and other forms were improved by research with aerating and foaming additives and by adding latex to the mix.

METALS

Ferroalloys.—American Agricultural Chemical Co., Pierce, and Virginia-Carolina Chemical Corp., Nichols, produced ferrophosphorus as a byproduct of the electric furnace process for smelting phosphate rock to make elemental phosphorus. Approximately 88 percent of the ferrophosphorus produced was shipped.

Rare-Earth Metals.—Titanium Alloy Manufacturing Division of National Lead Co., near Jacksonville, the only producer of monazite in Florida, recovered a small quantity of monazite as a byproduct in concentrating titanium minerals, but made no shipments during the year.

Steel.—Florida Steel Corp. of Tampa, and Easterby & Mumaw, Inc., Charlotte, N.C., merged during the year. Florida Steel operated four plants in Tampa including an electric furnace with a 51,000-ton ingot capacity per year, one plant in Miami, and one in Orlando. Easterby & Mumaw, with plants in Charlotte and Raleigh, N.C., was engaged in steel fabrication and warehousing.

Sovreign Resources, Inc., and John D. McArthur, Chicago, announced that a steel plant with a capacity of 75,000 to 90,000 tons of finished reinforcing bars and merchant shapes, would be constructed in the Miami trade area. The plant was expected to be in production in the first half of 1961.

Sa-Nu Steel Corp., Hialeah, placed in operation a small steel smelting plant employing about 10 persons.

Metal and Thermit Corp. began constructing a new $500,000 detinning plant, east of Tampa. The company, largest detinner in the world, will recover tin and steel from scrap obtained from both domestic and foreign sources.

Titanium Concentrates.—For the fifth consecutive year, Florida ranked second in the Nation in production of titanium concentrates.

---

[12] Excavating Engineer, Florida Quarry Has Bright Future: Vol. 54, No. 1, January 1960, pp. 8–10.

[13] Pit and Quarry, Seminole Keeps Pace with Florida Boom: Vol. 53, No. 3, September 1960, pp. 143–145.

[14] Dixie Contractor, Quality Lime Solves Water Problem, Reopens Abandoned Quarry: Aug. 12, 1960, pp. 30–31.

[15] Dean, Stan, All Wright . . . All Ways: Business Wheels, vol. 9, No. 2, 1960, pp. 9–12.

Total output of concentrates, including ilmenite and rutile, was a record 286,000 tons valued at $7,489,000, increases of 9 percent in tonnage and 4 percent in value over 1959. Ilmenite output increased 9 percent in tonnage and 5 percent in value over 1959; rutile output increased 3 percent, and value remained about the same.

E. I. du Pont de Nemours & Co., Inc., produced ilmenite from the Highland mine near Lawtey, Clay County, and from the Trail Ridge mine near Starke, Bradford County. Du Pont was the principal producer of ilmenite.

Titanium Alloy Manufacturing Division of National Lead Co. (Skinner mine), Duval County, produced both ilmenite and rutile near South Jacksonville; the company was the largest producer of rutile.

Florida Minerals Co. (Vero mine), Indian River County, produced both ilmenite and rutile. Rutile Mining Co. of Florida (Jacksonville mine) did not produce any titanium concentrates during the year, but made shipments of rutile from stocks.

A Florida Supreme Court decision gave Coastal Petroleum Corp., a wholly owned subsidiary of Coastal Carribean Oils, Inc., rights to all minerals under the company's drilling leases, covering about 4.5 million acres. The decision upheld a prior action, early in the year, of the District Court of Appeals in Tallahassee which denied a State of Florida contention that State drilling leases excluded rights to metallic minerals. The position of Coastal Petroleum was that its leasehold interests gave it claim to all minerals, including not only oil, gas, and sulfur, but also metallic minerals such as ilmenite, rutile, and zircon.

Zircon.—Florida for the 21st consecutive year ranked first in the Nation in zircon production. Output was slightly under 1959, but value increased 6 percent. E. I. du Pont de Nemours & Co., Inc., the largest producer, recovered and sold zircon from its Trail Ridge and Highlands operations, for use in refractories and foundries. Titanium Alloy Manufacturing Division of National Lead Co. (Skinner mine), Duval County, recovered and sold zircon. Florida Minerals Co. (Vero mine), Indian River County, recovered zircon as a by-product of rutile and ilmenite mining.

Columbia-National Corp., the only producer of zirconium sponge in the Southeast, which had closed in December 1959, reopened its Pensacola plant to supply a contracted 700,000 pounds per year of zirconium sponge to AEC. The plant had been closed pending corrosion tests on the metal.

MINERAL FUELS

Natural Gas.—Production of natural gas, all from Sunniland field, Collier County, decreased 12 percent from 1959. Houston Texas Gas & Oil Corp., a division of the Houston Corp., was authorized by the Federal Power Commission to spend $16 million to build 235 miles of sales laterals and to boost its compressor capacity by 30,000 horsepower. The company, which owned a transmission line from Baton Rouge, La., to Miami, planned to increase its maximum deliveries by 93 million cubic feet per day, and transport the gas into Florida for sale to 21 new customers for resale purposes, to 11 new consumers,

615629—61——19

and to 1 existing company at a new location. New companies to be supplied included two electric power companies, Florida Power Corp., St. Petersburg, and Florida Power and Light Co., Miami, and the U.S. Phosphoric Products Division of Tennessee Corp. for use as the raw material in a 350-ton-per-day ammonia plant under construction at Tampa.

Peat.—Florida ranked second in the Nation in peat production, moving up from third in 1959. Total output from seven producers in four counties was 39,000 tons valued at $162,000, an increase of 14 percent in tonnage and 3 percent in value over 1959. Putnam County was first in production, followed by Hillsborough, Orange, and Palm Beach, in order of output. Two types of peat, humus and reed-sedge, were produced chiefly for soil improvement.

Petroleum.—Preliminary crude petroleum production, from 11 wells, all in Sunniland field, Collier County, and all operated by Humble Oil & Refining Co., decreased from 424,000 barrels in 1959 to 368,000 barrels in 1960, a 13-percent decline. Cumulative production through 1959 totalled 6.5 million barrels.

The U.S. Supreme Court handed down a formal order setting the seaward boundary of Florida and providing the State with constitutional authority to control the leasing of submerged land seaward for 10.5 miles into the Gulf of Mexico. The Court ruled that Florida was entitled to a 3-marine-league belt under the gulf, as described in the State's 1868 constitution, and upheld Florida's contention that Congress approved such a 3-league boundary for Florida after its admission into the Union.

Coastal Production Co. was formed as a wholly owned subsidiary of the Houston Corp., St. Petersburg, for the purpose of participating in exploration and production along the route of natural gas lines operated by the company's subsidiaries, Coastal Transmission Co. and Houston Texas Gas & Oil Corp.

The 23 Federal leases, totaling 132,400 acres, in the Marquesas area off Florida failed to yield production. Exploration on the leases, acquired jointly by The California Co. and Gulf Oil Corp. in 1959, was conducted during 1960. A 15,294-foot test well, the Gulf-Calco No. 1 OCS, was plugged and abandoned in April. The company began drilling on tract OCS–44, using a floating vessel, and planned to do additional core drilling during 1961. Application for the first deep test off the west coast was made to the State, on State Lease 224–B, 4 miles off La Costa Island, Lee County. The test was to be drilled jointly by the California Co. and Coastal Petroleum Co. Mobile Oil Co. completed a dry hole and abandoned a 12,525-foot wildcat in Santa Rosa County, about 10 miles south of the Alabama line and 50 miles southeast of the Citronelle field in Alabama. The decision to drill came after nearly 2 years of geophysical and geological studies covering 235,000 acres in western Florida and southern Alabama.

Florida Southern Oil Co., a subsidiary of Frontier Refining Co., Jacksonville, exercised its option to buy a 100-acre tract near Drummond Point, and began construction of a $15 million refinery, expected to be completed by late 1961. The company signed a long-term contract with U.S. Oil of Louisiana, Inc., for 10,000 barrels per day of crude oil with deliveries scheduled to start July 1962.

Gulf Oil Co. announced that construction had begun on a new petroleum and products terminal on Drummond Point near Jacksonville, that would cost $3.5 million and be completed late in 1961. The company also completed expansion of its multi-State division office in Jacksonville, at a cost of $1 million.

REVIEW BY COUNTIES

Mineral production was recorded in 41 of 67 counties, 3 more than in 1959. Polk, Dade and Hillsborough, in order of value, were again the three leading mineral-producing counties. Polk County furnished 43 percent of the total mineral production value, Dade furnished 13 percent, and Hillsborough 12 percent. Other important mineral producing counties, in order of value, were Hernando, Clay, Flagler, Gadsden, and Broward, each having a total value of more than $5 million, and Citrus and Duval Counties, having values over $2 million, each. Crushed limestone was produced in 20 counties; sand and gravel in 12; phosphate rock and crushed oystershell in 6; clay in 5; titanium concentrates, lime, and peat in 4; and perlite and vermiculite were processed in 3 counties, each, zircon in 3 and cement in 2. The county with the largest percentage increase in value during the year was Taylor with 154 percent over 1959. Of the leading 10 counties, Sumter, Polk, and Hernando had the greatest increases in mineral production value, 17, 7, and 7 percent, respectively, over 1959; total mineral production value of these 10 counties was $163.2 million, 92 percent of the total State value.

Alachua.—Total value of mineral production increased 62 percent over 1959. Listed in order of output, the Newberry Corp. (Newberry Corp. quarry), Williston Shell Rock Co. (Buda and Haile quarries), Ocala Lime Rock Co. (Haile quarry), and W. & M. Construction Co., Inc. (Norfleet quarry), a new quarry in the county, crushed limestone for use in concrete, as roadstone and screenings, and for agriculture. Eighty-nine percent of the total tonnage was transported by railroad and eleven percent by truck.

Bay.—Taylor Sand Co. (Taylor mine) and Cato Sand Co. (Mill Bayou mine) produced building and paving sand; all of the sand was transported by truck.

Broward.—Broward County ranked eighth in value of mineral production, for the second consecutive year, and was third in stone output. Crushed stone decreased 25 percent in quantity and 17 percent in value compared with 1959, the record year. Sand and gravel output increased over 400 percent in tonnage and value, a new record. Ten companies crushed limestone at thirteen quarries; a new quarry reporting for the first year was R. H. Wright, Inc. (Green quarry). The three leading quarries, in output, were Hollywood quarries (Broward County quarry), Maule Industries, Inc. (Prospect quarry), and R. H. Wright, Inc. (Green quarry). Meekins, Inc., operated three quarries (Oakland Park No. 5, Hollywood No. 1, and Deerfield No. 4 quarries); R. H. Wright operated two quarries (Green and Wright quarries). Broward County Highway Department crushed limestone for use in its road construction program. Crushed lime-

TABLE 9.—Value of mineral production in Florida, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Alachua	$635,126	$1,030,731	Limestone.
Bay	(2)	(2)	Sand and gravel.
Broward	6,233,292	(2)	Limestone, sand and gravel.
Citrus	2,562,813	2,522,756	Limestone, phosphate rock, miscellaneous clay.
Clay	(2)	(2)	Ilmenite, zircon, staurolite, miscellaneous clay.
Collier	(2)	(2)	Petroleum, limestone, natural gas.
Columbia	(2)	(2)	Limestone, phosphate rock.
Dade	23,310,400	23,642,909	Cement, limestone, sand and gravel, lime.
Duval	(2)	(2)	Rutile, ilmenite, oystershell, zircon.
Escambia	406,239	356,812	Sand and gravel.
Flagler	(2)	(2)	Cement, limestone.
Gadsden	(2)	6,727,050	Fuller's earth, sand and gravel, miscellaneous clay.
Gilchrist	(2)	(2)	Phosphate rock.
Glades	----------	(2)	Sand and gravel.
Gulf	(2)	(2)	Magnesium compounds, lime.
Hendry	(2)	(2)	Limestone.
Hernando	8,333,638	8,893,350	Do.
Hillsborough	21,221,344	20,798,784	Cement, phosphate rock, oystershell, peat, gemstones.
Indian River	(2)	(2)	Rutile, ilmenite, zircon, limestone.
Lafayette	182,700	209,088	Limestone.
Lake	573,157	585,786	Sand and gravel.
Lee	(2)	(2)	Limestone, oystershell.
Leon	75,850	110,545	Sand and gravel.
Levy	825,939	784,152	Limestone.
Manatee	(2)	(2)	Limestone, oystershell.
Marion	(2)	(2)	Limestone, lime.
Monroe	(2)	(2)	Limestone.
Orange	(2)	(2)	Peat.
Palm Beach	(2)	(2)	Limestone, peat.
Pasco	(2)	(2)	Limestone.
Pinellas	(2)	(2)	Oystershell, marl, limestone.
Polk	65,755,924	76,812,386	Phosphate rock, sand and gravel.
Putnam	(2)	(2)	Sand and gravel, kaolin, peat.
St. Johns	----------	(2)	Limestone.
St. Lucie	(2)	(2)	Sand and gravel.
Sarasota	----------	(2)	Limestone.
Sumter	(2)	(2)	Do.
Suwannee	(2)	(2)	Do.
Taylor	763,400	1,940,000	Lime.
Volusia	(2)	(2)	Sand and gravel.
Walton	(2)	(2)	Oystershell.
Undistributed	32,566,178	32,505,651	
Total	163,446,000	176,920,000	

[1] The following counties are not listed because no production was reported: Baker, Bradford, Brevard, Calhoun, Charlotte, DeSoto, Dixie, Franklin, Hamilton, Hardie, Highlands, Holmes, Jackson, Jefferson, Liberty, Madison, Martin, Nassau, Okaloosa, Okeechobee, Osceola, Santa Rosa, Seminole, Union, Wakulla, and Washington.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

stone was used chiefly for concrete, roadstone, and screenings and was transported primarily by truck. Florida Silica Sand Co., Inc. (Pegram mine) and Davie Sand Corp. (Ft. Lauderdale mine) produced sand for building and fill purposes, respectively. Dade-Broward Rock Co. (Opa Locka mine) produced building sand and gravel. All three sand and gravel producers reported for the first year.

Citrus.—Citrus County ranked ninth in value of mineral production. Crushed limestone output decreased slightly from 1959 due to decreased requirements for stone used in cement. General Portland Cement Co. (Citrus County quarry) crushed limestone and mined miscellaneous clay for use in manufacturing cement. Colitz Mining Co. (Blue River quarry) produced limestone for concrete, roadstone, and screenings; Crystal River Quarries, Inc. (Crystal River quarry), for agricultural purposes. Both Colitz and Crystal River were new operations reporting for the first year.

Kibler-Camp Phosphate Enterprise (Enterprise mine) the only hard-rock phosphate producer in the State, mined 77,000 tons of phosphate rock valued at $670,000; tonnage decreased slightly, but value increased over 1959.

Soft-rock phosphate was produced at five mines by five companies; total output decreased 5 percent in quantity and increased 4 percent in value over 1959. Producers, in order of output, were Sun Phosphate Co. (Dunnellon mine), the largest producer in the State, Soil Builders, Inc. (Mincoll mine), Kellogg Co. (Kellogg mine), Camp Phosphate Co. (Hernando mine) and Superior Phosphate Co. (Bar mine). All of the phosphate rock was used for agricultural purposes and as a feed additive.

Clay.—Clay County ranked fifth in value of mineral production, moving up from sixth in 1959. Total mineral production value increased 5 percent over 1959, due principally to increases in ilmenite, zircon, and staurolite production. E. I. du Pont de Nemours & Co., Inc. (Highland and Trail Ridge mines) produced ilmenite, zircon and staurolite; ilmenite and staurolite output increased 11 and 4 percent, respectively, and zircon output decreased slightly from 1959.

Solite Corp., a subsidiary of Southern Lightweight Aggregates Co. (Russell mine) mined miscellaneous clay for producing aggregate for use in structural concrete and masonry. The company was listed in 1959 as the Florida Solite Corp., but changed its name to Solite Corp. in 1960. The company is in its second year of operation in the State.

Collier.—Collier County was the only county reporting petroleum and natural gas production. All of the output came from Sunniland field. Production of petroleum decreased 13 percent and natural gas production 12 percent from 1959.

Industrial Limerock, Inc. (Sunniland quarry) and Sunniland Limerock Co. (Sunniland quarry) crushed limestone for concrete, roadstone and screenings; total output was 2 percent less than in 1959. Sixty-four percent of the stone was transported by truck and 36 percent by railroad.

Columbia.—Loncala Phosphate Co. (Fort White mines), mined soft-rock phosphate which was processed at its Lake City Junction plant; tonnage and value more than doubled over 1959. The material was used primarily for agricultural purposes and as a livestock-feed additive.

Limestone Products, Inc. (Columbia City quarry), a new operation reporting for the first year, crushed limestone for concrete, roadstone, and screenings.

Dade.—Dade County was second in value of mineral production for the second consecutive year; total value of mineral production increased one percent over 1959. The county led the State for the third consecutive year in crushed stone output; 13 companies operated 18 quarries. The three leading producers were Ideal Crushed Stone Co. (Dade County quarry), Maule Industries, Inc. (Red Road, Tropical, and Homestead quarries), and Oolite Crushed Stone Co. (Richmond quarry). Stone production was 7.7 million tons valued at $9.7 million. New producers, reporting for the first year, were A. J. Capeletti, Inc. (Pennsuco quarry), Joe Daniel, Inc., division of A. J. Capeletti, Inc. (Joey quarry), Harry C. Delaney, Inc. (Peterson

quarry), and R. H. Wright, Inc. (Meekins quarry). Dade County Highway Department reported for the first year since 1948.

Lehigh Cement Co. (Miami mill) and General Portland Cement Co. (Everglades mill) both produced masonry and portland cement. Both companies crushed limestone for use in manufacturing cement. Total masonry and portland cement output declined for the first year since production began in 1958. Portland cement decreased 6 percent in quantity and 5 percent in value below 1959; masonry cement declined 3 and 2 percent, respectively.

Sand and gravel output and value more than doubled over 1959 and was higher than any year since 1954. Total output was 712,000 tons valued at $530,000. Sand producers, in order of output, were Sample Rock Co., Inc. (Opa Locka mine), fill sand; Des Rochers Sand Co., Inc. (Cape Florida mine), paving sand; and Sand Lake Development Co. (Miami mine), reporting production for the first year since 1955. Golden Brown Soil Co. (Miami mine) produced sand for fill and lawn dressing and paving gravel.

The city of Miami (Hialeah limekiln) produced 23,000 tons of quicklime valued at $244,000, for use as a water-softening and purification agent in its municipal waterplant. Output and value increased 6 percent over 1959.

Perlite, Inc., Hialeah, expanded perlite produced in Western States, for use in concrete, building plaster, and soil conditioning.

Duval.—Duval County was 10th in value of mineral production; total value increased 1 percent over 1959. Titanium Alloy Manufacturing Division of National Lead Co. (Skinner mine) produced and shipped ilmenite, rutile, and zircon. Zircon shipments by the company increased 2 percent over 1959. A small amount of monazite also was produced but none was shipped during the year. Rutile Mining Co. of Florida (Jacksonville operation) ceased mining in 1958, but made shipments in 1960 from stocks, although at a reduced rate from 1959.

White Shell Corp. (White Shell plant) produced 36,250 tons of crushed oystershell valued at $523,000, for use as poultry grit; tonnage decreased 10 percent and value 8 percent under 1959.

Tennessee Products & Chemical Corp. expanded perlite produced in Western States, at its plant near Jacksonville, for use in building plaster; tonnage and value remained the same as in 1959. Zonolite Co. exfoliated vermiculite at its plant near Jacksonville, using material mined by the company at deposits in South Carolina and Montana.

United States Gypsum Co. calcined gypsum at its plant near Jacksonville for use in manufacturing building products. The company completed a new plant to produce paper used in the manufacture of its products at the Jacksonville plant.

Kaiser Gypsum Co. of Oakland, Calif., exercised its option to purchase 34 acres near Jacksonville for the construction of a $3 million gypsum-products plant, expected to be completed in 1961.

Universal Atlas Cement Co., division of United States Steel Co., secured options on three sites along the eastern seaboard for cement distributing stations. One of the sites was near Jacksonville.

Florida Southern Oil Co., a subsidiary of Frontier Refining Co., Jacksonville, exercised its option to purchase a 100-acre tract near

Drummond Point, and began constructing a $15 million refinery, expected to be completed in late 1961. The company signed a long-term contract with U.S. Oil of Louisiana, Inc., for 10,000 barrels of crude oil per day, with deliveries to start in July 1962.

Escambia.—Sand and gravel, the only mineral commodity produced in the county, decreased 19 percent in quantity and 12 percent in value under 1959. Ward Gravel Co. (Century mine) and Campbell Sand and Gravel Co. (Flomaton mine) produced building sand and gravel; Clark Sand Co. (Pensacola mine) produced building sand only. Total output of the three mines was 387,000 tons valued at $357,000; about 95 percent of the material was processed, 66 percent was transported by railroad, and the remainder by truck.

Flagler.—Flagler County ranked sixth in value of mineral production, dropping from fourth place in 1959, as output of masonry and portland cements and crushed stone used in the manufacture of cement declined. Portland cement output decreased 15 percent in quantity and 14 percent in value; masonry cement decreased 16 percent in both quantity and value, and crushed stone output decreased 15 percent in quantity and 16 percent in value from 1959. Masonry and portland cements were manufactured by Lehigh Portland Cement Co. at its Bunnell mill; crushed stone was produced at its Coquina quarry. Shipments of cement from the Bunnell plant decreased for the second successive year.

Gadsden.—Florida, and Gadsden County, ranked first in the Nation in production of fuller's earth; the county, for the third year, ranked seventh in the State in total value of mineral production. Output of fuller's earth reached a new high; total production by three companies was 252,000 tons valued at $6.4 million, an increase in tonnage and value of 3 percent over 1959, the previous record year. Producers, in order of output, were Minerals and Chemicals Philips Corp. (La Camelia mine), Floridin Co., Inc. (Quincey mine which was acquired by Pennsylvania Glass Sand Co. in 1959), and Magnet Cove Barium Corp. (Havana mine). About midyear, Minerals & Chemical Corp. and Philips Brothers, Inc., merged to form Minerals and Chemicals Philips Corp.

Florida Gravel Co. (Chattahoochee mine) mined 213,000 tons of sand and gravel valued at $357,000; only the sand was processed. Both sand and gravel were transported equally by railroad and truck, 50 percent, each. Brundydge Sand Co. (Havana mine) produced 10,000 tons of sand valued at $7,000.

Appalachee Correctional Institute (Chattahoochee mine), produced miscellaneous clay for use in manufacturing brick.

Gilchrist.—Loncala Phosphate Co. (Mona mine), the only mineral producer in the county, mined and processed soft-rock phosphate; output increased 64 percent and value 70 percent over 1959 the largest increase since 1953.

Glades.—Caloosa Industries, Inc. (Ortona mine), a subsidiary of Lykes Bros., Tampa, mined building sand, all of which was transported by truck. The company, reporting for the first year, was the only mineral producer in the county.

Gulf.—Michigan Chemical Corp. produced magnesium compounds from sea water near Port St. Joe. Tonnage and value of refractory

and caustic-calcined magnesias increased considerably in 1960, the first full year of operation. The oxide was used by the plastic, refractories, fertilizer, chemical, paper, glass, and petroleum industries. In addition to magnesia, the company produced quicklime at its Port St. Joe limekiln for use in paper, chemical, and other industrial uses.

Hendry.—Caloosa Rock Corp. (La Belle quarry) crushed limestone for concrete aggregate, roadstone, and screenings. The company, in its third year of operation in the county, increased tonnage 51 percent and value 108 percent over 1959. All of the stone was transported by truck.

Hernando.—Hernando County ranked fourth in value of mineral production, moving up from fifth in 1959; value was 7 percent higher than in 1959. The county ranked second in output of crushed limestone, moving up from third in 1959; a record 5.4 million tons valued at $8.9 million was produced, increases of 11 percent in tonnage and 7 percent in value over 1959. Seven companies crushed limestone at seven quarries; two of the three leading crushed-limestone producers in the State, Florida Rock Products Co. (Lansing quarry) and Camp Concrete Rock Co. (Gay quarry) were first and second, respectively, in output. Other producers, in order of output, were Brooksville Rock Co. (Broco quarry), Lansing Rock Co. (Brooksville quarry), Aripeka Limerock Co., Inc. (Aripeka quarry), William P. McDonald Corp. of Florida (Cowrock quarry), and Hernando Limerock Co. (Brooksville quarry), a new operation reporting for the first year.

Hillsborough.—Hillsborough County, for the second consecutive year, ranked third in value of mineral production, led the State in production of crushed oystershell, and was second in peat. General Portland Cement Co. (Tampa mill) manufactured portland and masonry cements; portland cement shipments decreased 3 percent in quantity and 1 percent in value; masonry cement shipments decreased 36 percent in quantity and 35 percent in value. American Cyanamid Co. (Sydney mine) and the American Agricultural Chemical Co. (Boyette mine) produced land-pebble phosphate rock; combined marketable production decreased 7 percent in quantity but increased 3 percent in value over 1959.

Bay Dredging & Construction Co. (State Lease No. 639) crushed oystershell for use as roadstone, concrete, and poultry grit; output increased 17 percent in quantity and 5 percent in value, making 1960 a record year for the company. A small amount of agatized coral, as gem stone material, was collected by Robert Morgan in the Tampa Bay area.

Holmes Nurseries (Tampa), Ruth C. McKissick (Limona), and F. E. Stearns' Peat (Val Rico) produced both reed-sedge and humus-type peat. F. E. Stearns pulverized its product using a company-designed pulverizer. The county ranked second to Putnam in total peat production.

Indian River.—Florida Minerals Co. (Vero mine), mined beach sands and recovered ilmenite, rutile, and zircon. Ilmenite output increased 8 percent in quantity but value decreased from 1959. Zircon and rutile output decreased slightly. The Indian River County Highway Department crushed limestone for use in road building, for the first year. Airlite Processing Corp. of Florida, expanded perlite ob-

tained from out-of-State at its plant near Vero Beach; tonnage and value both decreased considerably from 1959.

Lafayette.—Williston Shell Rock Co. crushed limestone at its Dell quarry and established a record high for both quantity and value, 234,000 tons valued at $204,000. The company also opened a new quarry, the Chauncey quarry, which it operated during the last 2 months of 1960, producing 6,000 tons of crushed limestone valued at $5,000. Sixty-nine percent of the stone produced in the county was transported by railroad and the remainder by truck.

Lake.—Four companies mined building sand at four locations; output increased 11 percent in quantity and 2 percent in value over 1959 a record high for the county. Producers, in order of output, were E. R. Jahns Industries, Inc. (Clermont mine), operated in 1959 by Clermont Sand Co.; Silver Lakes Estates (Leesburg mine); Central Sand Co. (Tavares mine), and Coddings White Sand Co. (Eustis mine), which also produced a small amount of blast sand and reported for the first year. All of the sand was processed; 84 percent was transported by railroad and the remainder by truck.

The Florida Division of Oakland Consolidated Corp. of Michigan started construction of a new sand plant west of Clermont, with a capacity of 7,500 tons per day.

Lee.—West Coast Rock Co. (Fort Myers quarry) crushed limestone for use in concrete, roadstone, and screenings; tonnage and value increased considerably over 1959. Most of the stone was transported by truck.

Oystershell was dredged by three companies operating on separate State leases; output totaled 82,400 tons valued at $96,000, a decrease in both quantity and value from 1959. Producers, in order of output, were Fort Myers Shell Co. (Lease No. 1082), Fort Myers Shell Co. (Lease No. 1344), a new operation reporting for the first year, and Fort Myers Dredging Co. (Lease No. 1218).

Leon.—Three companies mined building sand at three locations; total production was 79,000 tons valued at $111,000, an increase of 39 percent in quantity and 46 percent in value over 1959. Producers, in order of output, were Asa Maige Sand Co. (Norfleet mine), Middle Florida Sand Co. (Tallahassee mine), and Johnson Sand Co. (Norfleet mine). All of the sand was processed and was transported by truck.

Levy.—Five companies crushed limestone from five quarries for use as concrete, roadstone, and screenings, and for agricultural purposes; total output was 414,200 tons valued at $784,000, a decrease of 32 percent in tonnage and 5 percent in value below 1959, the lowest recorded output since 1954. Producers, listed in order of output, were United Limerock Co. (Williston quarry), Dixie Lime Products Co. (Lebanon quarry), Levy County Lime Rock Co. (No. 1 quarry) and Ralph Swiney (Miller quarry), reporting for the first year. The stone was transported 57 percent by railroad and 43 percent by truck.

Manatee.—Southern Dolomite Co. (Palmetto quarry) crushed limestone for agricultural purposes and transported it by rail and truck; tonnage and value both decreased from 1959. Bradenton Dredging and Shell Co. (Lease No. 61) crushed oystershell for concrete and roadstone; output decreased considerably below 1959.

Marion.—Three companies and one noncommercial producer crushed limestone at five quarries; output decreased 8 percent in quantity and 23 percent in value under 1959. Producers, in order of output, were Dixie Lime Products Co. (Plant No. 3 quarry), Ocala Lime Rock Co. (Kendrick quarry), and Cummer Lime and Mfg. Co. (Kendrick and Martin quarries). The material was used for concrete, roadstone, and agricultural purposes and was transported 62 percent by railroad, 22 percent by truck, and 16 percent by water. The Marion County Highway Department, reporting for the first year since 1949, crushed limestone for use in its road program. Dixie Lime Products Co. (Ocala No. 1 limekiln) produced quicklime for building and chemical purposes; tonnage and value increased slightly over 1959.

Monroe.—Charley Toppino and Sons, Inc. (Stock Island quarry) crushed limestone for use in concrete block, ready-mixed concrete, and fill; output increased 55 percent over 1959. R. H. Wright, Inc. (HDSSF quarry), a new producer, crushed limestone for concrete, roadstone, and screenings. All stone was transported by truck.

Orange.—The county was third in peat production; Daetyler Peat mine (Orlando) and Raymond Johnson (Apopka) produced 8,521 tons of humus and reed-sedge peat; output decreased 3 percent from 1959. The peat was used primarily as a soil conditioner. No other mineral commodities were produced in the county.

Palm Beach.—The county ranked fourth in peat production; Latham Farms (West Palm Beach) produced peat for use as a soil conditioner; tonnage and value increased over 1959. Belle Glade Rock Co. (Belle Glade quarry) crushed limestone for concrete, roadstone, and screenings; output decreased considerably from 1959. Palm Beach County Highway Department, the largest noncommercial producer of crushed limestone in the State, crushed 173,000 tons valued at $96,000, for highway use.

Pasco.—Camp Concrete Rock Co. (Ivy quarry) and Port Richey Mining Corp. (Hudson quarry), a new producer, crushed limestone for concrete, roadstone, and screenings. Combined output of the two companies increased county output 26 percent in tonnage and 55 percent in value over 1959. All of the material was transported by truck.

Pinellas.—Benton and Co. (Lease No. 460) dredged and crushed oystershell for use in concrete and road material; output decreased 53 percent in quantity and 42 percent in value from 1959. Seminole Shell Co., Inc. (Dunedin quarry), the only marl producer in Florida, produced marl for use as a filler, and reported for the first year. Pinellas County Highway Department, which reported for the first time, crushed limestone for use in roadbuilding.

Polk.—Polk County led in mineral production value, and established a new record. The county furnished 43 percent of the total State value, $76.8 million compared with $65.8 million in 1959, an increase of 17 percent. The increase was due to expanding output of phosphate rock and continued sand and gravel production. Marketable land-pebble phosphate-rock output came from 12 mines operated by 8 companies established a record high. Output totaled 11 million tons valued at $74.6 million, an increase of 8 percent in quantity and 18 percent in value over 1959. The three leading county producers, in order of out-

put, were International Minerals & Chemical Corp. (Achan and Noralyn mines), Virginia-Carolina Chemical Corp. (Clear Springs and Homine mines), and American Agricultural Chemical Co. (South Pierce mine). Other companies operating in the county were American Cyanamid Co. (Orange Park mine), Swift and Co. (Varn and Watson mines), Davidson Chemical Co. Division of W. R. Grace Co. (Bonny Lake and Clark-James mines), Armour Agricultural and Chemical Co. (Armour mine) and Smith-Douglass Co., Inc. (Tenoroc mine). New plants and major expansions of existing facilities highlighted the industry in the county in 1960. International Minerals & Chemical Corp. Bartow, announced plans for a new $1 million calcining plant at Noralyn to process material for Electric Reduction Co., Toronto, Ontario, Canada. The company installed new equipment designed to control both liquid and gas wastes in chemical processing of phosphate rock. Virginia-Carolina Chemical Co., Bartow, tripled the superphosphate capacity of its Nichols plant, as part of a $10 million expansion program, and completed a new $1 million flotation plant at the Clear Springs mine. The company sold its interest in Gulfcoast Transit Co. and Mid-South Towing Co., phosphate rock and coal haulage companies. American Agricultural Chemical Co., Pierce, began constructing a new washer at Palmetto, with completion scheduled for 1961. American Cyanamid Co., Brewster, acquired approximately 3,500 acres of phosphate-rock-bearing land during the year and expanded its phosphoric acid plant to 200,000 tons per year. The company installed a large chain mill and scrubber in its triple superphosphate building. Swift and Co., Bartow, announced an increase of its phosphoric acid capacity that would double output. Davison Chemical Co. Division of W. R. Grace Co. closed its Pauway No. 4 mine near Lakeland and opened a new mine, the Clark-James. The company also completed its new 400-ton-per-day sulfuric acid plant, expanded its phosphoric acid facilities, and installed pollution control equipment. Armour Agricultural Chemical Co., Fort Meade, announced that construction would begin in 1961 on a new phosphoric acid and triple superphosphate facility, estimated to cost $10 million. Smith-Douglass Co., Inc., Plant City, perfected a new phosphate ore-flotation process that demonstrated savings in equipment and operation costs.

Polk County was the leading sand and gravel producing county and mined 3.1 million tons of sand valued at $2.3 million. This was 45 percent of the State output, and a decrease of 8 percent in tonnage and 5 percent in value below 1959. Ten companies produced sand from 10 mines. The three leading producers of sand and gravel in the State, all in Polk County, in order of output, were Mammoth Sand Co. (Lake Wales mine), Pembroke, Standard Sand Co. (Standard mine) Davenport, and Oak Ridge Sand Co. (Achan mine) near Mulberry. Most of their output was used for building and paving purposes. Other producers, also listed in order of output, were Gall Silica Sand Co., Inc. (Lake Wales mine), Lake Wales Independent Sand Co. (Independent mine), Lake Wales Concrete Sand Co. (Lake Wales mine), MacCalla Bros. (Polk County mine), Waverly Road Sand Co. (Winter Haven mine), Davenport Sand Co. (Polk County mine), and Superior Sand Co. (Winter Haven mine), a new company reporting

for the first year. Ninety-nine percent of the sand was processed; 96 percent was transported by railroad and 4 percent by truck.

Putnam.—The county ranked first in peat production, and second in sand and gravel production for the third consecutive year. Sand output totaled 955,000 tons valued at $824,000, a 23-percent decrease in tonnage and 18-percent decrease in value from 1959. Eight companies produced building, paving, glass, or fill sand at eight mines, two more than in 1959. Producers, in order of output, were Diamond Interlachen Sand Co., Inc. (Interlachen mine); All-Florida Sand Co. (Interlachen mine); Keuka Sand Co. (Putnam County mine); Edgar Plastic Kaolin Co. (Edgar mine); Southern Materials Co. of Florida (Putnam Hall mine), a new company reporting for the first year; Keystone Sand Co. (Grandin mine); Chesser and Strickland Sand Co. (Hollister mine), new in 1960; and United Clay Mines Corp. (Crossley mine). Ninety-five percent of the sand was processed; 50 percent was transported by truck and 50 percent by railroad.

Kaolin was produced by Edgar Plastic Kaolin Co. (Edgar mine) and United Clay Mines Corp. (No. 4 mine); quantity and value decreased 2 and 7 percent, respectively, below 1959; the clay was used in pottery, stoneware, floor and wall tile, and clay crucibles.

Putnam County ranked first in peat output, up from third in 1959. Glen Saint Mary Nurseries Co. (Glen Saint Mary) and Troxlers Peat Co. (Florahoma) mined 13,850 tons of humus peat for use as a soil conditioner; output increased 128 percent over 1959, establishing a record high for the county.

St. Johns.—Phillip McLeod (St. Johns County quarry) resumed limestone crushing after an absence of 1 year; quantity and value were about the same as in 1958. The stone was used for concrete, roadstone, and screenings and was transported by truck.

St. Lucie.—Fort Pierce Sand and Material Co. (Pierce mine operated by Dixie Sand Co. in 1959), mined paving sand; tonnage and value more than trebled over 1959. None of the sand was processed and all was transported by truck.

Sarasota.—Florida Dolomite Co. (Sarasota quarry) resumed crushed limestone production for agricultural purposes, after an absence of 1 year; tonnage increased 8 percent and value 15 percent over 1958. Fifty percent of the stone was transported by railroad and 50 percent by truck.

Sumter.—Three companies crushed limestone at three quarries, for concrete, roadstone, and agricultural purposes; total output increased 32 percent in quantity and 56 percent in value over 1959. Quality Lime Products Co. (Sumterville quarry), the largest producer in the county, and Nobleton Rock Co. (Nobleton quarry) crushed limestone for roadstone and concrete; Peacock Lime Rock Co. (Wildwood quarry) crushed limestone for agricultural uses and reported for the first year. The stone was transported 69 percent by railroad and 31 percent by truck.

Suwannee.—Florida Rock Products Corp. (Suwannee quarry) and Live Oak Stone Co. (Live Oak quarry) crushed limestone for roadstone, concrete, and screenings. Live Oak's quarry was sold to Florida Rock Products Corp. Division of Shands and Baker, about midyear and Live Oak Stone Co. began operating on adjacent property. Com-

bined output of the two operations increased 91 percent in quantity and 70 percent in value over 1959.

Taylor.—Taylor was the largest lime producing county. Buckeye Cellulose Corp. (Foley limekiln) produced 97,000 tons of quicklime for use in its own paper plant for water purification and causticizing. The company, in its second year of operation, announced plans for increasing plant output of bleached kraft and dissolving pulps by 33,000 tons per year, 13 percent above 1960 capacity. It was anticipated that lime needs of the captive operation would increase accordingly.

Volusia.—White Sand and Materials Co. (New Smyrna Beach mine) produced building sand, and produced gravel for the first year since 1955; total tonnage and value decreased from 1959. Houser Concrete Co. (Deland mine) produced a small amount of building sand and reported for the first year since 1955.

Walton.—Bay Towing and Dredging Co. (Lease No. 753), the third largest oystershell producer in the State, crushed oystershell for use in concrete, roadstone, and screenings. Output increased 33 percent over 1959 and was larger than any year since 1957.

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, U.S. Department of the Interior, and the Geological Survey of Georgia.

By James L. Vallely [1] and Garland Peyton [2]

SUBSTANTIAL increases in the production value of barite, kaolin, and stone and smaller increases in cement, fuller's earth, miscellaneous clay, scrap mica, peat, and sand and gravel, carried Georgia's 1960 mineral production to a new high of $91.2 million, 6 percent above 1959. Decreases in output of feldspar, sheet mica, talc, coal, bauxite, iron ore, iron oxide pigments, and manganese ores were more than offset by the gains of the other minerals.

Clays comprised 44 percent of the State's total production value; stone, 41 percent; sand and gravel, 3 percent; other nonmetals, 11 percent; and coal, peat, and metals, slightly more than 1 percent.

Among the States, Georgia led in the output of kaolin, marble, and crude iron oxide pigments and was second in fuller's earth, third in barite and mica, and fourth in feldspar.

TABLE 1.—Mineral production in Georgia [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	3,352	$36,232	3,519	$40,160
Coal—do	7	34	4	21
Gem stones	(2)	(3)	(2)	(3)
Iron ore (usable)—thousand long tons, gross weight	186	945	128	613
Manganese ore—short tons, gross weight	1,547	(4)		
Mica, sheet—pounds	18,461	119	10,218	89
Peat—short tons	4,288	(4)	6,904	73
Sand and gravel—thousand short tons	2,909	2,982	3,338	3,047
Stone—do	13,771	35,973	14,297	37,033
Talc and soapstone—short tons	53,692	107	40,200	88
Value of items that cannot be disclosed: Barite, bauxite, cement, feldspar, iron oxide pigments, manganiferous ore, mica (scrap) and values indicated by *footnote 4*		10,979		11,181
Total Georgia [5]		86,262		91,203

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than $1,000.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Total adjusted to eliminate duplicating value of clays and stone.

[1] Commodity-industry analyst, Bureau of Mines, Knoxville, Tenn.
[2] Director, Geological Survey of Georgia, Atlanta, Ga.

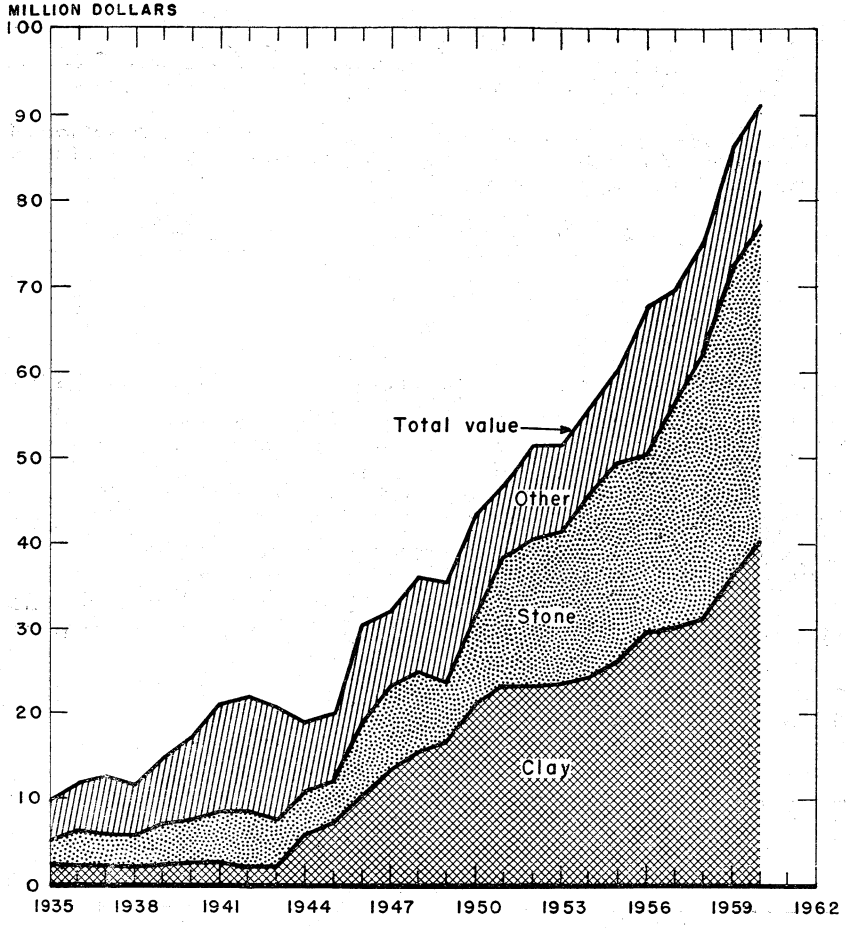

FIGURE 1.—Value of clays and stone, and total value of mineral production in Georgia, 1935–60.

Employment and Injuries.—Employment in the mineral industries was slightly higher than in 1959. Total man-hours worked increased from 15.9 to 16.2 million, an increase of 2 percent, and the number of men working daily increased from 7,200 to 7,492; however, the average active days decreased from 276 to 270. Employment in nonmetal mines increased 8 percent, more than offsetting the losses in quarries and mills (2 percent), sand and gravel plants (12 percent), metal mines (42 percent), and coal mines (40 percent).

Four fatal accidents were recorded, three in quarries and mills, one more than in 1959, and one at sand and gravel mines compared with none in 1959. The number of nonfatal accidents declined from 424 to 364, and the overall injury-frequency rate improved 15 percent. As in 1959, no accidents were recorded for coal or metal mines.

TABLE 2.—Employment and injuries in the mineral industries

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Non-fatal injuries	Injuries per million man-hours
1959:							
Nonmetal mines	80	3,582	282	8,089,463	----------	227	28
Quarries and mills	66	3,096	277	6,854,085	2	184	27
Sand and gravel mines	35	349	281	784,432	----------	13	17
Metal mines	19	153	123	150,281	----------	----------	----------
Coal mines	4	20	154	24,720	----------	----------	----------
Total	204	7,200	276	15,902,981	2	424	27
1960: [1]							
Nonmetal mines	70	3,886	280	8,697,775	----------	174	20
Quarries and mills	72	3,187	264	6,724,995	3	179	27
Sand and gravel mines	39	315	273	687,100	1	11	17
Metal mines	20	92	118	87,158	----------	----------	----------
Coal mines	2	12	155	14,886	----------	----------	----------
Total	203	7,492	270	16,211,914	4	364	23

[1] Preliminary figures.

Trends and Developments.—Numerous plant expansions and improvements were recorded in the State's mineral industry in 1960. Chattahooche Brick Co. completed its fifth tunnel kiln and increased plant capacity 30 percent.[3] Merry Bros. Brick and Tile began constructing the first of two kilns and accessory equipment to cost $4 million. Stevens Fire Brick Co. installed new mixing and blending equipment and planned to overhaul firing and clay-preparation facilities. Bestwall Gypsum Co. began construction of an acoustical ceiling tile plant as an addition to its new plant[4] completed in 1959. Consolidated Quarries Corp., with crushed granite plants at Lithonia and Douglasville, merged with Georgia Marble Co. The new Yatesville granite quarry of Tyrone Rock Products Co.,[5] and Georgia Lightweight Aggregates Co.'s slate-expanding plant[6] at Rockmart were described. Numerous improvements and expansions were completed at quarries and plants in the Elberton granite district.

Humble Oil Co. completed drilling the first of two test wells in South Georgia;[7] it was the 94th dry hole drilled in the State since 1938.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Primary barite production, after a 2-year decline, increased 33 percent in tonnage and 26 percent in value. Crushed and ground barite were shipped principally for barium chemicals and well-drilling muds. Production came from Bartow County.

[3] Brick and Clay Record, vol. 316, No. 4, April 1960, p. 74.
[4] Pit and Quarry, vol. 53, No. 4, October 1960, p. 80; Rock Products, vol. 63, No. 11, November 1960, p. 67.
[5] Rock Products, vol. 63, No. 8, August 1960, p. 96; Pit and Quarry, vol. 53, No. 5, November 1960, p. 100.
[6] Brick and Clay Record, vol. 136, No. 6, June 1960, p. 90.
[7] Petroleum Week, vol. 11, Nos. 8, 16, 21, 1960.

Cement.—Shipments of portland cement were slightly higher than in 1959, with a 4-percent increase in value; masonry cement shipments were lower in tonnage and value. Out-of-State shipments were principally to Florida, with smaller tonnages to Alabama and South Carolina. Marquette Cement Manufacturing Co. produced portland and masonry cements at Rockmart; Penn-Dixie Cement Corp. manufactured portland cement at Clinchfield. Marquette completed its plant modernization program at Rockmart, and construction of a new kiln and other facilities was underway at Penn-Dixie's Clinchfield plant.

Clays.—Clay ranked first in value of mineral production and accounted for 44 percent of the State total, compared with 42 percent in 1959. Kaolin production exceeded 2 million tons for the first time, tonnage and value increasing 9 and 11 percent, respectively, over 1959. Fuller's earth production was 93,700 tons valued at $1,777,000, a decrease of 6 percent in tonnage but an increase of 3 percent in value. Miscellaneous clay was down 1 percent in tonnage and up 2 percent in value.

Georgia led the Nation in production of kaolin and ranked second in fuller's earth. Twenty companies mined kaolin in 9 counties; 6 companies produced fuller's earth in 5 counties (Decatur, Grady, Jefferson, Thomas, and Twiggs), and miscellaneous clay was mined by 14 companies in 11 counties. The leading kaolin producers were: Georgia Kaolin Co., J. M. Huber Corp., Minerals and Chemicals-Phillips Corp., and Southerns Clays, Inc. Producers of fuller's earth were: Cairo Production Co., Inc., Diversey Corp., Econo-Sorb Co., Georgia-Tennessee Mining and Chemical Co., Milwhite Co., Inc., and Waverly Petroleum Products Co.

Feldspar.—Appalachian Minerals Co. mined feldspar rock from several locations in Jasper County and produced flotation concentrate for glass and pottery uses at its mill near Monticello.

Gem Stones.—A small quantity of asterated quartz and corundum were the only gem materials reported in 1960.

Gypsum.—Bestwall Gypsum Co. (Brunswick plant) and National Gypsum Co. (Savannah plant) calcined imported gypsum for manufacturing wallboard and other gypsum products.

Mica.—Sheet mica production dropped to the lowest level since 1951. Output was 10,200 pounds valued at $88,600 compared with 18,500 pounds valued at $118,900 in 1959, a decrease of 45 percent in quantity and 26 percent in value. Included in the total were 3,150 pounds of full-trimmed mica and 4,546 pounds of punch obtained from 78,772 pounds of hand-cobbed mica. All hand-cobbed and full-trimmed mica was sold to the Government through the General Services Administration (GSA) at the Spruce Pine (N.C.) purchase depot. Scrap mica decreased 22 percent in tonnage but increased 21 percent in value. Output of ground mica was 27 percent below 1959. Scrap mica was mined in Cherokee and Hart Counties. Except for a few pounds in Cherokee County, all sheet mica came from Hart, Pickens, and Upson Counties.

TABLE 3.—Kaolin and fuller's earth sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Baldwin	(1)	(1)	(1)	(1)
Decatur	(1)	(1)	(1)	(1)
Floyd			(1)	(1)
Grady	(1)	(1)	(1)	(1)
Jefferson	15,582	$311,640	17,325	$300,242
Macon			(1)	(1)
Meriwether			(1)	(1)
Richmond	66,755	487,759	82,241	614,505
Sumter			(1)	(1)
Thomas	(1)	(1)	(1)	(1)
Twiggs	1,047,732	19,392,919	1,072,215	21,087,151
Washington	560,283	9,244,089	574,113	10,808,208
Wilkinson	271,882	5,242,161	305,684	5,382,449
Other counties	77,257	1,005,643	163,348	1,406,751
Total	2,039,491	35,684,211	2,214,926	39,599,306

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."

TABLE 4.—Kaolin sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Pottery and stoneware:						
Whiteware	71,484	$1,323,704	$18.52	66,005	$1,289,382	$19.53
Stoneware, including chemical stoneware	228	4,122	18.08	(1)	(1)	(1)
Art pottery, etc	(1)	(1)	(1)	9,096	143,438	15.77
Floor and wall tile	(1)	(1)	(1)	15,915	233,564	14.68
Refractories:						
Firebrick and block	154,777	1,166,156	7.53	224,071	1,550,171	6.92
Fire-clay mortar				1,200	5,580	4.65
Foundries and steelworks	362	6,545	18.08			
Saggers, pins, stilts, and wads	3,021	54,620	18.08	(1)	(1)	(1)
Fillers:						
Paper	577,652	9,684,738	16.77	568,583	10,523,764	18.51
Paper coating	749,821	15,005,779	20.01	808,916	17,144,103	21.19
Rubber	93,433	1,471,323	15.75	100,342	1,377,951	13.73
Linoleum and oilcloth	3,965	71,687	18.08	(1)	(1)	(1)
Paint	47,553	973,816	20.48	66,160	1,342,605	20.29
Plastics, organic	9,114	206,666	22.68	8,899	209,894	23.59
Chemicals	14,416	250,397	17 37	(1)	(1)	(1)
Exports	38,255	821,975	21.49	53,749	1,186,708	22.08
Other [2]	176,198	2,923,501	16.59	198,301	2,815,095	14.20
Total	1,940,279	33,965,029	17.51	2,121,237	37,822,255	17.83

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes enameling, glass refractories, zinc retorts and condensers, other refractories, fertilizer filler, insecticides and fungicides, other fillers, portland and hydraulic cements, catalysts, and uses indicated by footnote 1.

TABLE 5.—Miscellaneous clay sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Bibb	(1)	(1)	(1)	(1)
Columbia	(1)	(1)	(1)	(1)
Crawford	500	$500	300	$126
Floyd	(1)	(1)	(1)	(1)
Fulton	(1)	(1)	(1)	(1)
Gordon	31,000	12,710	25,170	10,571
Houston	(1)	(1)	(1)	(1)
Macon	(1)	(1)		
Polk	(1)	(1)	(1)	(1)
Richmond	(1)	(1)	(1)	(1)
Walker	85,000	34,850	(1)	(1)
Whitfield	29,000	11,900	(1)	(1)
Other counties	1,167,249	487,871	1,278,574	549,830
Total	1,312,749	547,831	1,304,044	560,527

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."

Sand and Gravel.—Sand and gravel production increased 15 percent in tonnage but only 2 percent in value. Sand production increased 16 percent in tonnage and 1 percent in value; however, output of gravel, little changed from 1959, was 10 percent higher in value. Output of both paving and structural sand increased 21 percent. All other sands, except for fill and railroad ballast, decreased in tonnage and value. Twenty-eight companies produced sand only in 22 counties, and 5 companies produced sand and gravel in Bibb, Muscogee, and Richmond Counties. Brooks, Crawford, Muscogee, Talbot, Taylor, and Thomas were the principal producing counties. Atlanta Sand & Supply Co. (Crawford Co.), Bannockburn Sand Co. (Brooks Co.), Brown Bros. (Talbot Co.), Dawes Silica Mining Co. (Dougherty, Effingham, Long, and Thomas Counties), Howard Sand Co., and Taylor Sand Co. (Taylor Co.) were the State's leading producers.

TABLE 6.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Bibb	(1)	(1)	(1)	(1)
Brooks	(1)	(1)	265,178	$217,618
Chatham	(1)	(1)	(1)	(1)
Chattooga	(1)	(1)	1,482	3,334
Crawford	(1)	(1)	(1)	(1)
De Kalb	16,887	$13,400	15,056	10,400
Dougherty	282,833	201,464	173,724	147,842
Douglas	7,028	4,850	7,000	5,000
Effingham	(1)	(1)	(1)	(1)
Elbert	2,600	3,000	2,600	1,500
Evans	9,051	7,096	9,525	9,525
Fulton	(1)	(1)	169,244	124,174
Glynn	(1)	(1)	(1)	(1)
Long	(1)	(1)	(1)	(1)
Montgomery	(1)	(1)	(1)	(1)
Muscogee	(1)	(1)	(1)	(1)
Richmond	(1)	(1)	(1)	(1)
Spalding	(1)	(1)		
Talbot	334,282	187,517	(1)	(1)
Tattnall	(1)	(1)	(1)	(1)
Taylor	(1)	(1)	363,500	182,100
Telfair	26,904	29,594	7,488	8,236
Thomas	(1)	(1)	(1)	(1)
Tift			2,500	2,500
Ware	(1)	(1)	31,270	48,091
White	4,344	3,218	4,000	3,000
Undistributed	2,225,141	2,531,578	2,285,252	2,283,842
Total	2,909,070	2,981,717	3,337,819	3,047,162

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 7.—Sand and gravel sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Structural sand	1,981,584	$1,446,211	$0.73	2,405,893	$1,627,290	$0.68
Paving sand	326,981	225,090	.69	395,768	281,629	.71
Railroad ballast sand	(1)	(1)	(1)	8,787	6,814	.78
Other sand and gravel [2]	600,505	1,310,416	2.18	527,371	1,131,429	2.15
Total	2,909,070	2,981,717	1.02	3,337,819	3,047,162	.91

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other sand and gravel."

[2] Includes fill, glass, molding, blast, engine, filtration, and other sands; structural and paving gravel; and uses indicated by footnote 1.

TABLE 8.—Dimension granite sold or used by producers, by counties

County	1959			1960		
	Cubic feet	Short tons (equivalent)	Value	Cubic feet	Short tons (equivalent)	Value
DeKalb	780,634	66,355	$967,644	810,196	67,230	$1,055,389
Elbert	565,247	47,725	1,410,882	470,191	39,255	2,177,929
Hancock				19,175	1,592	28,763
Madison	167,819	14,300	503,457	169,382	14,059	508,146
Oglethorpe	(1)	(1)	(1)	(1)	(1)	(1)
Rockdale	(1)	(1)	(1)	(1)	(1)	(1)
Total	1,906,335	161,510	3,717,610	1,793,469	149,070	4,599,036

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total."

TABLE 9.—Dimension granite sold or used by producers, by uses

Use	1959			1960		
	Cubic feet	Value		Cubic feet	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Rough monumental	890,926	$1,896,755	$2.13	769,644	$1,877,819	$2.44
Curbing and flagging	490,300	856,879	1.75	(1)	(1)	(1)
Rubble	367,000	65,896	.18	416,699	78,680	.19
Dressed monumental	(1)	(1)	(1)	143,920	1,487,417	10.34
Rough construction	1,100	360	.33			
Rough architectural	500	700	1.40			
Other [2]	156,509	897,020	5.73	463,206	1,155,120	2.49
Total	1,906,335	3,717,610	1.95	1,793,469	4,599,036	2.56

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes dressed architectural and uses indicated by footnote 1.

TABLE 10.—Crushed granite sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete, road metal	8,515,313	$12,578,639	$1.48	9,392,448	$13,905,600	$1.48
Riprap	115,301	201,876	1.75	(1)	(1)	(1)
Railroad ballast	532,892	666,401	1.25	117,196	162,020	1.38
Other	925,791	1,269,068	1.37	958,202	1,770,712	1.85
Total	10,089,297	14,715,984	1.46	10,467,846	15,838,332	1.51

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."

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

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and road metal	348,376	$622,509	$1.79	784,357	$1,227,942	$1.57
Railroad ballast	7,988	11,583	1.45	(1)	(1)	(1)
Other [2]	789,332	1,328,653	1.68	913,360	1,530,144	1.68
Total	1,145,696	1,962,745	1.71	1,697,717	2,758,086	1.62

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes agstone, cement, terrazzo, roofing, and uses indicated by footnote 1.

Stone.—Stone was produced in 31 counties by 49 companies and 3 Government-and-contractor operations. Dimension granite was produced in 6 counties from 26 quarries, crushed granite in 16 counties from 22 quarries, and crushed limestone in 8 counties from 10 quarries. Crushed and dimension marble was produced in Pickens County and crushed marble only in Gilmer County. Crushed slate was mined in Bartow, Murray, and Polk Counties, quartzite in Richmond County, dimension sandstone in Pickens County, crushed sandstone in Polk County, and byproduct quartz in Jasper County. Leading producers of crushed granite were Stockbridge Stone Division of Vulcan Materials Co., Tyrone Rock Products Co., and Weston and Brooker Co.; leading producers of dimension granite were Coggins Granite Industries, Inc., Worley Bros. Granite Co., Inc., and Davidson Granite Co. Georgia Marble Co. produced crushed and dimension marble, and Marble Products Co. crushed marble only. Dalton Rock Products Co. and the two cement companies, Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp., were the leading crushed limestone producers. Superior Stone Co., Division of American-Marietta Co. was the only producer of quartzite. Slate was mined for roofing granules by the Funkhouser Mills Division of Ruberoid Co. and Georgia Talc Co. and for manufacturing lightweight aggregate by Georgia Lightweight Aggregate Co.

Talc and Soapstone.—Georgia Talc Co., with mines and mills at Chattsworth, Murray County, was the only talc producer. Production of crude talc decreased 25 percent in tonnage and 18 percent in value from 1959. Sales of sawed and ground talc also were lower than in 1959.

Vermiculite.—Zonolite Co. produced exfoliated vermiculite at its Atlanta plant.

METALS

Bauxite.—American Cyanamid Co., the only producer, mined crude bauxite in Floyd and Sumter Counties. The bauxite was dried at the company's Hall Station drying plant, Bartow County, and shipped for chemical use.

Gold and Silver.—The last production of gold and silver in Georgia was in 1953. The history of gold mining in Georgia shows a large production from placer mining and important production from gold-

quartz veins. About 80 percent of the total gold production of the State was from the placer operations before 1880. There was a steady production of about 5,000 ounces of gold yearly from lode mines during the period 1880–1905. The increase in the price of gold in 1933 led to a revival of placer mining, with a sustained small production during the period 1933–42. Production since 1942 has been very small. Table 11 shows the production of gold and silver, 1830–1960.

TABLE 12.—Mine production of gold and silver, 1830–1960

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1830–1880	696, 617	$14, 398, 902			696, 617	$14, 398, 902
1881	6, 047	125, 000			6, 047	125, 000
1882	12, 095	250, 000			12, 095	250, 000
1883	9, 627	199, 000	1, 300	$1, 000	10, 927	200. 000
1884	6. 628	137, 000			6. 628	137, 000
1885	6, 580	136, 000			6, 580	136, 000
1886	7, 378	152, 500	1, 300	1, 000	8, 678	153, 500
1887	5, 322	110, 000	650	500	5, 972	110, 500
1888	5, 031	104, 000	650	500	5. 681	104, 500
1889	5, 206	107, 605	605	465	5. 811	108, 070
1890	4, 838	100, 000	400	517	5, 238	100, 517
1891	3, 900	80, 622	400	517	4, 300	81. 139
1892	4, 608	95, 251	400	517	5, 008	95, 768
1893	4, 856	100, 375	500	650	5, 356	101, 025
1894	4, 794	99, 095	325	423	5, 119	99, 518
1895	6, 192	128, 000	400	520	6, 592	128, 520
1896	7, 305	151, 000	600	776	7, 905	151, 776
1897	7, 222	149. 300	600	776	7, 822	150, 076
1898	6, 221	128. 600	500	646	6, 721	129, 246
1899	5, 466	113, 000	400	517	5, 866	113, 517
1900	5, 646	116, 700	400	517	6, 046	117, 217
1901	6, 023	124, 500	400	517	6, 423	125, 017
1902	4, 730	97, 800	400	517	5, 130	98, 317
1903	3, 000	62, 000	400	517	3, 400	62, 517
1904	4, 688	96, 900	1, 500	870	6, 188	97, 770
1905	4, 687	96, 900	900	549	5, 587	97, 449
1906	1, 146	23, 700	300	203	1, 446	23, 903
1907	3, 135	64, 800	700	500	3, 835	65, 300
1908	2, 719	56, 200	200	100	2, 919	56, 300
1909	2, 099	43, 400	200	100	2, 299	43, 500
1910	1, 161	24, 000	300	200	1, 461	24, 200
1911	1, 697	35, 070	212	112	1, 909	35, 182
1912	695	14, 360	77	48	772	14, 408
1913	731	15, 108	75	45	806	15, 153
1914	787	16, 270	67	37	854	16, 307
1915	1, 733	35, 821	138	70	1, 871	35, 891
1916	1, 090	22, 539	74	49	1, 164	22, 588
1917	333	6. 889	57	46	390	6, 935
1918	285	5, 893	27	27	312	5, 920
1919	37	767	8	9	45	776
1920	35	732	194	211	229	943
1921	49	1, 022	4	4	53	1, 026
1922	156	3, 224	364	364	520	3, 588
1923	26	529	2	1	28	530
1924	32	655	5	3	37	658
1925	468	9. 683	46	32	514	9, 715
1926	149	3, 074	9	5	158	3, 079
1927	50	1, 042	7	4	57	1, 046
1928	44	911	5	3	49	914
1929	125	2, 574	16	9	141	2, 583
1930	203	4, 194	23	9	226	4, 203
1931	88	1, 827	12	3	100	1, 830
1932	279	5, 760	30	9	309	5, 769
1933	558	14, 273	65	23	623	14, 296
1934	970	33, 898	48	31	1, 018	33, 929
1935	994	34, 782	74	53	1, 068	34, 835
1936	450	15, 735	28	21	478	15, 756
1937	743	25, 995	49	38	792	26, 033
1938	872	30. 520	71	46	943	30. 566
1939	670	23, 450	58	39	728	23, 489
1940	961	33, 635	630	448	1, 591	34, 083

TABLE 12.—Mine production of gold and silver, 1830–1960—Continued

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1941	311	$10,885	38	$27	349	$10,912
1942	30	1,050	7	5	37	1,055
1943	12	420			12	420
1944	5	175			5	175
1945						
1946	21	735			21	735
1947	76	2,660	13	12	89	2,672
1948	19	665	3	3	22	668
1949	18	630			18	630
1950						
1951	3	105			3	105
1952						
1953	2	70			2	70
1954–60						
Total	870,774	18,089,777	17,266	15,760	888,040	18,105,537

TABLE 13.—Mine production of gold and silver, 1830–1960, by counties

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
Bartow	63	$1,340	9	$5	72	$1,345
Carroll	93	2,613	4	2	97	2,615
Cherokee	4,537	96,143	130	81	4,667	96,224
Cobb	26	604	3	2	29	606
Dawson	353	8,129	6	4	359	8,133
Douglas	1,823	36,461	61	38	1,884	36,499
Forsyth	260	6,114	12	7	272	6,121
Fulton	21	604	1	1	22	605
Greene	3	71			3	71
Gwinnett	119	4,154			119	4,154
Habersham	3	82	2	1	5	83
Hall	323	7,601	21	10	344	7,611
Haralson	296	6,301	133	115	429	6,416
Lincoln	243	7,040	1,106	960	1,349	8,000
Lumpkin	8,475	212,546	794	464	9,269	213,010
McDuffie	2,518	62,487	379	232	2,897	62,719
Oglethorpe	7	145			7	145
Paulding	750	17,305	167	93	917	17,398
Rabun	412	8,637	19	10	431	8,647
Union	37	969			37	969
White	5,598	147,894	409	252	6,007	148,146
Wilkes	410	8,792	1,664	1,085	2,074	9,877
Undistributed	844,404	17,453,745	12,346	12,398	856,750	17,466,143
Total	870,774	18,089,777	17,266	15,760	888,040	18,105,537

TABLE 14.—Leading gold mines, 1881–1960

Mine	County	Total value of gold production
Franklin	Cherokee	$88,643
Hamilton	McDuffie	61,578
Battle Branch	Lumpkin	43,883
Loud	White	37,512
Ferey	do	36,692
Pine Mountain	Douglas	36,461
Calhoun	Lumpkin	26,495
Standard	do	19,655
Allison	White	18,735
Blow	do	18,000
Findley	Lumpkin	15,473
Childs	White	14,760
Barlow	Lumpkin	13,805
Bunker Hill	do	11,864
Lockhart	do	11,220
Crown Mountain	do	10,372

Iron Ore.—Shipments of brown iron ore declined for the third consecutive year, and were down 31 percent in tonnage and 35 percent in value. Most of the output came from the Stewart-Webster County area south of the Fall Line, with less than one-third from the Bartow-Polk County area. Leading producers were Brown-Nuggett Mining Co., Dunbar and Layton, and Smith Mining Co.

Crude iron oxide pigments sold or used decreased 21 percent in tonnage but only 6 percent in value. Finished pigment sales also were lower in tonnage and value. New Riverside Ochre Co. in Bartow County was the only producer.

Manganese.—Manganiferous ore (−35 percent Mn) for use in making steel was mined by three companies in Bartow County. Production and value increased more than 30 percent. No manganese ore (+35 percent) was produced during the year.

MINERAL FUELS

Coal.—Two operators, excluding those producing less than 1,000 tons annually, mined bituminous coal in Walker County. Tonnage decreased 43 percent and value was 38 percent below 1959.

Peat.—Output of peat was 61 percent higher than in 1959; production came from Lowndes and Screven Counties, and was used principally for agricultural and horticultural purposes.

REVIEW BY COUNTIES

Mineral production was reported from 76 of Georgia's 159 counties, compared with 70 counties in 1959. Twenty counties had production valued above $1 million; 10 exceeded $2 million and made up 74 percent of the State's total production. The leading counties, in descending order were: Twiggs, Washington, Pickens, Wilkinson, Polk, Houston, De Kalb, Bartow, Elbert, and Richmond.

Baldwin.—General Refractories Co. mined kaolin for use in refractories.

Bartow.—Value of mineral production increased 14 percent. Increased barite, limestone, and iron ore production more than offset losses in slate, iron oxide pigments, and manganese.

Barite producers were: B. R. Cain Mining Co., T. E. Johnsey, Paga Mining Co., and New Riverside Ochre Co. The latter company also was the State's only producer of crude and finished iron oxide pigments. Thompson-Weinman & Co. operated a grinding plant at Cartersville to produce fillers, or extenders, from barite, kaolin, marble, mica, and other minerals. Funkhouser Mills Division of the Ruberoid Co. mined slate to produce flour and roofing granules. Marquette Cement Manufacturing Co. quarried limestone for use in its cement plant at Rockmart. Hodge Mining Co., Joe Mosteller, and Mosteller Bros. mined brown iron ore. Lake Mining Co., Mosteller Bros., and Oakland Heights Mining Co. mined manganiferous ore.

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

County	1959	1960	Minerals produced in 1960 in order of value
Baldwin	(2)	(2)	Kaolin.
Bartow	$2,888,907	$3,299,896	Barite, slate, limestone, iron ore, iron oxide pigments, manganiferous ore.
Bibb	342,180	322,844	Sand and gravel, miscellaneous clay.
Brooks	(2)	217,618	Sand and gravel.
Chatham	(2)	(2)	Do.
Chattooga	(2)	3,334	Do.
Cherokee	(2)	(2)	Mica.
Clarke	(2)	(2)	Granite.
Clayton	(2)	(2)	Do.
Cobb	498,000	552,747	Do.
Columbia	(2)	(2)	Miscellaneous clay.
Crawford	(2)	(2)	Sand and gravel, miscellaneous clay.
Dade		(2)	Limestone.
Decatur	(2)	(2)	Fuller's earth.
De Kalb	(2)	(2)	Granite, sand and gravel.
Dooly		(2)	Iron ore.
Dougherty	201,464	147,842	Sand and gravel.
Douglas	(2)	(2)	Granite, sand and gravel.
Effingham	(2)	(2)	Sand and gravel.
Elbert	1,414,084	2,179,429	Granite, sand and gravel.
Evans	7,096	9,525	Sand and gravel.
Fannin	10,470	(2)	Limestone, granite.
Fayette	(2)	(2)	Granite.
Floyd	676,311	613,553	Limestone, bauxite, miscellaneous clay, kaolin.
Franklin	(2)		
Fulton	(2)	(2)	Granite, sand and gravel, miscellaneous clay.
Gilmer	(2)	(2)	Marble.
Glynn	(2)	(2)	Sand and gravel.
Gordon	12,710	10,571	Miscellaneous clay.
Grady	(2)	(2)	Fuller's earth.
Gwinnett	(2)	(2)	Granite.
Hall	(2)	(2)	Do.
Hancock	(2)	(2)	Do.
Hart	(2)	(2)	Mica.
Henry	(2)	(2)	Granite.
Houston	(2)	(2)	Cement, limestone, miscellaneous clay.
Jasper	(2)	(2)	Feldspar, sandstone.
Jefferson	311,640	300,242	Fuller's earth.
Jones	(2)	(2)	Granite.
Lamar		(2)	Do.
Long	(2)	(2)	Sand and gravel.
Lowndes	(2)	(2)	Peat.
Macon	(2)	(2)	Kaolin.
Madison	503,457	508,146	Granite.
Meriwether		(2)	Kaolin.
Mitchell	(2)	(2)	Limestone.
Monroe	(2)		
Montgomery	(2)	(2)	Sand and gravel.
Murray	146,084	118,300	Talc, soapstone, slate.
Muscogee	1,090,660	1,474,500	Granite, sand and gravel.
Oglethorpe	678,481	651,798	Granite.
Pickens	(2)	(2)	Marble, sandstone, mica.
Polk	(2)	(2)	Cement, slate, miscellaneous clay, sandstone, iron ore.
Pulaski		(2)	Iron ore.
Rabun	(2)	(2)	Granite.
Richmond	(2)	(2)	Sandstone, kaolin, miscellaneous clay, sand and gravel.
Rockdale	(2)	(2)	Granite.
Screven	(2)	(2)	Peat.
Stewart	(2)	(2)	Iron ore.
Sumter	(2)	(2)	Bauxite, kaolin.
Talbot	187,523	(2)	Sand and gravel.
Tattnall	(2)	(2)	Do.
Taylor	(2)	182,100	Do.
Telfair	29,594	8,236	Do.
Thomas	(2)	(2)	Sand and gravel, fuller's earth.
Tift		2,500	Sand and gravel.
Towns	100	1	Gem stones.
Troop		150	Do.
Twiggs	19,392,919	21,087,151	Kaolin, fuller's earth.
Upson	2,121	(2)	Mica.
Walker	68,685	(2)	Limestone, miscellaneous clay, coal.
Ware		48,091	Sand and gravel.
Warren	(2)	(2)	Granite.
Washington	9,244,089	10,808,208	Kaolin.
Webster	232,725	(2)	Iron ore.
White	3,218	3,000	Sand and gravel.

See footnotes at end of table.

TABLE 15.—Value of mineral production in Georgia, by counties [1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Whitfield	$11,900	(2)	Limestone, miscellaneous clay.
Wilkinson	5,242,161	$5,382,449	Kaolin.
Undistributed	[3] 43,065,521	43,270,770	
Total	86,262,000	91,203,000	

[1] The following counties are not listed because no production was reported: Appling, Atkinson, Bacon, Baker, Banks, Barrow, Ben Hill, Berrien, Bleckley, Brantley, Bryan, Bullock, Burke, Calhoun, Butts, Camden, Candler, Carroll, Catoosa, Charlton, Chattahoochee, Clay, Clinch, Coffee, Colquitt, Cook, Coweta, Crisp, Dawson, Dodge, Early, Echols, Emanuel, Forsyth, Glascock, Greene, Habersham, Haralson, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lanier, Laurens, Lee, Liberty, Lincoln, Lumpkin, McDuffie, McIntosh, Marion, Miller, Morgan, Newton, Oconee, Paulding, Peach, Pierce, Pike, Putnam, Quitman, Randolph, Schley, Seminole, Spalding, Stephens, Taliaferro, Terrill, Toombs, Treutlen, Turner, Union, Walton, Wayne, Wheeler, Wilcox, Wilkes, Worth.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[3] Revised figure.

Bibb.—Burns Brick Co. and Cherokee Brick and Tile Co. mined miscellaneous clay for manufacturing brick and other clay products. Macon Brick & Block Co., Sand Supplier, Inc., and Cornell-Young Co. produced building and paving sand. Cornell-Young Co. also produced a small tonnage of gravel.

Brooks.—Bannockburn Sand Co. mined building, paving, and railroad ballast sand near Valdosta.

Chatham.—Fitzgerald-Montgomery Sand Corp. mined building sand. Bestwall Gypsum Co. (new plant completed at Brunswick in late 1959) and National Gypsum Co., Savannah, calcined imported crude gypsum for board, lath, and plaster.

Chattooga.—Wolf Creek Sand Co. produced unwashed foundry sand.

Cherokee.—Georgia Talc Co. (Waleska mine) and Thompson-Weinman & Co. (Brady mine) produced scrap mica (sericite), and Glenn Young produced a minor quantity of sheet mica.

Clarke.—Gainesville Stone Co. quarried granite at Athens for riprap, aggregate, and roadstone.

Clayton.—Tyrone Rock Products Co. continued to expand production of crushed granite at its new Clayton quarry.

Cobb.—Stockbridge Stone Division of Vulcan Materials Co. quarried and crushed granite for concrete and roadstone at the Kennesaw quarry.

Columbia.—Georgia Vitrified Brick & Clay Co. mined miscellaneous clay at the Campania mine.

Crawford.—Atlanta Sand and Supply Co. mined building, paving, blast, engine, and other sands near Gaillard. Middle Georgia Pottery Co. mined miscellaneous clay at Lizella for use in manufacturing clay products.

Dade.—Dave L. Brown Co. quarried and crushed limestone at Morganville for concrete and roadstone.

Decatur.—The Milwhite Co. mined and processed fuller's earth at Attapulgus. Econo-Sorb Co. produced a small tonnage of fuller's earth, but ceased operations early in the year.

De Kalb.—Tonnage and value of both crushed and dimension granite were higher than in 1959. Consolidated Quarries Division of Georgia Marble Co. and Stone Mountain Grit Co., Inc., quarried granite for

riprap, concrete, road metal, poultry grit, filter, and stone sand. Davidson Granite Co., Inc., produced riprap, rubble, curbing and flagging, and dressed architectural stone. Stone Mountain Granite Corp. and J. T. Reagin Granite Co. quarried rubble, curbing, and flagging. Stamps Sand Co. mined paving sand.

Dooley.—Chandler Bros. (Unadilla mine) was a new producer of brown iron ore.

Dougherty.—Dawes Silica Mining Co., Musgrove Sand Co., and Quick Service Sand Co. mined building sand; Garrett Base Materials Co., paving sand; and Albany Lime & Cement Co., filter sand.

Douglas.—Consolidated Quarries Division of Georgia Marble Co. quarried and crushed granite at Douglasville for riprap, concrete, and road metal. J. Tom Bell mined building sand for local use.

Effingham.—Dawes Silica Mining Co. produced building, blast, filter, molding, and other sands.

Elbert.—The value of monumental, rough, and dressed dimension granite produced by companies operating quarries in the county totaled over $2 million, 54 percent higher than in 1959. Twelve companies were active during the year: Coggins Granite and Marble Industries, Comolli Granite Co., Continental Granite Co., Doves Creek Granite Co., Elberton City Quarries, Elberton Granite Finishing Co., Elberton Granite Industries, Inc., Harpers Quarry, Inc., M. W. Kantala & Sons, Robin Blue Quarries, Inc., A. G. & M. H. Veals, and Worley Bros. Granite Co.

Evans.—Evans Concrete Products Co. mined building sand.

Fannin.—Fannin County Highway Department quarried and crushed granite for roadstone at Blue Ridge, and Willingham-Little Division of Georgia Marble Co. crushed limestone for concrete, roadstone, agricultural stone, terrazzo, and other uses.

Fayette.—Tyrone Rock Products Co. quarried and crushed granite for concrete and roadstone.

Floyd.—American Cyanamid Co. mined bauxite from three pits and kaolin from another; Oconee Clay Products Co. mined shale for use in its clay-products plant at Milledgeville. Ready-Mixed Concrete Co. and Floyd County Highway Department quarried and crushed limestone for railroad ballast, concrete, and roadstone.

Fulton.—Hitchcock Corporation 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. produced building, paving and fill sand for local use. Atlanta Brick and Tile Co. and Chattahooche Brick Co. mined clay for use in brick and other clay products. Zonolite Corp. exfoliated crude vermiculite shipped into the State at its Atlanta plant.

Gilmer.—The Willingham-Little Division of Georgia Marble Co. mined and crushed marble at Whitestone for terrazzo, roofing granules, agricultural stone, and other uses.

Glynn.—Gray Towing Co. produced building and filter sands. Bestwall Gypsum Co. completed the first full year of operation of its new calcining and gypsum products plant at Brunswick.

Gordon.—Plainville Brick Co. mined shale for use in its brick plant at Plainville.

Grady.—Cairo Production Co. mined and processed fuller's earth for absorbent uses.

Gwinnett.—Stockbridge Stone Division of Vulcan Materials Co. and The State Board of Correction produced crushed granite for concrete and roadstone.

Hall.—Gainesville Stone Co. quarried and crushed granite for concrete, roadstone, and riprap.

Hancock.—Weston and Brooker Co. produced crushed granite for concrete, roadstone, and railroad ballast at Granite Hill. Middle Georgia Quarrying Co. opened a new dimension granite quarry near Sparta.

Hart.—Funkhouser Mills Division of the Ruberoid Co. mined mica schist and produced ground mica at Hartwell. Arthur Mining Co. Taylor mine, and Payne Bros. produced hand-cobbed and full-trim mica. Stokes Buchanan, Ralph Cunningham, and Mitchell Lumber Co., produced full-trim mica.

Henry.—Stockbridge Stone Division of Vulcan Materials Co. quarried granite for concrete and roadstone.

Houston.—Penn-Dixie Cement Corp. mined clay and limestone and manufactured portland cement at Clinchfield. Georgia Limerock Co. quarried and crushed limestone, principally for agricultural use.

Jasper.—Appalachian Minerals Co. mined feldspar rock from several locations and produced flotation-grade feldspar and byproduct quartz at its Monticello mill.

Jefferson.—Georgia-Tennessee Mining and Chemical Co. mined fuller's earth near Wrens for absorbent uses.

Jones.—Hitchcock Corp. (Gray quarry) and Weston-Brooker Co. (Ruby quarry) produced crushed granite for concrete and roadstone, riprap, and railroad ballast.

Lamar.—Tyrone Rock Products Co. completed the first full year of operation at its Yatesville quarry and produced crushed granite for concrete and roadstone.

Long.—Dawes Silica Mining Co., Inc., mined building sand at Ludowici.

Lowndes.—Georgia Peat Moss Co. produced peat for agricultural and horticultural uses.

Macon.—American Cyanamid Co. mined kaolin at the Cavender bauxite mine.

Madison.—Coggins Granite Industries, Inc., quarried rough monumental granite from the Piedmont quarry near Carlton.

Meriwether.—Lehigh-Portland Cement Co. mined kaolin near Greenville for use in its Florida cement plants.

Mitchell.—Bridgeboro Stone Co., Inc., crushed limestone for concrete, roadstone, and agricultural use.

Montgomery.—R. W. Geiger mined building and paving sand at Mt. Vernon.

Murray.—Georgia Talc Co. mined crude talc from the Georgia, Lindsey, and Southern mines and marketed crayons and ground talc for insecticides, roofing, rubber, and textiles; the company also quarried and crushed slate for roofing granules.

Muscogee.—Brown Sand and Gravel Co. and Calhoun Sand and Gravel Co. operated pits near Columbus, and Stockbridge Stone Division of Vulcan Materials Co. quarried granite for riprap, concrete, and roadstone. Alabama Aggregates Co. closed its quarry in January.

Oglethorpe.—Seven companies quarried dimension granite. Elbert County Granite Co., Inc., produced both rough and dressed monumental stone, and the following produced rough monumental stone only: American Granite Quarries, Inc., Dixie Granite Quarries, Enterprise Granite Co., Hoover Granite Quarries, Inc., Liberty Granite Co., and Oglethorpe Granite Co.

Pickens.—Pickens County ranked third in the State in value of mineral production. Georgia Marble Co. quarried and dressed marble for building and monumental stone at Tate. Marble Products Co. of Georgia (Whitestone mine) and Calcium Products Division of Georgia Marble Co. mined and crushed marble for terrazzo, roofing granules, filler, whiting, agricultural, and other uses. Carl Johnson and Hardy Johnson quarried dimension sandstone for flagging and rubble. A. B. Schuer mined a small quantity of hand-cobbed mica.

Polk.—Polk County ranked fifth in the State in value of mineral production with a 4-percent increase in value over 1959. Marquette Cement Manufacturing Co. produced portland and masonry cements at Rockmart from clay and sandstone mined in Polk County and limestone mined in Bartow County by the cement company. Georgia Lightweight Aggregate Co. mined and expanded slate for lightweight aggregate at Rockmart. Only a small tonnage of brown iron ore was produced by two operators during the year.

Pulaski.—Pope and Chandler mined brown iron ore near Hawkinsville.

Rabun.—Rabun Quarries, Inc., produced crushed granite for concrete and roadstone.

Richmond.—Albion Kaolin Division of Interchemical Corp. mined kaolin for refractories; Georgia-Carolina Brick & Tile Co., Georgia Vitrified Brick & Clay Co., and Merry Bros. Brick & Tile Co. mined miscellaneous clay for brick and other clay products. Superior Stone Co. Division of American-Marietta Co. quarried and crushed quartzite for concrete and roadstone. Richmond Sand Co. and Speer Sand and Gravel Co. produced sand and gravel for building, paving, and railroad ballast.

Rockdale.—Kelly Granite Co., Inc., quarried dimension granite for rubble, curbing, and flagging.

Screven.—Atlanta Peat Co. produced humus peat near Sylvania for agricultural and horticultural uses.

Stewart.—Brown iron ore production decreased for the second successive year, dropping 35 percent in both tonnage and value. Producers were: H. E. Bowden, Dunbar and Layton, Luverne Mining Co., and Smith Mining Co.

Sumter.—American Cyanamid Co. mined kaolin from the Holloway mine and bauxite from the Thigpen mine.

Talbot.—Brown Bros. and Taylor Sand Co. mined building and paving sand.

Tattnall.—Phillips Sand Co. mined a small tonnage of building sand for local use.

Taylor.—Butler Sand Co. and Howard Sand Co. produced building sand.

Telfair.—Flanders Bros. mined building sand for local use.

Thomas.—Dawes Silica Mining Co. produced building, glass, filler, and other industrial sands. Waverly Petroleum Products Co. mined and processed fuller's earth for absorbent uses.

Tift.—Quality Sand Co. mined building sand for local use.

Towns.—J. M. Steinoff collected a small quantity of corundum.

Troup.—Fred O. Scruggs collected a considerable quantity of rose quartz.

Twiggs.—Twiggs County ranked first in the State in value of mineral production. Georgia Coating Clay Co., Georgia Kaolin Co., J. M. Huber Corp., and Southern Clays, Inc., mined and processed kaolin for whiteware and pottery, refractories, paper filling and coating, and many other filler uses. Stevens Fire Brick Co. mined kaolin for fire brick and other refractories, and The Diversey Corp. mined and processed fuller's earth for insecticides, absorbents, and filtering uses.

Upson.—Southern Mining Co. and Joe L. Snyder produced hand-cobbed and full-trimmed mica.

Walker.—Georgia Limestone Co. quarried and crushed limestone for concrete and roadstone. Key-James Brick Co. mined shale for the manufacture of brick at the Chattanooga, Tenn., plant. W. T. Blevins and Powell & Hixon were the State's only bituminous coal producers.

Ware.—E. W. Pafford mined building sand near Waycross.

Warren.—Weston and Brooker Co. quarried and crushed granite at Camak for concrete, roadstone, riprap, and railroad ballast.

Washington.—Washington County ranked second in the State in value of mineral production. Kaolin, the only mineral produced, was used for whiteware, pottery, refractories, and heavy clay products; and for paper coating and filling, and many other filler purposes. Producers were American Industrial Clay Co., Anglo-American Clay Corp., Champion Paper and Fibre Co., Minerals and Chemicals-Phillips Corp., Thiele Kaolin Co., United Clay Mines Corp., and General Refractories Co.

Webster.—Brown-Nuggett Mining Co. was the only brown iron ore producer.

White.—Helen Sand and Rock Co. mined building sand for local use.

Whitfield.—Dalton Brick & Tile Corp. mined miscellaneous clay for the manufacture of brick and other clay products. Dalton Rock Products produced crushed limestone for concrete, roadstone, and agricultural stone.

Wilkinson.—Wilkinson County ranked fourth in the State in value of mineral production. Kaolin was mined principally for paper filling and coating, rubber, and paint by Evans Clay Co., M & W Clay Co., and Minerals and Chemicals-Phillips Corp. Refractory kaolin was mined by Harbinson-Walker Refractories Co., D. C. Hardie, and Oconee Clay Products Co.

The Mineral Industry of Hawaii

By L. E. Davis[1] and R. Y. Ashizawa[2]

THE VALUE of Hawaii's mineral output established a new record of $9.3 million in 1960, compared with $7.6 million in 1959. An outstanding event of the year was the first full-scale production of portland cement at two new plants on Oahu Island. The anticipated gains in the production of sand and gravel, and stone materialized when the quantities required to keep pace with Hawaii's construction boom reached 4 million tons valued at $7.8 million, compared with 3.5 million tons and $6.7 million in 1959. Increases in the output of trachyte and volcanic cinder were also substantial.

Employment.—In 1960, Hawaii's mineral industry reported to the Bureau of Mines that 695 employees worked a total of 1,031,353 manhours. There were 2 fatalities and 35 nonfatal lost-time injuries. The fatalities occurred at separate basalt quarries on Oahu Island and were the result of falls.

Consumption, Trade, and Markets.—There was no notable change in the marketing pattern of the mineral industry. None of the minerals produced and processed in Hawaii was exported. Interisland shipments were limited to sand and volcanic cinder barged from Molokai to Oahu and trachyte from the island of Hawaii to Oahu. Mineral-material receipts from the Mainland consisted chiefly of cements, pe-

TABLE 1.—Mineral production in Hawaii[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand 376-pound barrels			113	$571
Pumice—thousand short tons	276	$548	361	676
Sand and gravel—do	463	1,253	490	1,324
Stone—do	3,034	5,480	3,535	6,443
Value of items that cannot be disclosed: Clays, gem stones, and lime		363		353
Total Hawaii[2]		7,630		9,254

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

[1] Supervisory commodity-industry analyst, Bureau of Mines, San Francisco, Calif.
[2] Statistical assistant, Bureau of Mines, San Francisco, Calif.

615629—61——21

troleum products, natural asphalts, salt, and special construction, chemical, and fertilizer materials.

Trends and Developments.—Heavy demand for construction materials raised Hawaii's mineral production to a new record in 1960. The State's structural concrete and concrete-products industry became virtually self-sufficient when two new cement plants went on stream. Hawaii's first steel plant, constructed for Hawaiian Western Steel, Ltd., Honolulu, began production of ingots for reinforcing rod at Barbers Point in July. Scrap metal obtained locally was utilized. The new $1.5-million electric arc furnace facility was built adjacent to the company's rolling mill which had been hot-rolling Canadian ingots since 1959 into reinforcing rod.

With a combined annual production capacity of 2.7 million barrels (more than double Hawaii's past annual rate of consumption), the new $25.5-million cement industry took steps to expand further the use of portland cement concrete into all areas of construction, including homes and highways. Technical advancements in Hawaii's construction industry, which brought about increased use of prestressed, precast, thin-shell, and lift-slab concrete, and concrete tile, block, and pipe, adversely affected a structural clay products industry, which discontinued operations during 1960. Future requirements for clay tile and brick appeared limited and would necessitate imports.

Legislation and Government Programs.—State management of Hawaii's mineral-resources program was assigned as a function of the Division of Water and Land Development, Department of Land and Natural Resources, pending final approval by the State legislature.

Metallurgical research on the extraction of alumina from Hawaii's bauxitic soils, conducted under an agreement negotiated early in 1959 by the then Territory of Hawaii, was completed during 1960 at the Bureau of Mines Rolla Metallurgy Research Center at Rolla, Mo. Beneficiation methods were applied to the bauxite samples from Kauai, Maui, and Hawaii, and a detailed report on the study was being prepared for the State government and for subsequent release as a Bureau of Mines Report of Investigations. Additional metallurgical research on bauxitic soils of Hawaii, including the recovery of titanium and iron minerals, continued at the Rolla Center under the Bureau's program to develop methods of utilizing domestic deposits of aluminous materials.

The Federal Geological Survey continued its drilling and sampling project on Kauai to determine the distribution, quantity, and type of bauxite resources on the island. In the summer of 1960, the project was enlarged to include reconnaissance of bauxitic soils on Maui. A progress report on the drilling tests and sampling of the deposits in eastern Kauai was placed on open file in Honolulu by the Geological Survey.

No new ordinances or resolutions affecting Oahu's minerals or mineral-extraction operations were adopted by the City and County of Honolulu in 1960. Correspondence from the office of the attorney general stated that the Land Court of the State of Hawaii was presented with a question on the validity of mineral reservations contained in Royal Patents issued upon Land Commission Awards. The supreme court of Hawaii was expected shortly to consider the question

which is both unique and important to Hawaii, since title to large areas of land is burdened with the reservation.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Kilns of the new cement plants on Oahu Island were fired, and full-scale production of portland cement began in August 1960. Hawaiian Cement Corp. and Permanente Cement Co. established their highly automated plants at Barbers Point and Waianae, respectively, with a combined annual capacity of 2.7 million barrels. Raw-material sources were coral limestone from nearby company quarries, gypsum from San Marcos Island, Mexico, silica sand from South Viet Nam and California, and other materials from local and Mainland sources. Both plants were operated for several months and were then shut down temporarily in November for operational adjustments while the cements were being tested pending approval for use in Federal projects. Sales of the locally produced portland cement during 1960 were for use in non-Government construction projects, and shipments of cement from the Mainland continued.

Clays.—A dwindling market for structural clay products and the encroachment of residential development on clay deposits and on an existing plant site forced Hawaii's clay brick and tile producers on Oahu to discontinue operations in 1960. Waialae Tile, Ltd., operators of the former Wilsonite Brick Co., Ltd., Wilson claypit near Waimanalo and the brick and tile plant on Oili Road, Honolulu, lost its plant-site lease. The plant was situated on estate land earmarked for construction of tract homes. GasprO, Ltd., ceased mining clay at Kokokahi and discontinued production of clay products at its Honolulu plant during the latter part of 1960. The company established a new plant at Waimanalo to fabricate its Stahlton prestressed concrete floor and roof systems.

Gem Stones.—Maui Divers of Hawaii, at Lahaina, Maui, continued to skin dive for substantial quantities of black coral at a depth of more than 200 feet in the channel between Maui and Lanai Islands. The precious gem material, which was cut and polished and fashioned into freeform jewelry at the Maui Diver's lapidary, was fast becoming a popular tourist item. Pex of Hawaii, Honolulu, sold tumble-polished Hawaiian olivine that had been collected during prior years.

Lime.—The quantity of quicklime and hydrated lime sold or used by producers on Oahu and Maui was slightly lower in 1960, compared with 1959. Increased sales of lime to the building trade and to pineapple canneries offset much of the drop in lime shipped to sugar mills for use in clarifying cane juice. During 1960, Hawaii's cane sugar industry, the principal market for lime, felt the effects of the 1958 strike that disrupted the 2-year harvesting cycle. The Oahu lime plant used coral limestone as its raw material; at the Maui plant, coral beach sand was calcined to produce lime.

Pumice (Volcanic Cinder).—Volcanic cinder used for construction and repair of roads on Hawaii Island, particularly in the Kapoho area which was buried by lava in January 1960, represented much of the

rise in the total volume quarried in 1960, compared with 1959. The need for good roads to reduce the cost of truck haulage was apparent at many of the sugar and pineapple plantations in the Hawaiian Islands. Although some companies were surfacing their main haulage systems with asphaltic concrete, others maintained excellently compacted haul roads utilizing volcanic cinders. Increased quantities of lightweight trachyte were quarried at Puuwaawaa on Hawaii Island for local use and for shipment to Oahu. Volcanic cinder from Molokai Island was shipped to Oahu for use in lightweight concrete and concrete products. On Oahu, the demand for black cinder from Makiki Round Top in Honolulu was substantially above that of the previous year.

Salt.—Construction of a plant and pond facilities at Barbers Point, Oahu, to produce solar-evaporated salt from sea water was announced by Smith Chemical Products, Inc., Honolulu. The company leased 8 acres of ground on the ocean front for its plant and concentrating ponds, and expected to make limited shipments of salt beginning in the latter half of 1961. Virtually all of Hawaii's requirements of salt for live stock feed, food processing, and other industrial and domestic uses, including table salt, were shipped from plants in California and Louisiana in 1960.

Sand and Gravel.—Output of natural coral beach and dune sands and basaltic streambed sand and gravel increased from 463,000 tons in 1959 to 490,000 tons in 1960. The quantity of coral sand obtained from the northern shores of Oahu decreased. Oahu's additional requirements of sand for concrete and mortar were barged from Molokai Island and obtained from Barbers Point on Oahu Island, where sand was produced from dredged coral. Sand requirements on the other islands were supplied from beach, dune, and stream deposits. Basaltic streambed gravel was used by county and plantation crews and by local contractors for road base, fill, and drain rock. Stream deposits were also sources of the smoothly rounded pukapuka (holey) bluestone cobbles used for the imu (underground rock oven) during the traditional and frequently held Hawaiian luaus.

Stone.—The volume of stone quarried in the Hawaiian Islands increased to 3.5 million tons in 1960 from 3 million tons in 1959. Output of basalt rock quarried and crushed, primarily for base course and concrete aggregate, accounted for nearly 65 percent of the stone yield. The rock was commercially produced at four quarries on Oahu, three quarries on Hawaii, and one each on Kauai, Maui, and Molokai, and at various noncommercial government or contractor project sites. A portable crusher was shipped from Hawaii Island to Lanai in 1960 to process basalt rock for highway construction. The quantity of coral limestone consumed in the State increased from 526,000 tons in 1959 to 846,000 tons in 1960. Oahu Island, where limestone quarry operations were predominant, lost one quarry and gained three new quarries. Limestone was used for base course, concrete aggregate, agricultural purposes, and for manufacturing cement and lime. The output of miscellaneous stone, including Hawaiian aa, fieldstone, moss rock, and decomposed rock, declined, owing principally to the limited uses for the material.

Vermiculite.—Vermiculite of Hawaii, Inc., a successor to Vermiculite of Hawaii, Ltd., moved its office and plant facilities in Honolulu,

from Mokumoa Street to Mapunapuna Street. Crude vermiculite mined near Libby, Montana, was exfoilated at the plant to produce lightweight aggregate for heat and sound insulation, plaster and concrete aggregate, roofing, and horticultural uses.

MINERAL FUELS

The first stage of the Standard Oil Co. of California refinery at Barbers Point, Oahu, was completed in October 1960. Dedication ceremonies were conducted on November 3, and production was started on 13 products ranging from asphalt through various grades of jet fuels, diesel, and liquefied petroleum gases. The company simultaneously announced reductions in its wholesale prices of gasoline, fuel oil, kerosine, diesel oil, and stove oil. Crude oils from Sumatra and Arabia were pumped to the refinery through offshore submarine pipelines connecting the refinery to the tanker mooring area 2 miles off the southeast coast of Barbers Point. The second-phase construction of the catalytic cracking plant and related facilities for production of high-octane motor gasoline, aviation gasolines, and other products was expected to be completed by the end of 1961, instead of mid-1962 as previously announced. In 1960, the Hawaii Division of the Union Oil Co. of California completed construction of its storage and distributing facilities on Maui Island for gasolines, fuel oil, and solvents.

REVIEW BY ISLANDS

Hawaii.—James W. Glover, Ltd., operated a stationary crushing and screening plant at its main Hilo facility and a portable crusher at Kalopa to process basalt rock and aa rock. The portable crusher was shipped to Lanai Island for a highway project during the latter part of 1960. The J. M. Tanaka, Inc., quarry, southeast of Kailua-Kona, was the source of basalt and aa rock prepared by the producer primarily for use in asphaltic concrete. Corps Construction, Ltd., in the same area, processed aa rock obtained near Keauhou. The 299th pit near Hilo Airport supplied aa rock for road base. Decomposed volcanic rock and cinder from deposits on plantation lands in the Papaaloa and Paauhau areas and on cattle-ranch lands west of Honokaa were used for roads. The Kau Desert was the source of road and fill material used by maintenance crews at the Hawaii National Park. Streambeds in the North Kohala District and beach deposits in the Puna District yielded some sand and gravel for local projects.

TABLE 2.—Value of mineral production in Hawaii, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Hawaii	$1,374,934	$1,394,001	Stone, pumice (volcanic cinder), sand and gravel.
Honolulu	5,317,011	6,526,046	Stone, sand and gravel, cement, lime, pumice (volcanic cinder), clays.
Kauai	208,463	563,673	Stone, sand and gravel, pumice (volcanic cinder).
Maui	729,669	770,124	Stone, pumice (volcanic cinder), sand and gravel, lime, gem stones.
Total	7,630,000	9,254,000	

Substantial quantities of volcanic cinder and ash were obtained near Kapoho by Kuwaye Bros., Inc., for use as road base and were screened for use as a soil additive. Plantation operators, including Hawaiian Agricultural Co., Ltd., at Pahala, Honokaa Sugar Co., at Haina, Kohala Sugar Co., at Hawi, and the Pepeekeo Sugar Co., as well as the county maintenance crews obtained cinder from company-owned pits for road construction and repair. Trachyte was quarried and processed at Puuwaawaa by Volcanite, Ltd., for local use as lightweight concrete aggregate and for shipment to Oahu via Kawaihae Harbor.

Kauai.—One of the last of the plantations in the Hawaiian Islands to change its sugarcane haulage system from railroad to truck, the Lihue Plantation Co., utilized nearly 150,000 tons of coral limestone during 1960 for road construction. The coral was dredged from the reef and stockpiled toward the mountain (mauka) from Kapaa from May through December 1959.

Grove Farm Co., Ltd., quarried and processed coral limestone and volcanic cinder near Koloa and basalt rock near Puhi, primarily for sale to building and paving contractors. Output of the Koloa cinder which was used to maintain the company's plantation haul roads decreased; output from both the limestone and basalt operations was greater than in 1959. Decomposed basalt rock for use as road base was quarried near Kilauea by crews of the Kilauea Sugar Co., Ltd. The crews used a bulldozer to work the single-bench quarry.

McBryde Sugar Co., Ltd.'s Kapeku Cinder Hill deposit, 1.8 miles south of Kalahea, was the island's principal source of volcanic cinder sold and used for horticulture, road and driveway surfacing, concrete aggregate, and fill. The deposit consisted of clean black cinders on the northwest side of the hill and weathered cinder on the southeast side, both of which were consumed in relatively large quantities during 1960.

Virtually all of the accessible beaches from Haena along Highways 56 and 50 to Bonham, the Wahiawa Stream, and the Hanapepe and Waimea Rivers were sources of coral sand and basaltic streambed sand and gravel, used in concrete and for road maintenance.

Lanai.—James W. Glover, Ltd., Hilo, Hawaii Island, shipped its Kalopa portable crusher to Lanai Island, Maui County, for the Kaumalapau highway project. The crusher was set up at a site one-half mile east of Kaumalapau Harbor, where basalt and aa rock were quarried and processed for use as base course and concrete aggregate.

Maui.—Hawaiian Commercial & Sugar Co., Ltd., operated its rotary kiln and continuous hydrator facility near Lower Paia, utilizing coral beach sand to produce hydrated lime for the sugar, pineapple, and building construction industries. A new dust collector and a 22-foot stack were added to the lime plant in January 1960. The company also worked the Puuhele Cinder Pit near Maalaea and obtained substantial quantities of the volcanic cinder for concrete aggregate.

Crews from Baldwin Packers, Ltd., worked the Wahikuli cinder pit 2 miles northeast of Lahaina for volcanic cinder for road construction and maintenance. County road crews and contractors utilized cinder from the Honokohau ash pit and the Kahakuloa cinder pit in northwestern Maui and from the Puu Pane pit of the Haleakala

Ranch Co. near Makawao. Black cinder from the upper and lower banks of Puumahoe, west of the Makena post office, was sold by Ulupalakua Ranch, Ltd., in 60-pound bags and by the cubic yard to growers of orchids and other flowers and also for walkways and driveways. The maintenance crew of the Hawaii National Park used black cinder obtained from a bank near Red Hill at the summit of Haleakala Crater for repairing Park roads and trails.

The quarry and processing plant operated by Kahului Railroad Co. at Camp 10 near Puunene supplied all of the local requirements for crushed basalt rock used in concrete aggregate and for railroad ballast. Coral beach sand used to blend with fines from the rock crusher was obtained from the Kaa area at Kahului Bay. Coral sand from the Wailuku dunes and from Kaanapali beach were used primarily for maintenance of plantation roads, some of which were oil surfaced. The 2½-mile double-crescent-shaped Kaanapali beach, a source of sand for many years, was taken over by a resort development project near the end of 1960. Basaltic gravels hauled from various stream deposits were used by county crews for road maintenance.

Black coral gem material obtained from the deep channel between Lanai and Maui Islands was fashioned into jewelry by Maui Divers of Hawaii at Lahaina.

Molokai.—Honolulu Construction & Draying Co., Ltd., shipped substantial quantities of lightweight volcanic cinder from the Waieli cinder pit and coral sand from the Papohaku beach on Molokai, Maui County, to Oahu via the company-constructed Hale O Lono barge facility. A $150,000 dredging operation was begun by mid-1960 to enlarge the channel at the barge harbor to accommodate larger tugs for the company's $1.5-million sand and cinder project. Volcanic cinder used on Molokai for fill and road maintenance was obtained principally from the Mauna Loa, Kaunakakai, and Puuluahine cinder pits.

Molokai Rock & Equipment, the island's sole commercial supplier of quarried stone, sold and used crushed basalt rock from stockpiles maintained at its quarry and plant site at Manawainui Gulch near Kaunakakai. Local requirements of coral sand used for concrete aggregate were obtained chiefly from the Moomomi dunes. Basaltic gravels from streambeds were used for fill and road maintenance.

Oahu.—A record construction year and the completion of Hawaii's new cement plants on Oahu, Honolulu County, advanced the value of the island's mineral output to $6.5 million from $5.3 million in 1959. The total yield of stone quarried and crushed on Oahu for use as riprap, roadstone, and concrete aggregate and for manufacture of cement and lime rose from 2.2 million tons in 1959 to 2.6 million tons in 1960, with values of $3.9 million and $4.6 million, respectively.

Clark-Halawa Rock Co., Hawaii Division of Pacific Cement and Aggregates, Inc., San Francisco, operated a basalt quarry at Halawa Valley near Aiea and a limestone quarry near Lualualei. Pacific Concrete & Rock Co., Ltd., quarried basalt rock at the Palailai quarry near Ewa and limestone at its Kailua quarry. Basalt rock was quarried by Honolulu Construction & Draying Co., Ltd. (HC&D), at the Kapaa quarry on the Kailua side of Oahu and by Hawaiian Rock & Supply Co., Ltd., at the Kaena quarry near Camp Erdman.

Nanakuli Paving & Rock Co., Ltd., worked its Testa quarry near Nanakuli for coral limestone. Coral pits of the Ewa Plantation Co. and the Malaekahana and Laie quarries of the Kahuku Plantation Co. were sources of limestone used for construction and maintenance of plantation roads. Road crews of the City and County of Honolulu hauled coral limestone from stockpiles maintained at Laie, and maintenance crews at Schofield Barracks worked the quarry at Kolekole Pass.

GasprO, Ltd., produced quicklime and hydrated lime at its rotary kiln and continuous hydrator facility near Waianae, utilizing coral limestone purchased from Clark-Halawa's Lualualei quarry. The Waianae limestone quarry site, from which the lime plant had been obtaining its raw material, was sold during the year to a land-development group.

Three new coral limestone deposits on Oahu were opened for commercial use in 1960. Oahu Aggregates, Inc., established its dragline and processing plant operation at Barbers Point to produce a wide range of aggregates from base course to washed concrete and mortar sand. The entire operation was conducted in the course of creating a new harbor at Barbers Point. Sand from the plant supplemented the coral sands obtained by other producers from northern Oahu and eastern Molokai.

Hawaiian Cement Corp., jointly owned by American Cement Corp., Cyprus Mines Corp., and a Honolulu hui (group), opened its 533-acre coral limestone deposit at Barbers Point to supply basic raw material to its new 1-million-barrel dry-process cement plant. Permanente Cement Co. obtained coral limestone from its quarry site near Maile, 2 miles from its new 1.7-million-barrel wet-process cement plant. Both of the cement plants installed extensive dust-collection systems, television monitors, automated controls, and other equipment of the latest type.

Clay used for brick and tile was obtained near Kokokahi by GasprO, Ltd. The company discontinued its clay-products operation before the end of 1960. Waialae Tile, Ltd., liquidated its brick and tile operation on Oili Road, near Waialae Avenue, Honolulu. Substantial quantities of black cinder were taken from stockpiles maintained at the Makiki Round Top cinder deposit to meet the demand for use as cushion under pipes and concrete slabs and for lightweight concrete aggregate. Large quantities of lightweight aggregate for Oahu's construction industry were shipped from a volcanic cinder deposit on Molokai by HC&D and from a trachyte deposit on the island of Hawaii by Volcanite, Ltd. Crude vermiculite from Montana was exfoliated at the relocated Honolulu plant of Vermiculite of Hawaii, Inc., and was used as lightweight aggregate in building products and in agriculture.

The Mineral Industry of Idaho

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 Idaho Bureau of Mines and Geology.

By Frank B. Fulkerson,[1] Gary A. Kingston,[1] and Norman S. Petersen [1]

IDAHO mineral production in 1960 declined 18 percent, largely because of a 7-month strike in lead-zinc mines of the Coeur d'Alene mining region, Shoshone County. Output of all minerals was $57.4 million, compared with $70.2 million in 1959. The 1960 value was the lowest since 1946. Lead, zinc, and silver declined $10.3 million (24 percent) in value. A similar sharp decrease of $2.6 million (49 percent) was recorded in copper production. Cobalt, columbium-tantalum concentrate, and rare-earth metals were not produced in 1960. In contrast, the overall nonmetal output continued to increase, because of greater production of phosphate rock, even though several nonmetals, including sand and gravel, dropped in output.

An index measuring the change in the volume of production showed that the quantity of minerals produced was 87 (1959=100). The index was an average of the percentage increases or decreases from 1959 to 1960 in the quantity of the commodities produced, weighted by their 1960 values.

Trends and Developments.—Important new developments took place in nonmetal industries. J. R. Simplot Co. completed construction of a $1.5 million clay-beneficiation plant in Latah County; The Bunker Hill Co. finished erection of a $2 million phosphate-products plant at Kellogg; and J. R. Simplot Co. and Food Machinery & Chemical Corp. began to expand the capacity of their Pocatello phosphate-products plants.

The Federal Bureau of Mines and the Idaho Bureau of Mines and Geology reported widespread beryllium discoveries in the Sawtooth Mountains in south-central Idaho and in the Yellow Jacket Mountains, 80 miles to the north. Further prospecting and exploration was believed necessary to determine the extent and importance of the occurrences.

Consumption, Trade, and Markets.—A slowdown in business activity in Idaho as well as in the Nation was a principal factor affecting mineral production in 1960. Output of several mineral products declined because of lower construction activity. Employment in the construction industry dropped 5 percent, and the value of building per-

[1] Commodity-industry analyst, Bureau of Mines, Albany, Oreg.

TABLE 1.—Mineral production in Idaho[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate short tons, antimony content	678	(2)	635	(2)
Clays[3] thousand short tons	39	$33	36	$29
Cobalt (content of concentrate) thousand pounds	1,141	(2)	----	----
Columbium-tantalum concentrate (oxide content) thousand pounds	189	(2)	----	----
Copper (recoverable content of ores, etc.) short tons	8,713	5,350	4,208	2,702
Gold (recoverable content of ores, etc.) troy ounces	10,479	367	6,135	215
Iron ore (usable) thousand long tons	6	56	9	(2)
Lead (recoverable content of ores, etc.) short tons	62,395	14,351	42,907	10,040
Mercury 76-pound flasks	1,961	446	1,538	324
Phosphate rock thousand long tons	1,610	7,412	2,177	11,044
Pumice thousand short tons	93	137	56	88
Rare-earth metals concentrate short tons	522	80	----	----
Sand and gravel thousand short tons	9,184	8,080	7,088	6,594
Silver (recoverable content of ores, etc.) thousand troy ounces	16,636	15,057	13,647	12,351
Stone thousand short tons	1,079	1,931	1,318	2,141
Titanium concentrate short tons, gross weight	(2)	(2)	2,014	30
Uranium ore short tons	3,374	30	(2)	(2)
Zinc (recoverable content of ores, etc.) do	55,699	12,811	36,801	9,495
Value of items that cannot be disclosed: Barite, cement, abrasive garnet, gem stones, gypsum (1959), mica, nickel (1959), peat, and values indicated by footnote 2. Excludes value of raw materials used in manufacturing cement	----	4,068	----	2,388
Total Idaho	----	70,209	----	57,441

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Excludes fire clay and bentonite (1960); included with "Value of items that cannot be disclosed."

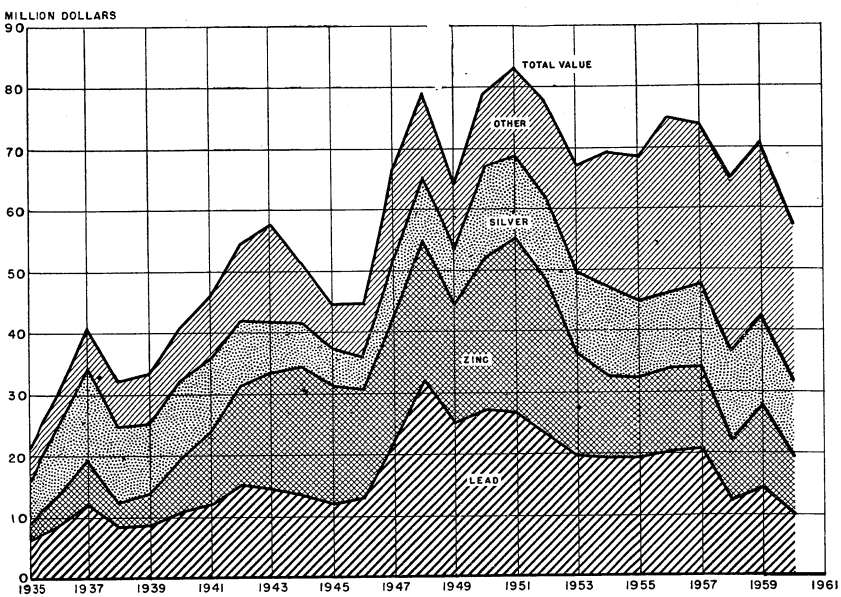

FIGURE 1.—Value of silver, lead, and zinc and total value of mineral production in Idaho, 1935–60.

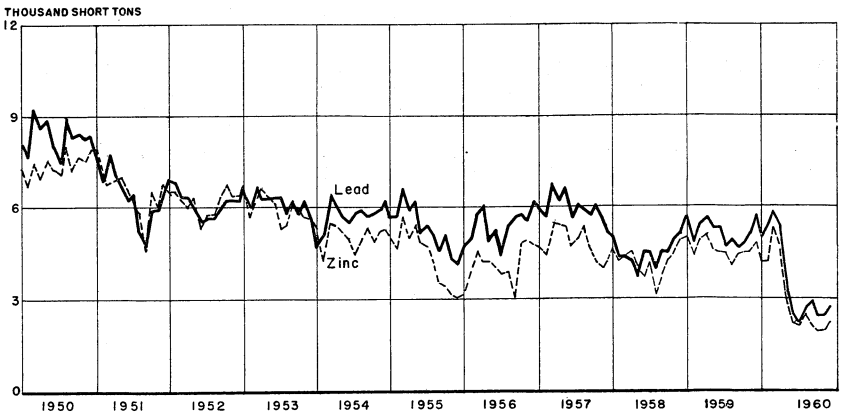

FIGURE 2.—Mine production of lead and zinc in Idaho, 1950–60, by months, in terms of recoverable metals.

TABLE 2.—Selected economic statistics

	1959	1960[1]	Change, percent
Personal income:			
Total—millions	$1,187.0	$1,224.0	+3
Per capita	$1,804.0	$1,824.0	+1
Construction activity:			
Building permits—millions	$39.9	$33.9	−15
Cement shipments to and within Idaho—thousand 376-pound barrels	1,230.0	1,351.0	+10
Average weekly hours of construction workers	37.7	37.3	−1
Mineral production—millions	$70.2	$57.4	−18
Factory payrolls—do	$146.1	$148.0	+1
Average monthly employment:			
Construction	10,100.0	9,600.0	−5
Food processing	8,600.0	9,300.0	+8
Lumber	12,800.0	12,200.0	−5
All manufacturing	30,300.0	29,900.0	−1
Total labor force	261,200.0	261,800.0	0
Unemployment	13,000.0	14,200.0	+9

[1] Preliminary figures.

Source: Survey of Current Business, Construction Review, Idaho Labor Market, Labor Force and Employment in Idaho, Distribution by Industry of Wages Paid for Covered Employment in Idaho, and Bureau of Mines.

mits issued by the principal cities decreased 15 percent. Employment declined despite several active road and other large projects. Construction was in progress on the Mountain Home Titan Missile Base, which will cost $40 million to complete. Regarding general economic conditions in the State, personal income received by Idaho residents from all sources increased, but the gain both in the State total and in the per capita figure was less than the U. S. advance because of the decline in construction, particularly in residential building, an unfavorable price for lumber, and depressed metal-mining production that resulted from the strike and poor markets.

Employment and Injuries.—Employment was reduced sharply by a strike and by mine closures. The phosphate fertilizer, phosphoric acid, and sulfuric acid industries were the only mineral industries to

record gains in employment, according to the Idaho Employment Security Agency.

Legislation and Government Programs.—Five contracts were active, compared with 11 in 1959, under the program of the Office of Minerals Exploration (OME), U.S. Department of the Interior, to encourage exploration for strategic and critical minerals. A new project was begun at the Copper Camp group, Valley County.

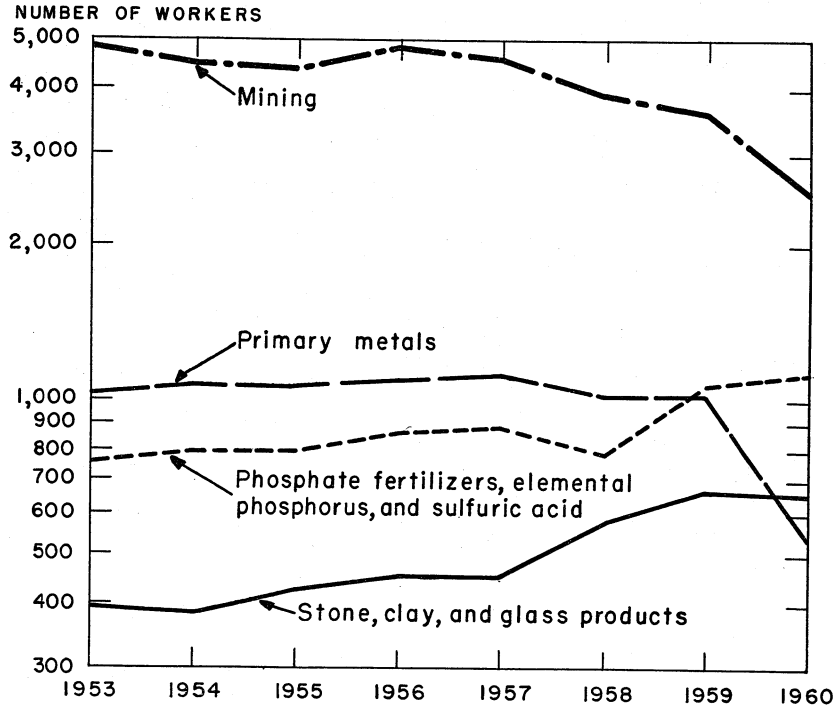

FIGURE 3.—Employment Trends
(Source: Idaho Employment Security Agency.)

TABLE 3.—Annual employment and earnings in the mineral industries

Year	Mining							
	Metals		Nonmetals		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)
1956	4,498	$23,161	268	$1,210	26	$94	4,792	$24,466
1957	4,388	23,716	249	1,123	21	84	4,658	24,923
1958	3,633	19,359	259	1,281	27	149	3,918	20,789
1959	3,305	18,393	292	1,379	20	127	3,619	19,899
1960	2,282	13,550	235	1,187	20	132	2,537	14,869

TABLE 3.—Annual employment and earnings in the mineral industries—Con.

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)
1956	458	$1,894	1,173	$6,399	861	$4,655	2,492	$12,948
1957	451	1,980	1,232	6,818	880	4,932	2,563	13,730
1958	579	2,760	1,034	5,314	787	4,518	2,400	12,592
1959	664	3,228	1,036	5,656	[1] 1,139	[1] 6,834	2,839	15,718
1960	654	3,376	534	3,023	1,244	7,991	2,432	14,390

[1] Part of the 1959 gain was due to obtaining greater detail from multi-industry employers.

Source: Idaho Employment Security Agency. Industry groups may not correspond with those in the Bureau of Mines canvass.

TABLE 4.—Hours and earnings of production workers in mining

	1956	1957	1958	1959	1960
Annual average:					
Weekly earnings	$97.11	$101.02	$95.68	$101.91	$103.21
Hourly earnings	$2.34	$2.47	$2.53	$2.58	$2.66
Weekly hours	41.5	40.9	37.7	39.5	38.8

Source: Idaho Employment Security Agency.

TABLE 5.—Injury experience in the mineral industries [1]

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:						
Quarries and mills [2]	236	123	232,438		2	9
Nonmetal mines and mills	616	219	1,079,226	2	24	24
Sand and gravel operations	209	152	254,176		5	20
Metal mines and mills	2,780	275	6,122,808	3	302	50
Coal mines						
Total	3,841	251	7,688,648	5	333	44
1960: [3]						
Quarries and mills [2]	194	125	194,056		4	21
Nonmetal mines and mills	583	240	1,121,044		39	35
Sand and gravel operations	267	178	380,689		12	32
Metal mines and mills	2,601	184	3,836,538	1	262	69
Coal mines						
Total	3,645	190	5,532,327	1	317	57

[1] Compiled by the Bureau of Mines from reports by individual companies.
[2] Includes cement- and lime-processing plants.
[3] Preliminary figures.

TABLE 6.—Office of Minerals Exploration contracts active during 1960

County and contractor	Property	Commodity	Contract		
			Date	Total amount	Government participation, percent
Custer:					
Clayton Silver Mines	Clayton	Lead, zinc	July 19, 1957	$130,840	50
Lemhi:					
Golden Copper Queen Mining Syndicate.	Copper Queen	Copper	Sept. 3, 1959	[1] 39,940	50
Shoshone:					
Abot Mining Co	Pilot group	Lead, zinc, copper.	June 3, 1959	43,550	50
American Smelting and Refining Co.	East Page	Lead, zinc	Sept. 18, 1957	660,206	50
Valley:					
Copper Camp Co	Copper Camp group.	Copper	June 17, 1960	34,840	50

[1] Changed from 1959 by amendment.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Sunshine Mining Co., Shoshone County, output of cathode metal (662 tons containing 96 percent antimony) was 8 percent below that of the previous year, but was slightly more than 1 percent higher in antimony content. Antimony contained in concentrate produced from ores of the Unit, Sunshine, Rambo, Suncon, and Yankee Girl properties was recovered by leaching and electrolysis. Cathode metal resulting from electrolysis was marketed to various smelters, secondary smelters, and brokers throughout the United States and Canada.

Smelter production of antimonial lead and high-purity antimony metal (99.99 to 99.999 percent Sb) by The Bunker Hill Co., Shoshone County, was interrupted by an extended strike in the Coeur d'Alene region. Because it is not identifiable by mine source, The Bunker Hill Co. output of antimony contained in antimonial lead is not included in State mineral-production totals.

Beryllium.—Exploration interest during the year centered about beryllium mineralization in the Idaho batholith. A Department of the Interior press release announced in August the discovery of widespread beryllium mineralization in the Sawtooth Mountains area of south-central Idaho (Elmore County) by field exploration teams of the Federal Bureau of Mines and the Idaho State Bureau of Mines and Geology. The discovery resulted from a lead provided by a local prospector, Kenneth Liddiard. In November, the two Bureaus announced a second discovery, this one in the Yellow Jacket Mountains (Lemhi County), 15 miles west of Cobalt and 80 miles north of the Sawtooth Mountains deposit. Although no deposits of economic

value were revealed by reconnaissance sampling of the two areas, the find indicated the possible existence of beryllium ore in commercial quantities. Further exploratory work was needed to ascertain the extent and importance of the discoveries.

Beryllium International, Inc., a Washington, D.C. company, acquired options on the 13 Sawtooth area discovery claims of Kenneth Liddiard; immediate investigation was scheduled to determine the extent of the occurrence.

Cobalt.—There was no production of cobalt in the State. In June, Calera Mining Co., a subsidiary of Howe Sound Co., abandoned interest in the Blackbird mine and mill at Cobalt, Lemhi County. Declining market prices brought Calera's cobalt production to a halt when the company's contract to deliver cobalt to the Government was completed in 1959. Domestic market demand for cobalt metal and oxide was being supplied principally by imports from Europe (Belgium-Luxembourg) and Africa (Republic of the Congo).

Columbium-Tantalum.—Columbium-tantalum dredging operations at Bear Valley, Valley County, were not resumed by Porter Bros. Corp. of Boise after completion in 1959 of the company contract with the Government. Research was conducted under a cooperative agreement between the Porter company and the Federal Bureau of Mines (Albany, Oreg.) to develop a commercial process for treating the euxenite (columbium-tantalum-bearing mineral) concentrate. Should the research prove successful in developing an economical process, it was anticipated by the company that both the two-boat dredging operation and the concentration plant at Lowman again would become active. Porter Bros. Corp., from 1955 through 1959, extracted a total of 130,521 tons of black-sand concentrate from its Bear Valley claims. Sizable tonnages of stockpiled byproduct ilmenite, monazite, and magnetite remained at the company plant at Lowman and warehouse at Boise.

Copper.—Output of copper was 4,208 tons, a sharp decline (52 percent) from the 8,713 tons produced in 1959. Calera Mining Co. milled stockpiled ore at Cobalt, Lemhi County, before quitting the Blackbird mine and mill operation in June; gold and silver also were recovered. The Blackbird mine was in previous years the leading copper producer in the State, the metal resulting as a byproduct of cobalt mining. Extended production stoppages at mines in the Coeur d'Alene region owing to a labor dispute reduced the quantity of copper produced in that area; output at the Sunshine mine was unaffected.

Gold.—Closure of the largest gold-producing operation, the Calera Mining Co. Blackbird mine, resulted in a 41-percent decline to 6,135 ounces, compared with 10,479 ounces in 1959. Also contributing to the decline was the curtailment, because of a prolonged strike, of the lesser quantities normally recovered from northern Idaho base-metal mines. In contrast with the State trend, the Lucky Friday Silver-Lead Mines Co. Lucky Friday mine, unaffected by the strike showed a 149-percent increase over the previous year and accounted for 24 percent of the State total.

TABLE 7.—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)
1951–55 (average)	123	34	2,455	23,902	$837	14,803	$13,397
1956	104	21	2,071	9,210	322	13,472	12,193
1957	93	20	2,100	12,301	431	15,067	13,637
1958	85	31	1,681	15,896	556	15,953	14,438
1959	47	24	1,834	10,479	367	16,636	15,057
1960	79	20	1,105	6,135	215	13,647	12,351
1863–1960 [3]	----------	----------	139,821	8,295,000	193,471	717,214	537,081

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	3,791	$2,288	71,701	$21,587	67,887	$19,222	$57,331
1956	6,656	5,658	64,321	20,197	49,561	13,580	51,949
1957	7,912	4,763	71,637	20,488	57,831	13,417	52,735
1958	9,846	5,179	53,603	12,543	49,725	10,144	42,860
1959	8,713	5,350	62,395	14,351	55,699	12,811	47,935
1960	4,208	2,702	42,907	10,040	36,801	9,495	34,802
1863–1960 [3]	171,000	70,885	6,941,000	947,935	2,217,000	453,780	2,203,152

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings, and old slag re-treated, and ore shipped to smelters during the calendar year indicated. Because of rounding, individual items may not add to total shown.
[2] Does not include gravel washed.
[3] Partly estimated for years before 1901.

TABLE 8.—Gold production at placer mines

Year	Mechanical and hydraulic methods			Small-scale hand methods			Total		
	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)
1951–55 (average)	17	1,200	6,444	17	4	95	34	1,205	6,539
1956	13	350	2,484	8	2	38	21	352	2,522
1957	16	250	2,916	4	2	49	20	252	2,965
1958	13	92	2,501	18	7	89	31	100	2,590
1959	10	92	1,878	14	5	89	24	98	1,967
1960	[1] 9	64	793	11	6	50	20	70	843

[1] Includes 4 dragline dredges and 5 hydraulic operations; combined to avoid disclosing individual company confidential data.

Iron Ore.—Shipments of iron ore increased 63 percent, rising to 8,967 long tons from 5,501 long tons in 1959. Production went to cement plants and to several steel plants in Oregon and Washington. Two new producers—one each in Washington and Benewah Counties—accounted for the increase.

Lead.—Output of lead dipped 31 percent to 42,907 tons (the lowest since 1895), compared with 62,395 tons in 1959; the drop resulted from nearly complete stoppage of major mining and ore processing in the Coeur d'Alene region because of labor disputes at operations of the

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	6	6	201	$7	55	(1)
Bonner	5		106	4	22,652	$21
Boundary	1				169	(1)
Butte	3		2	(1)	76	(1)
Clearwater		1	67	2	11	(1)
Custer	10	1	233	8	145,881	132
Gem	4		1,109	39	5,275	5
Lemhi	17	1	781	27	7,812	7
Shoshone	22	1	2,591	91	13,458,522	12,181
Valley		1	3	(1)	3	(1)
Undistributed [2]	11	9	1,042	36	6,052	5
Total [3]	79	20	6,135	215	13,646,508	12,351

County	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Boise							$7
Bonner			18	$4			28
Boundary			4	1			1
Butte			1	(1)			(1)
Clearwater							2
Custer	109	$70	1,108	259	143	$37	506
Gem	2	1	11	3	9	2	50
Lemhi	1,451	932	70	16	9	2	985
Shoshone	2,606	1,673	41,692	9,756	36,639	9,453	33,153
Valley							(1)
Undistributed [2]	40	26	3	1	1	(1)	69
Total [3]	4,208	2,702	42,907	10,040	36,801	9,495	34,802

[1] Less than $560.
[2] Includes values and quantities that cannot be shown separately for Ada, Adams, Blaine, Clark, Elmore, Idaho, Jerome, and Owyhee Counties.
[3] Because of rounding, individual items may not add to total shown.

American Smelting and Refining Co. and The Bunker Hill Co. The northern-Idaho lead-producing area yielded little metal from May through December because of a work stoppage called by the International Union of Mine, Mill and Smelter Workers, after failure of the union and the affected mining companies to reach a new contract agreement on issues of wages, fringe benefits, and management responsibilities. The mining community of Kellogg and the surrounding area suffered severe economic paralysis from an approximate $1 million-a-month salary loss for more than 7 months of the year. A sizable increase (48 percent) in output over the previous year at the Lucky Friday Silver-Lead Mines Co.'s Lucky Friday mine (operated by Hecla Mining Co.) and lesser production increases at the Sunshine Mining Co. Sunshine group and The Bunker Hill Co.'s Star mine (operated by Hecla Mining Co.) helped to alleviate the impact of the strike-caused production losses. Through a National Labor Relations Board supervised election in December, Bunker Hill Co. employees chose a new bargaining agent, and the company negotiated a 5-year settlement with the new union; a contract between American Smelting

TABLE 10.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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, gold-silver, gold old tailings, gold-silver old tailings, and gold assay rejects [2]	21	9,169	1,789	6,087	4,000	21,700	18,000
Dry silver	16	358,610	550	9,514,319	4,294,600	5,760,100	934,200
Total	37	367,779	2,339	9,520,406	4,298,600	5,781,800	952,200
Copper and copper assay rejects [2]	12	77,637	741	12,623	3,165,500	24,200	4,000
Lead	16	150,670	1,576	2,880,601	541,900	29,766,600	2,516,100
Lead-zinc and zinc [2]	16	496,113	636	1,224,917	372,700	49,669,100	67,418,000
Total	44	724,420	2,953	4,118,141	4,080,100	79,459,900	69,938,100
Other "lode" material:							
Zinc: Old slag smelted	1	13,107	--------	7,869	37,300	572,300	2,711,700
Total "lode" material	79	1,105,306	5,292	13,646,416	8,416,000	85,814,000	73,602,000
Gravel (placer operations)	20	[3]	843	92	----------	----------	----------
Total	99	1,105,306	6,135	13,646,508	8,416,000	85,814,000	73,602,000

[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] 69,616 cubic yards.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	714	439	----------	----------	----------
Concentration and smelting of concentrates:					
Ore	4,102	13,596,045	8,024,400	84,966,500	70,855,100
Direct smelting:					
Ore and assay rejects [1]	476	42,063	354,300	275,200	35,200
Old slag	----------	7,869	37,300	572,300	2,711,700
Total	476	49,932	391,600	847,500	2,746,900
Placer	843	92	----------	----------	----------
Grand total	6,135	13,646,508	8,416,000	85,814,000	73,602,000

[1] Combined to avoid disclosing individual company confidential data.

and Refining Co. and the Mine-Mill union was signed shortly after the Bunker Hill election.

The outlook for the Coeur d'Alene area improved during the year when The Bunker Hill Co. entered into a long-term agreement with National Lead Co. for the purchase of all Bunker Hill metal production; the contract was to become effective January 1, 1961, and, along with the new labor-management agreement, was expected to bring Bunker Hill Kellogg operations to maximum production capacity.

Mercury.—State mercury output declined 22 percent to 1,538 flasks (76 pounds each) from 1,961 flasks in 1959. This was the lowest production since 1955, when output was 1,107 flasks. Production at the Idaho-Almaden mine (Rare Metals Corporation of America) near Weiser was 11 percent less than in 1959, and the Holley Minerals Corp. operation, also near Weiser, was idle. Ore treated yielded 2.1 pounds of mercury a ton, compared with 2.6 pounds in the previous year. Value of production dropped 27 percent below 1959, based on an average price of $210.76 a flask.

Nickel.—Upon closure of the Calera Mining Co. Blackbird mine, Lemhi County, nickel production in Idaho ceased. Mine output of the metal halted in June 1959 with the fulfillment of commitments for cobalt (associated in the ore with the nickel) under Government contracts.

Rare-Earth Metals.—There was no production of the rare-earth-bearing minerals (monazite and euxenite) in Idaho during the year. The Porter Bros. Corp. dredging operation was shut down (see Columbium-Tantalum), and no shipments of monazite resulted from reprocessing of stockpiled concentrate at the J. R. Simplot Co. Boise sand plant (see Titanium).

Silver.—Because of the work stoppage occasioned by the northern-Idaho labor dispute, silver output declined to 13.6 million ounces, a drop of 18 percent from 1959. The Sunshine group and Lucky Friday mines, unaffected by the strike, were the leading producers and accounted for 64 percent of the State total.

Thorium.—There were no commercial shipments of thorium-bearing ore or concentrate during the year. The location of new thorite mining claims in the Salmon area of Lemhi County subsided, and there was limited activity by several companies, one of which (Nuclear Fuels & Rare Metals Corp.) was redesigning a mill owned by Salmon River Uranium Development Corp. The mill, near North Fork, was to be used by Nuclear Fuels to beneficiate ore from a property near Tendoy. In the Lemhi Pass area, Rare Metals Corporation of America explored properties leased in 1959 from Agency Creek Thorium & Rare Metals Corp.

Titanium.—Stockpiled ilmenite dredge concentrate was reprocessed at the J. R. Simplot Co. Boise plant to produce 2,032 tons of ilmenite for high-density concrete and roofing granules.

Tungsten.—Small-scale mining and milling were resumed late in the year by Salmon River Scheelite Corp. at the Tungsten Jim mine on Thompson Creek near Clayton, and exploratory work was continued. No tungsten concentrate was shipped.

Uranium.—Owing to an increase in grade of ore, the value of uranium production increased despite a decrease in ore shipments. Two producers shipped—The Childs Co. (Lightning group) and Phillips Petroleum Co. (Elk No. 1 Deerstrike)—from mines in Custer County.

Vanadium.—Minerals Engineering Co. and Susquehanna-Western, Inc., a subsidiary of The Susquehanna Corp., organized a joint venture for recovery of vanadium contained in Idaho phosphate rock. The new company, named Susquehanna Minerals, purchased the former Calera Mining Co. cobalt refinery in Salt Lake City, Utah, where high-purity vanadium oxide was to be produced at the rate of 1.5

million pounds annually. A two-stage process developed by Minerals Engineering Co. and Food Machinery & Chemical Corp. was planned—the first step would be carried out at Pocatello and the second, a refining step, would take place at the Salt Lake City plant, for which $500,000 in new facilities was authorized.

Zinc.—Because of the strike in the Coeur d'Alene region, production of zinc dropped to 36,801 tons—a 34-percent decline compared with 1959 and the lowest output since 1935. The Bunker Hill Co. Star mine, Shoshone County, operated the entire year by Hecla Mining Co., was by far the leading producer; concentrates formerly going to the Bunker Hill smelter were stockpiled.

NONMETALS

Barite.—The Sun Valley barite mine of J. R. Simplot Co., Blaine County, was idle throughout the year; however, shipments were made from stocks to the company grinding plant in Power County, west of Pocatello. Shipments of ground barite, marketed principally as a weighting agent for oil-well drilling muds, were reduced sharply compared with 1959.

Cement.—Idaho Portland Cement Co. continued production of portland and masonry cements at Inkom, Bannock County. Production and shipments were 6 percent lower than in 1959. Cement was shipped mainly to destinations within the State; smaller quantities were shipped to other markets in the Rocky Mountain area.

Clays.—The quantity of clay sold or used by Idaho producers increased 6 percent over 1959. Greater production of fire clay accounted for the advance. Miscellaneous clay used in making heavy clay products, mainly building brick, was produced in Bonneville, Cassia, Elmore, and Minidoka Counties. Fire clay for refractories was mined in Latah County.

A small tonnage of bentonite mined near Grandview, Owyhee County, was marketed as a hydroseal for irrigation canals and reservoirs and for use in oil-well drilling muds.

J. R. Simplot Co. completed construction in February of a $1.5 million clay-beneficiation plant at Bovill, Latah County. The installation was built to produce mixtures of clay, quartz, and mica suitable for use as paper clay and glass sand. The sand section of the plant began operating in February; the clay section began test operations in October.

Garnet (Abrasive).—Production and shipments of abrasive garnet by Idaho producers were down sharply from the previous year. Shipments were made from operations in Benewah, Ada, and Boise Counties. Output by Porter Bros. Corp. (Boise County) and J. R. Simplot Co. (Ada County) was a byproduct of milling sand concentrates previously dredged at the companies' operations in Valley County.

Gypsum.—No production of gypsum was reported from the Rock Creek gypsum mine in Washington County; however, shipments from stocks were made during the year. Less gypsum was marketed for agricultural purposes than in 1959.

Mica.—Test lots of hand-cobbed mica were shipped to the General Services Administration (GSA) mica-purchase depot at Custer, S. Dak., from prospects near Riggins, Idaho County, and Murphy, Owyhee County. In July, controlling interest in Western Mica Corp., Deary, Latah County (Muscovite mine), was purchased by Ida-Mica Industrial Minerals, Inc. No production of mica was reported from the Muscovite mine in 1960.

Peat.—Peat production advanced more than twofold compared with 1959; however, tonnages remained relatively small. Reed-sedge peat, produced at bogs in Bannock and Teton Counties, was marketed mainly for soil-conditioning uses.

Perlite.—Oneida Perlite Corp. began developing a newly discovered perlite deposit northwest of Malad, Oneida County. The company constructed an expanding plant at Malad that was to process crushed ore shipped from the mine about 25 miles away. The largest use of the expanded perlite was expected to be in building plaster.

Phosphate Rock.—Production of marketable phosphate rock by Idaho producers increased to 2.2 million long tons, compared with 1.6 million long tons in the previous year. Mine production of phosphate rock advanced 3 percent over the 2.2 million long tons mined in 1959. Phosphate rock was produced from six operations in 1960—three in Caribou County, two in Bear Lake County, and one in Bingham County. In addition, shipments were made from stocks at a mine in Caribou County. San Francisco Chemical Co. began production in May from the newly opened Diamond Gulch property north of Montpelier (Caribou County). Output from the mine was trucked to the company mill at Montpelier for grinding before shipment to fertilizer-manufacturing plants in the western United States.

Phosphate rock sold or used by producers was 2 million long tons, an increase of 25 percent over the 1.6 million long tons sold or used in 1959. The largest use continued to be for manufacturing elemental phosphorus; the quantity of rock consumed for this purpose remained substantially the same as in 1959. The quantity of rock used to manufacture phosphate fertilizers and wet-process phosphoric acid and that shipped for export increased over 1959.

Phosphate rock was utilized at elemental phosphorous plants of Food Machinery & Chemical Corp., Mineral Products Division, Pocatello; Monsanto Chemical Co., Soda Springs; and Central Farmers Fertilizer Co., Georgetown. The Central Farmers firm used elemental phosphorus to make phosphoric acid, which in turn was used to produce phosphate fertilizers at the company Georgetown plant. J.R. Simplot Co. continued producing phosphate fertilizers at a plant west of Pocatello in Power County. San Francisco Chemical Co. operated a grinding and pulverizing plant at Montpelier, Bear Lake County.

In June, The Bunker Hill Co. completed construction of a $2 million plant at Kellogg, Shoshone County, which was to produce phosphoric acid for fertilizer use. The company was developing phosphate-rock deposits in Montana as a source of raw material for this plant; however, phosphate rock from Idaho and Wyoming was to be used initially. Sulfuric acid used in the process would be supplied from the nearby company acid plant. The new facility remained idle

throughout the year because of a labor dispute that halted all Bunker Hill operations in the Kellogg area. In September, Collier Carbon & Chemical Corp. began constructing a $225,000 acid-concentrating plant adjacent to the Bunker Hill phosphoric acid facility. The addition, owned by the Collier concern, would be used by Bunker Hill to manufacture highly concentrated phosphoric acid which would be shipped to Collier company fertilizer plants in California.

J. R. Simplot Co. in July announced that productive capacity at its Pocatello fertilizer plant would be doubled. Included in the proposed expansion program was an ammonium phosphate plant to manufacture complex fertilizers containing nitrogen and phosphorus. Also, additional dust- and fume-collecting equipment was to be installed. The expansion was scheduled for completion in 1961.

Food Machinery & Chemical Corp., Mineral Products Division, began a $2.5-million modernization program that would boost productive capacity at the Pocatello elemental-phosphorus plant.

Pumice and Volcanic Cinder.—Pumice and volcanic cinder sold or used by producers declined sharply compared with 1959. Output was from operations in Bonneville, Canyon, and Twin Falls Counties. Three pumice operations in Bonneville County continued to supply the major portion of the output. Pumice and volcanic cinder were used chiefly as lightweight-concrete aggregate. A quantity of crude pumice was used as feedlot fill and for surfacing roads. Boise Cascade Concrete, a subsidiary of Boise Cascade Corp., optioned 260 acres of pumice claims near Fairfield, Camas County, for the purpose of testing the extent and quality of the deposits. The firm considered establishing a plant at the deposits to manufacture lightweight-concrete products.

Sand and Gravel.—Sand and gravel output was 7.1 million tons—a decline of 23 percent from the 9.2 million tons produced in 1959. The drop was caused by decreased use of sand and gravel at State highway department and U.S. Forest Service projects. The quantity of sand and gravel used at State highway projects (3.1 million tons) was 38 percent less than for the previous year. Sand and gravel produced by commercial firms was 2.5 million tons, compared with 2.1 million tons for 1959. Noncommercial (Government-and-contractor) output was 4.6 million tons—a decline of 35 percent from the 7.1 million tons produced the previous year. Production was from operations in 36 of the 44 counties in the State. Cassia County ranked as the largest producing area; Bonneville and Owyhee Counties ranked second and third, respectively.

Industrial sands were produced at two operations—one each in Gem and Latah Counties. Special high-quality sands for glass, filter, plaster, and foundry purposes were produced.

Stone.—Total production of stone for all purposes advanced 22 percent over 1959. Output by commercial producers increased 43 percent from the previous year and was the principal cause of the rise. Increased use of roadstone at State and Federal projects also contributed to the advance. Noncommercial (Government-and-contractor) tonnages were 6 percent greater than in 1959. In terms of tonnage, basalt continued to be the principal stone quarried. Output was used chiefly for road construction and maintenance; smaller quantities were used

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	679	$844	775	$1,125
Road material	1,204	1,201	1,503	1,266
Railroad ballast	(1)	(1)	(1)	(1)
Other	219	174	208	226
Total	2,102	2,218	2,486	2,617
Government-and-contractor operations:				
Building	43	66	76	73
Road material	7,039	5,796	4,244	3,791
Other			282	113
Total	7,082	5,862	4,602	3,977
All operations:				
Building	722	909	851	1,198
Road material	8,243	6,997	5,747	5,057
Railroad ballast	(1)	(1)	(1)	(1)
Other	219	174	490	339
Grand total [2]	9,184	8,080	7,088	6,594

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Because of rounding, individual items may not add to totals shown.

for ballast and riprap. The quantity of limestone quarried decreased 15 percent from the previous year. Output, which was from quarries in Bannock and Lewis Counties, was used mainly for cement manufacture. Other uses included sugar refining, metallurgical flux, paper manufacturing, and agricultural applications. Quartzite used as flux in electric furnaces of elemental-phosphorus plants was quarried in Caribou and Power Counties. The quantity produced for this use increased moderately over 1959. Stone production was reported from 17 of the State's 44 counties.

Sulfuric Acid.—The Bunker Hill Co. continued production of sulfuric acid at Kellogg, Shoshone County, until May, when a labor dispute idled all Bunker Hill operations in the Kellogg area. Output, which normally was used partly for manufacturing fertilizers and partly at the company metallurgical works, was drastically reduced from the previous year. J. R. Simplot Co. continued to produce sulfuric acid at a plant west of Pocatello in Power County for use in an adjacent company fertilizer plant to manufacture phosphate fertilizers and wet-process phosphoric acid.

REVIEW BY COUNTIES

Ada.—Remaining stocks of ilmenite derived from earlier dredging in Valley County by Baumhoff-Marshall, Inc., were sold by J. R. Simplot Co., Boise.

Sand and gravel for construction and road use was produced in the county; however, output was down sharply from 1959 because of curtailed requirements for road gravel at State highway department projects. A quantity of crushed stone was produced for use at U.S. Army Corps of Engineers works.

Adams.—The South Peacock mine at Helena, 10 miles north of Cuprum in the Seven Devils district, was operated by Todd Russell and Jack Darling. Copper ore was hand sorted and shipped to the Tacoma, Wash., smelter.

Bannock.—Portland and masonry cements were produced at the Inkom plant of Idaho Portland Cement Co. Limestone for use at the plant was obtained from a nearby quarry. Peat was produced at about the 1959 rate from a bog near Downey. Sand and gravel production declined sharply because of reduced demand by State and county highway departments. Crushed stone output advanced compared with 1959 owing to increased use of basalt at State highway department projects.

TABLE 13.—Value of mineral production in Idaho, by counties

(Thousand dollars)

County	1959	1960	Minerals produced in 1960, in order of value
Ada	$613	(1)	Sand and gravel, stone, silver, gold.
Adams	22	(1)	Copper, silver, gold.
Bannock	(1)	(1)	Cement, stone, sand and gravel, peat.
Bear Lake	(1)	(1)	Phosphate rock, sand and gravel, stone.
Benewah	(1)	$212	Sand and gravel, abrasive garnet, stone, iron ore.
Bingham	(1)	(1)	Phosphate rock, sand and gravel.
Blaine	257	(1)	Barite, silver, lead, zinc, gold.
Boise	2	35	Stone, gold, silver.
Bonner	101	107	Sand and gravel, silver, lead, gold.
Bonneville	534	462	Sand and gravel, pumice, and clays.
Boundary	171	99	Sand and gravel, stone, lead, silver.
Butte	14	(1)	Lead, gold, silver.
Camas	----	80	Sand and gravel.
Canyon	263	232	Sand and gravel, pumice.
Caribou	(1)	(1)	Phosphate rock, stone, sand and gravel.
Cassia	598	957	Sand and gravel, clays.
Clark	79	36	Sand and gravel, copper, silver, gold.
Clearwater	(1)	188	Sand and gravel, stone, gold, silver.
Custer	436	549	Lead, silver, copper, uranium, zinc, gold.
Elmore	520	196	Sand and gravel, stone, clays, gold, silver.
Franklin	152	112	Sand and gravel, stone.
Fremont	(1)	27	Sand and gravel.
Gem	12	214	Sand and gravel, gold, silver, lead, zinc, copper.
Gooding	201	(1)	Sand and gravel.
Idaho	395	419	Stone, sand and gravel, gold, silver, mica.
Jefferson	312	----	
Jerome	8	204	Sand and gravel, gold, silver.
Kootenai	574	300	Sand and gravel.
Latah	(1)	153	Stone, sand and gravel, clays.
Lemhi	4,449	1,002	Copper, gold, sand and gravel, lead, silver, zinc.
Lewis	(1)	297	Stone.
Lincoln	33	(1)	Sand and gravel.
Madison	160	(1)	Do.
Minidoka	70	171	Sand and gravel, clays, stone.
Nez Perce	26	21	Sand and gravel.
Oneida	4	45	Do.
Owyhee	41	348	Sand and gravel, stone, clays, gold, mica.
Payette	106	37	Sand and gravel.
Power	1,880	272	Sand and gravel, stone.
Shoshone	44,341	33,393	Silver, lead, zinc, copper, antimony, gold, stone.
Teton	98	(1)	Sand and gravel, peat.
Twin Falls	356	267	Sand and gravel, pumice.
Valley	641	35	Titanium (ilmenite), abrasive garnet, sand and gravel, gold, silver.
Washington	484	840	Sand and gravel, mercury, iron ore.
Undistributed [2]	12,256	16,131	
Total	70,209	57,441	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes value of some sand and gravel, stone, and gem stones that cannot be assigned to specific counties and values indicated by footnote 1. Excludes value of raw materials used in manufacturing cement.

Bear Lake.—Mine production of phosphate rock was lower than in 1959 because of reduced output at the Central Farmers Fertilizer Co. Georgetown mine. Production was used by the firm to produce elemental phosphorus, phosphate fertilizers, phosphoric acid, and a beneficiated phosphate-rock product. A quantity of rock also was shipped for export. San Francisco Chemical Co. mined and shipped phosphate rock from the Waterloo mine early in the year; shipments were made from stocks at the mine during the last half of the year. Increased requirements for sand and gravel at State highway department projects resulted in a sharp production rise over the previous year.

Benewah.—Iron ore was mined near Tensed by C. C. Hill from an open-pit operation; ore was sold for use at a cement plant in Washington.

Bingham.—J. R. Simplot Co. continued mining phosphate rock at the Gay mine near Fort Hall. Production of both phosphate rock and phosphatic shale increased compared with 1959. Phosphate rock was shipped to the Simplot fertilizer works west of Pocatello in Power County. Phosphatic-shale production was utilized at the elemental-phosphorous plant of Food Machinery & Chemical Corp. at Pocatello.

Blaine.—Lead ore was mined and shipped from the six-claim La Grande group northwest of Hailey in the Mineral Hill district. In the same district, the Shelton Cheney Mining Co. Liberty Gem mine and the Star mine operated by Thornley Williams yielded silver ore. Exploration and development were conducted by Silver Star Queens Mines, Inc., at the Minnie Moore lead mine near Hailey.

The J. R. Simplot Co. Sun Valley barite mine was not operated in 1960; however, shipments of crude barite were made from stock to the company grinding plant at Pocatello. The quantity of crude barite shipped for grinding was down sharply compared with the previous year.

Boise.—Seven placer operations in the Boise Basin district yielded 185 ounces of gold and 41 ounces of silver from 22,324 cubic yards of stream and bench gravel and old tailings. A dragline dredge used on old tailings at the Pennington mine was the principal operation. Six small lode-gold mines were active, including the Gold Belt and Gold Hill properties in the Boise Basin district and the Golden Cycle and King mines in the Summit Flat mining district.

Bonner.—Small quantities of lead and silver ore were mined at four properties; a fifth mine, the Austin Meyer Corp. Weber mine, Lakeview district, yielded a comparatively large tonnage of lead ore. Selkirk Mining Co. announced plans to construct a 750-foot tramway at the Plowboy mine (lead ore), Kootenai mining district, to be used to carry ore from the mine to a stockpile area, from which the ore was to be trucked to a smelter. The Conjecture mine, north of Lake Pend Oreille, was under development by Conjecture Mines, Inc.

Bonneville.—Three operations in the county continued to supply the bulk of the pumice produced in the State. Output, which was marketed for use as lightweight-concrete aggregate, was less than in 1959. Sand and gravel production remained substantially the same as for the previous year.

Butte.—Minor tonnages of lead and gold-silver ores were produced from three mines in the Dome district.

Caribou.—Mine production of phosphate rock increased sharply over 1959. Greater production from the Conda mine (J. R. Simplot Co.) was the principal reason for the advance. Production from the new Diamond Gulch operation of San Francisco Chemical Co. and increased output from the Ballard properties of Monsanto Chemical Co. also contributed. J. R. Simplot Co. shipped phosphate rock from the Conda mine for fertilizer manufacture and for export; the Ballard mine continued to supply phosphate rock used at Monsanto's elemental-phosphorus plant at Soda Springs. Output from San Francisco Chemical Co. Diamond Gulch mine was ground at the company Montpelier mill. Phosphate rock for fertilizer manufacture was shipped from stockpiles at the J. A. Terteling operation during the year.

Clark.—Copper ore was mined from the Valley View mine, Birch Creek district.

Clearwater.—A dragline dredge was utilized by Moose Mountain Mining Co. on the Lilly No. 1 and No. 2 claims to recover 67 ounces of gold and 11 ounces of silver from 5,000 yards of stream gravel.

Custer.—Custer county ranked third in the State in the value of gold, silver, copper, lead, and zinc produced; Clayton Silver Mines (Clayton mine) was the principal producer, accounting for 93 percent of the tonnage of these ores mined in the county. Exploration and development at the Clayton mine, 2 miles north of Clayton in the Bayhorse district, consisted of 228 feet of raising, 1,034 feet of drifting, and 432 feet of crosscutting; mining was by the shrinkage stope method. The Clayton mill zinc circuit was idle because of low market prices, and some lead ore was bypassed in the mine for the same reason. The mine and mill were operated 6 and 7 days a week, respectively, for the entire year. The Clayton Silver Mines' annual report to shareholders stated in part:

> The North Drift, on the 800 level, was completed after advancing 760 feet to a point some 1,900 feet north of the shaft. The downward extension of the 500 north ore body was found approximately as planned at 1,400 feet north of the shaft. The drift was advanced on very good lead-zinc-silver ore for 140 feet. In the next 300 feet some lead and practically no zinc was found, but the silver content rose sharply. The occurrence of tetrahedrite which carried the silver in this latter area is rather erratic but the total content over a 40-foot width is considerable. By the end of the year not enough information had been gained to definitely establish grade and tonnage, but it looks as though there are over 225,000 tons with a probable content value of around $8.00 a ton at the present prices of lead and silver. The tonnage of lead-zinc-silver ore mentioned above in the first 140 feet between the 500 and 800 is estimated at 108,700 tons.
>
> The 500 North Drift was advanced 275 feet and a crosscut was driven 173 feet eastward to explore the east wall. Some mineralization but no ore was found.
>
> The reserves of broken ore in the south 700 and north 500 stopes were estimated at 4,000 tons at year's end.
>
> The diamond drilling contemplated during 1960 was deferred until 1961 from fear of increasing the mine water flow which had been near the pump's capacities.
>
> The major projects for 1961 will be development of the 800 north end ore body and diamond drilling.

In the Alder Creek district, the Empire group produced copper ore. It was the only other significant producer of base metal ores in the county. The White Knob lead mine also was active. In addition to

the Clayton mine, other mines producing in the Bayhorse district were the Ellis group (lead), Estes Gold (copper), and Red Top (lead-zinc) properties. The D & E mine (Sheep Mountain district) yielded lead-zinc ore and the Charles Dickens (silver) and Lucky Day (gold) mines produced in the Yankee Fork district.

The Grubstake mine (Seafoam district), the only active placer, yielded several ounces of gold from stream gravel.

Sidney Mining Co. conducted a diamond-drilling program in the Bayhorse district under an agreement with Umont Mining, Inc., which held a lease option from Bayhorse Mines, Inc.; the Bayhorse firm held the Ramshorn group containing 19 patented and 4 unpatented claims. Exploration was concentrated in the Beardsley Gulch area.

The Childs Co. and Phillips Petroleum Co. operated uranium properties and accounted for the total State production of uranium ore.

There was production but no shipment of tungsten concentrate at the Salmon River Scheelite Corp. Tungsten Jim mine near Clayton.

Elmore.—Talache Mines, Inc., mined gold ore from the Boise-Rochester group in the Middle Boise district; the Golden Stringer gold mine also was active in the district. Two placer operations produced in the Bear Creek district—dragline dredge at the Feathers placer on stream gravel and a small-scale hand operation on bench gravel.

Gem.—Of the four gold and base metal mines that produced, the Dewey mine (gold) near Emmett yielded the largest ore tonnage in the county. Other properties, all in the Westview mining district, were the Black Rock (gold-silver and lead-zinc), Checkmate (gold-silver from old tailings), and Eagle Talon (gold-silver). A new 40-ton jig-flotation mill was in operation at the Gem State Consolidated Mines, Inc., Dewey group mine. Gold sponge derived from sulfide ores was shipped to the Denver Mint, and concentrate went to the East Helena, Mont., smelter. The Gem State company, operating from March through December, did 400 feet of exploration-and-development raising, drifting, and crosscutting and 125 feet of long-hole drilling; 11,375 tons of development rock was mined to dump. The ore was mined by using stulled stopes.

Idaho.—Two placers using hydraulic methods and two small-scale hand placer operations were active. The Gold Bar placer, operated by Del Dewey in the Mt. Marshall district, was the principal producer. Idaho Mining & Milling Co. was readying a dredge to be used for recovering gold in the Florence Basin.

Kimberly Gold Mines, Inc., produced gold ore from the Kimberly group, Marshall Lake district, and blocked out enough ore to operate a 100-ton flotation mill near Riggins for 2 years. Two other gold properties—Gauntlet (Florence district) and Center Star (Ten Mile district)—produced lesser quantities of ore.

A test-lot shipment of hand-cobbed mica was made to GSA from the Mica lode and Lake Creek prospects east of Riggins.

Latah.—In February, J. R. Simplot Co. began operating the sand-separation section of a clay-sand beneficiation plant near Bovill. Output was shipped mainly for glass and foundry purposes. Fire clay produced near Helmer was used in manufacturing refractories at the Troy plant of A. P. Green Firebrick Co. The Muscovite mine

(mica) of Ida-Mica Industrial Minerals (formerly Western Mica Corp.) was idle throughout 1960. The mine in recent years had been a source of hand-cobbed mica which was shipped to the GSA for Government stockpiling. A quantity of crushed stone for road use also was produced.

Lemhi.—Lemhi County ranked second in the State in value of gold, silver, and base metals produced. Ore output came principally from the Calera Mining Co. Blackbird mine at Cobalt. Stockpiled ore was milled by the Calera company until operations ceased in June. Lesser quantities of gold, silver, copper, lead, and zinc ores were mined at 16 other lode properties; those yielding sizable tonnages were the Black Pine, Peacock, Golden Copper Queen, Twin Peaks group, United Idaho, and Yellowjacket mines. Hydraulic placering was carried out on the Leesburg-Tacoma placer near Salmon. Over 31,000 cubic yards of stream gravel yielded 194 ounces of gold.

The Agency Creek thorite claims near Salmon were examined by Rare Metals Corporation of America.

Power.—Phosphate rock was processed at two plants west of Pocatello. Phosphatic shale from the Gay mine, Bingham County, was utilized at the elemental-phosphorus plant of Food Machinery & Chemical Corp. J. R. Simplot Co. continued manufacturing phosphate fertilizers and wet-process phosphoric acid from rock produced at the company Gay mine, Bingham County, and Conda mine, Caribou County. The Simplot firm announced plans for doubling productive capacity at the Pocatello fertilizer works. The expansion, which was to include facilities for manufacturing ammonium phosphate fertilizer, was the second the company had announced in as many years. In 1959, the company completed installing additional grinding, filtering, and evaporating equipment and constructing a sulfuric acid plant as part of an expansion program begun in 1958. Quartzite quarried near Pocatello was utilized as flux in electric-furnace manufacture of elemental phosphorus. Sand and gravel production was reduced sharply compared with 1959 because of curtailed requirements at State highway department projects in the county.

Shoshone.—The value of gold, silver, copper, lead, and zinc production in Shoshone County declined 25 percent from 1959; of the five metals, silver ranked first, followed, in order of value, by lead, zinc, copper, and gold. Although value of the other four commodities dropped, that of gold increased 10 percent over the previous year. County production of these metals accounted for 95 percent of the State output.

Lead and zinc showed the lowest production since 1896 and 1938, respectively, because of an extended labor strike at major mining and milling operations in the county. The International Union of Mine, Mill and Smelter Workers called strikes at The Bunker Hill Co. and American Smelting and Refining Co. operations, resulting in unemployment for approximately 2,500 employees for over 7 months. The walkouts came after many monthly contract extensions following expiration of work agreements in 1959. American Smelting and Refining Co. mines (Page and Galena) were closed from May 25 to December 17 before settlement was reached with the Mine-Mill union. The Bunker Hill Co. employees moved to decertify the Mine-Mill

TABLE 14.—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 (thousand short tons)	Gold, lode and placer (troy ounces)	Silver, lode and placer (thousand troy ounces)
	Lode	Placer			
1951–55 (average)	49	--------	1,955	2,272	13,782
1956	36	2	1,675	1,963	12,663
1957	31	--------	1,701	2,254	14,398
1958	25	--------	1,337	2,363	15,615
1959	17	1	1,422	2,349	16,461
1960	22	1	980	2,591	13,459
1884–1960	--------	--------	(1)	428,000	617,830

Year	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
1951–55 (average)	2,208	66,483	64,644	$52,160
1956	2,889	60,221	46,738	45,701
1957	3,473	67,125	54,825	47,117
1958	3,884	52,488	49,532	38,645
1959	3,678	61,155	55,454	44,058
1960	2,606	41,692	36,639	33,153
1884–1960	99,000	6,472,000	2,087,000	1,819,052

[1] Complete data not available: 1904–1960, 105,071,000 short tons.

union as their representative and, after being on strike beginning May 5, the workers, through a National Labor Relations Board supervised election on December 10, voted in a new union (Northwest Metal Workers Union, independent).

According to The Bunker Hill Co. annual report to shareholders, the company lead smelter near Kellogg worked on a 6-day basis until the strike and all five electrolytic units were operated at the zinc plant. During the strike, research, field geology, and engineering projects were conducted. After considerable maintenance and repair, the smelter was ready to return to full production in December; however, only the zinc plant was in operation before the end of the year, producing small quantities of refined zinc and cadmium.

In June, The Bunker Hill Co. at Kellogg completed constructing a phosphoric acid plant which was begun in 1959. The plant remained idle throughout the year because of a labor dispute. In September, Collier Carbon & Chemical Corp. began erecting an acid concentrating plant adjacent to the Bunker Hill facility. The plant was to be used to concentrate standard-analysis phosphoric acid prior to shipment to Collier fertilizer plants in the West.

Beaver District.—The Day Mines, Inc., Goat mine (Monitor property), yielding zinc-lead-silver ore, was worked by lessees.

Evolution District.—Three silver properties produced—Rainbow property (Coeur d'Alene Mines Corp.), Silver Summit (Hecla Mining Co.), and Sunshine operating group (Sunshine Mining Co.). The Sunshine group was the principal producer, but output and average grade of ore milled was below 1959. Over 232,000 tons of ore, averaging 27.14 ounces of silver a ton, was mined. Ore from Sunshine properties was yielded mostly (93 percent) from the Unit mine

(214,926 tons), and the remainder was from the Sunshine, Rambo, Suncon, and Yankee Girl mines. The Sunshine company's annual report to shareholders stated the following:

> The extensive drifting, raising, and crosscutting on the 3400, 3550, 3700, and 4000 levels in connection with the new shaft development, has limited eastward exploration to drifting and diamond drilling in the Chester fault zone on the 4000 level and in the hanging wall of the Syndicate fault on the 3700 level. A total of 340 horizontal feet of new ore on those levels has been exposed with the vertical extent yet to be determined.
>
> A sand-fill system has been installed whereby the tailings from the mill are pumped back into the mine to fill the voids in stopes created by removal of the ore, heretofore filled with waste rock from exploration and development. The economy of a sand-fill system is based upon the expectation that less timber will be needed and that there will be better control of grade so that less waste rock is extracted.

Sunshine company mining costs increased due to general wage increases, but costs were below those experienced in 1956 and 1957. Ore reserves declined at all properties except the Unit mine, which showed a slight increase in available tonnage. Exploration and development by Sunshine Mining Co. totaled 8,034 feet of drifting, raising, crosscutting, and sinking; 62 diamond-drill holes yielded 10,717 feet of exploratory core.

Hunter District.—High-grade silver ore was mined and milled (133,724 tons) by Hecla Mining Co. at the Lucky Friday mine (1 mile east of Mullan) owned by Lucky Friday Silver Lead Mines Co. Ore, formerly milled at the Golconda Lead Mines concentrator, was diverted early in the year to a new 680-ton-a-day (maximum capacity) mill constructed at the mine; the company planned to expand mill capacity to 750 tons a day. Mill feed averaged 20 ounces of silver and nearly 11 percent lead.

The Morning mine (American Smelting and Refining Co.) and The Bunker Hill Co. Star mine (operated by Hecla Mining Co.) produced lead and zinc ore. A small ore tonnage was derived from the Morning mine as a result of closing operations. The Morning Mill was dismantled by Alaska Junk Co. of Spokane, Wash. The Bunker Hill Co. Star mine was unaffected by the regional labor strike because the property was operated by Hecla Mining Co., whose workers were represented by the nonstriking United Steel Workers of America. According to The Bunker Hill Co. annual report, the Star mine operated 5 days a week, with concentrate being stockpiled after May 5; yearend ore reserves were reported at 756,798 tons.

Lelande District.—The Hercules and Sherman mines of Day Mines, Inc., yielded lead ore. Hercules production was from stockpiled concentrates; the mine was closed in March, and the workings below the No. 5 adit were allowed to flood. Ore from the Sherman property was derived from cleanings.

Placer Center District.—The Dayrock, Galena, and Tamarack No. 5 mines were the principal producers in the district. According to the Day Mines, Inc., annual report, operation of the Dayrock mine was curtailed throughout the year to allow active development of the Hornet vein, an ore body that extended about 100 feet upward from the 1100-level drift. Operations at the Galena mine by American Smelting and Refining Co. were halted by the long strike. Only nomi-

nal development was carried out during the year on the Silver vein and the North vein. Drifting on the 2800 level of the North vein failed to disclose ore; limited work on the Silver vein indicated a comparatively small vein containing higher than average quantities of silver. The Day Mines' Tamarack property was mined (lead-zinc ore) on a small scale by a lessee. A small tonnage of copper ore was shipped from the Hansy mine.

Smelter District.—The Bunker Hill Co. fumed over 13,000 tons of zinc-dump slag that yielded 286 tons of lead and 1,356 tons of zinc.

Yreka District.—District output was predominantly from mines of The Bunker Hill Co.—Bunker Hill (lead-zinc ore) and Crescent (silver ore). The American Smelting and Refining Co. Page mine (lead-zinc ore) also was a significant producer. Sidney Mining Co. produced lead-zinc ores from the Nabob and Sidney properties. The Bunker Hill and Crescent mines operated on a 5-day basis until the strike; yearend ore reserves at these properties were 2,870,173 tons and 62,792 tons, respectively. Sidney Mining Co. halted mining activities in the Pine Creek area. An agreement between the Sidney company and Nabob Silver-Lead Co. for the operation of the Nabob mine was terminated, and production at the Sidney mine, from block leases, ceased in March.

Valley.—Dredging operations of Porter Bros. Corp. at Bear Valley were idle. No activity was reported at the Hermes mercury property (Holly Minerals Corp.).

Washington.—Iron ore was mined by George Budock at a property near Cambridge and by Glen Clark at the Mortimer mine near Weiser. Production was marketed at cement and steel plants in Oregon and Washington.

Rare Metals Corporation of America mined and furnaced mercury ore from the Idaho-Almaden property 16 miles east of Weiser. Over 55,000 tons of ore and nearly 44,000 tons of waste rock were moved at the open-pit operation. Exploration and development drilling totaled 14,440 feet.

The Rock Creek gypsum mine near Weiser was idle throughout the year; however, shipments from stock for agricultural purposes were made.

The Mineral Industry of Illinois

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Illinois State Geological Survey.

By Matthew G. Sikich [1]

VALUE of Illinois mineral output in 1960, greater than any prior year, was $590.8 million, a 3-percent increase over 1959, and 2 percent more than the $576.9-million record attained in 1958. Increases in production of clays, fluorspar, lead, lime, liquified petroleum gases, petroleum, sand and gravel, stone, tripoli, and zinc all contributed to the record output. Total quantities and values of output decreased in 1960 for portland and masonry cements, natural gas, natural gasoline, and peat. The total value of coal sold decreased, but output increased slightly. New highs in production of sand and gravel and stone were established.

Mineral fuels continued as the major commodity group, furnishing nearly 75 percent of the total value of mineral production. Nonmetals supplied 24 percent, and metals comprised the remainder.

Illinois produced a wide variety of mineral commodities. In 1960 the State led in fluorspar production, ranked fourth in bituminous coal output, and was among the leading States in producing minerals of construction—cement, clays, lime, sand and gravel, and stone. Illinois also ranked high as a center for processing mineral raw materials.

---

[1] Commodity-industry analyst, Bureau of Mines, Minneapolis, Minn.

615629—61——23

TABLE 1.—Mineral production in Illinois[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland thousand 376-pound barrels	9,486	$30,158	8,770	$29,321
Masonry do	439	1,636	369	1,411
Clays thousand short tons	2,229	4,950	2,357	5,479
Coal do	45,466	184,412	45,977	184,087
Fluorspar short tons	112,469	5,908	134,529	6,936
Gem stones	[2]	1	[2]	[3]
Lead (recoverable content of ores, etc.) short tons	2,570	591	3,000	702
Natural gas million cubic feet	13,739	1,910	11,666	1,458
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	[3]	[3]	16,496	1,313
LP gases do	[3]	[3]	358,366	19,941
Peat short tons	9,117	72	6,179	28
Petroleum (crude) thousand 42-gallon barrels	76,727	229,414	[4] 78,840	[4] 233,366
Sand and gravel thousand short tons	30,241	33,717	33,138	36,255
Stone do	35,294	45,081	41,721	55,593
Zinc (recoverable content of ores, etc.) short tons	26,815	6,167	29,550	7,624
Value of items that cannot be disclosed: Lime, tripoli, and values indicated by footnote 3		30,897		10,796
Total Illinois [5]		[6] 572,275		590,800

[1] Production as measured by mine shipments, sales or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.
[5] Total adjusted to eliminate duplicating value of clays and stone.
[6] Revised figure.

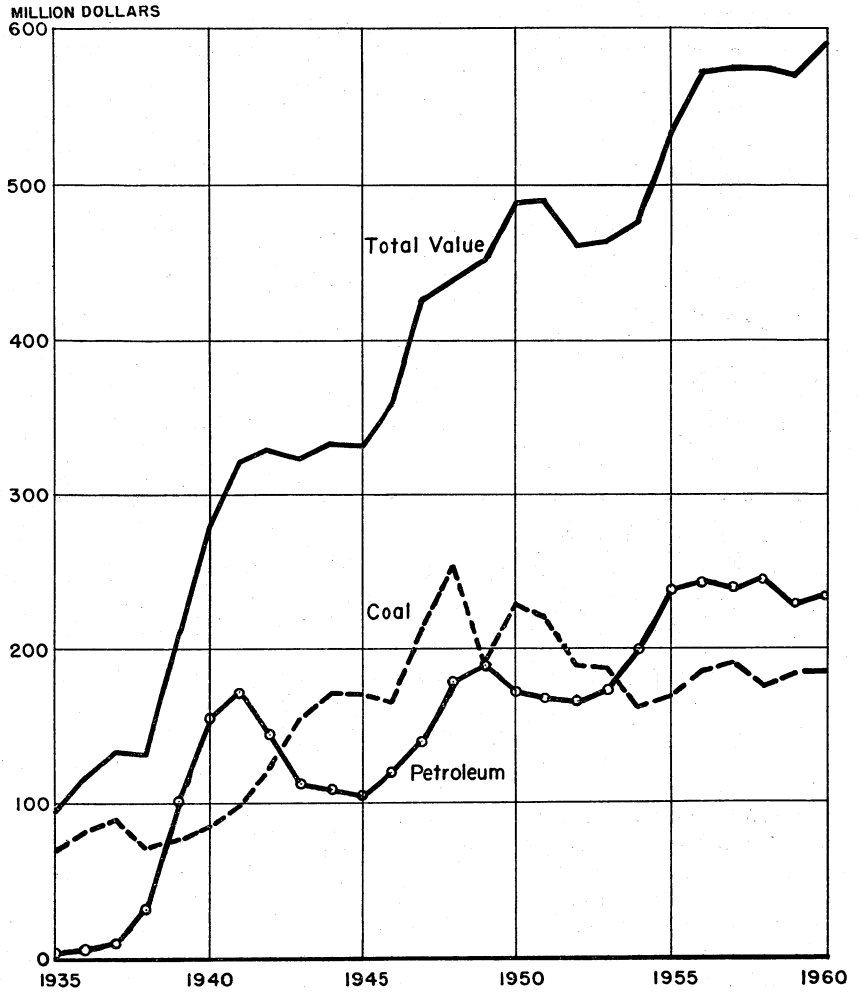

FIGURE 1.—Value of coal, petroleum, and total value of mineral production in Illinois, 1935–60.

Employment and Injuries.—Over 36.3 million man-hours was worked in the State's mineral industries in 1960, excluding officeworkers and employees of the entire petroleum industry. This represented a 4-percent decrease from the final figure of 37.8 million man-hours in 1959. Injury experience was less favorable than in the preceding year. A total of 15 fatal and 1,166 nonfatal disabling injuries was recorded for Illinois mineral industries in 1960, compared with 11 fatal and 1,081 nonfatal injuries in 1959. Table 2 contains a summary of employment and injury statistics for selected mineral industries. Certain industries are excluded from the table to avoid disclosing individual company confidential data.

TABLE 2.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Non-fatal			
1959:							
Cement [4]	913	2,389,359	--------	4	(5)	1.67	(5)
Clays [6]	1,166	2,043,820	1	56	7,235	27.89	3,540
Coal	10,499	17,683,051	9	721	99,068	41.28	5,602
Coke ovens	673	1,854,854	--------	10	(5)	5.39	(5)
Fluorspar	472	849,410	--------	26	5,764	30.61	6,786
Limestone [7]	2,479	5,023,169	1	135	(5)	27.07	(5)
Sand and gravel	1,912	3,906,490	--------	65	2,067	16.64	529
Smelters	1,328	3,171,689	--------	44	1,040	13.87	328
1960: [8]							
Cement [4]	908	2,348,220	--------	2	(5)	.85	(5)
Clays [6]	1,280	2,127,899	2	58	13,335	28.20	6,267
Coal	9,773	16,494,104	10	580	91,368	35.77	5,539
Coke ovens	711	1,840,788	--------	7	(5)	3.80	(5)
Fluorspar	456	880,665	--------	16	1,134	18.17	1,288
Limestone [7]	2,549	5,179,770	--------	411	(5)	79.35	(5)
Sand and gravel	1,973	3,918,005	2	54	17,651	14.29	4,505
Smelters	1,227	2,643,660	--------	20	1,185	7.57	448

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Data not available.
[6] Excludes pits producing clay used exclusively in manufacturing cement.
[7] Excludes quarries producing limestone used exclusively in manufacturing cement and lime.
[8] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal.—Output of bituminous coal increased 1 percent in quantity over 1959 but decreased slightly in total value. Coal was produced from 128 mines in 33 counties, compared with 137 mines in 36 counties in 1959. (Data exclude mines producing less than 1,000 short tons annually.) Major producing counties in order of decreasing production were Williamson, Fulton, St. Clair, Franklin, Christian, Saline, Jefferson, Perry, Knox, Montgomery, Randolph, Jackson, and Vermilion. Nine companies supplied 80 percent of total output, each producing over 1 million tons. The No. 10 and the River King mines of Peabody Coal Co. and the Orient No. 3 mine of Freeman Coal Mining Corp. were among the 10 largest producing mines in the United States in 1960.

Underground mines furnished 51 percent of the total production, and strip mines furnished 49 percent. Output from underground mines decreased 1 percent from 1959, whereas strip-mine production increased 3 percent.

TABLE 3.—Bituminous coal production in 1960, 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		37,620	37,620	$268,129
Bureau		1		370,608	370,608	(1)
Christian	1		4,117,552		4,117,552	(1)
Clinton	2		65,135		65,135	279,937
Douglas	1		505,589		505,589	(1)
Franklin	6		4,128,674		4,128,674	(1)
Fulton	3	15	26,624	5,317,533	5,344,157	22,178,776
Gallatin	2	1	67,844	19,007	86,851	296,150
Greene		1		7,062	7,062	38,038
Henry	1		73,295		73,295	(1)
Jackson	2	2	638,512	676,189	1,314,701	5,044,795
Jefferson	1	1	2,936,492	23,602	2,960,094	(1)
Kankakee		1		320,344	320,344	(1)
Knox		4		2,220,339	2,220,339	(1)
Logan	1		17,483		17,483	101,550
Macoupin	1		358,171		358,171	1,487,364
Madison	2		667,868		667,868	2,847,352
Menard	1		12,970		12,970	70,339
Mercer	1	1	24,250	2,981	27,231	141,254
Montgomery	1		1,931,657		1,931,657	(1)
Peoria	3	7	20,088	413,349	433,437	2,212,811
Perry	1	2	2,377	2,826,912	2,829,289	10,272,554
Randolph	1	2	779,618	937,159	1,716,777	(1)
St. Clair	5	4	1,523,607	3,319,749	4,843,356	17,887,239
Saline	2	8	1,250,428	1,714,686	2,965,114	11,999,588
Sangamon	2		98,515		98,515	443,298
Schuyler	1	1	6,288	587,746	594,034	(1)
Stark		1		170,350	170,350	736,116
Vermilion	3	5	42,396	1,055,513	1,097,909	4,891,622
Wabash		1		1,133	1,133	5,665
Washington	2		32,513		32,513	151,382
Will		1		368,573	368,573	(1)
Williamson	13	9	3,978,955	2,280,130	6,259,085	24,975,529
Total	59	69	23,306,901	22,670,585	45,977,486	184,086,847

[1] Figure withheld to avoid disclosing individual company confidential data; included in total.

Nearly 91 percent of the coal output was cleaned at 59 plants. All but a fraction of a percent of the underground production was cut by machines. Over 99 percent was loaded mechanically, using a total of 131 mobile loaders, 45 continuous-mining machines, and 8 duckbills or self-loading conveyors. A total of 170 power shovels and draglines, including wheel excavators, were utilized in stripping and loading operations at strip mines. Eighty-eight percent of the output was shipped to consumers by rail or waterway; the remainder was shipped by truck.

Approximately 26 million tons of coal was mined for use in electric powerplants, an increase of 2 million tons over 1959. Other markets for Illinois coal included general manufacturing and processing industries in the Midwest, domestic consumers, coke and gas plants, and railroads. Each of these purchased less coal than in the previous year. Over 69 percent of the 38.7 million tons of coal consumed in Illinois in 1960 was mined in the State. Average mine value was $4.00 per ton, compared with $4.08 in 1959.

Freeman Coal Mining Corp. began operating its new Orient No. 5 underground mine near Benton late in the year. The United Electric Coal Cos. began full-scale production at the Banner No. 27 strip mine near Glasford. In January, Old Ben Coal Corp. hoisted the

first coal from its new No. 21 underground mine at Sesser. This mine reportedly had a reserve of about 100 million tons of low-sulfur metallurgical coal. The company abandoned its Nos. 22 and 14 underground mines in January and June, respectively. In April, Stonefort Coal Mining Co., Inc., began operating its Allendale strip mine near Wyoming and abandoned the Little John strip mine near Victoria. The St. Ellen underground and Seminole strip mines in St. Clair County were abandoned by Peabody Coal Co. in May. The Orient Number Two Coal Co. abandoned the Orient No. 2 underground mine in Franklin County in November.

Coke.—Coke was produced at 6 plants. Total production was 1,971,000 short tons, valued at $37.1 million, compared with 2,045,000 tons, valued at $37.8 million in 1959. Over 1.8 million tons was used by producing companies in blast furnaces. About 161,000 tons of coke breeze valued at $893,000 was recovered at Illinois coke plants. Nearly 80,000 tons was used by producers in steam powerplants and agglomerating plants. Other products of coke-oven plants included coke-oven gas, ammonia, tar, and light oil.

Peat.—Production of peat decreased markedly from 1959. Output was reported by 3 companies in Cook, Kane, and Lake Counties. Although classed as a mineral fuel, Illinois peat was used principally for soil conditioning. The entire output was sold in bulk.

Petroleum and Natural Gas.—Crude-petroleum output increased nearly 3 percent in quantity and 2 percent in value over 1959 and comprised 39 percent of the total value of State mineral production. Output was chiefly from oilfields in the southeastern part of the State. Hydraulic-fracturing and water-flooding methods accounted for about half the total production. According to the Illinois State Geological Survey, 1,922 wells were completed in 1960, of which 769 were producing oil wells, 10 were gas wells, 526 were dry holes in pools, and 617 were unsuccessful wildcats. Total footage drilled was 4,027,597, of which 44 percent was in producing wells. Estimated proved crude-oil reserves at the beginning of 1960 were 594 million barrels, according to the American Petroleum Institute.

Marketed production of natural gas decreased 15 percent in quantity and 24 percent in value compared with 1959. Output of liquefied petroleum gases increased in quantity and value, whereas production of natural gasoline decreased, compared with 1959.

TABLE 4.—Crude petroleum production, by fields [1]

(Thousand barrels)

Field	1956	1957	1958	1959	1960 [2]
Albion	1,120	1,313	1,377	1,113	888
Benton	1,032	807	606	529	467
Boyd	899	952	668	485	382
Bridgeport	4,352	4,174	5,280	6,264	7,174
Centralia	546	2,076	3,480	2,160	1,420
Clay City	9,210	8,187	7,972	7,269	7,470
Dale	3,543	2,441	2,485	1,979	2,506
East Inman	1,513	1,415	1,537	1,126	746
Johnsonville	1,063	1,010	992	1,698	1,438
Louden	9,828	11,691	13,158	12,586	12,628
New Harmony	4,022	3,462	4,430	4,758	5,252
Phillipstown	1,168	547	691	606	653
Robinson	2,621	2,752	2,755	3,197	3,624
Roland	2,503	2,449	2,155	1,860	1,545
Sailor Springs	1,794	1,552	1,531	1,378	1,382
Salem	6,606	5,644	6,475	6,926	8,482
Other fields [3]	30,526	26,611	24,683	22,793	22,783
Total	82,346	77,083	80,275	76,727	78,840

[1] Based on Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Bureau of Mines figures.

NONMETALS

Cement.—Shipments of portland and masonry cements from Illinois plants decreased 8 and 16 percent in quantity, respectively, from 1959. Chief reason for the marked drop was the decline in sales for building construction, which was not offset by a substantial increase in sales for highway construction. Total value of output decreased 3 percent for portland cement and 14 percent for masonry cement, compared with 1959. Average unit values for both cements increased. Plants were operated in LaSalle and Lee Counties, by 4 companies.

Nearly 97 percent of the portland cement output consisted of types I and II (general use and moderate heat). The remainder was chiefly type III (high early strength). Over 59 percent was sold to ready-mixed concrete companies, 20 percent to highway contractors, 13 percent to concrete-product manufacturers, 7 percent to building-material dealers, and less than 1 percent to miscellaneous consumers. Approximately 98 percent of the output was shipped by rail; the remainder was shipped mostly by truck. About 87 percent of the portland cement and 51 percent of the masonry cement was shipped to consumers within the State.

TABLE 5.—Finished portland cement produced and shipped

(Thousand barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills	
			Quantity	Value
1951–55 (average)	4	8,704	8,701	$21,690
1956	4	8,823	8,629	24,866
1957	4	8,794	8,097	24,560
1958	4	9,433	9,205	29,308
1959	4	9,559	9,486	30,158
1960	4	9,270	8,770	29,321

Producing companies quarried over 2.6 million tons of limestone for use in manufacturing portland cement. Other raw materials consumed included over 175,000 tons of clay or shale and 49,000 tons of gypsum. Approximately 233 million kw.-hr. of electrical energy was used at the plants in 1960. Annual finished portland cement capacity remained at about 10 million barrels.

Medusa Portland Cement Co. announced plans for a major expansion program which included construction of a new kiln at its Dixon plant. Annual capacity of the new kiln was expected to be 1 million barrels. The company also was acquiring limestone properties in the southern part of the State, in an area regarded as a potential site for a new cement plant.

Clays.—Total output of miscellaneous and fire clays increased 6 percent in quantity and 11 percent in value over 1959. A substantial increase in production for manufacturing heavy clay products was recorded.

Production of fire clay increased 12 percent in quantity over 1959. Output was reported by 11 companies in Greene, Grundy, La Salle, McDonough, Marshall, Rock Island, and Tazewell Counties. The material was used for refractory purposes, manufacturing heavy clay products, and other uses.

TABLE 6.—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
1951–55 (average)	397	$1,243	1,922	$2,742	2,319	$3,986
1956	441	870	1,817	3,136	2,258	4,005
1957	438	2,345	1,479	2,810	1,917	5,155
1958	725	2,733	1,610	3,177	2,335	5,910
1959	322	2,158	1,908	2,792	2,229	4,950
1960	359	2,378	1,997	3,101	2,357	5,479

Miscellaneous clay was produced in 20 counties and was used for manufacturing building brick, draintile, sewer pipe, lightweight aggregate, cement, pottery, and other purposes. Output increased 5 percent in tonnage over 1959.

The Illinois State Geological Survey published a report covering investigations made to determine shale deposits that were self-bloating, those that require addition of bloating agents, and the mechanism and requirements that control the bloating of shales.[2]

Fluorspar.—Illinois ranked first among the 7 fluorspar-producing States, furnishing nearly 59 percent of total domestic shipments. Illinois output increased 20 percent in quantity and 17 percent in value over 1959, a poor year. Although somewhat improved, market conditions remained generally depressed, principally because of the high level of imports, which exceeded domestic shipments for the ninth consecutive year. However, some mines began operating 6 days a week, and some previously laid-off employees were recalled to work.

[2] White, Arthur W., Lightweight Aggregate From Illinois Shales: Illinois State Geol. Survey Circ. 290, 1960, 29 pp.

Results of a U.S. Tariff Commission investigation of the domestic fluorspar industry, conducted in response to a Senate resolution authorizing the Commission to make specific findings on further import restrictions, were made public. No recommendations were made because the Commission felt that recommendations for restrictions would be extra legal.

Approximately 76 percent of the fluorspar shipments were classified as acid grade; 13 percent as metallurgical grade; and 11 percent as ceramic grade. Shipments of acid-grade fluorspar increased nearly a fourth over 1959, the result of increased demand by the aluminum and chemical industries. Metallurgical-grade shipments increased chiefly because of increased consumption at steel plants after the strike-affected previous year. Shipments of ceramic-grade fluorspar decreased substantially from 1959.

Major fluorspar producers included Aluminum Company of America, Mackey-Humm Mining Co., Minerva Oil Co., and Ozark-Mahoning Co. All except Mackey-Humm Mining Co. also produced lead and/or zinc concentrates as byproducts of fluorspar mining. Minerva Oil Co. resumed operations at its Jefferson mine and began sinking a new shaft on the adjacent Fairbairn property. The company also began shipping bagged fluorspar concentrate by barge to Wellsville, Ohio, for distribution by truck from that point. Ozark-Mahoning Co. began processing some of its ore by heavy-medium separation preparatory to flotation. Wiley Cochran began production from a new mine in the Karbers Ridge area.

Mills in Illinois processed 392,000 tons of crude ore, from which nearly 131,000 tons of finished fluorspar was produced. The entire output of finished fluorspar came from Hardin County, although several thousand tons of crude ore was mined in Pope County.

Reports describing the geology, production, economic aspects, and uses of Illinois fluorspar [3] and exploration, development, and mining practices at two fluorspar mines in the State [4] were published.

Gem Stones.—Gem materials, consisting of fluorite and other mineral specimens, were collected by several companies and/or individuals. The specimens were used primarily for personal collections.

Lime.—Illinois ranked eighth in quantity of lime produced in 1960. Output was from plants in Adams and Cook Counties. Total shipments of quicklime and hydrated lime increased 10 percent in both quantity and value over 1959. Chief reason for the gain was the 13-percent increase in sales of quicklime for refractory purposes. Nearly 63 percent of the total was for refractory use, 31 percent for chemical and other industrial uses, and 6 percent for building purposes. A small quantity was sold for agricultural use.

Perlite.—Perlite-processing plants were operated in Champaign, Cook, Lake, and Will Counties. Crude material processed at the plants was mined in Colorado, Nevada, and New Mexico. Total sales of expanded perlite decreased substantially from 1959, principally because of the decline in building construction. Nearly 35 percent

[3] Finger, G. C., Risser, H. E., and Bradbury, J. C., Illinois Fluorspar: Illinois State Geol. Survey Circ. 296, 1960, 36 pp.

[4] Montgomery, Gill, Daly, J. J., and Myslinski, Frank J., Mining Methods and Costs at Crystal-Victory and Minerva No. 1 Fluorspar Mines of Minerva Oil Co., Hardin County, Ill.: Bureau of Mines Inf. Circ. 7956, 1960, 45 pp.

of the output was used as lightweight aggregate in building plaster. Over 31 percent was used as concrete aggregate. The remainder was for loose-fill insulation, filler, filter use, soil conditioning, and other purposes.

Sand and Gravel.—A record high production of 33.1 million short tons of sand and gravel was established, surpassing the previous high of 31.2 million tons set in 1956. The new mark represented a 10-percent increase over 1959. Illinois was one of the largest producing States, ranking fifth in 1960. Value of output increased 8 percent over 1959. Chief reason for the substantial rise was the 2.8-million-ton increase for paving use. Use of material for building construction was less than 1 percent higher than in 1959. Output for railroad ballast decreased 46 percent. Total output of industrial sands remained substantially the same as in 1959; an 11-percent increase in production of glass sand offset declines for other industrial uses.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	1,216	$2,962	1,344	$3,306
Molding	548	1,502	528	1,658
Building	4,615	4,435	4,769	4,292
Paving	5,215	5,101	6,806	6,407
Engine	73	127	57	105
Fill	677	377	674	392
Ground	197	1,845	181	1,851
Undistributed [1]	583	2,487	555	2,084
Total	13,124	18,836	14,914	20,095
Gravel:				
Building	3,419	3,531	3,322	3,349
Paving	9,690	9,093	11,686	10,886
Railroad ballast	304	221	164	120
Fill	936	546	805	447
Other	65	61	312	253
Total	14,414	13,452	16,289	15,055
Total sand and gravel	27,538	32,288	31,203	35,150
Government-and-contractor operations:				
Sand:				
Building	4	2	----	----
Paving	374	170	388	193
Total	378	172	388	193
Gravel:				
Building	27	11	27	11
Paving	2,298	1,246	1,517	901
Fill	----	----	3	[2]
Total	2,325	1,257	1,547	912
Total sand and gravel	2,703	1,429	1,935	1,105
All operations:				
Sand	13,502	19,008	15,302	20,288
Gravel	16,739	14,709	17,836	15,967
Grand total	30,241	33,717	33,138	36,255

[1] Includes railroad ballast, blast, grinding and polishing, filter, hydrafac, and other industrial sands (1959–60); fire or furnace (1960).
[2] Less than $1,000.

Nearly 62 percent of production was for paving use, 24 percent was for building purposes, and 8 percent was for industrial use. The remainder was for railroad ballast, fill, and other uses.

About 81 percent of the output was transported by truck and nearly 19 percent by rail. A small quantity was moved by water.

Production was reported from 72 counties. Major-producing counties—more than 1 million tons each—in 1960 were: Grundy, Kane, Lake, La Salle, McHenry, Peoria, Tazewell, Will, and Winnebago. Major producers included Chicago Gravel Co., Consumers Co., Elmhurst-Chicago Stone Co., Larson Bros. Sand & Gravel, McGrath Sand & Gravel Co., Inc., Material Service Corp., Ottawa Silica Co., Portage-Manley Sand Co., C. A. Powley Co., Road Materials Corp., and Wedron Silica Co.

Stone.—Production of stone reached a new high of 41.7 million short tons, an 18-percent increase over 1959, the previous record year. The substantial gain moved Illinois into second place in tonnage, among the producing States, exceeded only by Pennsylvania. The output consisted entirely of limestone, except for about 600 tons of sandstone produced in Alexander County for refractory purposes. Total value of output increased 23 percent over 1959. High demand for crushed limestone for road construction was the chief reason for the increase.

TABLE 8.—Limestone sold or used by producers, by uses

Use	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension: [1]				
Rubble (and flagging—1960)...thousand short tons	1	$4	4	$32
House-stone veneer (cut stone and flagging—1959)... thousand cubic feet	39	171	30	103
Total...approximate thousand short tons [2]	4	175	6	135
Crushed and broken:				
Riprap...thousand short tons	246	329	495	686
Concrete aggregate and roadstone...do	27,257	34,811	32,420	43,640
Railroad ballast...do	201	243	261	300
Agriculture...do	2,758	3,877	3,329	4,744
Asphalt...do	369	899	307	870
Cement...do	2,631	1,747	2,644	1,829
Other [3]...do	1,724	2,805	2,258	3,383
Total...do	35,186	44,711	41,714	55,452
Grand total...do	35,190	44,886	41,720	55,587

[1] Uses as shown combined to avoid disclosing individual company confidential data.
[2] Average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.
[3] Includes limestone for chemical uses, filler, metallurgical, and other purposes combined to avoid disclosing individual company confidential data.

Production for concrete aggregate and roadstone increased 5.2 million tons (19 percent) over 1959, and comprised 78 percent of the stone output. Crushed limestone for agricultural use increased 570,000 tons over 1959 and represented 8 percent of the total production. Other substantial gains were recorded for railroad ballast, blast furnace flux, riprap, and coal mine dust. Quantities of crushed lime-

stone used in alkali works, asphalt mix, various fillers, and as mineral food decreased. Material for other uses remained substantially the same.

Limestone was produced in 61 counties. The following 10 counties each produced over 1 million tons of limestone and together comprised nearly 67 percent of the State output: Cook, DuPage, Johnson, Kankakee, La Salle, Livingston, Randolph, St. Clair, Vermilion, and Will. Cook County, alone, furnished 31 percent of the total with output of 12.9 million tons. Major producers of limestone included Allied Chemical Corp., Anna Quarries, Inc., Columbia Quarry Co., Consumers Co., Dolese & Shepard Co., East St. Louis Stone Co., Elmhurst-Chicago Stone Co., Lehigh Stone Co., Marquette Cement Mfg. Co., and Material Service Corp.

Dimension limestone was produced in Cook, Kane, McHenry, Ogle, Pike, St. Clair, and Union Counties. Output was used for house stone veneer, flagging, and rubble.

Sulfur.—Elemental sulfur was recovered as a byproduct by the Pure Oil Co. at its Lemont refinery and by The Anlin Company of Illinois at its Hartford plant. Total output was somewhat greater than in 1959 because of the full-year operation of the latter plant, which began producing late in 1959. The 150-ton sulfur-recovery plant of The Anlin Company utilized refinery gases obtained from an adjoining Shell Oil Co. refinery.

Tripoli (Amorphous Silica).—Ozark Minerals Co. and Tamms Industries Co. mined and processed tripoli, or amorphous silica, near Elco and Tamms, respectively. Production of crude material increased 8 percent over 1959; sales of prepared material increased 20 percent in quantity and 8 percent in value. Output was sold for abrasive, filler, and other purposes.

Vermiculite.—Three companies exfoliated vermiculite at plants in Cook, Macoupin, and Will Counties from crude material mined in Montana, South Carolina, and South Africa. Output decreased slightly from 1959. Processed material was used as insulating material, lightweight aggregate in plaster and concrete, and for other purposes.

METALS

Lead and Zinc.—Production of lead and zinc, in terms of recoverable metals, increased 17 and 10 percent, respectively, in quantity over 1959. Chief reason for the rise was increased production from fluorspar mines in the Southern Illinois district that recovered lead and zinc as byproducts. Total values of these metals increased 19 percent for lead and 24 percent for zinc.

Principal producers in Northern Illinois (Jo Daviess County) were Eagle-Picher Co. and Tri-State Zinc, Inc. Both companies operated their mines throughout the year except for a strike at Eagle-Picher Co. operations during all of October. Major producers in Southern Illinois (Hardin and Pope Counties) were Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co.

Average weighted yearly prices used to calculate total values of lead and zinc production in 1960 were 11.7 cents per pound for lead and 12.9 cents per pound for zinc, compared with 11.5 cents per pound

for both metals in 1959. Prices were relatively stable in 1960. The quoted price of lead, New York, opened in January at 12 cents per pound and remained at that level until December 13, when it dropped to 11 cents. No further changes occurred before the close of the year. The quoted zinc price, East St. Louis, opened in 1960 at 12.5 cents per pound. On January 8 the price rose to 13 cents. The price declined to 12.5 cents December 13. Another half-cent decrease December 19 brought the yearend price to 12 cents.

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	
1951–55 (average)	19	786,362	2,764	$2,501	3,718	$1,118,769	18,255	$5,195,138	$6,316,408
1956	23	851,285	1,580	1,430	3,832	1,203,248	24,039	6,586,686	7,791,364
1957	23	853,661	--------	--------	2,970	849,420	22,185	5,146,920	5,996,340
1958	19	1,003,020	--------	--------	1,610	376,740	24,940	5,087,760	5,464,500
1959	22	930,265	--------	--------	2,570	591,100	26,815	6,167,450	6,758,550
1960	22	1,015,581	--------	--------	3,000	702,000	29,550	7,623,900	8,325,900

[1] Data include fluorspar ore from which lead and/or zinc was recovered as follows: 1951, 332,028 tons; 1952, 384,203 tons; 1953, 353,570 tons; 1954, 202,478 tons; 1955, 309,311 tons; 1956, 336,635 tons; 1957, 360,406 tons; 1958, 401,562 tons; 1959, 297,252 tons; and 1960, 380,385 tons.

TABLE 10.—Mine production of lead and zinc in 1960, by months, in terms of recoverable metals

(Short tons)

Month	Northern Illinois		Southern Illinois		Total Illinois	
	Lead	Zinc	Lead	Zinc	Lead	Zinc
January	100	1,520	135	660	235	2,180
February	100	1,870	130	635	230	2,505
March	110	2,080	135	635	245	2,715
April	110	2,125	140	900	250	3,025
May	120	2,010	145	925	265	2,935
June	100	1,965	155	820	255	2,785
July	80	1,270	170	915	250	2,185
August	105	1,860	130	705	235	2,565
September	100	1,800	150	770	250	2,570
October	110	1,000	150	765	260	1,765
November	110	1,400	160	750	270	2,150
December	100	1,425	155	745	255	2,170
Total	1,245	20,325	1,755	9,225	3,000	29,550

A publication concerning the geology of the Upper Mississippi Valley zinc-lead district was issued early in 1960.[5] The report was prepared by the Federal Geological Survey in cooperation with the Illinois State Geological Survey, the Iowa Geological Survey, and the Wisconsin Geological and Natural History Survey. The Upper Mississippi Valley district includes approximately 4,000 square miles in Illinois, Iowa, and Wisconsin. The report describes the geology,

[5] Heyl, A. V., Jr., Agnew, A. F., Lyons, E. J., and Behr, C. H., Jr., with special sections by Flint, A. E., The Geology of Upper Mississippi Valley Zinc-Lead District: U.S. Geol. Survey Prof. Paper 309, 1959 (1960), 310 pp.

areal and economic, and summarizes the stratigraphy and geomorphology of the entire district. Detailed geologic maps of favorable areas and mines are included in the report, and about 500 mines are described.

A bill granting subsidies to small lead-zinc mines passed both Houses of Congress but was vetoed by the President. Import quotas for lead and zinc were continued throughout 1960.

Pig Iron and Steel.—Approximately 5,247,000 short tons of pig iron was shipped from Illinois in 1960, a slight decrease from the 1959 figure. Estimated value of output was over $316 million. Twenty-two blast furnaces were operated by 6 companies in Chicago and Granite City. These furnaces operated at 67 percent of capacity. Granite City Steel Co. dismantled its old B furnace, which was to be replaced with a new blast furnace as part of an expansion program. Construction of the new furnace was nearing completion at the close of the year. Interlake Iron Corp. completed construction of a new continuous iron-ore sintering plant late in the year. Capacity of the plant was more than 3,000 short tons of sinter per day.

Over 7.1 million short tons of domestic iron and manganiferous ores (excluding agglomerates) was consumed in blast and steel furnaces and agglomerating plants. In addition, 1.4 million short tons of iron-ore pellets, produced at or near out of State mine sites, was consumed at furnaces in Illinois. Over 715,000 tons of foreign ore also was consumed. Nearly 3 million tons of sinter was produced at consuming furnaces. Approximately 4.4 million tons of agglomerate (sinter and pellets) was consumed. Other materials consumed in Illinois furnaces included 4 million tons of coke and 2 million tons of limestone and dolomite. The above data excludes nonintegrated steel plants.

Steel production was 8,229,281 short tons, according to the American Iron & Steel Institute, a slight increase over 1959. As of the beginning of 1960, annual capacity of the State's 95 steel furnaces, operated by 13 companies, was 12,794,000 tons.

Other Metals.—Refined thorium compounds were manufactured from monazite concentrate by the Lindsay Chemical Division of American Potash and Chemical Corp. at West Chicago. The company also produced rare-earth compounds.

Small but valuable quantities of certain metals, such as cadmium, gallium, and germanium, are recovered from Illinois ores in later processing stages. Because it is virtually impossible to distribute such mineral products by States of origin, their values are not included in the total value of mineral output of any State.

REVIEW BY COUNTIES

Mineral production, excluding liquid fuels and natural gas, was reported in 94 of the 102 counties in 1960. La Salle County continued to rank first, with mineral output valued at more than $35 million. Other leading counties, with total value of mineral production exceeding $10 million, were Christian, Cook, Franklin, Fulton, Hardin, Jefferson, Perry, St. Clair, Saline, and Williamson. Mineral values increased over 1959 for 62 counties; 34 counties recorded decreases from the preceding year; and no change was reported for 1 county. Ex-

cluded from the county-review section are details on liquid-fuel and natural gas operations, for which county breakdowns were not available. References to coal producers pertain only to those producing 1,000 short tons or more annually, unless otherwise stated.

Adams.—Quicklime and hydrated lime were produced at plants operated near Quincy by Marblehead Lime Co. and Menke Stone & Lime Co. chiefly for building, chemical, and industrial uses. These companies and the Black White Limestone Co. operated underground limestone mines in the county. Other limestone producers included Missouri Gravel Co. and Western Illinois Stone Co. The latter operated 3 quarries, near Loraine, Marcelline, and Quincy. Limestone was produced for various purposes, including concrete aggregate and roadstone, agriculture, flux, mineral food, various fillers, riprap, and lime manufacture.

TABLE 11.—Value of mineral production in Illinois, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Adams	$1,847,868	$2,310,787	Stone, lime, coal, sand and gravel.
Alexander	255,150	222,528	Tripoli, sand and gravel, stone.
Bond	(2)	214,506	Sand and gravel, stone, clays.
Boone	92,803	163,619	Sand and gravel, stone.
Brown	322,757	189,944	Stone, sand and gravel, clays.
Bureau	(2)	(2)	Coal, sand and gravel, clays.
Calhoun	19,324	13,290	Stone, sand and gravel.
Carroll	91,101	168,339	Sand and gravel, stone.
Cass	400	7,658	Sand and gravel.
Champaign	241,429	269,447	Do.
Christian	(2)	(2)	Coal, stone.
Clark	632,681	600,678	Stone, sand and gravel.
Clay	(2)	(2)	Stone.
Clinton	416,395	475,021	Coal, stone, sand and gravel.
Coles	(2)	789,728	Stone, sand and gravel.
Cook	24,656,565	30,060,552	Stone, lime, clays, sand and gravel, peat.
Crawford	(2)	135,556	Sand and gravel.
Cumberland	124,947	(2)	Do.
De Kalb	428,916	445,471	Stone, sand and gravel.
De Witt	96,391	80,375	Sand and gravel.
Douglas	2,159,511	(2)	Coal.
Du Page	(2)	(2)	Stone, sand and gravel.
Edwards	29,100	(2)	Sand and gravel, clays.
Effingham	(2)	(2)	Stone.
Fayette	94,182	88,669	Sand and gravel, clays.
Ford	125,812	(2)	Sand and gravel.
Franklin	(2)	(2)	Coal, sand and gravel.
Fulton	21,906,792	22,665,384	Do.
Gallatin	509,366	338,119	Do.
Greene	296,868	494,378	Stone, clays, coal, sand and gravel.
Grundy	(2)	(2)	Clays, sand and gravel.
Hancock	275,059	326,931	Stone.
Hardin	8,287,358	10,197,518	Fluorspar, zinc, stone, lead.
Henderson	254,112	328,982	Stone.
Henry	457,722	601,960	Coal, stone, sand and gravel.
Iroquois	840	1,434	Sand and gravel.
Jackson	(2)	5,345,076	Coal, stone, sand and gravel.
Jefferson	(2)	(2)	Coal, stone.
Jersey	(2)	(2)	Stone.
Jo Daviess	(2)	(2)	Zinc, lead, stone, sand and gravel.
Johnson	986,108	1,322,607	Stone.
Kane	2,447,514	2,774,810	Sand and gravel, stone, peat.
Kankakee	2,347,021	4,159,499	Stone, coal, clays, sand and gravel.
Kendall	(2)	376,707	Stone, sand and gravel.
Knox	9,615,582	(2)	Coal, stone, sand and gravel.
Lake	985,914	963,345	Sand and gravel, clays, peat.
La Salle	35,340,757	35,115,631	Cement, sand and gravel, stone, clays.
Lawrence	170,579	237,721	Sand and gravel.
Lee	(2)	(2)	Cement, stone, sand and gravel, clays.
Livingston	1,968,458	2,257,626	Stone, clays, sand and gravel.
Logan	(2)	618,069	Stone, sand and gravel, coal.
Macon	(2)	(2)	Sand and gravel.
Macoupin	1,577,488	1,513,242	Coal, stone.
Madison	4,336,809	4,113,535	Coal, stone, sand and gravel.
Marion	84,281		

See footnotes at end of table.

TABLE 11.—Value of mineral production in Illinois, by counties[1]—Continued

County	1959	1960[1]	Minerals produced in 1960 in order of value
Marshall	(2)	(2)	Sand and gravel, clays.
Mason	$3,435	$11,634	Sand and gravel.
Massac	(2)	(2)	Stone, sand and gravel.
McDonough	200,428	414,128	Stone, clays.
McHenry	2,797,321	3,164,138	Sand and gravel, stone.
McLean	507,128	398,778	Sand and gravel.
Menard	500,089	545,105	Stone, coal, clays.
Mercer	243,855	363,582	Coal, stone, clays.
Monroe	(2)	(2)	Stone.
Montgomery	(2)	(2)	Coal, stone.
Morgan		772	Sand and gravel.
Moultrie	9,835		
Ogle	1,294,565	1,575,180	Sand and gravel, stone.
Peoria	4,065,072	4,773,532	Coal, sand and gravel, stone.
Perry	12,132,382	10,272,554	Coal.
Pike	309,448	406,971	Stone, sand and gravel.
Pope	3,991	9,754	Sand and gravel, zinc.
Pulaski	(2)	630,212	Stone, clays, sand and gravel.
Putnam	2,250		
Randolph	4,458,949	7,439,217	Coal, stone, sand and gravel.
Rock Island	784,095	1,634,097	Stone, sand and gravel, clays.
St. Clair	23,671,114	21,409,993	Coal, stone, sand and gravel, clays.
Saline	10,714,958	11,999,588	Coal.
Sangamon	1,069,841	1,000,539	Sand and gravel, coal, clays, stone.
Schuyler	(2)	(2)	Coal, stone.
Scott	(2)	273,678	Stone, sand and gravel.
Shelby	(2)	226,831	Do.
Stark		738,216	Coal, sand and gravel.
Stephenson	161,743	427,321	Stone, sand and gravel.
Tazewell	1,233,114	1,603,193	Sand and gravel, clays.
Union	1,062,963	1,579,848	Stone, sand and gravel.
Vermilion	6,763,731	6,639,156	Coal, stone, clays, sand and gravel.
Wabash	(2)	243,580	Sand and gravel, coal.
Warren	103,652	(2)	Stone.
Washington	368,939	395,157	Stone, coal.
Wayne		13,965	Sand and gravel.
White	154,867	229,154	Do.
Whiteside	285,592	301,627	Stone, sand and gravel.
Will	8,870,394	9,475,255	Sand and gravel, stone, coal.
Williamson	25,052,366	24,975,529	Coal.
Winnebago	1,221,841	2,224,120	Sand and gravel, stone.
Woodford	(2)	(2)	Sand and gravel.
Undistributed	[3] 340,742,594	345,414,974	
Total	[3] 572,275,000	590,800,000	

[1] Excludes gem stones, petroleum, natural gas, natural gas liquids, and some stone and sand and gravel for which data by counties are not available; included with "Undistributed." The following counties did not report production: Edgar, Hamilton, Jasper, Piatt, and Richland.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.

Sand and gravel and crushed limestone for road use were produced under contract for the State highway department. Quincy Sand Co. produced sand and gravel for building, fill, and other purposes at its dredging operation near Quincy. Blick's Construction Co. produced paving sand, also near Quincy.

Triple S Mines, Inc., produced coal for local consumption from its No. 2 strip mine near Augusta. Some of the coal was crushed, cleaned by jigging methods, and oil treated.

Alexander.—Ozark Minerals Co. and Tamms Industries, Inc., near Elco and Tamms, respectively, produced amorphous silica. Both companies operated underground mines. Crude material was crushed, ground, sized, and dried at company-operated mills. Most of the processed material was bagged and shipped to consumers by rail. Output was greater than in 1959.

Sandstone was produced near Elco by the Western Fire Brick Co. Crude material was shipped to the company plant in East St. Louis for grinding. Output was sold chiefly for use in furnace linings.

H. H. Halliday Sand Co. operated a dredge on the Ohio River near Cairo and produced sand and gravel for building and road construction and railroad ballast. The county highway department produced paving gravel.

Bond.—The Bond Stone Co. produced crushed limestone from a quarry near Sorento. Output was used entirely as roadstone.

Richards Brick Co. mined clay near New Douglas, for manufacturing building brick at its plant in Edwardsville, Madison County.

Cyril Munie operated both fixed and portable sand and gravel plants and produced material for building and road construction and other uses. Greenville Gravel Co., Inc., produced gravel for building use at its fixed plant at Greenville. Paving sand was produced under contract for the State highway department.

Boone.—Belvidere Lime Quarry produced crushed limestone for roadstone and agricultural purposes at a quarry near Belvidere.

Several companies produced sand and gravel for building and road construction and other uses. Paving gravel was produced under contract for the county highway department.

Brown.—Crushed limestone for roadstone and agricultural use and sand and gravel for paving use and fill were produced by T. F. Hollembeak & Sons near Mount Sterling. Missouri Gravel Co. operated a portable crushing plant and produced limestone for road use. Paving gravel was produced under contract for the State highway department.

The Frederic Brick & Tile Co. produced clay near Mount Sterling and used the material for manufacturing building brick and draintile.

In March, the Big Four Mines acquired the strip coal mine formerly operated by K. D. Malcomson near Mount Sterling. Combined output of both companies was less than 1,000 short tons.

Bureau.—Midland Electric Coal Corp. produced 371,000 short tons of coal from its Mineral No. 1 strip mine, the only active coal mine in the county. The entire output was cleaned at the company plant, which also treated coal from the Victoria No. 5 mine of Midland Collieries, Inc., in Knox County. Shipments were primarily by rail.

Clay was mined near Sheffield by Sheffield Shale Products Co. for use in manufacturing building brick and other heavy clay products.

Sand and gravel was produced by 4 commercial operators near Manlius, Princeton, Spring Valley, and Wyanet. Output was for building and road construction, molding sand, fill, and other uses. Gravel was produced by the county highway department and the city of Princeton for paving use and fill, respectively. The State and county highway departments contracted for paving gravel.

The New Jersey Zinc Co. operated a zinc smelter at Depue. A labor strike began on August 5 and ended November 26 when the company and the United Steelworkers union signed a new contract, which expires July 27, 1963.

Champaign.—Expanded perlite was produced by the Ryolex Corp. at Champaign for use principally as lightweight aggregate in plaster and concrete. Crude material processed was mined in New Mexico.

615629—61——24

Fixed and portable sand and gravel plants were operated in the vicinities of Champaign, Ludlow, Mahomet, and Rantoul. Output was for building and road purposes, fill, and other uses. A report on the sand and gravel resources of the county was published.[6]

Christian.—Peabody Coal Co. produced coal from its No. 10 underground mine near Pawnee, the second largest producing mine in the United States in 1960. Output was 4.1 million tons, a 9-percent increase over 1959. Part of the output was cleaned by jigging methods.

Crushed limestone was produced by Edinburg Quarries and Tri-County Stone Co. near Edinburg and Nokomis, respectively. The material was used for roadstone and agriculture.

Clinton.—Citizens Coal Co. and Marion County Coal Mining Corp. produced coal from underground mines near Breese and Centralia, respectively. Total production increased 51 percent over 1959. Output was primarily for local consumption.

Crushed limestone was produced chiefly for use as roadstone. The county highway department produced gravel for building purposes. Paving sand was produced under contract for the State highway department.

Cook.—Total value of Cook County mineral output topped $30 million, 22 percent more than that of 1959. Limestone was produced for concrete aggregate and roadstone, agriculture, railroad ballast, flux, manufacturing lime and dead-burned dolomite, asphalt filler, coalmine dust, riprap, flagging, and other uses. Material Service Corp. continued operating its Federal, Riverside, Stearns, and Thornton quarries. Consumers Co. produced limestone from the Bellwood and McCook quarries. An article concerning the company's new 1,500-ton-per hour crushing and screening plant at the McCook quarry was published.[7] Other producers of limestone included Dolese & Shepard Co., operating a quarry near Hodgkins; Arcole Mid-West Corp., Lemont Stone & Material Co., and Elroy & Son, operating quarries near Lemont; and H. Turner & Son. The State highway department contracted for roadstone and paving gravel.

Sand and gravel producers included Chicago Gravel Co., Consumers Co., Material Service Corp., Road Materials Corp., and Worth Sand & Gravel Co., Inc. Output was for building and road construction, railroad ballast, and other purposes.

Marblehead Lime Co. produced quicklime and hydrated lime at plants in South Chicago and Thornton for building and various chemical and industrial uses. Quicklime for refractory use was produced at La Grange by Standard Lime & Cement Co.

Clays were produced chiefly for manufacturing building brick. Producers included Brisch Brick Co., Carey Brick Co., Chicago Brick Co., Illinois Brick Co., and Tuthill Building Materials Co.

Peat was produced and sold chiefly for soil conditioning.

The Pure Oil Co. recovered sulfur as a byproduct at its Lemont Refinery.

Perlite was expanded by Silbrico Corp. at Chicago from crude material mined in Western States. The processed material was used

[6] Anderson, R. C., Sand and Gravel Resources of Champaign County, Illinois: Illinois State Geol. Survey Circ. 294, 1960, 15 pp.
[7] Pit and Quarry, Automated Control: Vol. 52, No. 12, June 1960, p. 80.

for lightweight aggregate in plaster and concrete, insulation, soil conditioning, and other purposes.

U.S. Mica Co., Inc., produced ground mica at its plant in Forest Park.

Vermiculite was exfoliated at Chicago by Zonolite Co. from crude material mined outside the State.

Lindsay Chemical Division of American Potash & Chemical Corp. manufactured refined thorium compounds and rare-earth compounds at Chicago.

Blast and steel furnaces and coke-oven plants were operated in the Chicago area. Many of the furnaces were banked because of lack of demand for steel. Pig-iron producers were Interlake Iron Corp., International Harvester Co., Republic Steel Corp., United States Steel Corp., and Youngstown Sheet & Tube Co. All except United States Steel Corp. operated coke ovens. A new self-fluxing sinter plant was constructed by Interlake Iron Corp. at its Chicago facilities. The plant was built by Dravo Corp. under license from Lurgi Co. of Germany. Daily capacity of the new plant was over 3,300 short tons of sinter.

Steel producers included Acme Steel Co., Borg-Warner Corp., Ceco Steel Corp., Columbia Tool Steel Co., A. Finkl & Sons Co., H. M. Harper Co., International Harvester Co., Republic Steel Corp., and United States Steel Corp. H. M. Harper Co. completed a major expansion program which included four building additions having about 26,000 square feet of floor space and new equipment for producing stainless steel.

Douglas.—Approximately 506,000 tons of coal was produced by Moffat Coal Co. from its underground mine near Murdock. The entire output was cleaned by jigging. About three-fifths of the output was shipped to consumers by rail. The remainder was sold chiefly for local consumption.

Du Page.—Elmhurst-Chicago Stone Co. operated a limestone quarry at Elmhurst and produced material for use principally as concrete aggregate, roadstone, and railroad ballast. The company also operated stationary sand and gravel plants at Winfield and Warren. Output was for building and road construction. A quantity of sand and gravel was produced by township crews for road use.

Edwards.—Albion Brick Co. produced clay near Albion for manufacturing building brick.

Sand and gravel for various uses was produced near Albion by George Aulvin Sand & Gravel Co.

Fayette.—Diller Shale Products produced clay near St. Elmo for use in manufacturing draintile. Most of the finished product was sold to farmers in the area; the remainder was sold to lumber yards and other retailers for construction use.

Burtschi Sand & Gravel Co. and Melvin Dugan operated stationary sand and gravel plants near Vandalia and Hagarstown, respectively. Output was for building and road construction and other uses. Forrest Lutz produced natural-bonded molding sand near Mulberry Grove. Output was shipped mostly to steel companies and foundries. A small quantity was sold for paving use. The State highway department contracted for paving gravel.

Franklin.—Approximately 4.1 million tons of coal was produced, a 10-percent decrease from 1959. Output was from 6 underground mines. Old Ben Coal Corp. operated the Nos. 9, 14, 21, and 22 mines in 1960. The Nos. 22 and 14 mines were abandoned in January and June, respectively. The company began operating its new No. 21 mine near Sesser in January, producing low-sulfur metallurgical coal. The mine was expected to become one of the Nation's largest producing mines with a potential capacity of 15,000 tons per day. Freeman Coal Mining Corp. began initial production from the Orient No. 5 mine near Benton in November. Output was cleaned at the company plant in Williamson County. The Orient No. 2 mine of Orient Number Two Coal Co., near West Frankfort, was abandoned in November.

Paving gravel was produced under contract for the State highway department.

Fulton.—Fulton County ranked second in coal production, with more than 5.3 million tons, a 5-percent increase over 1959. Most of the output came from 15 strip mines; 3 underground mines supplied 26,600 tons. Approximately 95 percent of the production was cleaned at 7 plants. Full-scale production began at the Banner No. 27 strip mine, operated by The United Electric Coal Cos. near Glasford. A detailed article on the mine was published.[8] Bruketta & Sons Coal Co. abandoned its underground mine near Farmington in July. Little Coal Co. and Gibson Coal Co. opened strip mines in April and September, respectively.

Sand and gravel for building and road construction and other uses was produced by three companies.

Gallatin.—Coal was produced by three companies, operating one strip and two underground mines. None of the output was mechanically cleaned or treated. Over half the shipments were by barge on the Ohio River. Nearly all the remainder was sold locally. H. & V. Coal Co. began operating a new strip mine in August.

Paving sand and gravel was produced by Gail Denny Sand Co. and the county highway department and under contract for the State highway department.

Greene.—American Vitrified Products Co. produced clay near White Hall for use in manufacturing sewer pipe. Clay was produced near Roodhouse by Wyatt's Clay Mines, Inc., formerly Wyatt Clay Mines, and used by the company in manufacturing building brick.

Birch Creek Coal Co. produced coal from its strip mine near Roodhouse. Output decreased slightly from 1959. All shipments were for local consumption. A small quantity was treated with oil.

Limestone was produced by 5 companies, operating quarries near East Hardin, Hillview, Kane, and Roodhouse. Output was chiefly for roadstone, agriculture, and riprap. Paving gravel was produced by Lyle B. Moushon for the State highway department.

Grundy.—Clay was produced near Coal City by Illinois Clay Products Co. for use chiefly in manufacturing refractories. A small quantity was used for manufacturing miscellaneous heavy clay products. The cutback in steel production adversely affected sales in 1960.

---

[8] Coal Age, Banner Mine: United Electric's 4,000-Tpd On-River Producer of Illinois Coal, vol. 65, No. 12, December 1960, p. 70.

Sand and gravel was produced by Material Service Corp. near Morris chiefly for paving use. The State highway department contracted for paving gravel.

Hardin.—Shipments of finished fluorspar increased about one-fifth over 1959. Major producing companies were Aluminum Company of America, Mackey-Humm Mining Co. Minerva Oil Co., and Ozark-Mahoning Co. Aluminum Company of America continued to operate its group of mines and mill near Rosiclare. Acid-grade fluorspar and lead and zinc concentrates were produced at the mill, which treated some custom ore as well as company-mined material.

Minerva Oil Co. operated its Crystal and No. 1 mines and mills. Fluorspar, lead, and zinc concentrates were produced at the Crystal mill, whereas only fluorspar and zinc concentrates were produced at the No. 1 plant. Some custom ore was processed at both plants. The company also resumed operations at the Jefferson mine and began sinking a shaft on the adjacent Fairbairn property. In the latter part of the year the company was operating its mines and plants 6 days a week. The company began shipping fluorspar concentrate in 4-ply paper bags by barge on the Ohio River to Wellsville, Ohio. The bagged product was stored in a warehouse at Wellsville for subsequent distribution by truck. As a result, freight costs were reduced substantially.

Ozark-Mahoning Co. operated mines near Cave-in-Rock and a flotation mill at Rosiclare and produced fluorspar, lead, and zinc concentrates. The company curtailed operations during the summer because of depressed market conditions. Also, the company began to treat mine-run ore by heavy-medium separation on a small scale, prior to flotation.

Mackey-Humm Mining Co. operated its mine and heavy-medium and flotation plants. Metallurgical-grade fluorspar was produced in the heavy-medium plant, which also upgraded ore for other producers. Acid-grade fluorspar was produced in the company flotation plant. Acid-grade fluorspar also was produced at the flotation plant of Rosiclare Lead & Fluorspar Mining Co., which was operated only part of the year. Several companies mined fluorspar ore that was processed by other companies. Wiley Cochran began production from a new mine in the Karbers Ridge area.

Crushed and broken limestone was produced near Cave-in-Rock and Elizabethtown for roadstone, agricultural use, and metallurgical flux. The State highway department contracted for crushed limestone for road use.

Henry.—Schuler Coal Co. produced coal from an underground mine near Alpha. Most of the shipments to consumers were by rail.

McCarthy Improvement Co. opened a new limestone quarry near Cleveland. The company operated a portable crushing plant and produced material for roadstone and agricultural purposes.

Paving gravel was produced by Collinson Bros., who operated a portable plant near Kewanee. Schadt Service Co. operated a fixed sand and gravel plant near Silvis. Output was for building and road construction and other uses.

Jackson.—Coal production exceeded 1.3 million tons, 6 percent greater than in 1959. Truax-Traer Coal Co. operated its Burning

Star strip and underground mines and preparation plant near Elkville. The drift entrance of the Truax-Traer Coal Co. underground mine ceased production at the close of 1960. During the latter part of the year, the company was engaged in constructing an opening of a new slope mine several miles away. Elk Coal Co. operated an underground mine and preparation plant near Elkville. Farley Bros. Coal Co. produced coal from a strip mine near DeSoto.

Crushed limestone for agricultural and road purposes was produced near Ava by the Illinois Quarry Co.

Lawder Sand Co. produced sand and gravel near Grand Tower for building and road construction, railroad ballast, and other uses.

Jefferson.—Coal was produced by Freeman Coal Mining Corp. from the Orient No. 3 mine near Waltonville and by Belle Rive Mining Co., operating a strip mine near Belle Rive. Total production decreased 6 percent from 1959. The Orient No. 3 was the fourth largest producing mine in the United States in 1960. Output from the mine was cleaned, using jigging, tabling, and heavy-medium methods.

Crushed limestone for road use was produced near Mount Vernon by the Randall Stone Co.

Jo Daviess.—Four companies mined lead and/or zinc ores. Eagle-Picher Co. operated its Graham-Snyder-Spillane-Feehan and O'Rourke mines and Graham mill throughout the year except for a strike that lasted all of October. In July, the company reduced operations from 6 to 5 days a week with one shift per day, because of reduced sales of zinc. Ore mined by the company in Wisconsin was processed at the Graham mill. Tri-State Zinc Co. operated its Gray and Amelia mines, and treated ore from both mines at the company Gray mill. Hickory Hill Mining Co. and Little Ginte Mining Co. produced lead ore from the Hartwick and Little Ginte mines, respectively. The ore was processed at plants of other companies.

Broege Limestone Co. and Elmer Wienen & Sons produced crushed limestone for roadstone and agricultural purposes. The Midland Co. produced crushed limestone for use as railroad ballast. The State highway department contracted for roadstone.

Dubuque Sand & Gravel Co. operated a fixed plant at East Dubuque and produced material for building and other purposes.

Kane.—Sand and gravel was produced by 9 companies, operating fixed and portable plants at various locations. Output was for building and road construction, fill, and other uses. Sand and gravel for paving was produced by the city of Aurora, and under contract for the State highway department. An article describing the East Dundee sand and gravel plant of Material Service Corp. was published.[9] A report on the sand and gravel resources of the county also was published.[10]

Conco-Western Stone Co. and Fox River Stone Co. produced limestone near North Aurora and Elgin, respectively. Both companies operated portable crushing plants. Output was used for concrete aggregate and roadstone, agriculture, flux, asphalt filler, flagging, and rubble.

---

[9] Rock Products, Material Service Paces Chicago's Growth: Vol. 63, No. 3, March 1960, p. 92.

[10] Block, Douglas A., Sand and Gravel Resources of Kane County, Illinois: Illinois State Geol. Survey Circ. 299, 1960, 11 pp.

Peat was produced, primarily for soil conditioning.

Kankakee.—Coal production increased substantially over that of 1959. The entire output came from a strip mine operated by Peabody Coal Co. near Braidwood. Production also was reported from the Will County portion of the mine.

Crushed limestone was produced by Lehigh Stone Co. and Manteno Limestone Co. Output was for agricultural and road purposes and railroad ballast.

Clay mined near Kankakee and St. Anne was used for manufacturing building brick and other heavy clay products. Producers were Eastern Illinois Clay Co., Kankakee Clay Products Co., and St. Anne Brick & Tile Co.

Paving sand was produced near Kankakee by the Azzarelli Construction Co. and Kankakee Sand Co. The National Silica Division of Portage-Manley Sand Co. produced molding sand.

Knox.—Over 2.2 million tons of coal was produced in Knox County, a slight increase over 1959. Output came from the Rapatee No. 3 and Middle Grove No. 2 mines of Midland Electric Coal Corp., the Victoria No. 5 mine of Midland Collieries, Inc., and the Little John mine of Stonefort Coal Mining Co., Inc. All were strip mines. The Little John mine was abandoned in April. Production from the Victoria No. 5 was cleaned at the Bureau County plant of Midland Electric Coal Corp. Virtually the entire county coal output was shipped to consumers by rail.

Crushed limestone for roadstone and agriculture was produced near Abingdon by the Abingdon Rock Co., Inc.

Paving gravel was produced under contract for the State highway department by Knox County Gravel Co.

Abingdon Potteries, Inc., operated a feldspar-grinding plant at Abingdon. Crude material processed was mined by the company outside the State. The ground product was used entirely in manufacturing pottery.

Lake.—Nine companies produced sand and gravel near Antioch, Barrington, Gurnee, Ingleside, Libertyville, Spring Grove, and Wadsworth. Output was for building and road construction, railroad ballast, and other uses. Paving gravel was produced under contract for the county highway department.

The National Brick Co. produced clay near Deerfield and used the material for manufacturing building brick.

Peat produced in the county was used principally for soil conditioning.

Coke was produced at Waukegan by General Motors Corp.

Lake Zurich Concrete Products Co. expanded perlite at its plant in Lake Zurich from crude material mined in Colorado and New Mexico. Output was used as lightweight aggregate in plaster and concrete.

National Gypsum Co. manufactured gypsum products at Waukegan. Crude gypsum processed was mined by the company in Michigan.

La Salle.—La Salle County ranked first in value of mineral output (excluding liquid fuels and natural gas). Portland and masonry

cements were produced by Alpha Portland Cement Co. at La Salle and by Lehigh Portland Cement Co. and Marquette Cement Mfg. Co., at Oglesby. All three companies quarried limestone for use in manufacturing cement. Crushed limestone also was produced for agriculture and roadstone near Sheridan, Troy Grove, and Utica. The State highway department contracted for roadstone.

Alpha Portland Cement Co. and Marquette Cement Mfg. Co. produced shale for their own use in manufacturing cement. Material Service Corp. produced shale near Ottawa for use in manufacturing lightweight aggregate at its plant on the Illinois River. Several sizes of aggregates were produced, using 2 rotary kilns. Products were shipped by rail and river barge. Conco-Meier Co. and Hydraulic-Press Brick Co. mined clay near Lowell and Utica, respectively, and used the material for manufacturing building brick. LaClede-Christy Co. produced fire clay near Ottawa for use in manufacturing firebrick. Fire clay also was produced by Illinois Valley Minerals Co., and sold to steel mills for refractory use. Matthiessen & Hegeler Zinc Co. ceased mining fire clay in 1959. The company had formerly used the material for manufacturing zinc retorts for its zinc smelter at La Salle.

Sand and gravel was produced by 15 companies. Output was for building and road construction, railroad ballast, fill, and special uses such as glass manufacture, molding, grinding and polishing, sandblasting, engine use, filtering, oilfield fracturing, filler, enamel, and foundry use. Producers of silica sands included The American Silica Sand Co., Inc.; The Arrowhead Co.; E. C. Bellrose Sand Co.; Illinois Silica Sand Co.; Ottawa Silica Co.; and Wedron Silica Co. Paving gravel was produced under contract for the State highway department.

Lee.—The Medusa Portland Cement Co. produced portland and masonry cements at Dixon, and mined limestone and clay for use in manufacturing cement. The company announced plans for a major expansion and modernization program, including a 1 million-barrel addition to the annual capacity of its Dixon plant. A new kiln was expected to be put into operation in 1961.

Crushed limestone also was produced by Frank N. Butler Co., Oregon Stone Quarries, Stoneridge Limestone Co., and Wastone, Inc., all of whom operated portable crushing plants. Output was for roadstone and agricultural purposes.

Sand and gravel was produced by several companies near Dixon and Steward for building and road construction and fill.

Livingston.—Crushed limestone was produced near Chenoa, McDowell, and Pontiac. Output was for roadstone, agriculture, asphalt filler, and other purposes. Producers included Chenoa Stone Co., Livingston Stone Co., Ocoya Stone Co., Pontiac Stone Co., and Wagner Stone Co.

Hydraulic-Press Brick Co. mined clay near Streator and used the material for manufacturing building brick. Streator Clay Pipe Co., formerly Streator Drain Tile Co., also produced clay near Streator, chiefly for manufacturing sewer pipe. The company mined less than 1,000 tons of coal in conjunction with its clay-pit operation and used

the coal in its manufacturing process. Diller Tile Co., Inc., produced clay near Chatsworth for use in manufacturing building brick.

Paving gravel was produced.

Logan.—Sand and gravel for building and road construction, engine use, and fill was produced at a dredging operation of Lincoln Sand & Gravel Co. near Lincoln.

Crushed limestone for agriculture and roads was produced by Rocky Ford Limestone Co. from a quarry several miles southwest of Lincoln.

Over 17,000 tons of coal was produced from an underground mine near Lincoln. The mine was operated by Lincoln Coal Mining Co. until September 20, when McSpadden Bros. acquired the property. The latter company then operated the mine to yearend. The entire output was sold for local consumption.

Macoupin.—The sole producer of coal was the Little Dog Coal Co., operating an underground mine at Gillespie. Most of the 358,000 tons produced was sold locally. The entire output was cleaned by jigging and tabling.

Crushed limestone was produced under contract for the State highway department for use as roadstone.

International Vermiculite Co. exfoliated vermiculite at Girard from crude material mined outside the State. Output was used chiefly for insulating purposes.

Madison.—Coal was produced from 2 underground mines, operated by Livingston-Mt. Olive Coal Co. and Lumaghi Coal Co. near Livingston and Collinsville, respectively.

Limestone was produced by C. M. Lohr, Inc., Reliance Whiting Co., and Mississippi Lime Co. near Alton and Godfrey. The latter operated an underground mine, whereas the other companies operated open quarries. Output was for roadstone, agriculture, riprap, and other purposes. The State highway department contracted for roadstone.

Sand and gravel was produced near Alton and Granite City for building and road construction and engine and other uses. Producers included Alton Sand Co., Guth Sand Co., Gary Dredging Co., and Mississippi Lime Co. The latter two companies operated dredges near Alton.

No clay was produced in 1960, the Alton Brick Co. having ceased mining operations. Western Fire Brick Co. manufactured firebrick from clay produced in Missouri, in a plant at Granite City. Sandstone produced by the company in Alexander County was shipped to the Granite City plant, crushed, and used for patching furnaces.

Coke ovens and blast and steel furnaces were operated at Granite City by Granite City Steel Co. In 1960 the company dismantled its old B furnace, which was to be replaced with a new and larger furnace. Construction of the new furnace, with a daily capacity of about 1,800 tons of pig iron, was nearly completed at yearend. To support the expanded blast-furnace capacity, the company planned to construct a battery of 61 coke ovens which was expected to increase the company coking capacity about 80 percent. LaClede Steel Co. also produced steel in the county, operating open-hearth furnaces at Alton.

The Anlin Company of Illinois recovered sulfur from refinery gases at its new plant at Hartford.

Marshall.—Clay used in manufacturing building brick was produced by Hydraulic-Press Brick Co. near Sparland.

Paving gravel was produced by Vernon Henry, operating a portable plant near LaRose.

McDonough.—Crushed and broken limestone was produced near Colchester by Colchester Stone Co. and McClure Quarries, Inc. Output was for roadstone, riprap, and other purposes.

Clay was produced by 6 companies from pits near Colchester and Tennessee. Output was used in manufacturing pottery, stoneware, firebrick, building brick, sewer pipe, and other heavy clay products.

McHenry.—Sand and gravel was produced by 12 companies, operating portable and stationary crushing plants near Algonquin, Crystal Lake, Hebron, McHenry, Marengo, and Wauconda. Output was for building and road construction and other purposes. Major producers included Consumers Co., Material Service Corp., McHenry Sand & Gravel Co., and Tonyan Bros., Inc.

Garden Prairie Stone Co., Inc., produced limestone near Marengo for roadstone, agriculture, and flagging. The company also produced paving gravel.

Menard.—Limestone was produced near Athens by Athens Stone Quarry and Indian Point Limestone Products Co., Inc. Output was for roadstone, agriculture, and riprap.

The only coal producer was Wilcox-Verna Coal Co., Inc., operating an underground mine near Petersburg. The entire output of 13,000 tons was for local consumption. The underground mine formerly operated by Lloyd Coal Co. had been abandoned late in 1959.

Clay was mined near Petersburg by Springfield Clay Products Co., who used the material for manufacturing building brick and other heavy clay products.

Mercer.—Coal was produced from an underground mine operated near Alpha by Hazel Dell Coal Corp. and from a strip mine, operated by Viola Coal Co., near Viola. Approximately one-third of the county output was shipped by rail. The remainder was sold locally.

Crushed limestone for roadstone was produced by Linn Materials, Inc., near Viola.

Hydraulic-Press Brick Co. mined clay near Aledo for use in manufacturing building brick.

Montgomery.—Over 1.9 million tons of coal was produced from the Crown underground mine, operated by Freeman Coal Mining Corp. near Farmersville. Production increased 19 percent over 1959. The entire output was cleaned by jigging and pneumatic methods.

Crushed limestone was produced by several companies near Litchfield and Nokomis. The material was used for roadstone, agriculture, and riprap.

Peoria.—Over 433,000 tons of coal was produced from 7 strip and 3 underground mines, a 34-percent increase over 1959. Chief reason for the increase was the full-scale operation of The United Electric Coal Cos. Banner No. 27 strip mine near Glasford, which extends into Fulton County. Layne's Coal Co. opened a new strip mine near Brimfield. Three cleaning plants were operated. About one-fourth of the

county output was shipped by barge on the Illinois River. The remainder was sold locally.

Six companies produced sand and gravel near Chillicothe and Peoria for building and road construction, railroad ballast, and other uses.

Crushed limestone for roadstone and agriculture was produced near Princeville by LaMar Stone Co., Long Rock Co., and Princeville Stone Co.

Perry.—Approximately 2.8 million tons of coal was produced, a decrease of 19 percent from 1959. Output was from two strip mines, operated by Truax-Traer Coal Co. and The United Electric Coal Cos., and an underground mine operated by Big Five Coal Co. The latter mine was abandoned in March, after the shaft caved. Cleaning plants were operated by Truax-Traer Coal Co. and The United Electric Coal Cos.

Pope.—Egyptian Mining Co., Redd Mining Co., and J. W. Patton & Sons operated fluorspar mines. The crude ore was processed at plants in Hardin County and in Kentucky. Zinc was recovered from ore mined by J. W. Patton & Sons. The Empire mine of the Egyptian Mining Co. was closed after it was flooded early in the year.

Paving gravel was produced by Madeker Gravel Pit and the county highway department and also under contract for the State highway department.

Pulaski.—Crushed and broken limestone was produced by Columbia Quarry Co. near Ullin. Output was for roadstone, railroad ballast, riprap, and agriculture. Medusa Portland Cement Co. acquired additional limestone deposits in an area regarded as a potential site for a new cement plant.

Star Enterprises, Inc., mined clay near Olmstad and sold the material for absorbent uses and as a filler for fertilizers and insecticides.

The State highway department purchased paving sand and gravel from several companies.

Randolph.—Over 1.7 million tons of coal was produced from 2 strip mines, operated by Ritter Coal Co. and Southwestern Illinois Coal Co., and an underground mine, operated by Zeigler Coal & Coke Co. The latter two companies operated cleaning plants. The Ritter Coal Co. mine was closed until August.

Limestone was produced from 3 underground mines near Chester and Prairie du Rocher. Output was used chiefly for roadstone, agriculture, and in alkali works.

Sand for building and road construction, engine use, and fill was produced by Southern Illinois Sand Co. at a dredging operation near Chester.

Rock Island.—Crushed limestone was produced by Allied Stone Co., Collinson Stone Co., Cordova Quarry, Inc., and Midway Stone Co., Inc., for agricultural and road purposes. Sand and gravel was produced by five companies for building and road construction and other uses.

The Flintkote Co. produced clay near Carbon Cliff and used the material for manufacturing flue liners.

St. Clair.—Ranking third in 1960, coal production was more than 4.8 million tons, 8 percent below that of 1959. A 6-percent gain in strip-mine production did not offset a substantial decrease in output from underground mines. Virtually the entire county coal output was cleaned at eight preparation plants. Major producers were Peabody Coal Co. and Mid-Continent Coal Corp. Peabody abandoned its Seminole strip mine and its St. Ellen underground mine in May. The company also began using a new 9-bucket wheel excavator for stripping overburden at its River King mine, the tenth largest producing mine, and the fifth largest producing strip mine, in the United States in 1960. East Side Coal Co., Inc., abandoned its underground mine near Freeburg in May.

Limestone was produced for roadstone, agriculture, riprap, rubble, and other uses. Producers included Columbia Quarry Co., East St. Louis Stone Co., Hecker Quarry, Inc., Quality Stone Co., and Casper Stolle Quarry & Construction Co. In July the Quality Stone Co. opened a new quarry near Hecker.

Missouri-Illinois Materials Co. produced sand near East St. Louis for building and road construction and engine and other uses. The city of Belleville and the State highway department contracted for paving sand and gravel.

Hydraulic-Press Brick Co. produced clay near East St. Louis for use in manufacturing lightweight aggregate. Hill Brick Co. mined clay near Belleville and used it for manufacturing building brick.

American Zinc Co. of Illinois operated primary zinc reduction plants at Fairmont City and Monsanto. The Monsanto plant was closed for a 2-week period in the summer for major repairs.

C. K. Williams & Co. ground barite mined outside the State, at East St. Louis. The ground product was sold for paint and rubber filler and pharmaceuticals.

The Aluminum Company of America produced aluminum fluoride, gallium, and synthetic cryolite at its East St. Louis plant.

Saline.—Coal production increased 15 percent over 1959. Output of nearly 3 million tons was from 8 strip and 2 underground mines. Principal producers were Sahara Coal Co., Inc., and Saxton Coal Corp. Both companies also operated cleaning plants, using jigs. Approximately 91 percent of the county production was shipped to consumers by rail and 7 percent by water. The remainder was shipped by truck. New strip mines were opened by Marshall Equipment Co. and New Oak Hill Coal Co.

Sangamon.—Sand and gravel was produced near Springfield by Buckhart Sand & Gravel Co., Inc., Clear Lake Sand & Gravel Co., and Springfield Sand & Gravel Co. Output was for building and road construction and other uses. An article describing the operation of the Springfield Sand & Gravel Co. was published.[11] The city of Springfield contracted for paving sand and gravel.

Coal for local consumption was produced by Cantrall Coal Co. and Eddy Coal Co. from underground mines near Cantrall. Output decreased 5 percent from 1959.

---

[11] Rock Products, Problem: Tough Market; Solution: Build a New Plant: Vol. 63, No. 7, July 1960, p. 90.

Poston Brick & Concrete Products Co. produced clay near Springfield, chiefly for manufacturing building brick and lightweight aggregate. Springfield Clay Products Co. mined clay near Springfield for use in manufacturing draintile and floor and wall tile.

The State highway department contracted for roadstone.

Schuyler.—Approximately 594,000 tons of coal was produced, a 21-percent decrease from 1959. Output came from the Key strip mine of Peabody Coal Co. and an underground mine operated by D. & D. Coal Co. Nearly 99 percent of the production was from the Key mine. Peabody Coal Co. also operated a preparation plant at the Key mine. Over 89 percent of the total production was shipped by barge on the Illinois River, 9 percent by rail, and the remainder by truck.

Crushed limestone for roadstone and agricultural use was produced near Rushville by Elas Quarry.

Stark.—Stonefort Coal Mining Co., Inc., formerly Stonefort Corp., began coal production from its new Allendale strip mine near Wyoming in April. Over 170,000 tons was produced and the entire output was cleaned by jigging. Shipments to consumers were all by rail.

The county highway department produced paving sand near Toulon.

Tazewell.—Sand and gravel for building and road construction, railroad ballast, and other purposes was produced from plants near East Peoria, Mackinaw, and Washington. Producers were Hoffer Construction Co., McGrath Sand & Gravel Co., Inc., and C. A. Powley Co.

Peoria Brick & Tile Co. produced clay near East Peoria and used the material for manufacturing building brick.

Vermilion.—Coal was produced from 5 strip and 3 underground mines, all near Danville. Total production, 1.1 million tons, was 10 percent lower than in 1959. Strip mines furnished 96 percent of the total. Major producers were Fairview Collieries Corp. and The United Electric Coal Cos. Cleaning plants were operated by Fairview Collieries Corp. and the V-Day Coal Co. Lee Coal Co. opened a new strip mine. O'Neil Bros. Construction Co. abandoned its strip mine, formerly operated by Doo-Little Coal Co.

Material Service Corp. produced crushed limestone for roadstone at its Fairmount quarry.

Clay was mined by the Western Brick Co. near Danville. The material was used by the company for manufacturing building brick and lightweight aggregate.

Sand and gravel was produced by 6 companies, operating portable and fixed plants near Alvin, Danville, and Westville. Output was for road construction, fill, and other purposes.

Wabash.—Sand and gravel was produced near Allendale, Bellmont, and Mount Carmel. Producers were Allendale Gravel Co., Dunbar Sand & Gravel Co., and Mt. Carmel Sand & Gravel Co. Paving sand and gravel was produced under contract for the State highway department.

Approximately 1,100 tons of coal for local consumption was produced by Allendale Coal Co. from a strip mine near Allendale.

Washington.—Crushed limestone for roadstone and agricultural use was produced near Radom by Pitts Quarry.

Nearly 33,000 tons of coal was produced from underground mines operated by Bois Coal Co. near DuBois and Venedy Coal Co., Inc., near Venedy. Approximately one-fourth the total output was shipped by rail. The remainder was sold locally.

Will.—Sand and gravel was produced for building and road construction, railroad ballast, and other uses. Producers included Avery Gravel Co., Chicago Gravel Co., Elmhurst-Chicago Stone Co., Material Service Corp., C. H. Monk, and Peabody Coal Co. The State highway department contracted for paving sand and gravel.

Crushed limestone was produced for roadstone, railroad ballast, agriculture, riprap, flux, and other metallurgical purposes. Operating companies were Elmhurst-Chicago Stone Co., Lincoln Stone Co., Material Service Corp., and National Stone Co. Crushed limestone also was produced by the Illinois State Penitentiary.

Nearly 369,000 tons of coal was produced from the Will County portion of the Northern Illinois strip mine, operated by Peabody Coal Co. The mine extended into Kankakee County. The entire output was cleaned by jigging methods. Approximately half the total production was shipped to consumers by rail.

Johns-Manville Perlite Corp. processed crude perlite and vermiculite at Joliet. The crude material was mined in western States. Expanded perlite was sold for use as lightweight aggregate in plaster and concrete and other purposes; exfoliated vermiculite was used for manufacturing insulating material.

Williamson.—Williamson County ranked first in coal production with an output of nearly 6.3 million tons, an increase of 2 percent over 1959. Thirteen underground mines furnished 64 percent of the production. The remainder was from 9 strip mines. Major producers included Bell & Zoller Coal Co., Carmac Coal Co., Forsyth Carterville Coal Co., Freeman Coal Mining Corp., Peabody Coal Co., Stonefort Coal Mining Co., Inc., and Utility Coal Co. Over 6 million tons of coal was cleaned at 12 preparation plants. Approximately 96 percent of the output was shipped by rail. The underground mine of Blue Blaze Coal Co. near Carterville and several relatively small strip mines were abandoned in 1960.

The Mineral Industry of Indiana

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Indiana Department of Conservation.

By Donald F. Klyce [1] and Mary B. Fox [2]

VALUE of mineral production in Indiana in 1960 was slightly higher than in 1959. Variations were small in both output and value of most commodities. The most notable change was the decline in demand for dimension limestone, particularly dressed building stone. Coal shipments were substantially larger, but the weighted average value per ton decreased from $4.05 in 1959 to $3.96. A similar change was noted in the price of petroleum which declined from $2.97 to $2.94 a barrel.

Plans for constructing a new cement plant at Logansport were announced in October by Louisville Cement Co. A large industrial development in the dunes area of northern Indiana was still under consideration, although differences between conservationists and business development leaders remained to be resolved. Completion of the development would have a positive effect on the mineral economy of the State as substantial quantities of mineral materials would be required for construction and operation of the heavy industries proposed for the area.

TABLE 1.—Mineral production in Indiana [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives (whetstones)—short tons	5	$13	(2)	(2)
Cement, portland—thousand 376-pound barrels	14,245	47,231	14,052	$48,310
Clays—thousand short tons	1,692	2,915	1,822	3,396
Coal—do	14,804	59,954	15,538	61,570
Natural gas—million cubic feet	484	92	342	61
Peat—short tons	15,393	202	27,486	290
Petroleum (crude)—thousand 42-gallon barrels	11,554	34,315	[3] 11,590	[3] 34,075
Sand and gravel—thousand short tons	20,357	17,924	20,752	18,377
Stone—do	18,544	37,682	18,956	34,920
Value of items that cannot be disclosed: Masonry cement, gem stones (1960), gypsum, and values indicated by footnote 2	----------	8,817	----------	8,569
Total Indiana [4]	----------	206,359	----------	206,882

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Preliminary figure.
[4] Total adjusted to eliminate duplicating value of clays and stone.

[1] Commodity-industry analyst, Bureau of Mines, Minneapolis, Minn.
[2] Mineral Statistician, Geological Survey, Indiana Department of Conservation, Bloomington, Ind.

Employment and Injuries.—Preliminary information indicated that man-hours worked in the mineral industries in 1960 were slightly higher than in 1959, closely following the production trend. The largest increase was noted in the coke industry, which reflected recovery from the prolonged steel strike in 1959.

Five fatalities were recorded, compared with eight in 1959.

All employment and injury data for the mineral industry in Indiana with the exception of coal were collected from companies on a voluntary basis. Data represents virtually complete reporting by cement, coal, and coke producers and a high percentage of clay, sand and gravel, and stone producers.

TABLE 2.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of disabling injuries		Total number of days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Non-fatal			
1959:							
Cement [4]	1,549	4,011,792	-------	9	(5)	2.24	(5)
Clays [6]	651	1,540,201	1	32	6,474	21.42	4,203
Coal	3,707	5,973,788	4	269	40,054	45.70	6,705
Coke ovens	1,970	5,020,516	-------	15	(5)	2.99	(5)
Limestone [7]	2,931	5,759,304	3	212	(5)	37.33	(5)
Marl	23	24,870	-------	-------	-------	-------	-------
Sand and gravel	1,152	2,372,164	-------	36	1,107	15.18	467
Sandstone	123	268,182	-------	21	(5)	78.30	(5)
1960: [8]							
Cement [4]	1,390	3,720,220	-------	4	(5)	1.08	(5)
Clays [6]	721	1,245,109	-------	36	387	28.91	311
Coal	3,548	5,925,303	4	276	35,439	47.25	5,981
Coke ovens	2,120	6,167,387	-------	10	(5)	1.62	(5)
Limestone [7]	2,656	5,210,876	-------	126	(5)	24.18	(5)
Marl	25	25,440	-------	-------	-------	-------	-------
Sand and gravel	1,184	2,457,244	-------	38	885	15.46	360
Sandstone	96	152,380	1	4	(5)	32.81	(5)

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Data not available.
[6] Excludes pits producing clay used exclusively in manufacturing cement.
[7] Excludes quarries producing limestone used exclusively for manufacturing cement.
[8] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Whetstones from sandstone quarried near Orleans in Orange County were manufactured by The Hindostan Whetstone Co. of Bedford.

Most of the mill output consisted of small tapered stones used for removing fingernail cuticle and was marketed through beauty supply houses. Sharpening stones also were fabricated.

Whetstones have been produced in this area since 1812 and the sharpening stone industry was one of the earliest mineral developments in Indiana. The stone is quarried from beds just above the Mississippian-Pennsylvanian unconformity. The material consists of

quartz grains less than one-eighth millimeter in diameter bonded by iron oxide and clay.

Cement.—Four cement plants (Lehigh Portland Cement Co. at Mitchell, Lone Star Cement Corp. at Limedale, Louisville Cement Co. at Speed, and Universal Atlas Cement Co. at Buffington) produced portland and masonry cements. The average mill values of portland and masonry cements increased from $3.32 and $3.44 in 1959 to $3.44 and $3.75 per barrel, respectively. As a result, value of shipments in 1960 was higher than in 1959, although volume decreased 450,000 barrels. Stocks of portland cement at mills at yearend were 2 percent lower than in 1959.

Shipments of portland cement went chiefly to ready-mixed concrete companies, concrete product manufacturers, building material dealers, and highway contractors. About 42 percent of the cement shipped was used in Indiana. Out-of-State shipments went mainly to Illinois, Kentucky, and Wisconsin.

Over 3 million tons of limestone and large quantities of slag, clay, gypsum, and sand were used in making cement. More than 345 million kilowatt hours of electrical energy was used at the cement plants.

Alumina cement was produced by Universal Atlas Cement Co.

In addition to plans for the projected Logansport plant, Louisville Cement Co. completed a new finish-grinding department at its Speed plant, which included a two-compartment 10- by 34-foot mill.

Lehigh Portland Cement Co. continued rebuilding its Mitchell plant, which when completed will result in virtually a new operation with increased capacity of 700,000 barrels. Two kilns, completed in 1959, were in operation during the year. Five mills (two raw and three finish) were being installed, and cement storage silos and a storage building were being built.

The Indiana Geological Survey provided the Portland Cement Association with samples of carbonate rocks of Indiana to assist in the Association's research program on alkali reactivity of carbonate rocks—expansion and dedolomitization.

Clays.—Fire clay was produced in seven counties and used for stoneware, floor and wall tile, architectural terra cotta, art pottery, firebrick and block, heavy clay products, art products, and for "daubing" coke ovens.

Miscellaneous clay was mined in 21 counties. The material was used in heavy clay products (building and paving brick, draintile, sewer pipe), cement, lightweight aggregate, stoneware, and plastics.

Increased clay production reflected a greater demand from manufacturers of heavy clay products and lightweight aggregate, which more than offset a drop in demand for clay for use in cement.

Figures compiled by the Indiana Geological Survey indicated that the value of products manufactured from clay and shale totaled $25,860,486, a decrease of 13 percent from the 1959 value. Although many companies reported decreases in income for the year, a large part of the total decrease indicated for the State must be attributed to the fact that some companies did not submit reports. Common and face brick and structural tile supplied about 45 percent of the total value of manufactured clay products, draintile and sewer pipe, 26

percent; vitreous china plumbing fixtures, pottery, and art products, 28 percent, and miscellaneous items, the remainder.

TABLE 3.—Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Fire clay		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951-55 (average)	477	$888	1,160	$1,524	1,637	$2,412
1956	645	1,202	1,405	2,255	2,051	3,457
1957	398	748	1,077	1,821	1,475	2,569
1958	315	518	1,056	1,959	1,371	2,477
1959	366	565	1,326	2,350	1,692	2,915
1960	348	635	1,474	2,761	1,822	3,396

The Indiana Geological Survey published [3] a directory of producers and users of clay and shale in Indiana.

Gem Stones.—Calcite specimens were found at a quarry near North Vernon in Jennings County. Total output of gem stones, however, was negligible in value compared with that of other mineral commodities.

Gypsum.—Gypsum was mined in Martin County by National Gypsum Co. and United States Gypsum Co. Output was larger than in 1959. Mills at the mine sites produced lath, wallboard, prepared plaster, and other products.

The gypsum was mined from the lower part of the St. Louis limestone at depths of approximately 450 feet. The gypsum was mined by the room and pillar method from a face about 14 feet high, by drilling and blasting.

Mineral Wool.—Mineral wool was manufactured in plants in Huntington, Madison, Starke, Wabash, and Wayne Counties from blast-furnace slag obtained from steel mills in Lake County.

Perlite.—Crude perlite, mined in western States, was expanded at plants in Hammond (Lake County) and Scottsburg (Scott County). The processed material was used in building plaster, as concrete aggregate and insulation, and in other industrial materials.

Sand and Gravel.—Output of sand and gravel was about the same as in 1959 with only minor variations in use. Most of the material was used for building and highway construction and maintenance. A larger quantity of sand and gravel for use as fill was reported than in previous years. Commercial production was reported from 67 counties by 175 producers.

County highway departments in 13 counties reported production of sand and gravel, mostly for roads.

Major sand and gravel production came from Marion, Allen, Vigo, Kosciusko, and St. Joseph Counties. The 10 leading producers, in alphabetical order, were Allen-Whitley County Gravel Co., Inc., Columbia City; American Aggregates Corp., Indianapolis; Paul C. Brudi Stone & Gravel Co., Inc., Fort Wayne; Irving Bros. Gravel

[3] Harrison, J. L., Directory of Producers and Users of Clay and Shale in Indiana: Indiana Geol. Survey Directory No. 7, 1960, 38 pp.

Co., Inc., Marion; Irving Materials, Inc., No. 2, Fortville; May Stone & Sand, Inc., Fort Wayne; Neal Gravel Co., Inc., Covington; Portage-Manley Sand Co., Rockton, Ill.; Standard Materials Corp., Indianapolis; and Western Indiana Gravel Co., Lafayette.

A report on the gravels of Indiana was published.[4]

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Molding	455	$646	420	$578
Building	3,655	2,850	4,081	3,242
Paving	3,578	2,916	3,296	2,666
Engine	84	93	92	107
Fire or furnace	(1)	(1)	136	153
Fill	499	281	1,030	395
Undistributed [2]	185	187	92	64
Total	8,456	6,973	9,147	7,205
Gravel:				
Building	4,297	4,370	3,640	4,002
Paving	5,882	5,528	5,579	5,697
Railroad ballast	280	207	385	310
Fill	999	623	1,401	812
Other	80	62	50	76
Total	11,538	10,790	11,055	10,897
Total sand and gravel	19,994	17,763	20,202	18,102
Government-and-contractor operations:				
Sand:				
Paving	1	(3)	1	(3)
Fill			(3)	(3)
Total	1	(3)	1	(3)
Gravel:				
Building			55	36
Paving	318	145	423	210
Fill	44	16	71	29
Total	362	161	549	275
Total sand and gravel	363	161	550	275
All operations:				
Sand	8,457	6,973	9,148	7,205
Gravel	11,900	10,951	11,604	11,172
Grand total	20,357	17,924	20,752	18,377

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes railroad ballast (1959), filter (1960), glass, and other construction and industrial sands.
[3] Less than $1,000.

Slag.—Slag was a byproduct of pig-iron production in Lake County blast furnaces. It was used as an ingredient in manufacturing cement, mineral wool, roofing granules, was expanded for lightweight aggregate, and crushed for use as aggregate.

Stone.—Limestone and sandstone were quarried, and 97 percent of the production was crushed for various uses, including raw material

[4] McGregor, D. J., Gravels of Indiana: Indiana Geol. Survey Rept. of Progress 17, 1960, 53 pp.

for cement, concrete aggregate, roadstone, filler, flux, railroad ballast, and agricultural limestone.

The output of stone was more than 400,000 tons larger than in 1959, but value declined 7 percent. The loss was due mainly to a $3.1 million decline in the value of shipments of dressed dimension stone. Although the production of crushed stone continued to increase, its low unit value could not compensate for the decreased output of the higher priced dimension stone.

Crushed limestone was produced in 41 counties. The largest output came from Clark, Putnam, Lawrence, Allen, Newton, Monroe, and Scott Counties. Major producers included Louisville Cement Co., May Stone & Sand, Inc., Mulzer Brothers, Newton County Stone Co., Inc., The Ohio & Indiana Stone Corp., and Standard Materials Corp.

Dimension limestone, quarried mainly in Lawrence and Monroe Counties, furnished 34 percent of the value of the limestone produced, but it represented only 3 percent of the output by weight.

TABLE 5.—Limestone sold or used by producers, by uses

Use	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension: Building:				
Rough architectural (block)--thousand cubic feet	2,719	$2,731	2,817	$2,934
Dressed (cut and sawed)--do	4,331	11,481	3,374	8,345
Flagging and rubble--do	1,047	201	1,103	221
Total (approximate thousand short tons)[1]	587	14,413	529	11,500
Crushed and broken:				
Riprap--short tons	42	50	300	371
Concrete aggregate, roadstone, etc:				
Commercial--do	13,000	16,659	13,245	16,695
Government-and-contractor--do	13	14		
Railroad ballast--do	293	366	419	523
Agriculture--do	1,917	2,665	2,095	2,870
Cement--do	2,225	1,720	2,037	1,582
Other[2]--do	337	874	227	715
Total commercial--do	17,814	22,334	18,323	22,756
Total Government-and-contractor--do	13	14		
Total--do	17,827	22,348	18,323	22,756
Grand total--do	18,414	36,761	18,852	34,256

[1] 145 pounds per cubic foot.
[2] Includes limestone for filter beds (1959), flux, chemicals, whiting or whiting substitutes, asphalt filler, fertilizer, dust for coal mines, mineral food, mineral wool, and other miscellaneous uses.

TABLE 6.—Calcareous marl production

Year	Number of producers	Short tons	Value	Year	Number of producers	Short tons	Value
1951-55 (average)	5	17,706	$12,521	1958	7	60,196	$39,637
1956	8	99,561	65,755	1959	8	62,589	39,979
1957	7	103,452	65,011	1960	9	56,406	38,389

Although an increasing proportion was sold as rough architectural block, most of the material was cut and finished by companies operat-

ing the quarries. In the Bloomington-Bedford area, 15 independent finishing mills reported purchases of dimension limestone for fabrication into dressed stone. Leading producers were Indiana Limestone Co. and Ingalls Stone Co. (Bedford), and Bloomington Limestone Corp., Empire Stone Co., B. G. Hoadley Quarries, Inc., Victor Oolitic Stone Co., and Woolery Stone Co., Inc. (Bloomington).

Sandstone was produced in four counties. It was quarried by Indiana Sandstone Co., Inc., and Springs Valley Sandstone Co., in Lawrence County; Hinkle Sandstone Co., in Monroe County; and French Lick Sandstone Co., Inc., in Orange County. General Refractories Co. quarried a quartz conglomerate in Martin County. Except for the latter, who used the material for silica brick, sandstone quarried was cut and dressed and used for building purposes.

A bulletin [5] was published on the petrography of Indiana sandstones.

Members of the Indiana Geological Survey worked with the American Society for Testing Materials on revised specifications for building limestone. The Survey also assisted the Public Building Service of the General Services Administration in resolving a difficulty caused by use of the term "crystalline limestone" in dimension stone specifications.

Calcareous marl was produced from pits in seven counties. The leading output came from Kosciusko, Steuben, and La Porte Counties. The material was sold for soil conditioning.

Roofing granules were produced from natural slag in the Hammond area by H. B. Reed & Co., Inc.

Sulfur.—Byproduct sulfur was recovered from crude petroleum at the Whiting refinery, American Oil Co. (Standard Oil Co. of Indiana). The Mathieson-Fluor process was used.

MINERAL FUELS

Coal.—Production of coal increased 5 percent, but value of shipments rose at a lower rate because of a decrease in price from $4.05 per ton in 1959 to $3.96. Eighty-one mines were operated, one more than in 1959. Of these, 47 were strip mines and 34 were underground mines.

More than 11.5 million tons of coal was mechanically cleaned at 18 plants.

About 11.4 million tons of coal was moved by rail; 1.9 million tons by water; and 1.5 million tons by truck. Most of the remainder, was moved by tramways and conveyor.

Mining-equipment sales to Indiana coal producers included four continuous mining machines and seven gathering and haulage conveyors. More than 98 percent of the coal mined underground was mechanically loaded.

Electric utility companies were the leading consumers of Indiana coal, using 62 percent of the output. Coal was mined in 15 counties of which five (Greene, Pike, Sullivan, Vigo, and Warrick) supplied more than 82 percent of the State total.

[5] Greenberg, S. S., Petrography of Indiana Sandstones Collected for High-Silica Evaluation: Indiana Geol. Survey Bull. 17, 1960, 64 pp.

The Federal Bureau of Mines reported on a study [6] of devices and methods used for testing and splicing 160-volt and 440-volt cables and for providing ground-fault protection for 440-volt circuits as developed and used by the electrical staff of the Tecumseh open-pit coal mine, Boonville.

TABLE 7.—Bituminous coal production in 1960, 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	1	9	2,000	877,525	879,525	$3,599,599
Daviess		1		38,771	38,771	200,768
Dubois	4		18,050		18,050	72,378
Fountain		2		11,290	11,290	71,797
Gibson	2		465,631		465,631	(1)
Greene	2	7	10,954	1,447,012	1,457,966	6,109,160
Knox	2	1	631,912	260,352	892,264	3,493,990
Owen		2		(1)	(1)	(1)
Parke		2		20,026	20,026	115,785
Pike	4	6	75,448	1,832,455	1,907,903	7,368,017
Spencer	1	3	6,037	(1)	(1)	(1)
Sullivan	5	2	1,206,842	182,818	1,389,660	5,763,771
Vermillion	2	1	18,916	4,458	23,374	139,817
Vigo	4	2	2,005,022	453,066	2,458,088	10,793,401
Warrick	7	9	312,090	5,267,833	5,579,923	20,027,551
Undistributed				389,361	395,398	3,814,143
Total	34	47	4,752,902	10,784,967	15,537,869	61,570,177

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.

The Indiana Geological Survey published [7] a bulletin on the geology and coal deposits of the Brazil Quadrangle, Ind. A map published [8] by the Federal Geological Survey on the geology and coal deposits of the Switz City Quadrangle in Greene County was based on results of a study made in cooperation with the Indiana Geological Survey.

Coke.—During the year five coke plants with 2,191 ovens were operated. More than 11 million tons of coal was used to produce 8 million tons of coke valued at $156 million. Output was up 16 percent over 1959. Indiana ranked third in coke production in the Nation, led only by Pennsylvania and Ohio. Most metallurgical coal used in the coke oven was shipped from Kentucky and West Virginia. None was mined in Indiana. Most of the coke produced was used in Lake County blast furnaces.

Peat.—Peat was produced from bogs in Benton, Blackford, Grant, Hamilton, Marion, and Wells Counties.

[6] Douglas, Sandford J., Testing and Splicing Electric Cables and Frame-Grounding Pit Equipment, Tecumseh Coal-Strip Mine, Boonville, Ind.: Bureau of Mines Inf. Circ. 7995, 1960, 17 pp.

[7] Hutchison, H. C., Geology and Coal Deposits of the Brazil Quadrangle, Indiana: Indiana Geol. Survey Bull. 16, 1960, 50 pp.

[8] Kottlowski, F. E., Geology and Coal Deposits of the Switz City Quadrangle, Greene County, Indiana: Geol. Survey Coal Inventory Map C41.

TABLE 8.—Peat production

Year	Number of producers	Short tons	Value	Year	Number of producers	Short tons	Value
1951–55 (average)	7	8,765	$44,544	1958	5	12,106	$144,974
1956	7	11,383	78,594	1959	5	15,393	202,094
1957	8	13,805	129,750	1960	7	27,486	290,338

Petroleum and Natural Gas.—The Indiana Geological Survey reported that drilling for oil and gas continued to increase. The number of wells drilled increased 18 percent over 1959, to 1,072. Of these, 678 were development wells, and 394 were wildcats, resulting in 288 oil producers, 9 gas producers, 15 new pools, 17 extensions, 2 additional pay zones, and 741 dry holes. In addition, 61 secondary wells were reported, consisting of 44 water-input or disposal wells, 12 oil wells, 4 gas storage wells, and 1 dry hole.

Approximately one-third of the oil was produced by secondary-recovery methods, about the same proportion as in 1959.

Exploratory drilling was carried on in 42 counties, but nine-tenths of the activity was concentrated in 10 counties in the southwestern part of the State. The greatest activity was in Spencer County (354 wells), Gibson (194 wells), Pike (108 wells), Posey (86 wells), Dubois (53 wells), Vanderburgh (49 wells), Warrick (35 wells), Knox (34 wells), Sullivan (33 wells), and Perry (23 wells).

Testing of the Ste. Genevieve limestone and sandstone formations of the Chester series accounted for an estimated 62 percent of the total drilling.

Extensions to pools were more significant than new-pool discoveries. A well drilled in Posey County extended the productive area of the Heusler Consolidated pool. Twelve new wells produced from the Waltersburg sandstone. Also in Posey County, six new wells in the Point pool extension produced from sandstone in the Aux Vases formation.

Eleven sub-Trenton tests wells were drilled in Delaware, Jennings, Owen, Wabash, Steuben, Jay, and Vermillion Counties.

The proved oil reserves on December 31 was 66,251,000 barrels, and the total liquid hydrocarbon reserve was 66,361,000 barrels.[9]

Samples and pertinent data from 5,476 Indiana wells and 360 out-of-State wells were listed in a publication.[10] These samples, together with those received since July 1958, were available for use by industrial representatives. Petroleum exploration maps, showing location and total depth of wells drilled in 17 counties in northern Indiana, and a map showing pipelines in Indiana also were issued.[11]

[9] American Gas Association, American Petroleum Institute, and Canadian Petroleum Association, 1960, Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas: Vol. 15, 27 pp.

[10] Dawson, T. A., Sullivan, D. M., and Hreha, A. J., Catalogue of Well Samples of the Indiana Geological Survey: Directory 8, 1960, 458 pp.

[11] Walker, F. H., and Rarick, R. D., 1960, Map of Indiana Showing Crude Oil, Natural Gas, and Refined Petroleum Products Pipelines: Misc. Map 6.

TABLE 9.—Crude petroleum production in 1960, by major fields [1]

Name	Field			Number of wells		Production (barrels)
	Year discovered	Area (acres)	Location, county	Producing	Completed	
Carbon Consolidated	1940	1,670	Posey	135	1	349,795
College Consolidated	1941	660	do	54	0	122,012
Grandview	1940	420	Spencer	41	3	108,760
Griffin Consolidated	1938	6,630	Gibson and Posey	679	18	2,333,398
Heusler Consolidated	1938	1,570	Posey and Vanderburgh	103	19	162,831
Inman East	1943	360	Posey	31	0	156,793
Lamott Consolidated	1941	1,270	do	96	1	172,090
Mt. Vernon Consolidated	1941	1,970	do	164	0	310,977
Mumford Hills	1940	830	Gibson and Posey	65	5	153,316
Owensville Consolidated	1940	1,630	Gibson	142	0	272,663
Owensville North Consolidated	1943	1,830	do	104	(2)	108,548
Patoka East Consolidated	1947	970	do	69	5	164,046
Plainville	1950	350	Daviess	55	1	111,380
Powells Lake Consolidated	1955	430	Posey	43	0	410,336
Spencer Consolidated	1948	520	do	53	0	147,050
Springfield Consolidated	1946	2,300	do	275	(2)	1,023,281
Union-Bowman (New) Consolidated	1941	14,130	Gibson, Knox, and Pike	604	52	1,218,521
Union Chapel East	1959	280	Spencer	22	15	362,974
Vaughn Consolidated	1941	610	Vanderburgh	52	(2)	103,150
Vienna	1933	320	do	48	0	157,875
Welborn Consolidated	1941	1,520	Posey	134	2	192,763
Wheatonville Consolidated	1949	1,310	Gibson	115	22	243,721
Undistributed				1,928	928	3,667,840
Total				5,012	1,072	12,054,120

[1] Petroleum Section, Indiana Geological Survey.
[2] Correct entry not determinable

METALS

Aluminum.—The smelter of the Aluminum Company of America at Yankeetown in Warrick County began limited production in June. At the company's Lafayette works, a large extrusion press was put into production, and at the Richmond works, construction of additional facilities for the production of closures was begun.

Pig Iron and Steel.—Plants in East Chicago (Inland Steel Co. and Youngstown Sheet and Tube Co.) and Gary (United States Steel Corp.) produced pig iron and steel. The American Iron and Steel Institute reported that production was substantially higher than in 1959, when the plants were shut down because of a 116-day steel strike. Output of pig iron was 8.4 million tons, up 27 percent; steel production increased to 13.8 million tons, up 19 percent over 1959. More than 6.2 million tons of coke and 3.1 million tons of limestone and dolomite were used at integrated steel plants.

United States Steel Corp. announced plans for new metallurgical laboratory facilities at the Gary Steel Works. An administration building, a control-center office building, and metallurgical testing and ceramics development laboratories were included. Plans also were announced for constructing a third galvanized steel sheet production line at the Gary plant, scheduled for operation in mid-1962.

REVIEW BY COUNTIES

Production valued at more than $1 million, excepting petroleum and natural gas, was reported from each of 22 counties. About 57

percent of the State total came from nine counties: Clark, Lake, Lawrence, Monroe, Pike, Putnam, Sullivan, Vigo, and Warrick. These nine counties produced all or most of the State's output of cement, coal, and dimension stone. Mineral output was reported from all counties except Brown, Franklin, Jefferson, Ohio, and Union.

Although petroleum and natural gas production and value is included in the State total, a breakdown by counties is not available. Major production came from Gibson and Posey Counties, which would rank high if petroleum data could be included on a county basis.

Adams.—Limestone, clay, and sand and gravel were produced. The stone was quarried and crushed for use as road material and for agricultural purposes by John W. Karch Stone Co. near Bryant and by Meshberger Bros. Stone Corp. near Linngrove and Pleasant Mills.

Clay mined near Decatur by Krick Tyndall Co. of Findlay, Ohio, was used in manufacturing heavy clay products. A pit near Geneva yielded sand and gravel for building purposes.

TABLE 10.—Value of mineral production in Indiana, by counties [1 2]

County	1959	1960	Mineral production in 1960 in order of value [2]
Adams	$525,033	$492,908	Stone, clays, sand and gravel.
Allen	1,620,574	1,950,074	Stone, sand and gravel.
Bartholomew	(3)	533,000	Stone.
Benton	(3)	(3)	Peat, sand and gravel.
Blackford	(3)	(3)	Stone, peat, clays.
Boone	87,418	78,770	Sand and gravel.
Carroll	(3)	(3)	Stone, sand and gravel.
Cass	(3)	509,956	Do.
Clark	(3)	(3)	Cement, stone, sand and gravel, clays.
Clay	4,309,485	4,079,841	Coal, clays, sand and gravel.
Clinton	(3)	(3)	Sand and gravel.
Crawford	(3)	(3)	Stone.
Daviess	(3)	260,719	Coal, sand and gravel.
Dearborn	200,720	(3)	Sand and gravel.
Decatur	(3)	(3)	Stone.
DeKalb	159,584	204,095	Sand and gravel.
Delaware	(3)	1,144,547	Stone, sand and gravel.
Dubois	138,317	124,701	Coal, clays, sand and gravel.
Elkhart	333,268	336,508	Sand and gravel, stone (marl).
Fayette	213,899	(3)	Sand and gravel.
Floyd	----------	(3)	Do.
Fountain	591,749	581,356	Sand and gravel, clays, coal.
Fulton	302,995	40,813	Sand and gravel, stone (marl).
Gibson	2,284,581	(3)	Coal, sand and gravel.
Grant	(3)	(3)	Stone, sand and gravel, peat.
Greene	6,840,450	6,321,180	Coal, clays, sand and gravel.
Hamilton	1,242,134	1,107,558	Stone, sand and gravel, peat.
Hancock	57,463	35,530	Sand and gravel.
Harrison	243,787	256,530	Stone.
Hendricks	(3)	(3)	Sand and gravel.
Henry	137,067	(3)	Do.
Howard	(3)	361,812	Stone.
Huntington	(3)	(3)	Stone, sand and gravel, clays.
Jackson	323,137	204,472	Clays, sand and gravel.
Jasper	(3)	(3)	Stone, sand and gravel.
Jay	92,440	93,400	Do.
Jefferson	12,463	----------	
Jennings	388,921	389,021	Stone, gem stones.
Johnson	----------	169,970	Sand and gravel.
Knox	4,713,794	3,758,855	Coal, sand and gravel.
Kosciusko	452,256	521,545	Sand and gravel, stone (marl).
Lagrange	(3)	413,634	Do.
Lake	(3)	(3)	Cement, sand and gravel, clays.
LaPorte	581,856	(3)	Sand and gravel, stone (marl).
Lawrence	12,632,531	10,065,896	Stone, cement.
Madison	1,102,805	1,024,732	Stone, sand and gravel.
Marion	(3)	3,699,515	Sand and gravel, peat.
Marshall	106,462	66,100	Sand and gravel.
Martin	2,907,913	3,186,735	Gypsum, clays, stone.
Miami	430,338	333,929	Sand and gravel.

See footnotes at end of table.

TABLE 10.—Value of mineral production in Indiana, by counties [1] [2]—Continued

County	1959	1960	Mineral production in 1960 in order of value [2]
Monroe	$8,818,858	$8,399,353	Stone.
Montgomery	118,819	65,713	Clays, sand and gravel.
Morgan	1,144,412	1,232,880	Clays, sand and gravel, stone.
Newton	(3)	(3)	Stone, sand and gravel.
Noble	(3)	(3)	Sand and gravel, stone (marl).
Orange	844,560	654,245	Stone, abrasives (whetstones).
Owen	1,923,598	2,263,324	Coal, stone, sand and gravel, clays.
Parke	351,206	399,484	Clays, sand and gravel, coal.
Perry	(3)	(3)	Stone, clays.
Pike	7,906,260	7,368,017	Coal.
Porter	407,203	309,950	Sand and gravel, clays.
Posey	(3)	75,594	Sand and gravel.
Pulaski	(3)	(3)	Stone, clays, sand and gravel.
Putnam	(3)	(3)	Cement, stone, clays, sand and gravel.
Randolph	256,884	316,742	Stone, sand and gravel.
Ripley	462,299	442,609	Stone.
Rush	(3)	(3)	Stone, sand and gravel.
St. Joseph	722,473	633,948	Sand and gravel.
Scott	(3)	819,396	Stone.
Shelby	832,685	877,287	Stone, sand and gravel.
Spencer	387,773	(3)	Coal, sand and gravel.
Starke	31,991	33,409	Sand and gravel.
Steuben	114,130	208,869	Sand and gravel, stone (marl).
Sullivan	3,934,949	6,105,515	Coal, sand and gravel, stone.
Switzerland	80,500	(3)	Stone, sand and gravel.
Tippecanoe	(3)	(3)	Sand and gravel.
Tipton	----------	(3)	Do.
Vanderburgh	(3)	(3)	Clays, stone.
Vermillion	720,503	680,694	Sand and gravel, clays, coal.
Vigo	12,273,811	11,556,826	Coal, sand and gravel, clays.
Wabash	125,911	133,485	Stone, sand and gravel.
Warren	(3)	608,913	Sand and gravel.
Warrick	18,139,473	20,311,551	Coal, stone, sand and gravel.
Washington	(3)	225,000	Stone.
Wayne	619,891	804,612	Sand and gravel, stone.
Wells	(3)	(3)	Stone, peat, sand and gravel.
White	325,200	424,600	Stone.
Whitley	(3)	(3)	Sand and gravel.
Undistributed	105,567,454	102,268,073	
Total [4]	206,359,000	206,882,000	

[1] Brown, Franklin, Ohio, and Union Counties did not report production.
[2] Natural gas and petroleum production not available by counties. Value included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Total adjusted to eliminate duplicating value of clays and stone.

Allen.—May Stone & Sand, Inc., produced limestone and sand and gravel near Ft. Wayne. The limestone quarry, nearly 300 feet deep, was one of the deepest manmade excavations in Indiana. The material was crushed and sold for flux, concrete aggregate and roadstone, and agstone.

The Klopfenstein Tile Works at Grabill was idle and consequently did not operate its clay pit. The Bolyard Tile Co. at Monroeville also remained shut down during the year.

In addition to May Stone & Sand, Inc., sand and gravel pits and processing plants were operated by Paul C. Brudi Stone & Gravel Co., Ft. Wayne; Irving Gravel Co., Inc., Harlan; and W. W. Gravel Co., Inc., Roanoke. Building and road materials were produced.

Bartholomew.—Meshberger Stone Co., Inc., operated a limestone quarry and crushing plant near Columbus. The output was used for agriculture and road construction. The Driftwood Gravel Co., Inc., which formerly operated a pit and processing plant in the Columbus area, moved to a site near Edinburg in adjoining Johnson County.

Benton.—Moss peat was mined from a pit near Otterbein by Millburn Peat Co., Inc., of Chicago. The material was sold for horticultural purposes and soil conditioning.

Road gravel was produced from a pit near Fowler by Mt. Gilboa Gravel Co.

Blackford.—Inman Tile Co. mined clay near Hartford City for its own use. J & K Stone Co. of Muncie operated the Montpelier quarry and crushed the output for road use.

Hartford Peat and Gravel Co. produced reed and sedge peat from a bog near Hartford City.

Carroll.—Delphi Limestone Co. produced roadstone and agricultural limestone at its quarry and plant near Delphi. Sand and gravel for road use and building construction was produced near Cutler and Flora.

Cass.—Limestone was quarried and crushed near Keeport by France Stone Co. of Toledo, Ohio, and at Logansport by Cass County Stone Co. Most of the output was used as roadstone and agstone, although some fluxstone and railroad ballast were produced.

Sand and gravel for building use and fill was mined near Monticello.

Plans for constructing a cement plant at Logansport were announced by Louisville Cement Co.

Clark.—Louisville Cement Co. manufactured portland and masonry cements at Speed. It produced clay and limestone for its own use and sold limestone for riprap and roadstone.

Limestone was quarried and crushed at plants near Jeffersonville (Atkins Stone Co.), Sellersburg (Sellersburg Stone Co.), and Utica (Louisville Sand and Gravel Co.). Although some agstone was produced, the material was used mostly for road construction and maintenance.

Sand and gravel was mined in the Jeffersonville-Utica area and was used principally for building and road purposes.

Clay.—Coal was produced from nine strip mines and one underground mine. During the year, Brown Coal Co. abandoned its strip mine near Centerpoint; Dellacca Coal Co. abandoned its strip mine at Carbon; G & F Coal Corp. acquired the Lone Star Coal Co. strip mine at Brazil. The largest production was reported from the Chinook mine of Ayrshire Collieries Corp.

Fire clay and miscellaneous clay were mined and sold or used for manufacturing vitrified sewer pipe, art pottery, building brick, floor and wall tile, refractories, and heavy clay products.

Gravel pits near Poland and Carbon were operated for road material and fill.

Crawford.—Limestone was quarried and crushed at Marengo by Hy-Rock Products Co. and at Eckerty by Mulzer Bros. Most of the material was sold for use as roadstone and concrete aggregate.

Decatur.—Four limestone quarries and crushing plants were operated. Harris City Stone Corp., Greensburg, and New Point Stone Co., Batesville, reported the largest output. Most of the material was used for road construction and agricultural purposes.

Delaware.—In the Muncie area, materials for building and road construction were obtained from two limestone quarries and four sand and gravel pits. J & K Stone Co. and Muncie Stone & Lime Co. crushed stone for concrete aggregate and roadstone.

Dubois.—Fire clay and miscellaneous clays were mined at two sites near Huntingburg and used in manufacturing stoneware, fire brick, and building brick.

Production of coal was reported from four underground mines.

Sand and gravel was produced near Jasper.

Elkhart.—E. M. Ulmer & Son produced marl near Etna Green. It was used for soil conditioning.

Sand and gravel, mined at five places in the Goshen-Elkhart area, was used for building, paving, and fill.

Fountain.—Two strip coal mines were operated at Kingman and Wernick. The Kingman mine of Morgan Coal Co. was abandoned in April.

Clay was mined and used for manufacturing building brick and as a filler in plastics.

Sand and gravel pits near Covington and Kingman yielded building and paving materials and railroad ballast.

Fulton.—Marl was produced from a pit near Kewanna. In the Rochester area, building and road materials were obtained from four sand and gravel pits.

Gibson.—Princeton Mining Co. from the Kings Station mine and Somerville Coal Co. from the Somerville mine, mined coal underground.

Sand and gravel was mined in three places.

The county was a major producer of petroleum. Fields in Gibson County and adjoining Posey County supplied more than half the State output.

Grant.—A bog near Jonesboro yielded peat.

The Pipe Creek Stone Co. produced flagging, riprap, fluxstone, roadstone, railroad ballast, and agricultural limestone at a quarry near Sweetser.

Two sand and gravel pits in the Marion area produced material for building and paving.

Greene.—Seven strip and two underground coal mines were operated. The Airline, Linton, and Friar-Tuck strip mines were the leading producers. In September the Linton mine was abandoned. Ayrshire Collieries acquired the Friar-Tuck mine from Sherwood-Templeton Coal Co. during the year.

Clay for building brick was mined near Bloomfield, and fire clay was mined near Switz City.

Sand and gravel was produced near Bloomfield.

Hamilton.—Limestone was quarried and crushed near Noblesville by Stony Creek Stone Co., Inc. Nearly all the material was used in road construction.

Sand and gravel was produced at five places. Peat was produced from two bogs near Noblesville.

Harrison.—Two quarries near Corydon (Corydon Crushed Stone & Lime Co. and Mathes Stone Quarry) produced roadstone and agstone. Davis Crushed Stone and Lime Co. at DePauw produced poultry grit, railroad ballast, road material, and agricultural limestone.

Howard.—Yeoman Stone Co., Kokomo, produced house veneer and flagging as well as crushed stone used for concrete aggregate, roadstone, and agricultural purposes.

Huntington.—Draintile was manufactured from clay mined near Huntington at the plants of Majenica Tile Co. and Simpson Clay Works. Erie Stone Co., Toledo, Ohio, operated a quarry and plant at Huntington and produced fluxstone, roadstone, agstone, railroad ballast, and material for mineral wool.

Sand and gravel was mined near Andrews.

Jackson.—Three clay pits yielded material used in manufacturing cement, building brick, and heavy clay products.

Sand and gravel was mined at two places and used for building and paving.

Jasper.—In the Rensselaer area, a limestone quarry operated by W. C. Babcock Construction Co., Inc., produced road material and agricultural limestone. The Rensselaer Gravel Co. produced building and paving material.

Jay.—Rockledge Products, Inc., operated a limestone quarry and crushing plant at Portland and produced roadstone, concrete aggregate, and agricultural limestone. Paving sand was obtained from a pit near Bluffton.

Jennings.—Paul Frank, Inc., operated a limestone quarry and plant at North Vernon and produced roadstone and agstone. Calcite specimens were collected as gem material from a quarry near North Vernon.

Knox.—Coal was produced from one strip mine and two underground mines. Largest production was reported from the Enoco mine. Sand and gravel was obtained from three pits near Vincennes.

Kosciusko.—Output from four marl pits was sold for soil conditioning.

More than 750,000 tons of sand and gravel was mined from six pits. Most of the material was used for building and road construction. Engine sand, railroad ballast, and fill also were produced.

Lagrange.—Marl was obtained from a pit near Howe. Sand and gravel was produced at five places.

Lake.—Portland and masonry cements were manufactured at Buffington by Universal Atlas Cement Co. Raw materials included blast furnace slag from local steel mills and limestone brought by boat from Michigan quarries. Building brick was made from clay mined near Munster by National Brick Co. of Chicago.

Industrial sand (molding and engine) was produced from a pit near Gary by John N. Bos Sand Co., Chicago.

Byproduct sulfur was recovered from crude petroleum by the Standard Oil Co. at the Whiting plant.

Roofing granules were manufactured from slag by H. B. Reed Co., Inc., at Hammond. Vulcan Materials Co., Chicago, produced railroad ballast, lightweight aggregate, and other products from slag at its plant in Gary.

Pig iron and steel were produced by U. S. Steel Corp., Gary, and by Inland Steel Co. and Youngstown Sheet and Tube Co., East Chicago.

Plants of General Refractories Co., Inc. (Gary), and Harbison-Walker Refractories Co. (East Chicago and Hammond) produced refractories.

La Porte.—Engine, glass, and molding sands, and building and paving materials were obtained from pits in the county. A deposit near Walkerton yielded marl for soil conditioning.

Lawrence.—Dimension limestone was quarried and milled in the Bedford area by Indiana Limestone Co., Inc., and Ingalls Stone Co. Finished building stone also was produced at several mills from rough blocks purchased from local quarries.

Bedford Ground Limestone Co. produced finely ground limestone from spalls purchased from stone mills. The output was sold for mineral food, glass manufacture, and agricultural use.

Crushed limestone was produced by Mitchell Crushed Stone Co., Inc., Oolitic Ground Limestone Co., and Ralph Rogers & Co., Inc. It was sold for flux, concrete aggregate, roadstone, railroad ballast, and agstone.

Sandstone was quarried and milled for use as building stone by Indiana Sandstone Co., Inc., Bedford, and Springs Valley Sandstone Co., West Baden, which operated a quarry at Williams.

Portland and masonry cements were produced at Mitchell by Lehigh Portland Cement Co., which quarried limestone for its own use. Two new kilns replaced 10 smaller kilns, which were part of the original plant. Plant capacity had been substantially increased by modernization.

Madison.—Standard Materials Co. of Indianapolis quarried limestone at Lapel. Most of the material was sold for concrete aggregate and roadstone. Some agstone and riprap were produced.

Building and paving materials were obtained from five sand and gravel operations.

Marion.—Reed and sedge and humus peat were obtained from a bog near Indianapolis and sold for soil conditioning and horticultural purposes by Peat-Moss, Inc., of Indianapolis.

Indiana Cut Stone Corp. produced building stone from purchased rough blocks.

Several sand and gravel pits and plants were operated in metropolitan Indianapolis and supplied materials for building, road construction, and fill. The county had the largest production of sand and gravel in the State.

Martin.—Brick was manufactured from clay mined near Loogootee by Loogootee Clay Products Corp.

A deposit of quartz conglomerate near Shoals was mined and crushed by General Refractories Co. The processed material was shipped to company plants for use in refractories.

Gypsum was mined and processed at two plants near Shoals, one operated by National Gypsum Co. and the other, by United States Gypsum Co. A variety of gypsum products was manufactured.

Monroe.—Dimension limestone and sandstone and crushed limestone were produced. Limestone quarries and mills were operated by Ed. Bennett Stone Co., Bloomington Limestone Corp., Empire Stone Co., B. G. Hoadley Quarries, Inc., Independent Limestone Co., Indiana Limestone Co., Ingalls Stone Co., McNeely Quarries, Inc., Midwest Quarries Co., Inc., Victor Oolitic Stone Co., Texas Quarries, Inc., and Woolery Stone Co., Inc. Most of the quarry operators milled the stone at plants in the Bloomington and Bedford areas. Several independent

mills fabricated purchased stone. A fine-grinding plant was operated in Bloomington by Indiana Calcium Corp., using spalls purchased from the stone mills. The output was used for a variety of industrial purposes.

Bloomington Crushed Stone Co. operated a quarry and plant near Bloomington and produced roadstone, concrete aggregate, and agstone.

Hinkle Sandstone Co. quarried and milled sandstone for building use.

Montgomery.—Brick and heavy clay products were manufactured from clay mined near Crawfordsville. Road materials were obtained from four sand and gravel pits.

Morgan.—Building brick, heavy clay products, and lightweight aggregate were manufactured at plants in Brooklyn and Martinsville from clay mined in the area.

Limestone quarried and crushed near Lewisville was used for concrete aggregate, roadstone, and agricultural purposes.

Sand and gravel was mined at three pits near Martinsville and used for fill and building and paving.

Newton.—Newton County Stone Co., Inc., produced riprap, agstone, roadstone, and concrete aggregate from a quarry and plant east of Kentland.

Building and paving material was obtained from a sand and gravel pit near Morocco.

Noble.—Marl was obtained from a pit near Albion. It was used for soil conditioning. Four sand and gravel pits were mined for building and paving materials.

Orange.—Dimension sandstone for building use was milled at French Lick by French Lick Sandstone Co., Inc. The material came from quarries in Lawrence and Martin Counties. Crushed limestone for agricultural use and road material was produced at Paoli by Calcar Quarries, Inc., at French Lick by William Cave Stone Co., and at Orleans by Radcliff & Berry, Inc.

Whetstones were quarried and milled near Orleans by Hindostan Whetstone Co.

Owen.—Coal was produced from two strip mines (Old Glory and Burcham).

Fire clay from the Old Glory mine was sold to manufacturers of architectural terra cotta and building brick.

Ingalls Stone Co. operated the Romona limestone quarry and milled the output at its plant in Bedford. Crushed and broken limestone was produced at Spencer by Dunn Limestone Co., Inc., and Clayton Winders & Sons', and near Freedom, by Gordon and Shepard Stone Co. It was used for riprap, flux, railroad ballast, roadstone, and agstone. American Aggregates Corp. purchased the Dunn Limestone Co., Inc., late in the year.

Sand and gravel was produced at three places.

Parke.—Coal was mined from two strip mines (Maple Grove and Turner). Fire clay also was obtained from the Turner mine and sold to firebrick manufacturers. Cayuga Brick & Tile Co., Bloomingdale, mined clay for use in manufacturing heavy clay products.

Sand and gravel was obtained from pits near Montezuma and Rockville for road use.

Perry.—Mulzer Bros. quarried and crushed limestone at Derby for road and agricultural use. U.S. Brick Co. mined clay near Tell City for its own use.

Pike.—Six strip and four underground coal mines were operated. The largest output came from the Enos strip mine. The No. 2 mine at Petersburg was acquired by the Day Coal Co. from the Miley Coal Co. The latter company continued to operate the No. 1 mine. Both were underground operations.

Porter.—Clay was mined near Chesterton by Charles Lorenz & Son and Chas. H. Schrock. The material was sold for pottery and blast furnace use.

Sand for industrial use (engine, fire, and molding) was produced at four places. Road gravel was mined near Valparaiso.

Pulaski.—Francesville Drain Tile Corp., Francesville, mined clay for its own use. Francesville Stone Co., Inc., quarried and crushed limestone in the same area for road materials and agricultural use. A sand and gravel pit operated near Monterey.

Putnam.—Portland and masonry cements were produced at Limedale by Lone Star Cement Co. The company mined clay and quarried limestone in the same area for its own use.

Indiana State Farm, Greencastle, mined clay for making brick and heavy clay products and quarried limestone for road material and agricultural use.

Limestone quarries and crushing plants were operated by Midway Stone Co., Inc., at Cloverdale, Ohio, Indiana Stone Corp. at Greencastle, Russellville Stone Co. at Russellville, and Standard Materials Corp. at Manhattan.

Sand and gravel was produced near Brazil.

Randolph.—Portland Stone Co. operated the Hiatt Quarry near Albany, and the H. & R. Stone Co. operated a quarry near Ridgeville. Most of the material was used for roads, although some riprap and agstone was produced. Sand and gravel was obtained from three sites.

Ripley.—Four limestone quarries and crushing plants were operated by Cord Stone Co., Paul Frank, Inc., New Point Stone Co., and South Eastern Materials Corp. Most of the material was used for road construction and agricultural purposes.

Rush.—McCorkle Stone Co. and Rush County Stone Co., both of Milroy, operated limestone quarries and crushing plants.

Road material and fill was produced from three gravel pits.

Scott.—The Scott County Stone Co. operated the Hardy quarry and Standard Materials Corp. operated the Hanover quarry. The crushed stone was used mostly for concrete aggregate and road material.

Shelby.—Limestone was quarried and crushed at Norristown (Cave Stone Co., Inc.) and St. Paul (St. Paul Quarries, Inc.). Riprap, flux, railroad ballast, roadstone, agstone, and asphalt filler were produced. The Meshberger Stone Co. purchased the Cave Stone Co. during the second half of the year. Building and road material was obtained from sand and gravel pits near Shelbyville.

Spencer.—Three strip mines and one underground coal mine were operated. Largest production came from the Mulzer Bros. strip mine.

Molding sand was mined from the Hardy Sand Co. pit near Richland.

Steuben.—Marl, obtained from pits near Fremont and Hudson, was sold for soil improvement.

Sand and gravel was mined at five sites.

Sullivan.—Two strip mines and five underground mines produced coal. Output was substantially larger than in 1959 as two mines, which had been opened in 1959 (Hoosier Gem and Thunderbird), went into full production.

Limestone was quarried and crushed near Freelandsville by Kixmiller Brothers.

Sand and gravel was produced at three places.

Switzerland.—Tri-County Stone Co. operated a quarry and plant near Cross Plains and produced road material, agstone, and asphalt filler. The county highway department produced road gravel.

Vanderburgh.—Mulzer Bros. operated the West Franklin quarry and produced concrete aggregate and roadstone.

Standard Brick & Tile Co., Evansville, mined clay for use in making building brick.

Bedford-Nugent Co., Evansville, processed sand and gravel dredged from the Ohio River.

Vermillion.—Coal was produced from one strip mine and two underground mines.

Arketex Ceramic Corp. mined fire clay from the Dana pit near Newport for use in manufacturing glazed structural tile. Cayuga Brick Corp. mined clay for its own use near Cayuga.

Sand and gravel pits and processing plants were operated near Cayuga by Materials Service Corp. of Chicago, and near Clinton by Standard Materials Corp. of Indianapolis. Building and paving material was produced.

Vigo.—Coal production was reported from two strip mines and four underground mines. The Green Valley, Viking, and Chieftain mines were the principal producers. Terre Haute Vitrified Brick Works, Inc., mined clay near West Terre Haute for its own use.

Sand and gravel was produced from five places.

Wabash.—Mill Creek Stone Co. operated a limestone quarry and plant near Rich Valley. The output was sold for road material and filler. Sand and gravel production was reported by seven operators.

Warrick.—Coal production was reported from seven underground mines and eight strip mines. Warrick County output was the largest in the State. The underground mine of Simpson Mining Co. near Boonville was destroyed by fire in February. In July, Barnett Coal Co. opened a strip mine that was acquired by B & B Coal Co. in October. In February, R. & K. Coal Co. acquired the underground mine near Boonville formerly operated by Rudolph Oil & Coal Co.

At Boonville limestone quarries were operated by Lemmons & Co., Inc., and Sunlight Coal Co. Road material was produced.

Midwest Sand & Gravel dredged sand and gravel from the Ohio River.

Washington.—Hoosier Lime & Stone Co., Salem, operated a limestone quarry and produced concrete aggregate and roadstone.

Wayne.—DeBolt Stone Quarry, Richmond, produced riprap, road material, and agstone. Sand and gravel was produced at five sites. The Richmond plant of American Aggregates Corp. reported the largest output.

Wells.—Limestone was quarried and crushed near Bluffton by Erie Stone Co. of Toledo, Ohio, and Heller Stone Co., Inc. Agstone, road material, railroad ballast, flux, and riprap were produced. Road gravel was produced near Bluffton. Moss peat was obtained from a bog near Warren.

White.—Monon Crushed Stone Co., Inc., operated a limestone quarry and plant near Monon. Agstone, railroad ballast, concrete aggregate, and roadstone were produced.

The Mineral Industry of Iowa

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Iowa.

By Samuel A. Gustavson [1]

MINERAL production for Iowa was valued at $95 million in 1960, compared with $88.6 million in 1959. Rising demand for road construction materials, especially sand and gravel and crushed limestone, more than offset slight declines in requirements for building construction. Sales of cement and gypsum, although slightly less than in 1959, were still near record highs.

Iowa's principal commercial minerals are limestone, sand and gravel, gypsum, coal, clays, and peat. Some interest has been shown during recent years in lead and zinc deposits near Dubuque, Dubuque County, and in low-grade iron ore deposits in northeastern Iowa, but there has been no production.

Employment and Injuries.—Data on cement, coal, and gypsum was based on 100 percent coverage for each industry. Labor data was partially estimated for the clay, sand and gravel, and stone industries.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Portland cement production and sales each declined about 5 percent from 1959, but still were exceeded only by 1958 and 1959. The average unit value per barrel, f.o.b. mill, increased to nearly $3.50 in 1960, compared with $3.31 in 1959, and total value of cement sales for 1960 was the highest on record, exceeding 1959 by about 1 percent. There was no change in the number of cement plants operating—two in Cerro Gordo County, two in Polk County, and one in Scott County. Total capacity of these plants remained unchanged at slightly over 14 million barrels per year.

Plants operated a total of 27 kilns. Three companies used a wet process, and two used a dry process. Raw materials used in the manufacture of the cement were limestone and clay or shale from local sources, gypsum purchased chiefly from producers operating in Webster County, and purchased iron ore or mill scale. Types I and II, general-use and moderate-heat cements, and type III, high-early-strength and air-entrained cement, were produced at all plants. The market area for sale of cement was chiefly in Iowa and Minnesota, followed by Illinois, Wisconsin, North Dakota, South Dakota, and

[1] Chief, Minneapolis Field Office, Division of Mineral Resources, Bureau of Mines, Minneapolis, Minn.

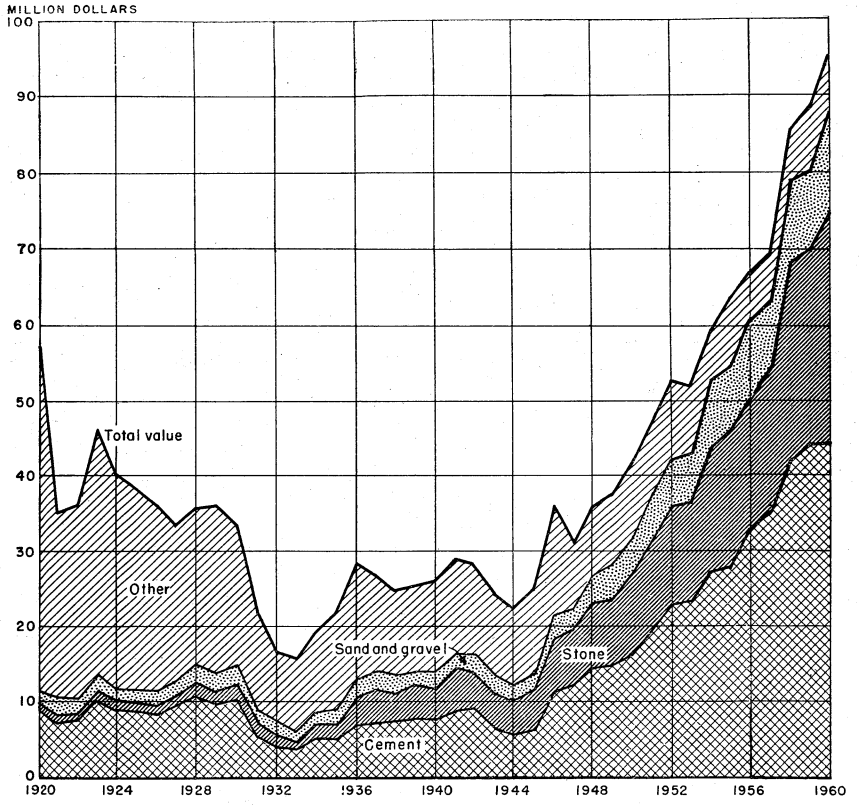

FIGURE 1.—Value of cement, stone, and sand and gravel, and total value of mineral production in Iowa, 1920–60.

Nebraska. Sales as reported by the companies were: 15 percent to building material dealers; 16 percent to concrete product manufacturers; 47 percent to ready-mixed concrete companies; 17 percent to highway contractors; 4 percent to other contractors; and 1 percent to miscellaneous. Most of the cement was shipped by railroad, chiefly in bulk; a relatively small percentage was shipped by truck; and no movement by boat was reported. A total of 283 million kilowatt-hours of electrical energy was consumed—118 million company-produced and 165 million purchased.

Masonry cement was produced at four of the five plants. Sales were down 12 percent from the previous year. The marketing area was similar to that for portland cement. Average value per barrel was $4.54 compared with $4.19 in 1959.

Clays.—Shale and clay deposits were mined for use chiefly in the manufacture of building brick, building tile, draintile, cement, mortar mix, and lightweight aggregate. Some fire clay was used in the manufacture of refractories. The Carter-Waters Corp. of Kansas City, Mo., mined shale from a pit near Centerville, Appanoose County, for the manufacture of lightweight aggregate. The company used a kiln

TABLE 1.—Mineral production in Iowa [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland thousand 376-pound barrels	12,701	$42,081	12,105	$42,330
Masonry do	469	1,967	412	1,874
Clays thousand short tons	911	1,168	1,022	1,346
Coal do	1,180	4,214	1,068	3,845
Gypsum do	1,318	5,587	1,283	5,428
Sand and gravel do	13,484	11,658	14,692	13,516
Stone do	20,501	25,759	23,185	30,321
Value of items that cannot be disclosed: Other nonmetals		520		660
Total Iowa [2]		88,557		95,030

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Total adjusted to eliminate duplicating value of clays and stone.

for bloating the shale. Clay used in the manufacture of cement declined, paralleling the slight drop in quantity of cement produced. Of the total clay production, about 48 percent was used in cement manufacture, compared with 52 percent in 1959. Clay used in the production of heavy clay products increased 6 percent over 1959 and, together with the new production for manufacture of lightweight aggregate, effected a 12-percent increase in production of clays for the State.

As in 1959, shale or clay pits were operated by 26 firms in 16 counties. The only changes were the sale late in 1959 of Iowa Clay Products Co. Centerville operation, in Appanoose County, to Adel Clay Prod-

TABLE 2.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of lost-time injuries		Total number days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1959:							
Cement [4]	1,069	2,736,112		3	(5)	1.10	(5)
Clays [6]	395	744,882		22	729	29.53	979
Coal	526	840,160	2	29	13,178	36.90	15,685
Gypsum	481	1,195,546		5	129	4.18	108
Limestone [7]	1,505	3,107,374	1	97	(5)	31.54	(5)
Sand and gravel	982	1,964,378		36	915	18.33	466
1960: [8]							
Cement [4]	1,083	2,658,584		3	(5)	1.13	(5)
Clays [6]	350	732,973	1	17	6,374	24.56	8,696
Coal	470	762,541		23	7,920	30.16	10,386
Gypsum	461	961,669					
Limestone [7]	1,340	3,016,234		84	(5)	27.85	(5)
Sand and gravel	1,247	2,396,664	2	25	13,365	11.29	5,589

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Data not available.
[6] Excludes pits producing clay used exclusively in manufacturing cement. Includes clay processing plants operated in conjunction with the mine.
[7] Excludes quarries producing limestone used exclusively in manufacturing cement and lime.
[8] Preliminary figures.

ucts Co., which company also had a pit in Dallas County, and the new operation of Carter-Waters Corp.

Gypsum.—Iowa was one of the Nation's major producers of gypsum and gypsum products. In 1960 the State was third in output, following Michigan and California. Production for Iowa in 1960 was about 3 percent less than in 1959, reflecting the slight downward trend in building construction. For many years, all of Iowa's production was from mines in Webster County; however, in 1960 the United States Gypsum Co. started production from a new mine near Sperry in Des Moines County and had nearly completed a plant for processing and manufacturing gypsum products including wallboard and lath.

In Webster County four companies mined and manufactured gypsum products. The products included base-coat plaster, ready-mixed and other special-use plasters, gypsum lath, wallboard, sheathing, tile, other preformed items, and pulverized gypsum. The major markets were in the building industry, in cement manufacture (as a retarder), for agricultural use, and as a filler. Other miscellaneous markets were in the glass and pottery industry, for art moldings, and for medical and dental purposes. The estimated unit value of crude gypsum was $4.23 per ton, about the same as in 1959 when it was calculated at $4.24.

Lime.—Linwood Stone Products Co., Inc., was the only producer of quicklime and hydrated lime in the State. Production was slightly greater than in 1959. The company with quarry and plant in Buffalo, Scott County, mined high-calcium limestone, and burned it in a rotary kiln. Fuels used were natural gas and bituminous coal. The products were sold chiefly to the chemical and construction industries.

Perlite.—Perlite was expanded in plants operated by each of the four gypsum producers, in Webster County. Virtually all of the output was used in lightweight plaster, chiefly premixed. Crude perlite was purchased from Colorado and Nevada. The chief market area was in Iowa and adjacent States.

Sand and Gravel.—There was a 9-percent increase in tonnage and a 16-percent increase in value of sand and gravel produced in Iowa in 1960. Production of building and paving sand increased, paralleling the continued high demand for use in highway work. Average unit values for these uses was only slightly higher than they were 4 years before, in spite of rising labor and material costs, chiefly because of competition in bidding for work. Industrial uses of sand produced in the State included molding sand, blast sand, engine sand, and filter sand. Sales of molding sand, with a relatively high unit value, were considerably greater than in 1959. Molding sand was produced chiefly from a friable sandstone deposit in Clayton County. Sales of sand for other industrial uses declined slightly. The chief industrial use for gravel was in filter beds. Sales were less than in 1959.

About 10 percent of the commercial sand and gravel production was sold as unwashed pit-run material. Commercially produced sand and gravel was transported chiefly by truck. Slightly under 8 percent was hauled by rail, and less than 1 percent, about 30,000 tons, was hauled by water. All noncommercial sand and gravel was hauled by truck.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,494	$2,226	2,888	$2,547
Paving [1]	1,376	1,254	1,642	1,528
Railroad ballast	(2)	(2)	19	14
Fill	352	190	671	321
Other	13	8	(2)	(2)
Undistributed [3]	121	286	168	560
Total	4,356	3,964	5,388	4,970
Gravel:				
Building	1,416	2,026	1,567	2,403
Paving [1]	5,314	4,206	4,784	4,346
Fill	204	127	342	153
Undistributed [4]	86	236	83	133
Total	7,020	6,595	6,776	7,035
Total sand and gravel	11,376	10,559	12,164	12,005
Government-and-contractor operations:				
Sand:				
Paving [1]	185	78	37	15
Fill			17	6
Total	185	78	54	21
Gravel:				
Paving [1]	1,883	1,009	2,437	1,470
Fill	41	12	8	2
Other			29	18
Total	1,924	1,021	2,474	1,490
Total sand and gravel	2,109	1,099	2,528	1,511
All operations:				
Sand	4,540	4,042	5,442	4,991
Gravel	8,944	7,616	9,250	8,525
Total	13,484	11,658	14,692	13,516

[1] Includes materials used in bridges, culverts, etc.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes molding, blast, engine, filter, and other industrial sands.
[4] Includes railroad ballast and other gravel.

The 10 leading producers, several operating in two or more areas of the State, in alphabetical order were:

Acme Fuel & Material Co., Muscatine.
Concrete Materials & Construction Division, American Marietta Co., Cedar Rapids.
Coon Valley Gravel Co., Des Moines.
Hallett Construction Co., Crosby, Minn.
Keefner Sand & Gravel Co., Des Moines.
L. G. Everist, Inc., Sioux Falls, S. Dak.
Maudlin Construction Co., Webster City.
Northern Gravel Co., Muscatine.
Van Dusseldorf Construction Co., Colfax.
Weaver Construction Co., Iowa Falls.

Stone.—Limestone was Iowa's chief mineral raw material, both in tonnage and value. In 1960 production exceeded the previous record year, 1958. Greater use of crushed limestone for highway con-

struction and as a concrete aggregate was responsible for the overall increase. These two uses accounted for more than 75 percent of the State's limestone output. Other important markets for limestone declined in 1960. Cement manufacturers used 14 percent of the total; their demand was 7 percent less than in 1959. Soil conditioning and other agricultural uses accounted for about 6 percent of the total limestone production; consumption was 5 percent less than in 1959.

Dimension limestone was produced only in Jones County. The chief use in 1960 was for curbing. Other uses included veneer on houses and flagging for walks or patios.

Several plants in the State specialized in sized limestone and would supply stone to meet most size specifications.

The 10 leading producers of limestone, listed alphabetically, were:

B. L. Anderson, Inc., Cedar Rapids.
Concrete Materials & Construction Division, American Marietta Co., Cedar Rapids.
Dewey Portland Cement Co., Kansas City, Mo.
E. I. Sargent Quarries, Inc., Des Moines.
Kaser Construction Co., Des Moines.
Marquette Cement Manufacturing Co., Chicago, Ill.
Missouri Valley Limestone Co., Oakland.
Penn-Dixie Cement Corp., Nazareth, Pa.
Schildberg Construction Co., Greenfield.
Weaver Construction Co., Iowa Falls.

TABLE 4.—Limestone sold and used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1959		1960	
	Quantity	Value	Quantity	Value
Commercial:				
Agriculture	1,359	$1,878	1,296	$1,787
Dimension	8	74	5	80
Fluxing stone	34	52	(1)	(1)
Riprap	156	200	254	380
Concrete aggregate, roadstone, etc	14,354	18,091	17,498	23,007
Cement	3,602	3,795	3,345	3,621
Other [2]	256	956	217	939
Total	19,769	25,046	22,615	29,814
Government-and-contractor, all uses (concrete aggregate, roadstone, riprap)	732	713	570	507
Grand total	20,501	25,759	23,185	30,321

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes limestone for poultry grit (1959), asphalt filler, fertilizer, dust for coal mines, filter beds, mineral food, lime, railroad ballast, stone sand, and other uses.

MINERAL FUELS

Coal.—Production and value of coal were about 9 percent less than in 1959. Coal mining had recorded a declining trend in Iowa for a number of years, as use of natural gas and other petroleum products replaced coal for heating homes and for industrial purposes. Most of the coal produced was consumed in electric-power plants or for heating public buildings. Virtually all Iowa coal was consumed within the State; about two-thirds was hauled to destination by rail and one-third by truck. In 1960 three fewer underground and seven

TABLE 5.—Bituminous coal production in 1960, by counties

(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Appanoose	8		58,224		58,224	$318,388
Keokuk		1		2,987	2,987	14,935
Lucas	1	1	33,690	8,000	41,690	169,136
Mahaska	1	7	1,028	253,778	254,806	835,832
Marion	3	10	78,222	514,322	592,544	2,074,028
Monroe	5	2	25,968	26,839	52,807	173,840
Van Buren		1		15,869	15,869	83,312
Wapello	1	3	2,968	46,129	49,097	175,749
Total	19	25	200,100	867,924	1,068,024	3,845,220

fewer strip mines operated than in 1959. The average price per ton of coal was $3.60 in 1960, compared with $3.57 in 1959. Prices ranged from $5.73 to $2.75 per ton.

In the 19 operating underground coal mines, there were 17 cutting machines, 22 hand-held or post-mounted drills, and 1 mobile drill used in mining; and 41 animals (horses or mules), 6 electric locomotives, and 4 shuttle cars used in haulage. The 25 strip mines used 28 power shovels of less than 3 cubic yards capacity, 1 power shovel with a capacity between 3 and 5 cubic yards, 13 draglines with buckets of less than 3 cubic yards capacity, 12 draglines with 3- to 5-cubic-yard buckets, 1 dragline with a 6- to 12-cubic-yard bucket and 1 with a bucket of over 12 cubic yards; 38 bulldozers; 22 horizontal power drills; 11 vertical power drills; and 69 trucks. Of the total of 56 power shovels and draglines, 6 were electric, 2 diesel-electric, 38 diesel, and 10 gasoline-operated. Only 3 of the companies employed more that 20 men in their mining operations.

Peat.—Bogs in Worth and Winnebago Counties were operated by the Colby Pioneer Peat Co. and the Eli Colby Co. Both companies had processing plants at Hanlontown. Peat was sold both in bulk and packages.

REVIEW BY COUNTIES

Mineral production was reported from all counties except Davis, Ida, Iowa, Jefferson, Page, Ringgold, Union, and Wayne. Some sand and gravel or limestone may have been produced in these counties, as several companies reporting production of these materials did not submit a breakdown showing output by county of origin. Data covered production of 120 commercial and 29 noncommercial producers of sand and gravel and 91 commercial and 7 noncommercial producers of limestone. Estimates were made for a few nonreporting companies producing these commodities, based on previous reports and other sources of information—notably reports submitted by State, county, and municipal highway departments.

Appanoose.—The Carter-Waters Corp. built a plant, including a rotary kiln, and started production of lightweight aggregate from a shale deposit near Centerville. Adel Clay Products Co. purchased

TABLE 6.—Value of mineral production in Iowa, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Adair	(2)	(2)	Stone.
Adams	(2)	(2)	Do.
Allamakee	$82,869	$74,213	Stone, sand and gravel.
Appanoose	829,398	1,093,772	Stone, coal, clays.
Audubon	408	(2)	Sand and gravel.
Benton	52,075	(2)	Sand and gravel, stone, clays.
Black Hawk	815,737	1,094,044	Stone, sand and gravel.
Boone	190,810	(2)	Sand and gravel, clays.
Bremer	499,355	6,200	Sand and gravel, stone.
Buchanan	49,280	152,066	Stone, sand and gravel.
Buena Vista	53,721	205,574	Sand and gravel.
Butler	338,717	206,756	Sand and gravel, stone.
Calhoun	76,829	87,571	Sand and gravel.
Carroll	150,392	185,149	Do.
Cass	(2)	(2)	Stone, sand and gravel.
Cedar	(2)	502,764	Do.
Cerro Gordo	22,689,740	23,392,562	Cement, stone, clays, sand and gravel.
Cherokee	87,001	363,503	Sand and gravel.
Chickasaw	(2)	(2)	Stone, sand and gravel.
Clarke	(2)	(2)	Stone.
Clay	103,930	154,590	Sand and gravel.
Clayton	40,028	(2)	Sand and gravel, stone.
Clinton	(2)	(2)	Stone, sand and gravel.
Crawford	113,528	137,346	Sand and gravel.
Dallas	461,153	449,241	Sand and gravel, clays.
Decatur	(2)	(2)	Stone.
Delaware	382,010	383,504	Stone, sand and gravel.
Des Moines	311,820	529,746	Stone, gypsum, sand and gravel.
Dickinson	(2)	47,600	Sand and gravel.
Dubuque	424,532	473,416	Stone, sand and gravel.
Emmet	118,856	115,231	Sand and gravel.
Fayette	352,935	257,040	Stone, sand and gravel.
Floyd	328,024	399,570	Stone, clays, sand and gravel.
Franklin	478,202	335,626	Sand and gravel, stone, clays.
Fremont	(2)	(2)	Stone.
Greene	317,400	332,556	Sand and gravel.
Grundy	----------	(2)	Sand and gravel, stone.
Guthrie	(2)	(2)	Sand and gravel.
Hamilton	(2)	396,214	Stone, sand and gravel.
Hancock	241,065	337,475	Sand and gravel, stone.
Hardin	1,293,778	1,824,732	Stone, sand and gravel.
Harrison	446,600	456,600	Do.
Henry	(2)	(2)	Do.
Howard	149,123	152,747	Do.
Humboldt	336,690	336,144	Do.
Jackson	168,883	236,682	Do.
Jasper	(2)	(2)	Sand and gravel, stone.
Jefferson	(2)	----------	
Johnson	(2)	921,676	Stone, sand and gravel.
Jones	175,147	245,713	Do.
Keokuk	(2)	(2)	Stone, coal, clays.
Kossuth	(2)	(2)	Sand and gravel.
Lee	492,133	570,188	Stone, sand and gravel.
Linn	1,098,425	2,140,902	Do.
Louisa	(2)	(2)	Stone.
Lucas	184,982	169,136	Coal.
Lyon	77,137	99,872	Sand and gravel.
Madison	2,119,133	2,860,843	Stone, clays.
Mahaska	1,120,063	1,131,707	Coal, stone, clays.
Marion	2,805,852	2,817,706	Coal, stone, sand and gravel.
Marshall	(2)	(2)	Stone, sand and gravel.
Mills	(2)	(2)	Stone.
Mitchell	397,556	468,850	Stone, sand and gravel.
Monona	114,000	146,250	Sand and gravel.
Monroe	313,062	198,022	Coal, stone.
Montgomery	(2)	(2)	Stone.
Muscatine	1,100,311	917,828	Sand and gravel, stone.
O'Brien	209,543	147,143	Sand and gravel.
Osceola	(2)	(2)	Do.
Palo Alto	(2)	106,888	Do.
Plymouth	216,341	348,533	Do.
Pocahontas	(2)	(2)	Stone, sand and gravel.
Polk	14,434,737	14,296,416	Cement, sand and gravel, clays.
Pottawattamie	(2)	(2)	Stone.
Poweshiek	(2)	(2)	Do.
Sac	(2)	(2)	Sand and gravel.
Scott	13,163,584	13,247,437	Cement, stone, lime, clays, sand and gravel.
Shelby	----------	34,198	Sand and gravel.
Sioux	(2)	571,162	Sand and gravel, stone.
Story	475,742	(2)	Sand and gravel, stone, clays.

See footnotes at end of table.

TABLE 6.—Value of mineral production in Iowa, by counties—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Tama	(2)	$438,974	Stone, sand and gravel.
Taylor	(2)	(2)	Do.
Union	$5,978		
Van Buren	528,591	775,491	Stone, coal, sand and gravel.
Wapello	440,767	743,987	Sand and gravel, stone, coal, clays.
Warren	33,991	62,358	Sand and gravel, clays.
Washington	(2)	(2)	Stone.
Webster	6,320,862	6,295,150	Gypsum, stone, sand and gravel, clays.
Winnebago	(2)	72,802	Sand and gravel, peat.
Winneshiek	76,165	95,038	Sand and gravel, stone.
Woodbury	(2)	293,555	Sand and gravel.
Worth	51,360	581,906	Stone, sand and gravel, peat.
Wright	97,798	125,013	Sand and gravel.
Undistributed	14,916,450	13,674,532	
Total [3]	88,557,000	95,030,000	

[1] The following counties are not listed because no production was reported: Davis, Ida, Iowa, Page, Ringgold, and Wayne.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Total adjusted to eliminate duplicating value of clays and stone.

and operated the pit and plant of Iowa Clay Products Co., also at Centerville.

Bituminous coal was produced at eight underground mines—the largest operator was Sunshine Coal Co. Three companies reporting production in 1959 had no production for 1960. They were Big Five Coal Co., Monitor Coal Co., and Kirkville Coal Co. Kirkville Coal Co. was a strip-mining operation.

Three companies produced limestone for highway or agricultural use.

Benton.—Clay was produced by the Garrison Brick & Tile Works for manufacture of heavy clay products. Some sand and gravel and limestone were produced in the county.

Boone.—Clay for mortar mix and heavy clay products was produced by Grarok, Inc. Sand and gravel was produced for building and highway use by several companies.

Cerro Gordo.—Mineral products from Cerro Gordo County represented about 25 percent of the State total. Two cement companies, Lehigh Portland Cement Co. and Northwestern State Portland Cement Co., manufactured portland cement and mortar mix using locally produced clays and limestone. Clay was also mined by the Mason City Brick & Tile Co. for the manufacture of building tile and draintile.

Limestone was produced for highway construction by the Weaver Construction Co. and Welp & McCarten, Inc. Sand and gravel was produced, chiefly for building and highway use, by three companies.

Clayton.—Concrete Materials & Construction Co. mined a friable sandstone deposit on the Mississippi River about a mile south of the town of Clayton and processed the material chiefly for use as a molding sand.

Dallas.—Adel Clay Products Co., Redfield Brick & Tile Co., and United Brick & Tile Co. of Iowa all produced miscellaneous clay for the manufacture of building brick, building tile and draintile. Sand and gravel was produced by four companies, chiefly for building and road use.

Des Moines.—United States Gypsum Co. continued development of an underground gypsum mine near Sperry and construction of facilities for processing the gypsum, including a board plant. Some gypsum was produced in 1960. The processing plant was scheduled for operation in 1961.

Some sand and gravel and limestone, chiefly for highway use, also was produced in the county.

Floyd.—Miscellaneous clay was produced by the Rockford Brick & Tile Co. for the manufacture of heavy clay products. Five companies produced crushed limestone and one company produced sand and gravel—chiefly for use in highway work.

Franklin.—Sheffield Brick & Tile Co. produced clay for heavy clay products. Sand and gravel was produced by four companies and limestone by three companies. Limestone was used chiefly for road work. Some sand and gravel was sold for railroad ballast.

Hardin.—Limestone and sand and gravel primarily for building and paving purposes and valued at $1,825,000 was produced by seven sand and gravel operators and two limestone producers.

Keokuk.—Fire clay, chiefly for use in manufacturing heavy clay products, was mined by the Nelson Clay Products Co., formerly reported as John Nelson & Sons. Limestone was produced by the Kaser Construction Co. of Des Moines.

Coal was produced by the Nelson Coal Co. from a strip-mining operation.

Linn.—Over $2 million worth of limestone and sand and gravel was produced by four sand and gravel producers and four limestone producers.

Lucas.—One underground bituminous coal mine was operated by the Big Ben Coal Co. on a 72-inch seam. The Liberty Coal Co. operated a strip mine.

Madison.—Nearly $3 million worth of crushed limestone was quarried in the county and used chiefly by the Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. A substantial tonnage of crushed limestone also was produced for concrete aggregate and highway use. Marquette Cement Manufacturing Co. mined clay for use in its cement plant in Polk County.

Mahaska.—Bituminous coal was produced by seven companies operating strip mines and one operating an underground mine. The underground operation was by Lennie Coal Co. and was new during the year. Carbon Hill Coal Co., an operator in 1959, was idle in 1960. Angus Coal & Hauling Co. and Mich Coal Co. were the county's largest producers.

Miscellaneous clay for the manufacture of heavy clay products was produced by the Oskaloosa Clay Products Co. and What Cheer Clay Products Co. The latter company produced some material classed as fire clay.

Limestone for highway and agricultural purposes was also produced in the county.

Marion.—Most of the bituminous coal produced in the State came from mines in Marion County. Ten of the producers operated strip mines, and three operated underground mines. Largest producers included: Wilkinson Coal Co., Weldon Coal Co., Beard Coal Co.,

Lovilia Coal Co., and Jude Coal Co., Inc. Valley Coal Co. and Cedar Creek Coal Co., who produced in 1959, were idle in 1960.

Four companies operated limestone quarries producing stone for road and agricultural use, and four companies reported production of sand or gravel for building and road use.

Monroe.—Bituminous coal was produced from five underground mines and two strip pits. One underground mine and two strip pits operating the previous year were idle; they were the White Oak Coal Co., Prothero Coal Co., Inc., and South Iowa Coal Co. One new strip pit was operated by C. N. Knox Coal Co.

A small quantity of limestone was produced for highway and agricultural use.

Polk.—Polk County was second in value of minerals produced in the State. Two cement companies operating in the county were the Marquette Cement Manufacturing Co., and Penn-Dixie Cement Corp. Clay and limestone used by these two companies for cement manufacture were produced in Madison County.

Clay for the manufacture of building brick and tile was produced by the Des Moines Clay Co. and John Furman Contracting Co. Considerable sand is produced in the county, chiefly for building and road use. The percentage of gravel in the deposits was low, and gravel had to be shipped into the county.

Scott.—Dewey Portland Cement Co., with a plant near Davenport, was purchased by the American Marietta Co. The plant produced types I and II, general-use and moderate-heat cements, and type III, high-early-strength cement using clay and limestone from nearby company-owned sources.

Linwood Stone Products Co., Inc. produced quicklime and hydrated lime at its plant near Buffalo. It was the only lime producer in the State. The products were sold chiefly for chemical, metallurgical, or water treatment uses.

Limestone and sand and gravel were produced by several companies, chiefly for highway and building purposes.

Story.—Heavy-clay products were produced by the Nevada Brick & Tile Co. Sand and gravel and limestone for building and highway use were produced.

Van Buren.—Bituminous coal was produced from a strip mine by Laddsdale Coal Co., Inc.

An underground limestone quarry was operated by Douds Stone, Inc. The production was for highway construction, concrete aggregate, and agricultural use.

Some sand and gravel also was produced in the county.

Wapello.—One underground and three strip-mining operations produced bituminous coal during 1960. Airline Coal Co., New Tanning Coal Co., Inc., and South Iowa Coal Co. operated strip mines, and Aubrey Coal Co. operated an underground mine.

Clay for the manufacture of building brick and tile was produced by the Ottumwa Brick & Tile Co. Some limestone and sand and gravel were produced for highway or agricultural use.

Warren.—Building brick and tile were produced by the Carlisle Brick & Tile Co. and Goodwin Tile & Brick Co.

Sand and gravel for highway use was produced by Carlisle Sand & Gravel, Inc.

No production of coal was reported in the county during the year.

Webster.—Webster County was one of the leading sources of gypsum for the Nation. Four companies operating mines and processing facilities, each with board plants, were: Bestwall Gypsum Co., The Celotex Corp., National Gypsum Co., and United States Gypsum Co. Perlite was expanded by each of the companies for the manufacture of lightweight plasters. The mines were all open-pit operations.

Limestone was produced by Ft. Dodge Limestone Co., Inc. and the Northwest Limestone Co., both from underground operations.

Considerable building tile, draintile, and building brick was produced in the county. Producers included Johnston Clay Works, Inc., Kalo Brick & Tile Co., Lehigh Sewer Pipe & Tile Co., and Vincent Clay Products Co.

Winnebago and Worth Counties.—Peat was produced in these two counties by Eli Colby Co. and Colby Pioneer Peat Co.

The Mineral Industry of Kansas

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of Kansas.

By A. D. Hahn,[1] Edwin D. Goebel,[2] and Walter H. Schoewe[2]

MINERAL production in Kansas in 1960 was valued at $484 million. This brought the total value of minerals produced in the State since 1861 to approximately $9 billion. Output was reported from 100 of the State's 105 counties. Four counties, in which the value of the mineral production was $20 million or more, were in order of rank: Ellis, Barton, Russell, and Butler. The five principal minerals, in order of value, were petroleum, natural gas, cement, stone, and salt.

Employment and Injuries.—According to the Employment Security Division of the Kansas Department of Labor, the average annual employment in Kansas mining industries in 1960 was 16,900 persons—a decrease of about 8 percent from 1959. Average weekly earnings per person in the mining industries was $98.80 compared with $100.14 in 1959.

TABLE 1.—Mineral production in Kansas[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement[2]—thousand 376-pound barrels	10,405	$32,282	8,162	$26,373
Clays—thousand short tons	1,021	1,271	894	1,224
Coal—do	772	3,607	888	4,197
Helium—thousand cubic feet	21,643	343	21,696	350
Lead (recoverable content of ores, etc.)—short tons	481	111	781	183
Natural gas—million cubic feet	604,410	72,529	634,410	74,226
Natural gas liquids:				
Natural gasoline—thousand gallons	107,814	5,576	115,868	6,694
LP gases—do	124,874	6,658	127,270	6,343
Petroleum (crude)—thousand 42-gallon barrels	119,543	347,870	[3] 113,455	[3] 329,020
Salt—thousand short tons	1,123	13,670	1,213	14,109
Sand and gravel—do	11,334	7,937	9,710	6,808
Stone[4]—do	13,999	17,108	11,814	15,031
Zinc (recoverable content of ores, etc.)—short tons	1,017	234	2,117	546
Value of items that cannot be disclosed: Natural cement, gem stones, gypsum, pumice, stone (crushed sandstone)		2,012		1,436
Total Kansas[5]		[6] 508,077		483,958

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes natural cement, included with "Value of items that cannot be disclosed."
[3] Preliminary figure.
[4] Excludes certain stone included with "Value of items that cannot be disclosed."
[5] Total adjusted to eliminate duplication in the value of clays and stone.
[6] Revised figure.

[1] Mine examination and exploration engineer, Bureau of Mines, Bartlesville, Okla.
[2] Geologist, State Geological Survey of Kansas, University of Kansas, Lawrence, Kans.

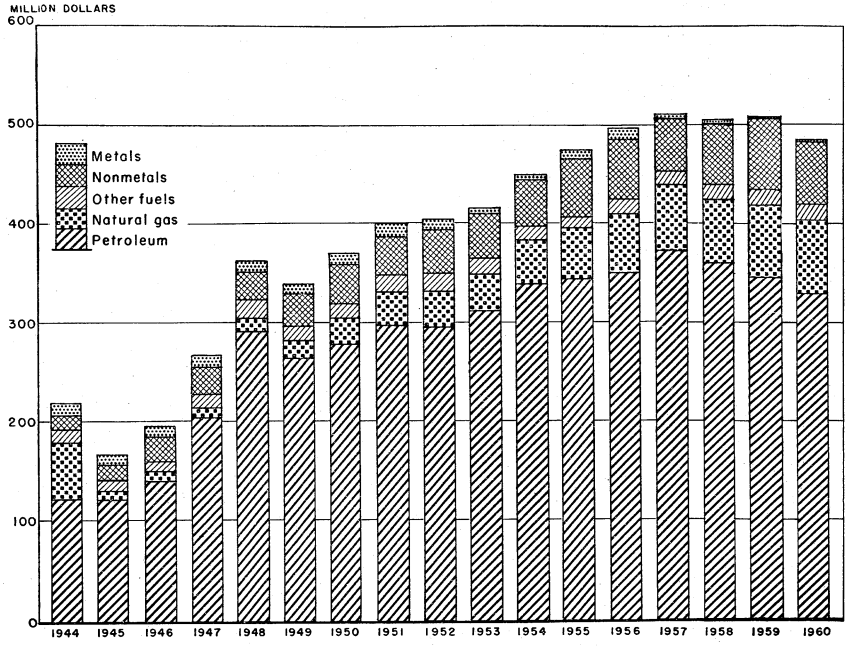

FIGURE 1.— Value of mineral production in Kansas 1944–60.

TABLE 2.—Average annual employment for selected mineral industries

Industry	1951–55 (average)	1956	1957	1958	1959	1960
Mining (total)	18,660	19,300	18,500	18,200	18,300	16,900
Metal mining	500	400	300	100	(1)	(1)
Mining and quarrying of nonmetallic metals, except fuels	1,710	2,000	1,800	1,800	1,900	1,700
Bituminous coal and lignite mining	570	400	400	300	300	300
Crude petroleum and natural gas	15,880	16,000	16,000	16,000	16,100	14,900
Petroleum refining and related industries	5,160	4,900	4,900	4,800	4,900	4,700

[1] Employment estimated to be less than 100.

Source: Employment Security Division, Kansas Department of Labor.

The Workmen's Compensation Commission, State of Kansas, reported that 893 on-the-job injuries occurred in the mining industries in 1960. Of these, 16 were fatal injuries, all in the crude petroleum and natural-gas-production industries.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of mineral fuels (petroleum, natural gas, natural gas liquids, coal, and helium) was about 87 percent of the value of all minerals produced.

Carbon Black.—Quantity and value of carbon black declined in 1960. The material was processed in furnace-type plants of Columbian

Carbon Co. at Hickok and United Carbon Co. at Ryus in Grant County. Both used liquid petroleum gases and natural gas as feed.

TABLE 3.—Carbon black production

	1957	1958	1959	1960
Carbon black produced, all grades....pounds..	76,419,500	75,443,750	91,644,160	87,302,185
Value at plants	$5,131,569	$5,271,143	$6,387,598	$5,621,236
Natural gas processed....thousand cubic feet..	5,667,958	3,262,970	4,624,404	3,914,444
LP gases and other liquid fuel processed barrels..	347,975	2,251,023	390,063	398,415

Source: Kansas Corporation Commission.

Coal.—Production of bituminous coal rose 15 percent compared with the 1959 output. The increase resulted from substitution of coal for natural gas fuel in an industrial plant in southeastern Kansas. Thirteen coal mines, each producing more than 1,000 tons of coal, were operated in Bourbon, Cherokee, Coffey, Crawford, and Osage Counties. Most of the coal was produced at 11 strip-mining operations; less than 0.5 percent of the total output came from 2 underground mines.

TABLE 4.—Coal production

(Excludes mines producing less than 1,000 short tons)

Year	Number of mines			Short tons (thousands)	Value (thousands)
	Underground	Strip	Total		
1951–55 (average)				1,564	$6,301
1956	4	15	19	884	3,856
1957	3	14	17	749	3,331
1958	2	13	15	823	3,711
1959	2	11	13	772	3,607
1960	2	11	13	888	4,197

Helium.—The Federal Bureau of Mines, at its Otis helium plant in Rush County, extracted 21.9 million cubic feet of helium gas from natural gas from the Ryan, Pawnee Rock, Behrens, Unruh, and Reichel fields—about 9 percent less than in 1959. Shipments totaled 21.7 million cubic feet valued at $349,754.

Natural Gas.—Kansas ranked fifth in marketed production of natural gas. Estimated proved recoverable gas reserve decreased slightly to 19,620 billion cubic feet. Natural gas was produced in 47 counties; the Kansas part of the Hugoton field, covering all or part of Finney, Grant, Hamilton, Haskell, Kearny, Morton, Seward, Stanton, and Stevens Counties, supplied 71 percent of the State output.

A comprehensive report containing information on existing and potential natural gas storage projects in the State was published in 1960.[3]

Important new gasfields discovered during the year and the initial production of the discovery wells, according to the Kansas Geological Survey, were as follows:

[3] Jewett, J. M., and Goebel, E. D., Underground Storage of Natural Gas in Kansas: State Geol. Survey of Kansas, Oil and Gas Investigations No. 21, 1960.

TABLE 5.—Marketed production of natural gas

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1951-55 (average)	426,820	$40,046	1958	561,816	$64,047
1956	526,091	59,448	1959	604,410	72,529
1957	586,690	66,883	1960	634,410	74,226

TABLE 6.—Marketed production of natural gas from the Kansas part of Hugoton gas area

Year	Million cubic feet	Year	Million cubic feet
1942	46,365	1952	375,082
1943	70,922	1953	387,635
1944	92,923	1954	346,732
1945	90,345	1955	394,257
1946	119,638	1956	381,875
1947	157,663	1957	396,889
1948	185,873	1958	349,264
1949	247,869	1959	404,764
1950	320,545	1960	451,820
1951	371,002		

Source: 1942-57 data from Goebel, E. D., Hilpman, P. L., Hornbaker, A. L., and Beene, D. L., Oil and Gas Developments in Kansas During 1957: State Geol. Survey of Kansas, Univ. of Kansas Pub. Bull. 133, 1958, p. 33. 1958-60 data from Conservation Division, Kansas Corporation Commission.

County:	*Pool or field*	*Initial production (thousand cubic feet per day)*
Chautauqua	Coach Lines	4,000
Clark	Sitka Northeast	4,700
Comanche	Nescatunga	3,680
Do	----do	4,750
Edwards	Fellsburg	4,740
Kingman	Freemyer	917
Do	Hurn	70
Do	Klaver	1,400
Marion	Dobbs	75
Do	Tajchman	1,200
Morton	Kinsler Southeast	7,000
Seward	Arkalon	3,500
Do	Arkalon East	1,750
Do	Evalyn	40,598
Do	Thirty-Three	902
Do	Thirty-Two	1,200
Stafford	Dillwin West	4,940
Stevens	Center	4,661

Natural Gas Liquids.—Production of natural gas liquids increased 4 percent in quantity and 7 percent in value. Of the total recovered, a little more than half was LP gases and the remainder was natural gasoline. As in 1959, 14 natural gasoline plants were active during the year. Proved recoverable reserves of natural gas liquids was estimated by the American Gas Association at 8,333 million gallons, an increase of 63 million gallons.

TABLE 7.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	114,868	$6,540	82,158	$2,767	197,026	$9,307
1956	105,482	5,928	90,287	3,843	195,769	9,771
1957	119,247	6,569	103,494	4,042	222,741	10,611
1958	110,293	6,229	115,175	5,193	225,468	11,422
1959	107,814	5,576	124,874	6,658	232,688	12,234
1960	115,868	6,694	127,270	6,343	243,138	13,037

TABLE 8.—Natural gasoline and LP gases produced in 1960

(Barrels)

Company	Location		Natural gasoline	Butane	Propane	LP gases	Total
	Nearest town	County					
Cities Service Oil Co	Burrton	Reno	15,021	14,168	9,696		38,885
Do	Wichita	Sedgwick	359	446	305		1,110
Colorado Interstate Gas Co	Lakin	Kearny	138,942				138,942
Hugoton Production Co	Ulysses	Grant	134,918	151,233	155,313		441,464
Independent Lease Management Co	Otis	Rush	10,146				10,146
Kansas Hydrocarbon Co	Cheney	Sedgwick	34,833	28,892	33,872		97,597
Kansas-Nebraska Natural Gas Co	Deerfield	Kearny	131,119		18,301	12,494	161,914
Northern Natural Gas Co	Holcomb	Finney	105,903				105,903
Do	Sublette	Haskell	282,147				282,147
Pan American Petroleum Corp	Ulysses	Grant	509,321	649,145	437,219		1,595,685
Panhandle Eastern Pipe Line Co.	Liberal	Seward	495,682	250,410	141,719		887,811
Skelly Oil Co	Medicine Lodge.	Barber	111,260		94,887		206,147
Socony Mobil Oil Co., Inc	Ulysses	Grant	233,838	64,199	100,644		398,681
Do	Spivey	Kingman	207,814	93,936	194,095		495,845

Source: Conservation Division, Kansas Corporation Commission.

TABLE 9.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	116,976	$314,472	1958	119,942	$359,826
1956	124,204	346,529	1959	119,543	347,870
1957	123,614	372,078	1960 [1]	113,455	329,020

[1] Preliminary figures.

Petroleum.—Petroleum was recovered in 79 counties; Kansas ranked sixth among the Nation's oil-producing States. The western part of the State was the most productive area. The five leading counties were Ellis, Barton, Russell, Butler, and Graham.

TABLE 10.—Crude petroleum production, indicated demand and stocks in 1960 by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Kansas (end of month)	Month	Production	Indicated demand	Stocks originating in Kansas (end of month)
January	9,733	10,030	9,431	September	9,451	9,364	8,420
February	8,942	8,901	9,472	October	9,610	8,990	9,040
March	9,255	9,605	9,122	November	9,569	9,256	9,353
April	9,395	7,946	10,571	December	9,668	9,623	9,398
May	9,550	9,813	10,308				
June	9,086	9,374	10,020	Total:			
July	9,410	10,174	9,256	1960 [1]	113,455	113,785	
August	9,786	10,709	8,333	1959	119,543	119,852	

[1] Preliminary figure.

Drilling and Exploration.—Exploratory and development drilling (excluding eastern Kansas) totaled 12.4 million feet,[4] about 13 percent less than in 1959. According to the Kansas Geological Survey, wells drilled totaled 4,479—1,307 less than 1959. Well completions in 1960 were classified as 1,556 oil wells, 159 gas wells, 68 oil and gas wells, 181 repressuring or disposal wells, and 543 dry wildcat wells. The proved crude oil reserve [5] decreased for the fifth consecutive year.

Pipelines.—No major pipelines were constructed. Mobil Oil Co. completed an addition to its Hickok gas plant at an approximate cost of $500,000. The addition housed two compressors with a combined delivery capacity of 100 million cubic feet of natural gas a day at a pressure of 300 pounds. The gas was delivered to Cities Service Gas Co.

Skelly Oil Co. announced plans to build a gasoline plant in Clark County, adjacent to the Kansas Power and Light Co. Minneola gas booster station.

TABLE 11.—Pipeline runs of crude petroleum by fields [1]

(Thousand barrels)

Field	1956	1957	1958	1959	1960
Bemis-Shutts	3,055	5,922	5,063	4,868	4,472
Bloomer	1,024	954	789	723	679
Browning	400	1,126	1,031	768	400
Burnett [2]	2,074				
Chase-Silica	3,482	4,271	3,260	3,689	3,219
Cooper	1,513	1,416	1,317	1,109	951
El Dorado	4,359	4,619	4,371	4,443	4,291
Fairport	986	1,061	1,065	1,040	991
Garfield	1,836	1,742	1,092	649	464
Geneseo-Edwards	2,784	2,236	1,812	1,680	1,565
Gladys	1,810	1,859	1,638	1,202	763
Gorham	1,515	1,501	1,499	1,421	1,311
Hall-Gurney	3,598	3,543	3,296	3,253	3,229
Iuka-Carmi	1,472	1,219	1,035	855	702
Kraft-Prusa	3,712	3,437	3,092	2,890	2,526
Marcotte	1,887	2,020	1,779	1,596	1,424
Morel	1,482	1,617	1,477	1,354	1,299

See footnotes at end of table.

[4] Oil and Gas Journal, vol. 59, No. 5, Jan. 30, 1961.
[5] American Petroleum Institute and American Gas Association, Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas: Vol. 15, Dec. 31, 1960, p. 11.

TABLE 11.—Pipeline runs of crude petroleum by fields[1]—Continued

(Thousand barrels)

Field	1956	1957	1958	1959	1960
Ray	1,225	1,314	1,353	1,363	1,289
Rhodes	947	1,074	664	403	305
Ritz-Canton	1,470	1,563	1,542	1,321	1,199
Seeley-Wick [3]	1,307	978	719	583	1,097
Silica South [4]	1,003				
Spivey-Grabs [5]	1,758	2,031	1,961	2,370	2,492
Trapp	4,241	3,728	3,366	3,120	2,752
Trico [6]	935	1,239	1,253	1,117	991
Unger	147	1,126	1,189	1,008	772
Welch-Bornholdt	1,106	1,240	1,216	932	878
Other fields	73,345	71,218	73,063	75,746	73,283
Total	124,467	124,054	119,942	119,503	113,344
Change in field stocks [7]				+40	+111
Total production [7]	124,204	123,614	119,942	119,543	[8] 113,455

[1] Based on Kansas Geological Survey data adjusted to Bureau of Mines total.
[2] Combined with Bemis-Shutts in 1957.
[3] Includes Hamilton in 1960.
[4] Combined with Chase-Silica in 1957.
[5] Formed by combination of Spivey field and Grabs field in 1956.
[6] Formed in 1956 by combination of Allphin, Allphin Northwest, Annon, Annon South, Basset, Laura Southeast, Marcotte South, Noah, Spaulding, White Southwest.
[7] Bureau of Mines data.
[8] Preliminary figure.

TABLE 12.—Wells drilled and crew-weeks spent in geophysical oil and gas prospecting in 1960

County	Wells drilled [1]							Geophysical prospecting [2] (crew-weeks)		
	Oil	Gas	Oil and gas	Service	Dry	Unclassified [3]	Total	Seismograph	Gravity meter	Magnetometer
Allen	15			9		286	310			
Anderson	1				1	13	15			
Barber	11	15	3		28		57	6		
Barton	87	2		5	93		187	4		
Bourbon	1					13	14			
Brown					1		1			
Butler	146			32	94	3	275	1		
Chase	7				4	5	16			
Chautauqua	9	2		1	7	66	85			
Cheyenne					8		8	1		
Clark		8	2		9		19	17		4
Clay					2		2			
Coffey						8	8			
Comanche		3	1		5		9	66		6
Cowley	90	1		3	91		185	2		
Crawford	33						33			
Decatur	7				17		24	26		
Dickinson	5			1	4		10			
Douglas						25	25			
Edwards	9	2	2		10		23	2		
Elk	1				1	7	9			
Ellis	101			2	107		210			
Ellsworth	7	1			6		14			
Finney	17	9		2	11		39	23		
Ford	1	1			12		14	4		
Franklin	7			12	1	38	58			
Geary					5		5			
Gove					1		1	2		
Graham	30				47		77	2		
Grant		6			2		8	23		
Gray					1		1			
Greeley					1		1	11		2
Greenwood	116	1		19	53	6	195			
Hamilton		5			3		8	1		7
Harper	17	3	4	1	22		47	14		
Harvey	22	1			14		37			

See footnotes at end of table.

TABLE 12.—Wells drilled and crew-weeks spent in geophysical oil and gas prospecting in 1960—Continued

County	Wells drilled [1]							Geophysical prospecting [2] (crew-weeks)		
	Oil	Gas	Oil and gas	Service	Dry	Unclassified [3]	Total	Seismograph	Gravity meter	Magnetometer
Haskell	26	7	5		12		50	9		
Hodgeman	13				33		46	15		
Jackson					5		5		1	
Jefferson					1		1			
Jewell					2		2			
Johnson					1	39	40			
Kearny		1			7		8	30		
Kingman	59	5	25	2	56		147			
Kiowa	5	3	1		11		20			
Labette	3					25	28			
Lane					2		2	5		
Leavenworth					2		2			
Lincoln					2		2	4		
Linn						5	5			
Logan					4		4	2		
Lyon	4				2		6			
Marion	176	12	10	15	80		293	6		
Marshall					9		9		3	
McPherson	45	1		2	38		86	3		
Meade	2	13	5		41		61			
Miami	5			6		54	65			
Mitchell					1		1	5		
Montgomery	13			21		51	85			
Morris	13			1	20		34			
Morton	3	21	4	1	13		42	15		1
Nemaha									12	
Neosho	32			16		210	258			
Ness	4			1	20		25	8		
Norton	15				8		23	1		
Osborne					1		1			
Ottawa					1		1			
Pawnee	1			1	11		13	3		
Phillips	20			1	6		27			
Pottawatomie					12		12		9	
Pratt	10	5			24		39	6		
Rawlins	29				9		38	14		
Reno	5	2			22		29	13		
Rice	39			1	32		72			
Riley	3				13		16			
Rooks	29				35		64	6		
Rush	4			3	21		28	10		
Russell	48	1		9	32		90			
Saline	23			2	9		34			
Scott	1				6		7	8		
Sedgwick	20			1	48		69	2		
Seward	2	14	5		10		31			
Sheridan					10		10			
Sherman					5		5	6		
Smith					2		2	3		
Stafford	81	5	1	1	92		180	2		
Stanton		2			6		8	28		2
Stevens		7			2		9	2		
Sumner	67			5	97		169	13		
Thomas					8		8			
Trego	6			1	7		14	4		
Wabaunsee	3				3		6			
Wallace					2		2	29		
Washington					1		1			
Wichita					4		4	10		
Wilson	3			2		30	35			
Woodson	4			2		69	75			
Total: 1960	1,556	159	68	181	1,562	953	4,479	467	17	22
1959	2,161	194	57	372	1,994	1,008	5,786	503.25	39.50	52.25

[1] State Geological Survey of Kansas, Oil and Gas Developments in Kansas During 1960: Bull. 155.
[2] International Oil Scouts Association, International Oil and Gas Development: Vol. 31, 1960 (excludes southeastern Kansas).
[3] Estimate.

TABLE 13.—Important new oilfields discovered in 1960

Field	County	Initial production (barrels per day)	Field	County	Initial production (barrels per day)
Cheyenne East	Barton	131	Hair	Ness	154
Redwing Southeast	do	135	Bull Creek	Rice	167
Edmonds Southwest	Butler	160	Rino [1]	do	137
Nescatunga	Comanche	298	LeSage	Rooks	241
Willroads	Ford	248	Driscoll West	Russell	141
Eubank South	Haskell	456	Dieter	Saline	192
Satanta North	do	144	Newby	Scott	129
Victory	do	192	Nellie East	Stafford	121
Wieland West	Hodgeman	130	Holman	Sumner	170
Rosedale Northeast	Kingman	280	Olive Branch	do	150

[1] Field extends into adjacent county.

Source: Kansas Geological Survey.

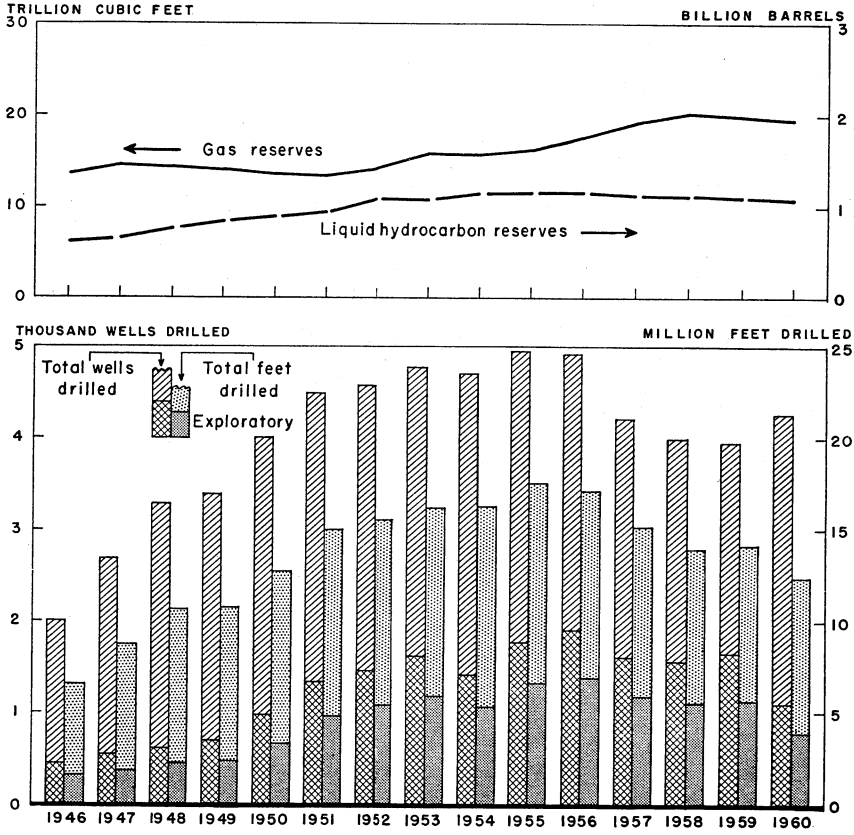

FIGURE 2.—Proved reserves and drilling in Kansas 1946–60.

Refineries.—Thirteen refineries operated, and processed 109,940,000 barrels of crude petroleum—equivalent to 97 percent of the year's production.

Petrochemicals.—Western Petrochemical Corp. completed expansion and modernization of its refinery at Chanute. The plant was equipped to produce a white, high-melting, microcrystalline wax.

NONMETALS

Cement.—Portland, natural, and masonry cements were manufactured. Portland cement plants in Allen, Neosho, Montgomery, Wilson, and Wyandotte Counties produced about 8 million barrels, 64 percent of total capacity. About 67 percent was produced by wet-process and 33 percent by dry-process. More than 77 percent of the portland cement was handled in bulk and the remainder was bagged; 95 percent of the shipments were made by rail. Natural cement was produced by Fort Scott Hydraulic Cement Co. in Bourbon County. Masonry cement was manufactured by all the cement plants.

Ash Grove Lime & Portland Cement Co. constructed new storage and materials-handling facilities at its Chanute plant. A total of 60,000 tons of limestone, shale, clinker, gypsum, and coal could be stored in the new building.

TABLE 14.—Portland cement production and shipments

(Thousand barrels and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1951-55 (average)	8,795	8,734	$22,039	1958	9,244	9,298	$28,843
1956	10,486	10,240	29,371	1959	10,177	10,056	30,889
1957	8,118	7,864	23,593	1960	7,996	7,877	25,194

TABLE 15.—Destination of shipments of all types of portland cement to Kansas from mills

Year	Kansas (thousand barrels)	Change, percent		Year	Kansas (thousand barrels)	Change, percent	
		In Kansas	In United States			In Kansas	In United States
1951-55 (average)	5,993			1958	6,397	+28	+6
1956	6,963	−4	+6	1959	6,889	+8	+9
1957	4,981	−28	−6	1960	5,070	−26	−7

Clays.—Clay sold or used was 13 percent less in quantity than in 1959. Output was used mostly in manufacturing brick, sewer and

TABLE 16.—Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951-55 (average)	685	$738	1958	875	$1,145
1956	977	1,169	1959	1,021	1,271
1957	909	1,240	1960	894	1,224

draintile, other structural shapes, lightweight aggregate, and cement. A small amount of fire clay was used by potteries.

Buildex, Inc., announced plans to build a shale-expanding plant near Marquette with a capacity of 125,000 cubic yards of lightweight aggregate a year.

Gypsum.—The tonnage and value of crude gypsum mined was less than in 1959. Gypsum-processing plants were operated by National Gypsum Co. near Medicine Lodge, Barber County, and Bestwall Gypsum Co. near Blue Rapids, Marshall County. A fire on August 11 destroyed the calcining, regrinding, and packing departments of the Bestwall Gypsum Co. plant on the Tuttle Creek Reservoir site. Construction on a new plant north of Blue Rapids was not advanced enough to begin calcining crude gypsum before December. Gypsum for the plant was obtained from an underground mine.

Lime.—Midwest Lime Co. completed construction of a vertical-kiln lime plant, 4 miles west of Bonner Springs, Leavenworth County, but did not produce commercial lime during 1960.

Pumice.—Crude pumice was mined in Lincoln and Norton Counties. The tonnage shipped was 26 percent less, and the value was 39 percent less than in 1959. The material was used in abrasives and cleaning powders.

Salt.—Salt output increased 8 percent over 1959. Evaporated and rock salt were produced at six plants in Barton, Ellsworth, Reno, and Rice Counties. Brine was pumped in Sedgwick County by Frontier Chemical Co., Division of Vulcan Materials, for use in manufacturing industrial inorganic chemicals.

A section of the Carey salt mines at Hutchinson was used by Underground Vault and Storage Co., Inc., for industrial storage. Temperature in the mine remains virtually constant, ranging from 68 to 70 degrees.

TABLE 17.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	362	$5,203	539	$2,333	901	$7,436
1956	461	6,352	543	2,815	1,004	9,167
1957	522	7,785	496	2,568	1,018	10,353
1958	373	7,962	[1] 700	[1] 3,386	1,073	11,348
1959	389	9,035	[1] 734	[1] 4,635	1,123	13,670
1960	402	9,358	[1] 811	[1] 4,751	1,213	14,109

[1] Brine included with rock salt (previously included with evaporated salt) to avoid disclosing individual company confidential data.

Sand and Gravel.—Sand and gravel production was reported in 66 counties. Both quantity and value were 14 percent less than in 1959. Virtually the entire output was dredged from flood plain or riverbed deposits and partly processed by dewatering on a 16-mesh screen. About half the tonnage pumped was discarded as silt and fine sand. The product was mostly coarse material containing no pebbles larger than 1 inch and was used for road construction and maintenance. Most plants also screened a few tons of building sand.

TABLE 18.—Sand and gravel sold or used by producers

(Thousand short and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1951-55 (average)	7,397	$5,313	1,777	$596	9,174	$5,909
1956	10,656	7,429	1,859	593	12,515	8,022
1957	7,680	5,425	1,665	750	9,345	6,175
1958	8,282	5,806	2,035	963	10,317	6,769
1959	9,257	6,661	2,077	1,276	11,334	7,937
1960	8,178	6,148	1,532	660	9,710	6,808

TABLE 19.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Limestone [1]		Sandstone		Miscellaneous stone		Total stone [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1956	11,654	$14,630	315	$516	1,465	$557	13,434	$15,703
1957	8,871	11,278	(2)	(2)	1,540	648	[3] 10,412	[3] 11,926
1958	11,495	14,653	(2)	(2)	929	383	[3] 12,424	[3] 15,036
1959	13,367	16,883	(2)	(2)	632	225	[3] 13,999	[3] 17,108
1960	11,446	14,899	[4] 1	[4] 12	367	120	[4] 11,814	[4] 15,031

[1] Includes diatomaceous marl and limestone for cement.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Excludes sandstone.
[4] Excludes crushed sandstone.

Stone.—Stone was quarried in 45 counties. Greatest activity was in Allen, Dickinson, Elk, Jewell, Neosho, Shawnee, Wilson, and Wyandotte Counties. These 8 counties furnished 48 percent of the total value of the stone produced in Kansas. The following classes of stone were produced: Crushed limestone in 43 counties, crushed sandstone in 4 counties, dimension limestone in 6 counties, dimension sandstone in 2 counties, and miscellaneous stone (chats) obtained from lead-zinc mill tailing in Cherokee County.

Diatomaceous marl was mined at an open pit in Wallace County. The tonnage and value of this production is included in the totals reported for stone in table 1.

METALS

The Kansas lead-zinc mining area is part of the Tri-State district, which also includes northeast Oklahoma and southwest Missouri. Lead-zinc mines remained idle during the year, although a small tonnage of mine-run ore was produced in gouging and cleanup operations. The recovered lead and zinc concentrates were obtained mostly by remilling selected mill tailing, accumulated throughout the years at several mills in the district. Further details on Tri-State lead-zinc mining are given in the Oklahoma chapter.

Smelters.—The Eagle-Picher Co. manufactured pigments and sulfuric acid at its lead smelter near Galena. Zinc- lead pigments were made by Ozark Smelting & Mining Co. in its plant at Coffeyville.

TABLE 20.—Mine production of lead and zinc, in terms of concentrate and recoverable metals [1]

Year	Mines producing	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content [2]			
						Lead		Zinc	
		Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1951–55 (average)	----	7,364	$1,420	43,835	$4,204	5,548	$1,724	23,324	$6,694
1956	41	10,130	1,955	53,142	4,688	7,635	2,397	28,665	7,854
1957	43	5,703	1,026	29,189	2,311	4,257	1,218	15,859	3,679
1958	25	1,828	242	8,210	499	1,299	304	4,421	902
1959	11	702	93	1,971	149	481	111	1,017	234
1960	4	1,411	129	4,162	314	781	183	2,117	546

[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.

Lead.—The tonnage of lead recovered increased 62 percent over that of 1959. Lead concentrates were produced at two custom mills, the Bird Dog mill of The Eagle-Picher Co. and the Robinson mill of Rea Lead & Zinc Co., and at the underground mill operated by Ora Black.

Zinc.—More than twice as much zinc concentrate was produced as in 1959. Concentrates were recovered in The Eagle-Picher Co. Bird Dog mill, Rea Lead & Zinc Co. Robinson mill, and Ora Black's mill.

REVIEW BY COUNTIES

Mineral production was reported in 100 of the State's 105 counties; no mineral production was reported in Brown, Lane, Mitchell, Ottawa, and Wichita Counties. Sixty counties reported mineral output valued at more than $1 million each, and the five principal producing counties—Ellis, Barton, Russell, Butler, and Graham—contributed 27 percent of the value of mineral production.

Allen.—Allen County led in output of cement. Portland and masonry cements were produced by Lehigh Portland Cement Co. at Iola and by The Monarch Cement Co. at Humboldt. Petroleum and natural gas were recovered. Clay for making heavy clay products was quarried by Humboldt Brick & Tile Co. and United Brick & Tile Co. Limestone was quarried and crushed for concrete aggregate, roadstone, and agricultural use.

Anderson.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agricultural use by Murray Limestone Products Co. and Hunt Rock Co. Petroleum was produced chiefly by secondary-recovery methods.

Atchison.—George W. Kerford Quarry Co., Ralph H. Bromley & Sons Quarry, and the U.S. Army Corps of Engineers produced crushed limestone for concrete aggregate, roadstone, and riprap.

Barber.—The county ranked sixth in natural gas and natural gas liquids output. Petroleum was obtained from 35 fields in the county, and natural gas liquids were recovered by Skelly Oil Co. at its Medicine Lodge plant. Crude and calcined gypsum was produced by

TABLE 21.—Value of mineral production in Kansas, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Allen	$12,715,480	$11,308,497	Cement, petroleum, stone, clays, natural gas.
Anderson	1,401,954	1,330,290	Petroleum, stone, sand and gravel.
Atchison	330,563	265,172	Stone, sand and gravel.
Barber	12,604,890	11,087,324	Natural gas, petroleum, gypsum, natural gas liquids, sand and gravel.
Barton	34,124,448	30,790,851	Petroleum, natural gas, clays, sand and gravel, salt.
Bourbon	748,742	597,955	Stone, cement, petroleum, coal.
Brown	479		
Butler	23,346,396	23,620,359	Petroleum, stone.
Chase	361,110	319,864	Petroleum, natural gas, sand and gravel.
Chautauqua	2,801,764	2,524,871	Petroleum, natural gas, stone.
Cherokee	2,844,568	3,613,059	Coal, zinc, lead, stone, clays, natural gas.
Cheyenne	58,234	54,243	Petroleum, sand and gravel.
Clark	1,432,055	1,354,617	Natural gas, petroleum, sand and gravel.
Clay	157,389	366,487	Sand and gravel, stone, petroleum.
Cloud	285,564	298,231	Clays, sand and gravel.
Coffey	356,573	346,837	Petroleum, stone, coal, natural gas.
Comanche	88,038	78,095	Petroleum, sand and gravel.
Cowley	12,200,199	11,395,368	Petroleum, natural gas, sand and gravel, stone.
Crawford	1,647,525	1,766,281	Coal, clays, petroleum, stone, natural gas.
Decatur	1,088,749	1,118,297	Petroleum.
Dickinson	1,328,866	1,259,819	Stone, sand and gravel, petroleum.
Doniphan	342,222	376,767	Stone.
Douglas	132,336	286,444	Petroleum, stone, sand and gravel.
Edwards	2,199,313	2,448,198	Natural gas, petroleum, sand and gravel.
Elk	1,554,427	1,386,555	Stone, petroleum, natural gas, sand and gravel.
Ellis	32,736,609	33,702,795	Petroleum, stone, sand and gravel.
Ellsworth	7,328,355	6,043,522	Petroleum, salt, natural gas, clays, sand and gravel.
Finney	8,986,222	7,300,054	Natural gas, petroleum, natural gas liquids, sand and gravel.
Ford	136,988	201,475	Sand and gravel, natural gas, petroleum.
Franklin	1,022,669	1,175,979	Petroleum, clays, stone, sand and gravel.
Geary	642,357	592,575	Stone, sand and gravel.
Gove	48,696	35,463	Petroleum, sand and gravel.
Graham	20,078,075	18,164,565	Petroleum.
Grant	16,216,904	16,585,459	Natural gas, natural gas liquids, petroleum, sand and gravel.
Gray	(2)	(2)	Sand and gravel.
Greeley		11,090	Do.
Greenwood	17,397,977	14,374,529	Petroleum, stone.
Hamilton	613,027	548,350	Natural gas, petroleum, sand and gravel.
Harper	4,068,141	4,183,034	Petroleum, natural gas, sand and gravel.
Harvey	1,155,338	1,993,847	Petroleum, natural gas.
Haskell	6,181,665	11,955,431	Petroleum, natural gas, natural gas liquids, sand and gravel.
Hodgeman	874,644	1,207,361	Petroleum.
Jackson	98,747	113,999	Stone, sand and gravel.
Jefferson	486,750	(2)	Stone.
Jewell	(2)	(2)	Do.
Johnson	1,011,902	236,029	Stone, petroleum, natural gas.
Kearny	9,250,781	8,777,671	Natural gas, natural gas liquids, petroleum, sand and gravel.
Kingman	11,505,365	12,848,749	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	2,784,053	2,861,257	Petroleum, natural gas, sand and gravel.
Labette	450,237	443,285	Petroleum, stone, natural gas.
Leavenworth	579,889	496,938	Stone, sand and gravel, natural gas.
Lincoln	(2)	(2)	Stone, pumice.
Linn	364,713	519,468	Stone, petroleum.
Logan	1,899	11,589	Petroleum.
Lyon	670,654	667,427	Petroleum, sand and gravel, stone.
Marion	9,652,209	10,368,639	Petroleum, natural gas, stone.
Marshall	720,076	494,314	Gypsum, sand and gravel, stone.
McPherson	10,900,800	10,440,356	Petroleum, natural gas, sand and gravel.
Meade	4,665,666	4,604,296	Do.
Miami	1,596,202	1,313,914	Petroleum, stone.
Mitchell	7,371		
Montgomery	7,150,260	4,781,214	Cement, petroleum, stone, clays, natural gas.
Morris	1,200,691	1,389,160	Petroleum, stone, natural gas, sand and gravel.
Morton	14,939,345	12,445,844	Natural gas, petroleum.
Nemaha	40,962	39,293	Petroleum, stone, sand and gravel.
Neosho	8,193,005	7,564,919	Cement, petroleum, stone, clays, natural gas.
Ness	1,684,490	1,791,224	Petroleum, sand and gravel.
Norton	2,428,414	2,452,932	Petroleum, pumice, sand and gravel.
Osage	152,168	37,400	Coal.

See footnotes at end of table.

TABLE 21.—Value of mineral production in Kansas, by counties[1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Osborne	$229,487	$214,252	Petroleum, sand and gravel, stone.
Pawnee	5,312,360	4,213,732	Petroleum, natural gas, sand and gravel.
Phillips	5,694,906	5,632,300	Petroleum, stone, sand and gravel.
Pottawatomie	93,838	220,463	Stone, sand and gravel.
Pratt	7,136,747	5,659,876	Petroleum, natural gas, sand and gravel.
Rawlins	242,669	1,169,883	Petroleum.
Reno	12,820,471	12,015,301	Salt, petroleum, natural gas, sand and gravel, natural gas liquids.
Republic	(2)	(2)	Sand and gravel.
Rice	16,393,733	15,658,437	Petroleum, salt, natural gas, stone, sand and gravel.
Riley	266,842	793,784	Petroleum, stone, sand and gravel.
Rooks	16,949,647	16,058,630	Petroleum.
Rush	1,808,536	1,457,041	Petroleum, helium, natural gas, natural gas liquids.
Russell	26,692,236	24,852,926	Petroleum, natural gas, sand and gravel.
Saline	2,074,955	2,439,622	Petroleum, sand and gravel.
Scott	106,515	125,040	Petroleum.
Sedgwick	13,605,922	10,009,238	Petroleum, salt, sand and gravel, natural gas, natural gas liquids.
Seward	5,165,877	6,187,259	Natural gas, natural gas liquids, petroleum.
Shawnee	930,957	1,075,343	Stone, sand and gravel.
Sheridan	1,599,100	1,337,929	Petroleum, sand and gravel.
Sherman	468,157	381,967	Do.
Smith	7,650	5,850	Sand and gravel.
Stafford	17,252,227	17,186,369	Petroleum, natural gas, sand and gravel.
Stanton	2,943,660	2,495,716	Natural gas, petroleum.
Stevens	12,607,505	13,447,800	Do.
Sumner	8,730,337	9,189,528	Petroleum, natural gas, sand and gravel.
Thomas	77,935	102,446	Sand and gravel, petroleum.
Trego	5,576,974	4,985,647	Petroleum, sand and gravel.
Wabaunsee	703,349	806,844	Petroleum, stone, sand and gravel.
Wallace	65,480	67,560	Stone, sand and gravel.
Washington	138,965	(2)	Sand and gravel.
Wichita	631		
Wilson	6,234,081	4,839,357	Cement, stone, petroleum, clays, natural gas, sand and gravel.
Woodson	2,251,005	2,269,587	Petroleum, natural gas.
Wyandotte	8,868,520	7,501,243	Cement, stone, sand and gravel.
Undistributed	1,592,117	786,927	
Total	[3] 508,077,000	483,958,000	

[1] Lane and Ottawa Counties are not listed because no production was reported in 1959 or 1960.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.

National Gypsum Co. Gravel for road surfacing was produced by the Barber County Highway Department.

Barton.—Barton County ranked second in total value of mineral and petroleum production. Sand for building and road surfacing was produced by DuBois Sand Co., Moos Bros. Sand Co., Arkansas Sand Co., Klepper Sand Co., and James Dirks. Clay for heavy clay products was quarried by Kansas Brick & Tile Co. and Acme Brick Co.

Bourbon.—Fort Scott Hydraulic Cement Co., Inc., manufactured natural and masonry cements at Fort Scott. Dimension sandstone was quarried by Bandera Stone Co., Cullor Limestone Co., Inc., and Fort Scott Hydraulic Cement Co., Inc. Bourbon County Highway Department quarried and crushed limestone for concrete aggregate, roadstone, riprap, agricultural stone, and other uses. Coal was strip-mined by Garrett Coal Co. A small quantity of petroleum was recovered.

Butler.—Butler County ranked fourth in value of mineral and petroleum production. Secondary-recovery operations supplied a large part of the petroleum. Vickers Petroleum Co., Inc., at Potwin, pro-

duced benzene, toluene, xylenes, and higher aromatics. Mobil Oil Co. produced select aromatic oils from petroleum fractions at its plant near Augusta. Limestone was quarried and crushed for concrete aggregate and roadstone by Myers Material, Inc. and Carr Rock Products Co.

Chautauqua.—Petroleum and natural gas were recovered. Sedan Limestone Co. quarried and crushed limestone for concrete aggregate and roadstone.

Cherokee.—The State's entire production of lead and zinc originated in Cherokee County. Producers were Ora Black, The Eagle-Picher Co., Henderson-Tucker Mining Co., M and B Mining Co., and Rea Lead and Zinc Co. At Galena, The Eagle-Picher Co. operated its lead smelter and pigment plant and produced sulfuric acid by the contact method. A few pounds of mineral specimens, mostly calcite and sphalerite crystals in hand specimens, were produced for sale by roadside vendors.

The county continued to lead in coal mining. Strip mines were operated by P & M Coal Mining Co., Wilkinson Coal Co., S & M Coal Co., Inc., and Black Diamond Coal Co. Miscellaneous stone (chats) was obtained from lead-zinc mill tailing by four operators. Leading producers were The Eagle-Picher Co., Baxter Chat Co., and Southwest Rock & Chat Co. Crushed limestone for concrete aggregate and roadstone was produced by John J. Stark. Clay for manufacturing heavy clay products was mined by United Brick & Tile Co. A small quantity of natural gas was recovered.

Cloud.—Cloud County led in value of clay produced. Clay for manufacturing heavy clay products was quarried near Concordia by Cloud Ceramics. Earl Beaver Sand Co. and Fyfe Sand & Gravel Co. produced building sand and fill sand.

Cowley.—Petroleum and natural gas were produced. Dimension limestone was quarried and dressed by Silverdale Cut Stone Co., Silverdale Limestone Co., and John V. Elam. Crushed limestone was produced by C. L. Daniels Stone Co. Sand and gravel was quarried by McFarland Gravel Co., Oxford Sand & Gravel Co., Andrews Sand & Gravel Co., Myers Materials, Inc., Wilson Bros., and Warren R. Phillips.

Crawford.—Crawford County ranked second in value of coal and clay produced. Coal was mined underground by Blue Ribbon Coal Co. and strip mined by Clemens Coal Co., Apex-Compton Coal Co., Inc., Palmer Coal Co., and Cliff Carr Coal Co. Clay was quarried by W. S. Dickey Clay Manufacturing Co. for use in making heavy clay products. John J. Stark quarried and crushed limestone for concrete aggregate, roadstone, agricultural stone, and riprap. Small quantities of petroleum and natural gas were recovered.

Dickinson.—Limestone was quarried and crushed for concrete aggregate, roadstone, agricultural stone, and riprap by Anderson-Oxandale and Riddle Quarries, Inc. Sand and gravel for building and paving was produced by Shoffner Sand & Gravel Co. A small quantity of petroleum was recovered.

Doniphan.—George W. Kerford Co., Inc., Wolf River Limestone, Inc., Everett Quarries, Inc., Doniphan County Engineer, and the

U.S. Army Corps of Engineers quarried and crushed limestone for concrete aggregate, roadstone, agricultural stone, and riprap.

Douglas.—Sand for building and miscellaneous uses was produced by Bowersock Mills & Power Co. near Lawrence. Crushed limestone for concrete aggregate and roadstone was produced by Clark Rock Quarry. Petroleum was recovered. Cooperative Farm Chemicals Association produced ammonia, ammonium nitrate, and nitrogen solutions, using natural gas as raw material.

Edwards.—Petroleum and natural gas were recovered. Showalter Sand & Gravel Co. and Kinsley Sand & Gravel Co. produced sand and gravel for building and paving.

Elk.—Elk County ranked second in value of stone produced. Limestone was quarried and crushed for concrete aggregate, roadstone, railroad ballast, agricultural stone, and riprap by Concrete Materials-Construction Co. Petroleum and natural gas were recovered.

Ellis.—Ellis County led in total value of mineral and petroleum production. Crushed limestone was produced by Ellis County Highway Department.

Ellsworth.—Rock salt was mined near Kanopolis by Independent Salt Co. Clay for heavy-clay products was quarried and used by Acme Brick Co. Petroleum and natural gas were recovered. Stoppel Construction Co. and Ellsworth County Highway Department produced sand for paving and structural uses.

Finney.—Natural gas and petroleum were produced in the Finney County section of the Hugoton gas area. Natural gasoline was recovered by Northern Natural Gas Co. at its plant near Holcomb. Sand was dredged from the bed of the Arkansas River by Sam Alsop Construction Co.

Ford.—Sand and gravel was dredged by Miller Sand & Gravel Co., Dodge City Sand Co., and Davis & Sons Sand Sales. Petroleum and natural gas were recovered.

Franklin.—Buildex, Inc., mined miscellaneous clay near Ottawa and produced lightweight aggregate by the Haydite process. Petroleum was recovered mainly by secondary-recovery methods. Limestone was quarried and crushed for concrete aggregate, roadstone, and agricultural stone by Dan Fogle.

Graham.—Graham County ranked fifth in value of mineral and petroleum production.

Grant.—Grant County led in output of natural gas liquids and ranked second in natural gas production. Natural gas was recovered from the Hugoton and Panoma gas areas. Columbian Carbon Co. at Hickok and United Carbon Co. at Ryus produced the State's entire output of carbon black. Hugoton Production Co., Mobil Oil Co., and Pan American Petroleum Corp., produced natural gasoline, butane, and propane. Petroleum was recovered.

Greenwood.—Petroleum was produced in Greenwood County, largely by secondary-recovery methods. Greenwood County Engineer, Myers Materials, Inc., and Sedan Limestone Co. quarried and crushed limestone for concrete aggregate and roadstone.

Haskell.—Natural gasoline was recovered at the Northern Natural Gas Co. plant near Sublette. Petroleum, natural gas, and sand and gravel were produced.

Johnson.—Limestone was quarried and crushed for concrete aggregate and roadstone by Reno Construction Co. and Deitz Hill Development Co. Petroleum and natural gas were recovered.

Kearny.—Kearny County ranked fourth in output of natural gas and natural gas liquids. Petroleum also was recovered. Kansas-Nebraska Natural Gas Co. recovered natural gasoline, propane, and LP gases at Deerfield; Colorado Interstate Gas Co. recovered natural gasoline at Lakin. Popejoy Sand & Gravel Co. and Kearny County Highway Department obtained sand from local deposits.

Kingman.—Kingman County ranked third in recovery of natural gas liquids. Natural gasoline, butane, and propane were recovered by Mobil Oil Co. at Spivey. Petroleum and natural gas were produced. Sand for construction was produced by Ray Wells.

Lincoln.—Sandstone was quarried for filter beds, concrete aggregate, roadstone, railroad ballast, and riprap by Quartzite Stone Co. Ernest Hanzlicek mined pumice.

Marshall.—Bestwall Gypsum Co. mined and processed gypsum at Blue Rapids. New plant facilities, built on high ground to replace the former plant in the Tuttle Creek Reservoir site, began operating in December. Blue River Sand & Gravel Co., Heinzelman Construction Co., C. V. Garrett, and Hugo P. Vogler produced sand and gravel. Anderson-Oxandale, Hopper Bros. Quarries, and Swanson Construction Co. quarried and crushed limestone for concrete aggregate, roadstone, and agricultural stone.

Montgomery.—Portland and masonry cements were manufactured by Universal Atlas Cement, Division of United States Steel Corp., at its Independence plant. Petroleum and natural gas were recovered. Clay for making heavy clay products was quarried by United Brick & Tile Co. Limestone was crushed by H & S Rock Co. and Universal Atlas Cement, Division of United States Steel Corp.

Morton.—Morton County ranked third in natural gas production. Output came mostly from the Greenwood and Hugoton gas areas. Petroleum also was recovered.

Neosho.—Neosho County ranked second in production and shipment of cement. Ash Grove Lime & Portland Cement Co. produced portland and masonry cements. Petroleum and natural gas were recovered. A large part of the petroleum was recovered by secondary-recovery methods. Crushed limestone was produced by Harry Byers & Sons, Inc., O'Brien Rock Crusher, and Neosho County Engineer.

Norton.—Pumice was mined at Calvert by Wyandotte Chemical Corp. for use in cleaning and scouring products. Petroleum was recovered.

Osage.—Osage County ranked third in coal production. Coal was mined underground by Bell Coal Co. and strip-mined by Johnson Coal Co.

Reno.—Reno County led in value of salt produced. Morton Salt Co., Carey Salt Co., and Barton Salt Co. produced evaporated salt. Rock salt was mined by Carey Salt Co. Petroleum, natural gas, and natural gas liquids were recovered. Cities Service Oil Co. recovered natural gasoline, propane, and LP gases at its Burrton plant. J. E. Steele Sand & Gravel Co., J. H. Shears Sons, Inc., Mummey Sand &

Gravel, Fountain Sand Pit, Haven Sand Co., and the city of Hutchinson produced sand and gravel.

Rice.—Evaporated and rock salt were produced at Lyons by American Salt Corp. Natural gas was recovered. Riddle Bros. Quarries quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Sand and gravel was quarried by Rock Hill Stone & Gravel Co., Tobias, Wright, and Birchenough, Inc., Arensman Sand & Gravel Co., Sterling Sand & Gravel Co., Inc., and A. L. Stapleton.

Rush.—Petroleum, natural gas, natural gas liquids, and helium were recovered. Natural gasoline and butane were recovered at the Independent Lease Management Co. Otis plant. Helium was recovered from natural gas at Otis by the Federal Bureau of Mines.

Russell.—Russell County ranked third in total value of mineral output. Natural gas was recovered.

Saline.—Saline County ranked third in production of sand and gravel. Salina Sand Co., Inc., Shoffner Sand, Inc., and Central Kansas Sand Co. dredged sand and gravel for building, paving, and other uses. Petroleum was recovered.

Sedgwick.—Sedgwick County ranked second in output of sand and gravel. Kansas Hydrocarbon Co. recovered natural gasoline and LP gases at its Cheney plant, and Cities Service Oil Co. recovered natural gasoline, propane, and LP gases at its Wichita plant. Petroleum and natural gas were recovered. Sand and gravel was produced by 13 commercial operators. Frontier Chemical Co., a Division of Vulcan Materials Co., pumped brine from wells and manufactured chlorine, caustic soda, and salt. These materials were used to produce chloroform, wood preservatives, carbon tetrachloride, and grain fumigants.

Seward.—Seward County ranked second in natural gas liquids production. Natural gas—mainly from the Hugoton gas area—and petroleum were recovered. Natural gasoline, butane, and propane were recovered by Panhandle Eastern Pipe Line Co. at its Liberal plant.

Shawnee.—Shawnee County ranked fourth in value of sand and gravel output. Building, paving, and fill sand and gravel, blast sand, and engine sand were produced. Producers included Kansas Sand Co., Inc., Consumers Sand Co., Victory Sand & Gravel Co., River Sand Co., and Topeka Sand Co.

Stafford.—Natural gas and petroleum were recovered. Partin Sand & Gravel Co. and Stafford County Highway Department produced sand and gravel for road surfacing and building.

Stevens.—The county continued as the State's leading producer of natural gas.

Trego.—Petroleum and sand and gravel were produced. The county ranked sixth in sand and gravel production. San Ore Construction Co., Inc., Siebert Sand Co., and Trego County Highway Department mined paving sand and gravel.

Wallace.—DeLore Division of National Lead Co. produced diatomaceous marl for use as flatting pigment in paint. Sand and gravel was produced for paving and structural use.

Wilson.—General Portland Cement Co. manufactured portland and masonry cements at Fredonia. Carr Rock Products Co. and Benedict Rock & Lime Co. quarried and crushed limestone for concrete aggregate, roadstone, and agricultural stone. Acme Brick Co. in

Buffalo and Excelsior Brick Co. in Fredonia quarried clay for use in manufacturing heavy clay products. Petroleum and natural gas were recovered.

Wyandotte.—The county led in output of stone and sand and gravel. Thompson-Strauss Quarries, Inc., Peerless Quarries, Inc., and American Rock Crusher Co. mined limestone in underground quarries and crushed it for concrete aggregate, roadstone, agricultural stone, and asphalt base. Sand and gravel was produced by six operators; leading producers were Holliday Sand & Gravel Co., Stewart Sand & Material Co., American Sand & Gravel Co., Builders Sand Co., and Peck-Woolf Sand & Material Co. Portland and masonry cements were manufactured by Lone Star Cement Corp.

The Mineral Industry of Kentucky

This chapter has been prepared under a cooperative agreement for collecting mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Kentucky Geological Survey.

By Avery H. Reed, Jr.,[1] Preston McGrain,[2] and Mildred E. Rivers[3]

MINERAL PRODUCTION in Kentucky in 1960 was about the same as in 1959. Coal output increased 6 percent, and production of miscellaneous clay established a new annual record. Among the States, Kentucky ranked second in ball clay and fluorspar production and third in production of bituminous coal. The total value of mineral output decreased 1 percent but was 18 percent below 1948, the record year.

Coal mining dominated Kentucky's mineral industry, supplying 68 percent of the total value, compared with 65 percent in 1959. Leading companies were Peabody Coal Co., United State Steel Corp., Nashville Coal Co., Inland Steel Co., and Bethlehem Mines, Inc.

Employment and Injuries.—Employment decreased in all industries. Man-hours worked at coal mines were about the same as in 1959, but 1,800 less men worked, a decline of 6 percent.

Injury experience was about the same as in 1959. Sixty-four fatalities occurred, compared with 46 in 1959 and 59 in 1958.

Trends and Developments.—Kentucky Power Co., subsidiary of American Electric Power Co., broke ground at Louisa, Ky., for construction of a $39 million electric powerplant. The 265,000-kw. plant was scheduled to burn 800,000 tons of coal annually. All the coal was expected to be purchased from mines in eastern Kentucky.

The U.S. Engineers Board of Review approved a $151 million high dam at Devil's Jump on the Big South Fork of the Cumberland River in McCreary County. The proposed dam will be 483 feet high, the highest dam east of the Mississippi, and will create a reservoir extending 67 miles upstream into Tennessee.

Legislation and Government Programs.—The Federal Geological Survey and the Kentucky Geological Survey started work on a cooperative program to map the bedrock geology of the State on a 7½-minute-quadrangle basis. The $12 million program was expected to take 10 years to complete. Approximately 30 geologists will be employed. One-third of the counties in Kentucky had never been mapped in detail. In eastern Kentucky, 12 counties had never had

[1] Chief, Knoxville Field Office, Knoxville, Tenn.
[2] Assistant State geologist, Kentucky Geological Survey, Lexington, Ky.
[3] Statistical assistant, Bureau of Mines, Knoxville, Tenn.

TABLE 1.—Mineral production in Kentucky [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	26,598	$335	[2]	[2]
Clays—thousand short tons	984	3,595	[3] 951	[3] $2,646
Coal—do	62,810	270,139	66,846	282,395
Fluorspar—short tons	18,579	887	25,855	1,173
Gem stones	[4]	[5]	[4]	[5]
Lead (recoverable content of ores, etc.)—short tons	409	94	558	131
Natural gas—million cubic feet	73,504	17,420	75,329	18,380
Natural gas liquids:				
Natural gasoline—thousand gallons	35,868	2,133	[2]	[2]
LP gases—do	213,171	12,267	[2]	[2]
Petroleum (crude)—thousand 42-gallon barrels	27,272	76,634	[6] 21,144	[6] 60,260
Sand and gravel—thousand short tons	5,081	5,568	5,113	5,763
Silver (recoverable content of ores, etc.)—troy ounces	75	[5]		
Stone [7]—thousand short tons	16,063	22,215	15,810	21,493
Zinc (recoverable content of ores, etc.)—short tons	673	155	869	224
Value of items that cannot be disclosed: Cement, ball clay (1960), crushed sandstone, and values indicated by footnote 2		8,202		22,080
Total Kentucky [8]		418,821		413,517

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Excludes ball clay; included with "Value of items that cannot be disclosed."
[4] Weight not recorded.
[5] Less than $1,000.
[6] Preliminary figure.
[7] Excludes crushed sandstone; included with "Value of items that cannot be disclosed."
[8] Total adjusted to eliminate duplicating value of clays and stone.

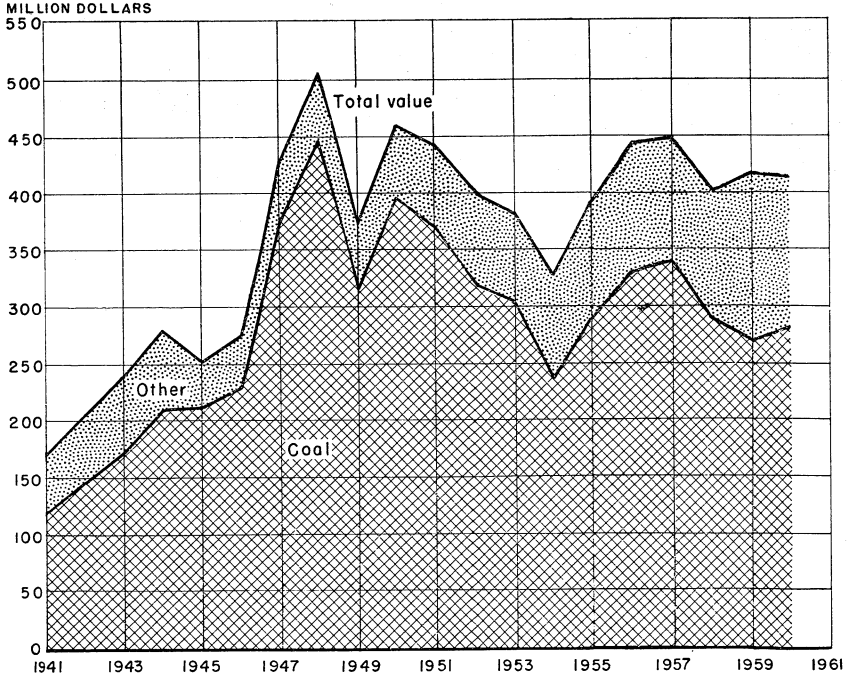

FIGURE 1.—Value of coal and total value of all minerals produced in Kentucky, 1941–60.

TABLE 2.—Employment and injuries in the mineral industries

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:							
Oil and gas	(1)	4,613	248	9,164,512	1	119	13
Coal mines [2]	2,122	30,272	162	38,841,048	44	1,854	49
Quarries and mills	99	2,431	250	4,968,741	1	158	32
Nonmetal mines and mills	66	854	203	1,443,288		56	39
Sand and gravel mines	32	493	291	1,146,762	1	16	15
Coke ovens	2	(3)	(3)	(3)		3	(3)
Total	(1)	(3)	(3)	(3)	47	2,206	(3)
1960: [4] [5]							
Coal mines [2]	2,200	28,493	169	38,615,455	61	1,869	50
Quarries and mills	103	2,461	228	4,490,997	2	146	33
Nonmetal mines and mills	64	698	176	983,766	1	44	46
Sand and gravel mines	32	390	286	1,005,331		16	16
Coke ovens	1	(3)	(3)	(3)		1	(3)
Total	2,400	(3)	(3)	(3)	64	2,076	(3)

[1] Data not available.
[2] Excludes officeworkers.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Excluding oil and gas.
[5] Preliminary figures.

areal geologic maps made, and 7 central and 12 western counties had never been mapped. Kentucky, however, has the distinction of being the first State to be completely mapped for topography by the Federal Geological Survey, on a scale of 1 inch to 2,000 feet.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal.—Coal production increased 6 percent but was 21 percent below the 1947 record. Bituminous coal was mined at 2,164 mines in 43 counties, compared with 1,724 mines in 43 counties in 1959. Leading counties were Hopkins, Muhlenberg, Pike, and Harlan. Leading producing companies were Peabody Coal Co., United States Steel Corp., Nashville Coal Co., Inland Steel Co., and Bethlehem Mines, Inc.

Tennessee Valley Authority purchased options on about 70,000 acres of coal land in eastern Kentucky and studied potential sites for power plants in the area.

Peabody Coal Co. placed an order for the world's largest power shovel, a 115-yd. giant more than twice the size of any shovel now in service. It will be as tall as a 20-story building, weigh about 7,000 tons, and will require over 12,000 horsepower to operate. It will have estimated capacity to handle 3 million cubic yards of overburden per month. The shovel was scheduled for delivery about August 1962.

Tennessee Valley Authority announced that its new Paradise steam plant under construction on Green River at the village of Paradise, a few miles from Central City, would be the largest steam-electric generating plant in the world. The first unit was estimated to cost $100 million. The plant was being built on top of the Muhlenberg

County coal field. Coal for the plant will be supplied by Peabody Coal Co. from a huge strip mine it will open a short distance from the plant. The plant will have an initial capacity of 1,200,000 kilowatts and an ultimate capacity of 2,400,000 kilowatts.

At the end of the year, West Kentucky Coal Co. closed the East Diamond mine, near Madisonville, which had been in operation since 1945 and which has produced nearly 17 million tons of coal.

In the eastern Kentucky coal field, 2,037 mines in 31 counties produced 36,260,000 tons, compared with 1,609 mines in 31 counties, and 33,194,000 tons in 1959. Average production per mine decreased from 20,600 to 17,800 tons. Underground mines produced 88 percent, auger mines 7 percent, and strip mines 5 percent of the total. Shipments were 82 percent by rail or water and 18 percent by truck. Captive tonnage was 21 percent of the total.

Equipment used at 1,866 underground mines included 1,050 cutting machines, which cut 88 percent of tonnage; 1,540 power drills, which drilled 84 percent of material drilled; 291 mobile loading machines, which loaded 51 percent of the tonnage; 45 continuous mining machines, which loaded 11 percent; and 56 conveyors, which loaded 1 percent; plus 1,001 locomotives, 457 shuttle cars, 112 rope hoists, and 102 mother conveyors.

Equipment used at 68 strip mines included 104 power shovels, 1 dragline, 69 bulldozers, 29 power drills, and 230 trucks.

Equipment used at 103 auger mines included 104 coal-recovery augers, 13 power shovels, 2 carryall scrapers, 56 bulldozers, 4 power drills, and 138 trucks.

Of the total coal production, 48 percent was cleaned, 30 percent was crushed, and 21 percent was treated.

In the western Kentucky coal field, 127 mines in 12 counties produced 30,587,000 tons, compared with 29,616,000 tons in 1959. Average production per mine decreased from 258,000 to 241,000 tons. Underground mines produced 42 percent, and strip mines 58 percent of total production. Shipments were 95 percent by rail or water and 5 percent by truck. All coal was sold in the open market.

Equipment used at 64 underground mines included 133 cutting machines, which cut 97 percent of the tonnage; 132 power drills, which drilled 94 percent of material drilled; 128 mobile loading machines, which loaded 96 percent of the tonnage; 171 locomotives, 253 shuttle cars, 26 rope hoists, 67 mother conveyors, and 4 continuous miners.

Equipment used at 61 strip mines included 103 power shovels, 39 draglines, 6 carryall scrapers, 92 bulldozers, 64 power drills, and 286 trucks. An estimated 144,800,000 cubic yards of overburden was excavated.

Equipment used at two auger mines included two coal-recovery augers, one bulldozer, and four trucks.

Thirty-seven cleaning plants cleaned 88 percent of the coal produced; 44 percent was crushed, and 23 percent was treated with oil or calcium chloride.

Natural Gas.—Marketed production of natural gas increased 2 percent but was 22 percent below the 1947 record. At yearend, 4,829 gas wells were producing. Cumulative natural gas production for the State since 1883 was 2,080,000 million cubic feet.

Natural Gas Liquids—*Natural Gasoline.*—Production of natural gasoline was considerably less than in 1959.

LP Gases.—Production of liquefied-petroleum (LP) gases increased over 1959.

Petroleum.—Production of crude petroleum decreased 22 percent below the record established in 1959. At the end of the year, 14,584 oil wells were producing. Leading counties were Henderson, Green, and Union, compared with Green, Henderson, and Daviess in 1959.

TABLE 3.—Coal production, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Bell	1,119,310	$4,359,331	1,493,535	$5,827,594
Boyd	116,366	529,430	26,001	124,024
Breathitt	588,730	3,573,591	553,681	3,366,380
Butler	202,802	803,716	213,552	959,922
Caldwell	35,857	107,573	45,885	137,655
Carter	48,226	233,900	18,600	95,790
Christian	36,061	181,386	70,348	404,384
Clay	1,022,831	4,219,978	1,284,121	4,662,180
Clinton	22,642	95,322	38,432	153,728
Daviess	804,004	2,328,055	967,707	3,354,799
Elliott	12,406	49,624	16,987	57,586
Floyd	3,744,379	21,717,006	4,278,155	25,677,479
Greenup	9,635	48,656		
Hancock	5,367	23,528	118,311	385,694
Harlan	5,205,160	30,987,702	6,235,601	34,969,612
Henderson	281,790	851,037	301,209	960,857
Hopkins	11,124,717	41,817,057	11,818,541	42,182,858
Jackson	138,385	611,661	125,726	436,232
Johnson	257,044	953,632	257,535	860,167
Knott	1,071,897	3,456,359	1,352,392	4,213,115
Knox	106,140	348,353	242,939	832,836
Laurel	337,123	1,362,934	110,074	378,189
Lawrence	42,787	194,681	44,808	153,577
Lee	113,497	544,066	54,340	275,339
Leslie	2,813,167	12,040,229	2,290,791	10,123,285
Letcher	3,843,184	20,686,903	4,244,832	23,370,065
Magoffin	187,266	445,035	73,174	143,421
Martin	55,281	187,955	35,053	119,180
McCreary	526,243	2,125,453	517,126	1,962,402
McLean	1,200	3,912	58,000	189,080
Menifee			1,300	6,695
Morgan	129,778	614,886	37,692	128,460
Muhlenberg	9,821,537	32,816,499	9,918,659	32,916,411
Ohio	3,294,916	10,649,271	3,239,246	10,641,826
Owsley	41,823	153,490	126,550	509,461
Perry	4,087,528	18,857,227	4,441,099	19,397,317
Pike	6,876,190	35,037,528	7,619,486	35,162,809
Pulaski	203,826	754,048	153,704	618,002
Rockcastle	107,590	369,041	38,588	145,476
Union	2,735,435	10,927,108	2,832,776	11,284,937
Wayne	7,226	44,006	9,057	57,149
Webster	1,271,840	3,836,156	1,002,374	3,227,657
Whitley	345,863	1,131,738	523,380	1,845,350
Wolfe	12,800	60,260	15,125	75,625
Total	62,809,849	270,139,323	66,846,492	282,394,605
Earliest record to date	2,644,743,000	(1)	2,711,589,000	(1)

[1] Data not available.

TABLE 4.—Crude petroleum production, by counties

County	1959		1960 [1]	
	Barrels	Value	Barrels	Value
Adair	80	$231	104	$296
Allen	80,959	233,972	121,929	347,376
Barren	41,868	120,999	37,665	107,308
Bath	5,462	15,785	5,523	15,735
Bell	746	2,156	535	1,524
Boyd	664	1,919	673	1,917
Breathitt	481,047	1,390,226	301,007	857,569
Breckinridge	40,792	117,889	138,108	393,470
Butler	464,347	1,341,963	403,105	1,148,446
Casey			2,520	7,180
Christian	890,307	2,572,987	1,152,420	3,283,245
Clinton	82,272	237,766	188,177	536,116
Crittenden	661	1,910	376	1,071
Cumberland	32,056	92,642	67,252	191,601
Daviess	1,818,744	5,256,170	1,611,557	4,591,326
Edmonson	1,184	3,422	1,679	4,783
Elliott	112,704	325,714	93,161	265,416
Estill	116,708	337,286	116,441	331,740
Floyd	18,472	53,384	24,436	69,618
Grayson	326	942	154	439
Green	[2] 9,417,504	[2] 25,034,067	2,542,148	7,242,580
Greenup	906	2,618	144	410
Hancock	382,517	1,105,474	349,551	995,871
Hardin	35,211	101,760	7,567	21,558
Harlan			146	416
Hart	18,154	52,465	96,454	274,797
Henderson	3,314,852	9,579,922	3,360,740	9,595,492
Hopkins	80,362	232,246	58,756	167,396
Jackson	506	1,462	1,357	3,866
Johnson	173,766	502,184	160,571	457,467
Knott	13,755	39,752	17,906	51,014
Knox	1,785	5,159	6,839	19,484
Laurel	552	1,595	155	442
Lawrence	279,277	807,111	328,165	934,942
Lee	822,772	2,377,811	1,080,104	3,077,216
Leslie	3,997	11,551	4,425	12,607
Letcher	1,751	5,060	13,351	38,037
Lincoln	47,773	138,064	65,933	187,843
Logan	2,323	6,713	1,904	5,425
Magoffin	1,392,105	4,023,183	1,222,270	3,482,247
Martin	22,037	63,687	21,222	60,462
McCreary	1,039	3,003	1,110	3,162
McLean	744,689	2,152,151	641,815	1,828,531
Menifee	1,314	3,797	622	1,772
Metcalfe	326,499	943,582	217,921	620,857
Monroe	119	344	8,979	25,581
Montgomery	283	818	86	245
Morgan	905	2,615	1,065	3,034
Muhlenberg	784,651	2,267,497	710,019	2,022,844
Ohio	1,000,025	2,890,072	989,866	2,820,128
Owsley	896	2,589	2,226	6,342
Perry	466	1,347	862	2,456
Pike	53,656	155,066	45,000	128,205
Powell	108,239	312,811	176,065	501,609
Rockcastle			196	558
Russell	7,628	22,045	20,318	57,886
Simpson	29,386	84,926	38,452	109,550
Taylor	1,095,995	3,167,426	1,746,027	4,974,431
Todd	6,320	18,265	5,975	17,023
Union	1,692,223	4,890,524	1,756,882	5,005,357
Warren	45,589	131,752	46,914	133,658
Wayne	23,079	66,698	24,478	69,738
Webster	1,092,077	3,156,103	1,044,274	2,975,137
Whitley	5,196	15,016	18,501	52,709
Wolfe	50,422	145,720	39,817	113,439
Total	[2] 27,272,000	[2] 76,634,000	21,144,000	60,260,000
Earliest records to date	395,122,000	874,206,000	416,266,000	934,466,000

[1] Preliminary figures.
[2] Revised figure.

Source: Kentucky Geological Survey.

NONMETALS

Barite.—Marion Mining Co., Inc., and J. Willis Crider Fluorspar Co. mined crude barite in Crittenden County for oil well drilling.

Cement.—Kosmos Portland Cement Co. operated the Kosmosdale plant throughout the year. Shipments of portland and masonry cements decreased 9 percent and 13 percent respectively, below the record established in 1959. Raw materials used in portland cement included limestone (73 percent), miscellaneous clay (23 percent), gypsum (2 percent), and iron ore (2 percent). Cement produced was mainly consumed within the State, but shipments were also made to Indiana and Ohio. Portland cement was used chiefly by ready-mixed concrete companies, concrete products manufacturers, and building material dealers.

Clays.—*Ball Clay.*—Kentucky ranked second in ball-clay production. Kentucky-Tennessee Clay Co., Old Hickory Clay Co., and Kentucky Clay Mining Co. mined ball clay at four mines in Graves County for whiteware, stoneware, art pottery, enameling, floor and wall tile, fire-clay mortar, kiln furniture and other refractories, fillers, and other uses.

Fire Clay.—Sixteen companies mined fire clay at 31 mines in Carter, Greenup, and Rowan Counties for firebrick and block, fire-clay mortar, and heavy clay products. Leading producers were General Refractories Co., Harbison-Walker Refractories Co., and North American Refractories Co. Production increased 24 percent but was 47 percent below the 1951 record. Total production was 307,000 tons, valued at $1,846,000.

Miscellaneous Clay.—Fourteen companies mined miscellaneous clay at 16 mines in 11 counties for floor and wall tile, heavy clay products, lightweight aggregate, and cement. Leading counties were Jefferson, Bullitt, and Hancock. Leading producers were Kosmos Portland Cement Co., Kenlite Division of Kentucky Light Aggregates, Inc., and Big Run Coal & Clay Co. Production increased 3 percent above the high established in 1959. Total production was 644,000 tons, valued at $800,000.

Fluorspar.—Nine companies or individuals mined fluorspar in Caldwell, Crittenden, and Livingston Counties for hydrofluoric acid, glass, ceramics, steel manufacture, and iron foundries. Leading producers were Calvert City Chemical Co. (Dyers Hill mine) and J. Willis Crider Fluorspar Co. (Pigmy mine). Marketable production increased 60 percent but was 81 percent below the 1941 record. Total marketable production was 26,700 tons, valued at $1,215,000. Total cumulative production from earliest records was 2,884,000 tons. Four companies processed or blended fluorspar purchased in Illinois, Kentucky, or Mexico for shipment to consumers. The leading shipper was Kentucky Fluorspar Co. Total shipments to consumers from Kentucky were 36,400 tons, valued at $1,621,000. Total shipments originating in Kentucky were 25,900 tons, valued at $1,173,000. Kentucky was the second largest fluorspar producing state.

Gem Stones.—The Majors Rocks collected mineral specimens (flint, fossils, calcite, and pyrite) for souvenirs. Total value reported was $400.

Sand and Gravel.—Twenty-three companies mined sand and gravel at 32 mines in 23 counties. Leading counties were Jefferson, Boone, and Henderson. Leading producers were Standard Materials Corp., Bedford-Nugent Co., Inc., and Ohio River Sand Co., Inc. Production increased 1 percent but was 10 percent below the 1956 record. Of the total production, 93 percent was washed, and 73 percent was hauled by truck, 22 percent by water, and 5 percent by rail.

TABLE 5.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Ballard	20,343	$14,970		
Boone	(1)	(1)	(1)	(1)
Breckinridge			(1)	(1)
Calloway	44,227	54,742	46,747	$88,570
Carlisle	19,828	12,700	14,500	16,900
Carroll	(1)	(1)	(1)	(1)
Daviess	230,714	308,021	(1)	(1)
Floyd	(1)	(1)	(1)	(1)
Fulton	(1)	(1)	(1)	(1)
Gallatin	(1)	(1)	196,425	163,560
Graves	79,419	57,700	59,500	69,600
Henderson	(1)	(1)	(1)	(1)
Hickman	35,563	27,200	26,150	30,600
Jefferson	1,962,533	2,036,984	1,908,473	2,002,247
Livingston	8,325	8,075	9,272	10,800
Lyon	14,326	9,450	10,033	11,700
Marion			15,000	17,550
Marshall	29,987	21,200	18,336	21,400
Mason	70,260	112,416	87,700	140,320
McCracken	445,850	558,000	(1)	(1)
Pike	5,000	5,300	5,800	6,380
Union	34,000	42,500	24,100	30,125
Undistributed	2,080,434	2,298,648	2,691,425	3,153,261
Total	5,080,809	5,567,906	5,113,461	5,763,013

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 6.—Sand and gravel sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,038,123	$2,255,856	$1.11	2,203,863	$2,508,751	$1.14
Paving	943,884	969,618	1.03	721,841	737,904	1.02
Fill	194,830	182,265	.94	370,303	263,979	.71
Glass	7,621	23,600	3.10	11,322	44,385	3.92
Molding	1,835	6,400	3.49	2,700	6,700	2.48
Other	(1)	(1)	(1)	(1)	(1)	(1)
Gravel:						
Paving	949,508	990,297	1.04	793,687	923,772	1.16
Structural	851,236	1,079,210	1.27	969,944	1,250,842	1.29
Other	(1)	(1)	(1)	(1)	(1)	(1)
Total sand and gravel	5,080,809	5,567,906	1.10	5,113,461	5,763,013	1.13

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."

TABLE 7.—Crushed limestone sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Adair	(1)	(1)	(1)	(1)
Allen	(1)	(1)	(1)	(1)
Anderson	(1)	(1)	(1)	(1)
Barren	138,000	$200,000	141,000	$180,250
Bourbon	(1)	(1)	(1)	(1)
Boyle	439,265	565,192	219,813	329,695
Breckinridge	(1)	(1)	(1)	(1)
Butler	(1)	(1)		
Caldwell	(1)	(1)	(1)	(1)
Carter	(1)	(1)	(1)	(1)
Casey	(1)	(1)	(1)	(1)
Christian	(1)	(1)	(1)	(1)
Clark	(1)	(1)	(1)	(1)
Clinton	(1)	(1)	(1)	(1)
Crittenden	(1)	(1)	(1)	(1)
Edmonson	(1)	(1)	(1)	(1)
Estill	50,000	75,000	(1)	(1)
Fayette	704,402	1,037,063	783,298	1,033,089
Fleming	(1)	(1)	(1)	(1)
Franklin	714,561	889,601	440,605	556,902
Garrard	(1)	(1)		
Grayson	(1)	(1)	(1)	(1)
Green			(1)	(1)
Hardin	784,020	1,124,404	553,287	777,977
Harlan	(1)	(1)		
Harrison	(1)	(1)	(1)	(1)
Hart	118,000	150,120	(1)	(1)
Henry			(1)	(1)
Jackson	(1)	(1)	(1)	(1)
Jefferson	2,097,594	2,908,845	1,963,126	2,596,071
Jessamine	(1)	(1)	(1)	(1)
Kenton	9,356	16,372	10,320	18,060
Lee	(1)	(1)	(1)	(1)
Letcher	(1)	(1)	(1)	(1)
Lincoln	143,248	179,060		
Livingston	(1)	(1)	(1)	(1)
Logan	(1)	(1)	(1)	(1)
Madison	(1)	(1)		
Marion	(1)	(1)	(1)	(1)
Meade	(1)	(1)	(1)	(1)
Menifee	160,800	267,910	(1)	(1)
Mercer	113,331	168,636	206,000	289,200
Metcalfe	(1)	(1)	(1)	(1)
Monroe	(1)	(1)	(1)	(1)
Morgan	(1)	(1)	159,412	187,477
Muhlenberg	159,875	184,843	264,049	330,975
Nelson	(1)	(1)	(1)	(1)
Nicholas	14,515	28,630	25,000	30,000
Ohio	(1)	(1)	(1)	(1)
Oldham	(1)	(1)	(1)	(1)
Pendleton	(1)	(1)	(1)	(1)
Pike	(1)	(1)		
Powell	51,560	79,650	(1)	(1)
Pulaski	(1)	(1)	(1)	(1)
Rockcastle	(1)	(1)	(1)	(1)
Rowan	(1)	(1)	(1)	(1)
Simpson	114,000	154,900	(1)	(1)
Todd	(1)	(1)	(1)	(1)
Trigg	34,125	34,125	133,009	174,705
Warren	406,638	582,919	(1)	(1)
Washington			(1)	(1)
Wayne	(1)	(1)	(1)	(1)
Undistributed	9,807,118	13,526,340	10,908,577	14,951,291
Total	16,060,408	22,173,610	15,807,496	21,455,692

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Stone.—*Limestone.*—Seventy-one operators crushed limestone at 96 quarries in 56 counties. Leading counties were Jefferson, Livingston, and Oldham. Leading producers were Reed Crushed Stone Co., Inc. (Livingston County), Kentucky Stone Co. (Anderson, Breckinridge, Hardin, Jessamine, Lee, Logan, Rockcastle, and Todd Counties), and

TABLE 8.—Crushed limestone sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	13,780,571	$19,166,557	$1.39	12,865,591	$17,736,683	$1.38
Agstone	1,297,678	1,690,223	1.30	1,184,605	1,589,804	1.34
Railroad ballast	346,963	379,326	1.09	(1)	(1)	(1)
Other uses [2]	635,196	937,504	1.48	1,757,300	2,129,205	1.21
Total	16,060,408	22,173,610	1.38	15,807,496	21,455,692	1.36

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes riprap, fluxing stone, fertilizer filler, cement, other uses, and uses indicated by footnote 1.

Ohio River Stone Co. (Oldham County). Production decreased 2 percent below the record set in 1959. Of the total tonnage, 81 percent was hauled by truck, 9 percent by rail, and 10 percent by water.

Sandstone.—Silica Corp. of America crushed sandstone in Pike County for glass and other uses. Kentucky Flagstone Co., Kentucky Kolor Stone, Inc., and Thomas C. Mayne quarried 2,200 tons of dimension sandstone in Logan and McCreary Counties for rough architectural and dressed building stone and for flagging.

Vermiculite.—Zonolite Co. exfoliated vermiculite from other States at the Wilder plant.

METALS

Ferroalloys.—Shipments of ferroalloys, including ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, and ferrochromic-silicon, increased 6 percent.

Lead.—Byproduct recovery of lead from fluorspar milling increased 36 percent.

Pig Iron and Steel.—Armco Steel Corp. produced foundry and basic pig iron at Ashland; shipments increased to the highest level since 1955. Steel was produced by Armco Steel Corp. at Ashland and by Acme Steel Co. at Newport. Iron ore consumed was 1 percent domestic and 99 percent imported. Imports, mainly from Labrador and Brazil, increased 34 percent and were 29 percent above the previous record, set in 1958.

Zinc.—Byproduct recovery of zinc from fluorspar milling increased 29 percent but was 75 percent below the 1951 record.

REVIEW BY COUNTIES

Of the 120 counties in Kentucky, 106 reported mineral production, compared with 107 in 1959. Leading counties were the large coal and petroleum producers, Hopkins, Pike, Muhlenberg, Harlan, Floyd, Letcher, and Perry, which supplied more than 50 percent of the total State value. In addition to the detailed county production listed in table 9, natural gas and natural gas liquids, of undetermined county origin, were produced.

Adair.—Shamrock Stone Co., Inc., crushed limestone for concrete, roads, and agstone, at the Butler quarry. Production of crude petroleum increased 30 percent.

Allen.—McLellan Stone Co., crushed limestone for concrete, roads, and railroad ballast at the Scottsville quarry. Production of crude petroleum increased 51 percent.

Anderson.—Kentucky Stone Co., crushed limestone for concrete, roads, railroad ballast, and agstone at the Tyrone mine.

Barren.—J. F. Pace Construction Co., crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 11 percent.

Bath.—Production of crude petroleum increased 2 percent.

Bell.—Ninety-two mines produced coal; leading producers were Kentucky Ridge Coal Co. (Crockett mine), Green Mountain Coal Co. (Green Mountain Strip mine), and Bell-Hi Coal Corp. (No. 1 mine). Production of crude petroleum decreased 28 percent.

TABLE 9.—Value of mineral production in Kentucky, by counties[1]

County	1959	1960	Minerals produced in 1960, in order of value[2]
Adair	(3)	(3)	Limestone, petroleum.
Allen	(3)	(3)	Petroleum, limestone.
Anderson	(3)	(3)	Limestone.
Ballard	$14,970	----	
Barren	320,999	$287,558	Limestone, petroleum.
Bath	15,785	15,735	Petroleum.
Bell	4,371,487	5,829,118	Coal, petroleum.
Boone	(3)	(3)	Sand and gravel.
Bourbon	(3)	(3)	Limestone.
Boyd	574,034	177,825	Coal, miscellaneous clay, petroleum.
Boyle	565,192	329,695	Limestone.
Breathitt	4,963,817	4,223,949	Coal, petroleum.
Breckinridge	(3)	(3)	Petroleum, limestone, sand and gravel, miscellaneous clay.
Bullitt	(3)	(3)	Miscellaneous clay.
Butler	2,201,254	2,108,368	Petroleum, coal.
Caldwell	(3)	(3)	Limestone, coal, fluorspar.
Calloway	54,742	88,570	Sand and gravel.
Carlisle	12,700	16,900	Do.
Carroll	(3)	(3)	Do.
Carter	1,457,377	1,642,993	Fire clay, limestone, coal.
Casey	(3)	(3)	Limestone, petroleum.
Christian	(3)	(3)	Petroleum, limestone, coal.
Clark	(3)	(3)	Limestone.
Clay	4,219,978	4,662,180	Coal.
Clinton	(3)	(3)	Petroleum, coal, limestone.
Crittenden	(3)	(3)	Limestone, barite, fluorspar, petroleum.
Cumberland	92,642	191,601	Petroleum.
Daviess	7,895,421	(3)	Petroleum, coal, sand and gravel, miscellaneous clay.
Edmonson	(3)	(3)	Limestone, petroleum.
Elliott	375,338	323,003	Petroleum, coal.
Estill	412,286	(3)	Petroleum, limestone.
Fayette	1,037,063	1,033,089	Limestone.
Fleming	(3)	(3)	Do.
Floyd	(3)	(3)	Coal, petroleum, sand and gravel.
Franklin	889,601	556,952	Limestone, gem stones.
Fulton	(3)	(3)	Sand and gravel.
Gallatin	(3)	163,560	Do.
Garrard	(3)	----	
Graves	1,577,045	1,405,069	Ball clay, sand and gravel.
Grayson	(3)	(3)	Limestone, petroleum.
Green	[4] 25,034,067	(3)	Petroleum, limestone.
Greenup	(3)	296,753	Fire clay, petroleum.
Hancock	1,373,902	1,552,016	Petroleum, coal, miscellaneous clay.
Hardin	1,226,164	799,535	Limestone, petroleum.
Harlan	(3)	34,970,028	Coal, petroleum.
Harrison	(3)	(3)	Limestone.
Hart	202,585	(3)	Petroleum, limestone.
Henderson	(3)	(3)	Petroleum, coal, sand and gravel.
Henry	130	(3)	Limestone, gem stones.
Hickman	27,200	30,600	Sand and gravel.

See footnotes at end of table.

TABLE 9.—Value of mineral production in Kentucky, by counties—Continued

County	1959	1960	Minerals produced in 1960 in order of value [2]
Hopkins	$42,049,303	$42,351,504	Coal, petroleum, miscellaneous clay.
Jackson	(3)	(3)	Coal, limestone, petroleum.
Jefferson	(3)	(3)	Cement, limestone, sand and gravel, miscellaneous clay.
Jessamine	(3)	(3)	Limestone.
Johnson	1,455,817	1,317,634	Coal, petroleum.
Kenton	16,372	18,060	Limestone.
Knott	3,496,111	4,264,129	Coal, petroleum.
Knox	353,512	852,320	Do.
Laurel	1,364,529	378,631	Do.
Lawrence	1,001,792	1,088,519	Petroleum, coal.
Lee	(3)	(3)	Petroleum, limestone, coal.
Leslie	12,051,780	10,135,892	Coal, petroleum.
Letcher	(3)	(3)	Coal, petroleum, limestone.
Lincoln	317,124	187,843	Petroleum.
Livingston	(3)	(3)	Limestone, fluorspar, zinc, lead, sand and gravel.
Logan	(3)	(3)	Limestone, sandstone, petroleum.
Lyon	9,450	11,700	Sand and gravel.
Madison	(3)		
Magoffin	4,468,218	3,625,668	Petroleum, coal.
Marion	(3)	(3)	Limestone, sand and gravel.
Marshall	21,200	21,400	Sand and gravel.
Martin	251,642	179,642	Coal, petroleum.
Mason	112,416	140,320	Sand and gravel.
McCracken	558,000	(3)	Do.
McCreary	2,129,026	1,968,266	Coal, petroleum, sandstone.
McLean	2,156,063	2,017,611	Petroleum, coal.
Meade	(3)	(3)	Limestone.
Menifee	271,707	(3)	Limestone, coal, petroleum.
Mercer	168,636	289,200	Limestone.
Metcalfe	(3)	(3)	Petroleum, limestone.
Monroe	(3)	(3)	Limestone, petroleum.
Montgomery	818	245	Petroleum.
Morgan	(3)	318,971	Limestone, coal, petroleum.
Muhlenberg	35,268,839	35,270,230	Coal, petroleum, limestone.
Nelson	(3)	(3)	Limestone.
Nicholas	28,630	30,000	Do.
Ohio	(3)	(3)	Coal, petroleum, limestone.
Oldham	(3)	(3)	Limestone.
Owsley	156,079	515,803	Coal. petroleum.
Pendleton	(3)	(3)	Limestone.
Perry	18,858,574	19,399,773	Coal, petroleum.
Pike	(3)	(3)	Coal, petroleum, sand and gravel, sandstone.
Powell	(3)	(3)	Petroleum, limestone, miscellaneous clay.
Pulaski	(3)	(3)	Coal, limestone.
Rockcastle	(3)	(3)	Limestone, coal, petroleum.
Rowan	350,701	536,852	Fire clay, limestone, miscellaneous clay.
Russell	22,045	57,886	Petroleum.
Simpson	239,826	(3)	Limestone, petroleum.
Taylor	3,167,426	4,974,431	Petroleum.
Todd	(3)	(3)	Limestone, petroleum.
Trigg	34,125	174,705	Limestone.
Trimble		5	Gem stones.
Union	15,864,132	16,324,419	Coal, petroleum, sand and gravel, miscellaneous clay.
Warren	714,671	(3)	Limestone, petroleum.
Washington		(3)	Limestone.
Wayne	(3)	(3)	Limestone, petroleum, coal.
Webster	6,992,259	6,202,794	Coal, petroleum.
Whitley	(3)	(3)	Coal, petroleum, miscellaneous clay.
Wolfe	205,980	189,064	Petroleum, coal.
Undistributed [5]	205,748,418	199,968,391	
Total	418,821,000	413,517,000	

[1] Excludes natural gas and natural gas liquids; included with "Undistributed." The following counties did not report production: Bracken, Campbell, Grant, Larue, Lewis, Owen, Robertson, Scott, Shelby, Spencer, and Woodford.
[2] Other than natural gas and natural gas liquids.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Revised figure.
[5] Includes natural gas, natural gas liquids, and values indicated by footnote 3.

Boone.—Standard Materials Corp. (Belleview mine) and Kentucky Sand Co. (Taylorsport mine) mined sand and gravel for structural, paving, and fill uses.

Bourbon.—Bourbon Limestone Co., Inc. (Snapp quarry) and Hinkle Construction Corp. (Farmers quarry) crushed limestone for concrete, roads, and agstone.

Boyd.—Ferguson & Yates Coal Co. (No. 1 mine), Big Run Coal & Clay Co. (Big Run mine), Flo Glo Coal Co. (No. 2–A mine), and Kentucky Eagle Coal & Clay Co. (No. 1 mine) were the active coal producers. Big Run Coal & Clay Co., Inc. (Princess mine) mined miscellaneous clay for heavy clay products. Production of crude petroleum increased 1 percent.

Boyle.—Caldwell Stone Co., Inc. (Danville quarry) and Boyle County Highway Department (Perryville quarry) crushed limestone for concrete, roads, and agstone.

Breathitt.—Ten coal mines were active; leading producers were Island Creek Coal Co. (No. 3 Elkhorn mine) and Vires Coal Co. (Nos. 5 and 7 mines). Production of crude petroleum decreased 37 percent.

Breckinridge.—Kentucky Stone Co. (Webster quarry) and White Stone Co. (Hardinsburg quarry) produced limestone for riprap, concrete, roads, railroad ballast, and agstone. Ohio Valley Corp. mined structural and paving sand and gravel at the Cloverport mine. Murray Tile Co., Inc. (Cloverport mine) mined miscellaneous clay for floor and wall tile. Production of crude petroleum increased 39 percent.

Bullitt.—Kenlite Division of Kentucky Light Aggregates, Inc. (Shepherdsville mine) mined miscellaneous clay for producing lightweight aggregate.

Butler.—Boonville Coal Sales Corp. (South Hill Strip mine), Skoog & Stuart Coal Co. (Skoog & Stuart mine), and M. R. Melton Coal Co. (Green River No. 2 mine) were the leading coal producers. Seven coal mines were active. Production of crude petroleum decreased 13 percent.

Caldwell.—Cedar Bluff Stone Co. (Cedar Bluff mine) and Fredonia Valley quarries, Inc. (Fredonia quarry) crushed limestone for concrete, roads, and agstone. Watson Bridge Mining Co. (Caldwell County Strip mine) was the only coal producer. James H. Cravens mined a small quantity of fluorspar at the Tyree mine.

Calloway.—Murray Sand Co., Inc., and the State highway department mined sand and gravel for structural, paving, glass, molding, and refractory uses.

Carlisle.—The State highway department mined paving gravel.

Carroll.—Standard Materials Co. (Milton mine) and Carrollton Gravel-Sand Co., Inc. (Carrollton mine) mined structural and paving sand and gravel.

Carter.—Nineteen mines produced 203,000 tons of fire clay for firebrick and block and fire-clay mortar. The leading producers were the General Refractories Co. Olive Hill Strip mine and the Harbison-Walker Refractories Co. Brinegar Strip mine. Acme Stone Co., Inc., and Standard Slag Co. (Carter quarry) crushed limestone for concrete and roads. Gollihue & Green Coal Co. (No. 4 mine), Willard

Coal Co. (No. 4 mine), and Fields Branch Coal Co. (Grayson Block mine) were the active coal producers.

Casey.—Casey Stone Co. (Bethel Ridge mine) produced limestone for riprap, concrete, roads, and agstone. A small quantity of crude petroleum was produced.

Christian.—Hopkinsville Stone Co., Inc., Harry Berry, Inc., and Christian Quarries, Inc., crushed limestone for concrete, roads, and agstone. Ralph Ligon, Inc., produced coal at the No. 6 Strip mine. Production of crude petroleum increased 29 percent.

Clark.—Boonesboro Quarries, Inc., crushed limestone for concrete and roads.

Clay.—House Branch Coal Co. (No. 2 mine), Keith & Peters (No. 1 Strip mine), and B. G. & M. Coal Co. (No. 1 Strip mine) were the leading coal producers. There were 82 active coal mines.

Clinton.—Shamrock Stone Co. crushed limestone for concrete, roads, and agstone at the Caldwell quarry. Albany Coal Co. (No. 1 mine), Cross Bros. Coal Co. (No. 1 mine), and Massengale & Guinn Coal Co. (No. 1 mine) were the leading coal producers. Six coal mines were active. Production of crude petroleum increased 29 percent.

Crittenden.—Alexander Stone Co. (No. 1 quarry) produced limestone for riprap, concrete, roads, and agstone. Marion Mining Co., Inc. (Cook mine) and J. Willis Crider Fluorspar Co. (Pigmy mine) mined barite for use in oil well drilling. J. Willis Crider Fluorspar Co. (Pigmy mine) was the leading producer of fluorspar. Kentucky Fluorspar Co., Roberts & Frazer, and two other brokers purchased fluorspar from local and foreign producers for shipment to a variety of consumers. Calvert City Chemical Co. operated its flotation mill at Mexico, treating fluorspar from its Dyer's Hill mine in Livingston County. Production of crude petroleum decreased 43 percent.

Cumberland.—Production of crude petroleum was more than double that of 1959.

Daviess.—Green Coal Co. (K–9 Strip mine), Morris Enterprises (Morris Strip mine), and Daviess County Coal Co., Inc. (No. 1 mine) were the leading coal producers. Six coal mines were active. Owensboro River Sand & Gravel Co. and Daviess County Sand & Gravel Co. mined sand and gravel for structural, paving, engine, and fill uses. Joseph L. Clark Tile Co. (Moselyville mine) mined miscellaneous clay for heavy clay products. Production of crude petroleum decreased 12 percent.

Edmonson.—McLellan Stone Co. and Nolin Stone Co., Inc., produced limestone for riprap, concrete, roads, and agstone. Production of crude petroleum increased 42 percent.

Elliott.—Copley Coal Co. (No. 2 mine) and Ralph Hartman Coal Co. (No. 3 mine) were the active coal producers. Crude petroleum production decreased 17 percent.

Estill.—Estill County Stone Co., Inc. (Estill mine) crushed limestone for concrete and roads. Production of crude petroleum decreased 1 percent.

Fayette.—Central Rock Co. (Lexington mine and Lexington quarry), Lambert Bros. Division of Vulcan Materials Co., and Blue Grass Stone Co. crushed limestone for concrete, roads, and agstone.

Fleming.—Gorman Construction Co. crushed limestone for concrete, roads, and agstone at the Carpenter quarry.

Floyd.—Floyd County ranked fifth in value of mineral production. Inland Steel Co. (Wheelwright mine) and Princess Elkhorn Coal Co. (No. 2 and Open Fork mines) were the leading coal producers. Three hundred and forty-three coal mines were active. Mare Creek Sand Co., Inc. (Allen mine) mined structural sand. Production of crude petroleum decreased 32 percent.

Franklin.—Blanton Stone Co., Inc. (Frankfort mine), Franklin County Stone Co. (Franklin quarry), and Frankfort Builders Supply Co., Inc. (Devil's Hollow mine) produced limestone for riprap, concrete, roads, and agstone. The Majors Rocks collected a small quantity of gem stones (calcite).

Fulton.—Hickman Sand & Gravel Co. and the State highway department mined paving sand and gravel.

Gallatin.—Standard Materials Corp. (Warsaw mine) and C & H Gravel Co., Inc. (Sam Hill mine) mined structural and paving sand and gravel.

Graves.—Four mines produced 102,000 tons of ball clay for use in whiteware, stoneware, art pottery, enameling, floor and wall tile, fire-clay mortar, saggers, pins, stilts, wads, and other uses. The leading producer was Kentucky-Tennessee Clay Co. The State highway department mined paving gravel.

Grayson.—Rogers & Brunnhoeffer and Ragland Bros. (Leitchfield quarry) crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 53 percent.

Green.—Nally & Gibson Stone Co. (Greensburg quarry) crushed limestone for concrete and roads. Production of crude petroleum decreased 70 percent.

Greenup.—Nine mines produced 68,000 tons of fire clay for use in firebrick and block, fire-clay mortar, and heavy clay products. The leading producers were M. A. McCoy (Greenup Strip mine), Harbison-Walker Refractories Co. (Riggs mine), and Sparks & Durham Clay Co. Production of crude petroleum decreased 84 percent.

Hancock.—Charbon Stripping Co. (Hawesville strip mine) was the only active coal mine. Four mines produced miscellaneous clay for use in floor and wall tile and heavy clay products; leading producer was Cannelton Sewer Pipe Co. Production of crude petroleum decreased 9 percent.

Hardin.—Osborne Bros., Kentucky Stone Co., Inc. (Upton quarry and Lilmay mine), and Waters Construction Co. produced limestone for riprap, concrete, roads, railroad ballast, fertilizer filler, and agstone. Production of crude petroleum decreased 74 percent.

Harlan.—Harlan County ranked fourth in value of mineral production. United States Steel Co. (No. 32 and Lynch No. 31 mines), Stonega Coke & Coal Co. (Glenbrook High Splint mine), and International Harvester Co. (No. 4 mine) were the leading coal producers. There were 158 active coal mines. A small quantity of crude petroleum was produced.

Harrison.—Genet Stone Co., Inc., crushed limestone for concrete, roads, and agstone at the Cynthiana quarry.

615629—61——29

Hart.—McLellan Stone Co. crushed limestone for concrete, roads, and agstone at the Horse Cave quarry. Production of crude petroleum was more than five times that reported for 1959.

Henderson.—Dolph Hazelwood Coal Co. (Mike & Pat mine), Community Coal Co. (Community mine), and Henderson Mining Co., Inc. (No. 1 Henderson mine) were the leading coal producers. There were 10 active coal mines. Bedford-Nugent Co., Inc., mined sand and gravel for structural, paving, and fill uses. Production of crude petroleum increased 1 percent.

Henry.—Geoghegan & Mathis, Inc., crushed limestone for concrete, roads, and agstone. The Majors Rocks collected a small quantity of gem stones (flint and fossils).

Hickman.—The State highway department mined 26,000 tons of paving gravel.

Hopkins.—Hopkins County led in value of mineral production. West Kentucky Coal Co. (Pleasant View mine), Peabody Coal Co. (White City Strip mine), and Coiltown Mining Co. (Coiltown mine) were the leading coal producers. There were 43 active coal mines. Green River Clay Products mined miscellaneous clay for heavy clay products at the Ashbyburg mine. Production of crude petroleum decreased 27 percent.

Jackson.—Moore Coal Co., Inc. (Moore No. 4 mine), Walker Harrison Coal Co. (No. 1 mine), and Marcum Coal Co. (Travis Creek Strip mine) were the leading coal producers. Nineteen coal mines were active. M. A. Walker & Co. crushed limestone for concrete and roads at the Clover Bottom and Indian Creek mines. Production of crude petroleum was more than double the 1959 production.

Jefferson.—Kosmos Portland Cement Co. produced masonry and portland cements at the Kosmosdale mill. Limestone was crushed at six quarries and one mine for concrete, roads, railroad ballast, and agstone. The leading producers were Louisville Crushed Stone Co. (Louisville mine), Louisville Sand & Gravel Co., and Falls City Stone Co. (Fern Creek quarry). Six mines produced structural, paving, fertilizer filler, and fill sand and gravel; leading producers were Ohio River Sand Co., Inc., and E. T. Slider Co., Inc. Kosmos Portland Cement Co. (Kosmosdale mine) and General Shale Products Co. (Coral Ridge mine) mined miscellaneous clay for cement and heavy clay products.

Jessamine.—Kentucky Stone Co. crushed limestone for concrete, roads, agstone, and railroad ballast at the High Bridge mine.

Johnson.—Tutor Key Coal Co. (No. 132 mine), Whitten Coal Co. (No. 8 mine), and Victoria Mining Co. (No. 2 mine) were the leading coal producers of the 58 active mines. Production of crude petroleum decreased 8 percent.

Kenton.—The Franxman Bros. crushed limestone for concrete and roads at the Covington quarry.

Knott.—Co-Dee Coal Co. (No. 3 Auger mine), Pine Bluff Coal Co. (No. 1 mine), and Riddle Coal Co., Inc. (Walkers Branch mine) were the leading coal producers of the 178 active mines. Production of crude petroleum increased 30 percent.

Knox.—Kentucky Knox Mining Co., Inc. (No. 1 Strip and No. 1 Auger mines) and F & M Coal Co. (No. 1 Strip mine) were the leading

coal producers of the 82 active mines. Production of crude petroleum more than tripled that of 1959.

Laurel.—Engle Mining Co. (No. 2 mine), Margin Coal Co. (No. 2 mine), and A. A. Fuson Coal Co. (No. 2 Strip mine) were the leading coal producers of the 16 active mines. Production of crude petroleum decreased 72 percent.

Lawrence.—Phillip Preece, Jr., Coal Co. (No. 1 Strip mine) and Thomson & Polly Coal Co. (No. 1 mine) were the leading coal producers of the 6 active mines. Production of crude petroleum increased 18 percent.

Lee.—Congleton Bros., Inc. (Pacemaker mine), Kentucky River Collieries, Inc. (No. 15 mine), and Cave Branch Coal Co. (No. 1A mine) were the leading coal producers of the 8 active mines. Kentucky Stone Co. crushed limestone for concrete, roads, railroad ballast, and agstone at the Yellow Rock mine. Production of crude petroleum increased 31 percent.

Leslie.—Deby Coal Co. (Deby No. 2 and Deby No. 3 mines), Mary Gail Coal Co. (No. 7 mine), Shamrock Coal Co. (No. 8 mine), and Lynn Mining Co. (No. 1 mine) were the leading coal producers. Forty-nine mines were active. Production of crude petroleum increased 11 percent.

Letcher.—Letcher County ranked sixth in value of mineral production. Bethelehem Mines Corp. (No. 22 mine), South East Coal Co. (Big Chief mine), and United States Steel Corp. (Lynch No. 31 mine) were the leading coal producers. There were 235 active coal mines. Hurricane Gap Quarries, Inc., crushed limestone for concrete and roads. Production of crude petroleum increased substantially over the amount reported for 1959.

Lincoln.—Production of crude petroleum increased 38 percent.

Livingston.—Reed Crushed Stone Co., Inc., produced limestone for riprap, concrete, roads, agstone, and railroad ballast at the Grand Rivers quarry. Calvert City Chemical Co. (Dyer's Hill mine) and Atwood Mining Co. (Atwood mine) mined fluorspar for metallurgical uses and for manufacturing hydrofluoric acid. Byproduct zinc and lead were recovered from fluorspar milling. The State highway department mined paving gravel.

Logan.—Kentucky Stone Co. crushed limestone for concrete, roads, railroad ballast, and agstone at the Russellville mine. Kentucky Flagstone Co. (Lewisburg quarry) and Kentucky Kolor Stone Corp. (Russellville quarry) quarried dimension sandstone for rough and dressed building stone and for flagging. Production of crude petroleum decreased 18 percent.

Lyon.—The State highway department mined paving gravel.

Magoffin.—Trusty Coal Co. (No. 2 mine), Tip Top Coal Co. (No. 8 mine), and Wiley Harper Coal Co. (No. 1 mine) were the leading coal producers. Ten coal mines were active. Production of crude petroleum decreased 12 percent.

Marion.—Ward & Montgomery (Lebanon quarry) and Lebanon Stone Co. crushed limestone for concrete, roads, and agstone. Marion County Highway Department mined paving gravel.

Marshall.—The State highway department mined paving gravel.

Martin.—Webbs Coal & Mining Co. (No. 2 mine), Warfield Mining Co. (No. 1 mine), and S & K Coal Co. (No. 2 mine) were the leading coal producers. Five coal mines were active. Production of crude petroleum decreased 4 percent.

Mason.—J. F. Hardymon Co. mined structural, paving, and fill sand and gravel.

McCracken.—Federal Materials Co., Inc., mined structural sand and gravel at the Paducah mine.

McCreary.—Stearns Coal & Lumber Co. (No. 18 and No. 16–2 mines) and B. R. Campbell & Son, Inc. (Campbell Strip mine) were the leading coal producers. Ten coal mines were active. Thomas C. Mayne quarried dimension sandstone for rough and dressed building stone at the Day Ridge quarry. Production of crude petroleum increased 7 percent.

McLean.—Highview Coal & Construction Co. (Centertown No. 1 Strip mine) was the only coal producer. Production of crude petroleum decreased 14 percent.

Meade.—Kosmos Portland Cement Co. (Hartford quarry) and Owensboro River Sand & Gravel Co. (Riverside mine) crushed limestone for cement, concrete, roads, and agstone.

Menifee.—A. W. Walker & Son crushed limestone for concrete and roads at the Frenchburg quarry. America Coal Co. (No. 1 mine) was the only coal producer. Production of crude petroleum decreased 53 percent.

Mercer.—Mercer Stone Co. and Mercer County Highway Department crushed limestone for concrete, roads, and agstone.

Metcalfe.—Montgomery & Co. crushed limestone for concrete, roads, and agstone at the Chapman quarry. Production of crude petroleum decreased 33 percent.

Monroe.—Trico Stone, Inc., crushed limestone for concrete, roads, and agstone at the Monroe quarry. Production of crude petroleum increased substantially over the amount reported for 1959.

Montgomery.—A small quantity of crude petroleum was reported.

Morgan.—Licking River Limestone Co. (Zag quarry), Kentucky Road Oiling Co. (Wrigley quarry), and Morgan County Limestone, Inc., crushed limestone for concrete, roads, and agstone. Marshall & Sheets Coal Co. (No. 1 Strip mine) and Marsillett Coal Co. (Nos. 9 and 11 mines) were the leading coal producers. Six coal mines were active. Production of crude petroleum increased 18 percent.

Muhlenberg.—Muhlenberg County ranked third in value of mineral production. River Queen Coal Co. (River Queen Strip mine), Peabody Coal Co. (Vogue Strip mine), and Gibralter Coal Corp. (Gibralter Strip mine) were the leading coal producers. There were 22 active coal mines. Greenville Quarries, Inc., crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 10 percent.

Nelson.—Geoghegan & Mathis crushed limestone for concrete, roads, and agstone at the Nelson quarry.

Nicholas.—Nicholas County Highway Department crushed limestone for concrete and roads..

Ohio.—Peabody Coal Co. (Ken Strip and Ken Highwall No. 2 mines) and Riverview Coal Co. (No. 1 Strip mine) were the leading

coal producers. Twenty-four coal mines were active. Fort Hartford Stone Co .and State Contracting & Stone Co. produced limestone for riprap, concrete, roads, railroad ballast, and agstone. Production of crude petroleum decreased 1 percent.

Oldham.—Ohio River Stone Co., Joe Clark Stone Co., and W. T. Liter (Crestwood mine) crushed limestone for concrete, roads, and agstone.

Owsley.—The Wilmuth Corp. (Early Bird Strip mine) and Reynolds Coal Co. (No. 3 mine) were the two active coal producers. Production of crude petroleum more than doubled that reported for 1959.

Pendleton.—Geoghegan & Mathis crushed limestone for concrete, roads, and agstone at the Butler and Falmouth quarries.

Perry.—Perry County ranked seventh in value of mineral production. Blue Diamond Coal Co. (Leatherwood Nos. 1 and 2 mines) and Jewel Ridge Coal Corp. (Blair Fork mine) were the leading coal producers. There were 107 active coal mines. Production of crude petroleum increased substantially over the amount reported for 1959.

Pike.—Pike County ranked second in value of mineral production. Eastern Coal Corp. (Stone mine), Republic Steel Corp. (Republic mine), and Kentland-Elkhorn Coal Co. (Kentland No. 1 mine) were the leading coal producers. There were 474 active coal mines. Pike Sand Co. (Walters mine) mined structural sand. Silica Corp. of America crushed sandstone for glass and miscellaneous uses. Production of crude petroleum decreased 16 percent.

Powell.—A. W. Walker & Son crushed limestone for concrete and roads at the Whiterock quarry. Big Run Coal Co. and H. B. Sipple Brick Co. (Faulkner No. 1 mine) mined miscellaneous clay for heavy clay products. Production of crude petroleum increased 63 percent.

Pulaski.—Ikerd & Bandy Coal Co., Inc. (No. 3 Strip mine) and Mount Victory Coal Co. (No. 1 mine) were the leading coal producers. Eleven coal mines were active. Somerset Stone Co., Inc. (Somerset quarry) and Strunk Construction Co. (Tateville quarry) crushed limestone for concrete, roads, and agstone.

Rockcastle.—Black Foot Coal Co. (No. 2 mine) and Low Ash Coal Co. (No. 1 mine) were the leading coal producers. Five coal mines were active. Kentucky Stone Co. (Mt. Vernon and Mullins mines) crushed limestone for concrete, roads, railroad ballast, and agstone. Initial production of crude petroleum was reported.

Rowan.—Morehead Limestone Co. and Kentucky Road Oiling Co. (Christy quarry) crushed limestone for fluxing stone, concrete, roads, and agstone. General Refractories Co. (Johnson and Caudill mines) mined fire clay for firebrick and block. Lee Clay Products Co., Inc. (Lee Clay mine) mined miscellaneous clay for heavy clay products.

Russell.—Production of crude petroleum increased substantially over the amount reported for 1959.

Simpson.—Southern Stone Co., Inc., crushed limestone for concrete, roads, and agstone at the Franklin quarry. Production of crude petroleum increased 31 percent.

Taylor.—Production of crude petroleum increased 59 percent.

Todd.—Kentucky Stone Co., Inc. (Todd quarry) and D. W. Dickinson & Son (Gallatin quarry) crushed limestone for concrete, roads, and agstone. Production of crude petroleum decreased 5 percent.

Trigg.—Cedar Bluff Stone Co., Inc., crushed limestone for concrete, roads, and agstone at the Canton and Cerulean quarries.

Trimble.—The Majors Rocks collected a small quantity of gem stones (pyrite).

Union.—Nashville Coal Co., Inc. (Uniontown mine), Pittsburg & Midway Coal Mining Co. (Dekoven mine), P & S Coal Co. (No. 1 Strip mine), and Louis F. Chapman (No. 1 Strip mine) were the active coal producers. Union Sand & Gravel Co. mined structural and paving sand and gravel. Clarks Clay Products Co. mined miscellaneous clay for heavy clay products. Production of crude petroleum increased 4 percent.

Warren.—McLellan Stone Co. (Warren and Smith Grove quarries) and Gary Bros. Crushed Stone Co. crushed limestone for concrete, roads, and agstone. Production of crude petroleum increased 3 percent.

Washington.—Nally & Gibson crushed limestone for concrete and roads.

Wayne.—Bassett Products Co. crushed limestone for concrete, roads, and agstone. Thomas Jones Coal Co. (No. 1 mine) and Lewis Roberts Coal Co. (No. 1 mine) were the only active coal producers. Production of crude petroleum increased 6 percent.

Webster.—Hart & Hart Coal Co. (Precision Washed Strip mine) and Russell Badgett Coal Co. (Choctaw Strip mine) were the leading coal producers. Seven coal mines were active. Production of crude petroleum decreased 4 percent.

Whitley.—Round Mountain Coal Co., Inc. (No. 1 Strip mine), Whitley Strip Mining Co., Inc. (Whitley Strip mine), and Reaves Dixie Gem Coal Co. (No. 3 mine) were the leading coal producers. Fifty coal mines were active. Corbin Brick Co. mined miscellaneous clay for heavy clay products. Production of crude petroleum increased substantially over the amount reported for 1959.

Wolfe.—C. L. Thompson Coal Co. (Miller mine), Perry Coal Co. (No. 1 mine), and Vancleave & Gibbs Coal Co. (No. 1 mine) were the active coal producers. Production of crude petroleum decreased 21 percent.

The Mineral Industry of Louisiana

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Louisiana Geological Survey.

By Peter Grandone [1] and Leo W. Hough [2]

LOUISIANA ranked second among the States in value of mineral production for the third consecutive year. To keep pace with Louisiana's accelerated industrial development, new records were made in output of crude petroleum, natural gas, natural gas liquids, and sulfur (in order of value).

The Louisiana mineral industry was dominated by crude petroleum, natural gas, and natural gas liquids, which furnished 94 percent of the total value of mineral output. Proved recoverable reserves of these fuels reached new highs despite increased production. In quantity of reserves added during 1960, Louisiana ranked first in the Nation for petroleum and natural gas and second for natural gas liquids. Nationally, recoverable reserves showed gains for natural gas and natural gas liquids and a loss for petroleum.

TABLE 1.—Mineral production in Louisiana [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clay—thousand short tons	[2] 904	[2] $904	749	$749
Natural gas—million cubic feet	2,670,271	411,222	2,988,414	511,019
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	846,110	60,295	875,567	66,214
LP gases—do	540,046	25,877	606,023	28,147
Petroleum (crude)—thousand 42-gallon barrels	362,666	1,145,569	[3] 394,360	[3] 1,237,823
Salt—thousand short tons	4,807	20,918	4,792	21,959
Sand and gravel—do	16,052	20,111	14,319	19,106
Stone (shell)—do	5,670	10,874	4,691	8,382
Sulfur (Frasch-process)—thousand long tons	2,252	52,779	2,256	52,639
Value of items that cannot be disclosed: Cement, bentonite (1959), gypsum, lime, and miscellaneous stone		20,286		24,042
Total Louisiana [4]		[5] 1,766,269		1,967,652

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite, included with "Value of items that cannot be disclosed."
[3] Preliminary figure.
[4] Total adjusted to eliminate duplicating value of clays used for cement and shell used in manufacturing lime and cement.
[5] Revised figure.

[1] Commodity-industry analyst, Bureau of Mines, Bartlesville, Okla.
[2] State geologist, Louisiana Geological Survey, Baton Rouge, La.

Construction of new plants and additions to existing petrochemical plants, natural gasoline plants, and refineries continued at a high level throughout the year. The Louisiana State Board of Commerce and Industry approved a total investment of $188 million in applications for new manufacturing plants and expansions of existing plants in 1960. Applications approved in 1959 for new industrial facilities had totaled $133 million. Also in 1960, the Board approved 180 industrial applications for ad valorem tax exemptions on new facilities. Of the total, 58 were for completely new manufacturing plants.

Among new industries coming to Louisiana was the $50 million petrochemical complex at Geismar, operated by Monochem, Inc., which was jointly owned by The Borden Co. and U.S. Rubber Co.

Freeport Sulphur Co. commenced operating its $30 million offshore mining platform in the Gulf of Mexico near Grand Isle. The huge facility, capable of producing 4,500 tons of molten sulfur daily, was connected to storage tanks on Grand Isle by a $2 million pipeline.

The Mississippi River is one of the greatest industrial attractions to the Baton Rouge-New Orleans area. The river is the largest freshwater supply in the United States, with an annual flow of over 300 billion gallons a day—more water than is used in the entire Nation. The river is navigable for large ocean-going vessals as far as Baton Rouge, and provides low-cost barge transportation to stations on the Mississippi, Ohio, Illinois, and Missouri Rivers.

The first phase of construction was completed on the Port of New Orleans bulk unloading facility on the new Mississippi River-Gulf Outlet. The terminal was capable of unloading, storing, and transferring bulk materials such as ores, sand, gravel, rock, shell, and coal. Bestwall Gypsum Co., first industry to contract for use of the unloading facility, constructed a $6 million wallboard plant on a 30-acre site adjacent to the terminal. The Mississippi River-Gulf Outlet will shorten the distance between New Orleans and the Gulf by 50 miles and will provide one-way ship traffic by 1962 and two-way traffic when fully completed in 1969.

Elsewhere, construction of two other major canal and docking facilities was announced. The Houma Navigation Canal from Houma to the Gulf, designed exclusively for barge traffic, was to be enlarged to take deep-water vessels. When completed, it was expected to make Houma a major terminus on the Gulf Intercoastal Waterway and open the area to further industrial development. Near Morgan City, a $50 million industrial marine complex to be known as Acadian Gateways was planned for a 16,000-acre tract bordering Bayou Black—an outlet to the Gulf and to the Intercoastal Canal.

To keep pace with industrial expansion, several Louisiana power and light companies were building new steam-electric generating stations and were adding generating units to existing stations. At St. Gabriel in Ascension Parish, Gulf States Utilities Co. dedicated the first 165,000 kilowatt generating unit at its $22 million Willow Glen plant. Future planning included the addition of a 220,000 kilowatt unit about 1965.

Legislation.—The U.S. Supreme Court issued a formal decree on December 12 to carry out its Gulf Coast tidelands oil decision of May.

The decree provided that Texas and Florida were entitled to the rich undersea deposits to a distance of 10½ statute miles, or 3 leagues. Louisiana, Alabama, and Mississippi were confined to the usual offshore boundary of 3 geographical miles.

The State and Federal Governments were making a joint survey to determine the physical measurements of the shoreline; subsequently about $308 million, held in escrow by the Federal Government under a separate agreement between the two parties signed on October 12, 1956, will be divided.

On May 31, the State Legislature passed a $55 million gas severance tax bill. The 2.3 cent tax per 1,000 cubic feet of gas produced was scheduled to expire August 1. The new bill extended it to June 30, 1964.

Employment.—Employment in the petroleum industry in 1960 was 85,860 workers—2,890 less than in 1959. In production of minerals, including fuels, employment in establishments with four or more employees was down 3.8 percent and wages were down 3.3 percent from 1959. Oil and gas operations provided 91 percent of the employment and 93 percent of the wages in 1960.

Approximately 17,000 persons were employed in manufacturing chemicals and allied products from petroleum, the largest manufacturing industry in the State. The annual payroll of these chemical industries was nearly $100 million as reported by the manufacturing Chemists' Association. However, it is difficult to segregate employment between petrochemical plants and petroleum refineries because some refineries also produce petrochemicals.

As reported by the Louisiana Department of Commerce and Industry, construction of 58 new plants and expansion of 122 facilities (various industries) in 1960 created 3,800 permanent jobs. Employment for building these facilities in 1960 was 4,156 for the 58 new plants and 5,588 for the 122 expansions.

TABLE 2.—Employment and wages in the mineral industries [1]

Industry	Average number of workers		Total wages and salaries (thousands)	
	1959	1960 [2]	1959	1960 [2]
Crude petroleum production, natural gas, and natural gas liquids	20,067	19,720	$137,221	$135,488
Oil- and gas-field contract services [3]	21,806	20,456	118,444	110,908
Sand and gravel pits and dredges	1,450	1,390	5,556	5,103
Salt mines	800	795	3,609	3,707
Nonmetallic minerals [4]	1,550	1,580	10,095	10,621
Total	45,673	43,941	274,925	265,827

[1] The Louisiana Unemployment Compensation Law covers four or more employees.
[2] Preliminary figures.
[3] Includes approximately 3,300 formerly in service industries. The additional item is geophysical services.
[4] Mainly sulfur, excludes shell production workers.

Source: Louisiana State Department of Labor, Division of Employment Security.

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 manufactured as byproducts of petroleum or used in the refining of petroleum [2]	Total
1951–55 (average)	29,453	15,799	1,473	4,810	3,473	6,192	10,276	71,476
1956	40,200	15,500	1,400	5,600	4,400	8,400	12,050	87,550
1957	42,300	15,700	1,500	5,800	4,700	8,400	12,350	90,750
1958	[3] 41,350	15,450	1,400	6,000	4,600	8,600	13,050	90,450
1959 [4]	42,100	13,500	1,320	6,380	4,440	9,000	12,100	88,840
1960 [5]	[3] 39,900	13,400	1,260	6,400	4,300	8,900	11,700	85,860

[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.
[4] Revised figures.
[5] Preliminary figures.

Source: Louisiana State Department of Labor, Division of Employment Security.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Louisiana was again a leading domestic producer of crude petroleum and natural gas and remained a major supplier of natural gas liquids and refined petroleum products.

Annual offshore leasing of mineral rights was held on February 24, and high bids totaling a record $285 million were accepted for 173 tracts of disputed Louisiana tidelands by a joint six-man committee representing the Louisiana Mineral Board and the Federal Bureau of Land Management. Onshore leasing also was in the spotlight, as one of the largest transferrals of producing property in the Louisiana history of oil and gas business was completed. Tennessee Gas Transmission Co. paid Pan American Petroleum Co. about $150 million for 10 leases in the Bastian Bay area of Plaquemines Parish. The properties involved 11 producing gas wells and 13 producing oil wells.

Despite depressed oil markets, regulatory uncertainties, and higher costs of drilling, the offshore oil industry staged a remarkable recovery from the recession that began in 1957. Development of the prolific

TABLE 4.—Value of construction contracts awarded

(Thousand dollars)

Type	1957	1958	1959	1960	Percent change from 1959
Residential [1]	$235,943	$245,604	$258,974	$206,129	−20.4
Nonresidential [2]	205,035	164,070	171,565	182,227	+6.2
Public works and utilities	188,653	268,513	230,716	190,522	−17.4
Total	629,631	678,187	661,255	578,878	−12.5

[1] Includes apartments, hotels, dormitories, and one- and two-family dwellings.
[2] Includes commercial, manufacturing, educational, and other nonresidential buildings.

Source: Louisiana Business Review, Dodge Statistical Research Service: Vol. 25, No. 2, February 1961, p. 14.

South Pass Block 24 Field dramatized the growing importance of the controversy-ridden Louisiana tidelands. Fifty-six drilling rigs operated offshore in 1960, compared with a low of 33 rigs in 1958. New, faster drilling techniques were used to overcome the higher costs of drilling in tidelands. Offshore production rose to one-fifth of the State oil (crude oil and field condensate) output and about one-eighth of the State natural gas production. Enthusiasm about the tidelands continued because these areas were considered most promising for development of domestic oil and gas.

Exploration and Reserves.—The number of wells drilled for petroleum and natural gas—3,712—was 2 percent less than in 1959. Statewide drilling of 968 exploratory wells (3 less than in 1959) proved 26 percent productive (28 percent in 1959) and led to discovery of 60 oil or natural gas fields, 13 oil and 4 gas discoveries were in north Louisiana, 19 oil and 18 gas discoveries were in south Louisiana, and 1 oil and 5 gas discoveries were offshore.

The Oil and Gas Journal reported that 28.7 million feet of hole was drilled during the year, only slightly less than the footage drilled in 1959 and 4 percent less than the record footage drilled in 1957.

Although total wells drilled and total wells completed dropped in 1960, the success ratio of exploratory wells was outstanding. Offshore, gains were made for number of exploratory wells drilled and number of exploratory wells completed.

The number of rigs operating offshore averaged 55 in 1960 and 49 in 1959; for the entire State, the average number was 287 in 1960 and 332 in 1959.

A report published by the Louisiana Geological Survey was expected to stimulate new interest in Sabine Parish and promote more exploration for oil and gas. Subsurface data for the study was obtained from logs of recently drilled deep wells. Although oil was the principal natural resource for the parish, the report included information on lignite, glauconite, and bentonite found in the area.[3]

Proved recoverable reserves of crude petroleum, natural gas, and natural gas liquids reached a new high despite increased withdrawal of each. Much of the increase in reserves came from extensions and revisions of previous estimates involving pools and fields discovered before 1960. The State petroleum reserves increased 125 million barrels (largest gain in the Nation) to a new record total of 4,785 million barrels (15 percent of the Nation's total oil reserves). About 30 percent of the crude petroleum reserve was offshore, compared with 30 percent in 1959 and 27 percent in 1958. Natural gas reserves increased 3.5 trillion cubic feet (the net increase for the United States was 1.2 trillion cubic feet) to a new record total of 63.4 trillion cubic feet (24 percent of the U.S. total natural gas reserve). Natural gas liquids reserve increased 75 million barrels (26 percent of the U.S. net increase) to a new record total of 1,433 million barrels (21 percent of the U.S. total).

Carbon Black.—Facilities added in 1959, by Continental Carbon Co., resulted in a 5-percent gain in the 1960 output of carbon black. The product was mainly used as an additive in rubber manufacturing.

[3] Andersen, H. V., The Geology of Sabine Parish. Louisiana Geological Survey, Geol. Bull. 34, 1960, 164 pp.

TABLE 5.—Crude petroleum production and estimated reserves in Louisiana offshore area

(Thousand barrels)

Offshore area	Number of wells		1959	1960	Estimated reserve
	1959	1960	Crude petroleum	Crude petroleum	
Bay Marchand: Block 2 [1] [2]	199	276	6,093	9,858	157,844
Belle Isle [2]	34	30	749	880	18,600
Caillou Island [1] [2]	446	472	15,062	16,694	140,278
Eugene Island:					
Block 18	31	55	1,223	2,482	33,546
Block 32	27	17	1,046	889	18,827
Block 126 [1]	70	79	3,396	3,176	104,286
Block 128	41	47	1,776	2,063	32,945
Block 188	18	20	721	1,026	13,105
Grand Isle:					
Block 16	57	87	2,410	3,819	55,828
Block 18	32	37	1,818	1,813	25,965
Block 47	58	68	3,340	3,974	49,970
Lake Washington [1] [2]	343	341	10,902	10,863	146,798
Main Pass: Block 69 [1]	180	182	7,417	7,305	154,543
Ship Shoal:					
Block 154	42	37	1,814	1,565	33,823
Block 176	----------	16	----------	682	11,318
South Pass:					
Block 24 [1] [2]	521	525	16,423	16,528	183,656
Block 27 [1]	147	198	5,620	7,274	128,898
Timbalier Bay [1] [2]	295	318	10,220	11,695	143,433
South Timbalier: Block 131	----------	14	----------	697	10,943
Vermilion: Block 120	----------	12	----------	389	10,936
West Cameron: Block 45	20	15	530	2,449	22,355
West Delta:					
Block 30 [1]	173	174	6,314	7,444	107,524
Block 53 [2]	14	13	1,044	817	16,832
Total	2,748	3,033	97,918	114,382	1,622,253

[1] Estimated ultimate recovery of 100 million barrels or more.
[2] Combined onshore and offshore.

Source: Oil and Gas Journal, vol. 59, No. 5, Jan. 30, 1961, pp. 127–128.

TABLE 6.—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
1951	232	100	1,054	472	22	41
1952	244	273	1,237	2,447	23	29
1953	257	202	1,294	3,007	23	100
1954	247	202	1,399	2,341	23	71
1955	271	294	1,680	5,636	26	52
1956	299	420	1,886	2,618	26	79
1957	330	182	2,079	6,382	26	4
1958	314	186	2,452	3,676	28	177
1959	[1] 363	616	[1] 2,670	4,742	33	162
1960	[2] 394	125	[2] 2,935	3,532	35	75

TOTAL PROVED RESERVES ON DEC. 31, 1960

1960	4,785	63,386	1,433

[1] Revised figure.
[2] Preliminary figure.

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: Vols. 4–15, 1949–60.

TABLE 7.—Carbon black production

Year	Million pounds	Year	Million pounds
1951–55 (average)	353	1958	503
1956	538	1959	599
1957	534	1960	631

Natural Gas.—Marketed production of natural gas continued a strong upward trend for the 15th consecutive year and Louisiana retained second position in the United States as a supplier of natural gas. National demand, both as a fuel and as a raw material, for petrochemicals continued to grow rapidly. Construction of offshore pipelines was continued to provide a market outlet for added gas reserves.

About 18 percent of the natural gas production was credited to north Louisiana (20 percent in 1959); 68 percent to south Louisiana (unchanged from 1959); and 14 percent to the offshore area (12 percent in 1959).

J. R. McDermott & Co., Inc., completed five shut-in gas wells and commenced a sixth well in the Block 68 Field, West Cameron Area, offshore Louisiana, then signed a gas-sale contract with Tennessee Gas Transmission Co. covering the reserves. The initial price to be paid by Tennessee was 22 cents per thousand cubic feet plus 1.8 cents per thousand cubic feet tax reimbursement. Under the contract the initial minimum delivery quantity per day would be an estimated 20 million cubic feet. The contract was subject to Federal Power Commission approval.

In the Eugene Island area, offshore from St. Mary Parish, the industry was drilling and completing multiple-zone wells with as many as five producing strings of pipe in each. The world's first quintuple producing well was completed by Sinclair Oil & Gas Co. and Associates in 72 feet of water at No. 6 Block 190 well. The operator completed the well in six zones, five of which may produce simultaneously. Five parallel 2-inch tubing strings with six packers were run inside the 9⅝-inch casing. On calculated open-flow potential tests, six zones of the Pliocene formation (depth of 6,156 to 7,104 feet) produced at the rate of 492 million cubic feet of gas per day. The five tubing strings will permit Sinclair to produce five zones simultaneously. The No. 2 zone was isolated by the additional packer to allow this zone to be produced alternately with No. 1 zone or when the lowest sand has been depleted.

Natural Gas Liquids.—Louisiana ranked second as a producer of natural gas liquids. Natural gasoline and cycle products were recovered by 78 plants (7 more than in 1959) in 30 parishes. Increased output of total condensable liquids was attributed mainly to a gain in natural gas produced and processed, especially casinghead gas from oil wells. A 12-percent gain (31 percent in 1959) by LP gases represented most of the increased output of condensable liquids. This confirmed the trend in natural gasoline plans to remove more butane from natural gasoline, then process the remaining heavier

TABLE 8.—New oil and gas discoveries in 1960, by parishes

Parish and field	Total depth (feet)	Production depth (feet)	Daily production rate (initial test)		Type of product
			Barrels	Thousand cubic feet	
North Louisiana:					
Catahoula:					
Boltners Brake	5,110	4,915–4,925	84	----------	Oil.
California Bayou	3,940	3,851–3,854	81	----------	Do.
South Utility	5,827	2,441–2,445	15.10	----------	Do.
Utility	5,521	2,378–2,379	28	----------	Do.
Wallace Lake	5,077	4,371–4,372	209	----------	Do.
Claiborne:					
Lick Creek	10,271	10,001–10,003	195	258	Do.
Oaks	10,872	10,684–10,704	98	147	Do.
Concordia:					
Lower Sunk Lake	8,511	5,923–5,925	106	42	Do.
Moro	3,855	3,737–3,745	5	----------	Do.
Whites Bayou	4,737	4,700–4,707	30	----------	Do.
DeSoto:					
Brushy Bayou	3,026	2,854–2,896	32	----------	Do.
Catuna	3,226	2,930–2,934	----------	3,932	Gas.
La Salle:					
Bayou Castor	2,700	2,607–2,626	----------	4,900	Do.
Searcy	3,757	2,691–2,693	33.64	----------	Oil.
Jackson: Cartwright	10,500	9,842–9,854	415	1,964	Gas.
Red River: Bayou Pierre	3,364	2,742–2,750	----------	250	Do.
Winn: Salt	1,457	1,409–1,411	21	----------	Oil.
South Louisiana:					
Allen: Spring Gully	8,214	7,825–7,831	120	96	Do.
Assumption: Pierre Pass	13,848	13,210–13,244	107	728	Do.
Beauregard:					
Brushy Creek	8,500	7,548–7,551	89	900	Do.
Buckston Marsh	8,506	7,587–7,590	70	105	Do.
Righthand Creek	9,230	8,672–8,678	142	81	Do.
Calcasieu:					
North Hayes	10,547	10,528–10,533	114	150	Do.
South Iowa	10,209	9,743–9,748	54	1,664	Gas.
South Bon Air	10,600	10,088–10,093	67.9	1,653	Do.
Cameron:					
Blue Buck	14,500	7,953–7,970	12	1,500	Do.
Deep Bayou	10,000	8,231–8,234	202	191	Oil.
Smith Ridge	11,500	7,655–7,661	48	2,100	Gas.
E. Baton Rouge: Sardine Point	10,997	9,679–9,684	240	155	Oil.
Evangeline:					
Fenris	8,610	8,038–8,044	162	163	Do.
North Savoy	10,460	10,027.5–10,031.5	105	580	Gas.
Iberia: S. Lake Sand	15,650	14,843–14,849	134	2,400	Do.
Iberville:					
Pat Bay	10,412	10,112–10,116	125	200	Oil.
Bayou Jacob	13,850	10,964–10,972	130	60	Do.
West Rosedale	10,074	9,996–10,064	45	344	Gas.
Jefferson: Bayou Segnette	10,500	9,196–9,202	324	155	Oil.
Lafayette:					
North Scott	12,962	12,756–12,774	184	3,487	Gas.
Vatican	11,647	10,951–10,969	145	5,000	Do.
Lafourche:					
Bayou Poignard	13,006	11,587–11,602	123	1,932	Gas.
Choctaw School	13,538	12,529–12,540	1	3,100	Do.
Point Chicot	11,850	10,952–10,961	120	3,965	Do.
Plaquemines: South Adams Bay	14,758	13,356–13,365	192	162	Oil.
Pointe Coupee: Kenmore	9,300	9,192–9,195	216	----------	Do.
St. John the Baptist: Frenier	10,460	9,037–9,041	144	127	Do.
St. Landry:					
Chataignier	9,224	8,601–8,605	144	132	Do.
Veltin	10,999	10,860–10,880	72	1,725	Gas.
St. Martin:					
South Happytown	12,515	12,058–12,063	60	540	Oil.
Tangipahoa: Wilmer	12,406	12,175–12,194	186	101	Do.
Terrebonne:					
South Sunrise	17,070	16,684–16,694	31.32	5,704	Gas.
South Chauvin	14,000	13,587–13,628	170	4,760	Do.
Vermilion:					
Cossinade	17,280	11,817–11,824	125	200	Oil.
Kaplan	11,570	11,363–11,383	132	4,686	Gas.
North White Lake	14,859	14,352–14,362	243	9,800	Do.
South Perry	15,856	14,717–14,732	185	4,775	Do.
Offshore:					
St. Mary: Eugene Island Block 100	13,596	12,292–12,298	324	390	Oil.
Terrebonne: Ship Shoal Block 169	11,495	11,055–11,100	12	4,000	Gas.
Vermilion: S. Marsh Island Block 23	13,982	12,000–12,022	75	2,963	Do.

Source: Louisiana State Department of Conservation, Annual Oil and Gas Report 1960, pp. 8–11.

TABLE 9.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1960, by parishes

Place	Drilling							Geophysical, crew-weeks		
	Proved field wells			Exploratory wells			Total	Method		
	Oil	Gas	Dry	Oil	Gas	Dry		Gravity meter	Reflection seismograph	Total
Parish:										
Acadia	43	20	33	2	5	22	125		215	215
Allen		1	9	3	2	9	24	28	85	113
Ascension	4	1	5		1	3	14	16	36	52
Assumption	5	4	5	2	1	11	28		96	96
Avoyelles						2	2		3	3
Beauregard	6	1	9	4	1	23	44		95	95
Bienville		9	10		2	12	33	2	14	16
Bossier	6	8	5		2	8	29		35	35
Caddo	216	22	34		1	10	283		14	14
Calcasieu	16	11	22	2	4	27	82		162	162
Caldwell		2	2			6	10		28	28
Cameron	12	10	12	1	6	32	73		159	159
Catahoula	27		33	6		49	115			
Claiborne	25	5	7	1	3	4	45		54	54
Concordia	22		33	4		31	90			
De Soto	26	21	49	5	5	18	124		5	5
East Baton Rouge			1	2		2	5	3	5	8
East Feliciana									11	11
Evangeline	2	5	2	2	1	3	15		27	27
Franklin	1		4			8	13		30	30
Grant	8		13			8	29			
Iberia	9	10	8		1	7	35	6	96	102
Iberville	28	2	8	3	2	6	49	38	53	91
Jackson			1		1	4	6		46	46
Jefferson	24	1	6	4		11	46		88	88
Jefferson Davis	2	8	6	2	3	13	34	6	73	79
Lafayette	1	5		2	4	9	21		31	31
Lafourche	103	22	28	8	7	32	200		109	109
La Salle	51	2	58	2	2	13	128			
Lincoln	2	13	4		2		21		17	17
Madison						9	9		19	19
Morehouse		1				1	2		2	2
Natchitoches	12		2			2	16			
Orleans						1	1		1	1
Ouachita		11	5		2	2	20		52	52
Plaquemines	181	13	17	12	6	41	270		187	187
Pointe Coupee	1		2	3		1	7		14	14
Rapides		2	1				3		64	64
Red River	20	6	9		1	9	45		6	6
Richland	5	1	6			2	14		19	19
Sabine	3	1	6	1		1	12		26	26
St. Bernard	6		3	1		5	15		72	72
St. Charles	20		9	1	2	5	37		38	38
St. Helena						2	2		20	20
St. James	2				1	3	6		30	30
St. John the Baptist			1	1		6	8		75	75
St. Landry	28	14	16	3	3	12	76		89	89
St. Martin	31	3	16	1	1	14	66		132	132
St. Mary	48	20	5	2	5	18	98		184	184
St. Tammany						1	1		1	1
Tangipahoa			2	1		2	5		10	10
Tensas	18	2	11	1	1	16	49			
Terrebonne	99	41	31	7	12	27	217		253	253
Union		122	3	1	1	5	132		2	2
Vermilion	11	11	10	5	11	32	80		179	179
Vernon									9	9
Washington						4	4		51	51
Webster	28	6	20	2	1	2	59	11	37	48
West Baton Rouge			1				1		13	13
West Carroll						3	3		2	2
Winn	103		38	5		32	178		21	21
Total:										
1960	1,255	437	621	102	103	641	3,159	110	3,195	3,305
1959	1,385	375	608	107	132	690	3,297	224	3,505	3,729

TABLE 9.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1960, by parishes—Continued

Place	Drilling							Geophysical, crew-weeks		
	Proved field wells			Exploratory wells			Total	Method		
	Oil	Gas	Dry	Oil	Gas	Dry		Gravity meter	Reflection seismograph	Total
Offshore:										
Bay Marchand	18	2	4			4	28			
Breton Sound	1	1	1				3		11	11
Cameron, East	1	7	3	2	3	5	21		25	25
Cameron, West	7	6	5		8	9	35		43	43
Delta, West	45	9	11	2	1	6	74		11	11
Eugene Island	43	6	30	7	2	16	104	2	39	41
Grand Isle	46	2	2				50		12	12
Main Pass	14	1	3			5	23	4	1	5
Marsh Island, South	7	7			4	3	21		25	25
Ship Shoal	8	3	8	4	4	8	35		55	55
South Pass	73	1	8	2		2	86	2	7	9
South Pelto	3		2	2			7		2	2
Timbalier, South	19		7	3		6	35		9	9
Vermilion		13	4	1	6	7	31		17	17
Total:										
1960	285	58	88	23	28	71	553	8	257	265
1959	284	58	88	14	23	35	502	52	294	346
Grand total:										
1960	1,540	495	709	125	131	712	3,712	118	3,452	3,570
1959	1,669	433	696	121	155	725	3,799	276	3,799	4,075

Source: International Oil Scouts Association, International Oil and Gas Development, Austin, Tex., vol. 31, 1961.

TABLE 10.—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]
1951-55 (average)	1,273,760	358,340	1,632,100	1,332,848	$112,897	207,503	91,749
1956	1,696,000	450,000	2,146,000	1,886,302	215,038	190,768	68,930
1957	1,877,000	470,000	2,347,000	2,078,901	232,837	187,057	81,042
1958	2,223,000	505,000	2,728,000	2,451,587	316,255	220,616	55,797
1959	2,442,000	514,000	2,956,000	[4] 2,670,271	[4] 411,222	186,599	99,130
1960	2,691,000	622,000	3,313,000	2,988,414	511,019	219,441	105,145

[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.
[4] Revised figure.

components to higher quality blending stocks for motor fuels. The LP gas consumption pattern changed in recent years, more in favor of chemical and fuel uses and less for blending into motor fuels at refineries.

To provide for rapid development of new gas supplies, the industry constructed vast facilities for processing natural gas and for recovering, delivering, and storing plant liquids. Union Oil Co. of California and Goliad Corp. installed a $13 million system for gas

processing and liquid recovery. One plant at Cow Island in Vermilion Parish could process 450 million cubic feet of gas daily and recover 295,000 gallons of liquids. The raw liquids were delivered through an 88-mile pipeline to a fractionating plant at Geismar, a few miles south of Baton Rouge, where the hydocarbon components were separated for petrochemical charge stock. Also in Vermilion Parish, Phillips Petroleum Co. put in operation a jointly owned natural gasoline plant which processed about 45 million cubic feet of natural gas daily from the the North Erath field.

TABLE 11.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951-55 (average)	688,396	$53,338	291,065	$12,972	979,461	$66,310
1956	773,949	62,394	305,222	14,727	1,079,171	77,121
1957	775,009	63,956	335,142	14,888	1,110,151	78,844
1958	783,099	50,371	410,869	21,435	1,193,968	71,806
1959	846,110	60,295	540,046	25,877	1,386,156	86,172
1960	875,567	66,214	606,023	28,147	1,481,590	94,361

At Grand Chenier in Cameron Parish, the CATC group (comprised of Continental Oil Co., Atlantic Refining Co., Tidewater Oil Co., and Cities Service Co.) put a $1.3 million gasoline plant in operation. The plant, operated by Continental Oil Co., processed about 175 million cubic feet of gas daily from the East and West Cameron fields.

In Acadia Parish, Union Texas Natural Gas Corp. installed two large absorbing towers at its gasoline plant. Runnels Gas Products Co. announced a $7 million expansion program at its Tepetate plant—completion was scheduled for early 1961.

In Terrebonne Parish, Tidewater Oil Co. built a natural gasoline plant to process 75 million cubic feet of gas daily from the Hollywood-Houma fields. About 1,030 barrels of plant liquids were recovered daily.

Continental Oil Co. announced a $2 million construction program to increase the processing capacity of its Lake Charles plant from 100 to 150 million cubic feet of natural gas daily. Completion was scheduled for January 1961. Shell Oil Co. announced plans for building a natural gasoline plant at the mouth of the Mississippi River, on Southwest Pass, to process gas from the firm's South Pass Blocks 24 and 27 oilfields.

At the Sorrento salt dome in Ascension Parish, Esso Standard, Division of Humble Oil & Refining Co., drilled a sixth well to enlarge the total storage capacity for plant liquids in the salt dome caverns to 1.8 million barrels. Also at Sorrento, Shell Oil Co. announced plans to begin an underground cavern at a depth of 3,300 feet, capable of storing 425,000 barrels of liquid butane for use by the company's Norco refinery.

Petroleum.—The petroleum industry in Louisiana established a new production record of 394 million barrels in 1960—second highest output in the Nation. The gain, 9 percent over 1959, came from new

offshore and onshore discoveries. About 11 percent of the crude oil was produced in north Louisiana, 67 percent in south Louisiana, and 22 percent in the offshore area—about the same distribution as in 1959.

To balance production with expected demand, the State Conservation Commission reduced petroleum allowables on May 1 from 977,153 to 938,170 barrels per day. This reduction, the first since September 1, 1958, represented a cut of the State's producing capacity set in 1953, based on the depth-bracket formula. Although the reduced allowable based on the formula remained in effect throughout the remainder of 1960, actual daily production, due to completions of new wells, advanced at such a rate that it became necessary to raise the volume allowable to 968,056 barrels per day on September 1, and again to 982,467 barrels per day on November 1. Also, the ban on multiple completion of wells, effective in June, was canceled on September 1 to obviate drilling unnecessary wells to each producing zone.

TABLE 12.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951-55 (average)	250,082	$699,314	1959	362,666	$1,145,569
1956	299,421	877,951	1960 [1]	394,360	1,237,823
1957	329,896	1,094,402			
1958	313,891	1,023,517	Total: 1902–60	5,510,614	12,885,533

[1] Preliminary figures.

According to a survey,[4] Louisiana had 9,182 oil wells classified as stripper wells. For the year covered, stripper wells represented 41 percent of total oil wells, but supplied only 3.4 percent of the annual production and 3.6 percent of the recoverable oil reserves. Thus, normal production decline from stripper wells was not expected to affect appreciably productive capacity and reserves in the immediate future.

Operations in the tidelands led to innovations in production practice as industry attempted cost reductions. The California Co. installed a 20,000 barrel underwater oil storage unit at its operations

TABLE 13.—Crude petroleum production, indicated demand, and stocks, in 1960, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks (end of month)	Month	Production	Indicated demand	Stocks (end of month)
January	33,622	32,834	18,135	September	31,582	31,000	17,911
February	31,299	30,396	19,038	October	34,154	34,912	17,153
March	33,715	33,280	19,473	November	33,699	32,372	18,480
April	32,504	33,199	18,778	December	35,426	34,342	19,564
May	32,046	31,989	18,835				
June	31,203	32,076	17,962	Total:			
July	32,524	33,775	16,711	1960	394,360	392,143	----------
August	32,586	31,968	17,329	1959	362,666	361,546	----------

[4] Interstate Oil Compact Commission, National Stripper Well Survey, January 1, 1960: Oklahoma City, Okla., Apr. 5, 1961.

in the Eugene Island Block 110 field. Oil production from the field, about 1,100 barrels per day, was stored in the submerged unit and barged to land in 10,000 barrel lots.

Shell Oil Co. announced a subsurface technique for producing oil wells in offshore waters. The new method eliminates surface platforms and permits installation of equipment for controlling the flow of oil and gas on the bottom of the sea. The first well using the new technique was completed in December under 56 feet of water.

TABLE 14.—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)
1951–55 (average)	14,956	48.1	1958	23,070	38.1
1956	20,905	41.2	1959	23,468	41.8
1957	21,945	42.2	1960 [1]	23,409	46.0

[1] Preliminary figures.

Refineries.—At the beginning of 1960 there were 12 operating and 1 inactive petroleum refineries in Louisiana. The crude oil capacity (barrels a day) was as follows: Operating, 760,500; standby, 8,500; and building, 11,000. Cracked gasoline capacity (barrels a day) was as follows: Operating, 238,200; shut down, 26,000; and building, 500.

Modernization of the Bay Petroleum Co., Division of Tennessee Gas Transmission Co., Chalmette refinery, was completed, and its crude oil capacity was increased from 26,000 to 37,000 barrels a day.

Esso Standard, Division of Humble Oil & Refining Co., Baton Rouge, increased fluid catalytic cracking capacity from 141,000 to 142,500 barrels daily and recycling capacity from 59,000 to 60,800 barrels a day.

The trend in the larger refineries was to install additional facilities to recover byproducts, especially aromatics, and to manufacture petrochemicals. Refiners who added substantial petrochemical capacity during the year were Bay Petroleum Co. at Chalmette, Esso Standard at Baton Rouge, and Cities Service Co. and Continental Oil Co. at Lake Charles.

Crude oil runs to stills of the refineries totaled 243 million barrels (about 6 percent less than in 1959) and represented about 62 percent of the State's annual production of crude oil.

Petrochemicals.—The petrochemical industry continued to place more emphasis on market development as existing domestic markets were approaching saturation and export markets were falling off because foreign countries were developing their own petrochemical facilities.

According to a survey by the Oil and Gas Journal (Sept. 5, 1960), excess petrochemical plant capacity was expected to develop when announced expansions were completed, particularly for olefin and aromatic production. To prevent this, the largest producers of the materials, the oil companies, were beginning to manufacture inter-

TABLE 15.—Crude petroleum production by districts and fields

(Thousand barrels)

District and field	1959	1960 [1]
Gulf Coast:		
Anse la Butte	1,775	1,687
Avery Island	2,712	3,089
Bateman Lake	2,836	2,694
Barataria	761	864
Bay de Chene	1,913	2,199
Bay Marchand	6,390	10,264
Bay St. Elaine	3,764	4,355
Bayou Blue	743	772
Bayou Choctaw	1,361	1,434
Bayou Mallet	981	812
Bayou Sale	3,138	3,948
Bully Camp	1,452	1,321
Caillou Island	14,751	17,040
Charenton	1,573	1,407
Cox Bay	1,348	1,391
Delta Farms	3,656	3,391
Dog Lake	770	738
Duck Lake	2,483	2,709
East White Lake	1,044	1,672
Egan	1,773	1,785
Erath	1,201	1,208
Garden Island	1,672	2,116
Gibson	853	913
Golden Meadow	2,500	2,355
Good Hope	855	983
Grand Bay	3,084	4,067
Gueydan	923	1,119
Hackberry	5,706	5,251
Horseshoe Bayou	760	739
Iberia	841	886
Iowa	1,553	1,383
Jeanerette	1,219	1,170
Jennings	1,439	1,518
Lafitte	3,176	3,419
Lake Arthur South	1,531	1,510
Lake Barre	4,336	5,340
Lake Chicot	783	730
Lake Fausse Point	1,651	1,577
Lake Pelto	4,086	4,571
Lake Salvador	2,067	2,310
Lake Washington	11,098	11,329
La Rose	1,133	975
Leeville	3,829	3,826
Little Lake	2,509	2,274
Lockport	795	780
Main Pass	9,581	11,110
Gulf Coast—Continued		
North Crowley	1,008	838
Paradis	2,479	2,732
Phoenix Lake	1,231	1,520
Pine Prairie	577	482
Point a La Hache		
Port Barre	781	877
Quarantine Bay	2,953	3,227
Romere Pass	2,807	2,786
St. Gabriel	529	585
Section 28	1,093	1,014
Shuteston	902	701
South Pass	7,168	11,120
Tepetate	1,442	1,499
Timbalier Bay	10,202	11,996
University	446	435
Valentine	2,981	3,502
Venice	4,411	4,567
Ville Platte	805	810
Vinton	1,777	1,856
Weeks Island	7,318	8,397
West Bay	4,275	5,182
West Cote Blanche	2,967	4,375
West Delta Block 30	5,960	6,799
West Lake Verret	1,245	1,263
White Castle	887	965
Other Gulf Coast	126,433	133,258
Total	317,082	347,767
Northern:		
Big Creek	483	428
Caddo	6,880	6,050
Cotton Valley	823	776
Delhi	5,086	5,144
Esperance Point	1,337	1,248
Haynesville	3,003	2,781
Lake St. John	1,845	1,569
Nebo [2]	1,523	1,513
Olla [3]	1,583	1,615
Rodessa	683	588
Sligo	1,405	1,388
Urania	812	837
Other Northern	20,121	22,656
Total	45,584	46,593
Total Louisiana	362,666	[4] 394,360

[1] Preliminary figures.
[2] Includes Hemphill, Trout Creek, and Jena.
[3] Includes Little Creek and Summerville.
[4] Louisiana Conservation Department.

mediates and end products, thus using a large part of the basic materials captively.

More than half of the announced new plants and expansions are in the Gulf Coast area from Brownsville, Tex., to New Orleans and Baton Rouge, La. Leading petrochemical producers in this area justified expansion because of nearby and readily available raw materials from refineries and gasfields; a plentiful supply of low-cost natural gas for fuel; ample supplies of fresh water, sulfur, salt, and lime; and ready access to water transportation for the plant products, either by ocean-going tanker or river barge. Also, many of the plants were dependent on other plants for interchange of raw materials and byproducts.

In Louisiana, chemical construction facilities costing an estimated $155 million were to be installed during 1960–61, as announced by the Manufacturing Chemists' Association (MCA). This included $53 million for 12 projects planned and $102 million for 17 projects

underway. Louisiana chemical producers in 1959 completed 16 projects costing nearly $216 million. The Louisiana total chemical construction expenditures for the 3-year period (1959–61) was $371 million—second highest in the United States and 12.4 percent of the national total of $3,002 million. The State total included 45 privately financed projects in 20 communities by 33 companies. MCA reported that Louisiana had received about $726 million in new chemical construction during the past 6 years.

Continental Oil Co. started constructing a plant at Lake Charles, Calcasieu Parish, in March, to manufacture petroleum-derived industrial alcohols from ethylene. Planned capacity was 50 million pounds a year of straight-chain primary alcohols for use in the manufacture of detergents, plastics, cosmetics, and textiles. The plant, scheduled for completion early in 1961, was to cost an estimated $10 million.

Hercules Powder Co., Lake Charles, completed its $16 million plant with capacity to produce more than 100 million pounds of polypropylene a year. Polypropylene is a plastic resin used for manufacturing film, automobile seat covers, webbing, and molded plastic items.

Cities Service Co. announced plans to build a multimillion-dollar petrochemical plant at its Lake Charles petroleum refinery. Annual capacity of the new facility was to be 120 million pounds of orthoxylene. Basic feed stock for the new plant would be supplied by existing units of the refinery.

Columbia-Southern Chemical Corp. completed an ethylene dichloride plant at its Lake Charles facility. The new $1 million plant adjoins the firm's chlorine and caustic soda manufacturing operation.

Petroleum Chemicals, Inc., Lake Charles, expanded its ethylene producing capacity from 200 million to 300 million pounds per year.

American Cyanamid Co., Jefferson Parish, announced further additions to its Fortier plant which will bring the total company investment in the New Orleans area to about $110 million.

Polymer Chemical Division, W. R. Grace & Co., announced plans for a 50-percent increase in capacity at its Baton Rouge plant. At this plant, a producer of high-density polyethylene plastics, the company had just completed additions in December 1959.

Esso Standard, Division of Humble Oil & Refining Co., completed a $16 million production facility for butyl rubber at its Baton Rouge petroleum refinery and chemical plant. First shipments of butyl rubber were made by barge in October. The company also increased its oxo-alcohol capacity at the Baton Rouge refinery to 90 million pounds per year.

General Chemical Division, Allied Chemical Corp., indicated it would enter the fluorocarbon field and construct a plant at Baton Rouge to produce the new group of plastics.

At Plaquemine, Iberville Parish, Dow Chemical Co. made first shipments of polyethylene in December. The plastic producing facilities at the plant were completed in October.

Shell Chemical Co. in Norco was constructing a $14 million addition to its existing petrochemical facilities. Added products were to be synthetic glycerin and acrolein.

Crown Zellerbach Corp. was constructing a $1.7 million chemical plant at Bogalusa, Washington Parish, to produce organic sulfur compounds.

At Chalmette, Bay Petroleum Co., wholly owned subsidiary of Tennessee Gas Transmission Co., was constructing a petrochemical plant to produce aromatics for use in manufacturing plastics and chemicals. Completion of the unit was scheduled for mid-1961.

NONMETALS

Barite.—Crude barite, imported from Arkansas, Missouri, and foreign countries, was ground for use in oil well drilling fluids in three plants at New Orleans and one at Lake Charles. Output of ground barite decreased 14 percent and shipments decreased 17 percent from 1959, reflecting less drilling for petroleum and natural gas.

Cement.—Portland cement, produced in three plants, was 6 percent below the 1959 output. The decline was mainly attributed to a 13-percent drop in value of construction contracts awarded (table 4) and to fewer highway construction programs.

Clays.—There was an overall 17-percent decline in production of miscellaneous clay. Clay used for lightweight aggregate and cement decreased 6 percent and 42 percent, respectively; clay for heavy clay products increased 15 percent. Again, the loss was attributed to less construction during the year. Over 245,000 tons of local clay was used to manufacture heavy clay products at 12 brick plants in 11 parishes. Lightweight aggregate was produced at Alexandria, Rapides Parish; Erwinville, Point Coupee Parish; and north of Shreveport, Caddo Parish.

TABLE 16.—Destination of shipments of portland cement to Louisiana from mills

Year	Louisiana (thousand barrels)	Change, percent	
		In Louisiana	In United States
1951-55 (average)	6,108		
1956	8,507	+16	+6
1957	7,585	−11	−6
1958	8,048	+6	+6
1959	8,908	+11	+9
1960	8,007	−10	−7

TABLE 17.—Miscellaneous clay sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951-55 (average)	533	$638	1958	755	$755
1956	785	785	1959	904	904
1957	642	642	1960	749	749

Gypsum.—Winn Rock, Inc., formerly Anderson & Dunhan, Inc., Winn Parish, mined crude gypsum for a retarder in portland cement. National Gypsum Co. and U.S. Gypsum Co. calcined imported crude gypsum and manufactured plaster, lath, and wallboard.

Bestwall Gypsum Co.'s new $6 million plant in New Orleans was to process about 200,000 tons of imported gypsum a year to produce plaster, lath, and gypsum board. The plant, on the new Mississippi River-Gulf outlet, was completed late in 1960.

Lime.—In October, U.S. Gypsum Co. began operating a new lime plant adjacent to its gypsum manufacturing plant, on the Inner Harbor Navigation Canal at New Orleans. The $1.5 million plant produced quicklime and hydrated lime from clam shell dredged from Lake Pontchartrain. A 10- by 250-foot rotary kiln was used to calcine the shell.

Pelican State Lime Corp. began commercial operation in March of a new lime manufacturing plant east of Morgan City, St. Mary Parish. The $1.5 million plant was designed to make 150 to 175 tons daily of quicklime from oyster shell dredged from a State lease in Vermilion Parish.

Nitrogen Compounds.—Air Reduction Sales Co. completed its $2 million plant at the old Ronaldson airport near Baton Rouge. The plant had a daily production capacity of 30 tons of liquid oxygen, nitrogen, and argon for industrial uses.

Salt.—Output of salt decreased slightly in quantity from 1959, although the value increased over $1 million. A detailed study of 66 salt domes in south Louisiana was published by the New Orleans Geological Society.[5]

Freeport Sulphur Co. purchased rights to produce brine from the salt dome beneath its Grand Isle sulfur mine. The company perfected a process which uses salt water rather than fresh water in the Frasch process of recovering sulfur from underground deposits.

Morton Chemical Co. began constructing a new $3.4 million plant to replace older facilities at Weeks Island. The plant will manufacture sodium sulfate and muriatic (hydrochloric) acid.

Sand and Gravel.—Production of over 14 million tons of sand and gravel—10 percent less than in 1959—reflected the decline in construction activity. Washed sand and gravel was 13.3 million tons, or 95 percent of the total. Sand use was as follows: Building sand, 44 percent; paving sand, 43 percent; other construction sand, 8 percent; fill sand, 3 percent; railroad ballast, blast sand, engine sand, and miscellaneous, 2 percent. Gravel use was as follows: Paving gravel, 57 percent; building gravel, 35 percent; other construction gravel, 4 percent; fill gravel, 3 percent; all other uses, 1 percent. There were 69 producers of sand and gravel in 22 parishes.

TABLE 18.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951-55 (average)	3,001	$10,234	1958	3,442	$18,960
1956	3,704	17,695	1959	4,807	20,918
1957	3,461	18,944	1960	4,792	21,959

[5] Salt Domes of South Louisiana, New Orleans Geol. Survey, New Orleans, La., July 1960, 145 pp.

TABLE 19.—Salt production, by types

(Thousand short tons and thousand dollars)

Type	1957		1958		1959		1960	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Evaporated salt	128	$2,692	131	$2,959	168	$4,279	191	$4,737
Rock salt	1,335	9,802	1,349	9,729	1,601	10,959	1,730	12,097
Brine	1,998	6,450	1,962	6,272	3,038	5,680	2,871	5,125

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
1951–55 (average)	6,434	$7,873	248	$116	6,682	$7,989
1956	14,820	18,555	254	85	15,074	18,640
1957	12,477	14,659	102	70	12,579	14,729
1958	14,610	16,982	451	137	15,061	17,119
1959	15,595	19,898	547	213	16,052	20,111
1960	13,935	18,990	384	116	14,319	19,106

Owens-Illinois Glass Co., Toledo, Ohio, began constructing a $3 million glass container plant on a 24-acre site on the Inner Harbor Navigation Canal near New Orleans. The plant, scheduled to be completed in July 1961, will require 55,000 tons of raw material to produce 50,000 tons of bottles and jars per year.

Stone.—Most of the stone production was shell (clam and oyster). A small amount of miscellaneous stone was produced in Winn Parish. Lacking an adequate supply of stone, Louisiana relies on shell as a substitute. Shell (almost pure calcium carbonate) meets the highest chemical specifications. Concrete aggregate and road construction used 73 percent of the output; cement, 17 percent; lime, 9 percent; and paint filler, rubber filler, and mineral food, 1 percent.

Sulfur.—Shipments of Frasch sulfur reached a new record high in 1960. The revival of sulfur sales to the steel industry (strikebound in 1959) added to the excellent demand established by such large sulfur consuming industries as fertilizers, chemicals, pulp paper, pigments, and rayon. Production of Frasch sulfur, which gained 11 percent over 1959, more than met the demand, and about 8,000 long tons of sulfur was stockpiled.

The world's first offshore sulfur mine—in the Gulf of Mexico near Grand Isle—started commercial production on April 14. This $30 million facility had a capacity of 4,500 tons of molten sulfur daily and was connected to storage tanks on Grand Isle by a $2 million pipeline.

Freeport Sulfur Co. reported that its new sulfur mine at Lake Pelto was placed in operation late in the year. To mine the deposit, the company reconditioned its barge-mounted plant, used originally at the depleted Bay Ste. Elaine deposit. The Lake Pelto sulfur deposit is about 60 miles southwest of New Orleans on the marshland shore of the Gulf of Mexico.

TABLE 21.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1951–55 (average)	1,710	1,628	$41,625	1958	2,055	2,028	$47,651
1956	2,429	2,239	59,330	1959	2,035	2,252	52,779
1957	2,125	2,156	52,690	1960	2,264	2,256	52,639

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. produced alumina at its Gramercy and North Baton Rouge plants. Alumina from the two plants was transported downstream to the firm's aluminum works at Chalmette for reduction to primary aluminum. In November, Kaiser announced plans for a $700,000 plant to produce activated alumina in a uniform spherical shape at the Baton Rouge alumina works. Completion was scheduled for the second quarter of 1961. The corporation also announced plans to erect a $1.4 million aluminum fluoride plant at Gramercy. Construction, to start about mid-1961, was to be completed by the third quarter of 1962.

On March 4, the Kaiser aluminum reduction plant at Chalmette returned to full production by reactivating its ninth potline; however, on August 6, one potline was shut down; a second was closed on October 2, and a third on November 13.

Ships carrying bauxite to the adjacent Ormet Corp. alumina plant were unloaded at the Burnside Bulk Marine Terminal, 30 miles south of Baton Rouge on the Mississippi River. The terminal also was used to load barges with alumina for shipment up the Mississippi and Ohio Rivers.

Iron Ore.—At the Burnside Marine Terminal, foreign iron ore was transferred from ocean ships to barges for shipment to steel mills in the St. Louis and Chicago areas.

Nickel-Cobalt.—The Freeport Nickel Co. nickel-cobalt refinery at Port Nickel was shut down during the year because it could no longer be supplied with nickel-cobalt sulfide concentrate from Cuba—its only source. Moa Bay Mining Co., Freeport Nickel Co. subsidiary and producer of nickel-cobalt sulfide concentrate at its mining and ore-concentrating facilities in Oriente Province, Cuba, was shut down April 1 due to unfavorable tariffs imposed by the Cuban Government.

REVIEW BY PARISHES

Minerals were produced in all but 2 of the 64 parishes. Mineral fuels were produced in 55 parishes, other minerals in 41 parishes. Five parishes reported mineral production valued at over $100 million (three in 1959): Plaquemines, $391 million; Terrebonne, $193 million; Lafourche, $182 million; St. Mary, $119 million; and Cameron, $109 million. Four parishes reported production valued between $50 and $100 million (six in 1959): Acadia, $90 million; Iberia, $83 million;

Vermilion, $77 million; and Jefferson, $65 million. Forty-one other parishes produced minerals valued at over $1 million each.

Acadia.—Exploratory drilling of 29 wells for petroleum and natural gas proved 24 percent productive, and of 96 development wells drilled, 66 percent were productive; also, 215 crew-weeks were spent in geophysical prospecting. The parish ranked first in the production of natural gas liquids, output of which was valued at $21.7 million. At Rayne, natural gas liquids were recovered at the No. 12 Toca plant of Texas Natural Gasoline Corp. and by the plant of LaGloria Oil & Gas Co.

TABLE 22.—Value of mineral production in Louisiana, by parishes[1]

Parish	1959	1960	Minerals produced in 1960 in order of value
Acadia	$70,754,658	$90,319,953	Petroleum, natural gas, natural gas liquids.
Allen	7,720,339	8,845,134	Do.
Ascension	1,256,907	1,748,880	Petroleum, natural gas, salt.
Assumption	16,892,480	19,278,463	Petroleum, natural gas.
Avoyelles	2,069,976	1,880,475	Petroleum, natural gas liquids, natural gas.
Beauregard	16,654,220	17,126,853	Petroleum, natural gas, natural gas liquids, sand and gravel.
Bienville	6,563,730	7,633,509	Natural gas, petroleum, clays.
Bossier	31,304,932	30,352,809	Natural gas, petroleum, natural gas liquids, sand and gravel.
Caddo	34,581,817	33,101,954	Petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Calcasieu	40,380,574	43,016,899	Petroleum, natural gas, cement, natural gas liquids, sulfur, lime, salt, clays.
Caldwell	312,719	535,947	Natural gas, petroleum.
Cameron	103,068,550	108,698,945	Natural gas, petroleum, natural gas liquids, salt.
Catahoula	3,979,715	5,332,550	Petroleum, sand and gravel, natural gas.
Claiborne	24,472,128	25,887,364	Petroleum, natural gas, natural gas liquids.
Concordia	14,698,106	14,640,903	Do.
De Soto	10,536,310	11,207,021	Natural gas, petroleum, natural gas liquids.
East Baton Rouge	12,087,018	13,904,742	Cement, lime, petroleum, sand and gravel, natural gas, clays, natural gas liquids.
East Feliciana	(2)	(2)	Sand and gravel.
Evangeline	10,973,554	10,538,150	Petroleum, natural gas, natural gas liquids, sand and gravel.
Franklin	2,762,866	2,569,871	Petroleum, natural gas.
Grant	1,080,060	794,541	Petroleum, sand and gravel.
Iberia	68,201,456	82,564,019	Petroleum, natural gas, salt, natural gas liquids, clays, sand and gravel.
Iberville	24,594,371	26,360,906	Petroleum, natural gas, salt.
Jackson	27,882	36,470	Natural gas.
Jefferson	57,960,009	65,349,365	Petroleum, natural gas, natural gas liquids, shell.
Jefferson Davis	43,941,348	41,263,656	Natural gas, petroleum, sand and gravel, natural gas liquids.
Lafayette	4,280,236	4,015,414	Natural gas, petroleum, clays.
Lafourche	163,122,021	182,042,789	Petroleum, natural gas, sulfur, natural gas liquids.
La Salle	16,650,787	17,265,039	Petroleum, natural gas, sand and gravel.
Lincoln	18,884,115	21,312,087	Natural gas, natural gas liquids, petroleum, sand and gravel, clays.
Livingston	507,323	286,059	Petroleum, sand and gravel, natural gas.
Madison	1,312,945	1,253,816	Petroleum, natural gas.
Morehouse	1,344,057	1,496,798	Natural gas, petroleum.
Natchitoches	332,397	372,878	Petroleum, clays, natural gas.
Orleans	9,130,161	(2)	Cement, shell, lime.
Ouachita	6,388,520	8,991,109	Natural gas, sand and gravel, petroleum, clays.
Plaquemines	365,083,061	391,096,358	Petroleum, sulfur, natural gas, natural gas liquids.
Pointe Coupee	7,392,081	7,534,889	Petroleum, natural gas, natural gas liquids, clays.
Rapides	2,280,261	1,931,306	Sand and gravel, petroleum, clays, natural gas.
Red River	896,954	859,560	Petroleum, natural gas, sand and gravel.
Richland	15,877,538	16,213,465	Petroleum, natural gas liquids, natural gas.
Sabine	506,798	509,280	Petroleum, natural gas.
St. Bernard	639,043	2,818,381	Natural gas liquids, petroleum, natural gas.
St. Charles	30,224,651	34,611,578	Petroleum, natural gas, natural gas liquids.
St. Helena	(2)	(2)	Sand and gravel.
St. James	4,359,165	4,400,733	Petroleum, natural gas.
St. John the Baptist	2,504,692	3,660,187	Petroleum, natural gas, shell.

See footnotes at end of table.

TABLE 22.—Value of mineral production in Louisiana, by parishes[1]—Continued

Parish	1959	1960	Minerals produced in 1960 in order of value
St. Landry	$35,278,059	$39,464,336	Petroleum, natural gas, natural gas liquids.
St. Martin	50,311,820	46,739,480	Petroleum, natural gas, salt, natural gas liquids.
St. Mary	102,636,201	118,885,616	Petroleum, natural gas, natural gas liquids, shell.
St. Tammany	605,077	2,098,451	Shell, sand and gravel, natural gas, petroleum, clays.
Tangipahoa	912,823	541,346	Sand and gravel, petroleum, clays.
Tensas	12,231,195	14,726,770	Petroleum, natural gas liquids, natural gas.
Terrebonne[3]	173,963,332	192,963,117	Petroleum, natural gas, natural gas liquids, sulfur.
Union	7,142,198	8,786,383	Natural gas, petroleum.
Vermilion	72,379,849	77,477,086	Natural gas, petroleum, natural gas liquids.
Washington	1,211,186	566,872	Sand and gravel.
Webster	31,598,615	32,743,676	Petroleum, natural gas, natural gas liquids, sand and gravel.
West Baton Rouge	951,669	1,069,869	Petroleum, natural gas.
West Carroll	318,919	343,365	Natural gas.
West Feliciana	(2)	(2)	Sand and gravel.
Winn	1,889,327	3,190,229	Petroleum, salt, stone, gypsum, natural gas.
Undistributed	[4] 16,246,199	64,393,999	
Total	[4] 1,766,269,000	1,967,652,000	

[1] East Carroll and Vernon Parishes not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Terrebonne Parish sulfur shipments included with Plaquemines Parish.
[4] Revised figure.

The Runnels Gas Products Co. announced a $7 million expansion of its Tepetate plant. Scheduled to be completed by January 1961, the new facilities were to produce butane, isobutane, propane, and ethane components. At its Rayne processing plant, Union Texas Natural Gas Corp. installed two large absorbing towers. Petroleum and natural gas also were produced in the parish.

Ascension.—The Burnside Marine Terminal unloaded bauxite from South America for Ormet Corp. and loaded alumina onto barges for shipment up the Mississippi and Ohio Rivers. The terminal also was used to transfer imported iron ore from ocean ships to barges for shipment to steel mills in the St. Louis and Chicago areas. At Geismar, Wyandotte Chemical Corp. operated its caustic soda and chlorine plant. Part of a $13 million system of plants for processing natural gas from southwest Louisiana was put on stream late in 1960. The recovered raw liquids from these plants were delivered by pipeline to Geismar, where the Riverside fractionating plant (jointly owned by Union Oil Co. of California and the Goliad Corp.) separated these liquids into petrochemical charge stocks—propane, isobutane, normal butane, and natural gasoline.

Esso Standard, Division of Humble Oil & Refining Co., began a sixth storage well to increase underground storage facilities of plant liquids in the Sorrento salt dome formation. When completed in July 1961, the new well will have storage capacity for 350,000 barrels of propane. Total storage capacity at Sorrento will be raised to 1.8 million barrels.

Borden Co. and U.S. Rubber Co. announced plans to erect a $50 million complex of chemical plants to convert hydrocarbons into numerous chemical products. One of these plants, a joint venture known as Monochem, Inc., will use hydrocarbons such as natural gas or low-

flash point liquid fuel to produce acetylene and vinyl chloride monomer. The plant, to be completed in 1962, will be located near Geismar.

Beauregard.—Exploratory drilling in the parish resulted in discovery of three oilfields—Buckston Marsh, Righthand Creek, and Brushy Creek. Petroleum, natural gas, and sand and gravel were produced; natural gas liquids were recovered at the Shoats Creek plant of Sunray Mid-Continent Oil Co.

Bossier.—Sunray Mid-Continent Oil Co. operated its Benton and Sarepta natural gasoline plants. Natural gas, petroleum, natural gas liquids, and sand and gravel, in order of value, were produced.

Caddo.—Caddo Parish again ranked first in total number of oil and gas wells drilled—283 wells in 1960, compared with 437 in 1959.

Caddo Light Aggregate Co., Inc., a subsidiary of Bayou State Oil Corp., produced lightweight aggregate at its plant northwest of Shreveport. Clay from a nearby open pit was used as raw material. Crude petroleum, natural gas, natural gas liquids, sand and gravel, and clay, in order of value, were produced.

Calcasieu.—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. Exploratory drilling in the parish opened two more oilfields—North Hayes and South Bon Air.

Gulf States Utilities Co., West Lake, completed the third unit (162,000-kw. capacity) at its Roy S. Nelson generating station in April.

Continental Oil Co. announced a $2 million construction program to increase processing capacity from 100 million to 150 million cubic feet of natural gas per day at its Lake Charles natural gasoline plant. Completion was scheduled for January 1961. The company also was constructing a $10 million petrochemical plant to manufacture petroleum-derived industrial alcohols formerly produced from natural fats and oils.

Cities Service Co. announced plans to build a multimillion-dollar petrochemical plant on existing property of the Cities Service Refining Corp. plant. Annual capacity of the new facility will be 120 million pounds of ortho-xylene. Existing units of the refinery will supply the basic feed stock for the new plant.

Petroleum Chemicals, Inc., expanded its ethylene producing capacity to 300 million pounds per year.

Hercules Powder Co. completed a $16 million plant having an annual capacity of more than 100 million pounds of polypropylene. Columbia-Southern Chemical Corp. completed an ethylene dichloride plant adjoining its chlorine and caustic soda manufacturing facilities.

Cameron.—Cameron Parish ranked fifth in total value of mineral production and first in value of natural gas. Completion of CATC group's $1.3 million adsorption-type gasoline plant at Grand Chenier was reported by Continental Oil Co., operator. The group includes Continental Oil Co., Atlantic Refining Co., Tidewater Oil Co., and Cities Service Co. The plant, with an initial capacity of 175 million cubic feet of gas daily, processed gas from the group's East and

West Cameron fields. The Deep Bayou oilfield and Blue Buck Point and Smith Ridge gasfields were discovered.

Catahoula.—Petroleum, sand and gravel, and natural gas were produced. Five oilfields were discovered—California Bayou, Wallace Lake, Utility, South Utility, and Boltners Brake.

Claiborne.—Petroleum, natural gas, and natural gas liquids were produced. Lick Creek and Oaks oilfields were discovered.

Concordia.—Three oilfields, Lower Sunk Lake, Moro, and Whites Bayou, were discovered. Petroleum, natural gas, and natural gas liquids were produced.

DeSoto.—Drilling for petroleum and natural gas in DeSoto Parish continued. The total of 124 holes drilled (176 holes in 1959) proved 31 oil wells and 26 gas wells. Test drilling resulted in discovery of the Catuna gasfield and the Brushy Bayou oilfield.

East Baton Rouge.—Construction of new facilities and expansion of existing facilities again was reported in the Baton Rouge area which contains one of the State's largest industrial complexes. Kaiser Aluminum & Chemical Corp. processed Jamaican bauxite into alumina at its North Baton Rouge plant. Polymer Chemicals Division, W. R. Grace & Co., announced plans to increase capacity by 50 percent at its Baton Rouge plant which produces high-density polyethylene plastics. Esso Standard, Division of Humble Oil & Refining Co.—operator of the world's largest petroleum refinery—completed its $16 million production facilities for butyl rubber. First shipments of butyl rubber were made in October by barge. The company also increased oxo-alcohol capacity at its Baton Rouge refinery to 90 million pounds a year.

General Chemical Division, Allied Chemical Corp., indicated it would enter the fluorocarbon plastic field and construct a plant at Baton Rouge to produce the new group of plastics. Clay was mined by Acme Brick Co. for manufacture of brick. Ideal Cement Co. produced portland, high-early-strength, and masonry cements from shell which was barged up the Mississippi River. The Sardine Point oilfield was discovered.

Evangeline.—Petroleum, natural gas, and sand and gravel were produced. Natural gas liquids were recovered by the Ville Platte plant of Continental Oil Co., and by the Mamou and Pine Prairie plants of Socony Mobil Oil Co. The Fenris oilfield and North Savoy gasfield were discovered.

Iberia.—Iberia Parish ranked first in salt production; more than a third of the salt came from three large mines. Petroleum, natural gas, natural gas liquids, clay, and sand and gravel also were produced. The South Lake Sand gasfield was discovered.

Iberville.—Petroleum, natural gas, and salt were produced. The West Rosedale gasfield and Bayou Jacob and Pat Bay oilfields were discovered. Dow Chemical Co. made initial shipments of polyethylene in December from newly expanded facilities at Plaquemine. The plastic producing facilities were completed in October.

Jefferson.—In April, Freeport Sulphur Co. began producing sulfur from its $30 million Grand Isle mine, seven miles offshore. The deposit, one of the largest known, was discovered by Humble Oil &

Refining Co. Freeport Sulphur Co. purchased rights to mine brine from the salt dome under the Grand Isle mine. The company utilized salt water in the Frasch process to mine sulfur. Because the mine was highly automated, water used in the process had to be constant in its mineral and salt content to assure continuous service. Water from the Gulf of Mexico in this area was not suitable. Jefferson Parish, with petroleum output valued at nearly $60 million, ranked fifth. Natural gas, natural gas liquids, and shell also were produced. The Bayou Segnette oilfield was discovered.

Workers at the American Cyanamid Co. Fortier plant ended an 85-day strike on November 21. The company announced plans for a $300,000-expansion program to augment an expansion completed in 1959.

Lafourche.—The parish ranked third in total value of minerals produced, second in crude oil produced, and fifth in natural gas output. Exploratory drilling by Sohio Petroleum Co. resulted in the discovery of the Choctaw School gasfield near Thibodaux. Other discoveries were the Point Chicot and Bayou Poignard gasfields. Natural gas liquids were recovered by the Lockport plant of Socony Mobil Oil Co.

Freeport Sulphur Co. used the Frasch process to mine sulfur at its Chacahoula mine.

La Salle.—Petroleum, natural gas, and sand and gravel were produced. Exploratory drilling resulted in discovery of the Bayou Castor gasfield and the Searcy oilfield.

Lincoln.—Lincoln Parish, with three natural gasoline plants, ranked second in recovery of natural gas liquids; output was valued at nearly $10 million. Natural gas, petroleum, and sand and gravel also were produced. Filtrol Corp. mined bentonite clay to be used for filtering and bleaching.

Orleans.—New Orleans Public Service, Inc., continued construction of the 230,000-kw. generating unit at its Michoud Station. The installation, estimated to cost over $24 million, was scheduled for operation in the spring of 1963. Cement, shell, and lime were produced. Most of the barite ground in the State was from imported ores and was processed in Orleans Parish by three companies. Alatex Construction Service, Inc., expanded crude perlite from Western States for use in acoustical plasters and as a concrete aggregate.

In October, U.S. Gypsum Co. completed a $1.5 million lime plant in New Orleans, to manufacture quicklime and hydrated lime. The plant was on the Inner Harbor Industrial Canal adjacent to the company gypsum products plant. Raw material for the plant was shell dredged from Lake Pontchartrain by local firms and barged to the plant.

Bestwall Gypsum Co. built a $6 million gypsum lath and plaster products plant near New Orleans.

Owens-Illinois Glass Co. broke ground July 20 for a new $3 million multifurnace glass container plant on the Inner Harbor Industrial Canal.

Ouachita.—Natural gas, sand and gravel, petroleum, and clay, in order of value, were produced during the year.

Plaquemines.—The total value of mineral production increased from $365 million (revised) in 1959 to $391 million in 1960—highest in the State. The parish ranked first in production of crude petroleum and sulfur and fourth in natural gas production. Geophysical prospecting amounted to 187 crew weeks. The parish ranked second in total number of oil and gas wells drilled—270 wells (223 in 1959). South Adams Bay oilfield was discovered onshore. The parish had vast onshore and offshore reserves of petroleum and natural gas.

Shell Oil Co. announced plans for building a natural gasoline and propane recovery plant at the mouth of the Mississippi River on Southwest Pass. The plant was to utilize a low-temperature refrigeration and absorption process to extract about 725 barrels of natural gasoline and 400 barrels of propane daily, liquids not recovered previously from gas in the firm's South Pass Blocks 24 and 27 oilfields.

One of the biggest sales of producing property in the history of the Louisiana oil and gas industry was completed when Tennessee Gas Transmission Co. paid Pan American Petroleum Co. more than $150 million for 10 leases in the Bastian Bay area of Plaquemines Parish. The properties included 11 producing gas wells and 13 producing oil wells in which Pan American had full working interest, and 1 oil well and 2 gas wells in which Pan American held part interest with other companies.

At yearend, U.S. Oil of Louisiana and Socony Mobil Oil Co. were drilling the deepest test ever attempted. The S–1 Louisiana Land & Exploration Co. well, aimed at 26,000 feet in the Lake Washington field, Plaquemines Parish, was expected to cost $1.75 million.

Timcoat Corp. produced rubberized asphalt mastic for marine pipeline coating.

Rapides.—Seven commercial sand and gravel producers operated. Paving gravel was produced by contract for the National Forest Service. Clay was mined for producing lightweight aggregate by Louisiana Lightweight Aggregate Co. and for structural clay products by Acme Brick Co. Crude petroleum and natural gas were produced.

Red River.—Petroleum, natural gas, and sand and gravel were produced. Exploratory drilling resulted in discovery of Bayou Pierre gasfield.

Richland.—Petroleum, natural gas liquids, and natural gas, in order of value, were produced.

St. Bernard.—Natural gas liquids were recovered by two plants. Petroleum and natural gas were produced.

Kaiser Aluminum & Chemical Corp. processed Jamaican bauxite to alumina at its Gramercy plant, then recovered the aluminum at its Chalmette reduction plant. On March 4, the Kaiser Chalmette aluminum works resumed full production by reactivating its ninth potline. Production had been curtailed since November 1959. However, one potline was shut down on August 6, a second on October 2, and a third on November 13.

At Chalmette, Bay Petroleum Co., wholly owned subsidiary of Tennessee Gas Transmission Co., began constructing a petrochemical plant to produce aromatics for use in plastics and chemicals, and as solvents. The unit was expected to be completed about mid-1961.

St. James.—Kaiser Aluminum & Chemical Corp. produced alumina at Gramercy. Late in the year, the firm announced plans to construct a $1.4 million aluminum fluoride plant at its Gramercy works. Production of natural gas increased and that of petroleum decreased.

St. John the Baptist.—Exploratory drilling led to discovery of the Frenier oilfield. Petroleum, natural gas, and shell were produced.

St. Landry.—St. Landry Parish ranked fifth in recovery of natural gas liquids; four recovery plants operated. Petroleum and natural gas also were produced. Exploratory drilling led to discovery of the Chataignier oilfield and the Veltin gasfield.

St. Mary.—St. Mary Parish ranked fourth in total value of minerals and in petroleum production, and also produced appreciable quantities of natural gas, natural gas liquids, and shell.

The Central Louisiana Electric Cooperative (CLECO) gasoline plant near Jeanerette extracted natural gasoline, butane, and propane from natural gas. Geophysical prospecting totaled 184 crew weeks during the year. The Eugene Island Block 100 oilfield was discovered offshore.

Tangipahoa.—Appreciable quantities of sand and gravel and miscellaneous clay were produced. Discovery of the Wilmer oilfield near Amite by North American Oil Co. of New Jersey, made the parish an oil producer for the first time.

Tensas.—Petroleum, natural gas liquids, and natural gas were produced.

Terrebonne.—Terrebonne Parish ranked second in total value of minerals produced, second in natural gas production, third in the number of wells drilled for exploration and development of petroleum and natural gas, and third in oil production. Exploratory drilling resulted in discovery of the South Sunrise and South Chauvin gasfields onshore, and Ship Shoal Area Block 169 offshore. Freeport Sulphur Co. began mining sulfur from its new Lake Pelto mine in the fall. The company's unique barge-mounted plant, formerly used at the Bay Ste. Elaine site, was refitted for use at the Lake Pelto mine. Natural gas liquids were recovered by four plants—Shell Oil Co. (two plants), Texaco, Inc., and Tidewater Oil Co.

Vermilion.—Vermilion Parish ranked third in value of natural gas and sixth in value of natural gas liquids. Exploratory drilling discovered the Cossinade oilfield and the South Perry, Kaplan, and North White Lake gasfields onshore, and the South Marsh Island Block 23 gasfield offshore. All were gaged as high potential producers of natural gas and petroleum.

Southeast of Abbeville, Phillips Petroleum Co. put into operation a joint-interest Vermilion natural gasoline plant to process nearly 45 million cubic feet of natural gas per day from the North Erath field. Plant products consisted of propane, butane, LP gas mixtures, and natural gasoline. At Cow Island, Union Oil Co. of California and the Goliad Corp. installed part of a $13 million system of plants and pipeline. At the Union Oil Co. plant, raw natural gas liquids

were extracted from natural gas and delivered by pipeline across the Atchafalaya Basin barrier to a terminal and processing plant at Geismar in Ascension Parish.

Webster.—Webster Parish ranked third in the value of natural gas liquids recovered. Petroleum, natural gas, and sand and gravel also were produced.

Winn.—Exploratory drilling resulted in the discovery of the Salt oilfield. Petroleum, salt, stone, gypsum, and natural gas, in order of value, were produced.

615629—61——31

The Mineral Industry of Maine

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 Geological Survey of Maine.

By Robert W. Metcalf [1] and Mary E. Otte [2]

THE VALUE of mineral production in Maine set a new record in 1960—$13.6 million, 3 percent above 1959. The output of clays, sand and gravel, stone, masonry cement, and mica was greater than in 1959. Greater roadbuilding activity was the principal factor for a record tonnage of sand and gravel. However, feldspar and portland cement output declined.

Maine's mineral resources were being intensively studied by Federal, State, and private agencies. Field and airborne surveys were continuing for metals and nonmetals. About $500,000 was spent in 1960 by mining companies, and Federal and State agencies in exploration surveys for nickel, copper, asbestos, diatomaceous earth, slate, columbite, beryl, and magnetic anomalies.[3] Possible asbestos deposits were explored by diamond drilling in greenstone rock in northwestern Maine.

The Maine Geological Survey had 12 field mapping parties throughout the State and during 1960 completed a geological-geophysical-geochemical study of a Penobscot County zone of magnetic anomalies, the results of which were to be published in 1961. Gravity studies in northwestern Maine and geochemical field research were undertaken by the Federal Geological Survey, and an extensive study of pegmatitic beryl was initiated by the Federal Bureau of Mines.

Two publications treating Maine minerals and mineral locations were issued during the year.[4] Both of these releases listed mineral occurrences; the second gave detailed directions on how to reach the locations.

Legislative and Government Programs.—Beryl and mica were purchased for the strategic minerals stockpile through the General Services Administration (GSA) purchase depots at Franklin, N.H. (beryl and mica), and Spruce, N.C. (mica).

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical clerk, Bureau of Mines, Pittsburgh, Pa.
[3] Engineering and Mining Journal, vol. 162, No. 6, June 1961, pp. 313, 315.
[4] Maine Geological Survey, Maine Mineral Collecting: Augusta, Maine, 1960. Morrill, Philip, and Others, Maine Mines and Minerals: Vol. 1, Western Maine, 1960, 82 pp.; vol. 2, Eastern Maine, 1960, 82 pp.

TABLE 1.—Mineral production in Maine[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrates—short tons, gross weight	3	$2	(2)	(2)
Clays—thousand short tons	25	26	41	$50
Gem stones	(3)	10	(3)	15
Mica:				
Scrap—short tons	157	4	171	6
Sheet—pounds	22,360	237	26,842	275
Sand and gravel—thousand short tons	9,452	3,644	9,833	3,892
Stone—do	819	2,766	1,012	3,851
Value of items that cannot be disclosed: Cement (masonry and portland), feldspar, peat (1959), and values indicated by footnote 2		7,050		5,990
Total Maine[4]		13,278		13,648

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Weight not recorded.
[4] Total adjusted to eliminate duplicating value of stone.

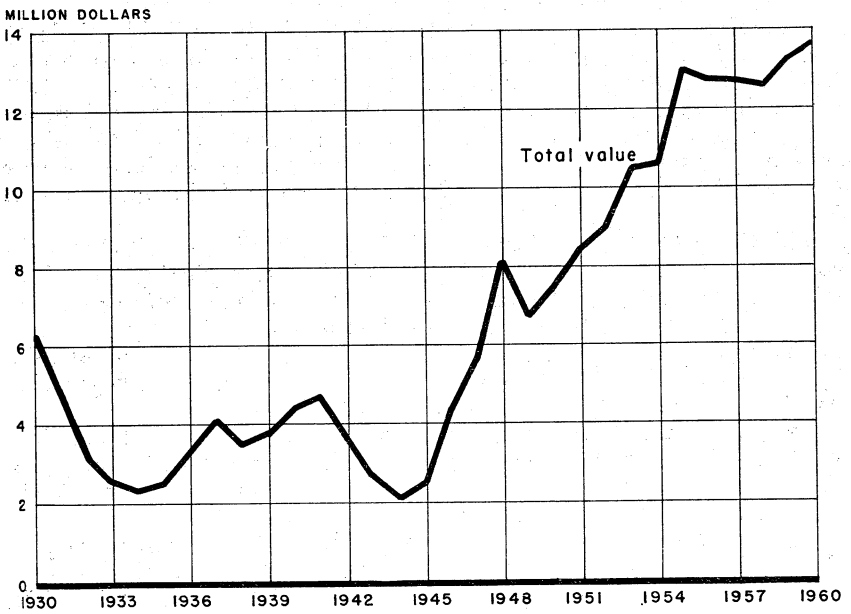

FIGURE 1.—Total value of mineral production in Maine, 1930–60.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Because of lower demand, production of portland cement decreased 16 percent; however, the average value per barrel remained

about the same. Dragon Cement Co., a division of American-Marietta Co., at Thomaston, Knox County, was the only cement-producing plant in Maine. A 4-percent wage increase took effect May 1. General use, moderate-heat, and high-early-strength cements were produced at its 2,050,000-barrel wet-process plant. Masonry cement showed a moderate gain in output over 1959. The New England States, primarily Maine and Massachusetts, consumed most of the portland cement and all of the masonry cement produced. A small quantity of portland cement was exported. Most of the portland cement was shipped in bulk in railroad cars and trucks. Portland cement consumers by classification according to use, in order of total consumption of cement, were: Ready-mix concrete companies, building-material dealers, and concrete-product manufacturers.

Clays.—Production of clays rose to over 41,000 short tons valued at nearly $50,000; tonnage increased nearly two-thirds and value almost doubled. New and improved machinery, including new kilns, and an active demand for housing contributed to the augmented clay output. Common or miscellaneous clay was used in making building brick. Eight clay mines were supplying adjacent brick-manufacturing plants, two in Androscoggin County, four in Cumberland County, and one each in Franklin and York Counties. The principal producers were Morin Brick Co., Androscoggin County, and LaChance Brothers Brick Co., Cumberland County.

Tests on clays from the Farmington (Franklin County) area and from localities in southwestern Maine indicated their suitability for commercial lightweight aggregate.[5] Physical, chemical, and thermal tests were made on about 100 samples.

Feldspar.—Output of crude feldspar dropped 14 percent to the lowest point since 1944. Foreign china imports, lower ceramic activity, and increased competition from other ceramic raw materials were contributing factors. Average value per ton also decreased to $6.09 from $6.31 in 1959. Over 90 percent of the feldspar sold was mined in Oxford County, and the balance was mined in Sagadahoc County. Producers' reports and purchases by feldspar grinders indicated output by six producers at nine mines in Oxford County and five mines in Sagadahoc.

Two companies crushed or ground feldspar, one at Topsham, Sagadahoc County, and the other at West Paris, Oxford County. The plant at Topsham crushed feldspar for poultry grit for use in Maine. The Oxford mill ground feldspar largely for ceramic purposes, although a sizable quantity was consumed for soaps and abrasives. Ceramic uses included electrical porcelain, tile, sanitary ware, and other pottery products. Sales of ground feldspar declined sharply; shipments were mostly to North Central and Eastern States.

Gem Stones.—Oxford County continued to be the chief area for collecting gem-quality stones and mineral specimens in Maine. Smaller quantities of material were found in several other counties, including Androscoggin, Cumberland, Hancock, Kennebec, Sagadahoc, Wash-

[5] Caldwell, D. W., Glacial Lake and Glacial Marine Clays of the Farmington Area, Maine. Origin and Possible use as Lightweight Aggregates: Maine Geol. Survey, Spec. Geol. Studies Ser. No. 3, Augusta, Maine, 1959, 48 pp. (Abstract in Rock Products, vol. 63, No. 3, March 1960, p. 67).

ington, and York. Included in the gem materials found in recent years were garnet (Androscoggin County); diopside, epidote, vesuvianite, and smoky quartz (Cumberland County); chalcopyrite and molybdenum (Hancock County); nephelite, sodalite, and zircon (Kennebec County); agate, amethyst, beryl, jasper, mica, rose quartz, the lithium minerals—amblygonite, lepidolite, and spodumene—and torbernite (Oxford County); beryl, mica, tourmaline (Sagadahoc County); galena (Washington County); and garnet, scheelite, and molybdenum (York County).

Mica.—Production of sheet mica increased 20 percent and scrap mica 9 percent. Sheet mica output was stimulated by larger Government buying for the strategic stockpile, and reached nearly 27,000 pounds in 1960. Virtually all the sheet mica came from Oxford County and was sold to the GSA purchase depots at Franklin, N.H., Spruce Pine, N.C., and Custer, S. Dak., as hand-cobbed or full-trim material. Sagadahoc County furnished a small quantity. Some punch and other mica was sold to industry. Mica grinders purchased limited quantities of scrap. Thirty-three individuals or firms reported sales to GSA from 14 mines; other quantities came from unidentified locations.

Nitrogen Compounds.—Anhydrous ammonia was manufactured at Searsport, Waldo County, for use as a fertilizer component.

Peat.—No production of moss peat was reported in 1960. Output in recent years came from Hancock and Washington Counties and was used chiefly as soil conditioner.

Sand and Gravel.—Sand and gravel production broke all records, rising to 9.8 million tons, 4 percent higher than in the previous record year, 1959. The chief factors in this increase were the active Federal, State, and local highway building and improvement programs. Cumberland County was the largest producing county (1.6 million short tons), followed in order by Penobscot, Kennebec, Aroostook, and Androscoggin. Washed, screened, or otherwise prepared material comprised 64 percent of the commercial sand and gravel and 30 percent of the Government-and-contractor tonnage.

Government-and-contractor output totaled 80 percent of the total sand and gravel compared with 84 percent in 1959. The Maine Highway Commission was by far the largest producer in the State, producing mostly for road construction and maintenance.

Stone.—An expanded roadbuilding program and greater demand for higher valued granite dimension stone combined to raise the total tonnage and value of stone marketed in 1960 by 24 percent in quantity and 39 percent in value. Output of limestone and sandstone also increased substantially, but basalt and slate tonnage declined. Seventeen commercial quarries operated in nine counties: Eight for granite in five counties; five for limestone in three counties; two for quartzite in two counties; and one each for basalt and slate in two counties. Three types of stone were quarried in one county (Kennebec) and two in another (Knox). Three granite quarries produced both crushed and broken and dimension stone; four produced only dimension stone; and one only crushed and broken stone.

TABLE 2.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Structural	242,724	$239,117	186,217	$127,989
Paving	164,958	110,442	238,021	204,262
Engine	3,191	4,628	2,989	3,736
Fill	98,644	31,404	117,577	34,929
Other	17,996	8,218	33,232	11,341
Gravel, construction:				
Structural	175,722	213,121	231,711	287,796
Paving	563,029	333,898	793,014	366,559
Railroad ballast	19,815	6,935	27,993	8,267
Fill	234,603	105,334	228,104	80,226
Other	11,081	5,162	31,146	14,274
Gravel, miscellaneous			78,486	41,389
Total	1,531,763	1,058,259	1,968,490	1,180,768
Government-and-contractor operations:				
Sand:				
Structural	2,915	1,020		
Paving	510,092	197,418	522,308	201,634
Other	12,960	4,536	3,038	1,113
Gravel:				
Structural	455	159		
Paving	7,391,954	2,381,860	7,334,362	2,505,383
Fill			5,260	2,705
Other	2,279	798		
Total	7,920,655	2,585,791	7,864,968	2,710,835
Grand total	9,452,418	3,644,050	9,833,458	3,891,603

Dimension stone quarried consisted of slate and granite. Dimension slate was marketed largely as flagging and electrical slate. Dimension granite included rough and dressed monumental stone, rough and dressed construction and architectural stone, rubble, curbing and flagstone, and paving blocks. Crushed and broken granite was used mostly as riprap and roadmaking material, and crushed quartzite and basalt chiefly as roadstone. Crushed and broken limestone was consumed for a variety of uses, but principally in making cement, as road base material, in paper manufacture, and as agricultural limestone. The chief stone-producing counties, in order of quantity, were Knox, Kennebec, and Cumberland, and in order of value, Knox, Hancock, and York.

METALS

Beryllium.—Beryllium sales were reported by two mines in Oxford County and one mine in Sagadahoc County, with additional small quantities reported from unspecified counties. All sales were through the GSA purchase depot at Franklin, N.H., for the strategic materials stockpile. The beryl averaged about 12 percent beryllium oxide.

Nickel.—A firm which had been exploring nickel prospects in Knox County for nearly 4 years continued its detailed drilling program.

REVIEW BY COUNTIES

Paving sand and gravel was produced by the Maine State Highway Commission in each county, both with its own crews and under

contract. Small quantities of building sand and gravel also were mined. In addition, Acadia National Park in Hancock, five towns or municipalities in Androscoggin County, two in Hancock County, and one in Penobscot County mined sand and gravel for local road and street maintenance. Acadia National Park in Hancock County contracted for production of miscellaneous stone. The Maine State Highway Commission also contracted for a small quantity of quartzite for road construction in Kennebec and Penobscot Counties.

TABLE 3.—Value of mineral production in Maine, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Androscoggin	(1)	(1)	Sand and gravel, clays, gem stones.
Aroostook	$405,685	(1)	Sand and gravel, stone.
Cumberland	1,061,125	$1,107,479	Sand and gravel, stone, clays, gem stones.
Franklin	(1)	(1)	Sand and gravel, clays.
Hancock	(1)	(1)	Stone, sand and gravel, gem stones.
Kennebec	424,625	827,431	Sand and gravel, stone.
Knox	(1)	(1)	Cement, stone, sand and gravel.
Lincoln	70,812	73,570	Sand and gravel.
Oxford	(1)	(1)	Mica, sand and gravel, feldspar, gem stones, beryllium concentrates.
Penobscot	523,114	840,993	Sand and gravel, stone.
Piscataquis	(1)	(1)	Stone, sand and gravel.
Sagadahoc	76,373	59,239	Sand and gravel, feldspar, gem stones, mica, beryllium concentrates.
Somerset	(1)	121,323	Sand and gravel.
Waldo	(1)	(1)	Stone, sand and gravel.
Washington	(1)	(1)	Sand and gravel, stone, gem stones.
York	(1)	(1)	Stone, sand and gravel, clays, gem stones.
Undistributed [2]	10,716,690	10,618,710	
Total	13,278,000	13,648,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes value of sand and gravel (1960), mica, gem stones (1959), and beryllium concentrates (1960) that cannot be assigned to specific counties; and values indicated by footnote 1.

Androscoggin.—Ten commercial sand and gravel producers were active, chiefly near Lewiston, Auburn, Leeds Junction, and Lisbon. Most of the sand and gravel was prepared for building and paving material and fill sand. Some bankrun sand and gravel for paving and fill, and miscellaneous gravel also was produced.

Two companies produced miscellaneous clay from open pits near Auburn for manufacturing building brick.

Quantities of gem material collected included beryl, mica, and perthite.

Gypsum products were manufactured at Lisbon Falls by United States Gypsum Co.

Aroostook.—Four producers mined sand and gravel commercially, two near Houlton and one each near Presque Isle and Hodgdon. Gravel was produced chiefly for building, paving, fill, and miscellaneous uses. Some building and paving sand also was produced.

Crushed limestone for use as concrete aggregate and roadstone was quarried near Houlton by Lawrence Burleigh and sold to local government agencies.

Cumberland.—Commercial sand and gravel was produced by nine companies from pits principally near Cumberland, Portland, and Scarborough. Most of the output was prepared building, paving, and fill sand and gravel, and some bankrun sand and gravel was produced for

fill. Leading producers were: Cumberland Sand & Gravel Co. (Cumberland), P. E. Hamlin (Portland), and Leroy S. Prout Sand & Gravel (Scarborough).

Quartzite, for concrete aggregate, roadstone, and riprap, was quarried at the Blue Rock quarry, Westbrook. The stone was blasted from the open quarry, hauled by truck to the local crusher, and stockpiled in various sizes to be used as needed.

Four companies mined miscellaneous clay from open pits near Gray, Gorham, North Yarmouth, and Cumberland for use in making building brick. Royal River Brick Co., Inc., Cumberland Center, installed new brick-manufacturing machinery. The LaChance Brothers Brick Co. installed a new tunnel kiln and dryer, which will make possible year-round brick manufacture, instead of the open-air intermittent brickmaking generally prevalent in Maine. Capacity of the new plant was 7 million brick per year. Clay reserves were said to be sufficient to last for 40 years at the 1960 rate of operation.[6]

Small quantities of smoky quartz and contact metamorphic minerals, such as diopside, epidote, and vesuvianite crystals, were collected as mineral specimens near West Casco and Topsham.

A major center for the production of radar antennas and complex products in space technology and the sonar and nuclear fields was planned for South Portland by Portland Industries Corp. Conversion of a large existing facility containing over 500 machine tools and 500,000 square feet of manufacturing area was projected.[7]

Franklin.—Three companies, two near Weld and one near Wilton, produced building and paving sand and gravel.

Miscellaneous clay for manufacturing building brick was produced near West Farmington.

Hancock.—Hancock County again led in granite production, with tonnage and value increasing 13 and 10 percent, respectively. Dimension granite was quarried by three companies near Hall Quarry and Stonington, chiefly for use as dressed construction and rough and dressed architectural and monumental stone.

Output of four commercial sand and gravel producers consisted mostly of paving gravel from pits near Blue Hill, Winter Harbor, Hancock, and Gouldsboro.

Pyrite, chalcopyrite, and molybdenum for mineral specimens were collected in the county.

The Penobscot Mining Co. revived activity in copper exploration at its Cape Rosier property and planned a major drilling and geological mapping program.

Kennebec.—Sand and gravel recovered by four commercial producers near Augusta, Fayette, Gardiner, and Waterville was sold mostly for building and paving sand and gravel, and fill gravel.

Crushed granite for use as road material was quarried near Gardiner and sold to local government agencies. H. E. Sargent produced crushed limestone for road material at a semiportable plant near Vassalboro for the Maine State Highway Commission.

[6] The New Englander, May 1960, p. 35.
[7] American Metal Market, vol. 67, No. 145, July 29, 1960, p. 12.

Knox.—Dragon Cement Co., a division of American-Marietta Co., utilized captive cement rock at its two-kiln plant at Thomaston to manufacture cement. Mostly general-use and moderate-heat cement and some high-early-strength portland cement was manufactured by the wet process. Mortar cement also was produced. Shipments of cement were mostly in bulk by railroad to ready-mix concrete companies and building-material dealers.

Knox County again led in quantity and value of stone produced, with a slight increase in 1960. Dimension granite was quarried by Hocking Granite Industries, Inc., Clark Island, mainly for dressed architectural, construction, and curbing stone. Some crushed stone for use as riprap also was produced. Limestone, crushed principally for road material, riprap, and for use in paper manufacture, was produced by the Rockland-Rockport Lime Co. quarry at Rockland, and the Lime Products Corp. quarries at Union and Warren.

A commercial producer near Warren sold processed sand and gravel for building and paving material, and bankrun gravel for fill. Some of the material was sold to local government agencies.

Roland F. Beers, Inc., continued its 4-year development and exploration program for nickel in Union. Milling tests had been run, both by the Federal Bureau of Mines and by private testing laboratories, to determine economic methods of primary concentration. The company expected to continue its detailed drilling program during the fiscal year 1960–61.

Lincoln.—Commercial gravel for structural work and bankrun gravel for fill were produced by Howard R. Wright near Newcastle.

Oxford.—Most of the sheet mica mined in Oxford County was sold through the GSA (Franklin, N.H.) purchase depot; some was sold through the Custer (S. Dak.) and Spruce Pine (N.C.) depots. Some hand-cobbed mica was sold to industry. Sales of sheet mica increased 23 percent in quantity and 16 percent in value. A small quantity of scrap also was sold by three producers to private industry. Thirty-two producers worked 13 mines at various localities in the county. Leading mica-producing mines operated included the Wardwell (Albany), Wheeler (Gilead), Pelletier and Cliff (both at Norway), Tyler and Rich (Mason), and the George Elliott (Rumford).

Six producers mined feldspar from open pits near West Paris, West Sumner, Hebron, and Norway. Bell Minerals Co., the leading producer, ground feldspar for ceramic uses, including pottery, and electrical procelain, tile, and sanitary ware, and for soaps and abrasives and metal polish. Major shipments were to Pennsylvania, Wisconsin, and New York; smaller quantities went to other States. The Bell Minerals Co. continued to explore new areas and to obtain more complete data on known or partially proven areas.[8]

Beryllium concentrate (beryl) production and value in the county increased slightly, although only two mines were operated compared with four in 1959. Stanley Pechnik worked the Pelletier mine (North Norway) and Lester E. Wiley the Wardwell mine (Albany). Sales were to the GSA (Franklin, N.H.) purchase depot.

[8] Brick & Clay Record, vol. 137, No. 2, August 1960, p. 37.

Oxford County remained the principal source of gem material. Rose quartz, jasper, beryl, and aquamarine specimens were collected near Swift River, Albany, and Waterford by individual collectors as a hobby, and by dealers for resale or jewelry manufacture.

Unscreened structural sand and gravel and paving and ice-control sand were recovered from pits near Rumford, Mexico, and Norway.

Penobscot.—Penobscot County ranked first in production of sand and gravel, with an increase of 13 percent in tonnage and 34 percent in value. Eight commercial producers operated, compared with five in 1959. Mostly building, paving, and fill sand and gravel was produced. Eighty-nine percent of the material was screened, and the entire production was transported by truck. Pits were operated chiefly near Stillwater, Lincoln, and Milford.

Bridge Construction Corp. produced crushed quartzite near Orono. Most of the stone was used as road material for local government projects.

Piscataquis.—Portland-Monson Slate Co. produced electrical and flagging slate at its Nos. 2 and 4 underground mines at Monson, and processed the slate at a local finishing mill. Lack of demand by industry for heavy switchgear panels resulted in slight decreases in quantity and value of output. Some flagstone and electrical slate was exported to Canada.

Sagadahoc.—Tonnage and value of feldspar decreased considerably, with only 5 operators compared with 12 in 1959. Some of the feldspar was purchased, crushed, and screened by Topsham Feldspar Co. at its Topsham mill solely for use as poultry grit. Consolidated Feldspar Department, International Minerals & Chemical Corp., did not operate its Topsham mill.

Earl Williams and Willard Titcomb sold full-trim mica from the Trott Cove mine near Woolwich to the GSA (Franklin, N.H.) purchase depot. Punch and other mica from the same mine was sold to industry.

Mrs. Francis MacDonald mined a quantity of beryllium concentrate (beryl) at various quarries near Georgetown and sold it to the GSA (Franklin, N.H.) purchase depot.

Perthite, quartz, mica, beryl, and tourmaline mineral specimens and semiprecious gem material were collected in the county.

Building and paving sand and gravel was recovered from pits near Bath and Topsham.

Somerset.—R. F. Beers. Co. (Troy, N.Y.) undertook geophysical and geological surveys for nickel near a sulfide-bearing gabbro body south of Moosehead Lake, and Scott Paper Co. continued diamond drilling for copper mineralization in the northern part of the county.

Waldo.—Dressed architectural and curbing dimension granite was quarried by Grenci & Ellis, Inc. at its Mount Waldo quarry near Frankfort.

Anhydrous ammonia was manufactured at Searsport by Northern Chemical Industries.

Washington.—Building, paving, and fill sand and gravel, and bank-run gravel for use as railroad ballast were recovered from pits by four commercial producers near Cutler, Machias, and East Machias.

Crushed basalt for use as concrete aggregate, roadstone, and screenings was produced by A. P. Wyman, Inc., Cutler.

Small quantities of galena and meta-rhyolite for mineral specimens were found near West Lubec.

York.—The John Swenson Granite Co., Inc., quarried dimension granite for dressed architectural stone, and some crushed granite for riprap from the Swenson Green quarry near York and the Swenson Pink quarry near Highpine.

Building and paving sand and gravel, and gravel for fill were recovered near Biddeford, Sanford, and York.

Miscellaneous clay for making building brick was mined near Eliot.

Scheelite, molybdenum, and garnet mineral specimens were collected in the county.

The Mineral Industry of Maryland

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Maryland Department of Geology, Mines, and Water Resources.

By James R. Kerr [1] and Mary E. Otte [2]

THE VALUE of mineral production in Maryland increased over $2.3 million in 1960 to a record high of $55.5 million. Greater output of sand and gravel, crushed stone, and cement offset smaller output of coal, natural gas, and clays. In terms of value, cement was the leading commodity, followed by stone and sand and gravel.

Baltimore County led in value of mineral production, followed by Carroll and Washington Counties.

TABLE 1.—Mineral production in Maryland [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2]—thousand short tons	661	$944	612	$853
Coal—do	842	3,188	748	2,799
Gem stones	(3)	2	(3)	2
Natural gas—million cubic feet	4,373	1,181	4,065	1,081
Sand and gravel—thousand short tons	10,034	12,983	10,076	13,221
Stone—do	7,445	15,476	7,944	16,962
Value of items that cannot be disclosed: Ball clay, cement (masonry and portland), lime, greensand marl, potassium salts, talc and soapstone	----	21,416	----	22,779
Total Maryland [4]	----	53,189	----	55,527

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producer).
[2] Excludes ball clay; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Total adjusted to eliminate duplicating value of clays and stone used in manufacturing cement and lime.
[5] Revised figure.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipment of portland and masonry cement from plants in Maryland continued to increase, rising 7 percent over 1959. Produc-

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical clerk, Bureau of Mines, Pittsburgh, Pa.

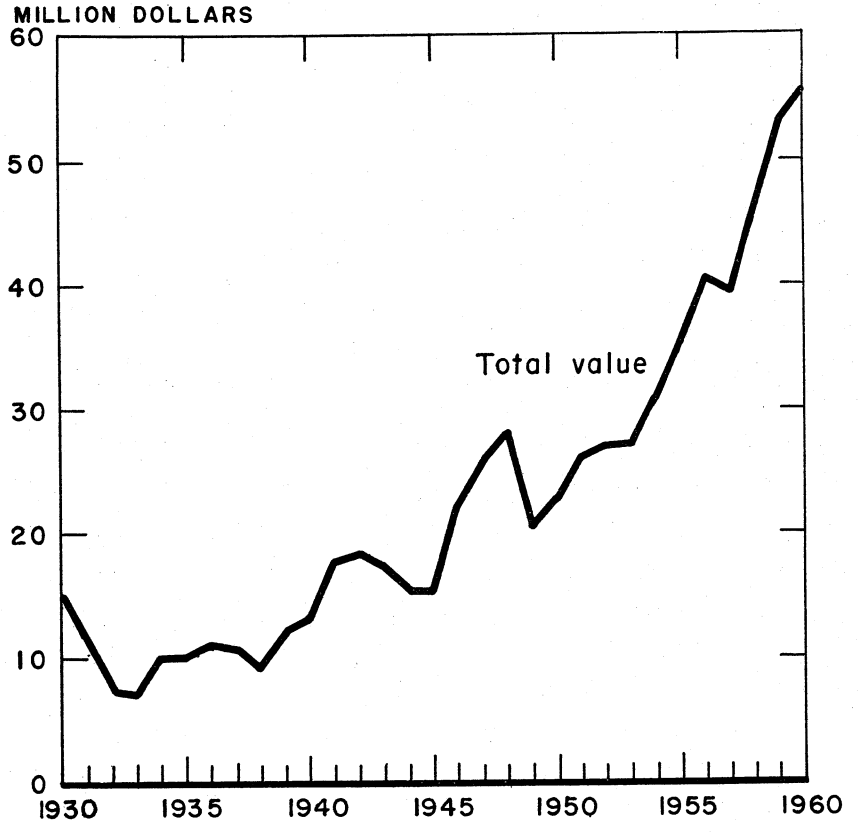

FIGURE 1.—Value of mineral production in Maryland, 1930–60.

tion of portland cement was at 77 percent of capacity, compared with 75 percent in 1959 and 60 percent in 1958. Most of the production was non-air-entrained, general-use, and moderate-heat types. Both wet and dry process plants operated, but most of the output was by the dry process. Power was both purchased and generated by the cement companies, but the larger quantity was purchased from local utility companies.

Most of the mineral output was used in Maryland, but substantial shipments were made to Virginia, Pennsylvania, and the District of Columbia. Much of the portland cement was used in ready-mixed concrete, concrete products, and highway and other construction. Cement came from Carroll, Frederick, and Washington Counties; Carroll County was the leading producer.

Clays.—Production of clays decreased 7 percent in tonnage and 10 percent in value, owing to decreased demand for refractory materials and heavy clay products. The output was mostly miscellaneous clay for use by the construction industry, either as building brick or as a raw material for cement. The production of miscellaneous clay decreased 3 percent and fire clay production decreased 55 percent. Al-

though reduced output of ball clay was reported, the uses remained unchanged; floor and wall tile, pottery, and refractories consumed most of the output.

Clay output came mostly from 14 captive mines. However, four mines produced clay for sale on the open market. Clay was produced in 10 counties. Baltimore County was the only source of ball clay. Allegany was the leading of four fire clay-producing counties, and Baltimore was the leading of eight miscellaneous clay-producing counties, followed by Prince Georges and Washington Counties. The output came from open pit mines except for two underground mines in Allegany County.

Widespread deposits of clay in southern Maryland that may be suitable for manufacturing lightweight aggregate of superior quality were discovered by Federal and State agencies. The St. Marys formation in southeastern Calvert and St. Marys Counties yielded clays that, when expanded, compared favorably in quality with the better expanded aggregates used in light-weight concrete.[3]

Gem Stones.—Williamsite was collected, chiefly by amateur collectors, at scattered localities, mainly in Cecil County.

Gypsum.—Imported gypsum was calcined at a plant near Baltimore for producing wallboard and lath and base-coat plasters.

Lime.—Output of lime decreased slightly compared with 1959, owing to reduced demand for hydrated agricultural lime. The industry, consisting of 3 producers in Frederick County, operated a total of 34 pot kilns and 2 continuous hydrators using both coke and coal as fuel. Production in 1960 slightly exceeded 60 percent of capacity.

Marl, Greensand.—Greensand marl continued to be produced at Dunkirk, Calvert County, from an open pit. After refining, the material was marketed as a soil conditioner.

Perlite (Expanded).—Expanded perlite production decreased slightly. Crude perlite from mines in New Mexico, Nevada, Colorado, and Arizona was expanded at plants in Baltimore and near Washington, D.C., chiefly for building plaster and concrete aggregate, and as a filter aid.

Pigments.—A wide variety of finished iron oxide pigments was produced at a plant in Prince Georges County. The principal varieties produced were natural red iron oxide, manufactured yellow iron oxide (pure), burnt and raw umber, manufactured magnetic black, Vandyke brown, burnt sienna, manufactured red iron oxide, and venetia red. Zinc chloride and zinc sulfate pigments were produced at Cockeysville and titanium dioxide pigments were produced at a plant near Baltimore.

Potassium Salts.—Potassium sulfate continued to be recovered as a byproduct of cement operations in Washington County. Output was at a slightly higher rate than in 1959.

Sand and Gravel.—Approximately the same tonnage of sand and gravel was produced as in 1959. A decline of 6 percent in the production of gravel for building and paving was offset by an increase of 9 percent in the output of sand, chiefly for the same purposes. As in past years, the commercial output was mostly for building (49 per-

[3] Rock Products, vol. 63, No. 3, March 1960, p. 22.

cent) and paving (40 percent). Other markets for sand were glass, grinding, fire, engine, and miscellaneous uses. Other markets for gravel were railroad ballast, fill, and miscellaneous uses. Government-and-contractor production, which was entirely paving gravel, decreased 33 percent.

Over 86 percent of the commercial production was washed, screened, or otherwise prepared, compared with 82 percent in 1959. The average value of commercial sand and gravel increased $0.02 to $1.31 per ton. All Government-and-contractor production was bank-run. Most of the sand and gravel was transported by truck.

Commercial sand and gravel was produced in 14 counties. Prince Georges County led, followed in decreasing order by Anne Arundel, Baltimore, and Cecil. Noncommercial operations were active in Prince Georges, Talbot, and Wicomico Counties.

TABLE 2.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1959		1960	
	Quantity	Value	Quantity	Value
Sand:				
Structural	2,376	$3,030	2,578	$3,233
Paving	1,729	2,274	1,867	2,541
Fill	11	4	44	16
Gravel:				
Structural	2,199	3,703	2,136	3,484
Paving	2,042	2,718	1,979	2,798
Fill	91	62	31	14
Gravel miscellaneous			418	247
Undistributed [1]	[2] 1,586	[2] 1,192	1,023	888
Total [3]	10,034	12,983	10,076	13,221

[1] Includes glass, grinding and polishing, fire or furnace, engine, and other sands; railroad ballast (1960) and other gravel.
[2] Revised figure.
[3] Includes Government-and-contractor paving sand and gravel.

Stone.—Output of stone increased 7 percent. Increased production of basalt, granite, and miscellaneous stone offset decreases in the output of limestone, marble, and sandstone. Production of limestone, the leading stone industry, decreased 9 percent chiefly because of lower demand for limestone as concrete aggregate, riprap, and railroad ballast. A greater quantity of limestone was marketed as agstone. Production of sandstone and marble decreased because of a lower demand for dimension stone and for standstone as refractory stone. Output of basalt doubled, owing to a greater demand for basalt as concrete aggregate. Less dimension granite was produced than in 1959, but the use of crushed granite as concrete aggregate expanded considerably. Larger quantities of miscellaneous stone were produced for rough dimension, rubble, and flagging uses, and for crushing for concrete aggregate, resulting in an overall increase of 65 percent in miscellaneous stone output.

The leading stone producing counties in order of decreasing production were Baltimore, Frederick, Washington, and Carroll. Limestone was produced in six counties, crushed basalt in four counties,

miscellaneous stone and sandstone in two counties, and marble and granite in one county.

Talc and Soapstone.—Production of crude talc and soapstone increased more than 10 percent. The output was ground and sawed at local plants. Most of the crude material was ground for marketing as asphalt filler, and for use in roofing, foundry facings, rubber, and refractories.

Two quarries, one each in Carroll County and Harford County, and three plants, two in Carroll County and one in Harford County, were active. A small quantity of crude Pennsylvania soapstone was ground, and imported talc was sawed into finished products.

Vermiculite, Exfoliated.—Crude vermiculite produced outside the State was exfoliated at a plant in Beaver Heights, Prince Georges County.

MINERAL FUELS

Bituminous Coal.—Production decreased 11 percent from 1959. Chief factors in the decline were significant decreases in strip mining in Allegany County and underground mining in Garrett County. Coal from strip mines comprised 65 percent of total output and was valued at $3.32 per ton compared with $4.54 per ton for coal from underground mines. Average value per ton for total State output dropped $0.04 to $3.74.

Coal mining in Maryland was characterized by small nonmechanized underground mines and small contour strip mines. Of the underground production, 74 percent was cut by 41 cutting machines, 81 percent was power-drilled by 43 hand-held or post-mounted drills, and 37 percent was hand-loaded onto face conveyors. Strip mining equipment included 39 power shovels, 6 dragline excavators, and 41 bulldozers. There was no mechanical cleaning in the State but 36 percent of total output was crushed and sized.

Coke and Coal Chemicals.—Bethlehem Steel Corp. produced 2,970,005 tons of coke at its Sparrows Point plant of 760 ovens, an increase of 24 percent over 1959. Associated coproducts yielded were coke breeze, 177,748 tons; coke oven gas, 45,916 million cubic feet; ammonium sulfate 27,489 tons; tar, 38 million gallons; and crude light oil, 14 million gallons. Light oil derivatives included benzene, 9 million gallons; toluene, 2 million gallons; and xylene, 658,083 gallons.

Natural Gas.—Production of natural gas decreased 7 percent. Output came from the Mountain Lake Park and Accident fields in Garrett County.

METALS

Copper.—On May 19, 1960, Kennecott Copper Corp. dedicated its $30 million electrolytic copper refinery at Hawkins Point in Anne Arundel County, just south of Baltimore. At midyear the plant was processing approximately 10,000 tons of high-purity copper per month originating from the company's copper mines in Arizona, Nevada, New Mexico, Utah, and Chile. Designed capacity was 16,500 tons per month.[4]

[4] Mining Congress Journal, vol. 46, No. 7, July 1960, p. 81.

615629—61——32

Iron and Steel.—The annual capacity of the State's steel industry at the beginning of the year was 8,380,960 tons. Blast-furnace capacity was 5,480,000 tons. Bethlehem Steel Co. announced plans to increase capacity to 9 million ingot tons during the next 2 years. Key to the increase was a plan to equip all seven furnaces in the new No. 4 open-hearth shop for the use of oxygen.[5]

Iron and Steel Scrap.—The collection of iron and steel scrap for open-hearth and electric steel furnace additions was reported throughout the State but was concentrated in the Baltimore area.

REVIEW BY COUNTIES

Allegany.—Coal production decreased 19 percent, owing to sharply curtailed strip-mining activity. Thrasher Construction & Stripping Co., a producer of large quantities in 1959, operated solely in Garrett County in 1960. C. A. Liller Coal Co. abandoned its mine late in 1959. Although the number of active underground coal mines decreased by five, underground production declined only slightly. Average value per ton for underground output remained at $4.44, but strip-tonnage value increased from $3.39 to $3.50 per ton. Leading underground mines were operated by W. & W. Coal Co. (Bakerstown No. 6) and Gary Coal Co. (Gary). The leading strip operators were Moran Coal Co. (Nos. 24 and 24B), Mack Coal Co. (Stewart and Sherman), and Phoenix Big Vein Coal Co., Inc. (Hoffa No. 5).

TABLE 3.—Value of mineral production in Maryland, by counties [1]

County	1959	1960	Minerals produced in 1960 in order of value
Allegany	$2,252,752	$1,912,778	Coal, sand and gravel, stone, clays.
Anne Arundel	(2)	(2)	Sand and gravel, clays.
Baltimore	11,749,123	11,278,181	Stone, sand and gravel, clays.
Calvert	(2)	(2)	Greensand marl.
Caroline	101,726	(2)	Sand and gravel.
Carroll	8,249,300	(2)	Cement, stone, clays, soapstone.
Cecil	969,331	1,537,378	Stone, sand and gravel, clays, gem stones.
Charles	50,000	(2)	Sand and gravel.
Dorchester	(2)	(2)	Sand and gravel, stone.
Frederick	7,435,241	7,905,813	Cement, stone, lime, clays.
Garrett	3,928,448	3,343,982	Coal, natural gas, stone, sand and gravel.
Harford	1,092,169	1,036,017	Sand and gravel, stone, talc.
Howard	----------	(2)	Stone.
Kent	83,342	17,000	Clays.
Montgomery	92,904	(2)	Stone.
Prince Georges	5,989,109	6,784,477	Sand and gravel, clays.
Queen Annes	168,364	67,000	Sand and gravel.
St. Marys	(2)	(2)	Do.
Talbot	(2)	(2)	Do.
Washington	(2)	(2)	Cement, stone, clays, potassium salts.
Wicomico	(2)	(2)	Sand and gravel, clays.
Worcester	38,323	(2)	Sand and gravel.
Undistributed [3]	10,989,118	21,645,268	
Total [4]	[5] 53,189,000	55,527,000	

[1] Somerset County is not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes gem stones not assigned to specific counties and values indicated by footnote 2.
[4] Total adjusted to eliminate duplicating value of clays and stone used in manufacturing cement and lime.
[5] Revised figure.

[5] Iron Age, vol. 185, No. 14, Apr. 7, 1960, p. 55.

Sand and gravel tonnage and value were slightly less than in 1959. The Cumberland Cement & Supply Co. quartzite No. 1 plant near Cumberland produced mainly processed glass, grinding and polishing, and structural sand; its No. 3 plant on a sand-and-gravel island near Cumberland produced washed and screened building and paving sand and gravel.

Limestone for concrete aggregate and roadstone was crushed by Fry Coal & Stone Co., Division of American-Marietta Co., at quarries near Corrigansville, Cumberland, and Flintstone.

Fire clay was produced at underground and open-pit mines by Kaiser Refractories & Chemicals, Division of Kaiser Aluminum Corp., near Frostburg, and by Mt. Savage Refractories at its Mt. Savage strip mine. The clay was used for manufacturing firebrick and block.

Anne Arundel.—Tonnage and value of sand and gravel increased 11 percent and 13 percent, respectively; the county ranked second in the State in output. Production by five producers near Hanover, Annapolis, Davidsonville, Baltimore, and Linthicum was chiefly prepared building and paving sand and gravel and fire or furnace sand.

Stoneware clay was mined by Severn Clay Co. at an open pit near Glen Burnie and sold for making floor and wall tile, and sanitary ware.

Baltimore and Baltimore City.—Despite a 4-percent decline in value of mineral production, the county again led in production and value of stone and clay.

Harry T. Campbell Sons Corp. quarried limestone near Texas and east of Marriottsville in Baltimore County; it was crushed for a wide variety of uses, chiefly for concrete aggregate and roadstone. The Arundel Corp. crushed limestone for road material at its Greenspring quarry. Miscellaneous stone (serpentine) quarried near Reisterstown was crushed for roadbuilding. Oystershell was crushed near Baltimore for use as poultry grit and lime.

Crushed basalt, chiefly for use as concrete aggregate and roadstone, was quarried by The J. E. Baker Co. at the Blue Mount quarry near Whitehall; The Arundel Corp., Baltimore City; and The Donley Stone Co. near Hyde.

Harry T. Campbell Sons Corp., Butler, quarried dimension granite for irregular-shaped and dressed construction stone, rubble, and flagging. The quarry was sold to C. E. Weaver Stone Co. in July.

C. E. Weaver Stone Co., Butler, quarried dimension quartzite for dressed and sawed architectural stone, irregular-shaped rough construction stone, rubble, and flagging.

Sand and gravel output (third highest in the State) decreased 16 percent in tonnage and 19 percent in value. Seven pits were operated during the year. Output, mainly building and paving sand and gravel, was recovered near Baltimore, Lansdowne, and White Marsh. Eighty-one men working an average of 274 days were employed by the sand and gravel industry.

Total value of clay production decreased 14 percent. The county was the only source of ball clay, which was mined near Baltimore and sold chiefly for manufacturing floor and wall tile. Miscellaneous

clay for building brick was recovered by two companies at three open-pit mines near Baltimore. Excelsior Brick Co., Baltimore, ceased operations.

Crude perlite purchased in New Mexico was expanded at a Baltimore plant for use chiefly as an aggregate in building plaster.

Imported gypsum was calcined near Baltimore. In addition, United States Gypsum Co. announced plans to build a gypsum products plant at Baltimore, which would use gypsum from Nova Scotia, to supply the growing Baltimore–Washington marketing area.[6]

Calvert.—Kaylorite Corp., Dunkirk, the only greensand marl producer in Maryland, sold refined material for use as a soil conditioner.

Caroline.—Structural sand and gravel, sand for fill, and paving gravel were produced by Cook & Son, Greensboro. Most of the material was processed and sold to local government agencies for road construction and maintenance.

Carroll.—Carroll County again led in shipments and value of cement. With an overall increase in value of production, the county ranked second in mineral output. Lehigh Portland Cement Co. produced crushed limestone, sandstone, and shale for manufacturing cement at its 3-kiln plant at Union Bridge. General use and moderate heat, and high-early-strength air-entrained and non-air-entrained portland cements and mortar cement were produced by the dry process. Cement was shipped mostly in bulk by truck to ready-mixed concrete companies. Major shipments were intrastate and to Virginia; significant quantities went to the District of Columbia, Pennsylvania, and Delaware.

Teeter Stone, Inc., subsidiary of H. T. Campbell Sons Corp., Medford, quarried and crushed limestone solely for use as concrete aggregate and roadstone.

Soapstone was mined at an open pit near Marriottsville by the Liberty Stone Co. Output which was ground at the local plant and at the company's Sykesville plant, was sold mainly as asphalt filler, and for use in roofing and foundry facings.

Cecil.—Crushed granite, chiefly for road construction and riprap, was quarried by Maryland Materials, Inc., near North East. Port Deposit Quarries Co., Inc., Port Deposit, produced dimension granite for irregular-shaped construction stone, rough architectural stone, and riprap. Harbison-Walker Refractories Co. produced and crushed quartzite near North East for manufacturing silica brick. D. M. Stoltzfus & Son produced basalt solely for use in road construction, at the Elk Mills quarry near Elkton, a one-bench quarry with an average face-height of 50 feet.

The tonnage and value of sand and gravel output by seven producers in the county increased 8 percent and 19 percent, respectively. Mostly structural, paving, and fill sand and gravel were recovered from pits near Rising Sun, Perryville, Port Deposit, and North East. Part of the output was sold to local government agencies for road work. Twenty-seven men employed by the sand and gravel industry in the county worked an average of 191 days.

[6] Pit and Quarry, vol. 53, No. 1, July 1960, p. 103.

Plastic fire clay and some white clay for making refractory firebrick and block were recovered from two open-pit mines near North East.

A quantity of williamsite was obtained by a gem-stone collector at the Chrome Pits mine.

Charles.—Paving sand and structural gravel were recovered at a stationary plant near LaPlata.

Dorchester.—Processed building sand and gravel and bank-run fill sand were recovered at a stationary plant near Federalsburg by J. Edwin Rosser, Inc.

Oystershell was crushed for poultry grit and lime by J. M. Clayton at Cambridge.

Frederick.—Shipments and value of cement continued to increase. Alpha Portland Cement Co. burned captive cement rock at its Lime Kiln plant for manufacturing cement. Mostly air-entrained and non-air-entrained general use and moderate heat and some high-early-strength portland cement were produced in the company's two 400- by 11.4-foot rotary kilns, by the wet process. Output was consumed mostly intrastate; large shipments went to Virginia, Delaware, and West Virginia.

Limestone and cement rock were quarried and crushed chiefly for concrete aggregate and roadstone and for cement and lime manufacture near Woodsboro, Middletown, Frederick, LeGore, New London, and Lime Kiln. The stone industry in the county employed 69 men who worked an average of 242 days.

Three operators of limekilns near LeGore, Woodsboro, and Middletown produced quicklime and hydrated lime chiefly for agriculture.

Miscellaneous clay for manufacturing building brick was mined at open pits near Buckeystown and Hopeland by Hudson Supply & Equipment Co.

Garrett.—Production of bituminous coal decreased 8 percent. Both underground- and strip-mined tonnage were less. There were 3 more strip mines active (21) but the new production did not offset reduced output by the Buffalo Coal Co., the leading producer, and the closing of the George L. Smith Contracting Co. Harvey mine. Other large strip-mine producers were Moran Coal Co. (4 pits), Thrasher Construction & Stripping Co., and the Casey Contracting Co. (3 pits). Two less underground mines (24) were active but the sharply decreased production of the Stanley Coal Co. Offutt mine was the chief factor in decreased underground output. Leading producers were W. & W. Coal Co., Droppleman Brothers Coal Co., and Utility Coals, Inc.

Vetter Bros., Inc., produced and crushed blue limestone at the Fry and Browning quarries 9 miles north of Oakland for use as concrete aggregate and roadstone. The company again had an accident-free record during the year.

Sand for ice control and building was produced at two pits near Oakland.

Harford.—Although the same number of sand and gravel producers (11) operated in the county as in 1959, tonnage and value decreased 3 percent and 19 percent, respectively. Eight stationary plants and three portable plants produced mainly building and paving sand and

gravel and miscellaneous gravel. Leading producers were Stancill's, Inc., Edgewood, and Maryland Sand & Gravel Co., Aberdeen. Other producing areas were near Abingdon and Webster Village.

Gatch Crushed Stone Co. (formerly Thomas B. Gatch & Sons), Churchville, quarried and crushed basalt for road material. The quarry, consisting of two benches with average height and width of face of 30 feet and 60 feet, respectively, began operating in May. D. M. Stoltzfus & Son, Inc., operated the Grays Run quarry and plant near Aberdeen, producing crushed basalt for road material. The Maryland Green Marble Co. quarried near Cardiff and produced cut and sawed marble for building interiors.

Talc was mined by Harford Talc & Quartz Co., Inc., Dublin, and sold mostly for use in foundry facings.

Howard.—The Arundel Corp. produced crushed basalt for concrete aggregate and roadstone at a quarry and crusher near Savage.

Kent.—Chestertown Brick Co., Chestertown, mined miscellaneous clay from an open pit for manufacturing firebrick and block.

Montgomery.—Albert D. Battista quarried dimension granite for rough and dressed construction and rubble at the Bradley Lane quarry near Rockville. Stoneyhurst Quarries, Bethesda, quarried dimension mica schist for rough building stone, rubble, and some flagging.

Prince Georges.—An overall increase in tonnage and value (8 percent and 19 percent, respectively) was attributed to increased demand for building and paving sand and gravel. The county again led the 15 sand and gravel-producing counties in the State. Production was reported from 15 operations—12 stationary, 2 portable, and 1 dredge—mostly from areas near Laurel, Upper Marlboro, and the District of Columbia. Seventy-eight percent of the material sold or used was washed and screened. The sand and gravel industry in the county employed 426 men, working an average of 276 days.

Plastic fire clay for refractories and for use in foundries and steelworks was produced by William L. Allen, Laurel. Miscellaneous clay, mainly for building brick, was recovered from open cuts by West Brothers Brick Co. near Washington, D.C., and The Washington Brick Co., Muirkirk. The latter company put a new tunnel kiln into operation and began using a redesigned hammermill crushing plant.

Mineral Pigments Corp., Muirkirk, sold finished iron oxide pigments, chiefly natural red iron oxide and manufactured yellow iron oxide.

Crude perlite from Colorado, Nevada, New Mexico, and Arizona, was expanded at two plants near Washington, D.C. for use chiefly as an aggregate in building plaster.

Queen Annes.—R. B. Baker & Sons, Inc., Queenstown, produced chiefly building and paving sand and gravel.

St. Marys.—Sand and gravel for structural and paving uses and gravel for fill and surface treatment were recovered from stationary plants near Hollywood and Leonardtown.

Washington.—The value of mineral production decreased slightly; the county dropped from second to third among the mineral-producing counties. Total cement value increased to comprise over 80

percent of the total value of minerals produced, whereas tonnage and value of stone decreased 20 percent and 21 percent, respectively.

North American Cement Corp. quarried and crushed limestone at the Security plant near Hagerstown, chiefly for manufacturing cement; some was also used for road material and railroad ballast. Five 125-foot rotary kilns and one 140-foot kiln were used to produce general use and moderate heat, and high-early-strength portland cements and masonry cement by the dry process. Shipments were mostly intrastate and to the District of Columbia, Virginia, and Pennsylvania.

Fry Coal & Stone Co., Division of American-Marietta Co., operated the Williamsport quarry near Pinesburg to produce crushed limestone for road material, dust for coal mines, stone sand, and agstone.

Victor Cushwa & Sons, Inc., Williamsport, recovered miscellaneous clay for manufacturing building brick and cement, and for fertilizer filler.

Potassium salts were obtained as a byproduct of cement clinker at the North American Cement Corp. plant at Security.

Wicomico.—Building and paving sand and gravel was recovered at a stationary plant near Hebron and at stationary and portable plants near Salisbury.

Miscellaneous surface clay for manufacturing building brick was mined near Salisbury.

Worcester.—George B. Cropper washed building sand at a stationary plant near Ocean City.

The Mineral Industry of Massachusetts

By Robert W. Metcalf [1] and James R. Kerr [1]

THE VALUE of Massachusetts mineral production broke all records in 1960, rising to $27.6 million, 6 percent higher than in 1959, the previous peak year. Production of lime, sand and gravel, and stone increased appreciably over 1959. Quantity and value of both lime and sand and gravel established new highs. Middlesex County led Massachusetts counties in value of mineral output, with nearly one-third of the total State value, followed by Berkshire, Norfolk, and Essex Counties.

The Yankee Atomic Electric Co. began operating a nuclear power plant at Rowe, Franklin County. This development was of major significance in Massachusetts and neighboring New England States. Ten privately-owned New England utilities joined to sponsor this 136,000-kilowatt operation, built by Westinghouse Electric Corp. at a cost of $50 million (including research and development expenses). The plant is fueled by uranium dioxide, and the core contains about 20 tons of uranium, enough for 18 months' operation before fuel reprocessing. The nuclear fuel reportedly is equivalent to 450,000 tons of coal in a conventional plant.[2]

TABLE 1.—Mineral production in Massachusetts [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	101	$229	83	$71
Gem stones	(2)	1	(2)	1
Lime—thousand short tons	144	2,289	154	2,370
Peat—short tons	773	(3)	(3)	(3)
Sand and gravel—thousand short tons	13,210	11,786	14,789	13,013
Stone—do	5,102	12,375	5,247	12,782
Value of items that cannot be disclosed: Mineral fuels and nonmetals		6		8
Total Massachusetts [4]		25,916		27,588

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Total adjusted to eliminate duplicating value of stone.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Steelways. New England's Historic Past—Atomic Future: Vol. 16, No. 4, September 1960, p. 18–20.

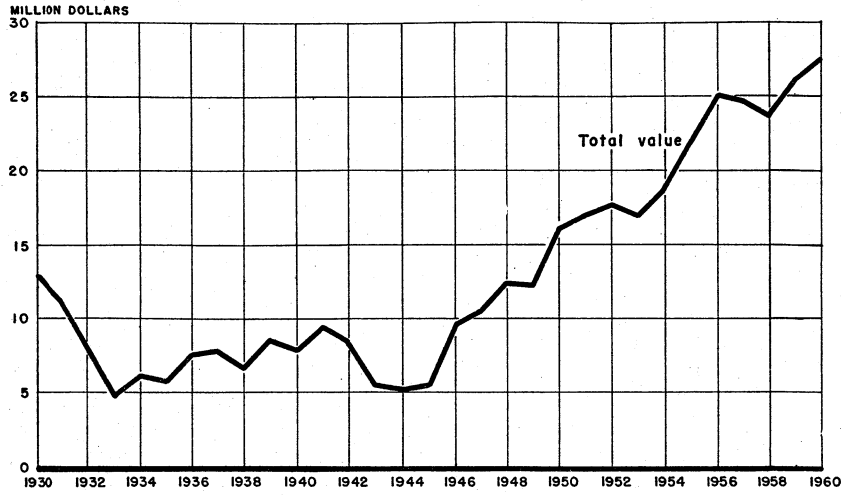

FIGURE 1.—Total value of mineral production in Massachusetts, 1930–60.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Argon.—Argon was produced by Air Reduction Co., Inc., in connection with nitrogen compounds operations at South Acton, Middlesex County.

Clays.—Production of clay totaled 83,000 short tons, 18 percent less than in 1959. Four companies were active at five locations in three counties. The miscellaneous clay was used in making building brick. The principal clay-producing county was Hampden, followed by Plymouth and Bristol.

Gem Stones.—Mineral specimens gathered in Massachusetts by collectors included margarite and emery from Hampton County near Chester. Other specimens collected in the State in recent years were epidote, quartz crystal, and magnetite.

Gypsum.—Nova Scotia gypsum was made into a variety of products at Charlestown, Suffolk County. The finished products were distributed chiefly to consumers in New England.

Lime.—Production of lime totaled 154,000 short tons valued at $2,370,000. These figures are new highs in quantity and value, and represent increases of 7 and 4 percent, respectively, above figures for 1959, the former peak year. The average value per ton dropped 3 percent. Lime was manufactured from both limestone and dolomite. Sizable quantities of quicklime and hydrated lime were consumed in construction and agriculture, although most of the tonnage was used for chemical and industrial purposes. Paper, paints, mason's and finishing lime, and precipitated chalk or whiting were among the principal uses reported. A small quantity of deadburned dolomite was exported to England for use in making acoustic tile. The three active lime companies were all in Berkshire County.

TABLE 2.—Lime sold by producers

Year	Short tons	Value	Year	Short tons	Value
1951–55 (average)	134,724	$1,950,532	1958	139,062	$2,120,677
1956	134,248	2,093,195	1959	143,567	2,289,250
1957	137,284	2,232,731	1960	153,710	2,370,059

Nitrogen Compounds.—Nitrogen compounds were produced by Air Reduction Co., Inc., South Acton, Middlesex County.

Oxygen.—Oxygen was produced by Air Reduction Co., Inc., in connection with Nitrogen Compounds operations at South Acton, Middlesex County.

Perlite.—The Whittemore Co., Roslindale, Suffolk, expanded crude perlite from Colorado, and sold it for use in building plaster and concrete aggregate, and for soil conditioning. Output was less than in 1959. Average market value per unit also declined.

Roofing Granules.—Natural and colored granules were produced and sold for use in roofing shingles by a firm at East Walpole, Norfolk County, using miscellaneous stone from Norfolk County as raw material. Output increased 9 percent compared with 1959.

Sand and Gravel.—Vigorous building and road construction programs brought a record sand and gravel output in 1960. Production increased 12 percent to nearly 14.8 million tons, and the total value rose 10 percent to $13 million. The average value per ton declined slightly to $0.88, compared with $0.89 in 1959. Total commercial building sand and gravel and commercial paving sand increased, although commercial sales of paving and fill gravel dropped sharply. On the other hand, paving gravel produced and used in Government-and-contractor operations, chiefly by the Massachusetts Department of Public Works, was 3.5 million short tons, more than three and a half times that of 1959. Of the total production, 84 percent was washed, screened, or otherwise prepared. Of the Government-and-contractor tonnage, 89 percent was produced under contract. All of the Government-and-contractor production and a major portion of the commercial output was hauled by truck. A small quantity of the commercial tonnage was shipped by rail.

Middlesex County was first in output of sand and gravel, with 4.3 million tons. Four other counties, Norfolk, Bristol, Worcester, and Hampden, produced over 1 million tons each.

Stone.—Production of stone rose 3 percent and consisted of granite, basalt, limestone, sandstone, and miscellaneous stone. Commercial stone comprised 97 percent of the total output and noncommercial or Government-and-contractor made up the balance. Commercial stone was quarried in 12 counties and Government-and-contractor stone (basalt only in 1960) in 4 counties.

Dimension granite, the leading dimension stone, declined 16 percent in quantity compared with 1959, and dimension sandstone was substantially higher than in 1959. The chief uses of dimension granite were for curbing stone, and dressed construction and dressed monumental stone. Other uses included architectural stone, rough construction stone, rubble, and paving blocks.

TABLE 3.—Sand and gravel sold or used by producers by classes of operations and uses

Class of operation and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Structural	[1] 3,007,104	[1] $3,013,307	2,907,009	$2,834,164
Paving	1,354,672	1,143,820	1,440,099	1,356,408
Fill	283,543	121,246	286,475	128,111
Blast	2,000	7,000	2,500	12,500
Other	370,381	251,761	415,758	273,386
Gravel:				
Structural	2,556,595	3,534,708	2,705,770	3,738,376
Paving	2,436,999	1,966,655	2,030,664	1,969,937
Railroad ballast	(2)	(2)	5,800	3,200
Fill	869,081	363,089	510,291	279,665
Other	305,434	246,072	300,130	234,873
Undistributed [3]	[1] 282,503	[1] 428,340	295,549	497,447
Total	11,468,312	11,075,998	10,900,045	11,328,067
Government-and-contractor operations				
Sand:				
Paving	29,155	20,314	162,382	91,068
Fill	6,903	5,113	----------	----------
Other	3,000	4,500	----------	----------
Gravel:				
Structural	43,000	38,500	----------	----------
Paving	995,425	396,895	3,497,881	1,550,148
Fill	664,075	244,773	229,162	44,070
Total	1,741,558	710,095	3,889,425	1,685,286
Grand total	13,209,870	11,786,093	14,789,470	13,013,353

[1] Revised figure.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes molding sand, ground sand, and miscellaneous gravel.

Output of crushed and broken stone increased 3 percent, and consisted mostly of basalt, with sizable quantities of granite and limestone, and a smaller tonnage of miscellaneous stone. The chief uses were for concrete aggregate and roadstone. Railroad ballast, agricultural limestone, and riprap were included among the principal uses. The 15-percent rise in output of basalt was noteworthy, reflecting increased road construction in the State.

Commercial stone was quarried by 31 companies at 34 locations in 12 counties, as follows: Basalt, 15 companies at 16 quarries in 9 counties; granite, 12 companies at 12 quarries in 6 counties; limestone, 4 companies at 4 quarries in 1 county; sandstone, 1 company

TABLE 4.—Stone sold or used by producers, by uses

Use	1959		1960	
	Short tons	Value	Short tons	Value
Crushed and broken stone:				
Riprap	114,821	$147,725	77,672	$55,851
Concrete aggregate and roadstone	3,730,886	6,015,495	3,788,199	6,144,033
Railroad ballast	345,239	508,913	342,197	462,162
Agricultural (limestone)	143,884	425,782	144,254	427,998
Undistributed [1]	767,553	5,277,136	895,098	5,691,986
Total	5,102,383	12,375,051	5,247,420	12,782,030

[1] Includes dimension stone, furnace flux, and other uses.

at 1 quarry; and miscellaneous stone, 1 company at 1 quarry. One company quarried both limestone and basalt, and another, both granite and basalt. Two types of stone were reported from six counties. Quarrying of dimension stone was concentrated in Middlesex County, and most of the crushed and broken stone was produced in Essex, Middlesex, Hampden, Norfolk, and Berkshire Counties.

Vermiculite.—Two firms—California Products Corp. and Zonolite Co.—sold exfoliated vermiculite at plants in Norfolk and Middlesex Counties, respectively. Crude vermiculite from foreign countries and domestic sources outside the State was exfoliated and marketed chiefly for use as plaster and concrete aggregate and for insulation.

MINERAL FUELS

Coke.—Operation of the Eastern Gas & Fuel Associates coke oven plant at Everett, Middlesex County, was discontinued in April 1960. After existing stockpiles at Everett are depleted, the company's New Haven, Conn., plant will fill all consumers' requirements.

The closing of the Everett plant was brought about by two chief factors—the gradual replacement over a period of years of coke for household heating by gas and oil and the substitution by gas distributing utilities of natural gas and oil gas for coke oven gas and water gas made from coke.

Peat.—One firm in Essex County reported output of peat humus. Sales were greater than in 1959.

METALS

National Research Corp., Cambridge, began investigating ultrafine metal powder production under a Bureau of Naval Weapons research contract. The higher melting-point metals, such as tantalum, molybdenum, and columbium, were being studied in an effort to produce powders comparable in fineness to those obtainable with lower melting-point metals. The particle size of lower melting-point metals had been reduced to one-millionth of an inch in diameter, by a process discovered about 1958.[3]

Zirconium.—The Norton Co., Worcester, which in 1951 developed a fused stabilized zirconia refractory, placed its first commercial installation in a furnace built by C. M. Manufacturing & Machine Co., Bloomfield, N.J. The refractory, used heretofore as a military and industrial research tool, was designed to operate continuously at temperatures near 3,992° F.[4]

REVIEW BY COUNTIES

The Department of Public Works, Commonwealth of Massachusetts, produced small quantities of crushed and broken basalt as riprap, concrete aggregate and roadstone, and fill in Barnstable, Franklin, Hampden, and Middlesex Counties.

[3] American Metal Market, vol. 67, No. 102, May 27, 1960, p. 10.
[4] Brick and Clay Record, vol. 138, No. 2, February 1961, p. 39.

Sand and gravel was produced for the Massachusetts Department of Public Works under contract and by its own crews in the following counties: Barnstable, Berkshire, Bristol, Franklin, Hampden, Hampshire, Middlesex, Nantucket, Norfolk, Plymouth, and Worcester. Three municipalities also reported production of sand and gravel for their own use in street or highway maintenance—North Adams, Berkshire County; Dartmouth, Bristol County; and Lawrence, Essex County.

TABLE 5.—Value of mineral production in Massachusetts, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Barnstable	$137,521	$177,191	Sand and gravel, stone.
Berkshire	3,919,736	4,333,785	Lime, stone, sand and gravel.
Bristol	1,883.573	1,970,787	Sand and gravel, stone, clays.
Dukes	(1)	(1)	Sand and gravel.
Essex	2,687,393	2,669,526	Stone, sand and gravel. peat.
Franklin	(1)	(1)	Sand and gravel, stone.
Hampden	(1)	(1)	Stone, sand and gravel, clays, gem stones.
Hampshire	644,946	439,345	Sand and gravel, stone.
Middlesex	7,572,861	9,156,381	Stone, sand and gravel.
Nantucket	1,573	(1)	Sand and gravel.
Norfolk	3,083.685	2,902,918	Sand and gravel, stone.
Plymouth	1,653,162	1,287,889	Sand and gravel, stone, clays.
Suffolk	551,628	(1)	Stone, sand and gravel.
Worcester	1,093,770	1.455,050	Sand and gravel, stone.
Undistributed [2]	2,686,429	3,195,274	
Total [3]	25,916,277	27,588,146	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes sand and gravel and gem stones not assigned to specific counties and values indicated by footnote 1.
[3] Total adjusted to eliminate duplicating value of stone.

Barnstable.—Fill gravel and building and paving sand and gravel were produced in large quantities by Frederick V. Lawrence, Inc., at a stationary plant near Falmouth. Whitehead Brothers Co. produced unprocessed molding sand near Provincetown, and Concrete Products Co. of Cape Cod, Inc., produced chiefly building gravel near Falmouth. Turner & Breivogel, Inc., quarried granite for riprap at Falmouth Heights.

Berkshire.—Lime production by New England Lime Co. (Adams), U.S. Gypsum Co. (Farnams), and Lee Lime Corp. (Lee) increased 4 percent in 1960. Chief use for the lime was for chemical and industrial purposes, but lime was also marketed for building and agricultural purposes. Crushed limestone, produced by the above lime-burning companies plus John S. Lane & Son, Inc., at its Tobey plant, West Stockbridge, increased 8 percent. Other than for lime manufacture, limestone was used chiefly as agricultural stone, whiting, mineral food, and asphalt filler. New England Lime Co. completed engineering for the possible installation of another fluo-solids kiln of greater capacity than those currently in operation. This firm also installed a new primary crushing unit and a tube mill in the fine-grinding circuit. Work was underway on expansion of precipitated chalk facilities, including a new dryer.[5]

Almost 600,000 tons of sand and gravel was produced at 17 plants, chiefly for building and paving purposes. General Sand & Stone

[5] Pit and Quarry, vol. 53, No. 1, July 1960, p. 138.

Corp. (Dalton) was the leading producer. Other large producers, in order of decreasing output, were Berkshire Gravel, Inc., (Pittsfield and Lenoxdale), Maxymillian, Inc. (Adams), Nicholas Klein, Jr., (Adams), Abby & Sons (Lee), Frank Bushika (North Adams), and Mountain Sand & Gravel Co., Inc. (Great Barrington). Oits Chester Granite Co. quarried a small quantity of rough monumental granite.

Bristol.—Over 1.1 million tons of sand and gravel was produced at 16 plants, a slight decrease from 1959. Tri-City Concrete Co., Inc., of Raynham, the largest producer, went out of business at the close of 1960. Morse Sand & Gravel Co. at Attleboro and Joseph Borge & Sons, Inc., of Swansea were major producers. McCabe Sand & Gravel Co. (Taunton), Brockton Sand & Gravel Co., Inc. (South Easton), River Sand & Gravel Co. (Seekonk), and Assonet Sand & Gravel Co., Inc. (Fall River) were other large producers. The county output was mainly for building and paving uses.

Basalt for concrete aggregate was quarried by Warren Bros. Road Co. at Acushnet and Morse Sand & Gravel Co., Attleboro.

Stiles & Hart Brick Co. mined miscellaneous clay at Taunton for manufacturing building brick.

Dukes.—Colby Construction Co. produced sand and gravel as building and paving material at a stationary plant near Vineyard Haven.

Essex.—Over 800,000 tons of sand and gravel, a decrease of 14 percent from 1959, was produced at 12 sand and gravel operations. The larger firms were: Yemma Bros., Inc. (Groveland); Videtta Corp. (West Peabody); Andover Sand & Gravel, Inc. (Lawrence); Essex Sand & Gravel Co., Inc. (Andover); and Miles River Sand & Gravel Co. (Ipswich). Highway and building construction consumed the major portion of the sand and gravel output.

Crushed basalt, chiefly for concrete aggregate and roadstone, was produced by Lynn Sand & Stone Co., Swampscott; Trimount Bituminous Products Co., Saugus; and Essex Bituminous Concrete Corp., West Peabody. Output was 8 percent greater than in 1959.

Andover Sand & Gravel, Inc., produced humus peat for soil conditioning from bogs near Lawrence.

Franklin.—Basalt, chiefly for railroad ballast and concrete aggregate and road base, was quarried by Greenfield Massachusetts Broken Stone Co. Dimension granite, chiefly for rough architectural uses, was quarried by Rockport Quarry Co., Inc., at Rockport. This firm supplied exterior architectural stone for the Bancroft Hall additions at the U.S. Naval Academy, Annapolis, Md. Karl A. Persson quarried granite for rubble, rough construction, and curbing and flagging.

Production of sand and gravel decreased 20 percent. Output in excess of 300,000 tons was reported by five producers, the larger of which were Joseph W. Zmetra (Sunderland) and Northfield Sand & Gravel (Northfield).

Hampden.—Crushed basalt was produced by John S. Lane & Son, Inc., at the Hampden No. 3 quarry at Westfield. The West Springfield quarry of this company was idle in 1960.

Over 900,000 tons of sand and gravel (a slight decrease) was produced at 12 operations. As in 1959, a large tonnage of building sand and gravel was produced. The leading producers were North Wilbraham Sand & Gravel Co., Inc., North Wilbraham; Monson Sand &

Gravel Corp., Monson; D. D. Ruxton Co., Inc., Ludlow; and Bay States Gravel, Palmer.

Dimension sandstone for dressed architectural uses was quarried by McCormick Longmeadow Stone Co., Inc., at the Worcester mine near East Longmeadow. Important buildings constructed using this stone included the First Presbyterian Church, Atlanta, Ga., Wright Hall at Smith College, Northampton, Mass., and the Biology Building at Rutgers University, New Brunswick, N.J.

Miscellaneous clay for building brick was mined by Hampshire Brick Co., Chicopee, and Westfield Clay Products Co., Westfield.

Hampshire.—Sand and gravel production, reported by the same eight producers as in 1959, decreased over 40 percent in 1960. The decline was directly attributable to sharply reduced output of fill gravel. Leading producers were Bill Willard, Inc., Northampton; Hampshire Sand & Gravel Co., Westhampton; and John Omasta, Northampton. Crushed basalt for concrete aggregate and roadstone was produced by John S. Lane & Son, Inc., at Amherst.

Middlesex.—Dimension granite was quarried at Westford by Morris Bros. Granite Co., Inc., and Oak Hill Granite Co., Inc., and at West Chelmsford by the H. E. Fletcher Co. Output was at a lower rate than 1959. Basalt, chiefly for concrete aggregate and roadstone, was quarried by B. & M. Crushed Stone Co. (Ashland), J. P. Condon Corp. (Dracut), and Rowe Contracting Co. (Malden). Winchester Crushed Stone Co. did not operate its Woburn quarry. Basalt output was 22 percent greater than in 1959.

Sand and gravel production, as reported from 20 operations, increased to slightly over 3 million tons, and the county remained the leading sand and gravel producer in the State. Eight companies produced more than 200,000 tons each. They were, in order of decreasing output, Acme Sand & Gravel Co., Inc. (Burlington), J. J. Cronin Co. (Wilmington), San-Vel Contracting Co. (Littleton), Ashland Sand & Gravel, Inc. (Ashland), Pomerleau Brothers (Westford), New England Sand & Gravel Co. (Framingham), Thomas Quinn Co. (Burlington), and Assabet Sand & Gravel Co., Inc. (Acton). The output, concentrated near Boston, was chiefly for building and paving.

The Zonolite Co. exfoliated vermiculite in a plant near North Billerica for lightweight aggregate and insulation.

Eastern Gas & Fuel Associates closed its Everett coke plant at the end of April 1960, due to changes in the use of fuel by former consumers. In general, users were changing from coke, coke oven gas, and water gas to natural gas and oil.

Nantucket.—A small quantity of paving sand was produced by the Nantucket Construction Co.

Norfolk.—Sand and gravel, largely for building, was mined at eight pits. The larger producers were Highland Sand & Gravel, Inc., West Roxbury; Wrentham Sand & Gravel Co., Inc., Wrentham; Boston Sand & Gravel Co., Canton; and Varney Bros. Sand & Gravel, Inc., Bellingham.

Crushed granite for roadstone and stone sand was quarried by Old Colony Crushed Stone Co. and Simeone Stone Corp. at Quincy and Wrentham, respectively. Bates Brothers Seam Face Granite Co. and J. S. Swingle, Inc., quarried dimension granite at Wey-

mouth and Quincy. Orders executed included architectural stone for exterior use in Boston College buildings, Boston, Mass., and at St. Gregory's Church, Cincinnati, Ohio. S. M. Larusso & Sons, Inc., quarried miscellaneous stone at Wrentham for roofing granules.

California Products Corp. exfoliated vermiculite imported from South Africa at Hingham, chiefly for plaster aggregate and insulation.

Plymouth.—Eleven sand and gravel producers reported total output of over 440,000 tons of sand and gravel. The leading producers were Boston Sand & Gravel Co. at Scituate; Marshfield Sand & Gravel Co., Marshfield; and Whitehead Brothers Co. at Marion and Onset. Output was chiefly for building and paving, but Whitehead Brothers produced molding sand.

Southeastern Stone, Inc., quarried basalt for concrete and roadstone and riprap at Taunton and crushed granite for the same uses at Hingham.

Miscellaneous clay was produced by Bridgewater Brick Co. (East Bridgewater) and Stiles & Hart Brick Co. (South Bridgewater). Output, used entirely for building brick, decreased 25 percent. These two affiliated firms were installing an up-to-date laboratory and new beehive kilns to replace scove kilns at the South Bridgewater location. The plant was to be converted from making molded common brick to making molded face brick of various colors and textures.[6]

Suffolk.—West Roxbury Crushed Stone Co., West Roxbury, crushed basalt for concrete aggregate and roadstone. Bank run gravel for fill and other uses was produced by D. B. Raymond at a stationary plant near Watertown. Crude perlite from Western States was expanded by The Whittemore Co., Permalite Division, at Roslindale. The expanded product was used for building plaster, concrete aggregate, and soil conditioning. Imported gypsum was calcined at Charlestown by the United States Gypsum Co. Distribution was chiefly to the New England States.

Worcester.—Sixteen producers of sand and gravel reported output in 1960, chiefly for building, paving, and fill. Leading producers included Worcester Sand & Gravel Co. (Shrewsbury), Rosenfeld Washed Sand & Stone Co. (Milford), DeFalco Concrete Corp. (Millbury), P. J. Keating Co. (Lunenburg), E. L. Dauphinais, Inc. (North Grafton), Direnzo Bros. Sand & Gravel, Inc. (Worcester), and Allaire Bros. (Auburn). Pandolf, Inc., Sterling, a new firm in 1960, produced basalt for concrete and roadstone. Holden Trap Rock Co. quarried basalt for roadstone and for use in the manufacture of bituminous concrete at Holden. The H. E. Fletcher Co. dimension granite quarry at Milford did not operate during 1960.

Bettinger Corp., Milford, began mass production of ceramic coated materials following a period of extensive research and development. Ceramic-coated mufflers and tailpipes, and ceramic-coated corrugated roofing, siding, and accessories, were the principal products sold.

[6] Brick and Clay Record, vol. 137, No. 4, October 1960, p. 31.

The Mineral Industry of Michigan

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Michigan Department of Conservation, Geological Survey Division, State of Michigan.

By Donald F. Klyce [1]

EXPANDED PRODUCTION of petroleum and increased shipments of iron ore were chiefly responsible for increasing the value of Michigan mineral production to a new high, 13 percent more than in 1959. Declines in shipments of cement, clays, and gypsum reflected a lag in building construction. A slower pace in road building resulted in a smaller demand for concrete aggregate and roadstone. Production of salt and chemicals derived from well brines also was below the 1959 level.

Iron ore regained first place in value, displacing cement which was second, followed by petroleum, sand and gravel, copper, salt, and stone.

TABLE 1.—Mineral production in Michigan [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	21,682	$72,198	21,187	$73,082
Masonry—do	1,344	5,126	1,174	4,612
Clays—thousand short tons	1,771	1,937	1,738	1,904
Copper (recoverable content of ores, etc.)—short tons	55,300	33,954	56,385	36,199
Gypsum—thousand short tons	1,721	6,595	1,463	5,609
Iron ore (usable)—thousand long tons, gross weight	7,247	62,921	10,792	95,791
Lime—thousand short tons	862	11,748	1,177	15,730
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight			180,460	(2)
Natural gas—million cubic feet	18,916	4,350	20,790	4,449
Peat—short tons	191,661	2,357	214,402	2,755
Petroleum (crude)—thousand 42-gallon barrels	10,439	30,691	[3] 15,665	[3] 45,585
Salt—thousand short tons	4,485	35,725	4,088	33,759
Sand and gravel [4]—do	48,052	41,193	46,910	39,304
Stone—do	30,095	30,379	31,256	32,274
Value of items that cannot be disclosed: Bromine, calcium-chloride and calcium-magnesium chloride, gem stones, magnesium compounds, natural gas liquids, potassium salts, and values indicated by footnote 2		49,371		45,864
Total Michigan [5]		381,297		429,055

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Preliminary figure.
[4] Includes friable sandstone.
[5] Total adjusted to eliminate duplicating value of clays and stone.

[1] Commodity-industry analyst, Bureau of Mines, Minneapolis, Minn.

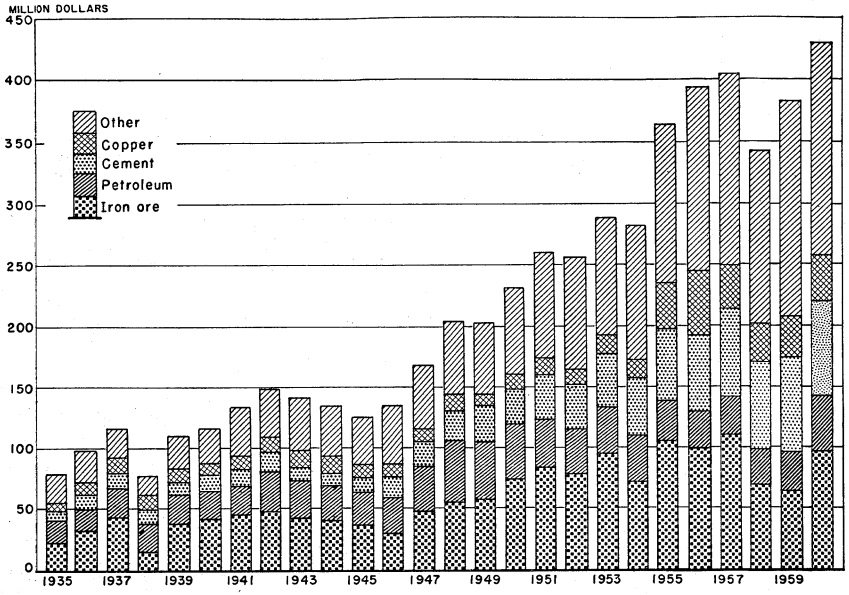

FIGURE 1.—Value of iron ore, petroleum, cement, copper, and total value of all minerals in Michigan 1935–60.

Employment and Injuries.—Preliminary data for the mineral industry indicated that man-hours worked in the iron-mining industry increased in 1960 as industry recovered from the long steel strike of 1959. Man-hours worked in the limestone industry, which had to meet larger demands for flux stone from the steel industry, also increased. A lag in building construction was indicated by the decline in man-hours worked in industries supplying cement, clays, gypsum, and sand and gravel. Data represent virtually complete coverage for most mineral commodities.

Three large limestone quarries, the Calcite and Cedarville quarries of the Michigan Limestone Division, United States Steel Corp., and the Alpena quarry of the Huron Portland Cement Co., again maintained excellent safety records. The Grand Rapids mine of the Bestwall Gypsum Co. also operated without lost-time injuries.

TABLE 2.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of lost-time injuries		Total number days lost or charged	Injury-frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1959:							
Cement [4]	1,662	4,582,305		17	(5)	3.71	(5)
Clays [6]	257	560,002		10	45	17.86	80
Coke ovens	1,032	2,687,416		8	(5)	2.98	(5)
Copper	1,852	3,727,593	4	90	28,614	25.22	7,676
Gypsum	523	1,118,345		15	459	13.41	410
Iron ore	5,415	7,418,528	7	204	55,033	28.44	7,418
Limestone [7]	1,612	2,777,824		23	(5)	8.28	(5)
Marl	84	69,292		1	(5)	14.43	(5)
Sand and gravel	3,335	5,704,276		114	9,285	19.99	1,628
Sandstone	20	32,947		3	(5)	91.05	(5)
Smelters	318	667,620		12	151	17.97	226
1960: [8]							
Cement [4]	1,587	4,185,732	1	13	(5)	3.34	(5)
Clays [6]	255	550,220		23	194	41.80	353
Coke ovens	916	2,667,843	1	6	(5)	2.62	(5)
Copper	1,866	4,166,446	3	127	23,727	31.20	5,695
Gypsum	473	972,552		4	48	4.11	49
Iron ore	5,369	10,240,893	3	292	28,572	28.81	2,790
Limestone [7]	1,543	2,962,292		35	(5)	11.82	(5)
Marl	73	44,049					
Sand and gravel	2,679	5,171,570	1	49	7,297	9.67	1,411
Sandstone	23	29,880					
Smelters	281	610,427		4	23	6.55	38

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Includes cement plants and quarries or pits producing raw material used in manufacturing cement.
[5] Data not available.
[6] Excludes pits producing clay used exclusively in manufacturing cement.
[7] Excludes quarries producing limestone used exclusively in manufacturing cement and lime.
[8] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of cement decreased 3 percent in quantity, but increased slightly in value over 1959. Production was reported from nine plants with total capacity over 31 million barrels, in seven counties. Stocks of portland cement at mills at yearend were 2.7 million barrels, down 216,000 barrels from the beginning of the year.

The average mill value of portland cement was $3.45 a barrel, compared with $3.33 in 1959. The average value of masonry cement was $3.93 a barrel compared with $3.81 in 1959.

Over 63 percent of the cement shipped was used within the State. Shipments out of State went mainly to Illinois, Ohio, Wisconsin, and New York, with small quantities to Minnesota, Indiana, North Dakota, and Pennsylvania.

Crude materials used in the manufacture of cement included 5.3 million tons of limestone, 1.6 million tons of clay or shale, and substantial quantities of gypsum, coal, sand, lime mud, glass sludge, slag, air-entraining compounds, and mill scale and pyrite cinders.

TABLE 3.—Finished portland cement produced, shipped, and in stock

(Thousand barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills		Stocks at mills Dec. 31
			Quantity	Value	
1951–55 (average)	7	15,919	15,913	$42,369	1,465
1956	8	20,485	20,237	61,749	1,779
1957	8	21,015	20,590	65,996	2,204
1958	8	19,841	19,691	65,738	2,443
1959	8	21,561	21,682	72,198	[1] 2,912
1960	9	20,971	21,187	73,082	2,696

[1] Revised figure.

Clays.—Miscellaneous clay and shale production decreased 2 percent from 1959. Nearly 87 percent of the material mined was used in manufacturing cement. Other uses were in heavy clay products (building brick, paving brick, draintile, and sewer pipe), lightweight aggregate, art pottery, and miscellaneous.

Clay or shale was produced in 10 counties at 17 operations. Alpena, Wayne, and Saginaw Counties reported the largest production.

Gem Stones.—Collection of agate, native iron and copper specimens, Petoskey limestone, celestite, sulfur, salt, dolomite, and alabaster was reported. Most of the agate was found on Lake Superior beaches of the Northern Peninsula.

Gypsum.—Gypsum was quarried in Iosco County and mined underground near Grand Rapids in Kent County. The raw material was processed at plants in National City, Grand Rapids, and Detroit. Crude gypsum also was shipped to plants in Illinois and Ohio. Principal products were plasterboard, exterior sheathing, lath, and plaster. Production was 15 percent below 1959 output, reflecting a decreased demand from the building industry.

Lime.—Lime production was reported from plants in Bay, Chippewa, Ingham, Mason, Menominee, and Wayne Counties. Five manufacturers produced only quicklime, one company produced only hydrated lime, and one produced both. Annual lime-burning capacity of the plants exceeded 1 million tons.

Principal uses for lime were for producing alkalis and other chemicals used in metallurgy, paper manufacture, and sugar refining. Production was 37 percent higher than in 1959. A new plant in Wayne County helped to increase output in 1960.

Natural Salines.—Natural well brines from two geological formations were source material for bromine, calcium chloride, calcium-magnesium chloride, magnesium compounds, and potash. Brines from the Filer sandstone supplied chemical plants in Mason and Manistee Counties; plants in Gratiot, Lapeer, and Midland Counties recovered chemicals from brines of the Sylvania formation. Production of chemicals from these sources decreased 10 percent from the previous year.

Perlite.—Perlite was expanded at plants in Grand Rapids and National City from crude ore mined in Colorado and Nevada, and used chiefly in building plaster. Small quantities were used for concrete aggregate, soil conditioning, and other applications.

Salt.—Salt production came from natural brines of the Dundee and Marshall formations, artificial brines formed by dissolving salt from the Salina formation, and one underground mine. Production was reported from 10 plants in six counties. Largest production came from Wayne County, which included output of International Salt Co.'s underground mine and artificial brine operations of Pennsalt Chemical Corp. and Wyandotte Chemicals Corp. Production of salt in Michigan was 9 percent less than in 1959. Although declines were noted for most use categories, the largest declines were in the manufacture of soda ash and ice control on highways.

Salt was used for a wide variety of industrial purposes; a major portion by the chemical industry. Large tonnages were purchased by Government agencies for ice control on highways.

Sand and Gravel.—Sand and gravel was produced from glacial deposits, present-day beaches, river channels, lakes, and sand dunes. Production was reported from all 83 counties.

Output of sand and gravel was 2 percent less than in 1959. Slightly decreased activity in highway construction and lesser demand from the building industry were partly responsible for the decline.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand: [1]				
Molding	1,919	$2,849	1,699	$2,719
Building	4,825	3,752	4,095	3,179
Paving	4,736	4,188	4,701	4,091
Engine	63	73	54	68
Filter	1	1		
Fill	1,288	531	1,959	764
Other	40	31	10	5
Undistributed [2]	663	1,617	610	1,558
Total	13,535	13,042	13,128	12,384
Gravel:				
Building	4,274	5,095	4,520	5,319
Paving	16,997	15,949	15,642	13,952
Railroad ballast	(3)	(3)	170	185
Fill	361	252	507	289
Other	307	334	59	42
Total	21,939	21,630	20,898	19,787
Total sand and gravel	35,474	34,672	34,026	32,171
Government-and-contractor operations:				
Sand:				
Building	4	2	1	1
Paving	2,362	1,039	929	410
Fill	578	135	1,193	370
Total	2,944	1,176	2,123	781
Gravel:				
Building	30	12	27	13
Paving	9,436	5,297	10,338	6,228
Fill	165	34	396	111
Other	3	2		
Total	9,634	5,345	10,761	6,352
Total sand and gravel	12,578	6,521	12,884	7,133
All operations:				
Sand	16,479	14,218	15,251	13,165
Gravel	31,573	26,975	31,659	26,139
Grand total	48,052	41,193	46,910	39,304

[1] Includes friable sandstone.
[2] Includes railroad ballast, blast, glass, grinding and polishing, and other ground and unground industrial sands.
[3] Included with "Other" gravel to avoid disclosing individual company confidential data.

Sand requirements for industrial uses—molding, glass, blasting, grinding, polishing, and other—decreased 7 percent from 1959.

Nearly 43 million tons of sand and gravel was moved by truck, 2.3 million tons by rail, and 1.6 million tons by water.

Operations in the Detroit area (Livingston, Macomb, Oakland, Washtenaw, and Wayne Counties) produced over 28 percent of the sand and gravel. Major production also came from Berrien, Calhoun, Genesee, Ingham, Kent, Muskegon, Ottawa, and Tuscola Counties.

Production was reported from 267 commercial operations and 122 Government-and-contractor operations.

The 10 largest producers, listed alphabetically, were:

American Aggregates Corp. (Kalamazoo, Livingston, and Oakland Counties)
Construction Aggregates Corp. (Ottawa County)
O. E. Gooding & Co. (portable operation)
Grand Rapids Gravel Co. (Kent County)
Pickitt & Schreur, Inc. (portable operation)
Sand Products Corp. (Manistee and Muskegon Counties)
Sargent Sand Co. (Mason and Tuscola Counties)
Straits Aggregate & Equipment Corp. (portable operation)
Walker Sand & Gravel Co. (Oakland County)
John G. Yerington (portable operation)

Stone.—Basalt, limestone, marl, and sandstone were produced.

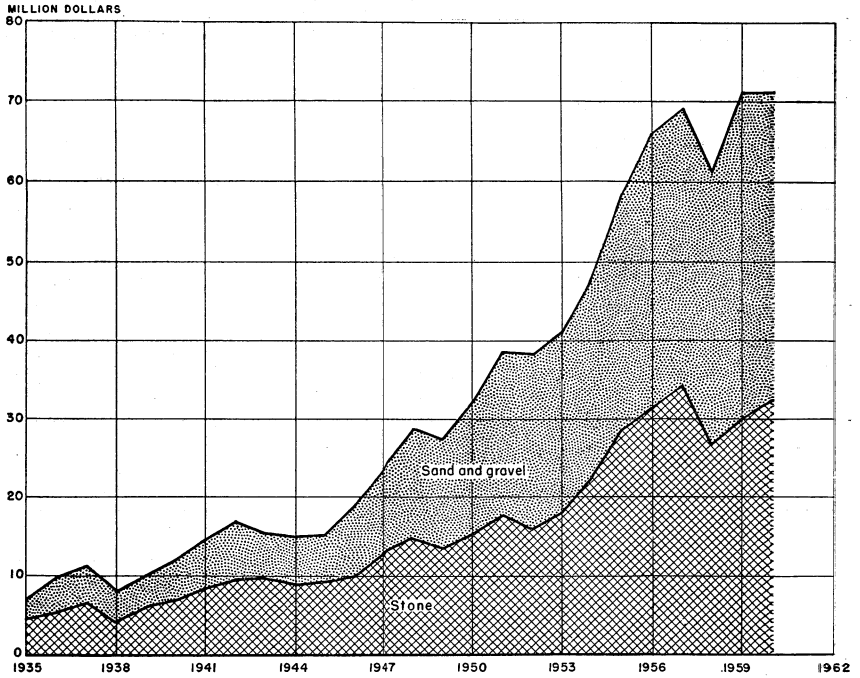

FIGURE 2.—Value of sand and gravel and stone in Michigan 1935–60.

Basalt.—Basalt from Precambrian rocks was quarried in Houghton County. It was crushed for road use.

Limestone.—Small quantities of dimension limestone was quarried in Charlevoix, Eaton, Huron, and Presque Isle Counties. Production was for rough construction, rubble, cut stone, and flagging.

Limestone was quarried and crushed in 19 counties by 21 producers at 24 sites and by 5 Government-and-contractor producers. Most of the output came from counties in the northern part of the State in the area bordering Lakes Huron and Michigan. Several large operators maintained port facilities near their quarry and mill sites. Over 25 million tons was moved by water to industrial users (cement and lime plants, steel mills, and other industries). The marketing area

via the Great Lakes included Michigan, Illinois, Indiana, Minnesota, New York, Ohio, and Pennsylvania. Crushed limestone shipments were 4 percent larger than in 1959. Of the 31 million tons shipped, 12.3 million tons was used by the steel industry for flux, 12.6 million tons by cement, chemical, and lime manufacturers, and 5.4 million by concrete aggregate and roadstone consumers. Miscellaneous uses, including agricultural limestone, made up the balance.

The largest producers, in alphabetical order, were:

Drummond Dolomite, Inc. (Chippewa County)
Dundee Cement Co. (Monroe County)
The France Stone Co. (Monroe County)
Huron Portland Cement Co. (Alpena County)
Inland Lime & Stone Co. (Mackinac County)
Michigan Limestone Div. of U.S. Steel Corp. (Mackinac and Presque Isle Counties)
The Michigan Stone Co. (Monroe County)
Penn-Dixie Cement Corp. (Emmet County)
Presque Isle Corp. (Presque Isle County)
The Wallace Stone Co. (Huron County)

TABLE 5.—Dimension stone sold or used by producers, by kinds

Year	Limestone		Sandstone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956	35,017	$110,159	11,190	$90,820	46,207	$200,979
1957	34,741	105,854	17,889	70,142	52,630	175,996
1958	50,965	120,361	18,776	132,981	69,741	253,342
1959	6,503	58,120	21,779	154,510	28,282	212,630
1960	6,801	58,889	11,615	97,395	18,416	156,284

TABLE 6.—Crushed and broken stone sold or used by producers, by kinds and uses

(Thousand short tons and thousand dollars)

Kind and use	1959		1960	
	Quantity	Value	Quantity	Value
Basalt: Concrete aggregate, roadstone:				
Government-and-contractor	86	$64	50	$56
Limestone:				
Flux	10,806	11,479	12,292	13,165
Concrete aggregate, roadstone:				
Commercial	5,490	6,393	5,063	5,830
Government-and-contractor	361	406	363	398
Agriculture	434	750	573	931
Other:				
Commercial [1]	12,684	10,949	12,737	11,647
Government-and-contractor	5	8	----	----
Total commercial	29,414	29,571	30,665	31,573
Total Government-and-contractor	366	414	363	398
Total limestone	29,780	29,985	31,028	31,971
Marl, calcareous: Agriculture	201	118	160	91
Total commercial	29,615	29,689	30,825	31,664
Total Government-and-contractor	452	478	413	454
Grand total	30,067	30,167	31,238	32,118

[1] Includes limestone for refractory (1959), riprap, railroad ballast, chemical uses, whiting or whiting substitutes, asphalt filler, dust for coal mines, mineral food, poultry grit, stone sand, cement, lime, and other miscellaneous purposes.

Marl.—Marl pits in 17 counties yielded 159,345 tons of material; all was used to neutralize acid soils. Production dropped 21 percent from 1959. Principal output was from Allegan, Calhoun, Kalamazoo, and St. Joseph Counties.

Sandstone.—Dimension sandstone was quarried in Baraga, Hillsdale, and Jackson Counties. It was used principally for rough construction, rubble, dressed or cut stone, and flagging.

Sulfur.—Byproduct sulfur was recovered from crude petroleum in Detroit at the Aurora refinery of the Ohio Oil Co. The Clauss process was used.

METALS

Copper.—Production of copper was up 2 percent over 1959. A 2-cent increase in the average price per pound raised the value of shipments by over $2 million. Although the Michigan copper industry showed an overall increase over 1959, a decline began in the latter part of the year which reflected reduced activity in the durable goods field, world-wide overproduction of copper, and a consequent drop in price, particularly in the last quarter of 1960.

Output was reported from 9 underground mines and 3 tailing reclamation plants.

Calumet & Hecla, Inc., operated 7 mines, one reclamation plant, and one smelter in Houghton and Keweenaw Counties. During the year the company introduced a high-conductivity lithium deoxidized copper for possible use in the field of electronics. Copper Range Co. operated the Champion mine and the Freda mill. The mill concentrated ore from the mine and tailing from the Redridge sands. Concentrate from the mill was processed at the White Pine Copper Co. smelter. Quincy Mining Co. operated a reclamation plant and smelter in Houghton County. White Pine Copper Co. operated a mine, mill, and smelter in Ontonagon County. A labor strike that had started October 28, 1959, was settled on February 22.

No silver was recovered in 1960 but the output was fire-refined and sold as "Lake copper" at a slight premium because of its silver content. The average weighted price increased to 32.1 cents a pound from 30.7 cents in 1959.

TABLE 7.—Mine production of copper in 1960, by months, in terms of recoverable metal

Month	Short tons	Month	Short tons
January	1,845	August	5,370
February	2,110	September	5,310
March	5,290	October	5,160
April	5,290	November	5,230
May	5,290	December	5,205
June	5,695		
July	4,590	Total	56,385

TABLE 8.—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
1951-55 (average)	10	2	2,841,141	1,885,572	28,887	$17,538,587
1956	12	3	6,427,095	2,233,599	61,526	52,297,100
1957	14	3	5,939,034	2,369,546	58,400	35,156,800
1958	11	2	5,957,879	1,336,077	58,005	30,510,630
1959	10	3	5,666,533	1,940,455	55,300	33,954,200
1960	9	3	5,600,290	2,192,818	56,385	36,199,170

The price quoted by primary producers for electrolytic copper, delivered, opened in 1960 at 33 cents a pound, rose to a high of 34.5 cents in January. On October 13 it was quoted at 30 cents, the price which held for the balance of the year.

Iron Ore.—Iron-ore shipments were nearly 50 percent larger than in 1959, although they fell short of the 10-year average. After midyear the increased demand resulting from the 1959 strike began to lag and shipments fell off and stocks at the mines increased. By yearend stocks of crude ore were nearly 500,000 tons larger than at the end of 1959. Twenty-two underground and five open-pit mines were active.

Mining costs declined below the 1959 level as well as below the 5-year average. According to a study by the Michigan Department of Conservation,[2] the average cost per ton (delivered at Lake Erie ports) for underground mines was $10.69 in 1960 compared with $11.34 in 1959. The cost per ton for labor fell to $3.07 from $3.46, supplies to $1.42 from $1.52, taxes (excluding Federal income tax) to $0.60 from $0.84, and general overhead to $1.16 from $1.19. Marketing costs remained at $0.07, and transportation costs decreased $0.09 to $3.11 from $3.20.

TABLE 9.—Crude iron ore[1] data in 1960, 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:						
Baraga			245		245	
Dickinson			1,422		1,422	
Gogebic	815	2,169		1,892		1,092
Iron	816	3,408		3,414		810
Marquette	1,655	4,488	2,285	2,196	4,300	1,932
Total	3,285	10,065	3,952	7,503	5,967	3,833
Range:						
Gogebic	815	2,169		1,892		1,092
Marquette	1,655	4,488	2,530	2,196	4,545	1,932
Menominee	816	3,408	1,422	3,414	1,422	810
Total	3,285	10,065	3,952	7,503	5,967	3,833

[1] Exclusive of iron ore containing 5 percent or more manganese.

[2] Michigan Department of Conservation, 1960 General Statistics Covering Costs and Production of Michigan Iron Mines; Geol. Survey Div., Lansing, Mich., June 1961, p. 9.

TABLE 10.—Usable iron ore shipped from mines, by ranges[1]

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total
1951–55 (average)	5,210	4,312	2,989	12,511
1956	5,689	3,889	2,958	12,536
1957	5,993	4,297	2,833	13,123
1958	3,722	2,995	1,394	8,111
1959	3,530	2,469	1,249	7,247
1960	4,881	4,018	1,892	10,792

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.

TABLE 11.—Usable iron ore produced, by ranges[1]

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total
1951–55 (average)	5,231	4,275	2,972	12,478
1956	5,869	4,264	2,910	13,043
1957	6,557	4,201	2,868	13,626
1958	4,111	2,896	1,397	8,404
1959	2,851	2,616	1,663	7,129
1960	6,619	4,079	2,169	12,866
Total 1854–1960	309,435	[2] 254,676	[2] 244,284	808,395

[1] Exclusive of iron ore containing 5 percent or more manganese, natural.
[2] Distribution by range partly estimated before 1906.

On the Gogebic range, average cost per ton (delivered at Lake Erie ports) for underground mines was $11.80 in 1960 and $13.10 in 1959; on the Marquette range, costs fell to $10.88 from $11.63; and on Menominee range to $9.87 from $10.08. The decline in costs resulted from the closing of higher-cost mines as demand fell off.

Of the ore mined in 1960, 28 percent came from open pits and 72 percent from underground mines. Average iron content of usable ore produced was 53.79 percent natural.

The trend to the use of concentrate from jaspilite ores continued, and 11.6 percent of iron-ore shipments were from this source, compared with 8.5 percent in 1959.

At yearend estimated reserves of iron ores in Michigan totaled 124 million tons,[3] not including about 1.8 billion tons[4] of low-grade hematitic ore.

The average weighted mine value of Michigan iron ore, without respect to grade, was $8.88 a long ton compared with $8.68 in 1959.

Except for a small quantity of crude ore used in manufacturing iron-oxide pigments, Michigan iron ore was shipped to producers of pig iron and steel. Approximately 98 percent of the iron ore shipped was transported by rail to ore docks at Ashland, Wis., and Escanaba

[3] Work cited in footnote 2.
[4] Pardee, F. G., and Kennedy, B. E., Low-Grade Ore Occurrences in Michigan: Univ. of Minnesota, 9th Ann. Min. Symposium, 1948, p. 24.

and Marquette, Mich., and thence by vessel to lower Lake ports. The balance was all-rail shipments to consuming districts.

Dates of first and last Lake shipments of ore in 1960 from Michigan and Wisconsin ports were: Ashland, April 17—November 6; Escanaba, March 28—November 17; Marquette, April 16—November 26; Superior, April 12—November 18.

Manganiferous Ore.—Shipment of manganiferous ore (containing 5 to 35 percent manganese natural) was resumed from the Cannon mine in Iron County. Production was not significant as a source of manganese. The ore was sold as an iron ore and a premium was paid for the contained manganese.

TABLE 12.—Manganiferous iron ore (containing 5 to 10 percent manganese, natural) and ferruginous manganese ore (containing 10 to 35 percent manganese, natural) shipped from mines

Year	Long tons	Year	Long tons
1951–55 (average)	32,738	1958	100,479
1956		1959	
1957	110,310	1960	161,125

Pig Iron and Steel.—The manufacture of pig iron and steel was based in Wayne County where five companies operated a total of 52 furnaces. The annual steel capacity was 7,984,000 tons, and 1960 production totaled 6,534,000 tons according to data published by the American Iron and Steel Institute. Pig-iron shipments increased 25 percent in quantity and 19 percent in value over 1959. Basic and Bessemer grades were produced.

McLouth Steel Corp., Detroit, constructed new facilities for handling and producing sinter at its Trenton works.

Jones and Laughlin Steel Corp. constructed an addition to the cold-finish processing building at its stainless steel plant in Detroit, to house wire-drawing equipment and inventory storage racks for wire coils. New equipment was purchased for annealing, wire drawing, and abrasive cutting at the same facility.

MINERAL FUELS

Natural Gas and Natural Gas Products.—Allegan County continued as the leading gas producing area with 40 percent of the State total. Oil well gas from the Albion-Pulaski-Scipio trend fields in Calhoun, Hillsdale, and Jackson Counties contributed 15 percent. Major production also was reported from fields in Crawford, Livingston, Osceola, Roscommon, St. Clair, Wayne, and Washtenaw Counties. The above areas accounted for nearly seven-eighths of the production; the remainder came from fields in 18 counties.

New fields developed during the year were Heath field in Allegan County, Springport field in Jackson County, Lenox field in Macomb County, and Puttygut field in St. Clair County. Two fields were abandoned—Cedar Creek field in Muskegon County and Mineral Springs field in Osceola County.

Peat.—Peat production increased for the eighth consecutive year. It was produced from bogs in 17 countries, with the largest production reported from Sanilac, St. Clair, Lapeer, and Oakland Counties. Output was sold mainly as a soil conditioner.

Petroleum.—The upward trend in petroleum production, which began in 1959 after 11 years of decline, continued in 1960. Output was 50 percent greater than in 1959. According to data published by the Michigan Department of Conservation,[5] exploratory and development well permits increased 27 percent, totaling 824. Exploratory wells drilled during the year resulted in four new oil fields, four new gas-fields, one new oil pool, and six extensions. Exploratory methods employed in these 15 discoveries were: Subsurface geology—five; trend geology—six; gravity—three; and nontechnical—one. Undeveloped acreage under lease exceeded 3.6 million acres.

Most of the drilling and half of the oil production were in fields of the Albion-Pulaski-Scipio trend in Calhoun, Hillsdale, and Jackson Counties in southern Michigan. Output in this area quadrupled from 2 million barrels in 1959 to nearly 8 million barrels. New pools and extensions extended the fracture zone to 38 miles. In 1960, 235 oil wells were completed along the trend.

During the latter part of the year attention shifted to further exploration of Niagaran reefs in eastern Michigan. These reefs are characterized by unstratified coral buildups, with crude sorting around the flanks. Oil and gas was produced from the overlying dolomite and the reef. Favorable economic factors included accessibility, marketing facilities, and relatively shallow depth.

Petroleum was produced in 40 counties. In addition to the areas described above, output in Bay, Isabella, Missaukee, Montcalm, and Osceola Counties each exceeded 500,000 barrels. Fourteen refineries, with a rated crude throughput capacity of 174,000 barrels daily, were operated.

TABLE 13.—Value of mineral production in Michigan, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Alcona	$96,987	$89,600	Sand and gravel.
Alger	75,208	94,123	Do.
Allegan	1,354,369	1,128,405	Petroleum, sand and gravel, peat, stone.
Alpena	39,446,554	36,093,544	Cement, stone, clays, sand and gravel.
Antrim	192,245	(2)	Clays, sand and gravel.
Arenac	1,878,822	1,649,178	Petroleum, stone, sand and gravel.
Baraga	43,652	353,612	Iron ore, sand and gravel, stone.
Barry	702,022	513,816	Sand and gravel, petroleum, stone.
Bay	10,412,398	10,454,259	Cement, petroleum, sand and gravel, lime.
Benzie	----------	780	Sand and gravel.
Berrien	979,650	1,125,122	Sand and gravel, stone, peat.
Branch	357,269	406,509	Sand and gravel, stone.
Calhoun	4,049,465	7,632,465	Petroleum, sand and gravel, stone.
Cass	184,723	262,710	Sand and gravel, stone.
Charlevoix	19,869	53,761	Do.
Cheboygan	226,850	208,747	Do.
Chippewa	4,796,961	4,525,614	Stone, lime, sand and gravel.
Clare	1,426,603	1,265,076	Petroleum, sand and gravel.
Clinton	369,344	284,905	Sand and gravel, clays, peat.
Crawford	538,403	626,437	Petroleum, sand and gravel.
Delta	1,199,432	418,482	Sand and gravel, stone.

See footnotes at end of table.

[5] Price, Lyle W., Acker, Robert M., Hautau, Gordon H., Ives, Robert E., 1960 Summary of Operations, Oil and Gas Fields: Michigan Dept. of Conservation, Geol. Survey Division, Lansing, Mich., June 1960, 44 pp.

TABLE 13.—Value of mineral production in Michigan, by counties [1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Dickinson	$1,398,716	$5,477,161	Iron ore, stone, sand and gravel.
Eaton	461,115	420,860	Sand and gravel, stone, clays, peat.
Emmet	10,210,091	12,198,884	Cement, stone, sand and gravel.
Genesee	766,612	775,647	Sand and gravel, petroleum.
Gladwin	1,491,151	1,306,823	Petroleum, sand and gravel.
Gogebic	10,530,773	16,452,545	Iron ore, sand and gravel.
Grand Traverse	8,778	(2)	Sand and gravel.
Gratiot	(2)	(2)	Salines, salt, petroleum, sand and gravel.
Hillsdale	5,116,765	11,132,708	Petroleum, sand and gravel, stone.
Houghton [3]	34,361,400	36,666,653	Copper, sand and gravel, stone.
Huron	981,387	926,367	Stone, sand and gravel, petroleum.
Ingham	1,171,167	1,007,588	Sand and gravel, lime, stone, peat.
Ionia	44,592	401,799	Stone, sand and gravel, petroleum.
Iosco	(2)	(2)	Gypsum, sand and gravel.
Iron	19,066,278	29,673,583	Iron ore, manganiferous ore, sand and gravel.
Isabella	2,802,591	2,560,101	Petroleum, sand and gravel, stone.
Jackson	1,489,030	5,585,970	Do.
Kalamazoo	942,071	629,399	Sand and gravel, stone, peat, petroleum.
Kalkaska	120,332	120,457	Petroleum, sand and gravel, stone.
Kent	2,883,610	3,056,652	Sand and gravel, gypsum, petroleum, peat.
Lake	41,373	55,611	Sand and gravel, petroleum.
Lapeer	843,826	1,057,142	Peat, sand and gravel, salines.
Leelanau	19,553	64,862	Sand and gravel.
Lenawee	4,144,759	3,498.460	Cement, sand and gravel, clays, peat.
Livingston	2,782,504	2,473,640	Sand and gravel.
Luce	103,779	28,239	Do.
Mackinac	(2)	(2)	Stone, sand and gravel.
Macomb	1,241,348	1,221,721	Sand and gravel.
Manistee	12,594,089	11,362,760	Salt, salines, sand and gravel.
Marquette	32,750,353	45,998,909	Iron ore, sand and gravel.
Mason	(2)	(2)	Salines, lime, petroleum, sand and gravel.
Mecosta	231,775	244,118	Petroleum, sand and gravel, stone.
Menominee	972,233	952,637	Lime, sand and gravel.
Midland	(2)	(2)	Salt, petroleum, sand and gravel, potash.
Missaukee	1,364,610	2,525,426	Petroleum, sand and gravel.
Monroe	1,224,003	(2)	Cement, stone, clays, petroleum, peat, sand and gravel.
Montcalm	2,901,899	2,399,188	Petroleum, sand and gravel, peat.
Montmorency	6.510	15,921	Sand and gravel.
Muskegon	1,939,149	1,878,896	Sand and gravel, salt, petroleum, stone.
Newaygo	344,179	257,699	Petroleum, sand and gravel, stone.
Oakland	5,937,115	5,257,064	Sand and gravel, peat, petroleum.
Oceana	918,126	790,922	Petroleum, sand and gravel.
Ogemaw	1,662,265	1,562,681	Do.
Osceola	2,029,208	1,920,351	Petroleum, sand and gravel, stone
Oscoda	7,763	43,537	Sand and gravel, petroleum.
Otsego	24,360	37,291	Sand and gravel.
Ottawa	2,224,305	2,712,552	Sand and gravel, petroleum, stone.
Presque Isle	(2)	(2)	Stone, sand and gravel.
Roscommon	1,258,891	1,489,098	Petroleum, sand and gravel.
Saginaw	538,465	709,779	Sand and gravel, clays, petroleum.
Saint Clair	15,301,753	14,165,260	Salt, petroleum, peat, cement, sand and gravel, clays.
Saint Joseph	200,538	162,167	Sand and gravel, marl, peat.
Sanilac	660,548	1,206,419	Peat, sand and gravel.
Schoolcraft	66,476	137,719	Sand and gravel.
Shiawassee	374,799	460,008	Sand and gravel, clays.
Tuscola	1,471,003	1,906,107	Sand and gravel, petroleum, peat.
Van Buren	523,276	352,409	Sand and gravel, petroleum, stone.
Washtenaw	1,708,078	1,749,766	Sand and gravel, petroleum, peat.
Wayne	44,269,585	45,061,398	Cement, salt, lime, sand and gravel, stone, clays, petroleum.
Wexford	63,340	97,949	Sand and gravel.
Undistributed [4]	83,602,203	87,479,442	
Total [5]	381,297,000	429,055,000	

[1] Gem stones, natural gas, and natural gas liquids not listed by counties as data are not available, included with "Undistributed."
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes value of mineral production in Keweenaw and Ontonagon Counties.
[4] Includes petroleum (1959), some sand and gravel and stone not assigned to specific counties and values indicated by footnotes 1 and 2.
[5] Total adjusted to eliminate duplicating value of clays and stone.

REVIEW BY COUNTIES

All 83 counties reported mineral production, with Marquette replacing Wayne as the leading producing county. Sand and gravel was produced in all 83 counties and was the only mineral commodity reported in 13.

The value of mineral production exceeded $1 million in 46 counties. The value of output increased in 46 counties and decreased in 37. The largest losses were recorded in counties producing sand and gravel.

Allegan.—Petroleum and natural gas were the major mineral commodities. Allegan County led in natural gas output. Marl, peat, and sand and gravel also were produced. Sand and gravel, used mostly for road construction, was mined at nine sites.

Alpena.—Huron Portland Cement Co. manufactured portland and masonry cements at Alpena using locally produced limestone and clay. Sand and gravel was produced at three sites for building and paving use.

Antrim.—Penn-Dixie Cement Co. mined clay for use at its Petoskey cement plant. The State and county highway department mined sand and gravel for road use.

Arenac.—Roadstone and sand and gravel for paving and building use were produced at six sites. Petroleum was produced at five fields. Nearly two-thirds of the output came from the Deep River and Sterling fields.

Baraga.—Cleveland-Cliffs Iron Co. resumed production of iron ore from its Ohio open-pit mine. Road material was mined at two sand and gravel pits, and a small quantity of sandstone was quarried for building purposes.

Barry.—Sand and gravel for building and paving use was produced at five pits. Marl for agricultural use was produced near Caledonia and Nashville. Petroleum was produced from three fields. The Hope field had the largest output.

Bay.—Aetna Portland Cement Co. produced portland and masonry cements at Bay City. Over 500,000 barrels of petroleum was produced, with the major part coming from the Kawkawlin field. Crude oil was refined at Bay City by the Bay Refining Corp. Monitor Sugar Div. of the Robert Gage Coal Co. produced lime for its own use.

Berrien.—Eight sand and gravel operations produced over $1 million of material for building, paving, and industrial (chiefly molding sand) purposes. Small quantities of marl and peat also were produced.

Branch.—Sand and gravel output from four sites was used for fill, building, and paving purposes. Marl was produced from a pit near Quincy. Five marl pits in the Sherwood area, that produced in 1959, were idle during the year.

Calhoun.—Petroleum was the major mineral commodity. Output was over 2.4 million barrels from fields of the Albion-Pulaski-Scipio trend, an increase of over 2 million barrels above that of 1959.

The value of sand and gravel produced declined sharply from $3 million to less than $750,000 chiefly because of a contract by the State

highway department was completed. Output came from eight pits. A small quantity of marl for agricultural purposes also was produced.

Cass.—Marl was dug from pits near Cassopolis and Jones. Sand and gravel was produced at four sites.

Charlevoix.—Limestone quarried at Vanderbilt by the Charlevoix Lime and Stone Co. was used for rough construction, flux, and agstone. The county and State highway departments produced road material from sand and gravel pits.

Cheboygan.—Roadstone was produced by the Afton Stone & Lime Co. Paving material was mined from gravel pits by Hugh Mason & Sons (Gaylord) and the Michigan State Highway Department.

Chippewa.—Limestone was quarried on Drummond Island by Drummond Dolomite, Inc. The material was crushed and sold as flux, and for concrete aggregate and roadstone, agstone, and stone sand. Sand and gravel for paving purposes was produced by I. L. Whitehead Co. of Sault Ste. Marie.

Clare.—Over 400,000 barrels of petroleum was produced at nine fields. Largest production came from the Hamilton, Headquarters, and Skeels fields. Over 317 million cubic feet of natural gas also was produced, chiefly from the North Hamilton and Headquarters fields. A small quantity of sand and gravel was produced by the State highway department.

Clinton.—Grand Ledge Clay Products Co. mined miscellaneous clay for manufacturing heavy clay products. Sand and gravel was produced at four sites. Humus peat, for horticultural use, was dug from a bog near Ovid.

Crawford.—Over 150,000 barrels of petroleum and nearly 1 billion cubic feet of natural gas was produced from the Beaver Creek field. Sand and gravel for road use was produced at two sites.

Delta.—Road material was produced from one limestone quarry and four sand and gravel pits. Two pits produced sand and gravel for building purposes only.

Dickinson.—The Groveland open-pit iron mine was operated by M. A. Hanna Co. The jaspilite ore was shipped to a concentrating plant near Randville. The Cornell and Bradley mines remained closed. Limestone was quarried by the Metro-Nite Co. near Felch, and the material was shipped to the company mill in Wisconsin and crushed and sold as filler. Jupiter Rock Products Co. of Sagola also quarried and crushed limestone. Sand and gravel for road use was produced at three pits.

Eaton.—Miscellaneous clay for use in manufacturing heavy clay products was mined by American Vitrified Products Co. and Grand Ledge Clay Products Co. Cheney Limestone Co. operated a quarry near Bellevue and crushed the output for concrete aggregate, roadstone, and agstone. Some rubble was also produced. Sand and gravel was produced at seven sites. A small quantity of moss peat was dug and sold for horticultural use.

Emmet.—The Penn-Dixie Cement Corp. plant at Petoskey manufactured portland and masonry cements and also quarried limestone for use in the plant. The State highway department produced road gravel.

Genesee.—A small quantity of petroleum was produced from the Otisville field. Eight sand and gravel pits yielded material valued at over $750,000. Foundry sand, fill, and building and paving material were produced.

Gladwin.—Petroleum, totaling 445,000 barrels, was produced from 12 fields. The Buckeye and Skeels fields had the largest output. A small amount of gravel for road use was produced.

Gogebic.—Pickands Mather & Co. produced iron ore from the Geneva-Newport, Peterson, and Sunday Lake underground mines. North Range Mining Co. operated the Penokee mine. Sand and gravel was produced at four sites.

Gratiot.—Michigan Chemical Co. produced bromine, calcium chloride, magnesium compounds, and salt at its St. Louis plant from well brines. During the year the company acquired from the U.S. Atomic Energy Commission (AEC) a rare-earth ion-exchange facility at St. Louis. The unit was originally built by Michigan Chemical Co. for production of rare-earth oxides for AEC. After the contract expired in 1959, the facility was placed on a standby basis and then declared surplus.

Sand and gravel was produced at four operations. Over 200,000 barrels of petroleum was produced, mostly from Sumner field. Leonard Refineries, Inc., operated two crude oil refineries at Alma.

Hillsdale.—Petroleum output was the largest of any county in the State. Production increased to nearly 3.7 million barrels from 1.3 million in 1959 and came from fields of the Albion-Pulaski-Scipio trend. Pits near Hanover and Reading yielded marl and a quarry near Hillsdale produced sandstone for flagging. Eight operators reported sand and gravel production.

Houghton.—Copper was produced by Calumet & Hecla, Inc., Calumet; Copper Range Co., Painesdale; and Quincy Mining Co., Hancock.

Calumet & Hecla, Inc., operated the Ahmeek No. 2, Allouez H. C. and Allouez conglomerate, Centennial No. 2, Peninsula, Seneca, and Osceola No. 13 mines. New centralized pumping facilities were installed on the Osceola lode. Explorations included over 13,000 feet of drifting and nearly 15,000 feet of diamond drilling.

Copper Range Co. operated the Champion mine throughout the year and milled the output at the Freda mill. Tailing from the Redridge sands also was treated at the Freda mill. Concentrates were processed at the White Pine Co. smelter in Ontonagon County.

Quincy Mining Co. operated its tailing reclamation plant continuously throughout the year, and the concentrate was smelted at the company smelter at Hancock.

Limestone Mountain Co. produced agricultural limestone, and the Houghton County Road Commission quarried basalt for use as roadstone. Road material was produced from three gravel pits.

Huron.—Limestone was quarried and crushed for concrete aggregate and roadstone, railroad ballast, and agstone by Wallace Stone Co., Bay Port. Some rough construction stone also was produced. Five operators produced sand and gravel. The Dwight and Grant fields yielded a small quantity of petroleum.

Ingham.—The Lansing Board of Water and Light produced quicklime for its own consumption from calcium carbonate precipitated in the water purification process. Roadstone was quarried from a limestone deposit by Central Michigan Sand and Gravel, East Lansing. Fourteen sand and gravel operations yielded materials valued at over $900,000.

Ionia.—The part of the Bloomer field lying in Ionia County yielded a small quantity of petroleum. Sand and gravel production was up as portable plant operators resumed work in the county. The material was used mostly for road construction. Limestone quarried near Ionia was crushed for use as concrete aggregate and roadstone.

Iosco.—Gypsum mines were operated near Tawas City by National Gypsum Co. and near Alabaster by United States Gypsum Co. National Gypsum Co. also operated a processing plant at National City and port facilities on Tawas Bay for shipment to its plants in Illinois and Ohio. The county highway department produced a small quantity of road gravel.

Iron.—The value of mineral production increased over 50 percent because of greater iron-ore production. The M. A. Hanna Co. operated the Cannon, Hiawatha, Homer, and Wauseca mines. Inland Steel Co. operated the Bristol and Sherwood mines, Pickands Mather & Co. the Buck unit, and Republic Steel Corp. the Tobin Group. Shipments of manganiferous ore were resumed from the Cannon mine. Road material was produced from two sand and gravel operations.

Isabella.—More than 760,000 barrels of petroleum and 300 million cubic feet of natural gas were produced. The Coldwater field was the principal producer. Marl for agricultural purposes was mined near Weidman, and sand and gravel production was reported by four operators. Crude oil was refined at Mt. Pleasant by Leonard Refineries, Inc.

Jackson.—The Pulaski field section of the Albion-Pulaski-Scipio trend yielded 1.8 million barrels of petroleum, up from 200,000 barrels in 1959. More than 600 million cubic feet of natural gas also was produced. Sandstone for building use was quarried at three sites near Napoleon. Crushed limestone for concrete aggregate, roadstone, and agstone was produced by Jeffrey Limestone Co., Parma. A pit near Horton yielded marl for agricultural use. Sand and gravel was produced at six sites and was used mostly for building and road construction.

Kalamazoo.—Peat for horticultural use was dug from bogs near Kalamazoo and Scott. Marl for agricultural use was produced at five sites. Sand and gravel production was considerably less than in 1959 as demand for road material slackened. Production was reported by six operators. The Alamo field yielded a small quantity of petroleum. Lakeside Refining Co., Kalamazoo, refined crude oil.

Kalkaska.—About 29,000 barrels of petroleum was produced, nearly all from the Kalkaska County part of the Beaver Creek field. Natural gas production totaled 94 million cubic feet. Small quantities of road materials (crushed stone and sand and gravel) were produced.

Kent.—Gypsum mines and processing plants were operated in the Grand Rapids area by Bestwall Gypsum Co. and Grand Rapids Plaster Co. Wallboard, lath, sheathing, and plaster were produced.

Sand and gravel valued at $1.7 million was produced, up nearly $300,000 from 1959. Local road building stimulated demand.

Peat bogs in the county yielded moss, humus, and reed-sedge peat which was used for soil conditioning. Nearly 174,000 barrels of petroleum and 22 million cubic feet of natural gas was produced from fields in the county.

Lake.—The Reed City, Sauble, and Chase fields produced 7,200 barrels of petroleum. Sand and gravel was produced by the county highway department for road use.

Lapeer.—Calcium chloride and calcium magnesium chloride were recovered from well brines by Wilkinson Chemical Co. at Mayville. The county lead in peat production with 65,000 tons. Sand and gravel production was reported from three operations.

Lenawee.—Portland and masonry cements were produced at Cement City by General Portland Cement Co. Clay for use at the plant was produced near Rollin. Heavy clay products were made from clay mined at Tecumseh by Comfort Brick & Tile Co. Peat was dug from a bog near Tecumseh. Sand and gravel production was reported from eight sites.

Mackinac.—Large limestone quarries were operated by Inland Steel Co. and Michigan Limestone Division of U.S. Steel Corp. Output was substantially higher than in 1959 because of greater demand for flux stone at steel mills. Most of the limestone produced was shipped by boat to consumers from ports at Cedarville and Port Inland. Other uses for the limestone produced included riprap, roadstone, agstone, cement, lime, chemical, and other industrial. Sand and gravel was produced at five sites.

Macomb.—Sand and gravel valued at over $1.2 million was produced by 18 operators. Output was about the same as in 1959. Most of the material was used in the Detroit metropolitan area for building and road construction.

Manistee.—Natural brines from the Filer sandstone formation yielded bromine and magnesium compounds. Chemical plants were operated in the Manistee area by Great Lakes Chemical Co., Michigan Chemical Co., Morton Chemical Co., and Standard Lime and Cement Co. Salt extracted from artificial brines was produced by Manistee Salt Works and Morton Salt Co. Industrial sands and building and road material were produced at four sites.

Marquette.—Iron ore was produced by Cleveland-Cliffs Iron Co. (8 mines), Inland Steel Co. (2 mines), and Jones & Laughlin Steel Corp., North Range Mining Co., and Pickands Mather & Co. (1 mine each). Iron ore shipments were over 40 percent larger than in 1959.

The Humboldt Mining Co. completed construction of its iron-ore pelletizing plant and began producing in September. The plant used jaspilite ore. Another facility in the county, the Eagle Mills pelletizing plant of the Cleveland-Cliffs Iron Co., also used jaspilite ore. Sand and gravel production was reported by seven operators.

Mason.—Chemical plants in the Ludington area produced bromine, calcium chloride and calcium magnesium chloride, magnesium compounds, and lime. The new limekiln at the Ludington plant of the Dow Chemical Co. was completed during the year. It was said to be

one of the largest kilns ever built for producing lime. Molding, engine, and grinding sands were produced from a pit near Ludington. The County Road Commission produced road gravel. Petroleum production declined to 142,000 barrels. In 1959, nearly 250,000 barrels was produced.

Mecosta.—Marl for agricultural use was produced near Blanchard and Mecosta. Sand and gravel was produced at three sites. About 49,000 barrels of petroleum and 212 million cubic feet of natural gas were produced from fields in the county.

Menominee.—Quicklime and hydrated lime were produced by Limestone Products Division of Northwestern-Hanna Fuel Co. and sold for chemical and industrial purposes. Sand and gravel was produced by three operators.

Midland.—Dow Chemical Co. extracted bromine, calcium chloride and calcium magnesium chloride, magnesium compounds, and potash from brines of the Sylvania formation. Salt from artificial brines was also produced.

Kaiser Aluminum and Chemical Corp. completed a periclase plant at Midland to process magnesium hydroxide purchased locally. The output was shipped to a Kaiser refractories plant in Ohio. Oilfields in the county yielded 317,000 barrels of petroleum and 68 million cubic feet of natural gas.

Missaukee.—Petroleum and natural gas were the principal mineral commodities. Petroleum production totaled 863,000 barrels compared with 459,000 in 1959, and natural gas production was 322 million cubic feet, up from 209 million in 1959. The largest output came from the McBain and East Norwich fields. A small amount of road gravel was produced.

Monroe.—Portland cement was manufactured by the Dundee Cement Co. in its newly completed plant at Dundee. The company also mined clay and quarried limestone at the site for its own use. Limestone was also produced by France Stone Co., Michigan Stone Co., and the Monroe County Highway Commission and sold or used for riprap, flux, concrete aggregate and roadstone, agstone, and railroad ballast. Clay mined near South Rockwood was used in making pottery by F. W. Ritter & Sons Co. Peat was produced for soil conditioning and small quantities of road gravel and petroleum were also reported.

Montcalm.—Petroleum production declined to 605,000 barrels from 798,000 in 1959. Natural gas output increased to 385 million cubic feet from 147 million cubic feet in 1959. The largest production of oil and gas came from the Reynolds field. Crude oil was refined at the Crystal Refining Co. plant in Carson City. Large quantities of sand and gravel, used mostly in road construction, was produced at five sites. Peat was dug from a bog near Lakeview.

Muskegon.—Salt was produced from artificial brines near Montague by Hooker Electrochemical Co. Sand for industrial purposes, chiefly molding sand, was also produced. About 23,000 barrels of petroleum was produced. The Naph-Sol Refining Co. at Muskegon refined crude oil.

Newaygo.—About 72,000 barrels of petroleum was produced from seven fields; the Ensley gasfield yielded 328 million cubic feet of natural gas. Marl and sand and gravel also were produced.

Oakland.—Sand and gravel valued at more than $5 million was produced at 26 operations, the largest output of any county in the State. Oakland County also was the fourth largest producer of peat. Small quantities of petroleum and natural gas were produced from the Northville field.

Oceana.—Seven fields yielded 251,000 barrels of petroleum and 47 million cubic feet of natural gas. Stony Lake, Pentwater, and Crystal Valley fields produced the largest quantities. Sand and gravel for building and paving use also was produced.

Ogemaw.—Nearly 500,000 barrels of petroleum and over 800 million cubic feet of natural gas were produced. The Rose City field yielded all the gas and with the West Branch field nearly all the oil. Crude oil was refined at West Branch Refineries, Inc., in West Branch. Sand and gravel was produced at four sites.

Ontonagon.—Copper was mined, milled, and smelted by White Pine Copper Co. (a wholly-owned subsidiary of Copper Range Co.). Operations in 1960 did not begin until settlement of a labor strike on February 21. Development of the newly discovered southwest ore body continued. Much diamond drilling and development shaft-sinking was accomplished during the year. Sand and gravel for road use was produced by the county and State highway departments.

Osceola.—The Reed City fields yielded the major part of the petroleum (528,000 barrels) and natural gas (445 million cubic feet) produced in the county. The Osceola Refining Co. at Reed City refined crude oil. A substantial quantity of sand and gravel and a small amount of marl also were produced.

Ottawa.—Production of about 2.2 million tons of sand and gravel was reported by eight operators. Industrial sands and building and road material were produced. A small amount of marl was dug near Denison. Nearly all of 214,000 barrels of petroleum produced came from the Walker field.

Presque Isle.—Limestone for a variety of industrial uses and for concrete aggregate, roadstone, and agriculture was produced at the quarries of both Michigan Limestone Division of U.S. Steel Corp. at Roger City and Chemstone Co. (operators for the Presque Isle Corp.) at Presque Isle. Much of the output from these operations was shipped by water to consumers in the Great Lakes area.

The Onaway Stone Co. produced dimension limestone from its quarry near Onaway. Part of the output was sold as rubble and rough construction stone, and the balance was milled for use as building stone and flagging. The Straits Aggregate Corp. operated a sand and gravel plant at Millersburg, and sold the output for railroad ballast, building and paving material, and fill.

Roscommon.—Over 1.2 billion cubic feet of natural gas and 271,000 barrels of petroleum were produced, mostly from the Headquarters and St. Helen's fields. Production of sand and gravel valued at $700,000 was reported by four operators. Most of it was used in road construction.

Saginaw.—Clay was mined in the Bay City-Saginaw area for use in cement and for filler and refractories. Road gravel was produced by the State highway department. Nearly 53,000 barrels of petroleum was produced, chiefly from the Birch Run field.

St. Clair.—Portland cement was produced at the Port Huron plant of the Peerless Cement Co., Division of American Cement Corp. The company mined clay from a pit at Smith's Creek for its own use.

Diamond Crystal Salt Co. recovered salt from artificial brines produced by dissolving salt from the Salina formation at St. Clair. Peat was produced near Capac. Four operators reported production of sand and gravel.

Five fields yielded 408,000 barrels of petroleum, of which 90 percent came from the Boyd and Peters fields. Over 1 billion cubic feet of natural gas was recovered from two oilfields and three gasfields.

St. Joseph.—Marl was recovered from pits near Three Rivers, Sherwood, and Burr Oak. A bog near Three Rivers yielded peat. Sand and gravel produced by three operators was used for fill, building purposes, and road construction.

Sanilac.—Peat valued at nearly $1 million was produced from bogs near Miden City and Sandusky, and sold for horticultural use. Road material was recovered from four sand and gravel pits.

Shiawassee.—A clay pit near Corunna yielded miscellaneous clay that was used in manufacturing heavy clay products by Michigan Vitrified Tile Co. Sand and gravel mined at five sites was used for fill and building and road construction.

Tuscola.—Seventeen sand and gravel producers reported an output of 1.3 million tons of material. It included molding and fill sand and sand and gravel for building and paving. Moss peat was produced at Caro. Petroleum production totaled 114,000 barrels, of which 95,000 barrels was recovered from the Akron field.

Van Buren.—Four fields yielded 21,000 barrels of petroleum. A small quantity of marl was recovered from a pit near Paw Paw. Molding and engine sand was produced from a pit near Grand Haven. Fill and road material was mined at four sites.

Washtenaw.—The Washtenaw County part of the Northville field yielded nearly half of a billion cubic feet of natural gas and about 45,000 barrels of petroleum. Nearly 1.9 million tons of sand and gravel was produced at 13 sites. Principal uses were for fill and building and paving. Peat was produced from bogs near Salem and Ypsilanti.

Wayne.—The value of mineral production in Wayne County exceeded $45 million, slightly higher than in 1959. Cement, clays, lime, natural gas, petroleum, salt, sand and gravel, and limestone were produced.

Portland and masonry cements were manufactured at two plants of Peerless Cement Co., Division of American Cement Corp. in Detroit. Clay for use at the plants was mined from the Ford clay pit near Allen Park. Portland cement was produced at the Wyandotte plant of the Wyandotte Chemical Corp. Flat Rock Clay Products Co. manufactured draintile from clay mined from a pit in Brownstown township. At Livonia, Lightweight Aggregates Corp. operated a lightweight aggregate plant using clay mined at the site. The output was sold to fabricators of lightweight aggregate products.

Hydrated lime was produced by the Wyandotte Chemical Corp. at Wyandotte. Most of the output was used in manufacturing chemicals. A new lime-producing facility was opened at Detroit by the

Solvay Process Division of Allied Chemical Corp. The quicklime produced was used by the company in chemical manufacture.

International Salt Co. mined salt from an underground mine in Detroit. Salt was recovered from artificial brines at Wyandotte by Pennsalt Chemical Corp. and Wyandotte Chemical Corp.

Nearly 2.1 million tons of sand and gravel was produced from pits throughout the county. The output included industrial sands (glass, molding, blast), as well as material for fill and building and paving purposes. Limestone was quarried near Flat Rock and Trenton and used for concrete aggregate and roadstone.

More than 500 million cubic feet of natural gas was recovered from the Wayne County part of the Northville field. About 14,000 barrels of petroleum was produced from the same field. Byproduct sulfur was recovered from crude petroleum by Aurora Gasoline Co., Division of Ohio Oil Co. in Detroit. Crude oil refineries were operated at Flat Rock by Petroleum Specialities, Inc., at Trenton by Socony-Mobil Oil Co., Inc., and at Wyandotte by Wyandotte Chemical Corp.

The Mineral Industry of Minnesota

By Matthew G. Sikich [1]

MINERAL output in Minnesota in 1960 was valued at over $515 million, a 48-percent increase over 1959. Chief reason for the marked gain was the 52-percent increase in iron-ore shipments. Record high output of sand and gravel, and stone also contributed substantially to the rise in total value of mineral production. Other value gains were recorded for masonry cement, gem stones, manganiferous ore, peat, and tube-mill liners. Decreases were reported for portland cement, clays, lime, and grinding pebbles. Iron-bearing ores (including those containing 5 percent or more manganese, natural) continued to comprise most mineral production in the State, furnishing 92 percent of the total value in 1960. However, demand for iron ore throughout most of 1960 was low; the Nation's steel industry operated at about half capacity during the latter part of the year. As a result, work schedules at many Minnesota mines were curtailed.

Employment and Injuries.—Nearly 37.1 million man-hours were worked in Minnesota mineral industries in 1960, excluding office-workers, compared with 29 million man-hours in 1959. Chief reason for the 28-percent gain over the previous year was the longer operating period for most of the State's iron ore mines and beneficiating plants, which were shut down during the 116-day labor strike in 1959.

Four fatalities, all in the iron-mining industry, occurred in 1960 compared with seven in 1959. The number of nonfatal disabling injuries in 1960 was 344, whereas 436 were recorded in 1959.

The Monroe mine of Oliver Iron Mining Division of United States Steel Corp. won the Sentinels of Safety Trophy, the top award, in the open-pit group of the 1960 National Safety Competition. The mine, near Chisholm, worked 518,046 man-hours without a disabling work injury. A number of other Minnesota mines and plants experienced injury-free records in 1960 and received Certificates of Achievement in Safety from the Federal Bureau of Mines.

All employment and injury data were collected from operating companies on a voluntary basis. Data represent virtually complete coverage of the Minnesota mineral industry.

[1] Commodity-industry analyst, Bureau of Mines, Minneapolis, Minn.

TABLE 1.—Mineral production in Minnesota [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----thousand short tons	153	$267	[2] 125	[2] $163
Iron ore (usable)----thousand long tons, gross weight	36,109	306,920	54,723	470,874
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	429,102	(3)	441,028	(3)
Peat----short tons	----------	----------	1,465	72
Sand and gravel----thousand short tons	28,486	20,726	30,302	24,611
Stone----do	3,639	9,461	4,234	10,034
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1960), gem stones, lime, and values indicated by footnote 3	----------	9,993	----------	9,767
Total Minnesota [4]	----------	347,178	----------	515,255

[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] Figure withheld to avoid disclosing individual company confidential data.
[4] Total adjusted to eliminate duplicating value of stone.

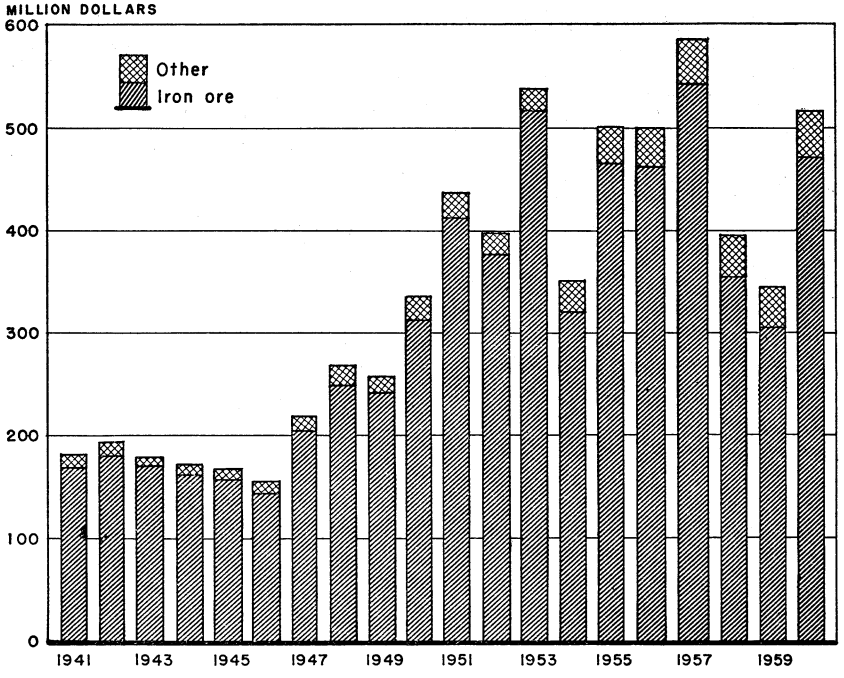

FIGURE 1.—Value of iron ore shipments and total value of all minerals produced in Minnesota, 1941–60.

REVIEW BY MINERAL COMMODITIES

METALS

Iron Ore.—Shipments of iron ore from Minnesota mines (excluding ore containing 5 percent or more manganese, natural) increased 18.6 million long tons, 52 percent over 1959. Principal reason for the substantial gain was the uninterrupted operating season compared with 1959, when a crippling 116-day strike virtually halted ore shipments during the peak operating period. However, because of the general decline in the Nation's economy, expected demand for iron ore by consuming furnaces in 1960 failed to materialize. Operations at many mines were curtailed because of the slack market.

Minnesota continued to lead the Nation in producing iron ore and supplied 66 percent of the total usable iron ore shipped from mines in the United States in 1960.

TABLE 2.—Dates of first and final cargoes of iron ore at United States upper Great Lakes ports

Port and dock	1958		1959		1960	
	First	Final	First	Final	First	Final
Ashland, Wis.:						
C&NW	May 18	Nov. 20	Apr. 24	Nov. 18	Apr. 17	Nov. 6
Soo Line	May 18	Nov. 20	Apr. 24	Nov. 18	Apr. 17	Nov. 6
Duluth, Minn.: DM&IR	May 17	Oct. 26	Apr. 23	Dec. 17	Apr. 19	Nov. 5
Escanaba, Mich.: C&NW	May 1	Dec. 5	Apr. 10	Dec. 8	Mar. 28	Nov. 17
Marquette, Mich.:						
DSS&A	June 10	Oct. 27	Apr. 27	Dec. 4	Apr. 29	Nov. 7
LS&I	Apr. 26	Dec. 7	Apr. 24	Dec. 12	Apr. 16	Nov. 26
Silver Bay, Minn.: Reserve	Apr. 26	Nov. 27	Apr. 20	Dec. 14	Apr. 11	Nov. 20
Superior, Wis.:						
GN	May 2	Dec. 1	Apr. 17	Dec. 20	Apr. 12	Nov. 18
NP–Soo Line	May 11	Nov. 29	Apr. 27	Nov. 29	Apr. 20	Nov. 5
Taconite Harbor: Erie	May 6	Nov. 29	Apr. 20	Dec. 14	Apr. 14	Nov. 20
Two Harbors, Minn.: DM&IR	May 14	Nov. 19	Apr. 14	Dec. 20	Apr. 5	Nov. 17

Source: Skillings' Mining Review.

TABLE 3.—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
1951–55 (average)	2,438	63,771	1,570	315	68,094
1956	2,242	59,346	1,285	350	63,222
1957	2,018	64,537	1,349	382	68,286
1958	1,119	39,833	1,027	241	42,221
1959	745	33,747	809	576	35,877
1960	1,166	54,442	1,361	473	57,442

[1] Exclusive of iron ore containing 5 percent or more manganese.

TABLE 4.—Crude iron ore[1] data, in 1960, by counties and ranges

(Thousand long tons)

County and range	Stocks Jan. 1, 1960	Production		Shipments		Stocks Dec. 31, 1960
		Underground	Open pit	Direct to consumers	To beneficiation plants	
County:						
Crow Wing	27	265	1,180	637	803	32
Fillmore			856		856	
Itasca			31,656	278	31,343	35
St. Louis	1,150	1,900	73,723	20,626	55,058	1,088
Total[2]	1,176	2,166	107,416	21,542	88,060	1,155
Range:						
Cuyuna	27	265	1,180	637	803	32
Mesabi	923	489	105,379	19,740	86,123	927
Vermilion	227	1,412		1,164	278	196
Spring Valley district			856		856	
Total[2]	1,176	2,166	107,416	21,542	88,060	1,155

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Data do not add to totals shown because of rounding.

TABLE 5.—Usable iron ore[1] data, in 1960, by counties and ranges

(Thousand long tons)

County and range	Stocks Jan. 1, 1960	Production	Iron content of production	Shipments	Stocks Dec. 31, 1960
County:					
Crow Wing	79	1,166	569	1,080	165
Fillmore		473	222	462	12
Itasca	411	12,890	6,928	12,427	875
St. Louis	1,899	42,912	23,428	40,754	4,057
Total[2]	2,390	57,442	31,147	54,723	5,109
Range:					
Cuyuna	79	1,166	569	1,080	165
Mesabi	2,125	54,442	29,573	51,813	4,754
Vermilion	185	1,361	783	1,368	178
Spring Valley district		473	222	462	12
Total[2]	2,390	57,442	31,147	54,723	5,109

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Data do not add to totals shown due to rounding.

TABLE 6.—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		
1951–55 (average)	43,982	1,037	21,369	22,406	68,127	32.89
1956	59,425	5,309	21,948	27,257	62,637	43.52
1957	68,439	6,836	23,539	30,375	67,656	44.90
1958	55,224	8,829	14,460	23,289	42,502	54.79
1959	48,024	8,401	11,513	19,914	36,109	55.15
1960	88,060	11,489	21,693	33,181	54,723	60.63

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Direct-shipping and beneficiated ore.

Iron ore was shipped by 23 companies, operating mines in Crow Wing, Fillmore, Itasca, and St. Louis Counties. Shipments from the Mesabi Range (in Itasca and St. Louis Counties) comprised 95 percent of the State total. Mines in the Cuyuna Range in Crow Wing County, the Vermilion Range in St. Louis County, and the Spring Valley district in Fillmore County furnished the remainder. Open-pit mines furnished 98 percent of the 109.6 million tons of crude ore mined in Minnesota in 1960; underground mines supplied the remainder. Over 80 percent of the crude ore mined during the year was beneficiated. Concentrate constituted 61 percent of the total usable ore shipped; direct-shipping grades furnished the remainder. Crushed, screened, and sized ores not further treated are considered as direct-shipping material. Average iron content of usable ore produced was 54.2 percent, natural, compared with 54.1 percent in 1959.

Approximately 11.4 million tons of taconite concentrate was shipped compared with 8.4 million tons in 1959. Taconite producers were: Erie Mining Co. (agent, Pickands Mather & Co.), at its taconite mine and processing plant near Hoyt Lakes; Reserve mining Co., at its mine in Babbitt and processing plant in Silver Bay; and the Oliver Iron Mining Division of United States Steel Corp., at its mine and concentrator near Mountain Iron and an agglomerating plant at Virginia. After settlement of its royalty dispute with Mesabi Iron Co., Reserve Mining Co. announced plans to increase its Silver Bay plant capacity to about 9 million tons of pellets per year. Plans included construction of a second primary crushing plant in Babbitt, double-tracking the 47-mile railroad, connecting Babbitt and Silver Bay, and constructing new fine-grinding, concentrating, pelletizing, and power facilities at Silver Bay. The expansion program was expected to take 3 years to complete and to cost about $120 million. Reserve also completed contract negotiations for using natural gas in its pelletizing operation—the first use of natural gas in processing Minnesota iron ore.

Encouraged by the passage of the Minnesota semitaconite tax law in 1959, The M. A. Hanna Co. and Oliver Iron Mining Division completed construction of pilot plants near Cooley and Coleraine, respectively, to experiment with treatment of semitaconites. Each plant was to use a Lurgi kiln to convert the nonmagnetic ore to magnetic form for processing by magnetic separation. Capacity of the Hanna plant was expected to be 10 tons of crude ore per hour; that of Oliver, up to 5 tons per hour. The principle of magnetic roasting, known for at least 50 years, was investigated on a pilot-plant scale in the Mesabi Range in the early 1930's and was found technically successful, but economically infeasible. New investigations are warranted by technological and economic changes since that time. In April, The M. A. Hanna Co. made the first shipments of ore from the Pierce mine, which had been under development since the summer of 1957. A new beneficiation plant, having crushing and screening equipment, followed by heavy-medium, cyclone, and spiral separation units, was completed early in the year at the Pierce property. Development work was underway at the Sargent mine, a former underground mine near Keewatin, which Hanna planned to convert to open-pit mining.

The company also was reopening the Mississippi No. 1 mine, to be operated in conjunction with the Sargent.

Jones & Laughlin Steel Corp. began shipments from its Lind-Greenway mine near Grand Rapids. A major stripping program was underway at the company Hill Annex mine near Calumet, extending the south end of the pit. The company also began constructing a new beneficiation plant to process previously unusable iron-bearing material at the Hill Annex. Production was expected to begin in the summer of 1961 at the rate of 500,000 tons of concentrate per year.

Oliver Iron Mining Division began constructing a new concentrator adjacent to its Sherman ore-sizing plant near Chisholm. The plant, with annual capacity of 1.5 million tons of concentrate, will process ores from the Monroe and Sherman groups of mines. The new plant was expected to be completed in 1961.

Pickands Mather & Co. ceased operations at the State-owned Scranton mine near Hibbing in June. However, W. S. Moore Co. obtained a 25-year lease on the property and planned to conduct tests to determine whether the low-grade ore in the mine can be beneficiated into a competitive product. Pickands Mather & Co. reopened the Corsica mine, which had been closed since 1954 and constructed a second screening plant at its Embarrass mine.

Late in 1960 Inland Steel Co. acquired complete ownership of Pacific Isle Mining Co., in which Inland previously held a 50-percent interest.

North Range Mining Co. began shipping from the Nahma mine, a new open-pit mine near Eveleth.

Virtually all the iron ore shipped from the State was for use in manufacturing pig iron and steel. Small quantities were sold for use in paint, as a dense medium for mineral beneficiation, and for manufacturing cement.

Over 97 percent of the ore was transported by rail from the mines and loaded into ore carriers at Lake Superior harbors for shipment to lower Lake ports and thence to consuming districts. Virtually all the remainder was shipped by rail to consumers. Some Minnesota iron ore was consumed at blast and steel furnaces operated at Duluth by the American Steel & Wire Division of United States Steel Corp. and Interlake Iron Corp. Both companies also operated coke ovens at Duluth. Operations were curtailed a large part of the year because of market conditions.

The 1960 navigation season for Minnesota ore shipments opened April 5 at Two Harbors. The final vessel cargo of the season left Silver Bay on November 20, one of the earliest closing dates on record. Chief reason for the early closing was the large stock of ore at lower Lake ports and consuming furnaces.

Lake Erie base prices for iron ore were unchanged from 1959, except for the addition of two new classifications under the Mesabi non-Bessemer grade. The additional classifications were: Fines (under ½ inch), quoted at $10.72 per long ton; and lump and coarse (½ inch and up), at $12.85 per ton. Base price for the standard Mesabi non-Bessemer grade was $11.45 per ton. Average

weighted mine value for Minnesota iron ore was $8.60 a long ton, compared with $8.50 in 1959.

The Federal Bureau of Mines expanded research work on iron ores at its new research center at Minneapolis. Pilot-plant development was conducted on an improved flotation process to separate silica from nonmagnetic taconites and semitaconties. Research was initiated on preparation of a super blast-furnace feed in the form of hard, pre-reduced pellets made from iron ore concentrates. Results of a fundamental study of goethite, a hydrated iron oxide mineral, were published.[2]

Statistical data for iron ores containing 5 percent or more manganese, natural, are not included with iron-ore data in this chapter but are treated separately as "manganiferous ore."

Manganiferous Ore.—Shipments of manganiferous ore (containing 5 to 35 percent manganese, natural) increased 3 percent over 1959. Manganiferous iron ore (containing 5 to 10 percent manganese, natural) comprised 88 percent of the total shipments. Ferruginous manganese ore (containing 10 to 35 percent manganese, natural) constituted the remainder. Total shipments consisted of 127,403 short tons of direct-shipping grade ore and 313,625 short tons of concentrate. Over 91 percent of the 1,170,859 short tons of crude manganiferous ore mined was beneficiated. Average natural iron and manganese contents of the total shipments in 1960 were 38.41 and 7.83 percent, respectively.

Total value of manganiferous ore shipped from State mines increased nearly 4 percent over 1959. Iron ores containing over 5 percent manganese, natural, have generally been priced as Old Range non-Bessemer on the combined natural iron and manganese content, plus a premium for the natural manganese exceeding 5 percent.

The output of manganiferous ore in 1960 came from eight mines in Crow Wing County in the Cuyuna Range. Producing companies

TABLE 7.—Shipments of usable[1] manganiferous iron ore and ferruginous manganese ore from mines in the Cuyuna Range

(Long tons)

Year	Manganiferous iron ore (5 to 10 percent Mn, natural)			Ferruginous manganese ore (10 to 35 percent Mn, natural)			Total shipments
	Shipments	Contents (natural)		Shipments	Contents (natural)		
		Fe, percent	Mn, percent		Fe, percent	Mn, percent	
1951–55 (average)	713,290	38.41	5.83	66,099	33.45	12.02	779,389
1956	481,946	38.01	6.58	84,053	[2] 31.82	11.93	565,999
1957	438,820	39.58	6.28	179,301	34.20	12.02	618,121
1958	285,995	41.47	6.22	44,901	34.51	13.14	330,896
1959	273,541	39.35	6.42	109,586	34.34	11.76	383,127
1960	345,426	38.97	7.15	48,349	34.37	12.74	393,775

[1] Direct-shipping and beneficiated ore.
[2] Partly estimated.

[2] Iwasaki, I., Cooke, S. R. B., and Columbo, A. F., Flotation Characteristics of Goethite: Bureau of Mines Rept. of Investigations 5593, 1960, 25 pp.

were The M. A. Hanna Co., Pickands Mather & Co., and Pittsburgh Pacific Co., Zontelli Brothers Division. The ore was shipped mostly for use in blast and steel furnaces. Some was sold to Manganese Chemicals Corp., which produced various manganese products at its Riverton plant. The Bureau of Mines continued research at its Minneapolis Research Center on developing methods of utilizing the potential manganese resources of the Cuyuna Range. Amenability studies of a wide variety of oxidized carbonate slates by the standard sulfatizing procedure were completed.

Nickel and Copper.—Approval by the State Executive Council of rules and regulations governing leases on State-owned land for exploration of copper-nickel deposits was pending at the close of the year.

Exploration of copper and nickel deposits, discovered in the northeastern part of the State in 1948 and investigated by Government agencies and private companies, indicated that the deposits are, at best, marginal.

NONMETALS

Abrasives.—Jasper Stone Co. produced grinding pebbles and tube-mill liners from its quartzite deposit in Rock County. Output of grinding pebbles decreased slightly in quantity and value from 1959. Sales of tube-mill liners decreased in quantity, but increased in value because of higher unit value. The company also sold a quantity of ashlar for architectural use and some broken material for riprap.

Cement.—Universal Atlas Cement Division of United States Steel Corp. produced portland and masonry cements at its Duluth plant, the only cement plant in the State. Shipments of portland cement decreased from 1959 principally because sales for highway construction were less. Output of masonry cement decreased in quantity from 1959 but increased slightly in value. Portland-cement output consisted of types I and II (general-use and moderate-heat) and portland-slag cement. Principal raw materials used were limestone, gypsum, blast-furnace slag, and iron dust. The plant has one 200-foot and two 150-foot kilns.

Clays.—Total output of clays and shale decreased from 1959, chiefly because output of lightweight aggregate was lower. Clay was produced by six companies from operations in Brown, Carlton, Goodhue, Hennepin, Ramsey, and Redwood Counties for use in manufacturing building brick, lightweight aggregate, vitrified sewer pipe, floor and wall tile, and other products.

Red Wing Potteries, Inc., continued to produce dinnerware and art pottery in Red Wing, chiefly from raw materials produced in other States.

Bloating tests of Minnesota clays and shales were conducted by the Bureau of Mines.

Gem Stones.—Amateur gem collectors gathered semiprecious gem stones principally agate and thomsonite, 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 mainly for personal gem collections or in handmade jewelry.

Lime.—Quicklime and hydrated lime were produced in Duluth by Cutler-Magner Co., the sole producer of lime in the State. Total output decreased from 1959. Over 92 percent was sold for chemical and industrial purposes, chiefly paper manufacture, water purification, and metallurgy. The remainder was sold for building and agricultural purposes. A rotary kiln was used for calcining, with bituminous coal as fuel.

Perlite.—Crude perlite mined in western States was expanded at plants in Minneapolis by Minnesota Perlite Corp. and Western Mineral Products Co. Total output of the expanded product increased over 1959. The material was sold for use as lightweight aggregate in plaster and concrete, paint additive, and for other purposes.

Sand and Gravel.—A record high was established for sand and gravel output. The new mark of 30.3 million short tons surpassed the previous high of 29.6 million tons set in 1958 and represented a 6-percent increase over 1959. Chief reason for the increase was the 1.6 million-ton rise in output for paving use, which more than offset a 4-percent decline in production for building use. Output for railroad ballast increased 13 percent over 1959. Molding-sand production increased 54 percent, whereas sand for glass manufacture decreased 4 percent, compared with 1959. Other quantities of special sands were used for grinding and polishing, sandblasting, oilfield fracturing, engine use, filler, and foundry applications.

Demand for silica sand was expected to rise when new glass-container plants, under construction near Rosemount in Dakota County and near Shakopee in Scott County, begin production in 1961.

Production was reported from every mineral-producing county except Dodge. Major producing areas were in Clay, Dakota, Hennepin, Polk, Ramsey, St. Louis, and Washington Counties, which furnished 39 percent of the State total.

Nearly 72 percent of the 1960 output was for paving and 22 percent for building use. Commercial operations furnished 62 percent of the total production; government-and-contractor operations supplied the remainder. Over 89 percent of the total was shipped by truck; about 6 percent, by river barge; and the remainder, by rail.

Stone.—Combined output of basalt, granite, limestone, marl, and quartzite reached a record high of 4.2 million short tons, a 16-percent increase over the previous high in 1959. The marked gain was chiefly attributable to an increase of 647,000 tons of crushed limestone for road construction.

Limestone was quarried from deposits in 16 south-central and southeastern counties. Total output of dimension and crushed limestone increased 21 percent in quantity and 13 percent in value over 1959. The quantity of crushed limestone for concrete aggregate and roadstone increased 29 percent over 1959. However, demand for agricultural limestone was low, resulting in an 11-percent decline in output compared with 1959. Output of dimension limestone remained substantially the same as in 1959, and was used chiefly for structural and architectural use.

TABLE 8.—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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,028	$3,275	3,685	$3,104
Paving	1,514	1,127	2,510	1,790
Fill	339	166	463	242
Grinding and polishing			1	2
Undistributed [1]	237	798	245	800
Total	6,118	5,366	6,904	5,938
Gravel:				
Building	2,916	3,778	3,046	4,590
Paving	6,572	5,358	7,996	6,789
Railroad ballast	447	330	507	480
Fill	278	125	234	135
Other	36	55	99	71
Total	10,249	9,646	11,882	12,065
Total sand and gravel	16,367	15,012	18,786	18,003
Government-and-contractor operations:				
Sand:				
Paving	3,292	1,637	2,574	1,352
Fill	43	11	14	4
Other	10	3	1	(2)
Total	3,345	1,651	2,589	1,356
Gravel:				
Building	44	19		
Paving	8,695	4,035	8,588	5,135
Fill	35	9	339	117
Total	8,774	4,063	8,927	5,252
Total sand and gravel	12,119	5,714	11,516	6,608
All operations:				
Sand	9,463	7,017	9,493	7,294
Gravel	19,023	13,709	20,809	17,317
Grand total	28,486	20,726	30,302	24,611

[1] Includes railroad ballast, glass, molding, engine, filler and other sand (1959–60), blast sand and foundry uses (1960) to avoid disclosing individual company confidential data.
[2] Less than $1,000.

TABLE 9.—Granite sold or used by producers, by uses

Use	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction thousand short tons	(1)	$29	13	$33
Rough architectural thousand cubic feet			32	51
Rough monumental do	26	90	25	83
Dressed architectural do	(2)	(2)	(2)	(2)
Dressed monumental do	(2)	(2)	(2)	(2)
Undistributed do	281	2,975	294	2,988
Total approximate thousand short tons [3]	26	3,094	42	3,155
Crushed and broken:				
Riprap thousand short tons			2	2
Concrete aggregate and roadstone do	116	202	123	237
Railroad ballast do	485	621	[4] 512	[4] 679
Other [5] do	54	179	34	4
Total do	655	1,002	671	922
Grand total do	681	4,096	713	4,077

[1] Less than 1,000 short tons.
[2] Figure withheld to avoid disclosing individual company confidential data; included in "Undistributed."
[3] Average weight of 166 pounds per cubic foot used to convert cubic feet to short tons.
[4] Includes poultry grit to avoid disclosing individual company confidential data.
[5] Includes fill and poultry grit (1959); and stone sand (1959–60) to avoid disclosing individual company confidential data.

TABLE 10.—Limestone sold or used by producers, by uses

Use	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction and rubble thousand short tons	12	$81	12	$63
Rough architectural thousand cubic feet	18	49	15	43
Sawed do	18	70	20	76
Cut do	90	693	88	760
House stone veneer do	270	678	251	641
Flagging do	2	2	5	4
Total approximate thousand short tons [1]	44	1,573	42	1,587
Crushed and broken:				
Riprap thousand short tons	(2)	(2)	53	66
Concrete aggregate and roadstone do	2,265	2,592	2,912	3,307
Agriculture do	458	684	406	648
Asphalt do	49	250	39	204
Other [3] do	36	47	2	7
Total do	2,808	3,573	3,412	4,232
Grand total do	2,852	5,146	3,454	5,819

[1] Average weight of 160 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 flux, mineral food, poultry grit, and uses indicated by footnote 2.

Granite was produced in central and northeastern Minnesota, and in the upper Minnesota River Valley. Most of the rough granite was cut, dressed, or polished at finishing plants in Cold Spring, Delano, and St. Cloud. Sales of dressed granite for architectural and monumental purposes increased slightly over 1959. Rough granite sold

for monumental use decreased 3 percent in quantity from 1959; production of crushed or broken granite increased 2 percent in quantity. Demand for crushed granite for concrete aggregate and roadstone and railroad ballast was slightly greater than in 1959.

Total production of quartzite, from Nicollet and Rock Counties, was nearly 48,000 short tons valued at about $120,000, about one-third less than in 1959. Sales of crushed and broken quartzite for concrete aggregate, filter blocks, and riprap decreased; sales for refractory purposes increased substantially over 1959. Some dimension quartzite was sold for architectural use.

In St. Louis County, Zenith Dredge Co. crushed basalt for roadstone and railroad ballast. Output decreased from 1959.

Production of calcareous marl increased 21 percent in quantity and 25 percent in value over 1959. Three companies reported production from pits in Cass, Crow Wing, and Wadena Counties. The entire output was sold for agricultural purposes. A report on occurrences and possible uses for marl in Minnesota was published in 1959.[3]

Sulfur.—Great Northern Oil Co. recovered byproduct sulfur at its Pine Bend refinery in Dakota County. Shipments increased slightly in quantity but decreased in value, compared with 1959.

Vermiculite.—Vermiculite was exfoliated at plants in Minneapolis and St. Paul from crude material mined in Montana. Output in 1960 decreased 18 percent in quantity, chiefly because of declining building activity. The material was sold principally for use as a lightweight aggregate for plaster and concrete, insulation, and litter.

MINERAL FUELS

Peat.—Record output of peat, nearly 1,500 short tons, was established in Minnesota in 1960. The Red Wing Peat Corp. large-scale operation in Carlton County furnished most of the State production. Early in 1960 the company installed a rotary dryer at its processing plant, which was completed in 1959. Several other companies produced peat from bogs in Aitkin, Pine, and St. Louis Counties. Minnesota peat was sold mostly for soil improvement. Other uses included ingredient for potting soils, mushroom beds, seed inoculant, packing for flowers, and earthworm-culture medium. Although some peat was sold in bulk, most of the sales were in containers that ranged in size from 1-quart packages to 6-cubic-foot bags. Demand for peat was fairly high. Most of the shipments were to consumers within the State; however, quantities were shipped as far as Georgia and Florida.

REVIEW BY COUNTIES

Mineral production was reported from all counties in the State except Waseca. With a predominance of iron-ore mines, St. Louis County continued to lead in value of minerals produced, furnishing nearly 71 percent of the State total. Twelve counties recorded mineral output in excess of $1 million. Mineral output value increased

[3] Schwartz, George M., and Others, Investigation of the Commercial Possibilities of Marl in Minnesota; Minnesota Office of Iron Range Resources and Rehabilitation in cooperation with Minnesota Geol. Survey, 1959.

for 56 counties and decreased for 30 counties, compared with 1959. Major gains for Crow Wing, Itasca, and St. Louis Counties were attributable to a substantial rise in iron-ore shipments. However, total value for Fillmore County decreased because shipments of iron ore were less. Mines in Fillmore County had not been involved in the long steel strike, which affected most other mines in the State in 1959. Virtually all the gains or decreases in other counties resulted from demand for road-construction materials. Sand and gravel production was common to all producing counties in 1960, except Dodge.

Anoka.—Minnesota Silica Sand Co. produced silica sand for molding and foundry use at its stationary plant near Minneapolis. Sand and gravel for road construction was produced by the Jay W. Craig Co. The county highway department produced gravel for road use and fill.

TABLE 11.—Value of mineral production in Minnesota, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Aitkin	$10,870	(2)	Peat, sand and gravel.
Anoka	18,204	$134,590	Sand and gravel.
Becker	(2)	(2)	Do.
Beltrami	171,699	75,602	Do.
Benton	(2)	110,483	Do.
Big Stone	(2)	(2)	Stone, sand and gravel.
Blue Earth	1,106,451	1,210,421	Do.
Brown	425,133	303,968	Sand and gravel, clays.
Carlton	187,994	256,788	Sand and gravel, peat, clays.
Carver	208,406	223,989	Sand and gravel.
Cass	25,155	152,853	Sand and gravel, stone.
Chippewa	309,805	532,826	Sand and gravel.
Chisago	(2)	(2)	Do.
Clay	703,971	1,544,419	Do.
Clearwater	2,328	113,724	Do.
Cook	83,245	38,362	Do.
Cottonwood	135,927	130,981	Do.
Crow Wing	9,212,198	10,706,391	Iron ore, manganiferous ore, sand and gravel, stone.
Dakota	798,568	1,352,764	Sand and gravel, stone.
Dodge	153,750	143,150	Stone.
Douglas	72,577	130,147	Sand and gravel.
Faribault	427,062	320,574	Do.
Fillmore	(2)	3,642,904	Iron ore, stone, sand and gravel.
Freeborn	(2)	(2)	Sand and gravel.
Goodhue	485,015	580,188	Stone, sand and gravel, clays.
Grant	113,872	9,231	Sand and gravel.
Hennepin	3,067,176	3,287,409	Sand and gravel, clays.
Houston	103,724	(2)	Stone, sand and gravel.
Hubbard	5,036	128,351	Sand and gravel.
Isanti	(2)	(2)	Do.
Itasca	60,703,342	103,610,362	Iron ore, sand and gravel.
Jackson	194,123	185,211	Sand and gravel.
Kanabec	(2)	7,805	Do.
Kandiyohi	475,552	289,097	Do.
Kittson	(2)	(2)	Do.
Koochiching	49,744	8,060	Do.
Lac qui Parle	514,429	645,203	Stone, sand and gravel.
Lake	41,514	(2)	Sand and gravel.
Lake of the Woods	82,782	68,611	Do.
Le Sueur	1,663,251	1,551,773	Sand and gravel, stone.
Lincoln	(2)	182,500	Sand and gravel.
Lyon	113,042	115,788	Do.
Mahnomen	(2)	501,656	Do.
Marshall	130,163	153,054	Do.
Martin	243,888	318,516	Do.
McLeod	133,852	194,271	Do.
Meeker	141,204	80,657	Do.
Mille Lacs	(2)	(2)	Stone, sand and gravel.
Morrison	72,750	393,717	Sand and gravel.
Mower	364,497	483,577	Stone, sand and gravel.
Murray	558	51,844	Sand and gravel.
Nicollet	309,681	273,778	Sand and gravel, stone.
Nobles	110,552	52,083	Sand and gravel.
Norman		2,586	Do.
Olmsted	326,654	283,976	Sand and gravel, stone.

TABLE 11.—Value of mineral production in Minnesota, by counties[1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Otter Tail	$261,571	$266,771	Sand and gravel.
Pennington	19,839	67,888	Do.
Pine	37,510	95,872	Sand and gravel, peat.
Pipestone	(2)	(2)	Sand and gravel.
Polk	527,597	896,995	Do.
Pope	112,600	148,564	Do.
Ramsey	457,009	(2)	Sand and gravel, clays, stone.
Red Lake	3,680	5,394	Sand and gravel.
Redwood	84,563	63,920	Sand and gravel, stone, clays.
Renville	713,830	(2)	Stone, sand and gravel.
Rice	298,910	337,873	Sand and gravel, stone.
Rock	382,436	635,831	Sand and gravel, abrasives, stone.
Roseau	129,337	53,757	Sand and gravel.
St. Louis	244,102,919	364,507,040	Iron ore, cement, sand and gravel, lime, stone, peat.
Scott	951,691	850,831	Stone, sand and gravel.
Sherburne	(2)	(2)	Sand and gravel.
Sibley	117,621	40,851	Do.
Stearns	3,191,620	2,458,478	Stone, sand and gravel.
Steele	391,713	636,023	Sand and gravel, stone.
Stevens	(2)	71,434	Sand and gravel.
Swift	237,363	180,990	Do.
Todd	147,566	223,933	Do.
Traverse	15,226	1,377	Do.
Wabasha	115,340	144,454	Stone, sand and gravel.
Wadena	(2)	60,452	Sand and gravel, stone.
Washington	1,195,717	1,708,899	Do.
Watonwan	84,767	102,989	Sand and gravel.
Wilkin	108,668	137,175	Do.
Winona	685,478	749,910	Stone, sand and gravel.
Wright	232,760	242,761	Sand and gravel.
Yellow Medicine	498,442	535,578	Stone, sand and gravel.
Undistributed	8,572,594	5,444,775	
Total	347,178,000	515,255,000	

[1] No production reported for Waseca County.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Becker.—The Becker County Sand & Gravel Co. at a fixed sand and gravel plant near Detroit Lakes produced material for building and road construction, railroad ballast, engine use, and fill. The State and county highway departments produced and contracted for sand and gravel for road use.

Beltrami.—Sand and gravel was produced chiefly for building and road construction. Producers included Jay W. Craig Co., Hallett Construction Co., and Ritchie & Tell. Paving gravel was produced by the Minnesota Highway Department.

Big Stone.—Granite for architectural and monumental purposes was produced by Cold Spring Granite Co. from its Agate quarry near Ortonville and by Delano Granite Works, Inc., from a quarry near Odessa: Material quarried by both companies was processed at their plants in Cold Spring and Delano, respectively. A custom-sawing plant was operated in Ortonville by Rausch Bros. Granite Co. Rough granite processed at the plant was quarried chiefly in Grant County, S. Dak.

The Hallett Construction Co. portable sand and gravel plant near Odessa produced material for building and road construction. Paving sand was produced by the State highway department.

Blue Earth.—Dimension limestone was quarried at Mankato by Mankato Stone Co. and Vetter Stone Co. principally for architectural use; some was sold for curbing, flagging, and rubble. A new processing

plant was constructed in 1960 by Vetter Stone Co. Limestone was crushed north of Mankato at quarries operated by Lundin Construction Co. and Mankato Aglime & Rock Co. Output was mainly for use as roadstone, agricultural lime, and riprap.

Sand and gravel for building and road construction and other uses was produced at fixed plants in the Mankato area by Guaranteed Gravel & Sand Co., Hiniker Sand & Gravel Co., and North Star Concrete Co. The State highway department contracted for sand and gravel for road use.

Brown.—Ochs Brick & Tile Co. produced shale from a pit near Springfield. It used the output chiefly for manufacturing building brick at its Springfield plant. Shale from the same pit was used by Acolite, Inc., for manufacturing lightweight aggregate at its plant in Springfield.

Sand and gravel for building and road construction was produced by Math N. Schumacher, Wallner Construction Co., and M. M. Youngman in stationary plants at Springfield, New Ulm, and Sleepy Eye, respectively. Portable plants were operated by Roberts Bros. and Carlson Bros., Inc. Paving sand was produced by the State highway department. The county highway department contracted for paving gravel.

Carlton.—Several companies produced sand and gravel near Carlton, Cloquet, and Moose Lake for building and road construction, railroad ballast, and fill. The State and county highway departments produced and contracted for paving sand and gravel. The city of Cloquet contracted for paving gravel.

The Nemadji Tile Co. produced fire clay near Moose Lake and used the material chiefly for manufacturing floor tile.

Red Wing Peat Corp. produced sphagnum peat from an 1,800-acre State-owned deposit near Corona, several miles east of Cromwell. Average thickness of the bog is about 15 feet. Harvesting was done on a large scale. A backhoe was used for ditching and blocking out 5- to 8-acre sections, thus accelerating the natural drying process. A unique feature employed by the company in harvesting was the use of "vacuum-cleaner" type rigs, which passed over the tilled peat and sucked up the top layer. Principal plant equipment was an oil-fired, rotary kiln, which the company installed in January for drying the peat. Much of the material was stockpiled after drying. The product was sold mostly in 6 cubic-foot polyethylene-lined bags. The plant was adjacent to tracks of the Northern Pacific Railway Co. However, substantial shipments were made by truck. Less than 50 days were spent in harvesting in 1960 because of poor weather.

Cook.—Approximately 5.6 million long tons of taconite-concentrate pellets was shipped from Taconite Harbor, the shipping port of Erie Mining Co. on the north shore of Lake Superior. The pellets were produced at the company plant at Hoyt Lakes in St. Louis County, and transported to the harbor on a 73-mile company-owned railroad. Traveling-belt conveyors were used to load pellets into ore vessels, instead of the conventional chute arrangement. In 1960 the first cargo of pellets was loaded at Taconite Harbor on April 14. The final cargo of the season left the harbor on November 20.

Edwin E. Thoreson, at a fixed plant near Grand Marais, produced sand and gravel for building and road construction. Paving gravel was produced by the State highway department and under contract for the county highway department.

Crow Wing.—An increase in iron-ore shipments was the chief reason for the 16-percent gain in total value of mineral output from Crow Wing County, compared with 1959. Operating companies and mines, from which iron and/or manganiferous ores were shipped in 1960 were as follows:

Company:	*Mines*
The M. A. Hanna Co	Alstead group, Feigh, Huntington, Musser, Portsmouth, Robert, and South Hillcrest.
Inland Steel Co	Armour No. 2.
Pickands Mather & Co	Mahnomen and Sagamore.
Pittsburgh Pacific Co. Zontelli Brothers Division	Mangan Lot No. 5, Manuel, Merritt Stockpile, North Yawkey, Sagamore, West Airport, and Mangan-Joan.
Rhude & Fryberger	Brown Underground.

All mines operated in the county in 1960 were open pits, except the Armour No. 2 and Brown Underground mines. Approximately 59 percent of the iron ore shipped was direct-shipping grade; the remainder was concentrate. Because of the poor market for ore, work schedules at most operating mines were curtailed. No shipments were made from the following mines, which had shipped in 1959: Maroco (The M. A. Hanna Co.), Mangan-Stai (Pittsburgh Pacific Co.), Rabbit Lake (Pickands Mather & Co.), and Carlson-Nelson (Rhude & Fryberger). The Maroco and Mangan-Stai mines were idle the entire year. Development work only was performed at the Rabbit Lake and maintenance work, at the Carlson-Nelson in 1960. Stockpile shipments of 2,135 tons from the Armour No. 1 mine of Inland Steel Co. were included with Armour No. 2 shipments. The Armour No. 1 shaft was abandoned in 1959. Rhude & Fryberger terminated its lease on the Brown Underground mine, which was operated only during April. Shipments were resumed from the North Yawkey mine, which had last shipped ore in 1956.

The entire State production of manganiferous ore came from eight mines in Crow Wing County. Shipments increased slightly over 1959.

The Manganese Chemicals Corp. plant near Riverton produced manganese carbonate, manganese dioxide, and other manganese products from Cuyuna Range manganiferous ore.

Ripley Sand & Gravel, Inc., at a fixed plant in Brainerd produced sand and gravel chiefly for building purposes.

Calcareous marl for agricultural use was produced near Pequot Lakes by Tweed Bros. A ¼-yard dragline mounted on a half-track chassis was used for excavating the material, which was stockpiled for drying before spreading.

Dakota.—Crushed limestone was produced by Edward Kraemer & Sons, Inc., and Northwestern Gravel Co., Inc. Output was used principally for roadstone. Both companies also produced sand and gravel for building and road construction. Other producers of sand and gravel included Bituminous Surface Treating Co., Cords Concrete Products, Jay W. Craig Co., Minnesota Quartz Co., and Standard

Building Material Co. Most of the output was for building and road purposes, but some was sold for sandblasting. Sand and gravel for road construction was produced under contract for the State and county highway departments.

Byproduct sulfur was recovered at the Great Northern Oil Co. refinery at Pine Bend. Shipments increased slightly in quantity over 1959 but decreased in value.

Brockway Glass Co. was constructing a new glass-container plant one mile north of Rosemount. The 242,000-square-foot plant was expected to cost $5.75 million and begin operating in 1961.

Fillmore.—Iron-ore shipments from Fillmore County mines decreased 20 percent from the record high of 575,000 long tons in 1959. The M. A. Hanna Co. shipped 382,000 long tons of concentrate from its group of open pits near Spring Valley. Schroeder Mining Co. shipped 80,000 tons of concentrate from its Krueger mine near Chatfield. The entire county output of iron ore was shipped by rail to consuming furnaces at Granite City, Ill.

Crushed limestone for agricultural and road purposes was produced by Hadland & Vreeman and Kappers Construction Co. at portable plants near Ostrander and Fountain and by Pederson Bros., at a fixed plant near Harmony. Hector Construction Co., Inc., also produced crushed limestone for roadstone, and paving sand near Lanesboro. Thompson Sand & Gravel produced sand for building use near Peterson. The State highway department produced paving sand.

Goodhue.—Fire clay was produced by the Red Wing Sewer Pipe Corp. from pits near Goodhue. Output was used by the company in manufacturing vitrified sewer pipe, draintile, and other products at its plant in Red Wing. Dinnerware and art pottery were manufactured at Red Wing by Red Wing Potteries, Inc., from raw materials produced in other States.

Mann Construction Co. operated a portable crushing plant at various quarries in the county, producing limestone for roadstone, agricultural use, and rubble. It also produced paving sand and gravel. Crushed limestone for road use was produced by Valley Limestone Co. from a quarry near Zumbrota.

Sand and gravel was produced by five commercial operators at fixed and portable plants near Frontenac, Lake City, and Red Wing. Output was used for building and road construction and fill. The State highway department produced and contracted for paving sand and gravel. The county highway department contracted for road gravel.

Hennepin.—Over 3 million tons of sand and gravel was produced in Hennepin County, a 13-percent increase over 1959. Operations were chiefly in the suburban areas of Minneapolis. Output was used principally for building and road construction. Commercial operators included the following: Great Northern Railway Co., Anderson Aggregates, Inc., Barton Contracting Co., Consolidated Materials Co., J. W. Craig Co., Chas. M. Freidheim Co., Frisk Sand Co., Glacier Sand & Gravel Co., Hedberg & Sons Co., Oscar Roberts Co., J. V. Gleason, Hopkins Sand & Gravel Co., Industrial Aggregate Co., Keller Bros. Gravel Co., and Mapco Sand & Gravel Co.

North Central Lightweight Aggregate Co., Inc., produced clay near Minneapolis and used it for manufacturing lightweight aggregate. Output decreased from 1959.

Minnesota Perlite Corp. and Western Mineral Products Co. expanded perlite at plants in Minneapolis from crude material mined in western States. The product was sold for use as lightweight aggregate in plaster and concrete, paint additive, and other purposes. Vermiculite was exfoliated in Minneapolis at plants operated by B. F. Nelson Mfg. Co. and Western Mineral Products Co. from crude ore mined in Montana and used chiefly as lightweight aggregate in plaster and concrete and for insulation and litter.

Mining and metallurgical research was conducted at the Bureau of Mines research center at Minneapolis.

Houston.—Hector Construction Co., Inc., operated a portable plant at various places in the county, producing crushed limestone for roadstone and agricultural purposes and paving sand. Botcher Construction Co. produced limestone for roadstone, agricultural use, riprap, and rubble. The State and county highway departments produced paving sand.

Itasca.—Total value of mineral output in Itasca County increased 71 percent because of a substantial rise in iron-ore shipments, compared with strike-bound 1959. Approximately 98 percent of the shipments was beneficiated ore. Direct-shipping grades constituted the remainder. All iron-ore mines operated in 1960 were open pits; no underground mines had been operated since 1953. The following operating companies and mines shipped iron ore in 1960:

Company:	*Mines*
Cleveland-Cliffs Iron Co	Canisteo, Hawkins, Hill-Trumbull, Holman-Cliffs and Sally.
The M. A. Hanna Co	Argonne group, Harrison group, Hunner, Mississippi group, and Patrick group.
Jessie H. Mining Co	Jessie.
Jones & Laughlin Steel Corp	Hill Annex and Lind-Greenway.
Oliver Iron Mining Division United States Steel Corp	Arcturus group, King group, and Plummer.
Pickands Mather & Co	Bennett, Danube, and Tioga No. 2.

The M. A. Hanna Co. and Oliver Iron Mining Division of United States Steel Corp. constructed pilot plants near Cooley and Coleraine, respectively, to investigate possible commercial utilization of the vast resources of semitaconite material in the Mesabi Range. Both companies were to use Lurgi kilns for converting the nonmagnetic ore to magnetite, which will respond to magnetic separation. The Hanna pilot plant was to treat 10 tons of feed per hour in a kiln 89 feet long and 9 feet in diameter; the Oliver plant was to treat up to 5 tons per hour in a kiln 50 feet long and 4½ feet in diameter. The Oliver plant, located at the company Trout Lake concentrator, began experimental production late in 1960. For fuel, Oliver began using propane, which was broken down in a special converter into a gas with a chemical composition suitable for the roasting process. Hanna planned to use gas manufactured at the plant from coke. Natural gas, lignite, or other fuels could also be used in the roasting process. Reduction roasting had been tested by Hanna in 1934, but

the work was economically unsuccessful. New tests were warranted following passage of a favorable State semitaconite tax law in 1959, and because of technological and economic changes since the early investigations.

Jones & Laughlin Steel Corp. began shipments from the Lind-Greenway mine on the western end of the Mesabi Range. A new washing plant at the mine was operated during the year. Mining was conducted in two separate pits, one on each side of the Prairie River, connected by a truck-haulage road. Conventional power-shovel methods were used. Jones & Laughlin also was developing a sizable addition to the Hill Annex mine near Calumet. A major stripping program was in progress to extend the south end of the pit. The company began building a new concentrator to process iron-bearing material at the Hill Annex. Planned capacity of the plant was about 500,000 tons of concentrate per year. Plant production was expected to begin in 1961.

The M. A. Hanna Co. began stripping at the formerly underground Sargent mine, near Keewatin, and reopened the adjacent Mississippi No. 1 mine under a new State lease, which permitted Hanna to mine in conjunction with operations at the Sargent mine the small tonnage of ore that remained on the Mississippi property.

Jessie H. Mining Co. was removing overburden by dredging at its new property near the Jessie No. 1. The mine was to be pumped dry for normal open-pit operation after the overburden had been removed.

The St. Paul and West Hill mines, operated in 1959 by Pacific Isle Mining Co. and Pickands Mather & Co., respectively, were idle except for maintenance work at the West Hill.

Paving sand and gravel was produced by Jay W. Craig Co. and the State highway department. Neil Baker Co. produced sand for building use at Grand Rapids. The county highway department produced and contracted for road gravel. The contract production was furnished mostly by Hawkinson Construction Co. from various pits in the county.

Kanabec.—Paving sand was produced by the State highway department.

The Mora Grey granite quarry of Cold Spring Granite Co. was not operated in 1960.

Lac qui Parle.—Cold Spring Granite Co. produced dimension granite for architectural and monumental purposes from the Cold Spring Red quarry near Odessa. The rough material was processed at the company plant in Cold Spring. The North Star Granite Corp. produced granite from its No. 9 quarry near Odessa. The rough granite was finished at the company St. Cloud plant and sold for monumental use. Granite for monumental purposes was also produced by Dakota Granite Co. and Dewar Bellingham Granite Co. near Bellingham. The former company processed the rough stone at its plant in Grant County, S. Dak.

Sand and gravel for building and road construction and fill was produced by W. J. Stolpman, who operated a portable screening plant and a stationary washing plant near Rosen. The State highway department produced paving sand. The county highway department produced and contracted for gravel for road use and fill.

Lake.—Reserve Mining Co. operated its large taconite-processing plant at Silver Bay. The company processed 15 million long tons of crude taconite, mined near Babbitt in St. Louis County, and shipped 5 million tons of taconite-concentrate pellets from Silver Bay during the year. The first cargo of pellets shipped from the port in 1960 was loaded on April 11. The 1960 navigation season for Minnesota ore shipments closed at Silver Bay on November 20. Reserve announced plans to increase the Silver Bay plant capacity to 9 million tons of pellets per year by constructing a second coarse crushing plant at Babbitt, double tracking the 47-mile railroad between Babbitt and Silver Bay, and increasing the length of the concentrator from 1,350 feet, to 2,150 feet as additional completed production lines are installed. Rod and ball mills were lengthened to increase their capacity. There were 12 units in the concentrator, each having a rod mill and a ball mill. Maintenance and repair buildings at the mine and the plant site were to be doubled in size. The powerplant and vessel-loading facilities also were to be enlarged. In 1960, contracts were completed for the use of natural gas in the company pelletizing operation.

Several companies produced sand and gravel for road construction, railroad ballast, and other uses.

Le Sueur.—Dimension limestone was produced and processed near Kasota by the Babcock Co. Principal products included stone cut to architectural specifications and stone veneer. A portion of the output was highly polished and sold for interior trim and facings. Some stone was sold for rough construction and riprap. Crushed limestone and gravel for road use were produced by Ed. Swartout near Kasota.

Silica sand produced from the Jordan Sandstone formation near Le Sueur by Gopher State Silica, Inc., was sold for use in manufacturing glass, molding, oilfield fracturing, filler, and building. E. H. Benjamin produced silica sand near Kasota, which was sold to limestone-processing plants for use in sawing and polishing. At a fixed plant near Gaylord, Glander Washed Sand & Gravel Co. produced sand and gravel for building and road construction. Lundin Construction Co. at a portable plant near Kasota produced gravel for building and road construction and other uses. Paving sand was produced by C. C. Cram near Waterville and by the State highway department.

Mille Lacs.—Cold Spring Granite Co. produced dimension granite from its Diamond Grey quarry near Isle and processed it at the company plant in Cold Spring for architectural and monumental purposes.

Sand and gravel for building and road construction was produced by Mille Lacs Sand & Gravel Co. at its fixed plant near Milaca. The State highway department produced and contracted for paving sand and gravel.

Mower.—Crushed limestone for roadstone and agricultural use was produced near Austin by Martin Bustad & Son and Osmundson Bros. Hickok Calcium White Rock Co. produced limestone for roadstone, flux, rough construction, and agricultural purposes.

Sand and gravel, which was produced by several companies at fixed and portable plants near Austin and Brownsdale, was used principally for building and road construction. Paving sand and gravel

was produced under contract for the State and county highway departments.

Nicollet.—Crushed and broken quartzite was produced by New Ulm Quartzite Quarries, Inc., at its quarry near New Ulm. Output decreased from 1959. Sales were principally for concrete aggregate, filter blocks for water and sewage-treatment plants, refractory purposes, poultry grit, and riprap.

Hallett Construction Co. produced sand and gravel near St. Peter for building and road construction. Courtland Sand & Gravel Co. at a fixed plant near Courtland produced sand for building use and fill. A. H. and J. H. Massopust produced paving gravel near New Ulm. Sand and gravel was produced under contract for the State and county highway departments.

Olmsted.—Patterson Quarries, Inc., and Quarve & Anderson Co. crushed limestone for roadstone and agricultural purposes.

Sand and gravel was produced near Rochester by Quarve & Anderson Co., Riverside Sand & Gravel Co., and Rochester Sand & Gravel Co. The material was used for building and road construction, fill, and other purposes. Paving sand and gravel was produced under contract for the State and county highway departments.

Otter Tail.—Mark Sand & Gravel Co. produced sand and gravel, operating a stationary plant about 15 miles east of Fergus Falls and a portable plant at various other locations. Output was chiefly for road construction. The company also furnished material to a concrete-block plant, a ready-mixed concrete plant, and a concrete-tile factory in Fergus Falls. L. A. Hansen produced paving gravel near Fergus Falls. John Dieseth Co. produced gravel at a portable plant for road construction and other uses. The Minneapolis, St. Paul & Sault Ste. Marie Railroad Co. produced gravel for railroad ballast and fill. T. L. Horstman produced sand and gravel for building use. The State and county highway departments and the city of Fergus Falls produced and contracted for paving sand and gravel.

Pine.—Peat was produced by the Pine City Peat Co. from an 80-acre deposit about 3 miles north of Pine City. The product was referred to as tamarack peat. Average depth of the bog is 12 feet, with a reported maximum depth of 60 feet. Excavating and hauling were done under contract. Peat was hauled to Pine City for grinding. Output, sold in bulk and in paper bags, was used primarily for soil conditioning.

Yost Bros. produced sand and gravel at a stationary plant 3.5 miles east of Beroun. The entire output was washed and used for concrete aggregate at the company ready-mixed concrete plant at Beroun. Jay W. Craig Co. at a portable plant in the county produced sand and gravel for road construction. Louis Hultgren & Sons produced sand for molding use near Kerrick. The State highway department produced and contracted for paving sand and gravel.

Polk.—Spring Gravel Co. produced sand and gravel at its stationary plant 15 miles southeast of Crookston. Output was sold mainly to road contractors and to a concrete-block factory and ready-mixed concrete plants at or near Grand Forks, N. Dak. Thorson Gravel Co. produced sand and gravel near Fertile for building and road construction, railroad ballast, and fill. Sand and gravel for building use,

railroad ballast, and fill was produced by the Great Northern Railway Co. near Benoit and by Northern Sand & Gravel, Inc., near Trail. Ahles & Lush and Jay W. Craig Co. at portable plants in the county produced paving sand and gravel. The State and county highway departments contracted for paving sand and gravel.

Ramsey.—Arsenal Sand & Gravel Co. produced sand and gravel near New Brighton for building and road construction and other uses. Paving sand and gravel was produced by Jay W. Craig Co., the State highway department, and under contract for the U.S. Army Corps of Engineers. No silica sand was produced in the county in 1960. The Ford Motor Co., which formerly mined silica sand from the St. Peter Sandstone formation, ceased operations in 1959.

The Twin City Brick Co. produced clay chiefly for use in manufacturing building brick at its St. Paul plant.

Sebesta Stone Co. produced dimension limestone at St. Paul and sold the material principally as rubble.

Vermiculite was exfoliated by the MacArthur Co. at St. Paul from crude material mined in Montana and was sold for use at lightweight aggregate in plaster and concrete, and for insulation.

Redwood.—Dimension granite for monumental use was produced near Belview by the View Quarry Co. and Johnson Quarry Co.

Ochs Brick & Tile Co. mined clay near Morton and hauled it by truck to the company brick plant at Springfield for processing.

Sand and gravel was produced for building and road construction and other uses by Buterbaugh Sand Co. and Chapman Gravel Co. at fixed plants near Walnut Grove and Belview, respectively.

Renville.—Cold Spring Granite Co. produced dimension granite for architectural and monumental purposes from its Rainbow quarry near Morton and processed the rough stone in Stearns County. The Melrose Tapestry quarry was not operated by the company in 1960.

Several companies produced sand and gravel near Belview, Danube, Olivia, and Sacred Heart. Output was used chiefly for building and road construction. Paving sand was produced by the State highway department.

Rice.—Bryan Rock Products, Inc., crushed limestone for roadstone and agricultural use at a portable plant near Northfield. Faribault Quarries produced dimension and crushed limestone near Faribault. Output was used for roadstone, architectural use, rough construction, flagging, and riprap.

Sand and gravel was produced by three companies chiefly in the vicinities of Faribault, Nerstrand, and Northfield. Output was for building and road construction. Paving sand was produced by the State highway department.

Rock.—The Jasper Stone Co. produced grinding pebbles and tube-mill liners at its quartzite quarry near Jasper. The company also sold some stone for architectural use and some broken material for riprap.

Hallett Construction Co. produced sand and gravel for building and road construction near Luverne. C. H. Hatting Gravel Co., Inc., produced gravel near Luverne. Output was screened and used mostly on county and township roads. Pronk & Sons produced sand and gravel from a pit about 4 miles west of Leota, mostly for road use. The remainder was used for concrete aggregate at the company

ready-mixed concrete plant, located at the gravel pit. Paving sand and gravel was produced under contract for the State and county highway departments. Demand for road material in the county was high.

St. Louis.—Mineral output in St. Louis County increased 49 percent in value over 1959, chiefly because of a marked gain in iron-ore shipments over strike-affected 1959. Mines in the county supplied 74 percent of the total usable ore shipments from the State. Approximately 51 percent of the total shipments was direct-shipping grade; the remainder was concentrate. The following operating companies and mines shipped iron ore in 1960:

Company:	*Mines*
Charleson Iron Mining Co	Missabe Mountain and Minnewas LOSP.
Haley-Young Mining Co	Elbern.
The M. A. Hanna Co	Agnew No. 2–South Agnew, Brunt, Douglas, Duncan, East Alpena, Enterprise, Morton-South Eddy, North Uno, Pierce, South Longyear, and Weggum.
Jones & Laughlin Steel Corp	Columbia, Longyear group, and Schley group.
W. S. Moore Co	Judson, Judson Extension, Mariska, Mariska Extension, Norman, Scranton, and Yawkey.
North Range Mining Co	Nahma.
Oglebay Norton Co	St. James.
Oliver Iron Mining Division, United States Steel Corp.	Canton (0–39), Emmett Extension, Gilbert, Hull-Rust group, Iron Range Reserve, Kosmerl, McKinley, Monroe group, Pillsbury, Pilotac, Pioneer, Rouchleau group, Sherman group, Soudan, and Stephens.
Oreclone Concentrating Corp	Prindle Tailings.
Pacific Isle Mining Co	Iroquois, Missabe Mountain LOSP, Shiras, Wacootah, and Wisstar.
Pickands Mather & Co	Albany, Bennett Annex, Embarrass, Erie Commercial, Erie Preliminary Taconite Plant, Mahoning, and Wade.
Pioneer Mining Co	Mary Ellen.
Pittsburgh Pacific Co	Chataco, Commodore, Fayal LOSP, Meadow, Meadow Extension, Missabe Mountain (South Lease), Pearce, Sidney, and Wyoming.
Republic Steel Corp	Susquehanna.
Reserve Mining Co	Peter Mitchell.
Rhude & Fryberger	Alworth, Boeing, and Pearsall.
Snyder Mining Co	Godfrey, Webb-Sellers Triangle, and Whiteside.
E. A. Young, Inc	Minnewas.
Zenith Mining Company	Zenith.

All mines were in the Mesabi Range except the Pioneer, Soudan, and Zenith underground mines in the Vermilion Range. Other underground mines shipping ore in 1960 were the Albany and the Godfrey.

Shipments of taconite concentrate increased about 3 million long tons over 1959. Taconite producers were as follows: Erie Mining Co. (operating agent, Pickands Mather & Co.), Reserve Mining Co., and the Oliver Iron Mining Division of United States Steel Corp. Erie operated taconite mines and its processing plant near Hoyt Lakes. Finished pellets were hauled over the 73-mile company-owned railroad to Taconite Harbor for shipment to lower Lake ports.

615629—61——36

Stockpile shipments were made from the Erie Preliminary Taconite Plant. Two new shaft furnaces were installed at the pelletizing plant in 1960.

Reserve Mining Co. produced taconite at its Peter Mitchell mine near Babbitt. The crude taconite was crushed to about 3-inch size and transported over the company railroad to Silver Bay for further crushing, concentrating, and pelletizing. The company announced plans to increase the annual capacity of its Silver Bay plant to 9 million tons of pellets. The expansion program included constructing a second primary crushing plant at Babbitt and double-tracking the 47-mile railroad connecting Babbitt and Silver Bay. Additional plans are mentioned in the Lake County section.

Oliver operated its Pilotac taconite mine and concentrator near Mountain Iron and hauled the concentrate to the company Extaca plant at Virginia for agglomeration by sintering and nodulizing.

Oliver also began constructing a new beneficiation plant at its Sherman ore-sizing plant near Chisholm. The plant was to process low-grade ores from the Monroe and Sherman groups of mines. Anticipated annual capacity of the plant was 1.5 million tons of concentrate. Plant production was scheduled to begin in 1961.

In April, The M. A. Hanna Co. began shipments from the Pierce mine near Hibbing. A new concentrator, which included crushing, screening, heavy-medium, cyclone, and spiral units, was completed early in the year. About 704,000 long tons of ore was shipped from the property in 1960. Approximately half the total output was concentrate.

Pickands Mather & Co. resumed shipments from the Albany underground and Wade open-pit mines. The company was testing the following new equipment at the Albany mine: A jumbo drill rig mounted on a tractor, a hydraulically-operated timbering machine, and a shuttle car to carry ore from the working face to a conveyor.

The company also reopened the Corsica mine, which was to be operated in conjunction with the Embarrass pit. A second screening plant was constructed at the latter mine. Pickands Mather ceased operations at the State-owned Scranton mine near Hibbing in June. However, W. S. Moore Co. obtained a 25-year lease on the property and operated the mine during the latter part of 1960. Moore planned to investigate whether the low-grade ore remaining in the mine could be treated economically.

Inland Steel Co. acquired complete ownership of Pacific Isle Mining Co. late in the year. Inland previously had held a 50 percent interest in Pacific Isle.

North Range Mining Co. made first shipments from the Nahma open-pit mine near Eveleth. The company, as agent for the Zenith Mining Co., also operated the Zenith underground mine at Ely. A new spiral circuit was added to the concentrating plant at the Zenith.

Rhude & Fryberger terminated its lease on the Alworth pit near Hibbing.

Annual capacity of the Coons-Pacific Co. plant near Eveleth was increased about 50 percent to 1.5 million tons of crude ore.

The American Steel & Wire Division of United States Steel Corp. and Interlake Iron Corp. produced coke and pig iron at plants in

Duluth. The former company also produced steel in open-hearth furnaces. Both companies curtailed operations because of poor market conditions.

Portland and masonry cements were produced at Duluth by the Universal Atlas Cement Division of United States Steel Corp.

Cutler-Magner Co. produced quicklime and hydrated lime at Duluth.

Mesaba Granite Co. quarried dimension granite for monumental use near Mountain Iron.

The Zenith Dredge Co. produced crushed basalt near Duluth for roadstone and railroad ballast.

Peat was produced by several companies, including St. Louis County Peat Products Co., Inc., and Arrowhead Peat Co. The former company produced peat from a privately owned, 350-acre bog at Central Lakes. Output was processed by shredding and screening. Arrowhead Peat Co. produced moss peat on company and State-owned land about 5 miles southeast of Wawina. Average depth of the deposit is 10 feet; the maximum depth is 35 feet. Excavating and loading equipment included 1 backhoe, 2 trucks, 2 tractors, and 2 discs. Peat was hauled to the company plant at Floodwood for processing. Plant equipment consisted of a hammermill and a screen. Sales, in packages and bulk, were for greenhouse use and soil improvement. The Wilderness Valley Farms Division of the Chun King Corp. produced reed-sedge peat on its 200-acre bog 3 miles south of Fens. The entire output was used by the company, mostly for mushroom beds and in producing a house-plant soil.

Over 2 million tons of sand and gravel was produced by 11 commercial companies and the State and county highway departments. Output was used for building and road construction, railroad ballast, fill, and other purposes.

Scott.—Crushed and broken limestone was produced near Shakopee by Bryan Rock Products, Inc., from its Merriam Junction quarry, and by B & R Rock Products Co. Output was used for agricultural and road purposes and riprap. Landers-Norblom-Christenson Co. crushed limestone near Savage chiefly for roadstone and asphalt filler.

Sand and gravel was produced near Belle Plaine, Chaska, Prior Lake, and Shakopee by four commercial operators and was used principally for building and road construction. Paving sand was produced by the State highway department. The county highway department produced and contracted for road gravel.

American Wheaton Glass Corp. was building a new glass-container plant in Valley Industrial Park near Shakopee.

Stearns.—Cold Spring Granite Co. operated six granite quarries near Cold Spring, Rockville, St. Cloud, and St. Joseph and finishing plants at Cold Spring and St. Cloud. The output was used chiefly for architectural and monumental purposes. Some granite was crushed at the Cold Spring plant and sold for poultry grit. North Star Granite Corp. produced dimension granite for monumental use at its Nos. 4 and 5 quarries near St. Cloud. The rough stone was processed at the company plant in St. Cloud. Delano Granite Works, Inc., produced granite for architectural use at a quarry near Rock-

ville. Royal Granite Co. operated a finishing plant in St. Cloud. Crushed and dimension granite were produced by Shiely-Petters Crushed Stone Co. near Waite Park. The crushed material was sold mainly for seal-coating bituminous roads and for railroad ballast. The company dimension output was used in constructing the upper lock and dam at St. Anthony Falls in Minneapolis. Granite was produced by the Minnesota State Reformatory at St. Cloud and used for rough construction.

Megarry Bros. and A. C. Petters Co., Inc., produced sand and gravel chiefly for use in building and road construction. The State highway department produced and contracted for paving sand and gravel.

Steele.—Limestone was produced near Owatonna by Klemmer Construction Co. for roadstone, agricultural use, and flagging. Much of the output was sold under contract to the city of Owatonna and to Rice and Steele Counties.

Owatonna Aggregates Corp. processed sand and gravel at a heavy-medium plant, which it had operated since 1953 near Owatonna. Crushing was performed with jaw and cone crushers. Ferrosilicon was used as the medium in the heavy-medium section of the plant. Concrete sand was produced by jigging. The company also operated a concrete-block plant, a draintile plant in Owatonna, and a ready-mixed concrete plant in Kenyon. Material was also furnished to another ready-mixed concrete plant in Blooming Prairie. Other producers of sand and gravel included Kohlmier Sand & Gravel Co. and Medford Washed Sand and Gravel Co., at plants near Owatonna and Medford, respectively. Output was used for building and road construction and fill. Paving gravel was produced under contract for the city of Owatonna, the village of Blooming Prairie, and the county highway department.

Wabasha.—Patterson Quarries, Inc., produced limestone at a portable crushing plant near Plainview for roadstone and agricultural purposes.

Producers of sand and gravel included the Chicago, Milwaukee, St. Paul & Pacific Railroad Co., Roverud Construction Co., and Wabasha Sand & Gravel Co. The material was used for building and road purposes, railroad ballast, fill, and other uses. Paving sand and gravel was produced under contract for the State and county highway departments.

Washington.—J. L. Shiely Co. produced crushed and broken limestone from the Larson quarry at St. Paul chiefly for roadstone and riprap and sand and gravel for building and road construction. Nienaber Contracting Co. crushed limestone for roadstone, agricultural use, and other purposes. Bryan Rock Products, Inc., crushed limestone for road use. Ashbach Construction Co. and Cemstone Products Co. produced sand and gravel. Output was used for building and road construction and other purposes. Paving sand and gravel was produced under contract for the State and county highway departments.

Winona.—Dimension limestone was produced near Winona by the Biesanz Stone Co., principally for architectural use. Limestone for

roadstone and agricultural use was crushed at St. Charles by Patterson Quarries, Inc., and produced by Fred Fakler at four quarries.

Winona Aggregate Co. produced sand and gravel for building and road construction at its dredging operation near Winona. Paving sand was produced by the State highway department.

Wright.—Delano Granite Works, Inc., processed rough stone quarried by the company in Big Stone and Stearns Counties, Minn., and Grant County, S. Dak., at its sawing and finishing plant at Delano.

Several companies produced sand and gravel chiefly for building and road purposes. Paving sand and gravel was produced by the State highway department and also under contract for both the State and county highway departments.

Yellow Medicine.—Near Granite Falls, crushed and broken granite for railroad ballast, riprap, and other uses was produced by the Green Co., contractor for the Great Northern Railway Co. Dimension granite for monumental use was produced near Echo by August Evanson.

Deutz & Crow Co., Inc., processed sand and gravel at a fixed plant in Canby; most of the output was used in the company ready-mixed concrete plant. Lesser quantities were sold for road use, mainly seal-coating. Bud Long Construction Co. at a portable plant near Hazel Run produced road gravel, which was sold to local townships and villages, and to home owners for surfacing private driveways. The State and county highway departments produced and contracted for paving sand and gravel.

The Mineral Industry of Mississippi

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Mississippi Geological Survey.

By Harry D. Kline [1] and Tracy W. Lusk [2]

VALUE of Mississippi mineral production in 1960 reached a record $199 million, thus continuing an upward trend for the ninth consecutive year. Mineral fuels, petroleum, natural gas liquids, and natural gas, were the most important mineral commodities and represented 91 percent of the value.

New construction pertinent to the mineral industry, included an electrolytic manganese plant and plants for manufacturing brick, clay pipe, potassium nitrate, chlorine, storage batteries, vinyl plastic, and polyurethane foam. The plants either were under construction or were scheduled for completion in 1961.

TABLE 1.—Mineral production in Mississippi [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons..	747	$4,064	1,017	$4,786
Natural gas.....million cubic feet..	162,095	25.125	172,478	32,426
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons..	23,207	1,495	23.648	1,552
LP gases.....do....	8,141	465	10.151	564
Petroleum (crude).....thousand 42-gallon barrels..	49,620	140.921	[2] 51,819	[2] 146,648
Sand and gravel.....thousand short tons..	7,520	7,743	6,181	5.568
Stone.....do....	[3] 126	[3] 114	807	808
Value of items that cannot be disclosed: Certain metals and nonmetals.....	----------	6,751	----------	7,271
Total Mississippi [4].....	----------	[5] 186,116	----------	198,862

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Preliminary figure.
[3] Excludes certain stone, included with "Value of items that cannot be disclosed."
[4] Total adjusted to eliminate duplicating value of stone.
[5] Revised figure.

[1] Mining Methods Research Engineer, Bureau of Mines, Bartlesville, Okla.
[2] Director, Mississippi Geological Survey, University, Miss.

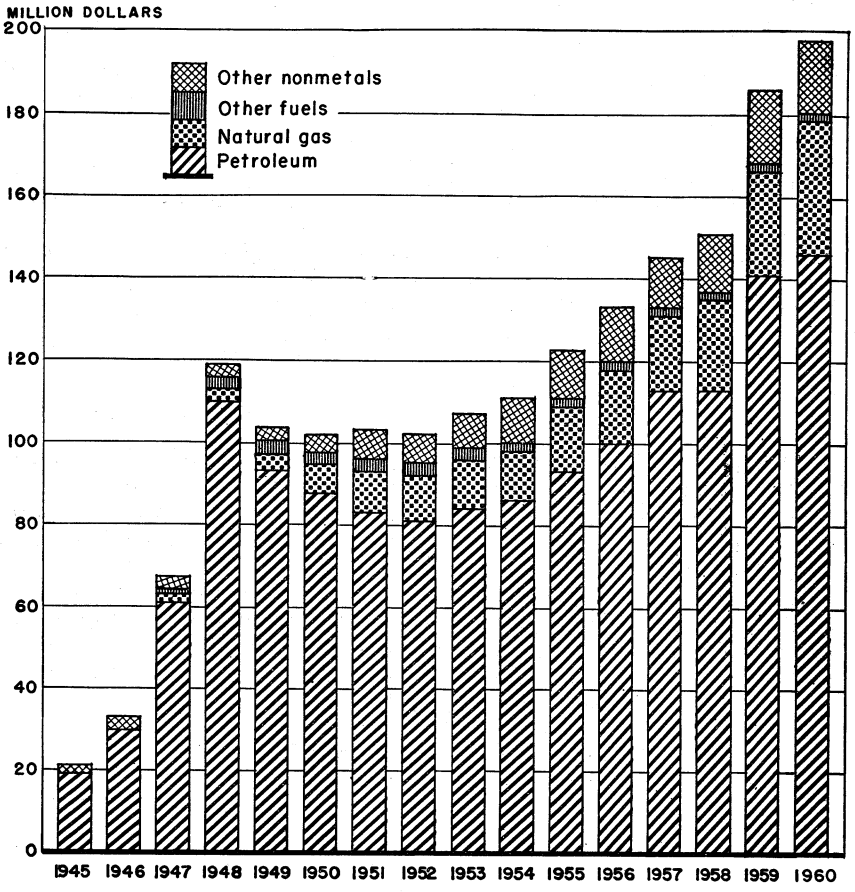

FIGURE 1.—Value of petroleum, natural gas, and total value of mineral production in Mississippi, 1945–60.

Improvement of seaport facilities at Gulfport and Pascagoula and river ports at Vicksburg and Greenville continued. Ownership of the port at Gulfport was transferred from the City of Gulfport to the State of Mississippi. This port will be administered by the State Agricultural and Industrial Board. On July 26, Harrison County voters approved a $5.5 million bond issue to finance deepwater channel improvements and development of a 1,200-acre industrial site in the Gulfport-Biloxi coastal area. The new facilities will aid in marketing Mississippi mineral products.

Mississippi Power Co. started constructing a 112,000-kilowatt unit at its steamplant between Gulfport and Biloxi.

Highway construction was 12 percent less than in 1959. Part of the decrease was attributed to Federal Government delays in providing matching funds.

The Atomic Energy Commission began studies concerning possible use of one of Mississippi's many salt domes for scientific purposes

important to the Nation's seismic research program. The proposed project, tentatively planned for Lamar County, will be economically important to the State.

The results of a geologic study along State Highway 16 from the Alabama line to Canton, Miss., were released in November. The report emphasized geologic units containing material suitable for highway construction.[3]

Another publication, prepared by the Federal Geological Survey in cooperation with the Mississippi Board of Water Commissioners and the Mississippi Geological Survey, was released in December. This report concerns mainly water-bearing formations and the quality, quantity, and availability of ground water supplies in 28 northern Mississippi counties.[4]

Employment and Injuries.—As a result of increased mineral production, average employment for the year showed a corresponding increase, according to the Mississippi Employment and Security Commission. Employment in the petroleum and natural-gas industries averaged 5,550 workers, and in nonmetal mining and processing industries, averaged 925 workers.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Production of natural gas, natural gas liquids, and crude petroleum continued on an upward trend. Mississippi ranked ninth among the Nation's oil-producing States. The preliminary 1960 total of 52 million barrels established a new crude-oil production record for the State. Daily average production was about 142,000 barrels of oil and 493 million cubic feet of natural gas from an increased number of wells and fields. Production came from 31 of the 82 counties, mostly in the southern half of the State.

A total of 700 development and exploration wells were completed during 1960, 52 more than in 1959, resulting in expansion of previously located fields and the discovery of new fields. Thirty-four wells were dually completed, and Humble Oil and Refining Co. made four triple completions (the first in the State) in the Bryan field, Jones and Jasper Counties. Geophysical and core-drill crews worked a total of 1,679 weeks, 126 less than 1959.

Twenty-three new field discoveries included Gilliard Lake, Glasscock, and Southwest Cranfield in Adams County; East Fork, McElveen, O'Neil, Smithdale, and Southeast Smithdale in Amite County; Reid in Calhoun County; Carmichael and West Langsdale in Clark County; Little Springs, Northeast Freewoods, and West Bude in Franklin County; Knoxo in Marion and Walthall Counties; South Amory in Monroe County; Johnston Station and Southeast McComb in Pike County; Puckett in Rankin County; Kokomo in Walthall County; Cypress Creek and South Thompson's Creek in Wayne County; and Bentonia in Yazoo County.

---

[3] Brown, Bahngrell W., Geologic Study Along Highway 16 From Alabama Line to Canton, Mississippi: Mississippi Geol. Survey Bull. 89, 52 pp.

[4] Lang, Joe W., and Boswell, Ernest H., Public and Industrial Water Supplies in a Part of Northern Mississippi: Mississippi Geol. Survey Bull. 90, 104 pp.

TABLE 2.—Oil and gas well drilling and total crew-weeks spent in geophysical and core-drill prospecting in 1960, by counties

County	Drilling [1]							Geophysical and core-drill prospecting (crew-weeks) [2]			
	Proved field wells			Exploratory wells			Total	Method			
	Oil	Gas [3]	Dry	Oil	Gas [3]	Dry		Reflection seismograph	Gravity meter	Core drill	Total
Adams	21		17	3		30	71	1			1
Amite	4	2	6	5		20	36	107	1		108
Attala								3	4		7
Calhoun					1		1				
Chickasaw						1	1				
Choctaw									6		6
Claiborne								22			22
Clarke	15		5	2		9	31	34			34
Clay		2				1	3	7			7
Copiah						1	1	74	7		81
Covington						1	1	31	5		36
Forrest		3	5			5	13	22	11		33
Franklin	5		9	3		25	42	85	4		89
George								10			10
Greene						2	2	15	5		20
Hancock		2				5	7	23	13		36
Harrison								16	18		34
Hinds	3		2			4	9	66	37	4	107
Holmes								5			5
Humphreys								16			16
Issaquena			1			4	5	6	6		12
Itawamba						2	2				
Jackson								19	4		23
Jasper	5					13	18	53			53
Jefferson	1	2	2			16	21	5	1		6
Jefferson Davis	1	5	2				8	36	1		37
Jones	29		7			3	39	104	4		108
Kemper								14			14
Lafayette								2			2
Lamar	6		4			4	14	62	7		69
Lawrence						1	1	30	11		41
Lincoln	6		3			8	17	23			23
Lowndes								1	6		7
Madison						1	1	44			44
Marion	5	4	6		1	3	20	47			47
Monroe			4	1		4	9	4			4
Montgomery									2		2
Neshoba								2			2
Newton								30			30
Noxubee								2	2		4
Oktibbeha								20	2		22
Panola								18			18
Pearl River	1	5	5			6	17	7	5		12
Perry						2	2	11	12		23
Pike	148	6	13	2		27	196	30			30
Quitman								28			28
Rankin			1	1		2	4	49			49
Scott			4			2	6	35			35
Sharkey						1	1	3	4	1	8
Simpson	5	1	3			3	12	27			27
Smith	5		1			11	17	65	1		66
Stone						2	2	3			3
Tallahatchie								6			6
Tunica								1			1
Walthall	6	6	3		1	6	22	18			18
Warren						1	1	22	6		28
Wayne	15		4	2		7	28	67	3		70
Wilkinson			1			10	11		21		21
Winston								4	1		5
Yalobusha								1			1
Yazoo			1	1		6	8	23	5		28
Total: 1960	281	38	109	20	3	249	700	1,459	215	5	1,679
1959	242	31	106	11	2	256	648	1,765		40	1,805

[1] Mississippi State Oil and Gas Bulletin, Jackson, Miss., vol. 60, No. 1, March 1960 through No. 12, February 1961.
[2] International Oil Scouts Association, vol. 31, 1960.
[3] Includes condensate.

According to the Mississippi State Oil and Gas Board, 208 oil pools and 47 gas pools were producing in 184 fields at yearend. Producible wells totaled 3,185, an increase of 431 over 1959.

TABLE 3.—Estimated proved recoverable reserves of crude oil, natural gas liquids and natural gas

	Proved reserves, Dec. 31, 1959	Changes in proved reserves, due to extensions and new discoveries in 1960	Proved reserves, Dec. 31, 1960 (production was deducted)	Change from 1959, percent
Crude oil ---- thousand barrels	389,337	67,881	407,098	+5
Natural gas liquids [1] ---- do	40,944	−2,258	36,181	−12
Natural gas ---- million cubic feet	2,486,524	242,194	2,542,338	+2

[1] Includes condensate, natural gasoline, and LP gases.

SOURCE: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association, Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas: Vol. 15, Dec. 31, 1960, pp. 11 12, 21.

TABLE 4.—Marketed production of natural gas [1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1951–55 (average)	158,163	$12,058	1958	160,143	$22,260
1956	185,137	18,143	1959	162,095	25,125
1957	169,967	17,507	1960	172,478	32,426

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

Natural Gas.—The marketed production of natural gas amounted to 172 billion cubic feet valued at $32.4 million, an increase of 6 percent in quantity and 29 percent in value over 1959. The increase was attributed to utilization in new industries and to expansion of facilities and corresponding consumption rates at existing plants. Proved reserves of natural gas increased 2 percent. Counties leading in natural-gas production in order of value were: Adams, Forrest, Jefferson Davis, Pearl River, and Monroe.

Of the total gas withdrawn, 45,316 million cubic feet was returned to producing reservoirs of the Cranfield and Brookhaven fields.

Natural Gas Liquids.—Production of natural gas liquids amounted to 33.8 million gallons valued at $2.1 million, an increase of 8 percent in quantity and 8 percent in value over 1959. About 25 percent of the gross production of natural gas was processed in the State's three natural gasoline and cycle plants—Brookhaven gas-cycling plant in Lincoln County, Cranfield gas-cycling operations in Adams County, and Little Creek processing plant in Pike County.

Sun Oil Co. installed a repressuring plant near McComb, Pike County. The plant was built to produce butane and propane gases.

TABLE 5.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	29,349	$2,184	16,947	$653	46,296	$2,837
1956	24,829	1,751	10,698	580	35,527	2,331
1957	25,152	1,469	10,044	472	35,196	1,941
1958	25,738	1,658	9,208	503	34,946	2,161
1959	23,207	1,495	8,141	465	31,348	1,960
1960	23,648	1,552	10,151	564	33,799	2,116

TABLE 6.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Production	Value	Year	Production	Value
1951–55 (average)	36,190	$85,288	1958	39,512	$113,004
1956	40,824	100,019	1959	49,620	140,921
1957	38,922	113,263	1960 [1]	51,819	146,648

[1] Preliminary figure.

TABLE 7.—Crude petroleum production, indicated demand, and stocks in 1960, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Mississippi
January	4,651	4,624	2,387
February	4,176	3,777	2,786
March	4,189	4,336	2,639
April	4,098	4,373	2,364
May	4,492	4,767	2,089
June	4,206	3,917	2,378
July	4,223	3,961	2,640
August	4,305	4,362	2,583
September	4,198	4,703	2,078
October	4,345	4,299	2,124
November	4,395	4,144	2,375
December	4,541	4,570	2,346
Total: 1960	[1] 51,819	51,833	----------
1959	49,620	49,643	----------

[1] Preliminary figure.

Underground storage capacity, as of October 1960, for natural gas liquids at seven caverns in Forrest County salt domes totaled 525,700 barrels of propane, 330,000 barrels of butane, and 1,650,000 barrels of LP gases. The storage facilities were used by Anchor Petroleum Co., General Gas Corp., Skelly Oil Co., and Warren Petroleum Corp.

Petroleum.—Production of 52 million barrels of petroleum, valued at $147 million, was 4.4 percent above the 1959 output and established a new record for Mississippi. The five leading petroleum producing counties were Lincoln, Adams, Pike, Jasper, and Lamar.

TABLE 8.—Crude petroleum production by fields [1]

(Thousand barrels)

Field	1956	1957	1958	1959	1960 [2]
Baxterville	5,874	4,939	4,993	5,843	5,901
Bolton	842	1,148	1,248	1,380	1,457
Brookhaven	3,019	2,541	2,218	1,920	1,924
Bryan				1,222	2,487
Church Hill					532
Cranfield	1,299	1,206	982	840	1,099
Diamond			959	1,040	1,166
Eucutta	1,484	1,318	1,611	1,559	1,363
Heidelberg	3,641	3,395	2,916	3,672	3,302
La Grange and South	2,137	1,936	1,649	1,714	1,453
Little Creek			1,440	5,896	5,669
Magee					727
Mallalieu	1,021	841	739	744	601
Martinsville					703
Maxie-Pistol Ridge	998	1,277	1,185	1,207	1,000
McComb					2,533
Merit					608
Overton and North					459
Raleigh				2,168	2,157
Sandersville					380
Soso	4,289	4,241	4,174	4,651	3,901
Tinsley	4,399	3,884	3,830	3,532	3,234
Yellow Creek	1,494	1,323	1,054	428	1,170
Other fields [3]	10,327	10,873	10,514	11,804	7,993
Total	40,824	38,922	39,512	49,620	51,819

[1] Based on Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Bureau of Mines data.

Well completions increased 8 percent over 1959; about 61 percent were development wells. Of 272 exploratory wells drilled, 23 were productive. The average depth of completed wells was 9,830 feet, 410 feet more than the 1959 average.

Approximately 14 percent of the crude petroleum produced was refined at three plants: Southland Oils, Inc., in Rogers Lacy; Paluxy Asphalt Co. in Crupp Station; and Pontiac Eastern Corp. in Purvis. Statewide petroleum-refining capacity was 28,000 barrels of crude oil per calendar day.

Petrochemicals.—Southbridge Plastic Products, Inc., announced plans for building a plant to manufacture vinyl plastic at Corinth, Alcorn County. Phillips-Foscue Corp. planned to build a plant at Tupelo, Lee County, to manufacture and fabricate polyurethane foam.

NONMETALS

Argon.—Spencer Chemical Co. produced argon at its facility in Vicksburg for the first full year. Argon, an inert gas, is used chiefly in processes requiring a completely inert atmosphere.

Cement.—Production of portland cement increased, and masonry cement output declined during the year. Portland and masonry cements were manufactured at the Marquette Cement Manufacturing Co. plant at Brandon and the Mississippi Valley Portland Cement Co. plant at Redwood.

Clays.—Clay production established a new record, exceeding the 1959 tonnage by 36 percent. Increases were reported in the quantities

TABLE 9.—Destination of shipments of portland cement to Mississippi from mills

Year	Mississippi (thousand barrels)	Change, percent	
		In Mississippi	In United States
1951-55 (average)	1,742		
1956	1,977	+4.8	+5.6
1957	2,188	+10.7	−6.4
1958	2,778	+26.9	+6.4
1959	3,072	+10.6	+9.3
1960	3,324	+8 2	−7.5

of bentonite, miscellaneous clay, fire clay, fuller's earth, and ball clay sold or used.

Miscellaneous clay, used for manufacturing heavy clay products and lightweight aggregates, furnished 59 percent of the clay production. Brick kilns operated in 15 counties.

Bentonite production, at open pits in Itawamba, Monroe, Pearl River, and Smith Counties, increased 19 percent over 1959. Bentonite was used principally as a binder in foundry and steelworks mold-making sands, and as a filtering and decolorizing agent.

Ball clay production, all from Panola County, increased slightly in quantity and value. Production of fuller's earth, mined in Tippah County and used for absorbents, increased 11 percent over 1959.

TABLE 10.—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
1951-55 (average)	234	$2,341	69	$772	297	$308	600	$3,421
1956	219	2,360	94	931	299	299	612	3,590
1957	220	2,372	101	968	295	295	616	3,635
1958	177	2,081	106	964	293	293	576	3,338
1959	200	2,494	117	1,138	430	432	747	4,064
1960	238	2,900	181	1,287	598	599	1,017	4,786

Atlas Tile and Brick Co. completed construction of a new plant at Shuqualak, Noxubee County. Locally mined clay was to be used to make buff and other light-colored face brick. The plant had a capacity of 50,000 brick per day.

Delta Macon Brick and Tile Co. began constructing a new clay-products plant at Macon, Noxubee County. The plant, with a planned daily capacity of 60,000 brick, was scheduled to be completed in June 1961. Clay for the plant was to be mined at open pits near Golson, 10 miles west of Shuqualak.

Limestone.—Southern Materials of Mississippi, Inc., was constructing a $300,000 plant between Clinton and Raymond, Hinds County, to produce agricultural limestone.

Magnesium Compounds.—The H. K. Porter Co. plant at Pascagoula completed its first full year of operation. The company used sea

water, dolomite, and chrome ore to produce periclase, other magnesium compounds, and brick.

Potassium Compounds.—Southwest Potash Co., Division of American Metal Climax, Inc., began constructing a $7-million plant at Vicksburg. Potassium nitrate and chlorine will be made by a new process.

Sand and Gravel.—Production of sand and gravel in Mississippi was down 18 percent in quantity and 28 percent in value from the record set in 1959. Most of the decrease resulted from a decline in road construction.

TABLE 11.—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
1951–55 (average)	3,311	$2,720	495	$315	3,806	$3,035
1956	4,991	4,554	324	147	5,315	4,701
1957	4,484	3,920	688	424	5,172	4,344
1958	5,614	5,149	931	1,091	6,545	6,240
1959	6,921	7,199	599	544	7,520	7,743
1960	6,068	5,522	113	46	6,181	5,568

Production of sand and gravel was reported from 22 of the 82 counties. Five counties—Copiah, Hinds, De Soto, Washington, and Adams—supplied 58 percent of the total value and 49 percent of the tonnage.

Sulfur.—Pontiac Eastern Corp. recovered elemental sulfur from sour natural gas processed at its Lamar County plant. Commercial sulfur production was reported for the first time.

METALS

Lead.—Contract Battery Manufacturing Co. completed a plant near Florence, Rankin County, for manufacturing storage batteries. The plant will use an estimated 12,000 pounds of antimonial lead each day it is operated.

Manganese.—American Potash and Chemical Corp. announced plans for building a $5-million electrolytic manganese metal plant adjacent to its sodium chlorate plant near Hamilton, Monroe County. Capacity of the new plant will be 10 million pounds of manganese a year. The plant will use ore from foreign sources, sulfuric acid from Tennessee, coal from Alabama, natural gas from Mississippi, and power from the Tennessee Valley Authority (TVA). The new plant was scheduled for completion late in 1961.

REVIEW BY COUNTIES

Adams.—The county was the leading producer of natural gas and ranked second in petroleum production. Three new oilfields, Glasscock, Southwest Cranfield, and Gilliard Lake, were discovered, and exploratory and development drilling added 24 oil wells to the county total.

Alcorn.—Corinth Brick & Tile Co. manufactured building brick from miscellaneous clay mined near Corinth.

Amite.—Exploratory drilling resulted in the discovery of five new oilfields—East Fork, McElveen, O'Neil, Southeast Smithdale, and

TABLE 12.—Value of mineral production in Mississippi, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Adams	$23,242,525	$27,180,956	Petroleum, natural gas, natural gas liquids, sand and gravel.
Alcorn	(2)	(2)	Clays.
Amite	54,413	634,771	Petroleum, natural gas.
Attala	(2)	3,375	Clays.
Bolivar	63,450	52,800	Sand and gravel.
Carroll	123,000	(2)	Clays.
Chickasaw	35,566	(2)	Natural gas, clays.
Clarke	779,927	1,048,360	Petroleum, natural gas.
Clay	138,069	168,549	Sand and gravel, stone, natural gas, petroleum.
Copiah	1,515,007	(2)	Sand and gravel.
De Soto	(2)	(2)	Do.
Forrest	13,119,486	9,430,947	Natural gas, petroleum, sand and gravel, clays.
Franklin	3,381,061	3,736,442	Petroleum, natural gas.
George	(2)	(2)	Sand and gravel.
Greene	4,689	5,082	Petroleum.
Grenada	(2)	(2)	Sand and gravel.
Hancock	406,861	432,235	Natural gas, petroleum.
Harrison	(2)	(2)	Sand and gravel.
Hinds	4,873,742	5,085,511	Petroleum, sand and gravel, clays, natural gas.
Holmes	(2)	(2)	Sand and gravel.
Itawamba	(2)	(2)	Clays.
Jackson	(2)	(2)	Magnesium compounds.
Jasper	16,626,848	15,022,275	Petroleum, natural gas.
Jefferson	6,232,029	5,086,974	Do.
Jefferson Davis	4,203,410	3,524,455	Natural gas, petroleum.
Jones	7,602,403	10,987,647	Petroleum, natural gas, clays.
Lamar	12,300,959	12,278,076	Petroleum, natural gas.
Lauderdale	(2)	(2)	Clays.
Lee	(2)	(2)	Do.
Leflore		(2)	Sand and gravel.
Lincoln	22,250,902	19,821,054	Petroleum, natural gas liquids, natural gas, clays.
Lowndes	660,545	(2)	Sand and gravel, clays.
Madison	998,632	795,887	Petroleum, natural gas.
Marion	2,679,279	3,090,046	Do.
Marshall	(2)	(2)	Clays.
Monroe	3,893,998	3,731,238	Clays, natural gas, sand and gravel, petroleum.
Noxubee	56,794	55,971	Stone.
Panola	(2)	(2)	Clays, sand and gravel.
Pearl River	4,186,575	4,108,273	Natural gas, petroleum, sand and gravel, clays.
Perry	(2)	(2)	Sand and gravel, petroleum.
Pike	8,580,758	17,087,385	Petroleum, natural gas liquids, natural gas.
Pontotoc	(2)	(2)	Clays.
Prentiss	(2)	(2)	Do.
Rankin	(2)	4,373,163	Cement, stone, petroleum.
Scott	136,916	75,448	Petroleum.
Sharkey	5,970	8,796	Do.
Simpson	3,577,736	5,260,185	Petroleum, natural gas.
Smith	10,392,032	10,580,681	Petroleum, clays, natural gas.
Stone		(2)	Sand and gravel.
Sunflower	5,750	5,599	Clays.
Tippah	(2)	(2)	Do.
Tishomingo	142,110	(2)	Sand and gravel, stone.
Walthall	400,408	1,568,190	Natural gas, petroleum.
Warren	(2)	(2)	Cement, stone.
Washington	932,000	(2)	Sand and gravel.
Wayne	9,618,265	9,787,060	Petroleum, natural gas.
Wilkinson	3,054,500	2,295,440	Do.
Yalobusha	(2)	(2)	Sand and gravel.
Yazoo	9,842,953	9,516,459	Petroleum, sand and gravel, natural gas.
Undistributed	9,996,133	12,022,457	
Total	[3] 186,116,000	198,862,000	

[1] The following counties were not listed because no production was reported: Benton, Calhoun, Choctaw, Claiborne, Coahoma, Covington, Humphreys, Issaquena, Kemper, Lafayette, Lawrence, Leake, Montgomery, Neshoba, Newton, Oktibbeha, Quitman, Tallahatchie, Tate, Tunica, Union, Webster, and Winston.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[3] Revised figure.

Smithdale. The value of petroleum products produced rose 850 percent above the 1959 value as a result of the new discoveries. The county was one of the leaders in crew-weeks of geophysical prospecting.

Attala.—Magnet Cove Barium Corp., Kosciusko, processed bentonitic clay and fuller's earth for drilling mud and other purposes. Bell's Brick Yard mined miscellaneous clay for manufacturing building brick and face brick.

Bolivar.—Rosedale Gravel Co. produced washed gravel from river bars for road construction.

Carroll.—Delta Brick & Tile Co. manufactured building brick from miscellaneous clay mined near Carrollton. Carroll County supervisors mined pit-run gravel for road construction.

Chickasaw.—Baldwyn Brick & Tile Co. manufactured brick from miscellaneous clay mined near Okolona. Two gasfields, Trebloc and Coleville, were producing natural gas.

Clarke.—Exploratory drilling resulted in the discovery of two new oilfields, Carmichael and West Langsdale. Development drilling added 15 oil wells to producing fields during the year.

Clay.—West Point Gravel Co. produced washed sand and gravel for highway and building construction. The State Lime Plant Board produced agricultural limestone from an open pit near Cedar Bluff.

Copiah.—The county led in the quantity and value of sand and gravel produced. Production of sand and gravel for highway and other construction purposes was reported by Traxler Gravel Co., Inc., Green Brothers' Gravel Co., Inc., and Lewis Gravel Co.

De Soto.—Memphis Stone & Gravel Co. and Weymouth Construction Co. produced washed sand and gravel for highway and other construction work.

Forrest.—Forrest County ranked second in natural-gas production. Development drilling added three gas wells to proved fields. American Sand & Gravel Co. produced sand and gravel for highway and other construction purposes. The company also operated the Hattiesburg Brick Works, using locally mined miscellaneous clay for making face brick and structural tile. Pittman Concrete & Gravel Co. produced washed sand and gravel.

Franklin.—Exploratory drilling resulted in the discovery of three oilfields, Little Springs, Northeast Freewoods, and West Bude.

Granada.—Chocchuma Gravel Co. started producing gravel for highway and other construction in a stationary plant, 4 miles south of Holcomb, with a capacity of 400 cubic yards per day.

Hancock.—Production of petroleum and natural gas remained the same as in 1959. Exploratory drilling was unproductive.

Hinds.—Southern Materials Co. planned production of agricultural limestone from open pits 15 miles west of Jackson. The county led in tonnage of miscellaneous clay mined, and ranked second in value of sand and gravel production. Development drilling added three oil wells to the county's total during the year.

Holmes.—Hammett Gravel Co. reported production of gravel for highway construction.

Itawamba.—American Colloid Co. processed locally mined bentonite for moldmaking in foundries and steelworks.

Jackson.—The H. K. Porter & Co., Inc., plant at Pascagoula produced magnesium compounds from sea water and dolomite, and completed its first full year's operation.

Jefferson.—The value of petroleum and natural gas produced was 18 percent below 1959. Development drilling added one oil and two gas wells. Geophysical prospecting was conducted throughout the year.

Jefferson Davis.—Production of petroleum and natural gas was 16 percent less than in 1959. Development and exploratory well drilling resulted in the discovery of five gas wells and one oil well during the year. The county ranked fourth in gas production.

Jones.—Laurel Brick & Tile Co., Inc., reported production of miscellaneous clay for use in manufacturing face brick. Development drilling opened 29 oil wells.

Lamar.—Pontiac Eastern Corp., Purvis, reported production of sulfur at its natural-gas purification plant. The county ranked fifth in value of petroleum production.

Lauderdale.—Meridian Brick Co. used locally mined miscellaneous clay for manufacturing building brick.

Lee.—Tupelo Brick & Tile Co. mined miscellaneous clay for manufacturing building brick and other heavy clay products.

Lincoln.—For the second consecutive year, the county led in petroleum production. Brookhaven Pressed Brick Co. produced miscellaneous clay for manufacturing brick and other heavy clay products.

Lowndes.—C & P Gravel Co., Columbus Gravel Co., Ellis Sand & Gravel Co., and Fleming Gravel Co. produced washed sand and gravel for road and building construction. Columbus Brick Co. mined miscellaneous clay for manufacturing building brick. Hooker Chemical Corp., Columbus, was expanding its capacity for making sodium chlorate.

Marion.—The county road department mined pit-run gravel for maintenance and construction of county roads. An 18-percent increase was noted in petroleum and natural gas production. Development and exploratory drilling added six oil and five gas wells.

Marshall.—Holly Springs Brick & Tile Co. and Southern Brick & Tile Co. mined miscellaneous clay from nearby pits for manufacturing building brick and other heavy clay products.

Monroe.—American Colloid Co. and Eastern Clay Products Department of International Minerals & Chemical Corp. mined bentonite principally for moldmaking in foundries and steelworks. Filtrol Corp. mined and processed bentonite for filtering and decolorizing uses. The county ranked fifth in natural-gas production and retained the lead in bentonite production.

Noxubee.—The State Lime Plant Board produced agricultural limestone from an open pit, 2 miles north of Macon. Atlas Tile & Brick Co. completed a new brick plant at Shuqualak. Delta Macon Brick Co. began constructing a face brick plant at Macon.

Panola.—Kentucky & Tennessee Clay Co. mined ball clay for glass-refractory use. Hotophia Creek Gravel Co., Inc., produced sand and gravel for paving and structural uses.

Pearl River.—Pearl River Clay Co. mined bentonite for use in insecticides and plastic cement. Williams Gravel Co. produced washed

sand and gravel for general construction purposes. The production of petroleum and natural gas was down 2 percent from 1959.

Perry.—Underwood Sand & Gravel Co. produced washed sand and gravel for building construction.

Pike.—Exploratory drilling in Pike County resulted in the discovery of two new oilfields. Development drilling was successful; 154 of the 167 wells drilled were productive. The county ranked third in value of petroleum produced.

Pontotoc.—Pontotoc Brick Co. and W. B. Ferguson mined miscellaneous clay for manufacturing building brick.

Prentiss.—Locally mined miscellaneous clay was used by Baldwyn Brick & Tile Co. to make building brick.

Rankin.—Marquette Cement Manufacturing Co. produced portland and masonry cements at its Brandon plant.

Simpson.—Productive development wells furnished a 47-percent increase in petroleum and natural gas production. The county ranked tenth in value of petroleum and gas produced.

Smith.—Bentonite was mined from the Burn's pit for use in filtering and decolorizing mineral oils, vegetable oils, and animal fats. Sam Bass and Smith County Lime Co. started mining agricultural limestone from open pits near Silverana. Production of petroleum and natural gas remained at the 1959 level.

Tippah.—Wyandotte Chemical Corp. and Howell Southern Products, Inc., mined and processed fuller's earth. The county ranked second in value of clay produced.

Tishomingo.—Tri-State Sand Co. mined and processed a sandy clay for moldmaking in foundries and steelworks. Southward Stone Co. quarried sandstone for building purposes.

Walthall.—Exploratory drilling resulted in discovery of the Kokomo gasfield. Productive development wells supplied a fourfold increase in the total value of petroleum and natural gas produced in the county.

Warren.—Mississippi Valley Portland Cement Co. produced portland and masonry cements at its Redwood plant using limestone and calcareous marl mined locally and shell shipped from Louisiana. Southwest Potash Co., Division of American Metal Climax, Inc., began constructing a plant in Vicksburg to produce potassium nitrate and chlorine.

Washington.—Greenville Dredging Co. and Greenville Gravel Co. produced sand and gravel for structural purposes.

Wayne.—Exploratory drilling resulted in discovery of two new oilfields, Cypress Creek by Lyle Cashion Co. and South Thompson's Creek by Larco Drilling Co. Development drilling added 15 oil wells to the proved fields.

Wilkinson.—Exploration drilling was unproductive.

Yazoo.—One new oilfield, Bentonia, was discovered in December by Humble Oil & Refining Co. Sand and gravel was produced for highway and other construction purposes.

The Mineral Industry of Missouri

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Division of Geological Survey and Water Resources, Department of Business Administration of Missouri.

By W. G. Diamond [1] and William C. Hayes [2]

VALUE of Missouri's mineral production in 1960 totaled $156 million, approximately $1 million less than in 1959. Missouri was the Nation's largest lead producer for the 53d consecutive year. Seventeen mineral commodities were produced in the State: Seven metals, seven nonmetals, and three mineral fuels. The five principal mineral commodities, in order of value, were cement, stone, lead, lime, and coal. Minerals and mineral fuels came from 105 of the State's 114 counties in 1960, metals from 10, nonmetals from 102, and mineral fuels from 17 counties.

TABLE 1.—Mineral production in Missouri [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	296,093	$3,924	180,702	$2,588
Cement—thousand 376-pound barrels	13,947	46,974	12,183	42,330
Clays—thousand short tons	2,635	6,898	2,540	7,207
Coal—do	2,748	11,937	2,890	12,450
Copper (recoverable content of ores, etc.)—short tons	1,065	654	1,087	698
Iron ore (usable)—thousand long tons, gross weight	349	3,278	365	3,760
Lead (recoverable content of ores, etc.)—short tons	105,165	24,188	111,948	26,196
Lime—thousand short tons	1,324	15,714	1,254	14,701
Natural gas—million cubic feet	----------	----------	75	19
Petroleum (crude)—thousand 42-gallon barrels	75	(2)	[3] 72	(2)
Sand and gravel—thousand short tons	10,279	11,406	10,207	11,601
Silver (recoverable content of ores, etc.) thousand troy ounces	340	308	16	14
Stone—thousand short tons	26,939	36,435	27,180	37,878
Zinc (recoverable content of ores, etc.)—short tons	92	21	2,821	728
Values of items that cannot be disclosed: Native asphalt, cobalt, gem stones, nickel, and values indicated by footnote 2	----------	[4] 2,289	----------	2,066
Total Missouri [5]	----------	[4] 157,189	----------	156,033

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Preliminary figure.
[4] Revised figure.
[5] Total adjusted to eliminate duplicating value of clays and stone.

[1] Commodity-industry economist, Bureau of Mines, Bartlesville, Okla.
[2] Assistant State geologist, Geol. Survey and Water Res., Rolla, Mo.

The Viburnum lead project of St. Joseph Lead Co. began producing during the year. Ore was hoisted through a shaft in Crawford County and milled in Iron County at a rate of 3,000 tons per day. Expenditures at Viburnum in 1960 totaled more than $6.5 million. Development of the Pea Ridge iron ore project continued. At yearend, the service shaft had reached a depth of 2,274 feet and the main ore-hoisting shaft, a depth of 1,882 feet. The first ore was mined from a drift 1,675 feet below the collar of the service shaft.

Exploration.—Unprecedented minerals exploration was experienced in Missouri in 1960 as a result of recent lead and iron ore discoveries. Expenditures and area tested by the exploration activities exceeded the totals for any previous year. Companies performing exploration in some capacity included: St. Joseph Lead Co.; National Lead Co.; American Zinc, Lead & Smelting Co.; American Smelting & Refining Co.; Bear Creek Mining Co. (subsidiary of Kennecott Copper Corp.); New Jersey Zinc Co.; American Metal Climax, Inc.; The Eagle Picher Co.; and Missouri-Cliffs, Inc. (subsidiary of Cleveland-Cliffs Iron Co.).

Exploration activity increased near Bunker. Mining Companies purchased nearly 77 acres in the Bee Fork area and 240 acres in the West Fork vicinity. Extensive drilling was done in the Midridge area.[3]

Missouri-Cliffs, Inc., explored for iron ore in Washington County. The company began its exploration in 1959 with studies of aerial magnetic maps.[4] Earl Vaught started drilling on a property about 10 miles south of Granby. The Granby area was the site of a rich ore deposit mined in the late 1800's.[5]

Employment.—Average employment declined 2 percent in the metal-mining industry and 11 percent in the nonmetal-mining industry. An increase of about 1 percent was noted in the coal-mining industry.

Government Programs.—No contracts for Government participation in exploration projects for strategic minerals, through the program of the Office of Minerals Exploration (OME), were in effect in Missouri at the end of 1960. Final settlement was made on the contract with American Zinc, Lead & Smelting Co. for the investigation of copper and lead resources in Dent and Iron Counties during the year.

TABLE 2.—Average annual employment of mining industries

Industry	1956	1957	1958	1959 [1]	1960
Metal mining	3,524	3,767	3,540	3,263	3,195
Nonmetal mining	3,991	4,030	3,941	4,286	3,820
Coal mining	921	970	800	856	864
Total	8,436	8,767	8,281	8,405	7,879

[1] Revised figures.

Source: Division of Employment Security, Department of Labor and Industrial Relations, State of Missouri.

[3] Mining World, vol. 22, No. 9, August 1960, p. 50.
[4] Mining World, vol. 22, No. 10, September 1960, p. 30.
[5] Work cited in footnote 4, p. 57.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetals supplied 71 percent of the total value of mineral production.

Barite.—Missouri was the second largest barite producing State and led the Nation in value of shipments, with $2.6 million. Barite was mined in Washington and Jefferson Counties and processed at grinding plants in Washington and St. Louis Counties. The output was used in oil-well drilling muds and chemicals.

TABLE 3.—Barite sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1951–55 (average)	318,644	$3,201,334	1958	199,268	$2,666,496
1956	381,642	4,461,955	1959	296,093	3,923,651
1957	317,350	3,938,486	1960	180,702	2,587,820

Cement.—Cement plants in St. Louis, Cape Girardeau, Jackson, and Ralls Counties produced 12.6 million barrels of portland cement, utilizing an average 80 percent of total plant capacity. About 59 percent of the cement was produced by wet-process and 41 percent by dry-process methods. Nearly 85 percent of shipments totaling 11.9 million barrels were in bulk and 15 percent in bags; approximately 92 percent was transported by railroad, and the remainder by truck and boat. Truck shipments were reported for the first time in Missouri with the installation of two truck bulk-loading silos by Missouri Portland Cement Co. at its Kansas City plant. All plants also produced masonry cement.

TABLE 4.—Portland cement production and shipments

(Thousand barrels and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1951–55 (average)	10,744	10,760	$28,772	1958	12,143	11,813	$39,376
1956	12,441	12,014	36,888	1959	13,610	13,583	45,430
1957	10,866	10,794	34,307	1960	12,606	11,856	40,915

TABLE 5.—Shipments of all types of portland cement to Missouri from mills

Year	Missouri (thousand barrels)	Change, percent		Year	Missouri (thousand barrels)	Change, percent	
		In Missouri	In United States			In Missouri	In United States
1951–55 (average)	6,854	----------	----------	1958	7,636	+11	+6
1956	7,643	−3	+6	1959	8,825	+16	+9
1957	6,851	−10	−6	1960	7,684	−13	−7

TABLE 6.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Fire clay		Diaspore		Burley		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1951-55 (average)	1,447	$7,211	31	$503	48	$446	855	$1,158	2,381	$9,318
1956	1,699	6,499	25	293	42	325	892	899	2,658	8,016
1957	1,672	6,206	10	123	50	398	916	921	2,648	7,648
1958	1,176	4,806	9	143	27	190	848	847	2,060	5,986
1959	1,623	5,630	6	93	28	197	978	978	2,635	6,898
1960	1,508	5,867	4	73	29	268	999	999	2,540	7,207

Clays.—Missouri ranked high in manufacture of refractories because of its many deposits of fire clay especially suitable for superduty refractories. Refractories were produced by Kaiser Refractories and Chemicals Division, Kaiser Aluminum and Chemicals Corp.; A. P. Green Fire Brick Co.; Harbison-Walker Refractories Co.; Walsh Refractories Corp.; Refractories Division, H. K. Porter Co., Inc.; Wellsville Fire Brick Co.; General Refractories Co.; North American Refractories Co.; and Corhart Refractories Co., Inc. Contractors mined most of the clay. Gilliam Mining Co., Bethlehem Co., and Fluetsch Bros. mined fire clay for use in horizontal zinc retorts in Oklahoma and Texas. Lightweight aggregate was produced from shale in Platte County by Carter-Waters Corp. Heavy clay products and cement also were made from miscellaneous clay. W. S. Dickey Clay Manufacturing Co. installed a new tunnel kiln at its Evens and Howard plant in St. Louis.[6] Hydraulic Press Brick Co. added facilities to produce shale and fire clay brick at its plant in St. Louis County at a cost of $350,000. Clays were produced in 20 counties; the five leaders were Gasconade, Audrain, Callaway, Montgomery, and St. Louis.

Gem Stones.—Gem varieties of agate and various other minerals were recovered in Missouri in 1960.

Lime.—Lime was produced at six lime plants—two in Greene County and one each in Marion, Newton, St. Francois, and Ste. Genevieve Counties. Production of lime decreased 5 percent from 1959, and value decreased 6 percent. Approximately 86 percent of the lime was used for chemical and industrial purposes, and 14 percent for building and refractory uses.

Perlite.—J. J. Brouk & Co. processed crude perlite mined in Western States, at its plant in St. Louis. The expanded perlite was used mainly as lightweight aggregate.

Sand and Gravel.—Sand and gravel was produced, chiefly from stream deposits, in 64 counties. Over 86 percent of total production was used for building and highway construction. Industrial sand was produced in Franklin, Jasper, Jefferson, St. Charles, and St. Louis Counties. These counties also led the State in total value of sand and gravel produced. Commercial operations furnished 94 percent of the total tonnage and 96 percent of the total value; the remainder

[6] Brick and Clay Record, vol. 137, No. 6, December 1960, p. 23.

TABLE 7.—Lime sold or used by producers
(Thousand short tons and thousand dollars)

Year	Quicklime	Hydrated lime	Total lime	
			Quantity	Value
1951–55 (average)	1,009	202	1,211	$12,054
1956	1,254	227	1,482	15,814
1957	1,172	221	1,393	16,475
1958	953	220	1,173	14,136
1959	1,089	235	1,324	15,714
1960	1,030	224	1,254	14,701

was Government-and-contractor output. Over 98 percent of the commercial sand and gravel was washed. Shipments of commercial production were 71 percent by truck, 26 percent by rail, and 3 percent by water or other methods.

TABLE 8.—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
1951–55 (average)	6,766	$6,790	1,087	$712	7,853	$7,502
1956	8,161	8,873	1,424	1,244	9,585	10,117
1957	7,198	8,000	1,282	942	8,480	8,942
1958	8,281	9,285	691	443	8,972	9,728
1959	9,573	10,959	706	447	10,279	11,406
1960	9,631	11,194	576	407	10,207	11,601

Stone.—Output from Missouri quarries included limestone, granite, marble, sandstone, and miscellaneous stone. Limestone production was reported from 82 counties and supplied 97 percent of the total tonnage and 94 percent of the total value. Crushed and dimension granite were produced in Iron County. Dimension marble was quarried in Jasper, Ste. Genevieve, and Greene Counties; crushed marble in Jasper, Jefferson, and Madison Counties. Sandstone was quarried in Shannon and Vernon Counties. Miscellaneous stone (chats) was produced in St. Francois and Jasper Counties. Principal uses for crushed stone were concrete aggregate, roadstone, riprap, and agricultural stone; dimension stone was used as monumental and building stone. Commercial producers supplied 98 percent of total tonnage.

Asphaltic sandstone for road surfacing was produced in Barton County by Bar-Co Roc, Inc.

Tripoli.—Tripoli was processed from Oklahoma ore by American Tripoli Division of The Carborundum Co. at its Seneca plant in Newton County. Production was lightly less than in 1959.

Vermiculite.—Crude vermiculite from Western States was exfoliated at plants in St. Louis and Jackson Counties.

TABLE 9.—Stone sold or used by producers, by kinds

Year	Granite		Marble		Limestone	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1956	3,456	$302	[1] 5,000	[1] $25	23,152,644	$31,051
1957	5,369	232	[2]	[2]	20,936,499	27,269
1958	3,648	260	[2]	[2]	23,387,507	30,774
1959	3,111	276	181,070	1,704	25,980,397	33,944
1960	3,806	233	148,930	1,737	26,410,534	35,475

Year	Sandstone		Miscellaneous stone [3]		Total stone	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1956	[2]	[2]	1,395,776	$820	24,578,243	$33,577
1957	[2]	[2]	1,117,339	751	22,097,639	29,836
1958	[2]	[2]	870,879	465	24,275,550	32,878
1959	5,209	$83	769,553	428	26,939,340	36,435
1960	2,811	42	614,287	391	27,180,368	37,878

[1] Excludes dimension marble.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Total stone."
[3] Chats; also includes small quantity of other stone.

METALS

Mine Mills and Smelters.—At the beginning of 1960 five mine mills were operating in Southeastern Missouri—National Lead Co. Madison mill (Madison County), St. Joseph Lead Co. Indian Creek mill (Washington County), and Federal, Bonne Terre, and Leadwood mills (St. Francois County). The new Viburnum mill of St. Joseph Lead Co. began processing ore from the newly developed mine on July 15. The company reported that a construction program started at the Federal mill would eliminate tables used to produce gravity concentrate and convert the mill to an all-flotation operation. Also, flotation circuits were added to produce copper concentrate. Zinc flotation circuits were added at the Leadwood mill. At Herculaneum, St. Joseph Lead Co. smelted and refined lead. The refinery building was enlarged and two 250-ton kettles were installed. The silver refinery was rebuilt and a third blast furnace was constructed. National Lead Co. refined cobalt and nickel at Fredericktown.

Cadmium, Gallium, Germanium, and Indium.—These metals occur as trace elements in Missouri lead-zinc ores and were recovered from zinc smelter flue dusts. Since no source was designated for any of the concentrate smelted in Missouri, no State of origin was assigned for these by-product metals.

Cobalt and Nickel.—Cobalt and nickel were recovered from the complex lead-copper-cobalt-nickel ores in Madison County by National Lead Co. at Fredericktown. The refinery was leased from the U.S. Government.

Columbium-Tantalum and Uranium.—Mallinckrodt Nuclear Corp., a subsidiary of Mallinckrodt Chemical Works, processed domestic euxenite concentrate, mostly from Idaho. The company supplied approximately 1,000 kilograms of 93-percent uranium oxide to the Consolidated Edison Co. Indian Point nuclear power plant. The

uranium oxide was shipped to Lynchburg, Va., mixed with thorium oxide, and fabricated into fuel element pellets. The company also received a contract from Argonne National Laboratory for 1,200 kilograms of highly enriched uranium metal (99.95-percent). Total cost of the two contracts was more than $34 million.

Copper.—Copper was recovered from lead-copper ore in Madison County and lead ore in St. Francois County. Output was greater than in 1959.

Iron Ore.—Meramec Mining Co., owned jointly by Bethlehem Steel Corp. and St. Joseph Lead Co., continued development of the Pea Ridge iron ore project. At yearend the mine service shaft and main hoisting shaft had reached depths of 2,274 feet and 1,882 feet, respectively. The 26-mile railroad spur running from Cadet to the mine and plant site was completed by Missouri Pacific Railroad Co. The warehouse, machine shops, and office building were completed. The first ore was mined from a drift 1,675 feet below the collar of the service shaft. The ore body was further explored by diamond core drilling equipment installed on the 1,675-foot level.

The long-range drilling program undertaken jointly by American Zinc, Lead and Smelting Co. and Granite City Steel Co. continued. In the Bourbon area, where 18 holes had been drilled since 1956, the possible existence of a 100-million-ton iron ore deposit was indicated. Engineering studies were started to bring the mine into production and build a 10,000-ton-per-day concentrating plant and a pelletizing plant.[7]

Brown-ore (limonite) and hematite-ore output increased 4 percent in tonnage and 15 percent in value over 1959. Production was reported from 20 mines in 7 counties.

Iron and Steel.—In May, the Sheffield Division of Armco Steel Corp. shut down three open-hearth furnaces at its Kansas City plant. According to the company, it was the first time in 25 years that all the open-hearth furnaces had been shut down because of business conditions. The electric furnace department continued to operate. The company Kansas City No. 1 rodmill also closed during 1960.

Iron and steel scrap and pig iron were used in making castings, by iron and steel foundries, principally in the St. Louis and Kansas City areas.

Lead.—Mine production of recoverable lead totaled 111,948 tons—45 percent of the U.S. production. For the third consecutive year, no lead was produced in Southwestern Missouri. The price of lead was 12 cents per pound (New York) from January 1 until December 13, then dropped to 11 cents through December 31. The new lead-mining property of St. Joseph Lead Co. at Viburnum started production on July 15. Ore was hoisted through Shaft No. 27 in Crawford County. Work continued on Shaft No. 28 at the mill site in Iron County. The milling rate was 3,000 tons per day. Only preliminary work was done on Shaft No. 29 in Washington County. When the three shafts are operational, the milling rate will be increased to 6,000 tons per day. The company provided complete community facilities at the Viburnum townsite near the mill. Company expenditures in 1960 exceeded $6.5 million.

[7] Mining World, vol. 23, No. 1, January 1961, p. 51.

TABLE 10.—Ferrous scrap and pig iron consumption
(Short tons)

Year	Ferrous scrap	Pig iron	Total scrap and pig iron
1956	1,039,866	45,722	1,085,588
1957	976,266	51,932	1,028,198
1958	896,231	36,257	932,488
1959	843,155	73,518	916,673
1960	827,811	44,649	872,460

TABLE 11.—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)
1951-55 (average)		6,726,993	1,586,710	336,646	$305	2,204	$1,240
1956	19	6,996,696	1,223,575	295,111	267	1,890	1,607
1957	16	6,874,008	1,271,684	183,427	166	1,604	966
1958	9	5,945,836	479,916	250,917	227	1,429	752
1959	4	5,573,517		339,760	308	1,065	654
1960	5	5,897,813		15,594	14	1,087	698

Year	Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951-55 (average)	125,901	$37,819	9,025	$2,669	$42,033
1956	123,783	38,868	4,380	1,200	41,942
1957	126,345	36,135	2,951	684	37,951
1958	113,123	26,471	362	74	27,524
1959	105,165	24,188	92	21	25,171
1960	111,948	26,196	2,821	728	27,636

TABLE 12.—Mine production of silver, copper, lead, and zinc in 1960, by classes of ore or other source material, in terms of recoverable metals

Source	Number mines	Material sold or treated (short tons)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lead ore [1]	5	5,897,813	15,594	1,087	111,948	2,821

[1] Includes lead-copper ore from one mine.

TABLE 13.—Mine production of lead and zinc in southeastern and central Missouri, 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)[3]	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1951–55 (average)	179,996	$30,908	5,825	$535	124,213	$37,277	3,286	$900
1956	174,131	33,266	6,484	542	123,395	38,746	3,345	917
1957	179,312	31,507	5,903	448	126,323	36,128	2,866	665
1958	159,068	23,015	770	41	113,123	26,471	362	74
1959	146,765	21,698	206	12	105,165	24,188	92	21
1960	155,781	23,105	5,602	446	111,948	26,196	2,821	728

[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 14.—Mine production of lead and zinc in southwestern Missouri, in terms of concentrate and recoverable metals [1]

Year	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content [2]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1951–55 (average)	2,170	$458,031	10,612	$1,103,085	1,688	$541,776	5,739	$1,768,940
1956	496	102,096	1,862	161,502	388	121,832	1,035	283,590
1957	29	5,576	161	12,742	22	6,292	85	19,720
1958–60								

[1] Based on southwestern 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.

TABLE 15.—Tenor of lead and zinc ore, old tailing, and slimes milled and concentrate produced, by district

	Southeastern Missouri	
	1959	1960
Concentrate production:		
Lead, short tons	146,765	155,781
Zinc, do	206	5,602
Concentrate obtained from:		
Lead, percent	2.63	2.64
Zinc, do	0.004	0.094
Metal content of ore:[1]		
Lead, do	1.89	1.90
Zinc, do	0.002	0.05
Average lead content of galena concentrate, do	73.12	73.33
Average zinc content of sphalerite concentrate, do	49.51	55.94
Average value per ton:		
Galena concentrate	$147.84	$148.31
Sphalerite concentrate	$56.68	$79.61
Total material milled, short tons	5,573,517	5,897,813

[1] Figures represent metal content of crude ore only as recovered in the concentrate; data on tailing losses not available.

TABLE 16.—Mine production of silver, copper, lead, and zinc in 1960 by months, in terms of recoverable metals

Month	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
January	14,559	117	8,724	51
February	159	125	9,481	44
March	80	106	10,822	----
April	79	107	9,392	144
May	80	84	9,189	102
June	159	107	9,429	37
July	159	83	8,084	512
August	159	98	9,793	668
September	160	105	9,047	557
October	----	51	9,329	235
November	----	52	9,328	234
December	----	52	9,330	237
Total:				
1960	15,594	1,087	111,948	2,821
1959	339,760	1,065	105,165	92

TABLE 17.—Quoted prices of 60-percent zinc concentrate and 80-percent lead concentrate at Joplin, Mo., in 1960

Zinc concentrate		Lead concentrate	
Period	Price per short ton	Period	Price per short ton
Jan. 1–Jan. 7	$76.00	Jan. 1–Nov. 7	$141.72
Jan. 8–Dec. 12	80.00	Nov. 8–Dec. 18	139.56
Dec. 13–Dec. 18	76.00	Dec. 19–Dec. 31	125.16
Dec. 19–Dec. 31	72.00		

Source: E&MJ Metal and Mineral Markets.

Silver.—Silver recovery decreased substantially because of less demand for desilverized lead. As a result, only pig lead was produced at the Herculaneum smelter of St. Joseph Lead Co. Lead and lead-copper ores in Madison and St. Francois Counties contain silver.

Silicon.—Monsanto Chemical Co. began producing ultrapure silicon metal for electronics use at its plant near St. Charles in St. Charles County.

Zinc.—Production of recoverable zinc increased after declining for 7 consecutive years. Output was reported from St. Francois and Washington Counties. The price of Prime Western slab zinc was 12½ cents per pound (East St. Louis) on January 1, rose to 13 cents January 8, dropped to 12½ cents December 13, and was 12 cents from December 19 to yearend.

No zinc was produced in the Southwestern Missouri part of the Tri-State district for the third consecutive year. (Details of Tri-State activity are given in the Oklahoma chapter.)

MINERAL FUELS

Coal.—Bituminous coal was mined in 15 counties; more than 1,000 tons each was reported from 33 mines. Ten underground mines in five counties supplied 3 percent of the State total coal tonnage and 5 percent of total value. All underground production was cut by ma-

chines; 81 percent was power drilled. Strip-mine production, reported from 23 mines in 12 counties, supplied 97 percent of total tonnage and 96 percent of total value. Overburden excavated in 1960, totaling nearly 46 million cubic yards, averaged 17 cubic yards for each ton of coal strip mined. At 8 mines, 66 percent of total coal tonnage was mechanically cleaned, and at 10 mines over 37 percent of total tonnage was crushed. Seven percent of the coal at six mines was oil treated.

TABLE 18.—Coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	2,873	$11,620	1958	2,592	$11,111
1956	3,283	13,223	1959	2,748	11,937
1957	2,976	12,691	1960	2,890	12,450

Petroleum.—Crude petroleum was recovered near St. Louis and near Tarkio in Atchison County. Quantity and value approximated that for 1959. Continental Oil Co. began work on a petroleum terminal at Bethany in July. The terminal, which will have a capacity of 70,000 barrels of gasoline and fuel oil, will be owned jointly by Continental, D–X Sunray Oil Co., and Skelly Oil Co. The plant will have four storage tanks for two grades of gasoline and two grades of fuel oil, and truck loading facilities. Petroleum products will come from Oklahoma. The strike at the Sugar Creek refinery of Standard Oil Co. (Ind.) at Kansas City involving more than 700 workers, that began in July 1959, ended in March.

REVIEW BY COUNTIES

Mineral production was reported in 105 of the 114 counties; 21 counties reported production valued at $1 million or more. Five counties—St. Louis, St. Francois, Ste. Genevieve, Cape Girardeau, and Jackson—contributed 58 percent of the total mineral-production value. No output was reported in Carroll, Chariton, Holt, Mississippi, New Madrid, Schuyler, Scotland, Scott, and Webster Counties.

Adair.—Coal was mined underground by Billy Creek Coal Co., Inc., and Blacksmith Coal Co., Inc. Bailey Limestone Co., Inc., crushed limestone for concrete aggregate, roadstone, and agricultural stone.

Andrew.—George W. Kerford Quarry Co. and the U.S. Army Corps of Engineers quarried and crushed limestone for riprap for the banks of the Missouri River.

Atchison.—Petroleum was recovered near Tarkio.

Audrain.—Audrain County, second in clay production for the sixth consecutive year, reported output of fire clay for refractories. Fire clay was mined by Kaiser Refractories & Chemicals Division, Kaiser Aluminum & Chemical Corp.; A. P. Green Fire Brick Co.; Walsh Refractories Corp.; Harbison-Walker Refractories Co.; North American Refractories Co.; and Wellsville Fire Brick Co. Limestone was quarried and crushed for concrete aggregate, roadstone, and agricultural stone by Molino Lime Co.

TABLE 19.—Value of mineral production in Missouri, by counties [1]

County	1959	1960	Minerals produced in 1960 in order of value
Adair	$293,787	$296,951	Coal, stone.
Andrew	14,123	95,708	Stone.
Atchison	(2)	(2)	Petroleum.
Audrain	1,056,524	1,167,180	Clays, stone.
Barry	(2)	31,000	Stone.
Barton	(2)	(2)	Coal, asphaltic sandstone, stone.
Bates	127,788	172,009	Stone, coal, sand and gravel.
Benton	14,728	(2)	Stone, sand and gravel.
Bollinger	(2)	(2)	Sand and gravel.
Boone	840,944	710,459	Stone, clays, sand and gravel.
Buchanan	323,516	375,160	Sand and gravel, stone.
Butler	22,825	92,084	Sand and gravel, clays.
Caldwell	318,239	297,673	Stone.
Callaway	2,001,267	1,980,431	Coal, clays, stone, sand and gravel.
Camden	(2)	(2)	Sand and gravel.
Cape Girardeau	12,256,145	11,676,509	Cement, stone, sand and gravel, clays.
Carter	(2)	(2)	Iron ore, sand and gravel.
Cass	370,789	383,470	Stone, clays.
Cedar	(2)	(2)	Stone.
Christian	13,600	(2)	Stone, sand and gravel.
Clark	358,066	413,180	Stone, coal.
Clay	1,265,759	2,036,751	Stone.
Clinton	133,929	180,848	Do.
Cole	243,268	270,219	Sand and gravel, stone.
Cooper	275,185	584,076	Stone, sand and gravel.
Crawford	135,795	1,249,488	Lead, clays, sand and gravel.
Dade	211,000	187,760	Stone, coal.
Dallas	(2)	(2)	Sand and gravel.
Daviess	(2)	(2)	Stone, sand and gravel.
De Kalb	132,748	144,190	Stone.
Dent	(2)	(2)	Sand and gravel.
Douglas	158,480	65,125	Do.
Dunklin	(2)	(2)	Do.
Franklin	1,058,340	1,150,347	Sand and gravel, stone, clays.
Gasconade	2,116,023	2,347,439	Clays, stone.
Gentry	(2)	(2)	Stone, sand and gravel.
Greene	3,072,660	2,636,417	Lime, stone, sand and gravel.
Grundy	(2)	(2)	Stone.
Harrison	298,554	359,119	Stone, coal.
Henry	5,438,233	6,346,958	Coal, stone.
Hickory	(2)	(2)	Stone, sand and gravel.
Howard	199,237	229,558	Do.
Howell	361,917	326,606	Iron ore.
Iron	322,781	277,944	Stone.
Jackson	11,126,180	11,328,133	Cement, stone, sand and gravel, clays.
Jasper	2,240,098	2,300,882	Stone, sand and gravel.
Jefferson	1,772,827	1,532,955	Sand and gravel, stone, barite.
Johnson	307,524	147,768	Stone.
Knox	(2)	(2)	Do.
Laclede	(2)	(2)	Sand and gravel, stone.
Lafayette	496,413	356,561	Sand and gravel, stone, coal.
Lawrence	10,400	5,500	Stone.
Lewis	(2)	(2)	Sand and gravel, stone.
Lincoln	124,888	85,945	Stone, sand and gravel, clays.
Linn	(2)	(2)	Stone, coal.
Livingston	305,791	399,978	Stone, sand and gravel, clays.
Macon	(2)	(2)	Stone.
Madison	3,754,418	4,152,337	Lead, cobalt, nickel, copper, stone, silver.
Maries	466,407	277,778	Clays, stone.
Marion	(2)	(2)	Stone, lime.
McDonald	(2)	(2)	Sand and gravel.
Mercer	(2)	(2)	Stone.
Miller	68,240	103,371	Stone, sand and gravel.
Moniteau	61,000	73,263	Do.
Monroe	256,403	343,616	Clays, stone, sand and gravel.
Montgomery	689,013	766,958	Do.
Morgan	40,928	28,686	Sand and gravel, stone.
Newton	434,280	425,316	Lime, stone.
Nodaway	168,532	197,221	Stone, sand and gravel.
Oregon	183,587	195,726	Iron ore, stone, sand and gravel.
Osage	270,185	408,571	Clays, sand and gravel.
Ozark	(2)	(2)	Sand and gravel.
Pemiscot	327,667	190,000	Do.
Perry	(2)	133,352	Sand and gravel, stone.
Pettis	(2)	(2)	Stone, sand and gravel.
Phelps	213,352	328,883	Clays, stone, sand and gravel.
Pike	454,091	311,571	Stone, sand and gravel.
Platte	202,801	504,620	Stone, clays.
Polk	18,350	(2)	Stone, sand and gravel.
Pulaski	62,015	(2)	Sand and gravel.

See footnotes at end of table.

TABLE 19.—Value of mineral production in Missouri, by counties [1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Putnam	$433,319	(2)	Coal.
Ralls	6,949,143	$5,764,215	Cement, stone, coal, sand and gravel.
Randolph	2,880,130	3,005,100	Coal, stone.
Ray	328,609	(2)	Stone.
Reynolds	(2)	(2)	Sand and gravel.
Ripley	54,377	45,261	Sand and gravel, iron ore.
St. Charles	1,124,759	1,170,713	Stone, sand and gravel.
St. Clair	1,311,591	(2)	Coal, stone, sand and gravel.
St. Francois	25,461,065	25,823,104	Lead, iron ore, lime, stone, zinc, copper.
Ste. Genevieve	13,411,804	12,900,372	Lime, stone, sand and gravel.
St. Louis	30,712,897	29,052,925	Cement, sand and gravel, stone, clays, petroleum.
Saline	487,987	484,450	Stone.
Schuyler	50,000	----------	
Scott	(2)	----------	
Shannon	533,500	393,428	Iron ore, stone, sand and gravel.
Shelby	(2)	(2)	Stone.
Stoddard	202,474	226,700	Sand and gravel.
Stone	(2)	(2)	Stone, sand and gravel.
Sullivan	(2)	(2)	Stone.
Taney	(2)	(2)	Do.
Texas	150,879	39,507	Stone, sand and gravel.
Vernon	450,966	277,691	Coal, stone, sand and gravel.
Warren	353,172	298,934	Clays, stone, sand and gravel.
Washington	7,299,826	6,171,183	Lead, barite, zinc, sand and gravel.
Wayne	370,199	82,238	Stone, sand and gravel, iron ore.
Worth	(2)	(2)	Stone.
Wright	116,575	63,633	Do.
Undistributed	7,345,596	9,549,972	
Total	[3] 157,189,000	156,033,000	

[1] Counties not listed because no production was reported in 1959 or 1960: Carroll, Chariton, Holt, Mississippi, New Madrid, Scotland, and Webster.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.

Barton.—Clemens Coal Co. and Jones Coal Co. strip mined coal. Bar-Co Roc, Inc., produced asphaltic sandstone for use on roads. Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by John J. Stark.

Bates.—Limestone was quarried and crushed for concrete aggregate, roadstone, agricultural stone, and riprap by Alvis Limestone & Concrete Products, Inc., and Frank Underwood. Coal was strip mined by Mullies Coal Co. Building gravel was produced by Clyde S. Miller.

Benton.—Trager Quarries, Inc., produced crushed limestone for concrete aggregate and roadstone. J. C. Orender obtained gravel for paving from deposits in the county. Missouri State Highway Department contracted for paving gravel.

Boone.—Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Adrian Materials Co., N. R. Garrett, Boone Quarries, Inc., Central Stone Co., and U.S. Army Corps of Engineers. Sand and gravel was produced by Columbia Sand & Towing Co. and Columbia Special Road District. Columbia Brick & Tile Co. mined shale and fire clay for heavy clay products.

Buchanan.—Pioneer Sand Co. produced building, paving, and railroad ballast sand. Limestone was quarried and crushed for concrete aggregate, roadstone, agricultural stone, and riprap by Everett Quarries, Inc., L. S. Stafford, and U.S. Army Corps of Engineers.

Butler.—Kittredge Sand & Gravel Co., Grobe & Sons, and the Missouri State Highway Department obtained sand and gravel for build-

ing, paving, and other uses. Clay for pottery was mined by Ozark Development Co.

Caldwell.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Farmers Rock & Lime Co., Everett Quarries, Inc., and Kingston Stone Co.

Callaway.—The county ranked third in clay output and fourth in coal production. Producers of fire clay for use in refractories included Harbison-Walker Refractories Co., Walsh Refractories Corp., Clayton & Crawson, Kaiser Refractories & Chemicals Division, Kaiser Aluminum & Chemical Corp., A. P. Green Fire Brick Co., and Refractories Division, H. K. Porter Co., Inc. Mariott-Reed Coal Co. strip mined coal. Limestone was quarried and crushed by Auxvasse Stone & Gravel Co., Callaway Rock Quarry, and Sulgrove Mining & Quarry Co. for concrete aggregate, roadstone, agstone, riprap, and railroad ballast. Missouri State Highway Department contracted for paving gravel.

Cape Girardeau.—Cape Girardeau County ranked fourth in value of mineral production and sixth in stone production. Marquette Cement Manufacturing Co. quarried limestone and clay for portland and masonry cements. During the year improved river-barge cement-loading facilities were completed. The Federal Materials Co., Inc., Farmers Limestone Co., and Jackson Limestone Quarry produced crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Cape Girardeau Sand Co. produced building sand and Eddie Erlbacher Materials Co. produced paving gravel. Kasten Clay Products, Inc., and Ceramo Co., Inc., mined common red clay for brick, pottery, and stoneware.

Carter.—Brown iron ore was shipped from Carter County to steel mills in Alabama. Missouri State Highway Department obtained paving gravel from local deposits.

Cass.—Hackler & Limpus Quarry, Emmet Brosnahan Rock Co., Marino & Hoover Crushed Rock Co., Deitz Hill Development Co., and S & W Quarries quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Miscellaneous clay for brick and tile was mined by United Brick & Tile Co.

Cedar.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Alvis Limestone & Concrete Products, Inc., and Freeto Construction Co.

Christian.—Joe Howard quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Missouri State Highway Department contracted for paving gravel.

Clark.—Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Baker Quarry Co. and Brooks Quarry, Inc. Coal was strip mined by Hamlin Bros. Coal Co.

Clay.—The county ranked fourth in value of stone production. Limestone was crushed mainly for concrete aggregate, roadstone, and riprap. Producers included Kansas City Quarries Co., Midwest Precote Co., J. H. Oldham Stone Co., Everett Quarries, Inc., and the Clay County Highway Department.

Clinton.—Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Everett Quarries, Inc.

Cole.—Sand and gravel, mined near the Osage and Missouri Rivers, was used mainly for building and paving. Producers included Leonard Barnhart, Jefferson City Sand Co., Elam Construction Co., Inc., and the Cole County Highway Department. Crushed limestone for use as riprap was produced by the U.S. Army Corps of Engineers.

Cooper.—Hall & Riley Quarries & Construction Co., W. J. Menefee Construction Co., Castle Bros. Quarry Co., and the U.S. Army Corps of Engineers quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Sand and gravel for building and paving was obtained by Missouri River Sand & Gravel Co.

Crawford.—The first lead ore was mined from Shaft No. 27 of the Viburnum operation of St. Joseph Lead Co. and milled in Iron County. A. P. Green Fire Brick Co., Dillon Bros., Walsh Refractories Corp., and Refractories Division, H. K. Porter Co., Inc., mined fire clay for refractories. Missouri State Highway Department contracted for paving gravel.

Dade.—Lockwood Rock Poducts quarried and crushed limestone for concrete aggregate and roadstone. Tyler & Claypool Coal Co. strip mined coal in the county.

Daviess.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Snyder Quarries. Sand for building use was obtained by Bethany Falls Transit Mixed Concrete Co.

De Kalb.—Limestone for concrete aggregate, roadstone, agstone, and riprap was produced by Everett Quarries, Inc.

Douglas.—Paving gravel was obtained from local deposits by Welton & Gray Gravel Co. Missouri State Highway Department obtained gravel for paving.

Franklin.—Franklin County ranked fourth in value of sand and gravel produced. Sand and gravel, used mainly for building and paving, was produced by Pacific Pebbles, Inc., St. Louis Material & Supply Co., Meramec Aggregates, Inc., Washington Sand Co., Clifford Dewert, and the Missouri State Highway Department. A small quantity was used for grinding and polishing. Crushed limestone and dolomite were produced for concrete aggregate, roadstone, agstone, and riprap by George P. Dawson, Inc., Oliver L. Taetz Co., Inc., J. E. McKeever, Edwin Bebermeyer, Tourville Limestone Quarry, and Porter Dewitt. Fire clay for refractories was mined by Kaiser Refractories & Chemicals Division, Kaiser Aluminum & Chemical Corp., Thacher & Hoer Mining Co., and Refractories Division, H. K. Porter Co., Inc.

Gasconade.—Gasconade County continued to lead in clay output. Eight refractories manufacturers used burley, flint, and diaspore fire clays. General Chemical Division of Allied Chemical Corp. mined fire clay for chemical uses. Limestone was quarried and crushed by Oliver L. Taetz Co., Inc., for concrete aggregate and roadstone.

Gentry.—Albany Gravel Co., Inc., crushed limestone for concrete aggregate, roadstone, and agstone and produced gravel for paving.

Greene.—Greene County ranked third in value of lime production and seventh in value of stone production. Ash Grove Lime & Portland Cement Co. quarried limestone at its Galloway and Springfield quarries for use in making lime and for concrete aggregate, roadstone, and soil conditioner. Other limestone producers included

Griesemer Stone Co., Graystone Quarry Co., and Concrete Co. of Springfield. Carthage Marble Co. prepared dimension marble at its quarry. Sand and gravel was obtained for paving by G. B. Mason and Fair Grove Sand Co.

Grundy.—Jay Wilcox Limestone Quarry Co., E. E. Trenary, and Trager Quarries, Inc., quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap.

Harrison.—L. W. Hayes, Inc., and Davis-Snyder Quarries, Inc., crushed limestone for concrete aggregate, roadstone, and agstone. Coal was mined underground in Harrison County by New Black Diamond Coal Co. Construction was started on a petroleum terminal at Bethany, to be owned jointly by Continental Oil Co., D–X Sunray Oil Co., and Skelly Oil Co. The terminal will have a capacity of 70,000 barrels of gasoline and fuel oil with four storage tanks, two for gasoline and two for fuel oil.

Henry.—Henry County continued to lead in coal production; six strip mines produced over 1,000 tons each. Producers included Peabody Coal Co., Redding Coal Co., Bud Jones Coal Co., Madole Bros. Coal Co., and W. & W. Coal Co. Williams Rock Co., Inc., Davis Rock Co., and O. A. Knisely quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Howard.—Glasgow Quarries and the U.S. Army Corps of Engineers produced crushed limestone for concrete aggregate, riprap, and agstone. Sand for paving uses was produced by Glasgow Sand Co.

Howell.—Howell County ranked third in iron-ore production. Shook & Fletcher Supply Co., Howard Construction Co., Four Mining Co., Lane & Essex, and Riggs & Morrison mined brown iron ore.

Iron.—Crushed granite for riprap and dimension granite for building and monumental purposes were produced by Heyward Granite Co. Dolomite was quarried for agstone by Duncan Bros., Inc. The Viburnum lead mill of St. Joseph Lead Co. began operating during the year at 3,000-tons-per-day capacity. Development of Shaft No. 28 at the millsite continued.

Jackson.—Jackson County ranked second in value of stone production, third in cement and sand and gravel, and fifth in total minerals. Limestone was crushed at 10 quarries for concrete aggregate, roadstone, riprap, and agstone. Leading producers were Beyer Crushed Rock Co., Union Quarries, Union Construction Co., Stewart Sand & Material Co., and Kansas City Quarries Co. Dimension limestone was produced by Gerald Hodgins Quarry, Charles Rove Rock Quarry, and George & Clark Stone Contractors. Limestone and shale for manufacturing portland and masonry cements were quarried near Independence by Missouri Portland Cement Co. Kansas City Quarries Co. and Stewart Sand & Material Co. produced sand and gravel mainly for building and paving purposes. United Brick & Tile Co. mined miscellaneous clay for heavy clay products. The Zonolite Co. plant in Jackson County exfoliated vermiculite from Montana. Standard Oil Co. (Ind.) produced heptene concentrate and sodium cresylate at its petrochemical plant at Sugar Creek, using petroleum fractions as raw material.

Jasper.—The county ranked fifth in value of stone and seventh in value of sand and gravel production. Carthage Marble Corp. quarried marble for use as rough building stone, dressed building stone, and dressed monumental stone; the company also produced crushed stone. Crushed limestone was produced by Independent Gravel Co., Carthage Crushed Limestone Co., and Freeto Construction Co. for concrete aggregate, roadstone, agstone, and other purposes. Miscellaneous stone (chats) was produced by American Zinc, Lead and Smelting Co. and Independent Gravel Co. Blast sand, grinding and polishing sand, building and paving gravel, and railroad ballast gravel were produced by Independent Gravel Co. Solar Nitrogen Chemicals, Inc., began constructing a $15 million plant to manufacture anhydrous ammonia, urea, and related products, adjacent to the explosives plant of Atlas Powder Co. near Joplin. Solar was a joint subsidiary of Atlas Powder Co. and Standard Oil Co. (Ohio).

Jefferson.—Jefferson County continued to rank second in value of sand and gravel produced. High-purity silica sand, used in plate glass and for molding, grinding, and polishing, was produced by Pittsburgh Plate Glass Co., Aubuchon Silica Mining Division of Portage-Manley Sand Co., and Masters Bros. Silica Sand Co. Building sand and gravel was produced by Monarch Building Materials Corp. and Ficken Material Co. Jefferson County Highway Department contracted for paving gravel. Marble Products Co. of Georgia crushed stone for use as an aggregate in terrazzo. Paul H. Guidicy produced crushed and dimension limestone. Leading producers of crushed limestone were Bussen Quarries, Inc., Vigus Quarries, Inc., Kitson Bros. Quarry, and Henry Trautman. Crude barite was mined by Postlewait Mining Co. Ammonia, ammonium nitrate, nitric acid, and ammonia solutions were manufactured by Armour Agricultural Chemical Co., Nitrogen Division, at its Crystal City plant. Dow Chemical Co. produced polystyrene and styrofoam at its Pevely plant, using styrene as raw material. Mallinckrodt Nuclear Corp. operated its nuclear fuel production center at Hematite.

Knox.—Knox County Stone Co., Inc., and McSorley Lime & Rock Co., Inc., quarried and crushed limestone for concrete aggregate, roadstone, riprap, agstone, and other uses.

Lafayette.—Sand for building and paving was obtained by Glasgow Sand Co. and Raymond Drivers Sand Co. Red Stone Co. and Deitz Hill Development Co. quarried and crushed limestone for concrete aggregate, roadstone, and riprap. Coal was mined underground by F. W. Goodloe Coal Co., Earl Ashford Coal Co., and Jones Coal Co.

Lewis.—Lewis County ranked sixth in value of sand and gravel production. Missouri Gravel Co. produced paving sand and gravel near LaGrange. Missouri Gravel Co. and Hamill Lime Co. produced crushed limestone for concrete aggregate, roadstone, agstone, and railroad ballast.

Lincoln.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Watson Quarry and Gessman Quarry. Missouri State Highway Department contracted for paving gravel. Lee Roberts produced fill sand and gravel and paving gravel. Fire clay for refractories was mined by Harbison-Walker Refractories Co.

Linn.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Bailey Limestone Co. Sayre Coal Co. strip mined coal.

Livingston.—Cooper Contracting Co., Farmers Rock & Lime, Inc., Trager Quarries, Inc., and Fred McVey Quarry quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Cooley Gravel Co. produced building, paving, railroad ballast, and fill sand. Sampsel Gravel Co. produced paving gravel. Midland Brick & Tile Co. mined miscellaneous clay for use in brick and tile.

Madison.—Ores containing lead, copper, silver, cobalt, nickel, and iron were mined at the Madison mine of National Lead Co. near Fredericktown. At the refinery near Fredericktown, cobalt and nickel were recovered from iron rejects of the lead-copper circuit of the Madison mill. Marble Products Co. of Georgia crushed stone for use as an aggregate in terrazzo.

Maries.—Maries County ranked eighth in value of clay production. Refractories Division, H. K. Porter Co., Inc., A. P. Green Fire Brick Co., and Harbison-Walker Refractories Co., mined diaspore, burley, and fire clays for refractories. Crushed limestone for concrete aggregate, roadstone, and agstone was produced by Smith Quarries.

Marion.—Marblehead Lime Co. quarried limestone near Hannibal for quicklime and hydrated lime; limestone also was produced for use as asphalt filler and mineral food. S. D. Fessenden & Sons crushed limestone for agricultural purposes.

Mercer.—Twin State Quarries, Inc., and Wilcox Quarries quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap.

Miller.—Eldon Quarry Co. crushed limestone for concrete aggregate, roadstone, and agstone. Gravel was obtained from local deposits by C. W. Roweth Co. and the Missouri State Highway Department.

Moniteau.—Limestone was quarried and crushed by Moniteau County Agricultural Association, Inc., for concrete aggregate, roadstone, and agstone. U.S. Army Corps of Engineers obtained crushed limestone for riprap. Missouri State Highway Department contracted for paving gravel.

Monroe.—Gilliam Mining Co., Bethlehem Co., and Fluetsch Bros. mined fire clay for use in horizontal zinc retorts and condensers. Fire clay for refractories was mined by Walsh Refractories Corp. Hamilton Lime Co., Central Stone Co., and Wilkerson Bros. quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Gravel was obtained locally by Wilkerson Bros. and the Missouri State Highway Department.

Montgomery.—Montgomery County ranked fourth in value of clay production. Fire clay for refractories was mined by six companies. McClain Lime Quarry crushed limestone for concrete aggregate, roadstone, and agstone. Two Rivers Sand & Gravel Co. produced sand and gravel mainly for paving.

Newton.—Quicklime and hydrated lime were manufactured by The Southwest Lime Co. using limestone quarried locally; limestone was sold for concrete aggregate, roadstone, agstone, and riprap. American Tripoli Division of The Carborundum Co. processed tripoli for

polishing and buffing compounds at its Seneca plant from crude material mined in Ottawa County, Okla.

Nodaway.—Dillon Stone Co. quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Earl Wilson Sand Co. dredged sand and gravel mainly for building and paving purposes.

Oregon.—Oregon County ranked fourth in value of iron-ore output. Miller & Reynolds, Plateau Iron Ore Corp., and Midwest Mining Co. mined brown iron ore from open pits. Limestone was quarried and crushed for use as soil conditioner by O. O. Mainprize. Missouri State Highway Department obtained paving gravel locally.

Osage.—The county ranked sixth in value of clays produced. Fire, diaspore, and burley clays were mined for use in manufacturing refractories. Producers included A. P. Green Fire Brick Co., North American Refractories Co., Kaiser Refractories & Chemicals Division, Kaiser Aluminum & Chemical Corp., and Walsh Refractories Corp. Paving gravel was obtained by Osage County Highway Department and Missouri State Highway Department.

Perry.—Gibbar Bros. crushed limestone for concrete aggregate, roadstone, and agstone, and produced gravel for building purposes.

Pettis.—Howard Construction Co. and W. J. Menefee Construction Co. quarried and crushed limestone for concrete aggregate and roadstone. Missouri State Highway Department contracted for paving gravel.

Phelps.—A. P. Green Fire Brick Co., Dillon Bros., and Refractories Division, H. K. Porter Co., Inc., mined fire clay for refractories. Bray Construction Co. and Jessie Nivens quarried and crushed limestone for concrete aggregate, roadstone and agstone. Sand and gravel for building and paving was produced by Grisham Sand & Gravel Co.

Pike.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Hamill Lime Co., Magnesium Mining Co., and Galloway Limestone Co. Sand and gravel for building and paving was obtained by Goodman Sand and Gravel Co. and Missouri State Highway Department. Hercules Powder Co. manufactured ammonia, methanol, formaldehyde, and pentaerythritol from natural gas at its petrochemical plant near Louisiana.

Platte.—Everett Quarries, Inc., Midwest PreCote Co., Bowen Construction Co., and U.S. Army Corps of Engineers quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Carter-Waters Corp. mined shale for manufacturing lightweight aggregate.

Polk.—Limestone was quarried and crushed for concrete aggregate and roadstone by W. J. Menefee Construction Co. Butcher Gravel Co. produced building and paving gravel near Humansville. Missouri State Highway Department contracted for paving gravel.

Pulaski.—J. H. Walser Construction Co. and Big Piney Sand Co. produced building and paving sand and gravel. Missouri State Highway Department contracted for paving gravel.

Putnam.—Coal was mined underground by Clark Coal Co. and strip mined by Kirkville Coal Co. and Husted Bros. Coal Co.

Ralls.—Ralls County ranked fourth in value of cement production. Universal Atlas Cement Co. produced portland and masonry cements at its plant near Ilasco. Limestone and shale for cement were ob-

tained near the plant. Central Stone Co. quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Coal was strip mined by Couch Coal Co. and Clarence D. Day. Paving gravel was obtained locally by Edward B. Cooper.

Randolph.—Randolph County ranked second in value of coal output. Coal was mined underground by D. L. Bradley Coal Co., Fately Coal Co., and Nejedly Coal Co. Peabody Coal Co. and Amidei Quarry & Mining Co. strip mined coal. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by N. J. Cooksey Co. and Potter Stone Co.

Ray.—Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Steva Stone Co. and Orrick Stone Co.

Ripley.—Building and paving sand and gravel were produced by Wright Gravel Co. Ripley County Mining Co. mined brown iron ore.

St. Charles.—St. Charles County ranked fifth in value of sand and gravel production. Tavern Rock Sand Co. produced glass, molding, engine, and other industrial sands. Missouri State Highway Department contracted for paving gravel. St. Charles Quarry Co., O'Fallon Quarry & Supply Co., Joerling Bros. Quarry, and Schiermeier Limestone Co. quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. Monsanto Chemical Co. began producing ultrapure silicon metal for electronic uses at its plant near St. Charles.

St. Clair.—St. Clair County ranked third in value of coal production. Coal was strip mined by Pittsburg & Midway Coal Mining Co. and Osage Coal Co. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Hunt Limestone Co. Missouri State Highway Department contracted for paving gravel.

St. Francois.—St. Francois County led in value of lead, iron ore, and zinc and ranked second in value of copper, lime, and total mineral production. At Iron Mountain, Midwest Ore Co. (formerly Ozark Ore Co.) mined hematite iron ore. St. Joseph Lead Co. mined and milled lead ore that yielded copper and zinc as byproducts. Valley Dolomite Corp. produced dead-burned dolomite for refractory uses; crushed dolomite was used as refractory material, fertilizer filler, concrete aggregate, roadstone, and agstone. St. Joseph Lead Co. produced crushed dolomite for agricultural and fluxing purposes. Chats from lead and iron ore milling was used mainly for concrete aggregate and roadstone; producers included St. Joseph Lead Co. and Trap Rock Material & Engineering Co.

Ste. Genevieve.—The county led in lime production and ranked third in stone output and total mineral production. Limestone, quarried and crushed by Mississippi Lime Co., was used to produce quicklime and hydrated lime at a plant near Ste. Genevieve. Lime was used for chemical, industrial, and building purposes. The company also sold limestone for glass, whiting, asphalt filler, poultry grit, coal mine rock dust, and various other purposes. Crushed limestone also was produced by Cliffdale Quarry & Manufacturing Co. and Ste. Genevieve Building Stone Co. Dimension limestone was produced by Ste. Genevieve Building Stone Co. Dimension marble was produced by Weiler Marble Co., Inc., and Tennessee Marble Co. Bauman Bros. obtained sand and gravel for building and paving.

St. Louis.—St. Louis County led in cement, sand and gravel, and stone production and total mineral production value. Portland and masonry cements were manufactured at Prospect Hill by Missouri Portland Cement Co. and at Lemay by Alpha Portland Cement Co. West Lake Quarry & Material Co. produced crushed and dimension limestone. Producers of crushed limestone included Vigus Quarries, Inc., Rock Hill Quarries Co., Riverview Stone & Material Co., Bussen Quarries, Inc., George A. Janssen, Inc., and Frank Ruprecht & Sons Quarry & Material Co. Stone was crushed for concrete aggregate, roadstone, riprap, and agricultural purposes. Sand and gravel for construction purposes, unground industrial sands, and ground sands were produced. Leading producers, by value, were Winter Bros. Material Co., Inc., Pioneer Silica Products Co., Missouri Aggregates, Inc., Missouri Illinois Material Co., and Simpson Sand & Gravel Co. Shale and plastic fire clay were mined for heavy clay products and refractories. Hydraulic Press Brick Co. built additional facilities to produce a new line of shale and fire clay face brick. Titanium pigments were produced by the Titanium Division of National Lead Co. Monsanto Chemical Co. increased its capacity to produce maleic anhydride 50 percent, to 60 million pounds per year; calcium phosphate, bisphenol, and fumaric acid also were produced. Crude vermiculite from Western States was exfoliated by Zonolite Co. Perlite, expanded at a plant in St. Louis from crude perlite mined in Western States, was used mainly as a lightweight aggregate in building plaster. A small quantity of petroleum was recovered. Crude barite was ground by the DeLore Division of National Lead Co.

Saline.—Hall & Riley Quarries, Howard Construction Co., Gilliam Rock, Inc., and Scott Quarries quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Shannon.—Shannon County ranked second in iron ore production. Brown iron ore was mined by Shook & Fletcher Supply Co. and Ozark Mining Corp. Ozark Stone Products Co. and Salem Stone Co. produced dimension sandstone. Limestone was quarried and crushed by Crider Bros. Lime Co. for use as soil conditioner. Missouri State Highway Department obtained paving gravel from local deposits.

Shelby.—Central Stone Co. and Turner Lime & Rock Quarry quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Stoddard.—Sand and gravel for building and paving was produced by Hill & Stuart, Inc., Brown Sand & Gravel Co., Inc., and Warren Gravel Co.

Stone.—Gillioz Co., Inc., quarried and crushed limestone for concrete aggregate and roadstone. Missouri State Highway Department contracted for paving gravel.

Sullivan.—Limestone was quarried and crushed by Partin Lime & Rock Co. and Twin State Quarries, Inc., for concrete aggregate, roadstone, and agstone.

Taney.—Poulin & Son Rock & Lime Co. quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Texas.—Limestone was quarried and crushed for soil conditioner by Long Bros. and Earl Duke. Missouri State Highway Department obtained paving gravel.

Vernon.—Coal was strip mined by M. L. Schooley Coal & Construction Co. and Ellis Coal Co. Trager Quarries Inc., Jones Coal & Rock Co., and Alvis Limestone & Concrete Products Co. quarried and crushed limestone for concrete aggregate and roadstone. Missouri Native Stone Co. produced dimension sandstone. Paving gravel for road maintenance was produced by Blue Mound Township and Osage Township.

Warren.—Walsh Refractories Corp. and Harbison-Walker Refractories Co. mined fire clay for refractories. Limestone was quarried and crushed for concrete aggregate, roadstone, and agstone by Sprick Quarry. Gravel for paving was obtained by Missouri State Highway Department and Warren County Department of Roads.

Washington.—The county ranked first in barite production and second in zinc and lead production. Barite production was reported from 13 operations by 10 companies. Leading producers were Milwhite Mud Sales Co., Magnet Cove Barium Corp., DeSoto Mining Co., Midwest Mining Co., and Hornsey Bros. Lead ore containing small quantities of zinc was mined and milled at the St. Joseph Lead Co. Indian Creek Plant. Lead also was recovered in mining and washing barite. Development of the Pea Ridge iron-ore deposit was continued by Meramec Mining Co. Building and paving sand and gravel and railroad ballast gravel were produced by Mount Sand & Gravel Co., Midwest Mining Co., and Missouri State Highway Department.

Wayne.—Brown iron ore was mined by various producers and shipped to steel mills. Harris Lime Co. quarried and crushed limestone for use as a soil conditioner. Building and paving sand and gravel was produced by Williamsville Stone Co. and Missouri State Highway Department.

The Mineral Industry of Montana

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

By Frank B. Fulkerson,[1] Gary A. Kingston,[1] and A. J. Kauffman, Jr.[2]

MINERAL production in Montana in 1960 increased $11.5 million (7 percent) over 1959 and reversed a 3-year decline in the annual value of output from mines, mills, quarries, and wells in the State. The 1960 value of $178.9 million was the third highest on record (exceeded only in 1956 and 1957). Production of copper gained over the preceding year after settlement in February of a 6-month strike at Butte mines. This was the main factor behind the increased State value for 1960. Quantity and value of marketable phosphate rock continued to advance to new highs. Output of several other commodities increased, including gold, silver, chromium, manganese, fluorspar, and natural gas. Declines were recorded for lead, zinc, cement, coal, and vermiculite.

Recovery of crude petroleum increased slightly; however, the total value of this product was $3.6 million less because the average value per barrel dropped from $2.56 to $2.41. More sand and gravel was produced than in 1959, but the value was less.

Crude petroleum, copper, and sand and gravel provided 80 percent of the State total value of mineral production.

Trends and Developments.—Two new phosphate rock mines were being developed. A mechanical planer devised by the Federal Bureau of Mines for underground phosphate mining was to be used at one of the mines with production scheduled to begin in 1961. Another development in the mineral industries was construction on a 190-mile petroleum pipeline from Glendive, Mont., to Minot, N. Dak. In 1961 a crude oil pipeline was to cross the State from the Cut Bank oilfield to the Wyoming State line south of Billings.

The Anaconda Company began an $11 million, 5-year program to bring high-grade copper ore reserves into production from deep levels. The company also planned a $6 million program for improving and enlarging the Anaconda Reduction Works.

Consumption, Trade, and Markets.—Immediate construction of the Libby Dam on the Kootenai River in northwestern Montana would be feasible under a basic agreement reached by the United States and

[1] Commodity-industry analyst, Bureau of Mines, Albany, Oreg.
[2] Chief, Albany Office of Mineral Resources, Bureau of Mines, Albany, Oreg.

TABLE 1.—Mineral production in Montana[1]

Mineral		1959		1960	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Chromium ore and concentrate[2]	short tons, gross weight	105,381	$3,765	106,716	$3,813
Clays[3]	thousand short tons	46	48	63	77
Coal (bituminous and lignite)	do	345	1,478	313	1,188
Copper (recoverable content of ores, etc.)	short tons	65,911	40,469	91,972	59,046
Fluorspar	do	18,542	(4)	31,273	(4)
Gold (recoverable content of ores, etc.)	troy ounces	28,551	999	45,922	1,607
Iron ore (usable)	thousand long tons, gross weight	50	254	55	293
Lead (recoverable content of ores, etc.)	short tons	7,672	1,765	4,879	1,142
Manganese ore and concentrate (35 percent or more Mn)	short tons, gross weight	21,604	1,520	29,036	1,996
Manganiferous ore and concentrate (5 to 35 percent Mn)	do	2,415	34	676	11
Natural gas	million cubic feet	30,743	2,306	33,418	2,373
Petroleum (crude)	thousand 42 gallon barrels	29,857	76,434	[5]30,240	[5]72,878
Sand and gravel	thousand short tons	10,930	12,587	12,589	11,657
Silver (recoverable content of ores, etc.)	thousand troy ounces	3,420	3,096	3,607	3,265
Stone	thousand short tons	1,186	1,691	1,183	1,576
Uranium ore	short tons	2,890	(4)	1,726	29
Zinc (recoverable content of ores, etc.)	do	27,848	6,405	12,551	3,238
Value of items that cannot be disclosed: Barite, cement, gem stones, gypsum, lime, mica, natural gas liquids, phosphate rock, pyrites (1959), talc, thorite concentrate (1959), tungsten (1960), vermiculite, and values indicated by footnote 4			15,248		15,217
Total Montana[6]			167,328		178,854

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes tonnage used for ferrochromium production; included with "Value of items that cannot be disclosed."
[3] Excludes fire clay and bentonite (1959); included with "Value of items that cannot be disclosed."
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Preliminary figure.
[6] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime; 1959 total revised.

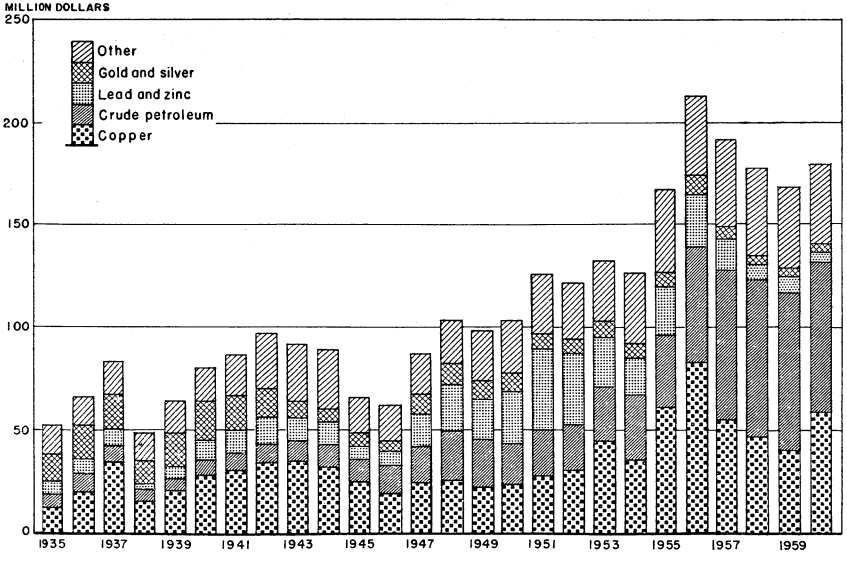

FIGURE 1.—Value of copper, crude petroleum, lead and zinc, gold and silver, and total value of mineral production in Montana, 1935–60.

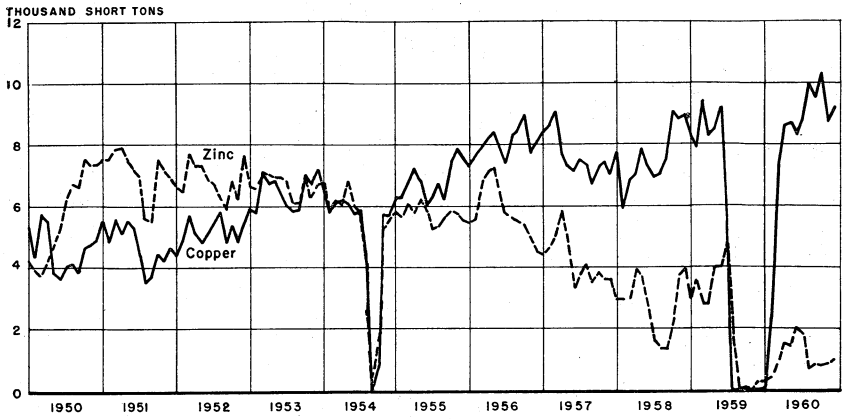

FIGURE 2.—Mine production of copper and zinc in Montana, 1950–60, by months, in terms of recoverable metals.

Canada. The agreement, if implemented by construction, would make possible the cooperative development of the upper Columbia River and its tributaries for power, flood control, and other benefits. The Libby Dam would form a reservoir extending across the boundary into Canada.

TABLE 2.—Indicators of Montana business activity

	1959	1960	Change, percent
Personal income:			
Total, million dollars	1,318.0	1,353.0	+3
Per capita, dollars	1,976.0	1,996.0	+1
Construction activity:			
Building permits, million dollars	36.3	33.6	−7
Heavy engineering awards, do	47.3	45.1	−5
Highway construction contracts awarded, do	20.6	30.9	+50
Cement shipments to and within Montana, thousand 376-pound barrels	1,425.0	1,078.0	−24
Cash receipts from farm marketings, million dollars	403.6	378.2	−6
Mineral production, do	167.3	179.1	+7
Annual average employment:			
Total nonagricultural industries, thousands	165.1	166.7	+1
Total manufacturing, do	19.9	20.2	+2
Lumber and timber products, do	7.5	7.2	−4
Metal mining and primary metal industries, do	7.7	8.2	+6
Contract construction, do	11.6	11.4	−2
Transportation and utilities, do	19.4	19.0	−2

Sources: Survey of Current Business, Construction Review, Pacific Builder & Engineer, Montana Highway Commission, The Farm Income Situation, Montana Labor Market, and Bureau of Mines.

Total and per-capita personal income received by Montana residents increased in 1960; however, the gain was smaller than the national percentage increase because of declining income from many basic sectors of the State economy, including agriculture, mining, lumber and timber products, and transportation and utilities. Cash receipts from agriculture declined, where as in the Nation this income rose. Operating economies in the petroleum industry and closing of zinc mining owing to uncertain market conditions reduced wage and salary income from mining. Activity in the lumber industry dropped

as the result of decreased homebuilding in the Nation. Employment by interstate railroads, an important industry in the State, continued to drop owing to mechanization and curtailed passenger service among other factors.

Construction declined only slightly, judging from the 2-percent decline in employment in this industry; however, the market for cement decreased sharply, probably because some large military and public works projects were completed. Building permit valuation, covering construction in the larger towns and cities, decreased 7 percent compared with a 10-percent decline in the Nation in this category of construction.

The Montana Highway Commission awarded a total of $30.8 million in contracts, 50 percent more than in 1959. The 1960 contracts included work on 38.4 miles of interstate highway, 218 miles of primary road, 232 miles of secondary road, and 10,776 feet of structure.

Employment and Injuries.—Average employment in the mining industry declined from 7,800 to 7,300 owing to less employment in petroleum production, metal mine closures, and the effects of the 1959–60 strike. Butte, center of the metal-mining industry in the State, has had a substantial labor surplus since 1957.

TABLE 3.—Employment for selected mineral industries

Year	Total mining	Metal mining	Nonmetals, including coal	Petroleum and natural gas	Processing	
					Primary metals	Petroleum refining
1951-55 (average)	11,500	8,400	1,100	2,000	3,700	(1)
1956	12,400	8,700	900	2,800	4,600	1,200
1957	11,300	7,500	900	2,900	4,900	1,200
1958	8,700	5,300	700	2,700	4,200	1,000
1959	7,800	4,600	700	2,500	3,100	900
1960	7,300	4,500	700	2,100	3,700	1,000

[1] Data not available before 1953.

Source: Montana State Employment Service, Montana Labor Market. Excludes proprietors and self-employed. Industry groups may vary from those in Bureau of Mines canvass.

TABLE 4.—Hours and earnings data in mining and related industries

Industry	1956	1957	1958	1959	1960
Mining:					
Average weekly earnings	$102.77	$96.79	$97.42	$101.91	$103.74
Average weekly hours	41.7	38.9	39.6	40.6	39.9
Average hourly earnings	$2.47	$2.49	$2.46	$2.51	$2.60
Metal mining:					
Average weekly earnings	$103.41	$92.78	$93.56	(1)	$101.79
Average weekly hours	42.2	38.2	38.5	(1)	39.0
Average hourly earnings	$2.45	$2.43	$2.43	(1)	$2.61
Primary-metals processing:					
Average weekly earnings	$98.89	$90.55	$91.57	(1)	$96.53
Average weekly hours	44.1	39.9	39.3	(1)	39.4
Average hourly earnings	$2.24	$2.27	$2.33	(1)	$2.45

[1] Strike in metal-mining industry beginning Aug. 19, 1959, unsettled at yearend.

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 5.—Employers, wage earners, and wages in mining

Fiscal year	Average number of employers	Average number of wage earners	Wages (thousands)	Average annual wage
1951–55 (average)	500	10,975	$48,972	$4,461
1956	528	12,193	65,154	5,344
1957	526	12,021	65,017	5,409
1958	448	9,019	48,503	5,378
1959	416	8,722	46,017	5,276
1960	492	6,641	36,031	5,426

Source: Unemployment Compensation Commission of Montana, Montana Labor Market. Industries and employment covered under unemployment insurance laws of Montana.

TABLE 6.—Injuries in the mineral industries

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:						
Quarries and mills [1]	187	260	389,633			
Nonmetal mines and mills	743	269	1,598,291	1	31	20
Sand and gravel operations	356	144	411,247		15	36
Metal mines and mills	3,947	233	7,365,059	3	152	21
Coal mines	228	140	255,339		5	20
Total	5,461	229	10,019,569	4	203	21
1960: [2]						
Quarries and mills [1]	183	286	419,288		1	2
Nonmetal mines and mills	715	262	1,497,835		17	11
Sand and gravel operations	239	134	255,379		8	31
Metal mines and mills	3,403	257	7,003,739	3	89	13
Coal mines	161	155	200,036		8	40
Total	4,701	249	9,376,277	3	123	13

[1] Includes cement- and lime-processing plants.
[2] Preliminary figures.

Employment in smelting and refining increased but did not regain all the losses that occurred in 1959 when a strike reduced the annual average.

Injury statistics in table 6 were compiled from reports by mining companies to the Bureau of Mines.

Government Programs.—The Office of Minerals Exploration (OME) approved a project at the Northern Milling Co. Marietta lead-zinc mine, Broadwater County. Other active contracts under a program to encourage exploration for strategic mineral occurrences covered work at mines in Jefferson (lead, zinc, copper), Judith Basin (lead, zinc), and Powell Counties (lead, zinc).

TABLE 7.—Office of Minerals Exploration contracts active during 1960

County and contractor	Property	Commodity	Contract		
			Date	Total amount	Government participation, percent
Broadwater:					
Northern Milling Co	Marietta	Lead, zinc	Sept. 2, 1960	$102,300	50
Jefferson:					
The Baltimore Syndicate, Ltd.	Baltimore	Lead, zinc, copper	July 27, 1959	22,930	50
Judith Basin:					
John Zupan	Dr. Kalloch	Lead, zinc	May 9, 1958	11,708	50
Powell:					
Howard Banks	Hidden Hand group.	do	June 23, 1959	13,900	50

REVIEW BY MINERAL COMMODITIES

METALS

Aluminum.—Anaconda Aluminum Company, Columbia Falls, produced 12 percent more primary aluminum than in 1959; output was 56,625 short tons according to the annual company report to shareholders. This was the highest production since 1956.

Production facilities were operated at 87.5 percent of capacity the entire year, which left 30 of 240 reduction cells inactive. A new wage contract was negotiated between Anaconda and the Aluminum Workers Trades Council, AFL–CIO, providing an average wage increase of $0.075 an hour; approximately 530 persons were employed at the Columbia Falls plant.

Chromium.—The American Chrome Co., a subsidiary of The Goldfield Consolidated Mines Co., continued mining and milling chromite at the Mouat operation (near Columbus) for delivery to the Government under a Federal stockpiling contract. Deliveries during the year totaled 106,716 tons of concentrate, leaving a balance of 82,259 tons to be delivered on a 900,000-ton contract. American Chrome Co. successfully produced ferrochromium from the Mouat ore at the pilot smelter near the company mill at Nye. Over 500 tons of refined ferrochromium was made, and carload lots were marketed to major steel producers.

After demonstrating that commercial-grade ferrochromium could be produced from the low-grade ore, American Chrome Co. proposed to the Government that the company be granted a Federal contract to smelt the 900,000 tons of stockpiled concentrate to ferrochromium.

Copper.—The return to production on February 15 of The Anaconda Company copper concentrator, after the prolonged 1959 strike, raised

copper output 40 percent to 91,972 tons, compared with 65,911 tons in 1959. The Anaconda Company Butte-area mines supplied over 99 percent of the State total.

A major development for the Butte area was an announcement by Anaconda of an $11 million, 5-year program to tap high-grade copper ore reserves at deep levels. Also, the company announced a $6 million replacement and modernization program at the Anaconda Reduction Works.

Full production at Anaconda underground and pit mines was attained in March following the February reopening. Average output per operating day at the Berkeley pit exceeded the 1959 average by 14 percent. The Kelley block-caving operation yielded a daily average of 11,505 tons of copper ore, and nine new ore blocks were brought into production. High-grade copper veins were mined in the Mountain Con mine, and the Steward mine was rehabilitated after development work disclosed high-grade copper veins at lower levels. The Kelley No. 1 shaft was being deepened to serve as a centralized hoisting shaft for working the deeper levels of the Butte mines.

Work was completed on an enlarged, tailings-disposal system at the Anaconda Reduction Works at Anaconda; also, a 370-foot diameter tailings thickener was constructed that was capable of recovering 12,000 gallons of water a minute for reuse.

Gold.—Production reached 45,922 ounces, a 61-percent increase over the 28,551 ounces in 1959. The Anaconda Berkeley pit and Kelley mine (Silver Bow County) and the Mayflower and West Mayflower properties (Madison County) of the Peter Antonioli estate yielded sizable quantities; all showed increased output over 1959 and contributed in large part to the State rise.

Iron Ore.—Two companies shipped 55,481 long tons of iron ore, 11 percent more than the 50,081-ton 1959 output. Magnetite from the Iron Cross property (Ralls & Harris Bros.) near Radersburg, Broadwater County, was used in manufacturing cement. The Willow Creek mine (Young-Montana Corp.) near Stanford, Judith Basin County, yielded magnetite for shipment to Cleveland Cliffs Iron Co., Superior, Wis., and to numerous companies in the Pacific Northwest and Canada. Lump ore mined from the Willow Creek property contained an average of 63 percent iron and slightly over 1 percent moisture.

Lead.—Output was 4,879 tons, a decline of 36 percent from 1959. This decrease was due to curtailed production of lead-bearing zinc ore by Anaconda. Operations at the Anaconda Reduction Works zinc concentrator were not resumed until April, following the late 1959 smelter strike settlement; the plant was closed again in September following suspension of company lead and zinc mining, further curtailing load output (see zinc). Also contributing to the drop in production was a 7-month strike at the American Smelting and Refining Co. Jack Waite mine.

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)
1951–55 (average)	143	11	5,411	26,243	$918	6,096	$5,517
1956	152	7	9,536	38,121	1,334	7,386	6,685
1957	125	13	10,790	32,766	1,147	5,558	5,030
1958	125	11	10,361	26,003	910	3,631	3,286
1959	96	14	8,779	28,551	999	3,420	3,096
1960	129	13	12,317	45,922	1,607	3,607	3,265
1862–1960			[3]	17,622,000	401,237	829,406	619,712

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	67,572	$39,633	18,876	$5,717	75,509	$21,385	$73,171
1956	96,426	81,962	18,642	5,854	70,520	19,322	115,157
1957	91,512	55,090	13,300	3,804	50,520	11,721	76,792
1958	90,683	47,699	8,434	1,974	33,238	6,781	60,649
1959	65,911	40,469	7,672	1,765	27,848	6,405	52,734
1960	91,972	59,046	4,879	1,142	12,551	3,238	68,298
1862–1960	7,580,000	2,478,800	914,000	142,599	2,661,000	503,251	4,145,600

[1] Includes recoverable metal content of gravel washed (placer mines), ore milled, old tailings retreated 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.
[3] Data not available.

TABLE 9.—Gold production at placer mines

Year	Mechanical and hydraulic methods			Small-scale hand methods			Total		
	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)
1951–55 (average)	4	281	1,410	[1] 7	2	41	11	283	1,451
1956	5	267	1,483	2	([2])	13	7	267	1,496
1957	8	170	724	5	1	78	13	171	802
1958	7	209	1,069	4	1	19	11	210	1,088
1959	9	157	973	5	4	29	14	161	1,002
1960	[3] 2	2	41	11	8	94	13	10	135

[1] Includes surface and underground (drift) placers.
[2] Less than 500 cubic yards.
[3] Includes 1 hydraulic operation and 1 nonfloating washing plant.

TABLE 10.—Mine production of gold, silver, copper, lead, and zinc in 1960, by counties, in terms of recoverable metals[1]

County	Mines producing		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Beaverhead	15	----	1,327	$46	39,125	$35
Broadwater	8	2	2,664	93	8,288	8
Deer Lodge	4	----	4	(2)	1,464	1
Granite	11	2	373	13	302,463	274
Jefferson	18	3	694	24	55,350	50
Judith Basin	2	----	----	----	336	(2)
Lewis and Clark	16	1	152	5	11,103	10
Madison	18	----	18,616	652	109,515	99
Meagher	4	1	11	(2)	4,072	4
Park	----	1	18	1	2	(2)
Powell	5	1	28	1	174	(2)
Ravalli	2	----	3	(2)	1,213	1
Silver Bow	11	----	21,819	764	2,918,104	2,641
Toole	1	----	3	(2)	357	(2)
Undistributed[3]	14	2	210	7	155,425	141
Total	129	13	45,922	1,607	3,606,991	3,265

County	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Beaverhead	10	$6	351	$82	181	$47	$217
Broadwater	1	1	41	10	13	3	114
Deer Lodge	----	----	----	----	----	----	1
Granite	55	35	299	70	1,666	430	822
Jefferson	15	10	279	65	143	37	186
Judith Basin	----	----	5	1	1	(2)	2
Lewis and Clark	17	11	555	130	5,480	1,414	1,570
Madison	54	35	----	----	1	(2)	786
Meagher	17	11	175	41	22	6	62
Park	----	----	----	----	----	----	1
Powell	1	1	1	(2)	1	(2)	2
Ravalli	----	----	5	1	4	1	3
Silver Bow	91,754	58,906	1,889	442	4,755	1,227	63,980
Toole	3	2	----	----	----	----	2
Undistributed[3]	45	29	1,279	299	284	73	549
Total	91,972	59,046	4,879	1,142	12,551	3,238	68,298

[1] Owing to rounding, individual items may not add to totals shown.
[2] Less than $500.
[3] Includes Flathead, Lincoln, Mineral, Missoula, Phillips, Sanders, and Stillwater Counties; combined to avoid disclosing individual company confidential data.

TABLE 11.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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 and dry gold old tailings [2]	42	9,187	22,039	99,637	2,700	72,700	29,900
Dry gold-silver	10	9,624	839	27,349	113,900	67,700	49,000
Dry silver and dry silver old tailings [2]	33	40,541	696	260,922	45,200	364,500	222,500
Total	85	59,352	23,574	387,908	161,800	504,900	301,400
Copper	11	11,974,566	19,090	2,356,757	174,729,600	----------	800
Lead	16	14,092	165	46,314	101,200	3,180,600	574,900
Lead-zinc	11	3,648	159	9,360	5,600	358,900	238,600
Zinc and old zinc slag [2]	5	261,782	2,767	797,824	382,000	5,399,900	23,724,000
Total	43	12,254,088	22,181	3,210,255	175,218,400	8,939,400	24,538,300
Other lode material:							
Lead cleanings, lead-zinc slag, zinc tailings, and manganese tailings [2]	4	[3] 3,981	32	8,797	10,300	313,700	262,300
Copper precipitates	----------	----------	----------	----------	8,553,500	----------	----------
Total "lode" material	132	12,317,421	45,787	3,606,960	183,944,000	9,758,000	25,102,000
Gravel (placer operations)	13	(4)	135	31	----------	----------	----------
Total	145	12,317,421	45,922	3,606,991	183,944,000	9,758,000	25,102,000

[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] Includes 198 tons of manganese tailings containing gold and silver.
[4] 9,910 cubic yards.

TABLE 12.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	74	5	----------	----------	----------
Concentration and smelting of concentrates	24,553	3,190,889	175,126,000	6,719,600	13,414,200
Total	24,627	3,190,894	175,126,000	6,719,600	13,414,200
Direct smelting:					
Ore	20,925	370,286	222,300	1,633,100	436,000
Old tailings	222	33,529	6,600	72,800	116,300
Old slag and cleanup [1]	13	12,251	35,600	1,332,500	11,135,500
Copper precipitates	----------	----------	8,553,500	----------	----------
Total	21,160	416,066	8,818,000	3,038,400	11,687,800
Placer	135	31	----------	----------	----------
Grand total	45,922	3,606,991	183,944,000	9,758,000	25,102,000

[1] Combined to avoid disclosing individual company confidential data.

Manganese.—Output from three companies—The Anaconda Company Trout Mining Co., and Taylor-Knapp Co.—exceeded the 21,604-ton (35 percent or more manganese) 1959 shipments by 34 percent, reaching 29,036 tons. Manganiferous (5 to 35 percent manganese) ore production was 676 tons, a 72-percent decrease compared with 1959. The drop was due to the extended closure of a base-metal smelter in Idaho that used the material as an electrolytic-cell cleaner.

Silver.—Silver production, 3,606,991 ounces, was up 5 percent from 1959 principally because of increased tonnages of copper ore mined from Anaconda properties. Silver obtained from copper ore more than offset a decline in the quantity of silver recovered from zinc ores, caused by curtailed zinc-ore mining by Anaconda.

Steel.—Webb & Knapp, Inc., continued studies to determine the feasibility of constructing an integrated steel plant at Anaconda. The proposed 350,000-ton-annual-capacity plant was to use iron-bearing slag derived from the Anaconda Reduction Works. A contract was signed during the year with the Bonneville Power Administration (BPA) for a total of 150,000 kilowatts of firm and interruptible low-cost Federal power. Shipment of 750 tons of slag was made to Strategic-Udy Metallurgical Chemical Process, Ltd., at Niagara Falls, Ontario, Canada, for large-scale testing in a prototype of the plant to be erected at Anaconda.

Tungsten.—Minerals Engineering Co. mined scheelite from the Calvert mine (Red Button group) near Wise River, Beaverhead County; the ore was trucked to a company mill at Glen for concentrating before shipment to an eastern consumer and to a processing plant at Salt Lake City, Utah. Mining and milling continued throughout the year except for a 1-month closure during the fall when facilities for a new upgrading process were installed at the mill. A company research program led to the new process that began successful operation in December and resulted in cost reductions. Through improved mining and stripping the Calvert mine yielded ore running 1.13 percent tungsten trioxide.

Uranium.—Ore shipments totaled 1,726 tons from six mines in Carbon County. Four operations delivered uranium ore to a reduction plant at Riverton, Wyo. Although total tonnage and value declined, average ore grade (percent of contained uranium oxide) increased over 1959.

Zinc.—Curtailed production of zinc ore by The Anaconda Company caused a 55-percent decline from the strike-reduced output of 27,848 tons in 1959. Anaconda's Alice pit (Silver Bow County) and East Helena slag fuming operation (Lewis and Clark County) produced most of the 12,551 tons. Mining at the company Anselmo zinc mine was not resumed following settlement in February of a 6-month labor strike and accessible ore recoverable by pit operations at the Alice mine was depleted and operations terminated in July. Also, the Elm Orlu-Black Rock low-grade zinc project was suspended because of market considerations. The termination of zinc mining by Anaconda brought about closure of the company electrolytic zinc operation at Anaconda; the Great Falls electrolytic zinc plant was to treat all zinc concentrate (purchased and toll) received by the company.

NONMETALS

Barite.—The quantity of barite sold or used by producers declined to about half of the 1959 total. Baroid Sales Division, National Lead Co., the only producer, mined and ground barite near Greenough, Missoula County. Output was used primarily as a weighting agent in oil-well-drilling mud.

The Montana Bureau of Mines and Geology announced discovery of barite mineralization on the west flank of Tobacco River Valley, 5 miles southwest of Eureka, Lincoln County. This discovery was incidental to a survey of mineral resources in northwestern Montana sponsored jointly by the State, the Great Northern Railway, and Pacific Power & Light Co.

Cement.—The quantity and value of cement shipments declined 24 and 22 percent, respectively, compared with 1959. The Trident plant (Gallatin County) of Ideal Cement Co., Montana Division, continued to be the only cement producer. Limestone and sandstone for use in the process were mined locally by the company. Destinations within the State accounted for 87 percent of the cement sold; shipments also were made to Wyoming, North Dakota, and Idaho.

Clays.—There was a substantial increase in production of miscellaneous clay and fire clay, but no bentonite was mined. Miscellaneous clay for making heavy clay products was dug in Fergus and Yellowstone Counties. Two companies—Treasurelite Division, Treasure State Industrial Products, Inc. (Cascade County), and Montana Lite-weight Aggregate Co. (Yellowstone County)—produced and expanded shale for use as lightweight aggregate. Fire clay was mined near Armington, Cascade County.

The Montana Bureau of Mines and Geology published a report of clay and shale resources in the State.[3]

Fluorspar.—Shipments of fluorspar by Cummings-Roberts, Darby, Ravalli County, increased to 31,300 tons from 18,500 tons in 1959. Crude fluorspar mined at the Crystal Mountain open pit was trucked to the Darby plant for processing. The steel industry continued to be the major consumer.

Gypsum.—The quantity and value of crude gypsum mined decreased 7 and 13 percent, respectively, compared with 1959. Two mines in Fergus County furnished the output. Most of the production was calcined and sold as ground gypsum, wallboard, and lath. Uncalcined gypsum was used as a retarder in portland cement.

Lime.—Quantity and value of lime output increased 37 and 41 percent, respectively, compared with 1959, approaching the tonnage and exceeding the value established as a high in 1958. Quicklime produced in Deer Lodge County was used locally at an ore concentrator and metallurgical works. Limestone also was calcined in Powell County.

Mica.—Three operations contributed to a fourfold increase in the quantity of mica shipped to the Government purchase depot at Custer, S. Dak. The bulk of the output came from the Thumper No. 1 mine

[3] Sahinen, U. M., Smith, R. I., and Lawson, D. C., Progress Report on Clays of Montana: Montana Bureau of Mines and Geol. Bull. 13, 1960, 83 pp.

(Planet Exploration Co.) near Gallatin Gateway, Gallatin County. Small quantities were recovered in Beaverhead and Madison Counties.

Phosphate Rock.—Output of marketable phosphate rock increased 7 percent above 1959 and reached a new high for both quantity and value. Mines in Beaverhead, Powell, and Silver Bow Counties furnished the output, part of which was exported to British Columbia. Phosphate rock was processed to elemental phosphorus, phosphoric acid, and phosphate fertilizers.

According to The Anaconda Company report to shareholders, its phosphate fertilizer plant at Anaconda was sold to J. R. Simplot Co., Pocatello, Idaho, and the Conda (Idaho) phosphate rock deposits were leased to the purchasing company. Sulfuric acid from the Anaconda plants was to be sold to the Simplot company. Until completion of dismantling and moving of the plant, Anaconda was to produce ammonium phosphate fertilizers for Simplot.

Phosphate rock from Conda, Idaho, was processed by Rocky Mountain Phosphates, Inc., using facilities at the old Domestic Manganese & Development Co. plant at Butte. A defluorinated phosphate product for use as an animal food supplement was made.

The Bunker Hill Co. continued work at the Jack Pine phosphate-rock prospect near Elliston. Development consisted of driving two tunnels and roadbuilding.

Encouraged by adaptation of the Bureau of Mines mechanical planer [4] to phosphate mining, Montana Phosphate Products Co. started work at a mine near Maxville designed specifically for use of the planer. Mining was scheduled to begin in 1961 on beds 5–7 feet thick that dip 30–60 degrees.

Sand and Gravel.—Output of sand and gravel increased to 12.6 million tons from 10.9 million tons in 1959, but the value decreased to $11.7 million from $12.6 million. A large increase in the quantity of sand and gravel used by the State highway department more than offset a sizable drop in requirements at U.S. Army Corps of Engineers projects. Distribution by use was as follows: Road material, 90 percent; building, 7 percent; railroad ballast and miscellaneous, 3 percent. These figures are identical to those for 1958 but differ from the 1959 percentages of 79, 15, and 6, respectively.

Stone.—Quantity and value of stone produced were 1.2 million tons and $1.6 million, respectively, a slight decrease from 1959. A drop in commercial output was almost offset by a gain in production for use by Federal, State, county, and municipal agencies. Greater quantities of limestone, granite, and sandstone were quarried, whereas basalt production dropped 23 percent. Building and decorative stone was produced at a quarry in Park County.

Sulfur.—Production and shipments of high-purity elemental sulfur by Montana Sulphur & Chemical Co., Yellowstone County, were less than in 1959. Two oil refineries in the area furnished hydrogen sulfide for processing.

[4] Service, A. L., and Howard, T. E., Design and Test Operation of a Pneumatic Vibrating-Blade Planer. A Progress Report on Phosphate-Mining Research, 1956–57: Bureau of Mines Rept. of Investigations 5437, 1959, 22 pp.

TABLE 13.—Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	807	$1,249	800	$1,200
Road material	634	691	554	646
Railroad ballast	497	294	(1)	(1)
Other [2]	126	102	452	363
Total	2,064	2,335	1,806	2,209
Government-and-contractor operations:				
Building	822	609	56	102
Road material	8,044	9,643	10,719	9,342
Other [2]			8	4
Total	8,866	10,252	10,783	9,448
All operations:				
Building	1,628	1,858	856	1,302
Road material	8,678	10,334	11,273	9,988
Railroad ballast	497	294	(1)	(1)
Other [2]	126	102	460	367
Grand total [3]	10,930	12,587	12,589	11,657

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Sand and gravel used for miscellaneous and unspecified purposes, including items indicated by footnote 1.
[3] Owing to rounding, individual items may not add to totals shown.

Talc.—Tonnage and value of talc mined were 5 and 10 percent lower, respectively, than in the record year 1959. Three companies produced from eight mines—two in Beaverhead County and six in Madison County. Part of the talc produced was ground at Barratts, Beaverhead County, and East Helena, Lewis and Clark County. Talc was shipped to grinders in Grand Island, Nebr., Los Angeles, Calif., and Ogden, Utah. Most of the ground product was used for making paint. There was a significant change in the use pattern of ground talc (1959 percentages are in parentheses): Paint, 68 percent (57 percent); ceramics, 22 percent (20 percent); and miscellaneous including paper, cosmetics, insecticides, rice polishing, and textiles, 10 percent (23 percent).

Vermiculite.—Output of crude vermiculite was 8 percent lower than in 1959. The Libby, Lincoln County, open-pit mine of Zonolite Co. continued to be the main source of vermiculite in the United States. Most of the production was shipped out of State for exfoliating; a small quantity was expanded by a company in Great Falls, Cascade County. Vermiculite traditionally used in the building industry for insulating and fireproofing, was, according to the company, beginning to be used in many lawn, garden, and agricultural products, and as a distribution agent in animal feeds.

MINERAL FUELS

Coal.—A 32,000-ton decline in output of bituminous coal and lignite brought the 1960 production down to 313,000 tons. Nineteen mines in nine counties contributed to the total tonnage. Musselshell County

mines furnished most of the bituminous coal, and Richland County was the major source of lignite. The steam-electric generating plant of Montana-Dakota Utilities Co. at Sidney was the leading lignite consumer.

Petroleum and Natural Gas.[5]—Recovery of petroleum set another record; output was 30.2 million barrels ($72.9 million) compared with 29.9 million barrels ($76.4 million) in 1959. The lower valuation was due to a $0.15-a-barrel decrease in the average price. Petroleum again was the leading commodity in value of output and represented 41 percent of the State value of mineral production. Forty-two percent of the State total came from the Pine, Cabin Creek, and Poplar-East fields; each field had output exceeding 3 million barrels. Other fields producing more than 1 million barrels included Elk Basin, Sumatra, Cut Bank, and Stensvad. Five oilfields, in Musselshell, Roosevelt, Rosebud, Sheridan, and Stillwater Counties and three gasfields, in Custer, Stillwater, and Toole Counties, were discovered compared with two and three fields, respectively, in 1959.

During the year, 343 wells (176 development and 167 exploratory) were drilled; total footage drilled was 1.7 million feet, and the average depth was 6,811 feet. Of the wells drilled, 128 yielded oil, 7 issued gas, and 208 were dry. The average daily output of the 3,707 producing wells in the State was 22.3 barrels.

Crude oil production from fields in central Montana had more than doubled in 2 years, mainly because of increasing recovery from the Stensvad field (brought into production in 1958) and continued expansion of the Sumatra and Ivanhoe fields. Montana ranked 12th in the Nation as a liquid petroleum source and 14th in proved reserves.

Ten refineries processed 24.9 million barrels of crude oil; Montana wells furnished 42 percent of the total and Wyoming wells supplied almost 58 percent. Canadian wells contributed less than 0.1 percent

Gross withdrawals of natural gas (marketed production plus quantities used in repressuring, as well as that vented and wasted) totaled 34.7 billion cubic feet, compared with 31.7 billion cubic feet in 1959. Cut Bank-Reagan in Glacier and Toole Counties continued to be the leading natural-gas-producing field (11.2 billion cubic feet). Other fields producing more than 1 billion cubic feet were Bowdoin, Cedar Creek, Bowes, Cabin Creek, Dry Creek, Keith Block, Kevin Sunburst, Pine, and Whitlash.

One of the most significant wildcat wells drilled in Montana in recent years was brought in by T. E. Murphy Corp. (Murphy, Sletvold No. 1), 13 miles northeast of Wolf Point, Roosevelt County. The test flow was 476 barrels a day through a 7/32-inch choke. The well was the westernmost in the Williston Basin yielding crude oil from a Devonian horizon. Another wildcat well (Sinclair, Kesterson No. 1) drilled by Sinclair Oil & Gas Co., 10 miles southeast of the main part of the Sumatra field in Rosebud County, showed promise of a new producing area. This was the first drilling activity in this vicinity.

[5] Montana Oil and Gas Conservation Commission, Montana Oil and Gas Statistical Bulletin and Annual Review, 1960.

Construction of a 190-mile pipeline from Glendive, Mont., to Minot, N. Dak., was begun by Farmers Union Central Exchange of South St. Paul, Minn. This was to be an extension of the line the company had from Laurel to Glendive. Announcement was made of a proposed crude-oil pipeline to be completed by mid-1961 from fields near Cut Bank to the Wyoming border south of Billings. The pipeline would connect at the southern end with other lines to transport crude oil to Midwestern markets.

A report concerned with oil and gas in Montana was published during the year.[6]

REVIEW BY COUNTIES

Beaverhead.—The Argenta mining district had nine operating base- and precious-metal mines, of which the Maulden was the principal producer, yielding 2,474 tons of lead ore. High-grade gold ore was mined from the Yellowband property.

Lively Mining Co. produced 1,890 tons of silver ore from the Hecla mine near Melrose in the *Bryant* district. Lead-zinc slag from the old Glendale Smelter dump was shipped to the East Helena smelter; 3,673 tons of old slag yielded nearly $80,000 in recoverable metals.

A total of 15 gold, silver, copper, lead, and zinc mines operated in the county compared with 13 in 1959; the Maulden, Hecla, Glendale Smelter dump, and the Jack mine were the only producing properties that had operated in 1959. The 11 new producers were the Amaranth, Coolidge, Cross, Eightball, Magnolia, Park, Yellowband, Comet, Sweeney, White Cap, and Clara properties.

Spokane National Mines, Inc., was developing the New Departure silver mine 16 miles west of Dillon; and old cyanide mill was rehabilitated to treat ores by flotation as well as cyanidation.

There were no developments at the Carter Creek iron deposit after its purchase by North American Utilities Corp. in 1959.

Sawyer Petroleum Co. assigned its Horse Prairie thorium property west of Armstead to Techmanix Corp., Salt Lake City, Utah. No activity was reported at the property. Techmanix processed 200 pounds of concentrate in a Salt Lake City pilot plant to produce a test lot of thorium hydrate, assaying higher than 90 percent.

Minerals Engineering Co. mined tungsten ore from the Calvert mine near Wise River. Ore was trucked to a mill near Glen; concentrate was shipped from the mill directly to purchasers or to a Salt Lake City, Utah, processing plant for upgrading. The company annual shareholders report stated the following concerning the mill:

> With respect to our research programs, important results were obtained during the past year. The new ore upgrading process developed for use in our Montana operations has been in successful operation since December and has been achieving a substantial reduction in cost that will be reflected in future earnings.

The company also reported that the mine was developed further by improved mining and stripping and was yielding ore running 1.13 percent tungsten trioxide.

---

[6] Perry, Eugene S., Oil and Gas in Montana: Montana Bureau of Mines and Geol. Bull. 15, 1960, 86 pp.

TABLE 14.—Value of mineral production in Montana, by counties [1]

(Thousand dollars)

County	1959	1960	Minerals produced in 1960 in order of value
Beaverhead	(2)	(2)	Tungsten, phosphate rock, talc, lead, stone, zinc, gold silver, copper, sand and gravel, mica.
Big Horn	$322	$245	Petroleum, sand and gravel, stone.
Blaine	572	498	Petroleum, coal, sand and gravel.
Broadwater	166	264	Iron ore, gold, sand and gravel, lead, silver, zinc, stone, copper.
Carbon	11,499	7,755	Petroleum, stone, coal, uranium, sand and gravel.
Carter	112	72	Petroleum.
Cascade	742	730	Sand and gravel. clays, coal, stone.
Custer	154	143	Sand and gravel. coal.
Daniels, Roosevelt [3]	10,633	8,932	Petroleum, sand and gravel.
Dawson, McCone [3]	3,604	3,652	Petroleum, sand and gravel, coal.
Deer Lodge	532	852	Lime, stone, sand and gravel, silver, gold.
Fallon, Prairie, Wibaux [3]	26,745	27,854	Petroleum, sand and gravel.
Fergus	(2)	(2)	Gypsum, clays, sand and gravel.
Flathead	552	405	Stone, sand and gravel, silver, gold.
Gallatin	(2)	(2)	Cement, stone, sand and gravel, mica.
Garfield, Petroleum [3]	394	468	Petroleum.
Glacier, Pondera, Teton, Toole [3]	10,671	9,810	Petroleum, sand and gravel, copper, stone, silver, gold.
Golden Valley	(2)		
Granite	1,063	1,403	Manganese, zinc, silver, lead, copper, gold, manganiferous ore.
Hill	121	45	Sand and gravel.
Jefferson	132	266	Stone, lead, silver, zinc, gold, copper.
Judith Basin	219	207	Iron ore, sand and gravel, lead, silver, zinc.
Lake	(2)	26	Sand and gravel.
Lewis and Clark	(2)	1,709	Zinc, sand and gravel, lead, copper, silver, gold.
Liberty	125	78	Petroleum.
Lincoln	(2)	(2)	Vermiculite, sand and gravel, zinc, lead, silver, gold.
Madison	964	1,347	Gold, talc, silver, copper, zinc, mica.
Meagher	(2)	62	Lead, copper, zinc, silver, gold.
Mineral	57	(2)	Lead, sand and gravel, zinc, silver, copper, gold.
Missoula	195	136	Sand and gravel, barite, stone, gold, silver.
Musselshell	2,427	2,931	Petroleum, coal.
Park	(2)	(2)	Sand and gravel, stone, gold, silver.
Phillips	146	(2)	Do.
Powell	(2)	(2)	Phosphate rock, lime, sand and gravel, stone, gold, copper, zinc, lead, silver.
Ravalli	(2)	(2)	Fluorspar, sand and gravel, lead, silver, zinc, gold.
Richland	(2)	(2)	Coal, petroleum.
Rosebud	7,059	9,092	Petroleum, coal.
Sanders	(2)	(2)	Lead, zinc, stone, silver, sand and gravel, copper, gold.
Sheridan	1,512	1,622	Petroleum, coal.
Silver Bow	51,719	66,353	Copper, silver, manganese, zinc, phosphate rock, gold, lead, sand and gravel.
Stillwater	(2)	(2)	Chromium, stone, petroleum, gold, silver.
Sweet Grass		(2)	Sand and gravel.
Treasure	(2)	46	Do.
Valley	1,726	495	Do.
Yellowstone	1,877	1,685	Petroleum, sand and gravel, clays.
Undistributed [4]	32,059	30,223	
Total [5]	[6] 167,328	178,854	

[1] Chouteau, Powder River, and Wheatland Counties did not report production.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Daniels and Roosevelt; Dawson and McCone; Fallon, Prairie, and Wibaux; Garfield and Petroleum; and Glacier, Pondera, Teton, and Toole Counties have been combined because of joint oilfield production.
[4] Includes value of gem stones, natural gas, natural gas liquids, petroleum, and some sand and gravel that cannot be assigned to specific counties and values indicated by footnote 2.
[5] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.
[6] Revised figure.

Phosphate rock produced at the Canyon Creek and Quartz Hill mines of Victor Chemical Works was shipped to the company elemental phosphorus plant at Silver Bow. Talc from the Tri-State Minerals Co. Smith-Dillon and Crown mines was ground at the Barratts mill. A small quantity of mica was produced at the Sparkle mine, 11 miles southeast of Dillon.

Big Horn.—Crude oil recovered from three fields was about 7,000 barrels less than in 1959. Natural gas withdrawals increased slightly.

Blaine.—Production of crude oil from the Bowes field was 280,000 barrels, compared with 333,000 barrels in 1959. Natural gas output from the same field increased to 1.4 billion cubic feet, 535 million cubic feet more than in 1959. One bituminous coal mine was active.

Broadwater.—Ralls & Harris Bros. shipped 19,313 long tons of iron ore (magnetite) from the Iron Cross mine near Radersburg; the ore went entirely into cement production.

The Marietta mine of Northern Milling Co. in the *Park* (*Indian Creek*) district yielded a sizable quantity of gold ore. Other gold properties operated were the Big Buck, *Beaver* district, and the Keating and Ohio Keating, both in *Cedar Plains* district. Small tonnages of lead and zinc ores were produced at the January and East Pacific, *Beaver* district, Silver Queen, Skyline, and Valley View mines, all in *Park* district.

A small quantity of stream gravel was worked at the Diamond Hill placer in the *Park* mining district.

Carbon.—Uranium ore was mined at the Bob No. 6, Dandy, Marie No. 2, and Perc No. 14 by The Hidden Splendor Mining Co., the principal producer. The Dandy and Perc No. 14 also were worked by Joe Highsmith. Pryor Mining Co. operated the Old Glory, and J. J. Stoick mined the Swamp Frog.

Decreases in the output of petroleum, natural gas, and coal compared with 1959 mainly were responsible for a drop of $3.7 million in the value of fuels and nonmetals. The Elk Basin field (ranking fourth in the State) yielded 2.7 million barrels of crude oil, 1.3 million barrels less than in 1959. A new field, Mackay Dome, on the Carbon-Stillwater County boundary had initial production of 2,600 barrels. Natural gas recoveries from the four fields in the county were 41 million cubic feet below 1959. There was an increase in the tonnage of limestone quarried at Warren by The Bighorn Limestone Co. Two bituminous coal mines were active.

Carter.—Output of crude oil from the Repeat field rose from 30,000 barrels in 1959 to 39,000 barrels.

Cascade.—Modernization of The Anaconda Co. Great Falls electrolytic copper refinery continued, and all Anaconda electrolytic zinc refining was diverted to the Great Falls plants.

Cascade county regained first position as a source of sand and gravel even though production was slightly less than in 1959. There was a fourfold increase in the quantity of fire clay mined at the Armington pit for use at the Anaconda Reduction Works in Deer Lodge County. Robinson Insulation Co. expanded vermiculite for use as loose-fill insulation, lightweight aggregate, and for soil conditioning. One mine produced bituminous coal.

Daniels and Roosevelt.—These counties were considered as a unit because the Bredette-North oilfield extends over the Roosevelt County line into Daniels County. Combined crude oil output was 3.3 million barrels, compared with 3.9 million barrels in 1959. Most of the production came from the Poplar-East field in Roosevelt County (ranking third in the State). Recovery from the Bredette-North field dropped from 87,000 barrels in 1959 to 29,000 barrels. In Daniels County the

Line Coulee field yielded 438 barrels, compared with 12,000 barrels in 1959. Initial production from Tule Creek, a new field, totaled 31,000 barrels.

Dawson and McCone.—Crude oil production from the two-county area (combined because the Richey field underlies parts of both counties) was slightly higher than in 1959. The Glendive field in Dawson County was the leading producer in the combined area. Recovery from the Richey-Southwest field in McCone County was 79,000 barrels (49,000 in 1959).

Deer Lodge.—Fluosolids reactor installation continued at the Anaconda Reduction Works and was to be completed late in 1961; the reactors were to be used in roasting copper concentrate. Also, a new conveyor system to move copper calcines from the roasters to the reverberatory furnaces was being installed. A remote-control unit for the conveyor belt and a distribution system between the ore crushing plant and the concentrator bins were installed. A new tailing thickener was put in operation, and an enlarged tailing disposal system neared completion.

Electrolytic zinc operations at the Anaconda Reduction Works were terminated at yearend. Future zinc concentrate intake was to be handled at the Great Falls electrolytic zinc plant.

The Anaconda Company annual shareholders report showed manganese nodule production of 7,369 tons and ferromanganese output of 11,017 tons. Cadmium recovered from zinc ores was 620 tons.

Gold and silver ores were mined at the Cameron, Gold Coin, Silver Chain, and Champion properties.

Quicklime made from limestone mined by Anaconda at Brown's quarry was used at company ore-processing and metallurgical operations. The company did not roast pyrite to make sulfuric acid as it had done for many years; gases from fluosolid reactors (roasting copper ores) were used instead. Anaconda operated its phosphate fertilizer plant for J. R. Simplot Co., Pocatello, Idaho, to whom it had been sold. Plans called for dismantling and shipping the plant to Pocatello, Idaho. Refractories were made from clay mined in Cascade County.

Fallon, Prairie, and Wibaux.—This area, considered as a unit for reporting petroleum production, continued as the major source in the State. Output of 11.5 million barrels ($27.9 million) was over 1 million barrels higher than that of 1959. The Pine field (5.1 million barrels), underlying the three counties, and the Cabin Creek field (4.5 million barrels), Fallon County, were the first and second ranking oilfields in the State.

Natural gas withdrawals totaled 6.9 billion cubic feet. Cedar Creek field in Fallon County dropped to third place from second as a source of natural gas. Output from the field was 4.6 billion cubic feet, compared with 5.1 billion cubic feet in 1959. Production from Pine field was 1 billion cubic feet (933 million in 1959); and withdrawals from Cabin Creek field in Fallon County totaled 1.1 billion cubic feet (971 million in 1959).

Fergus.—Gypsum was mined near Heath by United States Gypsum Co. and near Hanover by Ideal Cement Co. Lewistown Brick & Tile

Co. manufactured building brick and tile and other heavy clay products from clay mined at nearby pits.

Flathead.—Kaiser Aluminum & Chemical Corp. delivered the first alumina to Anaconda Aluminum Co., Columbia Falls, under a previously negotiated contract.

The Flathead mine in the *Hog Heaven* district, operated by Waino Lindbom, yielded silver ore.

Gallatin.—Gallatin County was the leading source of nonmetals in the State, and the Trident plant of Ideal Cement Co., Montana Division, was the principal mineral industry in the county. Limestone output from the Trident quarry (Ideal Cement Co.) led the State in stone production. Most of the mica mined in Montana came from a deposit near Gallatin Gateway.

Garfield and Petroleum.—Output of petroleum from the Cat Creek field (underlying parts of both counties) increased to 181,000 barrels—30,000 barrels more than in 1959.

Glacier, Pondera, Teton, and Toole.—This four-county area, considered as a unit for reporting petroleum production, was the second most important source of crude oil in the State. Total output was 4 million barrels compared with 3.9 million in 1959. Cut Bank, the principal gas-producing field (including Reagan) and an important crude oil source, underlies parts of Glacier, Pondera, and Toole Counties. The Pondera field (underlying Pondera and Teton Counties) had production totaling 505,000 barrels (521,000 in 1959). In order of crude oil output, the principal fields were Cut Bank (2.1 million barrels), Kevin-Sunburst (744,000 barrels), and Pondera.

Natural gas withdrawals totaled 12.5 billion cubic feet (11.3 billion cubic feet in 1959); Cut Bank-Reagan yielded 11.2 billion cubic feet and Kevin-Sunburst furnished most of the remainder.

Granite.—Battery-grade manganese ore was mined by Taylor-Knapp Co. and The Trout Mining Co. in the Philipsburg area. Trout Company produced and shipped a lesser quantity of under 35-percent metallurgical-grade ore to The Bunker Hill Co. for use as a cell cleaner at the Kellogg, Idaho electrolytic zinc plant.

Over 34,000 tons of zinc ore was mined from the Trout Mining Co. Algonquin property, *Flint Creek* district. Silver came from the Comanche Extension, Cudgie-Taylor, Harper, and Little Emma mines in the same district. Gold ore was mined at the Copper Queen, *Boulder* district, Bluebell, *Dunkelburg* district, and Mickey, *Red Lion* district properties. The Black Pine, *Henderson* district, and Sally Ellen, *South Boulder* district, both yielded silver ore.

Two small-scale hand placer mines were active—one each in the *Alps* (*Bonita*), and *Garnet* districts.

Jefferson.—Eighteen gold, silver, and base-metal mines were active, yielding nearly 13,000 tons of ore having a recoverable metals value of $184,759. Principal producer was the Alta-Custer, *Colorado* district, operated by Lahey-Leasing Co. The Crystal (M & H Mining Co.) and the Silver Crescent (Montana Gold & Silver Co.) both in the *Cataract* district, yielded moderate tonnages of gold-silver ore. Other producing properties were the Big Jim (lead-zinc) and Hie Ore (gold-silver). *Amazon* district; Bonanza Jack (gold-silver), Hiawatha (silver), Mount Thompson (silver), Obelisk (silver), and Silver Hill

(gold-silver), *Cataract* district; Loeber (gold), Nellie Grant (lead-zinc), and The Finder (gold), *Clancy* district; Uranium (lead), *Colorado* district; Klondyke (gold), *Elkhorn* district; Montana (silver), *Homestake* district; Yama (silver), *McClellan* district; and Silver Queen (silver), *Whitehall* district.

Stream gravel was worked at three small-scale hand placer operations—one in the *Cataract* district and two in the *Clancy* district.

Mines and mineral deposits of the county were the subject of a report.[7]

Judith Basin.—In the *Barker* district, the Block P group (lead-zinc) was worked by the Hughesville Lumber & Mining Co., Inc., and lead ore was mined at the Tiger property.

The Willow Creek iron deposit was mined by Young-Montana Corp. Ore was shipped to Cleveland Cliffs Iron Co., Superior, Wis.; The Anaconda Company, Anaconda, Mont.; Kaiser Engineering Co., Hanford, Wash.; Prairie Pipe Manufacturing Co., Ltd., Regina, Saskatchewan; Premier Steel Co., Edmonton, Alberta; Bethlehem Steel Co., Seattle, Wash.; and Oregon Steel Mills, Portland, Oreg.

Lewis and Clark.—Old tailings and slag represented the bulk of the material treated at 16 metal operations. Zinc slag from current and past production of the American Smelting and Refining Co. East Helena smelter was fumed at an adjacent plant of The Anaconda Company. Silver-bearing tailing from the Peck mill, *Helena* district was shipped by Louis Peura. Other producing metal mines were the Pearl (lead-zinc), *Blue Cloud* district; Nick & Dick (lead), *Canyon Ferry* district; Stemple Gold (gold), *Gould-Stemple* district; Mike Horse (lead), *Heddleston* district; assay office cleanup (lead), Franklin dump (gold), and Hopeful (gold), *Helena* district; Humdinger (gold), *Madison Gulch* district; Copper Hill (silver), *Marysville* district; Howard (gold-silver), Monte Christo (silver), Transit (lead-zinc), and Woodrow Wilson (gold), *Rimini* district; and the Rosetta (copper), *Wolf Creek* district.

Liberty.—Output of crude oil declined to 39,000 barrels, 16,000 less than in 1959. Natural gas withdrawals also were less—3.7 billion cubic feet compared with 3.9 billion cubic feet in 1959. Keith Block and Whitlash fields, each yielding over 1 billion cubic feet, were the principal natural gas sources.

Lincoln.—St. Paul Lead Co. mined lead-zinc ore from the St. Paul and Snowshoe properties in the *Libby* district. Several tons of gold ore was produced from the Gloria mine in the *Troy* district

Vermiculite mining near Libby by Zonolite Co. was the major nonmetal mining activity. A small quantity of sand and gravel also was produced.

Madison.—Gold ore was mined at the Mayflower and West Mayflower properties, *Renova* district and gold-silver ore was mined at the Dictator and Bell Union mines, *Sheridan* district. The Easton Pacific, *Virginia City* district also yielded considerable gold-silver ore. Fifteen other operating metal mines were the Strawberry (gold), Mammoth (gold), Colorado (gold), Concentrator (gold),

[7] Roby, R. N., Ackerman, W. C., Fulkerson, F. B., and Crowley, F. A., Mines and Mineral Deposits (Except Fuels), Jefferson County, Montana: Montana Bureau of Mines and Geol. Bull. 16, 1960, 122 pp.

Golconda (gold), Shoemaker (gold), Betty Bennit (lead), Hunt (gold), Clancy (copper), Blackace (gold), Little Goldie (gold), Moffet (copper), Lost Lode (gold-silver), Mountain Chief (gold), and Paige (gold).

Talc mining continued to be the principal nonmetal mineral industry activity in the county. Three companies operated six mines—Sierra Talc Co. (Yellowstone), Tri-State Minerals Co. (Regal and Treasure State), and American Chemet Corp. (Ruby, Sweetwater, and Madison). American Chemet had a screening plant at Alder. Mica from the Merlin mine, 12 miles south of Ennis, was sold to the Government purchase depot at Custer, S. Dak.

Meagher.—Hoco, Inc., operated the Black Hawk (silver) and Cumberland (lead) mines, and Hamilton Mines, Inc., mined lead-zinc ore from the Yellowstone property—all three properties were in the *Castle Mountain* district. The Copper Duke mine, *Musselshell* district, yielded copper ore.

Some placer mining was done at the *Beaver* district Little Buck placer.

Mineral.—The Nancy Lee mine in the *Keystone* district yielded a large tonnage of lead ore. Small tonnages of ore were produced at The Silverstreak (gold), Prosperity (silver), and Mineral King (silver) properties.

Missoula.—Gold ore was mined from the Pioneer, *Clinton* district, and Nine Mile, *Nine Mile* district mines.

As in past years, barite mining by Baroid Sales Division, National Lead Co. was the principal mineral industry in the county. Some sand and gravel and stone also were produced.

Musselshell.—Petroleum and bituminous coal were the principal commodities. Eight oilfields yielded 1.1 million barrels of crude oil, 375,000 barrels more than in 1959. There was one new field (Keg Coulee), and one field (Devils Basin) that did not produce compared with the preceding year.

The county continued to supply most of the bituminous coal mined in the State. Production from eight mines was 93,000 tons; 1959 output was 128,000 tons. The Roundup Mining Co. Roundup No. 3 mine was the principal producer.

Park.—The Nebraska No. 1 and No. 2 placer claims in the *Sheepeater* district yielded a small quantity of gold.

Phillips.—Little Rockies Mining & Development Co. produced a small tonnage of gold-silver ore from the Little Ben mine in the *Little Rockies* district. The Blue Rock and Lucky Maud placers in the same district, also were active.

Powell.—Five metal mines were active—the Royal (gold), Bonanza (gold), Black Cloud (copper), Golden Anchor (lead-zinc), and Arnold (copper) properties. The Golden Anchor, operated by Golden Anchor Mining & Milling Co., Inc., was the leading operation.

Bench gravel was mined by hydraulic methods to yield gold at the Ophir property in the *Ophir* district.

Powell County continued to be the chief source of phosphate rock in the State because of increased output by both Montana Phosphate Products Co. and George Relyea. Most of the production was exported to Trail, British Columbia, Canada, for use in manufacturing phosphate fertilizers by The Consolidated Mining & Smelting Com-

pany of Canada, Ltd. Limestone was calcined by Elliston Lime Co.; both quicklime and hydrated lime were marketed.

Ravalli.—The Curlew Mining & Exploration Co. Curlew mine, *Curlew* district, yielded a small tonnage of lead-zinc ore.

Fluorspar mining by Cummings-Roberts at the Crystal Mountain open pit continued to be the principal mineral industry in the county. Output was trucked to a mill at Darby.

Richland.—Output of lignite by Knife River Coal Mining Co. at Sidney increased. Crude oil recovery from the Brorson field reached 44,000 barrels, 8,000 barrels higher than in 1959.

Rosebud.—An increase of $2 million in the value of petroleum produced made the county second in the State as a crude oil source. The leading fields—Sumatra and Stensvad—produced 2.1 and 1.9 million barrels, respectively; both increased over 1959. Hibbard, a new field, produced 47,000 barrels. Bituminous coal output reached a new low.

Sanders.—The principal metal producing mine was the Jack Waite in the *Eagle* district, worked under a long-term lease by American Smelting and Refining Co.; however, production was curtailed by a 7-month strike. Two other metal mines—Montana Standard, *Prospect Creek* district (lead-zinc) and Raven *Thompson River* district (copper)—were small producers.

Sheridan.—Crude oil recovery reached 707,000 barrels, compared with 687,000 barrels in 1959. The first production from Dwyer, a new field, was 92,000 barrels. A small quantity of lignite was mined.

Silver Bow.—As in previous years, mines of The Anaconda Company led in quantity and value of gold, silver, copper, lead, and zinc produced in the State. Ore treated or sold rose from 8.7 million tons in 1959 to 12.2 million tons; however, the number of operating properties declined from 15 to 11. Value increased from $50.2 million to $64 million. Copper ore supplied 11.9 million tons of the total compared with 8.1 million tons for the preceding year. Zinc ore production dropped from nearly 600,000 tons in 1959 to less than 200,000 tons. Copper ores yielded 175 million pounds of recoverable copper, and zinc ores yielded 9.5 million pounds of recoverable zinc.

There was no mine production of manganese ore; The Anaconda Company shipped manganese nodules (56 percent manganese), produced from previously mined ore, to the company ferromanganese plant and to other consumers.

Summit Valley (Butte) District.—All metal produced in Silver Bow County came from this district. Leading producers were two Anaconda company copper mines—the Berkeley open pit and Kelley block-caving operation. The Anaconda Butte Hill vein mines (Mountain Con and Steward) ranked third in copper output. Over 8 million pounds of copper was recovered from mine water through precipitating operations of The Anaconda Company.

Silver ore was mined by Anaconda at the Alice mine, and old tailings from the Champion mine yielded silver ore for treatment at the company smelter.

Zinc mining was terminated by The Anaconda Company during the year; the only zinc property mined by the company was the Alice pit, from which approximately 170,000 tons of ore was taken.

615629—61——40

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 (thousand short tons)	Gold, lode and placer (troy ounces)	Silver, lode and placer (thousand troy ounces)
1951-55 (average)	20	5,271	18,426	5,600
1956	21	9,395	31,132	6,772
1957	19	10,673	27,312	5,069
1958	22	10,745	17,374	3,308
1959	16	8,679	18,615	3,204
1960	11	12,169	21,819	2,918
1882-1960		(1)	2,312,000	618,168

Year	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
1951-55 (average)	67,315	15,081	69,551	$69,521
1956	96,292	14,989	63,375	111,138
1957	91,393	9,617	43,169	73,328
1958	90,557	5,492	26,580	57,942
1959	65,810	4,456	22,459	50,149
1960	91,754	1,889	4,755	63,980
1882-1960	7,541,000	398,000	2,284,000	3,490,175

[1] Data not available.

The Anaconda Company annual report to shareholders stated that:

Underground and pit mining operations in Butte, Montana, were resumed on February 15, following settlement of the prolonged strike which started in these and other Western Operations on August 19, 1959. Full production from the mines was attained in March 1960.

Production of copper at the Berkeley pit in Butte averaged 32,610 tons per operating day, compared with an average of 28,500 tons per operating day in 1959. The average stripping ratio during this period was 2.40 tons of waste for each ton of ore mined.

A new and revolutionary type of electric truck is undergoing tests at the Berkeley pit, and results to date are encouraging. This vehicle, designed to haul approximately 70 tons per load, travels out of the pit on a 15 percent grade at a speed of from twelve to fifteen miles per hour. The development of a truck of this type will be a major improvement in cost and efficiency of hauling ore and waste from this and other open pits to the company as they increase in depth and length of haul.

The Kelley block-caving operation produced a daily average of 11,505 tons of copper ore. Nine new ore blocks were brought into production during the year, and the 1600 level was being prepared for production by the installation of track and other facilities.

High grade copper ore was produced from veins in the Mountain Con mine. The Steward vein mine was rehabilitated, and preparations are in progress to put it on an operating basis. Recent development work on lower levels of this mine has disclosed new high grade copper ore.

To improve production efficiency and to prepare for working the deeper levels of the Butte mines, several new projects were started during the past year. The principal project is the deepening of the Kelley No. 1 shaft for centralized hoisting. The sinking of the Mountain Con shaft was resumed to develop the high-grade ores which occur below present working levels. An internal subshaft is being sunk from the 4000 level of the Steward mine. This subshaft, the deepened Mountain Con shaft, and other subshafts will later become tributaries to a common 4400-foot level for transfer of ore to the Kelley No. 1 shaft.

The Tuolomne shaft is being rehabilitated and deepened and will be equipped for use as a new central pumping facility for the Butte mines. When completed, it will replace the central pumping plant now located at the High Ore shaft.

Two new fully automatic, rotary air compressors are being installed at the Cora compressor plant to replace the obsolete Leonard plant facilities.

The Anselmo zinc mine and the Emma manganese mine were not reopened after the strike.

Mining of zinc ore accessible through pit operations was completed at the Alice pit, and the operation terminated on July 29.

Work on the Elm Orlu-Black Rock low-grade zinc project was suspended, pending improvement in metal prices.

The company reported that the Butte, Anaconda & Pacific Railway Co. handled a record total of 12,709,515 tons of ore during the year.

Mines operating in the district not owned by Anaconda were the Mat lease (zinc), Mono Receiver No. 2 (silver), Northern Pacific (silver), Poser (silver), and Tuxedo (silver).

Victor Chemical Works mined phosphate rock at its Maiden Rock property near Melrose. Output, which was higher than in 1959, was processed to elemental phosphorus at the company Silver Bow plant.

Stillwater.—A small tonnage of gold ore was extracted from the Senate property in the *Yellowstone River* mining district.

American Chrome Co. continued mining and milling chromite for delivery to the Federal Government under a purchase contract. A small tonnage of concentrate was used in a company pilot plant for producing ferrochromium. The company annual report made the following statement, concerning the ferrochromium operation:

The addition of a refining furnace to the ferrochrome smelter pilot plant was completed in September and a production run of 520 tons of refined chrome was made. . . . Carload-lot sales of it have been made to leading steel companies. . . . . . Unfortunately the location of the mine imposes a marketing handicap because of high rail freight to the distant stainless steel production areas, and as the deposit contains only one grade of ore the range of ferrochrome grades which can be smelted from it is limited; also this ore must compete with cheap foreign ore imported without duty. . . .

The comprehensive marketing studies which American Chrome Company has made, as well as Government statistics on use, show a growing demand for ferrochrome and for use of the grades which can be produced at Nye. The steel companies have stated they would like to see a domestic source chromium facility operating in the United States. . . . A vigorous effect is being made to accomplish this objective and a Proposal to the Government is being made by American Chrome for smelting into ferrochrome the 900,000 ton chromite ore concentrate stockpile being completeed in 1961. Conversion of this stockpile would result in 388 million pounds of chromium. . . .

Toole.—Whitlash Mining Co. mined 31 tons of copper ore from the Whitlash mine in the *Gold Butte* district.

Valley.—Value of sand and gravel output dropped to $495,000 from $1.6 million in 1959 because of lessened demand by the U.S. Army Corps of Engineers at its Glasgow Air Force Base project and by the Bureau of Reclamation at the Milk River project. Valley County dropped from first to third place in output of sand and gravel.

Yellowstone.—Recovery of crude oil from two fields declined to 376,000 barrels—155,000 barrels less than in 1959. Waste gases from the Continental Oil Co. and Humble Oil & Refining Co. refineries near Billings were transported to Montana Sulphur & Chemical Co. for conversion to high-purity elemental sulfur.

The county ranked second in sand and gravel production. Output was moderately larger than in 1959. Shale was expanded to lightweight aggregate by a company near Billings. Lovell Clay Products Co. made heavy clay products from clay mined locally.

The Mineral Industry of Nebraska

By D. H. Mullen [1]

THE VALUE of mineral production in Nebraska in 1960 continued to rise and reached $103.7 million, a gain of 7 percent. Of all minerals produced, only clays and pumice failed to increase in value. The mineral fuels (natural gas, natural gas liquids, and petroleum) furnished 73 percent of the total value of all mineral output and 75 percent of the increase over the 1959 value. Output of petroleum increased 1.5 million barrels and was credited with 68 percent of the value of all minerals. Petroleum exploratory and development drilling was less than that of the preceding year; however, the success ratio remained high. An important achievement was the successful exploratory program in the Cambridge Arch area, east of the Denver-Julesburg basin, where the first production from Cambrian formations was made.

Modest but continued gains in value noted for most of the nonmetals contributed to the gradual increase in total value of mineral production.

TABLE 1.—Mineral production in Nebraska [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	131	$133	108	$109
Gem stones	(2)	3	(2)	4
Natural gas—million cubic feet	13,128	2,087	15,258	2,670
Petroleum (crude)—thousand 42-gallon barrels	22,881	65,897	[3] 24,428	[3] 70,108
Sand and gravel—thousand short tons	11,202	8,301	10,876	8,746
Stone—do	3,236	5,235	3,336	5,651
Value of items that cannot be disclosed: Cement, natural gas liquids, and pumice	----	17,679	----	18,384
Total Nebraska [4]	----	[5] 97,130	----	103,687

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Preliminary figure.
[4] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime (1959).
[5] Revised figure.

Construction of the 75,000-kilowatt sodium-cooled, graphite-moderated nuclear powerplant being built by the Atomic Energy Commission (AEC) at Hallam, and begun in April 1959, was 55 percent complete

[1] Commodity-industry analyst, Bureau of Mines, Denver, Colo.

at the end of the year; completion was scheduled for early 1962. Careful review of the design of the reactor, conducted to evaluate the possibility of an incident such as fuel-element failure, resulted in some design changes. The reactor will supply power to the distribution system of the Consumers Public Power District of Nebraska, which will operate the AEC reactor. Construction progress was delayed because the reactor vessel—successfully shipped by barge from Philadelphia by way of the Atlantic Ocean, Gulf of Mexico, Mississippi, and Missouri Rivers to a landing in Nebraska—slipped from a truck trailer 40 miles from the plant site on June 22. Reloading the 65-ton vessel, 22 feet in diameter and 35 feet in height was difficult; but it was delivered to Hallam on July 11. A complete examination showed that the vessel had sustained on serious damage; it was then moved into place.

Employment and Injuries.—Table 2 shows 1960 Bureau of Mines employment and injuries data in the minerals industries, exclusive of petroleum.

TABLE 2.—Employment and injuries in the mineral industries[1] in 1960[2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
Sand and gravel	180	761	1,420,464	----------	12	8.4
Stone	31	603	1,457,856	----------	16	11.0
Other[3]	7	236	735,550	----------	4	5.4
Total	218	1,600	3,613,870	----------	32	24.8

[1] Excludes petroleum.
[2] Preliminary figures.
[3] Includes clay and pumice mines and a refinery.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Natural Gas.—Natural gas from gas wells and oil-well gas after processing, marketed through pipelines, was 16 percent greater than in 1959. Dry natural gas came from fields in Deuel and Cheyenne Counties, and oil-well gas came from fields in Kimball, Banner, and Cheyenne Counties.

Natural Gas Liquids.—Natural gasoline, butane, and propane recovery at natural-gasoline plants was 9 percent above that of 1959. Natural gas liquids were recovered at five plants, two in Cheyenne, two in Kimball, and one in Deuel Counties. Natural-gasoline plants at the Big Springs field in Deuel County and at the West Sidney field in Cheyenne County were refrigeration-absorption plants; the Kimball and Banner plants near Kimball and the Huntsman plant in Cheyenne County were absorption plants. Daily capacity of the plants was 77.5 million cubic feet, and the average daily throughput was 68.9 million cubic feet.

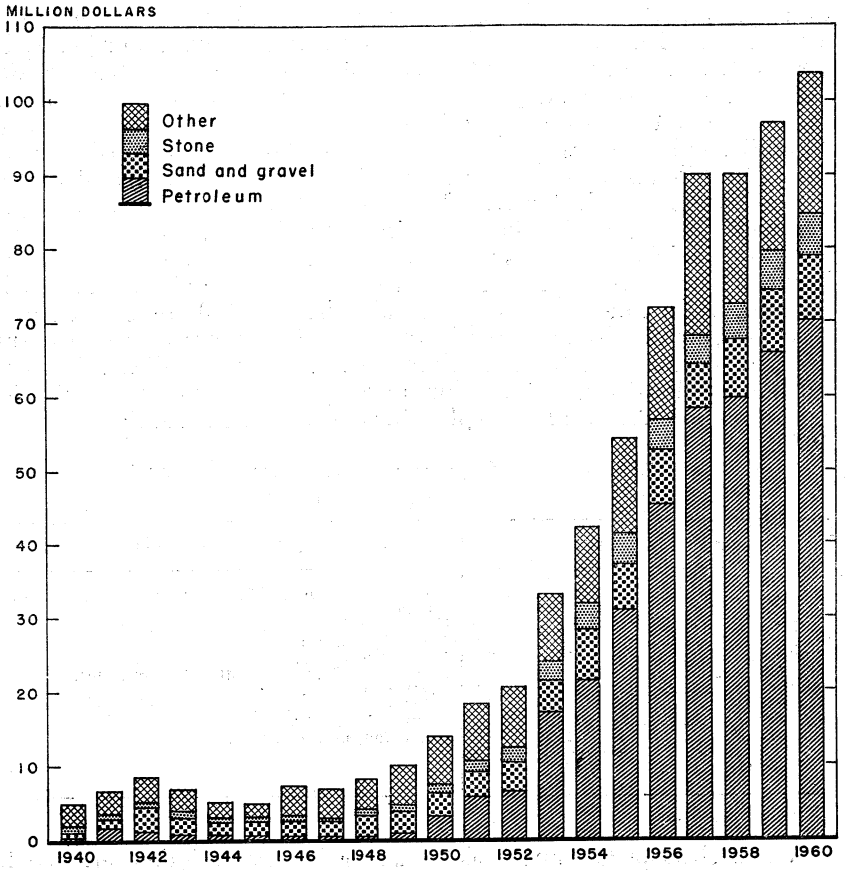

FIGURE 1.—Value of petroleum, sand and gravel, and stone, and total value of mineral production in Nebraska, 1940–60.

Petroleum.—Petroleum production from 1,571 wells in 255 fields in 9 counties was 7 percent above that of 1959. The increase in value (5 percent) represented 64 percent of the gain in total value of mineral production in 1960. Exploratory drilling, although lower than in 1959, was rewarding. Of 391 wells drilled, 36 were successful, giving a success ratio of 9 percent. The exploratory drilling east of the Denver-Julesburg basin in Red Willow, Dundy, and Hitchcock Counties along the Cambridge Arch, evoked considerable interest. Drilling in this area resulted in producing wells in Pennsylvanian formations. At the Sleepy Hollow field, production was obtained from Pennsylvanian and Cambrian formations, the latter the first in the State. Most of the exploratory drilling was done in the Nebraska part of the Denver-Julesburg basin where 307 wells were completed; 30 were successful for a success ratio of 9 percent, 1 percent less than in 1959. This drilling was centered in Banner, Cheyenne, and Kimball Counties, and, to a lesser extent, in Morrill

County. Of 34 additional exploratory wells drilled to the north and east in Box Butte, Dawes, Scotts Bluff, and Sioux Counties, 1, in Scotts Bluff, was successful. Although development drilling declined, it was particularly successful along the Cambridge Arch. In the Ackman field, discovered late in 1959 in Red Willow County, 46 additional wells, all producing from the Oread and Lansing-Kansas City (Pennsylvanian) formations, were completed; and at the Sleepy Hollow field, discovered in 1960, 19 wells were producing at yearend. At the Reiher field in Hitchcock County, a 1959 discovery, an additional 21 producers were completed. In the Denver-Julesburg basin, 53 new producers were completed in Kimball County, 46 in Banner, 29 in Cheyenne, and 22 in Morrill. Of 150 fields in the area having some development drilling, 26 had 2 or more new producers; of these, 8 had more than 3. Total drilling was 4.9 million feet (2.1 million exploratory, 2.8 million development) compared with 5.4 million feet (2.4 million exploratory, 3.0 million development) in 1959.

TABLE 3.—Crude petroleum production, by counties

(Thousand barrels)

County	1959	1960 [1]	Principal fields in 1960 in order of production
Banner	7,303	7,771	Singleton, Willson Ranch, Barrett, Brinkerhoff, Kenmac Ludden.
Cheyenne	4,155	3,822	Cook, Itner, Doran, Dorman, Juelfs, Spearow.
Garden	7	6	McCord, Richards.
Hitchcock	75	294	Reiher, Culbertson.
Kimball	10,238	10,975	Sloss, Brook, Southwest Potter, Enders, Jaunto.
Morrill	933	757	Olsen, Lane, Craig.
Red Willow	13	553	Ackman, Sleepy Hollow.
Richardson	142	153	Dawson, Falls City.
Scotts Bluff	15	97	Cedar Canyon, Roubadeau.
Total	22,881	24,428	

[1] Preliminary figures.

The Nebraska Oil and Gas Conservation Commission, created by the State Legislature in 1959, completed its staff with headquarters at Sidney in Cheyenne County. For each of nine fields, the Commission ordered special rules specifying semi-annual bottom-hole pressure surveys of key wells and quarterly gas-oil ratio tests at all wells. An intensive bottom-hole pressure and production tests at the Russell field in Kimball County were completed to determine the producing mechanism in the reservoir. Production was limited at three fields to conserve reservoir energy and use that energy properly. A maximum gas-flow limitation was ordered at the Rohlfing field in Cheyenne County until operators installed compression facilities and marketed the casing-head gas produced. An 80-acre well-spacing pattern was established temporarily at the Culbertson field, discovered in 1960, to determine the most economical method of development. The Commission staff completed a prescriptive field nomenclature for the entire State.

TABLE 4.—Wildcat- and development-well completions in 1960, by counties

County	Crude	Gas	Dry	Total	Footage
Wildcat:					
Arthur			1	1	5,100
Banner	9		63	72	451,600
Box Butte			2	2	6,700
Buffalo			4	4	16,360
Chase			2	2	9,900
Cheyenne	7		66	73	376,900
Dawes			1	1	3,000
Dawson			2	2	7,700
Deuel			3	3	10,600
Dundy	1		6	7	34,900
Frontier			4	4	15,600
Furnas			3	3	10,700
Gage			2	2	3,400
Gosper			1	1	3,900
Hall			1	1	4,100
Harlan			2	2	8,800
Hitchcock	1		11	12	54,600
Holt			1	1	3,600
Johnson			1	1	1,600
Kearney			1	1	4,400
Kimball	9		83	92	602,100
Lincoln			1	1	1,700
Morrill	4		32	36	170,500
Phelps			1	1	4,100
Red Willow	4		33	37	137,700
Scotts Bluff	1		10	11	60,100
Sioux			17	17	74,600
Wheeler			1	1	3,300
Total	36		355	391	2,087,500
Development:					
Banner	46		[1] 76	122	751,300
Cheyenne	29	2	[1] 43	74	375,000
Deuel			1	1	3,400
Dundy	1			1	4,500
Hitchcock	22		1	23	94,000
Kimball	53		113	166	1,094,300
Morrill	22		13	35	168,200
Red Willow	68		11	79	280,100
Richardson	1			1	3,300
Scotts Bluff	1		1	2	11,600
Total	243	2	[2] 259	504	2,785,700
Total all drilling	279	2	[2] 614	895	4,873,200

[1] Includes one service-well completion.
[2] Includes two development service-well completions.

Source: The Oil and Gas Journal.

NONMETALS

Cement.—Shipments of portland and masonry cements from plants in Cass and Nuckolls Counties declined slightly although the value was higher. Prices in 1960 averaged $3.45 per barrel for portland cement and $4.42 for masonry cement, compared with $3.31 and $4.23, respectively, in 1959. Shipments were made to consumers in Nebraska (79 percent) and Iowa (15 percent), and in lesser amounts, to consumers in South Dakota, Kansas, Minnesota, and Colorado. The eight kilns at the two plants, operating an average of 322 days each, had an output rate of 94 percent of capacity. Approximately 71.6 million kw. hours of electricity, all purchased, was used at the plants. One plant used finished portland cement as a base for manufacture of masonry cement; the other used cement clinker.

Clays.—Fire clay and miscellaneous clay were produced in four counties for manufacturing art pottery, building brick, draintile, sewer pipe, other clay products, and portland cement. Total clay production was 18 percent below that of 1959.

Gem Stones.—Gem stones and gem materials such as agate, agatized wood, jasper, petrified wood, and chalcedony were collected by gem societies and individuals in various parts of the State. The value, reported by collectors, was 33 percent above that of 1959.

Perlite.—Crude perlite from deposits in New Mexico was processed by Western Mineral Products Co. at its Omaha plant. The expanded product was used in building plaster and as a concrete aggregate.

Pumice.—The value of pumice produced in Custer County was 5 percent below that of 1959. The crude pumice was ground and sized for use in cleansing and scouring compounds and as an abrasive.

Sand and Gravel.—Production of sand and gravel came from 59 of the State's 93 counties. Output declined 3 percent in quantity but increased 5 percent in value compared with 1959, as more of the product was prepared. Commercial production at 134 operations in 54 counties was 93 percent of the State total. Major uses included paving and road construction (57 percent) and building (37 percent). Of the remaining 6 percent, produced by Government crews and contractors in 16 counties, 78 percent was used for roadbuilding and 11 percent each for building and fill. Fifty-nine percent of the total production was used for road construction and 35 percent for building. The quantity of sand and gravel washed, screened, or otherwise prepared continued to increase and was 88 percent of the total compared with 76 percent in 1959. The value of sand and gravel ranged from $0.44 per ton for unwashed material to $0.84 for washed. Counties that produced more than 500,000 tons each were Cass (1,165,200 tons), Dodge (1,115,100 tons), Douglas (869,400 tons), Hall (764,600), and Sarpy (834,300 tons).

Construction of the National System of Interstate and Defense Highways continued. Because the Bureau of Public Roads changed its method of reporting progress in 1960, no comparable data were available for 1959; however, a report [2] showed that from July 1, 1956, to December 31, 1960, 27.9 miles of the Interstate System had been completed to full standards; 12.9 miles, of which 0.3 mile was toll, had been improved to standards adequate for current traffic; 31.1 miles were under construction; and engineering and right-of-way acquisition had started on 195.1 miles. Total designated mileage of the system in Nebraska was 489.5 miles, leaving 222.2 miles to be planned and built. Under the Federal-Aid program for primary, secondary, and urban highways, 693.7 miles were completed, and 896.8 miles were under construction.

Stone.—Crushed and broken limestone was produced in 12 counties, and dimension limestone (rubble) was produced in 2 counties. Total stone output gained 3 percent in quantity and 8 percent in value over that of 1959. Crushed limestone was used as riprap, concrete aggregate, and road material and was also used in manufacturing cement,

[2] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960, press release BPR 61–6, Feb. 22, 1961.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	1,985	$1,534	1,821	$1,478
Paving	762	575	780	598
Railroad ballast	(1)	(1)	18	10
Fill	132	81	170	95
Other	30	12	61	24
Industrial sand:				
Blast	5	5		
Engine	1	1	1	(2)
Total sand	2,915	2,208	2,851	2,205
Construction gravel:				
Building	2,110	1,756	1,905	1,620
Paving	5,182	3,594	5,005	4,113
Railroad ballast	1	1		
Fill	33	27	6	5
Other	164	109	6	6
Miscellaneous gravel			341	224
Total gravel	7,490	5,487	7,263	5,968
Total sand and gravel	10,405	7,695	10,114	8,173
Government-and-contractor operations:				
Sand:				
Building			22	11
Paving	78	30	41	17
Total sand	78	30	63	28
Gravel:				
Building			62	31
Paving	719	576	552	489
Fill			85	25
Total gravel	719	576	699	545
Total sand and gravel	797	606	762	573
All operations:				
Sand	2,993	2,238	2,914	2,233
Gravel	8,209	6,063	7,962	6,513
Grand total	11,202	8,301	10,876	8,746

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other" sand.
[2] Less than $1,000.

as agricultural lime, for whiting, and as a filler in rubber, putty, and asphalt. In two counties, contractors produced crushed limestone for riprap and road construction for the State department of roads and county highway departments. Major production came from Cass, Nemaha, and Washington Counties.

Talc.—Sierra Talc Co. ground crude talc from mines in California and Montana at its plant at Grand Island in Hall County for use in ceramics, paint, plastics, paper, rubber, textiles, and toilet preparations.

Vermiculite.—Western Mineral Products Co. exfoliated crude vermiculite from mines in Montana at its plant in Omaha. The product was used for loose-fill insulation, as an aggregate in plaster, and for litter in stock pens.

METALS

Although no metals were produced in Nebraska, substantial quantities of ferrous and nonferrous metals were used at numerous manufacturing plants. Lead bullion from smelters in other States was refined by the American Smelting and Refining Co. (Asarco) at its plant in Omaha. Antimonial lead also was recovered as a byproduct.

REVIEW BY COUNTIES

Banner.—Banner County retained second place in production of petroleum. Output from 399 wells in 57 fields was 7.8 million barrels, a gain of 468,000 barrels or 6 percent over that of 1959. Major production came from the Singleton, Willson Ranch, Barrett, and Brinkerhoff fields. Of 66 exploratory wells completed, 7 were successful. All were within four townships in the center of the county, and each was less than 2 miles from producing areas.

The Falstaff field, discovered in October, began by producing 200 barrels of oil a day on pump from the J sandstone at a depth of 6,583 to 6,586 feet. An offset well to the east also pumped 200 barrels of oil a day, but offsets to the northeast and west were failures. The discovery well at the Bull Canyon field, west of any previously producing well in the county, was completed in February and pumped 187 barrels of oil a day from the J standstone at a depth of 6,755 to 6,759 feet. An offset well to the northeast was abandoned. Farther east in the same township, discovery wells were completed at the Gabe Rock field in January and at the Showlow field in August. Beginning production at each was 100 barrels of oil a day on pump from the J sandstone. Offsets at each field were failures. The North Lovercheck field, separated from the Lovercheck field by dry holes, was discovered in July. Starting production was 110 barrels of oil a day on pump from the J sandstone at a depth of 6,040 to 6,044 feet. An offset well to the north confirmed the discovery, but offset wells to the northeast and northwest were failures. The only D-sandstone discovery in the county during the year was completed in July at the Red Dog field; the discovery well pumped 125 barrels of oil a day at a depth of 6,239 to 6,253 feet. An offset well to the east was abandoned.

Development drilling resulted in 46 new producing wells, chiefly in the Willson Ranch field and 7 other fields. Oil-well gas from some Banner County fields was processed at natural-gasoline plants in Kimball County.

The county highway department produced paving gravel for road construction.

Cass.—The county led in the value of cement, clay, and stone; was second in sand and gravel; and ranked third in total value of mineral production. The value of mineral production represented 59 percent of the value of all nonmetal production and 16 percent of all mineral production in the State.

The Louisville plant of the Ash Grove Lime & Portland Cement Co. produced portland and masonry cements. Cement rock and shale used at the plant were mined from nearby deposits. Finished portland cement was used as a base for manufacturing masonry cement.

TABLE 6.—Value of mineral production in Nebraska, by counties [1]

County	1959	1960 [2]	Minerals produced in 1960 in order of value
Adams	$10,700	$38,100	Sand and gravel.
Antelope	(3)	17,700	Do.
Banner	21,050,740	[4] 22,342,500	Petroleum, sand and gravel.
Boone	(3)	(3)	Sand and gravel.
Boyd	16,900	15,200	Do.
Brown	37,100	(3)	Sand and gravel, gem stones.
Buffalo	523,000	241,100	Sand and gravel.
Butler	45,500	237,600	Do.
Cass	14,709,533	16,458,417	Cement, stone, sand and gravel, clays, gem stones.
Cedar	63,400	168,400	Sand and gravel.
Chase	2,800	----	
Cheyenne [4]	11,966,400	10,972,500	Petroleum, sand and gravel.
Clay	136,100	122,800	Sand and gravel.
Colfax	74,300	62,200	Do.
Cuming	(3)	189,100	Do.
Custer	64,200	(3)	Pumice.
Dawes	(3)	155	Gem stones.
Dawson	131,525	193,250	Sand and gravel, gem stones.
Deuel [4]	----	----	
Dixon	42,700	69,042	Sand and gravel, stone, gem stones.
Dodge	836,800	912,000	Sand and gravel, stone.
Douglas	781,151	823,820	Sand and gravel, clays.
Fillmore	105,800	(3)	Sand and gravel.
Franklin	32,000	(3)	Do.
Frontier	5,000	----	
Furnas	103,900	(3)	Sand and gravel.
Gage	264,150	(3)	Sand and gravel, stone.
Garden	20,160	82,400	Sand and gravel, petroleum.
Hall	361,800	545,700	Sand and gravel.
Hamilton	65,400	61,200	Do.
Harlan	17,400	----	
Hayes	(3)	(3)	Sand and gravel.
Hitchcock	236,300	872,600	Petroleum, sand and gravel.
Holt	71,100	67,300	Sand and gravel.
Jefferson	294,085	226,634	Sand and gravel, clays.
Kearney	37,500	95,800	Sand and gravel.
Keith	28,200	45,500	Do.
Kimball [4]	[5] 29,494,460	31,537,400	Petroleum, sand and gravel.
Knox	160,600	235,800	Sand and gravel.
Lancaster	175,645	(3)	Stone, clays.
Lincoln	10,000	150,805	Sand and gravel, gem stones.
Loup	----	31,000	Sand and gravel.
Madison	219,600	161,800	Do.
Merrick	4,400	(3)	Do.
Morrill	2,761,340	2,268,300	Petroleum, sand and gravel.
Nance	65,150	67,350	Sand and gravel, gem stones.
Nemaha	(3)	(3)	Stone.
Nuckolls	(3)	(3)	Cement, sand and gravel.
Otoe	(3)	70,200	Stone.
Pawnee	129,800	304,200	Do.
Perkins	36,500	12,200	Sand and gravel.
Phelps	124,900	83,500	Do.
Pierce	92,800	110,700	Do.
Platte	493,600	353,600	Do.
Polk	5,000	(3)	Do.
Red Willow	90,040	1,654,700	Petroleum, sand and gravel.
Richardson	568,460	572,638	Petroleum, sand and gravel, stone.
Saline	35,600	84,200	Sand and gravel.
Sarpy	1,362,800	(3)	Sand and gravel, stone.
Saunders	771,650	(3)	Sand and gravel, gem stones.
Scotts Bluff	200,800	344,900	Petroleum, sand and gravel.
Seward	(3)	(3)	Stone.
Sheridan	----	1,800	Sand and gravel.
Sherman	----	21,800	Do.
Sioux	(3)	10,360	Sand and gravel, gem stones.
Stanton	(3)	(3)	Sand and gravel.
Thayer	72,400	176,800	Do.

See footnotes at end of table.

TABLE 6.—Value of mineral production in Nebraska, by counties[1]—Continued

County	1959	1960[2]	Minerals produced in 1960 in order of value
Thomas	$300		
Valley	(3)	$41,700	Sand and gravel.
Washington		(3)	Stone.
Webster	(3)	(3)	Sand and gravel.
York	(3)	(3)	Do.
Undistributed[6]	[5] 10,322,943	12,514,902	
Total[7]	[5] 97,130,000	103,687,000	

[1] The following counties are not listed because no production was reported: Arthur, Blaine, Box Butte, Burt, Cherry, Dakota, Dundy, Garfield, Gosper, Grant, Greeley, Hooker, Howard, Johnson, Keya Paha, Logan, McPherson, Rock, Thurston, Wayne, and Wheeler.
[2] Value of petroleum is preliminary.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Excludes natural gas and natural gas liquids.
[5] Revised figure.
[6] Includes natural gas liquids, natural gas, some gem stones and sand and gravel (1959) that cannot be assigned to specific counties, and values indicated by footnote 3.
[7] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime (1959).

Kahler Pottery Co., Inc., mined fire or stoneware clay for manufacturing art pottery and flowerpots. Sand and gravel for building and paving was produced by Lyman-Richey Sand & Gravel Corp. at its Nos. 5 and 6 plants and by Western Sand & Gravel Co. at its Cedar Creek and South Bend plants.

Cheyenne.—Petroleum production from 327 wells in 63 fields was 3.8 million barrels, a decline of 8 percent from 1959; however, the county continued to rank third in petroleum output. Of 73 exploratory wells drilled, 7 in the northern half of the county were successful. The Faro field, 1.5 miles north of the Reimers field, was completed in April. Beginning production was 336 barrels of oil a day from the J sandstone at a depth of 4,773 to 4,775 feet. Offset wells to the east, south, and west and a stepout well to the northwest were failures. At the Keno field (discovered in June), east of the Sell field, early production was 200 barrels of oil a day from the D sandstone at a depth of 4,419 feet. Three offset wells were failures. The discovery well at the Black Jack field was completed in March and pumped 110 barrels of oil a day from the J sandstone at a depth of 5,399 feet. Two offset wells were abandoned. The discovery well at the Bezique field, completed in July, pumped 145 barrels of oil a day from the J sandstone at a depth of 5,343 to 5,353 feet. No extensions were attempted; however, the field was important because of its proximity to three other fields in the same township. Other discoveries and their beginning production rates were the West Sell field, 72 barrels of oil a day from the D sandstone, and the Ace High field, 148 barrels of oil a day from the J sandstone. New producers resulting from development drilling were in the Frei field (a 1959 discovery), and the Slama, Engelland, Graff, and Pebble fields. Oil-well gas from Cheyenne and Banner County fields was processed by Ohio Oil Co. at its Huntsman and West Sidney fields. Combined daily capacity of the plants was 25 million cubic feet of gas, and daily throughput averaged 18.5 million cubic feet. Natural gasoline, butane, and propane were recovered; and the residual gas was marketed through pipelines.

Deuel.—Natural gas from the Big Springs field was processed by Kansas-Nebraska Natural Gas Co., Inc., at its Big Springs compressor and refrigeration-absorption plant. The plant operated at capacity with a daily throughput of 35 million cubic feet of gas. Natural gasoline, butane, and propane were recovered; the residual gas was marketed through company-owned pipelines.

Dodge.—The county ranked second in producing sand and gravel. The output was used for building, paving, and fill material. Major producers were the Lyman-Richey Sand & Gravel Corp. Nos. 12 and 13 plants, Christensen Sand & Gravel Co., Lincoln Sand & Gravel Co., and Lux Sand & Gravel Co. Uehling Fertilizer Service produced limestone for agricultural use.

Douglas.—The county ranked third in producing sand and gravel, which was used as building, road-construction, and fill materials. Major producers were the Lyman-Richey Sand & Gravel Corp. Nos. 9 and 11 plants, Acme Sand & Gravel Co., Hartford Sand & Gravel Co., and McCann Sand & Gravel Co. Paving gravel was produced for the county highway department. Asarco operated its lead refinery at Omaha. Western Mineral Products Co. processed perlite and vermiculite from deposits in Western States in Omaha. Omaha Brick Works produced miscellaneous clay for manufacturing building brick and other heavy clay products.

Dundy.—One of the new oilfields discovered in 1960 was in Dundy County. Seven exploratory wells were completed. The discovery well at the Pierce Lake field, completed in November, pumped 203 barrels of oil a day from the Lansing-Kansas City (Pennsylvanian) formation at a depth of 4,138 feet. Two offset wells were successful, but no production was recorded for 1960.

Garden.—Petroleum production from the McCord and Richards fields was 14 percent below that of 1959. No drilling was done in the county during the year. Oshkosh Sand & Gravel produced building, paving, and fill sand. Sand and gravel for building and paving was produced for State, county, and city highway departments.

Hall.—Nine operators produced sand and gravel for building, paving, and fill. A small quantity of engine sand also was produced. Major operators were Luther & Maddox, H & M Equipment Co., Inc., Third City Sand Co., and Armour Construction Co. The Sierra Talc Co. plant in Grand Island ground crude talc from deposits in California and Montana.

Hitchcock.—Petroleum production from 38 wells in 3 fields increased nearly fourfold over that of 1959. In July and August the North Fork and the Culbertson fields, respectively, were discovered from the 12 exploratory wells completed. North Fork initial production was 48 barrels a day on pump from the Lansing-Kansas City formation at a depth of 4,060 to 4,064 feet. The Culbertson discovery well pumped 288 barrels of oil a day from the Lansing-Kansas City formation at a depth of 3,765 to 3,902 feet. At the Culbertson field, which may develop into a major producer, the State Oil and Gas Conservation Commission temporarily established an 80-acre well-spacing pattern as a means of observing the effects of wide well spacing on the yield of newly discovered fields. The Burr Oak and

Frakes fields, discovered in 1958 and 1959, respectively, were combined with the Reiher field, a 1959 discovery. The only other production came from the one-well Hudson field, a 1958 discovery. Development drilling, all in the Reiher area, added 22 new producers. One unsuccessful well was drilled just north of the field.

Jefferson.—Endicott Clay Products Co. mined miscellaneous clay for manufacturing building brick and other heavy clay products. Sand and gravel for building, paving, fill material, and other uses was produced by Consolidated Sand & Gravel Co., R. M. Weblemoe Co., and Steele Bros. Total sand and gravel production was 278,000 tons.

Kimball.—The county led in petroleum production and in value (30 percent) of all mineral production. Petroleum output, from 766 wells in 111 fields, was 7 percent above that of 1959. Exploratory and development drilling was extensive, but at a lower rate than in 1959. Of 92 exploratory wells completed, 9 were successful. Completed in April, the discovery well of the Haussner field near the western border of the county pumped 276 barrels of oil a day from the J sandstone at a depth of 7,176 to 7,180 feet. A step-out well 1 mile to the southeast, also completed in April, pumped 245 barrels of oil a day from the J sandstone in an open hole at a depth of 7,213 to 7,221 feet. Offset wells to the north and southeast were abandoned. The Euchre field, discovered in February, 2 miles northeast of the Haussner, had an initial production of 600 barrels of oil a day on pump from the J sandstone at a depth of 7,007 feet. Offset wells to the east, south, and west were abandoned, but an offset to the north pumped 205 barrels of oil a day from a 2-foot interval in the J sandstone. The Hilltop field north of Kimball was discovered in June. The discovery well pumped 260 barrels of oil from the J sandstone at a depth of 6,411 to 6,419 feet. An offset well to the west pumped 123 barrels of oil a day. The Malcolm field, discovered in September, directly west of the Hilltop, initially produced 240 barrels of oil a day on pump from the J sandstone at a depth of 6,420 feet. Three confirmation wells were failures. The Alpha field, southeast of the Cornils field, was discovered in October; its beginning production was 237 barrels of oil a day from the J sandstone at a depth of 7,004 to 7,018 feet. An offset well to the west and a step-out well to the northwest were failures. The Bravo field, discovered 2 miles east of the Alpha in August, initially produced 14 barrels of oil a day from the J sandstone at a depth of 6,872 to 6,875 feet. The Yukon field, discovered in October, southwest of the Russell field, pumped 181 barrels of oil a day from the J sandstone at a depth of 7,126 to 7,128 feet. Other discoveries and beginning production rates were the Apatite field, discovered in October, 62 barrels of oil a day on pump from the J sandstone; the Wewoka field, discovered in February, 141 barrels of oil a day on pump from the J sandstone; and an unnamed field, discovered in December, 40 barrels of oil a day on pump from the J sandstone.

Development drilling resulted in 55 new producing wells. Three fields, discovered in 1959, had considerable success. At the Russell field, eight wells were completed along the southern end; five wells

that failed were completed to the east, south, and west. Development added 4 producers and 4 failures to the Painter field in the central part of the county, and at the Brook field 12 new producers were completed. At the Southwest Potter field, discovered in 1951 in Kimball and Cheyenne Counties, five new oil wells were completed. Two to three new producers, each, were completed at the Cabella, Cornils, Fernquist, Fifer, Hill, Houtby, and Simpson fields.

Oil-well gas from fields in Kimball and Banner Counties was processed at the Kimball and Banner gasoline plants near Kimball by Antelope Gas Products Co. Natural gas liquids (natural gasoline, butane, and propane) were recovered, and residual gas was marketed through pipelines. Combined daily capacity of the plants was 17.5 million cubic feet of gas, and average daily throughput was 15.4 million cubic feet. Wilson Brothers, Inc., produced building and fill gravel.

Lancaster.—Yankee Hill Brick Manufacturing Co. produced miscellaneous clay for manufacturing building brick and other heavy clay products. Schwarck Quarries, Inc., produced dimension limestone (rubble) for building and crushed limestone for concrete aggregate, road building, and agricultural use.

Morrill.—Petroleum production from 60 wells in 11 fields was 19 percent below that of 1959. Exploratory drilling resulted in the discovery of four new fields. The Cutthroat field (discovered in July), about a mile north of the Cheyenne County line, initially produced 262 barrels of oil a day from the J sandstone at a depth of 5,230 to 5,234 feet. The Matador field, discovered in July, pumped 512 barrels of oil a day from the J sandstone at a depth of 5,110 to 5,112 feet. An offset well to the east was a failure. Beginning production from an unnamed field, discovered in December, 1 mile southeast of the Lindberg, was 263 barrels of oil a day on pump from the J sandstone at a depth of 5,254 to 5,270 feet. The most significant discovery was the Dunlap field, 5 miles northeast of the Craig field. The discovery well, completed in February, pumped 209 barrels of oil a day from the D sandstone at a depth of 4,120 to 4,123 feet. An offset well to the south pumped 309 barrels of oil a day; a third well pumped 465 barrels of oil a day. Offset wells to the east, north, and west were failures.

Development drilling, resulting in 23 new producers, was almost entirely in the Waitman field (18 new wells), discovered in 1957, and at the Lane field. Lyman-Richey Sand & Gravel Corp. produced building and paving sand and gravel at its No. 23 plant.

Nemaha.—Crushed and broken limestone for riprap, concrete aggregate, road construction, and agriculture was produced by Colaska Production Co. and Nelson Quarries, Inc.

Nuckolls.—Portland and masonry cements were produced at the Superior plant by Ideal Cement Co. Cement rock used at the plant was mined by the company at a quarry in Jewell County, Kans. The plant operated near capacity for 323 days. Portland cement clinker was used as a base in manufacturing masonry cement. C. F. Bondegard and the Estate of George K. Werner produced paving gravel.

Red Willow.—Petroleum production from 63 wells in 5 fields increased from 13,000 to 553,000 barrels of oil, nearly a 43-fold gain over that of 1959. Probably the most important discovery in the State was the production of oil from the Reagan (Cambrian) formation in the Sleepy Hollow field. The discovery well, completed in July, pumped 144 barrels of oil a day from a depth of 3,418 to 3,422 feet. The field is 7 miles northeast of the Ackman field, discovered in 1959. Additional wells were drilled, and by the end of the year there were 19 producing wells; the average daily production from the field was 454 barrels. At the Ackman field, 46 successful wells were drilled, and production at yearend exceeded 2,000 barrels a day. Producing formations in the Ackman field were the Lansing-Kansas City and Oread of Pennsylvanian age; the latter was a new producing horizon. The Silver Creek field, 2 miles south of the Sleepy Hollow field, was discovered in July, and initial production was 47 barrels of oil a day from the Lansing-Kansas City formation. Sand and gravel for building, paving, and fill was produced by Davidson-Merritt Sand & Gravel Co., Midwest Sand & Gravel Co., and McCook Sand and Gravel Co. Contractors produced building and paving sand for the Federal Bureau of Reclamation.

Richardson.—Petroleum production from the Barada, Dawson, Falls City, and Snethen fields increased slightly over that of 1959; and one successful development well was completed. Harmon Gravel Co. and the county highway department produced paving gravel. George W. Kerford Quarry Co. produced crushed and broken limestone for riprap and road construction.

Sarpy.—The county ranked fourth in the production of sand and gravel and fifth in crushed stone. Building and paving sand and gravel, railroad ballast, and fill sand were produced by the Lyman-Richey Sand & Gravel Corp. Nos. 2 and 7 plants, Richfield Sand and Gravel Co., and Thomas Construction, Inc. Contractors produced paving sand and gravel for the State and county highway departments. Total production was 834,300 tons. Crushed and broken limestone for riprap and road construction was produced by Stone Products, Inc., and by contractors for the State highway department.

Scotts Bluff.—Petroleum production from two fields increased more than sixfold over that of 1959. Production came from the Vessels field (discovered in 1957 and renamed the Cedar Canyon) and the Roubadeau field (discovered in January). The discovery well pumped 170 barrels of oil a day from the J sandstone at a depth of 5,667 to 5,670 feet. This discovery was the most northerly producer in western Nebraska. An offset well to the north and a step-out well to the southwest were abandoned. The Consumers Cooperative Refinery Association operated its refinery at Scottsbluff. Throughput was 901,520 barrels of crude oil, a slight decrease from 1959. Crude oil came from fields in Banner County and southeastern Wyoming. Eisele Concrete Products Co. produced building sand and gravel, and contractors produced paving gravel for the county highway department.

The Mineral Industry of Nevada

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Nevada Bureau of Mines.

By L. E. Davis,[1] R. Y. Ashizawa,[2] and L. Giorgetti[2]

THE TOTAL VALUE of 1960 mineral production in Nevada was $80.3 million, a gain of more than $10 million. This value had been exceeded in only 4 other years, 1954 through 1957. The gain was attributed to a strike-free metal-mining industry that produced 20,000 tons more copper than in 1959. The value of this increase in copper output more than offset declines in value of 5 other

TABLE 1.—Mineral production in Nevada[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate short tons, antimony content	10	$2		
Barite short tons	91,298	623	85,711	$580
Copper (recoverable content of ores, etc.) do	57,375	35,228	77,485	49,745
Fluorspar do	16,743	407	18,505	388
Gem stones	(2)	100	(2)	100
Gold (recoverable content of ores, etc.) troy ounces	113,443	3,971	58,187	2,037
Gypsum thousand short tons	818	2,738	802	2,721
Iron ore (usable) thousand long tons, gross weight	698	3,712	734	3,648
Lead (recoverable content of ores, etc.) short tons	1,357	312	987	231
Manganese ore (35 percent or more Mn)[3 4] short tons, gross weight	[5] 56,611	[5] 3,918	49,076	3,301
Manganiferous ores (5 to 35 percent Mn) do	200	(6)	(6)	(6)
Mercury 76-pound flasks	7,156	1,628	7,821	1,648
Petroleum (crude) thousand 42-gallon barrels	32	(6)	[7] 25	(6)
Sand and gravel thousand short tons	6,436	7,522	4,085	5,224
Silver (recoverable content of ores, etc.) thousand troy ounces	611	553	707	640
Stone thousand short tons	840	1,587	579	1,350
Talc and soapstone short tons	5,824	50	4,882	30
Zinc (recoverable content of ores, etc.) do	217	50	420	108
Value of items that cannot be disclosed: Brucite (1959), clays, diatomite, lime, magnesite, molybdenum concentrates (content), perlite, pumice (volcanic cinder), salt, sulfur ore, tungsten concentrate (60-percent WO_3 basis), uranium ore, and values indicated by footnote 6		8,458		9,091
Total Nevada[8]		[5] 70,164		80,285

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Includes concentrates and nodules.
[4] Quantity and value of low-grade shipments to custom mills not included.
[5] Revised figure.
[6] Figure withheld to avoid disclosing individual company confidential data.
[7] Preliminary figure.
[8] Total adjusted to eliminate duplicating value of limestone used in manufacturing lime.

[1] Commodity-industry analyst, Bureau of Mines, San Francisco, Calif.
[2] Statistical assistant, Bureau of Mines, San Francisco, Calif.

metals, 10 nonmetals, and crude petroleum. The metal commodities as a group rose in quantity and value about 25 percent, compared with 1959. In addition to an important increase in copper production, outputs of molybdenum concentrate and uranium ore reached record highs in both quantity and value. The number of flasks of mercury recovered and shipped in 1960 was the largest on record, but the value was exceeded in both 1955 and 1958, years in which a relatively high production was accompanied by a correspondingly high unit price. Only three of the nonmetals produced in 1960 displayed advances in both quantity and value. Two of the three, lime and diatomite, set new records and the third, salt, had greater production and value in only one previous year, 1957. In that year major strikes occurred in the salt industry in California; resulting in an abnormally high output in Nevada.

There were several significant developments during 1960. Extensive exploration for iron and copper ores occurred in Churchill and Pershing Counties by Southern Pacific Co. (iron) and Columbia Iron Mining Co. (iron); in Lyon County by Bear Creek Mining Co. (copper), Columbia Iron Mining Co. (iron) and Utah Construction and Mining Co. (iron); in Mineral County by Pacific States Steel Corp. (iron); and in White Pine County by Bear Creek Mining Co. (copper). A new iron property, the Barth mine in Eureka County, went into production late in the year. The Anaconda Company started construction on a 5,000-ton-a-day (2 section) sulfide flotation plant and took a 2-year option on 103 claims of the Mt. Wheeler mine and adjoining Jeppson claims, White Pine County. These claims will be explored for beryllium minerals supplementary to the exploration previously completed by Beryllium Resources, Inc. Construction was begun on a fertilizer plant at Caselton, Lincoln County, utilizing old tailings from the idle Combined Metals Reduction Co. lead-zinc mill. The Ruby Hill Mining Co. was formed in a joint venture to further test the Richmond-Eureka mine, Eureka County. One of the participants, Newmont Mining Corp., was to manage the deep drilling program. Open-pit mining was begun at the Merrimac antimony claims in Taylor Canyon, White Pine County, by Nokai Dome Oil Co. A multimillion dollar project was programed that would include a 4,500- to 5,000-ton-a-day mill, a lime plant, and a major water supply for the mill at a site near the Mineral County operations of Argentum Mining Co.

Employment and Injuries.—Employment statistics collected and compiled by the Federal Bureau of Mines in cooperation with the Nevada State Inspector of Mines disclosed virtually no change in overall employment in the mineral industries, compared with 1959. However, the number of man-hours worked generally followed production values in the commodity groups, up 23 percent in the metals group (production-value increase of 25 percent) and off 13 percent in the nonmetals group (production-value drop of 10 percent).

Fatal injuries were down 50 percent from the preceding year, nonfatal lost-time injuries dropped 14 percent, and total injuries per thousand workers dropped 16 percent. By commodity groups, injuries did not follow the man-hour trend as total injuries for metal mining declined 31 percent and those for nonmetal mining rose 15

percent. One fatality occurred that was charged to a metal mine when employees leaving work in a company truck collided head-on with another vehicle. An employee died as a result of injuries sustained in the accident. Three fatalities occurred at nonmetal operations. An employee working in a stone quarry was killed when struck on the head by a rock. A truck driven by an employee of a rock-products company was struck by a train, killing the driver. An electrician was killed when he fell through a manway in a flotation plant where mechanics were installing a pump.

TABLE 2.—Employment and injuries in the mineral industries [1]

Industry	1959				1960			
	Employees	Injuries			Employees	Injuries		
		Fatal	Nonfatal	Total		Fatal	Nonfatal	Total
Metal mining	2,977	6	94	100	3,201	1	68	69
Nonmetallic mining and quarrying	1,622	2	45	47	1,397	3	51	54
Total	4,599	8	139	147	4,598	4	119	123

[1] Excludes mineral fuels. Data collected and compiled by the Federal Bureau of Mines in cooperation with the Nevada State Inspector of Mines.

Average weekly earnings per employee that were reported by the Nevada Employment Security Department rose from $111.97 in December 1959 to $114.54 in December 1960. The average work-week dropped from 42 hours 54 minutes to 41 hours 36 minutes for the same period.

Consumption, Trade, and Markets.—Except for Ormsby County where mineral production was confined to volcanic cinder and sand and gravel, both metal and nonmetal commodities were reported from each Nevada county. The output of clays, volcanic cinder, salt, sand and gravel, stone (except limestone), and tungsten concentrate was totally consumed within the State. Most of the gypsum and limestone, and some of the perlite, was consumed by Nevada industries; the remainder was further processed for out-of-State consumers. Nevada had only one smelter (copper) and no refineries. Therefore, most metal ores were concentrated or beneficiated before shipment. The concentrates and residues produced, together with many ores, were consigned to mills and smelters outside the State or sold directly to consumers. Producers of iron ore and concentrate, magnesite and magnesia products, crude perlite, and diatomite were favored with a relatively good export trade in 1960. At Henderson, Clark County, Titanium Metals Corp. of America imported titanium minerals, from which the metal and its alloys were produced. American Potash & Chemical Corp. imported manganese ores that were treated to obtain electrolytic manganese dioxide, and Stauffer Chemical Co. utilized salt from sources in California to produce chlorine and caustic soda.

Legislative and Government Programs.—Several sections of the Nevada State Mining Laws were revised by the Nevada State Legislature and became effective in 1960. Section 517.040, which was amended effec-

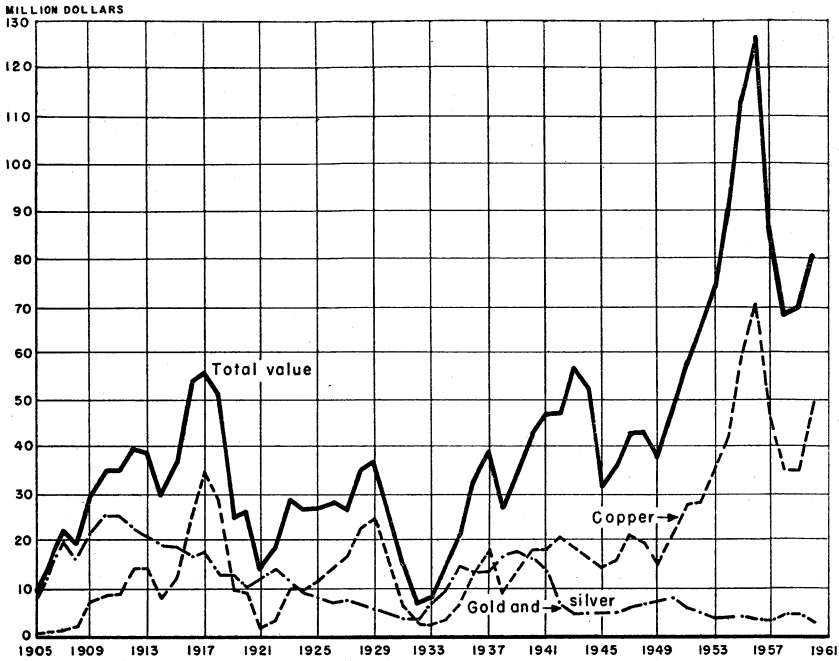

FIGURE 1.—Value of gold and silver, copper, and total value of mineral production in Nevada, 1905–60.

tive July 1, 1960, changed the requirements for location work to be performed within 90 days of locating mining claims. An amendment to Section 517.050, effective July 1, 1960, changed the requirements of the contents of the certificate of location. Section 517.230 was amended to include additional requirements for affidavits of annual work performed on mining claims, effective with work done after September 1, 1960. Section 407.070 of the Nevada Mining Claim Procedures was amended to authorize multiple use of any State park, effective July 1, 1960.

Public Land Orders, which had withdrawn land in Nevada in connection with the prosecution of World War II, were revoked. Involved were 2,500 acres near Gabbs, Nye County and 40 acres near Whitney, Clark County.

Only three Defense Minerals Exploration Administration (DMEA) contracts, under the supervision of Office of Minerals Exploration (OME), for mineral exploration in Nevada were still in effect at the beginning of 1960. An OME contract for lead-zinc in Esmeralda County was executed in May. Of the four contracts in effect all or part of the year, two had been completed, one was terminated, and one recessed by yearend.

A Government contract to purchase manganese nodules from Manganese, Inc., begun in 1952, was expected to continue through June 1961.

Work at the Federal Bureau of Mines Reno Metallurgy Research

TABLE 3.—Office of Minerals Exploration contracts active during 1960

County and contractor	Property	Commodity	Contract		
			Date	Total amount	Government participation (percent)
Elko: John H. Uhalde	Aladdin	Copper-lead	Apr. 29, 1957	$62,610	50
Esmeralda: Gold Eagle Mines, Inc.	Gold Eagle	Lead-zinc	May 18, 1960	20,660	50
Lincoln: Southpaw Joint Venture	Southpaw	Manganese	Dec. 27, 1957	12,852	75
White Pine: Hamilton Corp.	Hamilton	Lead-zinc-copper.	June 18, 1958	37,520	50

Center emphasized research in the rare and precious metals groups, but of primary interest in Nevada was the continuing program in the electrowinning of tungsten and molybdenum. Studies on the electrorefining of these two metals were in progress at the Boulder City Research Laboratory.

The Bureau's mining research activity in Nevada stressed rock slope stability and subsidence research, and in situ measurements and instrumentation and photoelastic investigations at open pit copper mines in White Pine County. Late in the year a tie-in survey was made of the borehole and underground workings at the Atomic Energy Commission (AEC) Nevada test site, Mercury, Nev.

Bureau of Mines resources work conducted in 1960 encompassed the collection and dissemination of statistics on minerals and accidents in Nevada in cooperation with State agencies. Resource investigations included: The mercury potential of Nevada (as a part of the total domestic potential); beryllium and other rare metals studies; and the beginning of a survey of chemical (mineral) raw materials and the clay resources of Nevada. The last study was being conducted in cooperation with the Nevada Bureau of Mines.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—The only production of antimony during 1960 was from the Nokai Dome Oil Co. property in the *Taylor* mining district, White Pine County. A small tonnage of ore was treated in its 30-ton capacity furnace and baghouse plant; the resultant antimony oxides were shipped to a Los Angeles, Calif., manufacturer for use as a paint pigment.

Property in the *Big Creek* mining district, Lander County, were inactive during the year. Mine development was in progress at the White Caps mine near Manhattan, Nye County, but no antimony ore was shipped.

Beryllium.—In March 1960, Beryllium Resources, Inc., Salt Lake City, Utah, completed exploration and relinquished its lease on the Mt. Wheeler mine in the Snake Range, about 40 miles southeast of Ely, White Pine County. Work included about 11,000 feet of under-

ground diamond drilling and 700 feet of drifts, crosscuts, and raises. About 2,000 tons of development ore which averaged 0.5 percent BeO, was stockpiled at the mine. The beryllium minerals, phenacite, bertrandite, and beryl, occur in a favorable limestone bed along and at the intersection of fissures that strike northeast, and quartz veins that trend from east to west.

During December, The Anaconda Company acquired a 2-year option on 103 claims of Mt. Wheeler Mines, Inc., and 16 claims of the adjoining Jeppson group. The company planned extensive underground exploration and development of the known beryllium bearing zones and an investigation of the entire area to determine the extent of the beryllium mineralization. The Bureau of Mines Salt Lake City Metallurgy Research Center continued concentration tests on the complex Mt. Wheeler ores.

Beryllium Associates, Salt Lake City, Utah, acquired a lease on the Leavitt group of 36 claims in the Virgin Mountains, about 14 miles south of Mesquite, Clark County, and began an investigation of the beryl and chrysoberyl-bearing pegmatite dikes during October through December.

Copper.—A 35-percent increase in 1960 in the recoverable copper output, compared with 1959, resulted from uninterrupted strike-free production. The copper properties of Kennecott Copper Corp. (White Pine County), The Anaconda Company (Lyon County),

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)
1951–55 (average)	138	12	8,626	98,404	$3,444	805,106	$729
1956	132	5	12,300	68,040	2,381	993,716	899
1957	107	9	11,770	76,752	2,686	958,477	868
1958	102	14	9,792	105,087	3,678	932,728	844
1959	67	10	8,788	113,443	3,971	611,135	553
1960	72	9	12,013	58,187	2,037	707,291	640
1904–60 [4]			([5])	15,113,093	376,978	315,924,764	216,904

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	65,001	$38,198	4,928	$1,524	8,463	$2,733	$46,628
1956	80,824	68,700	6,384	2,005	7,488	2,052	76,037
1957	77,750	46,806	5,979	1,710	5,292	1,228	53,298
1958	66,137	34,788	4,150	971	91	19	40,300
1959	57,375	35,228	1,357	312	217	50	40,114
1960	77,485	49,745	987	231	420	108	52,761
1904–60 [4]	2,650,788	1,008,645	389,859	61,919	482,620	93,319	1,757,765

[1] Includes recoverable metal content of gravel, washed (placer operations); ore milled; old tailings or slimes retreated; and ore, old tailings, and slag shipped to smelter 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] From 1904, when first satisfactory annual canvass of mine production was made, to 1960, inclusive.
[5] Data not available.

TABLE 5.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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
Churchill	2		(2)	(2)	(2)	(2)
Clark	6		168	$5,880	504	$456
Elko	7		571	19,985	56,239	50,899
Humboldt	1		(2)	(2)	59	53
Lander	5	1	(2)	(2)	1,586	1,435
Lincoln	6		177	6,195	(2)	(2)
Lyon	2	(3)	57	1,995	75	68
Mineral	5		431	15,085	(2)	(2)
Pershing	5	4	207	7,245	2,926	2,648
Washoe	2		243	8,505	67	61
White Pine	17		(2)	(2)	(2)	(2)
Undistributed [4]	14	4	56,333	1,971,655	645,835	584,514
Total	72	9	58,187	2,036,545	707,291	640,134

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Churchill			9,300	$1,088	300	$39	$1,127
Clark	(2)	(2)	99,800	11,676	17,300	2,232	20,244
Elko	7,700	$2,472	731,300	85,562	66,400	8,566	167,484
Humboldt							53
Lander	123,600	39,676	200	23	400	52	41,186
Lincoln	(2)	(2)	279,400	32,690	(2)	(2)	38,885
Lyon	(2)	(2)					2,063
Mineral	1,000	321	85,800	10,039	1,300	168	25,613
Pershing			8,000	936	3,600	464	11,293
Washoe							8,566
White Pine	(2)	(2)	351,100	41,079	338,600	43,679	84,758
Undistributed [4]	154,837,700	49,702,901	409,100	47,865	412,100	53,160	52,360,095
Total	154,970,000	49,745,370	1,974,000	230,958	840,000	108,360	52,761,367

[1] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] From property not classed as a mine.
[4] Includes Douglas, Esmeralda, Eureka, Nye, Storey Counties, and counties indicated by footnote 2.

Bristol Silver Mines Co. (Lincoln County), and the Copper Canyon group of claims (Lander County) were the source of virtually all the copper recovered from ores mined within the State. Although 26 active mines contributed to the total copper output, only 10 were classified as copper mines. Kennecott Copper Corp. mined only at its Liberty pit, but stockpile withdrawals were made from ore previously mined at the Tripp and Veteran pits. The company removed nearly 18 million tons of waste from the Liberty pit in mining 7.5 million tons of ore. Over 8,000 feet of churn drilling was done during routine exploration and development work in the Liberty pit area. Anaconda leached newly mined crude ore and ore stockpiled in 1959. The company shipped copper precipitates that had been produced in 1959 when labor strikes closed its smelting facilities to its Montana smelter. Approximately 5.5 million tons of waste was stripped from the pit area and more than 4 million tons of copper ore was mined. Exploration and development included over 2,000 feet of diamond drilling and about 50,000 feet of rotary drilling. Bristol Silver Mines Co. completed over 1,200 feet of long hole drilling

and more than 1,600 feet of drifts and raises in exploration, which resulted in nearly 7,600 tons of development rock. In 1960 Kennecott Copper regained the position of major Nevada copper producer, followed by Anaconda and Bristol Silver Mines Co.

Gold.—Total gold output in Nevada was nearly 50 percent less than in 1959. Placer gold recovery declined 98 percent, attributed to the closing of the Round Mountain dredging operation, Nye County, in December 1959. Nine placer properties and one sand and gravel

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	25	165,163	13,748	11,929	----	100	100
Gold-silver	2	79	19	677	----	----	----
Silver	9	55,881	406	323,414	400	7,200	4,600
Copper	10	11,779,975	39,805	265,881	154,940,300	165,600	186,700
Lead and antimony ore[2]	20	[3] 11,267	2,723	102,275	26,500	1,676,300	274,900
Lead-zinc	3	131	27	2,132	2,300	22,000	15,600
Zinc	3	516	6	394	200	9,500	356,600
Total	72	12,013,012	56,734	706,702	154,969,700	1,880,700	838,500
Other "lode" material:							
Gold (slag)	([4])	6	172	28	----	100	700
Lead residue	([4])	184	----	5	300	93,200	800
Total	([4])	190	172	33	300	93,300	1,500
Total "lode" material	72	12,013,202	56,906	706,735	154,970,000	1,974,000	840,000
Gravel: (placer operations)	9	([5])	1,281	556	----	----	----
Total all sources	81	----	58,187	707,291	154,970,000	1,974,000	840,000

[1] Details 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] Antimony-ore tonnage not included.
[4] From property not classed as a mine.
[5] 25,970 cubic yards.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	13,970	329,883	----	----	----
Concentration and smelting of concentrates:					
Ore	38,767	225,614	152,702,400	337,600	8,500
Direct smelting:					
Ore [1] [2]	3,997	151,205	2,267,300	1,543,100	830,000
Slag	172	28	----	100	700
Lead residue	----	5	300	93,200	800
Total	4,169	151,238	2,267,600	1,636,400	831,500
Placer	1,281	556	----	----	----
Grand total	58,187	707,291	154,970,000	1,974,000	840,000

[1] Includes antimony ore.
[2] Combined to avoid disclosing individual company confidential data.

operation reported gold recovery in 1960. The more than 10,000-ounce increase in lode gold output was not enough to offset the decline in placer recovery. About 70 percent of the lode gold was recovered in treating copper ores and concentrates, which were credited with the entire increase. Only one-fourth of the total 1960 recoverable lode gold was derived from gold ores. The Goldacres open-pit gold mine, Lander County, continued to lead in production of lode gold. Of all other lode mines in Nevada, only the Diamond-Excelsior lead mine, Eureka County, contributed appreciably to the remaining 5 percent of recoverable lode gold.

Iron Ore.—Production and shipments of iron ores and concentrates rose 8 and 5 percent, respectively, above 1959 tonnages. This increase was stimulated by the rising demands of Japanese steel mills. Nearly 68 percent of the direct shipping ores mined and 94 percent of all concentrates produced were consigned for export. Although direct shipping ore production and shipments increased 23 percent, the tonnage of iron ore received at concentrators was 2 percent lower. Shipments of concentrates dropped 6 percent, primarily as the result of negotiations between Mineral Materials Co. and Columbia Iron Mining Co., beginning in May and culminating in December with the sale of the Buena Vista mine and plant, Churchill County. The mine and plant were operated at reduced tonnage May through September and then closed. Only one other concentrator was operated—at the Minnesota mine in Douglas County by Standard Slag Co.

Of 13 active iron properties, the Iron King in Humboldt County was the only underground operation. In production for the first time in 1960, the Barth mine in Eureka County was the sole producer of hematite ore. All others were open pit mines that produced magnetite ores.

Some of the considerable exploration for iron ore conducted during the year began in 1959 or before. Utah Construction and Mining Co. explored the Dayton area, Lyon County; Columbia Iron Mining Co. explored the area near the juncture of Douglas, Lyon, and Ormsby Counties; Seaforth Nevada Corp. carried out geophysical surveys in the Brunswick Canyon area, Ormsby County; Pacific States Steel Co. pursued a drilling program near Hawthorne, Mineral County; the W. G. Austin interests tested two iron prospects near Luning, Mineral County; and the Southern Pacific Co. continued an extensive exploration program in the Buena Vista area of Churchill and Pershing Counties.

Iron and Steel Scrap.—Ferrous scrap consumption, including shredded detinned cans of The Anaconda Company copper leaching plant, Lyons County, decreased 7 percent from 1959. Home scrap produced was down 11 percent to 8,500 tons, 21 percent of consumption. Purchased scrap received remained constant at 35,000 tons, 87 percent of consumption.

Lead.—Recoverable lead production was 370 tons less than in 1959, declining more than 27 percent. Of the total lead produced, 85 percent was recovered from lead ores, 8 percent from copper ores, 5 percent as a residue resulting from treating manganese ores, and 2 percent from all other primary sources. Three lead mines in Elko County, one each in Eureka and White Pine Counties, and a copper mine in

Lincoln County were sources of more than three-fourths the lead produced. Thirty-six mines contributed to the total output. The major producers, with more than 100 tons each, were the Delno and Rosebud mines, Elko County; the Diamond-Excelsior, Eureka County; and the Hamilton, White Pine County.

During extensive exploration and development, ore was stockpiled at the Gold Note mine in Elko County, the LSZ property in Lincoln County, and the New Potosi mine in Mineral County. The exploratory work consisted principally of drifts and raises but included several hundred feet of longhole drilling.

Manganese.—The Clark County properties of Manganese, Inc., were the only source of manganese ore and concentrate in Nevada in 1960. The company mined ore from underground and open-pit deposits and concentrated and nodulized it in a nearby plant before shipment. Shipments, all to General Services Administration (GSA), were about 12 percent below the tonnages reported in 1959. During the year the company completed a substantial amount of development that included shaft sinking, drifting and crosscutting, and about 5,000 feet of rotary drilling. More than 8,000 tons of development rock was produced from underground exploration, and over 400,000 tons resulted from surface work. At Henderson, American Potash & Chemical Corp. produced electrolytic manganeses dioxide (battery grade) from ores mined in Mexico.

Mercury.—Nearly 2 percent less mercury ore was mined than in 1959, but 4 percent more tonnage was treated to recover the metal. Furnaced and retorted ores averaged 0.5 and 1 pound higher, respectively, than in 1959. Production rose 9 percent, shipments increased 16 percent, and yearend stocks were up nearly 73 percent. Twenty properties in 7 counties were the source of the total output, but 3 mines in Humboldt County yielded 90 percent of production and shipments. One of the three, the Cordero mine, was the major mercury producer in the State and the second largest in the nation. Five mines, 2 in Humboldt County and 1 each in Esmeralda, Nye, and Pershing Counties, yielded more than 100 flasks during 1960.

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]	
1951–55 (average)	25,481	3,662	754	116	2	3,780	$921,664	17
1956	111,088	16,609	30,083	2,846	53	5,859	1,522,871	51
1957						6,313	1,559,185	45
1958						7,336	1,680,384	35
1959	92,669	13,268	11,329	1,709	----------	7,156	1,627,847	20
1960						7,821	1,648,354	20

[1] Includes mercury recovered from miscellaneous dump material.
[2] Value calculated at average New York price.

Molybdenum.—Production of molybdenite concentrate in 1960 was limited to the byproduct output from copper ores mined by the Kennecott Copper Corp. in the Robinson district, White Pine County, and recovered in its nearby concentrator. Production was con-

siderably higher in 1959 when work was interrupted by strikes. The entire output was shipped to an out-of-State consumer.

Silver.—Production of recoverable silver rose 16 percent above 1959. The 99-percent decline in placer silver output, due to the closing of the Round Mountain mine, was more than offset by increased lode silver production. Recovery from silver ores was over 45 percent of the total lode silver output; byproduct recovery from the treatment of copper ores, 38 percent; from lead ores, 15 percent; and from all other lode mine sources, less than 2 percent. Four mines: The Liberty pit (copper ore) in White Pine County, the Mohawk (silver ore) in Esmeralda County, the Mt. Diablo (silver ore) in Mineral County, and the Bristol (copper ore) in Lincoln County, supplied more than 78 percent of the total lode silver recovered.

Tungsten.—Tungsten ore production was limited to 4 mines, only 1 of which yielded as much as 50 tons of crude ore. However, six producers shipped to the tungsten carbide plant of Nevada Scheelite Division, Kennametal, Inc., near Rawhide, Mineral County. Nevada Scheelite also purchased concentrates produced out-of-State and consumed its own stocks produced in previous years. Most of the tungsten concentrates produced and shipped in 1960 were recovered from ore mined at the Quick group of tungsten claims in the Fondaway Canyon area, Churchill County. A few tons of ore was mined and treated at a nearby tungsten prospect, but the property was abandoned after a test run. Stockpiled ore was treated at the Hilltop group, Churchill County, and the concentrate shipped. Relatively small tonnages of tungsten ores were mined and treated at two properties in the Paradise Peak area, Nye County, but shipments were made by only one producer. Shipments of tungsten concentrates to Nevada Scheelite depleted stocks at the Slim Pickens group, Mineral County, and materially reduced those held at the Minerva mine, White Pine County.

Uranium.—Commercial uranium ore was consigned to Oregon and Utah processing plants by four producers, two each in Elko and Lander Counties. The tonnage shipped was more than 3 times that in 1959, and although the average U_3O_8 content was 46 percent less, the total value rose over 54 percent.

Zinc.—The reported increase of nearly 94 percent in output of recoverable zinc, compared with 1959, was furnished principally through reactivation of the Willard zinc mine, White Pine County, and the Mountain View group of zinc claims, Eureka County. The Willard had been inactive since 1953 and the Mountain View group since 1956. More than 90 percent of the zinc production was recovered from ores of 6 mines: Zinc ores from the above mentioned mines; copper ore from the Bristol mine, Lincoln County; and lead ores from the Diamond-Excelsior in Eureka County, the Hamilton in White Pine County, and the Delno in Elko County.

Other Metals.—At the Overlook group of claims, a cobalt-nickel prospect near Battle Mountain, Lander County, only assessment work was done in 1960, consisting primarily of rehabilitating a tunnel and advancing the face a few feet. Two other nickel prospects, the Niganz in Eureka County and the Ludwig in Lyon County, were abandoned.

Some activity, consisting of shaft sinking and annual assessment

work, was reported at the Glasco columbium-tantalum claims in the Denio area of Humboldt County, Exploration and development work at the Rainbow group of claims (titanium minerals) in the *Northumberland* district, Nye County, included shaft sinking, rotary drilling, and trenching. At the Myrtle mine, a rutile prospect in Hungry Valley, Washoe County, shaft sinking and drifting was done in completing assessment work. This property was also prospected for mica.

No activity was reported from the tin prospect in the Rabbit Hole district of Pershing County. Considerable exploration work was done by rotary drilling (5,900) feet and trenching (300 feet) at a vanadium prospect (Siskon vanadium mine) in the west edge of the *Fish Creek* district, Nye County. A nearby property, the scene of considerable drilling in 1959, was abandoned in 1960. The proposed beneficiation plant for treating zircon ore, which was to be built near Caliente, Lincoln County, did not materialize.

NONMETALS

Barite.—The tonnage of crude barite mined was nearly double the 1959 figure, but shipments were down 6 percent and yearend stocks were 5 times the quantity reported at the close of 1959. The total output was supplied by 8 deposits in 4 counties with major production from the Rossi mine, Elko County, and the Mountain Springs property, Lander County. The State's only grinding plant, at Battle Mountain, crushed and ground crude barite mined from Nevada deposits. The plant product was shipped to the producer's out-of-State compounding plants and prepared for use in well-drilling muds. California grinders received all crude shipments.

Brucite and Magnesite.—Standard Slag Co. and Basic, Inc., mined magnesite from deposits in the Gabbs area, Nye County, and fired the mineral in nearby plants, producing caustic-calcined and refractory magnesias and various refractory products. Basic, Inc., upgraded magnesite by flotation, and brucite by heavy-medium separation. No brucite was mined in 1960, all shipments being made from beneficiated stockpile ore. Production of magnesite and shipments of brucite and magnesite were about 7 percent below 1959 figures.

Clays.—The quantity of clays sold or used was moderately below the 1959 figure. Clay pits were worked and stockpile withdrawals were made during the year for fuller's earth in Lyon County, bentonitic clay in Nye County, and fire and miscellaneous clays in Washoe and White Pine Counties. All of the fuller's earth and bentonitic clay was shipped to processors in California. Fire clay and miscellaneous clay were utilized within the State for furnace mortar and for refractory and building brick. Reno Press Brick Co., Reno, continued to lead in clay production.

Diatomite.—The quantity and value of Nevada diatomite production increased appreciably compared with 1959. Much of the increase was attributable to the development of a new pit of filter-grade diatomite by the Eagle-Picher Co., supplementing the output from its mine in Pershing County which began production in 1958. Five open-pit operations, one each in Churchill, Esmeralda, Lincoln, Pershing, and

Storey Counties, were the source of all diatomite mined. Preparation plants were operated in conjunction with open-pit mines in Esmeralda, Pershing, and Storey Counties. Crude material from a Churchill County deposit was processed in the producer's Lyon County plant. Prepared material was sold for filtration, insulation, abrasives, fillers, and other uses to paint and insecticide manufacturers, nitrate fertilizer producers, poultry supply dealers, and other chemical companies in the United States, Canada, Europe, South Africa, and South America. A small quantity of the crude mineral was sold to a California consumer for use as a soil conditioner and stock feed supplement.

Fluorspar.—The tonnage of crude fluorspar ore shipped to consumers in Nevada increased slightly over 1959 with principal production from the Crowell and Goldspar properties near Beatty, Nye County. Metallurgical-grade fluorspar from the Crowell mine was shipped to California steel plants. Crude fluorspar from the Goldspar mine was utilized in the producer's California cement plant. The Carp mine, Lincoln County, shipped a moderate tonnage of metallurgical-grade fluorspar from its stockpile to a California steel plant. Annual assessment work was completed on properties in Churchill, Clark, Lander, Pershing, and Nye Counties.

Gem Stones.—Significant quantities of gem material were gathered in Nevada by individual collectors, mineralogical clubs, and commercial producers. The yield of gem material was mostly wonderstone, which was collected in the Fallon area, Churchill County. The Lone Mountain Turquoise mine in the Lone Mountain area, Esmeralda County, a property in the Cortez District, Lander County, and the Turquoise Bonanza mine on the east slope of Pilot Mountain, Mineral County, were the sources of most of the State's turquoise output. Collectors reported appreciable quantities of petrified wood gathered in Churchill, Humboldt, and Nye Counties. Reports of noteworthy quantities of other gem materials collected included agate in Churchill, Elko, and Lyon Counties; opal in Humboldt, Lyon, and Pershing Counties; quartz crystals in Lyon and Washoe Counties, and jasper and black jade in Lyon County.

Gypsum.—Production of crude gypsum, which declined 2 percent in quantity from 818,000 tons in 1959 to 802,000 tons in 1960, was affected only slightly by the relatively lower demand for building materials in California, the principal market for Nevada's gypsum and gypsum products. A moderate tonnage of uncalcined gypsum continued to be sold for portland cement retarder and for agricultural use. The remainder of the crude output was processed at calcining plants in Nevada and California. The Blue Diamond Co. (division of the Flintkote Co.) quarry and plant in Clark County, was Nevada's principal producer of crude and calcined gypsum. The United States Gypsum Co. quarried in Pershing County and produced calcined products at its nearby plant at Empire in Washoe County. Fibreboard Paper Products Corp. shipped crude gypsum from its Clark County quarry to company plants at Los Angeles and Newark, Calif.

Lime.—Quicklime and hydrated lime output at plants in Clark and White Pine Counties gained 20 percent in quantity, compared with 1959. Output of metallurgical-grade lime, the principal product of

these plants, furnished virtually the entire increase. Other grades of lime were produced for the building trade as well as for water purification and softening, glass, agriculture, and insecticides. Some of the hydrated lime was consumed within the State, but most of the lime was shipped to other Western States including Hawaii. A new lime plant was under construction near Coaldale, Esmeralda County, to supply high calcium metallurgical lime required for mineral processing at the Argentum Mining Co. silver ore leaching operation.

Perlite.—Production of crude perlite decreased again in 1960, as demand by the building industry lessened. Three mines, two in Lincoln County and one in Pershing County, furnished the total yield. Expanded perlite was supplied by plants in Washoe and Clark Counties. A large percentage of the Nevada crude perlite was shipped to consumers in other States and Canada.

Pumice (Volcanic Cinder).—A decline in construction activities contributed to a moderate decrease in the output of volcanic cinder, compared with 1959. Production was limited to deposits in three

TABLE 9.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Glass	(1)	(1)	(1)	(1)
Molding	93,591	$382,251	(1)	(1)
Building	252,194	420,269	312,356	$501,353
Paving	146,200	139,314	102,537	112,448
Fill	45,146	44,742	23,457	21,170
Other	(1)	(1)	(1)	(1)
Gravel:				
Building	415,410	605,108	502,057	762,109
Paving	875,908	724,337	791,970	767,590
Railroad ballast	1,000	1,250	5,186	5,705
Fill	67,710	61,643	(1)	(1)
Other	203,735	184,147	(1)	(1)
Undistributed sand and gravel	79,260	240,511	297,098	711,037
Total sand and gravel	2,180,154	2,803,572	2,034,661	2,881,412
Government-and-contractor operations: [2]				
Sand:				
Building	30	30	6,076	8,525
Paving	107,034	129,882	256,247	339,482
Fill			65	65
Total	107,064	129,912	262,388	348,072
Gravel:				
Building	123,275	123,275	8,881	12,143
Paving	4,025,132	4,465,650	1,763,185	1,974,464
Fill			15,869	7,747
Total	4,148,407	4,588,925	1,787,935	1,994,354
Total sand and gravel	4,255,471	4,718,837	2,050,323	2,342,426
All operations:				
Sand	723,455	1,356,999	861,930	1,558,174
Gravel	5,712,170	6,165,410	3,223,054	3,665,664
Grand total	6,435,625	7,522,409	4,084,984	5,223,838

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes figures for State, counties, municipalities, and other Government agencies.

Nevada counties. Crude and prepared volcanic cinder from Mineral and Ormsby Counties was used in manufacturing concrete aggregate. Volcanic cinder output from Nye County was crushed, ground, and screened for use in building blocks.

Salt.—E. J. Huckaby Trucking Co., under contract to Leslie Salt Co., surface-mined solar salt at a dry lake bed 27 miles east of Fallon for local consumption.

Sand and Gravel.—Sand and gravel output dropped 36 percent in quantity from 6.4 million tons in 1959 to 4.1 million tons in 1960. Consumption of paving gravel, which comprised more than half of the total sand and gravel produced in the State, dropped from 4.9 million tons in 1959 to 2.6 million tons in 1960. An expected increase in road construction activity in 1960 did not materialize. As a result, several producers, who were solely dependent on government contracts, closed by midyear.

Requirements for paving material in Clark County declined by more than 1 million tons; demand for structural sand and gravel increased. Silica sand output from the Overton area for glass and molding uses was less in 1960. Producers in Washoe County reported a moderate decline in the output of sand and gravel for both building and road construction. All 17 counties yielded sand and gravel for construction. Notable output, other than that of Clark and Washoe Counties, came from Lincoln, Elko, and Humboldt Counties.

Stone.—The total output of stone quarried declined 31 percent in quantity from 840,000 tons in 1959 to 579,000 tons, chiefly because of decreased requirements for riprap and coarse aggregates normally used on government projects for retaining walls and bank protection, and as road base. Limestone quarried in Clark and White Pine Counties for lime, flux, and other uses, comprised a substantial part of the total stone yield. Production of dimension quartz and sandstone used for building construction increased for the first time since 1955, and large quantities of decorative rock were quarried in Clark and White Pine Counties. Marble was quarried in Mineral County for terrazzo,

TABLE 10.—Stone sold or used by producers, by uses [1]

Use	1959		1960	
	Quantity	Value	Quantity	Value
Dimension stone:				
Building stone:				
Rough architectural, cubic feet	769	$1,212	[2] 27,525	[2] [3] $111,711
Approximate equivalent, short tons	60		[2] [3] 4,862	
Sawed stone and cut block, cubic feet	[4] 14,551	[4] [5] 47,434	(6)	(6)
Approximate equivalent, short tons	[4] [5] 1,864		(6)	
Total [7], approximate short tons	1,924	48,646	4,862	111,711
Crushed and broken stone, short tons	838,253	1,538,555	574,061	1,238,771
Grand total [7], approximate short tons	840,177	1,587,201	578,923	1,350,482

[1] Includes basalt, granite, marble, calcareous marl, sandstone, and miscellaneous stone.
[2] Includes sawed stone and cut block and flagging.
[3] Includes rubble, rough construction, sawed stone and cut block and flagging.
[4] Includes flagging.
[5] Includes rough construction and flagging.
[6] Figure withheld to avoid disclosing individual company confidential data.
[7] Total include rubble and rough construction dimension stone and flagging.

615629—61——42

and calcareous marl was produced at one of several deposits in Washoe County for use in poultry and livestock feed.

Sulfur.—Production of sulfur ore from Nevada's only active sulfur deposit, in Humboldt County, decreased appreciably below the 1959 output. A relatively small tonnage was sold for use as a soil aid.

Talc and Soapstone.—Production and sales of talc and soapstone dropped to the lowest level reported in more than 20 years. The value of shipments to grinders was 52 percent below the 1959 figure as the quality of the minerals mined dropped appreciably. As in previous years the entire production came from Esmeralda County deposits.

Water.—Interest continued in the development of sources of geothermal power. At Brady's Hot Springs, Churchill County, on U.S. Highway 40 northeast of Fernley, the Magma Power Co. continued tests on the two wells drilled in the area, and in the Geyser Terrace area, south of Beowawe, Eureka County, the company completed a second test well and continued testing to determine if enough geothermal energy could be developed to operate an electric generating plant.

MINERAL FUELS

Petroleum.—Two wells of the Eagle Springs oilfield in Railroad Valley, Nye County, yielded 22 percent less crude oil than in 1959. Development drilling in the area was limited to one well started in early September by Shell Oil Co., but it did not produce in 1960. The Eagle Springs field had no gas or condensate production. Elsewhere in the State, a total of 10,336 feet was drilled in search of oil or gas. This footage included 4 test wells to an average depth of 2,584 feet. The centers of wildcat drilling were in Clark County in the general area east of Las Vegas and in Churchill County near Fallon.

REVIEW BY COUNTIES

Churchill.—Iron ore was mined from the Iron Hat property and the Buena Vista group of claims in the *Buena Vista* district. Ore from the former was direct shipping ore while that from the latter was upgraded in the producer's magnetic separation plant. Late in the year the Buena Vista mine and plant was sold to Columbia Iron Mining Co., a subsidiary of United States Steel Corp. Between May and December about 60,000 feet of diamond drilling was completed on the property for the new owner. The iron ore production was mostly consigned to iron and steel plants, but a small tonnage was sold for use as concrete aggregate for shielding purposes. Two operators in Fondaway Canyon, *Shady Run* district, mined and concentrated tungsten ore. The concentrates were sold to a Mineral County tungsten-carbide plant.

A Fallon producer supplied local requirements of sand for concrete and masonry and crushed gravel for concrete and base material for an airfield runway. Maintenance crews and contractors for the Nevada Highway Department used pit-run and prepared sand and gravel for several road projects in the county.

County crews also quarried and crushed basalt and limestone used by the Truckee-Carson Irrigation District. Miscellaneous stone was

TABLE 11.—Value of mineral production in Nevada, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Churchill	$692,482	$389,063	Sand and gravel, iron ore, tungsten, stone, salt, gold, lead, gem stones, silver, zinc.
Clark	12,567,850	11,718,209	Lime, manganese nodules, sand and gravel, gypsum, stone, lead, gold zinc, copper, silver.
Douglas	1,650,830	1,549,103	Iron ore, sand and gravel, zinc, lead, gold, silver.
Elko	1,251,522	647,241	Sand and gravel, barite, lead, silver, uranium, gold, zinc, copper, mercury, stone, gem stones.
Esmeralda	1,140,441	969,741	Diatomite, silver, gold, mercury, talc and soapstone, sand and gravel, gem stones, copper, stone, lead.
Eureka	591,023	238,123	Gold, sand and gravel, lead, zinc, silver, copper, iron ore.
Humboldt	2,526,087	2,698,072	Mercury, iron ore, sand and gravel, stone, gem stones, gold, sulfur ore, silver.
Lander	928,983	970,364	Barite, gold, uranium, copper, sand and gravel, gem stones, silver, mercury, zinc, lead.
Lincoln	[1] 1,486,741	1,386,807	Sand and gravel, perlite, copper, fluorspar, silver, lead, zinc, gold, stone, diatomite.
Lyon	19,041,083	20,232,382	Copper, diatomite, sand and gravel, stone, clays, gold, silver, gem stones.
Mineral	198,457	198,434	Silver, barite, sand and gravel, gold, lead, stone, tungsten, gem stones, copper, mercury, zinc, pumice (volcanic cinder).
Nye	4,851,382	1,695,473	Magnesite, fluorspar, sand and gravel, petroleum, mercury, gold, barite, pumice (volcanic cinder), silver, stone, tungsten, clays, iron ore, gem stones.
Ormsby	79,558	(2)	Pumice (volcanic cinder), sand and gravel.
Pershing	2,450,598	2,917,884	Iron ore, diatomite, gypsum, sand and gravel, mercury, perlite, gold, silver, lead, zinc.
Storey	1,217,450	1,135,790	Diatomite, gold, sand and gravel, silver.
Washoe	1,701,303	1,168,853	Sand and gravel, stone, clays, gold, silver, gem stones.
White Pine	[1] 17,710,079	32,231,151	Copper, gold, lime, molybdenum, silver, stone, sand and gravel, zinc, lead, tungsten, clays.
Undistributed [3]	[1] 78,131	138,310	
Total	[1] 70,164,000	80,285,000	

[1] Revised figure.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes gem stones, gold, mercury, manganiferous ore, tungsten, and silver that cannot be assigned to specific counties, and value indicated by footnote 2.

used by a highway contractor for riprap. A dry lakebed east of Fallon yielded the State's only salt production, which was consumed locally. Diatomite mined from a deposit near the county road between Nightingale and U.S. Highway 40 was processed in the producer's Lyon County plant.

A few tons of lead ore mined in the *Chalk Mountain* district yielded recoverable lead, zinc, silver, and gold. Gold ore from the Dixie Comstock property in the *Dixie Marsh* district was shipped to a California smelter for gold and silver recovery.

Clark.—The U.S. Lime Products Division, The Flintkote Co., operated three lime plants in the county and produced a wide variety of construction, agricultural, chemical, and industrial lime. Plants were operated at Apex (two rotary kilns), Henderson (four rotary kilns and a pressure hydrator), and Sloan (a batch hydrator). The company quarried high calcium limestone at the Apex quarry for making lime and for chemical and metallurgical use, concrete aggregate, railroad ballast, and poultry grit. The Sloan quarry was the source of dolomitic limestone used for metallurgical flux, in refractories and chemical processing, and for making lime.

Blue Diamond Co., Division of The Flintkote Co., produced crude gypsum for agricultural and cement retarder use and manufactured

gypsum plaster and wallboard at Blue Diamond near Las Vegas. Fibreboard Paper Products Corp. shipped crude gypsum from its quarry near Apex to its California wallboard plants.

Sand and gravel operators in the Las Vegas area produced larger tonnages of these materials than in 1959, principally for local use and Government construction projects. Some of the sand and gravel was trucked for use in the Lake Mead recreational area, at Nellis Air Force Base, and for State highway projects that included approaches to the City of Las Vegas and paving the Henderson-Boulder City and Valley of Fire roads. Silica sand produced in the Overton area was prepared for glass, molding, blast, and refractory uses. The Valley of Fire northeast of Las Vegas was the source of varicolored quartz quarried and shipped for use as decorative building stone. Building stone was also produced at a quarry a few miles southwest of Jean. Basalt (rubble) was used by crews of the Federal Bureau of Land Management in its Range Improvement program. Nearly 6,500 tons of granitic rock was used for riprap in the Davis Dam project of the Federal Bureau of Reclamation. Contractors for the City of Las Vegas quarried and prepared limestone for use in street construction. One plant at Las Vegas expanded perlite, which was obtained from a Lincoln County producer, for plaster and concrete aggregate. Another nearby plant utilized volcanic cinder from a Nye County deposit in making precast building block and tile.

The State's entire manganese ore and concentrate production was supplied by the mines, concentrator, and nodulizing facilities of Manganese, Inc. More than 250,000 tons of ore from open pit, underground, and stripping operations were fed to the mill, yielding over 60,000 tons of concentrate, from which nearly 44,000 tons of manganese oxide nodules were produced. At Henderson the American Potash & Chemical Corp. produced electrolytic battery-grade manganese dioxide from manganese ore mined in Arizona and Mexico. Approximately 93 percent of the recoverable lead credited to the county, together with some zinc and copper, was derived from lead residue produced by Manganese, Inc., as a byproduct in treating manganese ores. Some lead was recovered from dump material shipped from the Duplex property in the *Searchlight* district. Zinc ore mined at the Argentena prospect contained the remaining zinc and lead, and the Iron Gold copper mine furnished the remainder of the county's copper output. Ore from the Orion mine in the Eldorado Canyon area yielded gold and silver. The operators of this property completed considerable exploration work during the year and stockpiled about 250 tons of development rock.

Douglas.—Standard Slag Co. worked the Minnesota iron mine and upgraded the ore with magnetic separators. The entire output from the plant was shipped for export. During the year the company completed about 2,000 feet of diamond drilling and stripped 500,000 cubic yards of waste from the deposit. Sand and gravel from stream deposits of the Carson River in the Minden and Gardnerville areas were used for local construction and county road projects, and trucked to Carson City for concrete aggregate. Crews of the State and County highway departments produced sand and gravel for maintenance and repair of roads.

Lead-zinc ore from the Carbonate Hills mine in the *Mountain House* district contained virtually all the recoverable lead, zinc, and silver produced in the county during 1960. In the same district, an inclined shaft was rehabilitated at the Arrowhead gold mine, a 1959 producer. Gold was recovered by amalgamation from a few tons of ore that was mined from the Victoria prospect southeast of Gardnerville.

Elko.—A commercial plant at Elko prepared sand and gravel principally for use in building construction. Maintenance crews of State, county, and municipal road agencies produced their own requirements for sand and gravel used for seal coating, road base, and fill. A Las Vegas contractor utilized pit-run gravel and prepared sand and gravel for grading and surfacing State Route 11 between Jack Creek and Deep Creek. Utah Construction and Mining Co. made a sample shipment of limestone from the Pilot quarry near Elko to an out-of-State lime plant. Baroid Division, National Lead Co., mined crude barite at its Rossi property in the *Boulder Creek* district, where more than 1,000 feet of exploratory drilling was completed in 1960. The ore was shipped to the producer's plant at Merced, Calif. Crude barite previously mined by Estabrook Barite Co. was shipped from the company's Carlin stockpile to California grinders.

Three lead mines, the Delno and Gold Note in the *Delano* district and the Rosebud in the *Island Mountain* district, were the sources for a large portion of the recoverable lead, zinc, copper, and silver in the county. The Bootstrap mine in the *Boulder Creek* district furnished most of the gold output. Dump material from the Rio Tinto mine in the *Mountain City* district yielded recoverable copper. Cleanup at old operations in the *Lynn* district produced considerable gold and some silver. In 1960 there were two new producers of commercial uranium ore. Bogdanich Development Co. operated the Rimrock mine in the *Ivanhoe* district, and Valley Engineering and Development Co. mined uranium ore at the East and South Fork properties in the *Mountain City* district. Both operators shipped to processing plants in Oregon and Utah. During the year, about 4,000 feet of rotary drilling was completed at the South Fork property as part of an exploration program. Three mines in the *Ivanhoe* district, the Clementine, Governor, and Old Timer, were sources of relatively small tonnages of cinnabar ore furnaced or retorted to recover mercury. Assessment and maintenance work only were reported at the Liquid Metals and Silverado mercury mines in the *Tuscarora* district. In the *Battle Mountain* district some tunnelling, drifting, and crosscutting was done at the Horse Mountain claims and Silver Cloud mine, but no metal production was reported.

Esmeralda.—Great Lakes Carbon Corp., Dicalite Division, mined and processed diatomite at its mine and plant near Basalt. The plant products were shipped for use in paper, paint, and insecticides. The State's entire output of talc and soapstone came from deposits in the county. The quantity and value of this output were the lowest since before World War II. State and county road crews dug more than 20,000 tons of sand and gravel for use in the maintenance and repair of roads. Nearly 52,000 tons of pit run and prepared sand and gravel was used by Nacon Co., Inc., in constructing part of State Highway 3 east of Lida. About 350 tons of miscellaneous stone was quarried and

used as riprap by crews and contractors of the Nevada State Highway Department. Nevada Clay Products Co. conducted routine maintenance and some development work during 1960 at the President clay deposit near Dyer. No production, sales or shipments were reported by the company.

U.S. Milling and Minerals Corp. operated its Silver Peak mill on silver and gold ores mined at the Mohawk and Ohio mines, and several hundred tons of silver ore from a company-operated mine in Nye County. The Mohawk mine had been reactivated following its closure after a major cave-in late in 1959. Gold and silver were recovered from the Mary (Marybel) property in the *Silver Peak* district. The county's only lead output was contained in a shipment of lead ore made to a Utah smelter from the Poor Boy prospect in the *Lida* district. Over 2 tons of copper was recovered from material salvaged during equipment cleanup at an old mill site near Columbus Marsh. Considerable development, including shaft sinking and longhole drilling, was completed at the Gold Eagle (Sally Louise) lead-zinc mine in the *Weepah* district, but no ore was shipped. Mercury ores from three mines in the *Fish Lake Valley* district yielded all the mercury produced in the county during 1960. The B&B mine was the major producer and was credited with over 400 flasks produced and shipped.

Eureka.—Crews of the County of Eureka and the Nevada Highway Department produced about 57,000 tons of sand and gravel used in the county for road maintenance and repair.

Lead ore mined by Consolidated Eureka Mining Co. in the *Eureka* district contained nearly all the gold, silver, copper, lead, and zinc produced. However, a relatively small tonnage of zinc ore from the Mountain View group in the *Lone Mountain* district yielded some lead, zinc, and silver. The Ruby Hill Mining Co. was formed during the year as a compromise venture to end the operational conflict between Eureka Corp. and Richmond-Eureka Mining Co. The participating companies—Newmont Mining Corp., Cyprus Mines Corp., and Hecla Mining Co.—provided funds for full exploration and development of the Richmond-Eureka mine. No production was reported, but 42,293 feet of rotary drilling was recorded. The *Lynn* district was the source of placer gold and silver recovered at the Lynn placer property where bench gravels were worked. Cleanup at the Bulldog placer mine yielded a small quantity of gold.

A new iron mine began production and shipments in November. Ore from this mine was high in phosphorus, and to meet export specifications the producer blended the output with ore from an Humboldt County iron mine. The Modarelli iron mine was idle in 1960.

Humboldt.—Ores mined in the *Opalite* and *Poverty Peak* districts supplied 90 percent of Nevada's mercury production and shipments. The Cordero mine near McDermitt, the State's principal source of the metal, yielded more than 6,000 flasks. Extensive exploration and development work completed at the Cordero property during the year included shaft sinking, 3,500 feet of drifts and raises, and about 5,500 feet of churn and longhole drilling. In the *Poverty Peak* district, ore from the Cahill mine and dump material from the Hapgood property were retorted to recover mercury. At the McAdoo mercury mine in

the *Battle Creek* district exploration and development work was carried out, but no production was reported. Two iron mines were active—the Iron King underground mine and the Red Bird (Humboldt Iron) open pit operation, both in the *Jackson Creek* district. Some ore from the Iron King was blended with high phosphorus ore of the Barth mine, Eureka County, to bring the latter to export specifications. About 5,000 feet of rotary drilling was completed on the Homestead iron prospect in the Jackson Mountains northwest of Winnemucca. Near Winnemucca, the Homer Verne prospect yielded gold and silver by amalgamation from 30 tons of ore. Cleanup at the Buckskin gold property resulted in a few ounces of gold and silver. At the Getchell group of gold claims in the *Potosi* district considerable exploration and development work was done during 1960, including shaft sinking, raises, drifts, and crosscuts, and diamond, core, and longhole drilling.

Maintenance crews of the City of Winnemucca and Nevada Highway Department produced their own sand and gravel requirements for road repair. Contractors for the highway department dug more than 240,000 tons of pit-run sand and gravel and prepared the materials for highway projects in the northeastern part of the county. Sandstone was quarried and sawed at the Wadsworth claim near Virgin Valley for building use. Sulfur ore for agricultural use was mined from an open-pit deposit in the Kamma Mountains near Sulphur.

Lander.—Magnet Cove Barium Corp. operated its Battle Mountain grinding plant on crude barite that was withdrawn from a stockpile and newly mined from its Greystone claims. Two other barite properties, the Shelton mine in the *Argenta* district and the Mountain Springs deposit south of Battle Mountain, were also active during the year. Crude mineral from the Shelton mine was shipped to a grinder in the San Francisco Bay area. The operator of the Mountain Springs deposit, Mineral Products Division, Food Machinery Corp., shipped to a company-owned chemical plant at Modesto, Calif.

The Goldacres open-pit mine in the *Bullion* district was the county's largest active lode gold mine and the second largest lode gold producer in Nevada. Gold in ore from the New Pass (Thomas W.) mine at New Pass was ground in a stamp mill and recovered by amalgamation. Gold and silver were also recovered from ores of the Big Creek and McCoy mines of the *Big Creek* and *McCoy* districts, respectively. Bench gravels were worked by drift methods at the Dahl placers in the *Battle Mountain* district to recover gold and silver. Copper ore mined on the Copper Canyon property was shipped to the smelter at McGill, White Pine County, and copper precipitates recovered from dump material at the same location were shipped to the Tacoma, Wash. smelter.

Apex Uranium Inc. mined commercial uranium ore from the Early Day and Rundberg claims. The former property, in the *Reese River* district, was the State's most consistent uranium producer, yielding commercial ore each year since 1955. Ore from the Early Day was shipped to a Salt Lake City processing plant; the Rundberg production was consigned to a processor at Lakeview, Oreg. Uranium ores mined at the Low Boy claims in the same district by the Valley View

Uranium Mining Co., Inc., were shipped to the Oregon plant. Exploration and development at these mines included shaft sinking, tunneling, and drilling. A comparatively small tonnage of mercury ore from the Antler group of claims in the *Wildhorse* district was retorted to recover the metal.

Sand and gravel produced in the county by crews of State and county road agencies was used for highway maintenance.

Lincoln.—The Wilkin Pit near Pioche was worked to supply local construction needs for sand and gravel. A small quantity was used by the City of Caliente for paving. Sand and gravel was also produced at various locations in the county and used in paving projects by the Nevada Highway Department and the Atomic Energy Commission. More than 150,000 tons of pit-run and prepared aggregate was consumed in constructing a rerouted section of Highway 93 north of Pioche. Union Pacific Railroad Co. used several thousand tons of stone that was quarried and crushed near Caliente for railroad ballast. A small tonnage of miscellaneous stone was quarried by maintenance crews of the Bureau of Land Management and used for road repair. Lincoln County deposits supplied most of the crude perlite produced in the State during 1960. The crude mineral was quarried by Combined Metals Reduction Co. at the Hollinger property near Pioche, and by Delamar Perlite Co. at its open pit and underground mines southwest of Caliente. Most of the production was shipped to out-of-State expanding plants. Metallurgical-grade fluorspar mined near Carp by Wells Cargo, Inc., was consigned to a California steel producer. A comparatively small tonnage of diatomite was mined near Panaca and shipped to a California consumer for use in preparing soil conditioners and fillers in stock feed supplements.

Only four metal mines were active, and all shipments were to a Utah smelter. The Bristol copper mine, *Jack Rabbit* district, was the county's major producer followed by the LSZ and Hamburg lead mines, *Pioche* district, and the Tempiute silver mine, *Tempiute* district. Combined Metals Reduction Co. shipped a smaller tonnage of lead-zinc ore mined in 1959 or earlier. All ores shipped contained recoverable gold, silver, copper, lead, and zinc. One ton of ore from the Cherry (Old Silver Peak) mine near Carp, also shipped to the Utah smelter, contained a few ounces of recoverable silver. Construction was started on a plant at Caselton to produce a soil supplement from tailings at the idle Combined Metals Reduction Co. lead-zinc mill.

Lyon.—The Yerington mine of The Anaconda Company was the major active mining operation in the county during 1960, and the State's second largest copper producer. Shipments of copper precipitates to company smelting facilities in Montana exceeded production. Precipitates had been stockpiled during the labor strikes in 1959, which did not close the Yerington operations. Early in the year Anaconda began construction on a 5,000-ton concentrator at Weed Heights that was expected to begin treating sulfide ore by the fall of 1961. Bear Creek Mining Co., subsidiary of Kennecott Copper Corp., reportedly filed on 110 mining claims in Mason Valley as a result of extensive prior exploration in the area. The Yerington City Council granted a Kennecott request to release land for mining

that had been reserved for municipal expansion. Boyles Bros. Drilling Co. of Salt Lake City also drilled for Kennecott Copper Co. in the Yerington area, and for Columbia Iron Mining Co., a subsidiary of United States Steel Corp. Utah Construction & Mining Co. completed several thousand feet each of diamond and rotary drilling at the Dayton iron prospect. A small tonnage of gold ore from the Summit group of claims in the *Yerington* district was amalgamated to recover gold and silver. The producer completed considerable exploratory work on the claims and stockpiled about 300 tons of development rock.

Diatomite mined by Aquafil Co. Division, Kohl Enterprises, Inc., in Churchill County was processed in the producer's Fernley plant, and the prepared products were sold to out-of-State chemical companies. More than 10,000 tons of sand and gravel was prepared and used by State highway crews for road maintenance. Sand and gravel for building and road construction was produced by several operators along the Carson River, some of whom utilized old placer tailings near Dayton. Stone prepared for use as rubble and roofing granules was produced by Seaforth-Nevada Corp. near Stewart. Fuller's earth from stockpiles at the Jupiter pit near Weeks was shipped by Industrial Minerals & Chemical Co. to one of its California plants and prepared for feed pellets and various other uses.

Mineral.—Except for a token shipment of ore from the Nevada Rand gold prospect a few miles north of Hawthorne, all gold, silver, copper, lead, and zinc production was recovered from silver and antimonial lead ores of the *Candelaria* district. Argentum Mining Co. leached silver ores from its Lucky Hill, Mt. Diablo, and Northern Belle mines and produced bullion. Bullion and antimonial lead ore from the New Potosi mine were shipped to a California smelter. At the New Potosi an appreciable amount of exploration and development work was done and about 650 tons of development rock was stockpiled. At the Copper Chief copper prospect a few miles east of Mina, churn drilling was done as a part of an exploration program.

The Columbus (Noquez) barite mine near Candelaria was worked in 1960, and the crude mineral was shipped to the producer's plant at Terminal Island, Calif. The mine was worked by both open-pit and underground methods and development during the year included shaft sinking and drifting. Except for the sand and gravel produced by State highway crews for road maintenance in the county, all pit-run and prepared sand and gravel produced was consumed in the highway project on the west side of Walker Lake between Babbitt and Schurz. This project required approximately 20,000 tons of these materials in 1960. Sonora Marble Aggregate Co. quarried marble at a deposit near Luning and used the material for terrazzo. Argentum Mining Co. began constructing a lime plant near its ore leaching operation to supply lime for that operation. The company planned to sell any surplus lime on the open market. Volcanic cinder was produced from a deposit near Mina by Pumco Aggregate and was used for lightweight concrete aggregate.

Nevada Scheelite Division, Kennametal, Inc., operated a tungsten carbide plant near Rawhide, utilizing purchased tungsten concen-

trates in addition to those previously produced by the company. Mercury production was limited to one flask recovered from ore retorted at the Reward mine in the *Pilot Mountains* district.

Nye.—Magnesite mined in the Gabbs area by Basic, Inc., and Standard Slag Co. was converted to caustic-calcined and refractory magnesias and other products used by the refractories industries and by consumers of refractory products. Basic, Inc., upgraded previously mined brucite in a heavy-medium plant, and used most of the product in its Ohio refractories plant. Basic also placed a 500 ton-a-day flotation plant in operation about midyear to upgrade magnesite. Standard Slag Co. mined a relatively small tonnage of iron ore from its nearby Iron Mountain property and used the ore as an additive in producing deadburned magnesias. The Crowell (Daisy) and Gold Spar fluorspar mines produced during 1960. Metallurgical-grade fluorspar from the former was consigned to out-of-State consumers. The latter was operated by Monolith Cement Co. and the mineral was consumed in the producer's California cement plant. Crude barite from the Jumbo mine east of Tonopah was sold to a southern Nevada contractor for concrete aggregate used in special shielding. Barite mined at the Summit Creek deposit north of Tonopah was custom ground at Laws, Calif.

Sand and gravel was produced by crews of Nye County and the Nevada Highway Department and by a contractor for the Atomic Energy Commission. Over 74,000 tons of gravel was prepared for use in the highway project east of Warm Springs before winter weather shut down construction work. Western Silica Co. produced several hundred tons of opalite for silica flour at its Snowwhite operation southeast of Goldfield near the Esmeralda County line. Shipments of bentonitic clay were made from the New Discovery mine near Beatty to California for use in pharmaceuticals and underground workings were being developed during the year. Volcanic cinder was dug near Lathrop Wells by Cind R Lite Co. and trucked to the producer's cinder block plant in Las Vegas.

The oil wells of Shell Oil Co. at Eagle Springs yielded the entire crude petroleum output in the State. At yearend the company had not completed another well that had been begun in September in the area.

Five mercury properties were active in the county during 1960, but only the Horse Canyon mine near Manhattan yielded more than 100 flasks. Considerable exploration and development work was done at this mine, including shaft sinking and diamond drilling. At the Redbird mercury property in the *Belmont* district, development consisted of tunnels and raises. About 10,000 cubic yards of waste was stripped from the Ione mercury ore body in the *Union* district. Some shaft sinking and trenching were reported at the Jack Pot mine in the same district, but no ore was treated. At the A&B mine in the *Tybo* district, 50 feet of shaft was sunk, and 150 feet of drilling was completed. A part of the relatively small mercury yield was recovered in processing development rock.

Cleanup operations at the Round Mountain placer mine and silver ore trucked from the Tonopah King mine yielded virtually all the gold and silver produced in the county. Small quantities of gold and

silver were recovered by amalgamation from bench gravels worked by drift methods near Manhattan, and from gold ore of the Crown Point gold property. Late in the year the Tybo lead-zinc mine (*Tybo* district) was sold to the Carson Land and Development Co., Modesto, Calif. Two operators in the Paradise Peak area worked tungsten properties and produced concentrates. One producer shipped to the Mineral County tungsten carbide plant; the other stockpiled all concentrate produced.

Ormsby.—Reno Ready-Mix Concrete Co. produced volcanic cinder from the leased Carson City Cinder Lite deposit near the Carson City airport and prepared the material for use as lightweight aggregate. Sand and gravel obtained from deposits along the Carson River and Clear Creek was prepared for use as concrete aggregate by local producers. A contractor for the Nevada Highway Department produced more than 95,000 tons of pit-run and prepared sand and gravel for resurfacing Highway 50 south of Carson City. Highway department crews produced sand and gravel to meet State road maintenance requirements in the county.

Pershing.—The *Mineral Basin* district was the center of iron ore production and output was 5 percent greater than in 1959. Five operators at 7 open-pit mines and prospects mined nearly 195,000 tons of direct shipping grade ore, much of which was consigned to foreign iron and steel plants. Dodge Construction Co. was the major producer; its operations were at the Section 29 (Thomas) mine and Iron Horse (Ford Prospect) group. All ore that was shipped by this operator was exported. Nevada Iron Ore Co., Inc., worked the S.P. (Thomas) lease; the Segerstrom-Heizer property was mined by a contractor; Consolidated Minerals Corp. produced iron ore at the Section 16 mine; and W. M. Fisk mined from the Phoenix group and the Iron Mass prospect. Total shipments were 9 percent above 1959 figures.

A new deposit of filter-grade diatomite was developed by Eagle-Picher Co. in the Trinity Mountain area to supplement production from the Tunnel Hill mine west of Lovelock. The material was processed in the company plant at Colado and was sold for a wide variety of industrial uses. United States Gypsum Co. mined crude gypsum at its Empire quarry near Gerlach at the Washoe County line. The crude mineral was moved by overhead tram to the Empire mill and board plant across the county line. Sand and gravel was produced and prepared by crews of Pershing County and the Nevada Highway Department for road maintenance and repair. Crude perlite was produced at the Pearl Hill quarry northwest of Lovelock, crushed and sized at the Kodak plant, and shipped to the producer's expansion plant at Empire, Washoe County.

Only two mercury properties were active. Most of the recovered metal was produced in processing development ore mined at the Freckles (Roman) mine in the Table Mountain area. The remainder was retorted from cinnabar ore of the Hard Luck mine in the *Antelope* district. Two operators used a nonfloating washing plant and a third used small-scale hand methods to recover gold and silver from stream gravels in the Willow Creek area. Ancient river bed and bench gravels were washed by individuals in the *Rabbit Hole* and *Placerites* dis-

tricts to recover relatively small quantities of gold and silver. Lead ore from the Keystone mine in Mill Canyon, silver ore and dump materials from two mines in the Rochester area, and silver ore from the Silver Reef mine in the *Seven Troughs* district contained recoverable gold, silver, lead, and zinc. Gold ore from the Portland Extension mine in the latter district and the Green Gold prospect in the *Table Mountain* district were sources of relatively small quantities of gold and silver.

Storey.—A substantial percentage of Nevada's total diatomite production was mined at the Eagle-Picher Co. Celatom open-pit mine a few miles east of Clark Station. The crude material was crushed, dried, calcined, and classified in the company plant at Clark Station. The plant products were shipped to consumers in the United States and Canada for use in insulation, as an abrasive and filler, and in a variety of other applications. A comparatively small tonnage of sand was produced in the county for road maintenance by crews of the Nevada Highway Department.

Production of gold and silver was limited to the quantities recovered by amalgamation from ore mined at the site of the old Fisher mine and mill at Virginia City.

Washoe.—More than 1 million tons of sand and gravel was produced in the county for building and highway construction. A substantial percentage of the total output was produced and prepared at commercial plants along the Truckee River near Reno. The Steamboat Spring area yielded a modest quantity of sand and gravel and crews of the State and county road agencies produced sand and gravel at various places for their own use. Calcareous marl was quarried at the Double Check Products deposit 5 miles east of Flanigan and was used in preparing poultry and livestock feed. Pacific Fertilizer Co. did some exploration and maintenance work at its marl deposit near Pyramid, but no shipments were made. A small tonnage of miscellaneous stone was produced by a contractor for State highway use as riprap. Reno Press Brick Co. mined clays at its Faith and Geiger pits near Steamboat Springs and at the Revelation pit near Sparks; it used the materials for making brick and other clay products in its Reno plant. The United States Gypsum Co. processed crude gypsum from its nearby quarry in a mill and board plant at Empire and operated an adjacent expanding plant on crude perlite from its quarry near Lovelock, Pershing County.

Two gold mines operated intermittently in the *Olinghouse* district, the Sunbeam and the Renegade. Gold and Silver were recovered from ores of both mines by amalgamation. Exploration work at the Big Ledge and North View groups of claims in the *Peavine* district yielded about 300 tons of development rock that was stockpiled.

White Pine.—Virtually all the recoverable copper produced in White Pine County came from ores mined in the *Robinson* district by Kennecott Copper Corp. Copper ore mined from the Liberty pit was processed in the company's McGill concentrator and smelter together with previously mined ore from the Veteran and Tripp pits. These ores were the source of byproduct molybdenum concentrate that was recovered by flotation in the McGill concentrator and represented the entire molybdenum production in the State. Copper ores that were

produced at the Kansas mine, *Aurum* district, and the Sunnyside mine, *Robinson* district, together with material collected in cleanup at various small copper properties were shipped to a Utah smelter. Copper precipitates produced in cleanup at the Vanderbilt leaching plant were sold to the McGill smelter. Some diamond drilling was done at the Kansas mine as part of an exploration program, and an extensive drilling program for copper ore was conducted by the Bear Creek Mining Co., subsidiary of Kennecott Copper Corp., in the Lane City area. A very high percentage of the gold and silver credited to the county was recovered as a byproduct in treating copper ores of the *Robinson* district. However, lead ores of the Belmont, Hamilton, and Rocco Homestake mines, and zinc ore from the Willard mine, *Robinson* district, contained modest quantities of recoverable gold and silver together with some copper, lead, and zinc. The Mammoth mine in the *Robinson* district also yielded gold and silver, and the operator completed some tunneling, drifting, and shaft sinking during the year. Ore produced during exploration at the Belmont mine was stockpiled; some was shipped in 1960. The dust problem at the tailings area of the McGill concentrator was noticeably reduced through planned planting of rye grass, alfalfa, clover, and wheat. The Anaconda Company took an option on 103 lode claims in the Mount Washington area and on the Jeppson claims to the north. The former are the property of Mt. Wheeler Mines Co. and were explored previously for beryllium minerals by Beryllium Resources, Inc. Anaconda planned to continue the exploration. Some of the previously produced and stockpiled tungsten concentrate at the Minerva mine near Shoshone was shipped to the Nevada Scheelite tungsten carbide plant in Mineral County.

Kennecott Copper Corp. quarried high calcium limestone near McGill and produced hydrated lime for use in its nearby concentrator and smelter. The equipment used included 13 coke-fired shaft type kilns and a batch hydrator. Some of the limestone was consumed as metallurgical flux, concrete aggregate, and railroad ballast. Quartzite from the Star Dust quarry north of Baker was shipped to Utah and California for use as flagging and building stone. Crews and contractors for White Pine County and the Lehman Caves National Monument produced sand and gravel used by these agencies in structures, and road construction and repair. Maintenance crews of the Nevada Highway Department produced sand and gravel for their own needs at various places in the county. Fire clay dug from the McDonough clay beds near East Ely, was sold to Kennecott Copper Co., for use in its McGill copper smelter.

The Merrimac antimony claims were worked by open-pit methods, and a few tons of ore was shipped to a Utah smelter. The operator was paid for the contained gold, silver, copper, lead, and zinc, but no antimony was recovered. Late in the year the producer furnaced some stockpiled ore and recovered a comparatively high grade antimony oxide, which was shipped to a California buyer for use as a paint pigment.

The Mineral Industry of New Hampshire

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire State Planning and Development Commission.

By Stanley A. Feitler [1] and Mary E. Otte [2]

THE VALUE of New Hampshire mineral production reached a new high of $5.3 million in 1960, an increase of 12 percent over 1959. Increased tonnage and value of construction materials, principally for highways, offset the drop in quantity and value of sheet mica sold. Mineral production was reported from every county.

Legislation and Government Programs.—State and cooperative State-and-Federal highway construction continued during 1960. These highway programs and the continued purchase of strategic minerals for the Federal stockpile were the main reasons for the high mineral production. Strategic-quality mica (hand-cobbed and full-trimmed) produced in New Hampshire was purchased by General Services Administration (GSA) at its Franklin, N.H., Spruce Pine, N.C., and Custer, S. Dak. depots. All the State's beryl was sold to GSA at the Franklin, N.H. depot.

TABLE 1.—Mineral production in New Hampshire [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate.....short tons, gross weight	20	$12	14	$8
Clays.....do	26,150	26	27,260	27
Gem stones	(2)	10	(2)	15
Mica:				
Sheet.....pounds	119,163	1,133	80,065	904
Scrap.....short tons	(3)	(3)	415	14
Peat.....do	25	(3)	23	(3)
Sand and gravel.....thousand short tons	5,124	2,887	6,621	3,687
Stone.....short tons	82,141	488	104,105	594
Value of items that cannot be disclosed: Feldspar and values indicated by footnote 3	----------	166	----------	68
Total New Hampshire	----------	4,722	----------	5,317

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical clerk, Bureau of Mines, Pittsburgh, Pa.

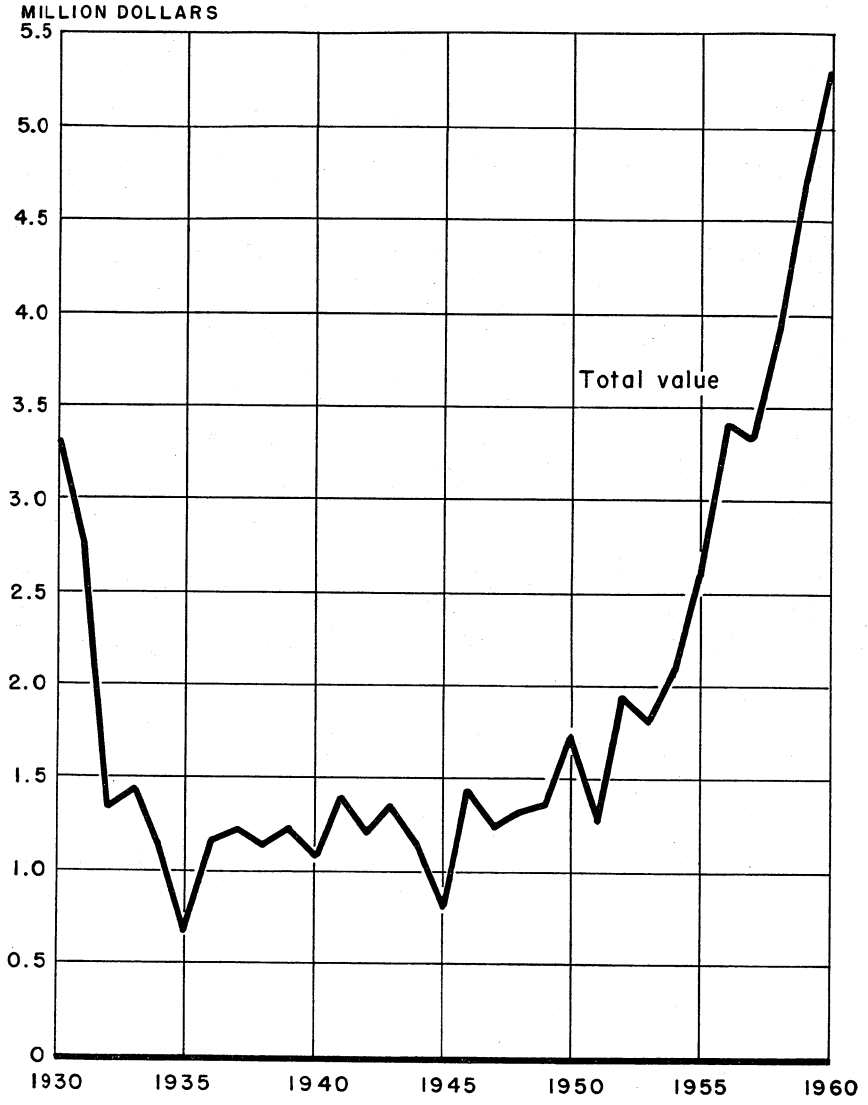

FIGURE 1.—Total value of mineral production in New Hampshire, 1930–60.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Production of miscellaneous clay for use in the manufacture of building brick was 4 percent greater than in 1959. Three brickyards operating in Rockingham and Grafton Counties produced about 11 million building brick.

Feldspar.—Tonnage and value of potash feldspar production continued to decrease because competition of imported ceramic products caused reduced consumption by the U.S. ceramic industry.

Although nepheline syenite imports from Canada had not made serious inroads into the potash feldspar market, they had increased competition among domestic producers for that part of the feldspar market that had not been taken over by nepheline syenite. The value of finely ground potash feldspar in 1960 was more than $0.50 lower per ton than in 1959. Total sales were lower than in 1959, as the decrease in sales for pottery and tile exceeded the increase in sales for sanitary ware and insulators. The principal markets for ground feldspar from New Hampshire were New York, Massachusetts, New Jersey, and Connecticut.

Gem Stones.—The value of recovered gem stones and mineral specimens increased during 1960. Gem and mineral dealers acquired material produced as a byproduct of mica and feldspar mining, but most of the value was in specimens obtained by amateur collectors, principally in Grafton, Carroll, Cheshire and Sullivan Counties. Fine, euhedral, smoky quartz crystals were recovered from vugs in granite at the Red Stone quarry near Conway (Carroll County).

Mica.—The value of sheet mica production, although 20 percent below 1959, was the second highest on record. Most of the value was in strategic-quality sheet mica which was sold to the Government at the GSA depots at Franklin, N.H., Spruce Pine, N.C., and Custer, S. Dak. Both quantity and value of full-trimmed mica were down more than 60 percent compared with 1959; the average price per pound dropped from $16.22 in 1959 to $14.18. The quantity of hand-cobbed mica dropped 22 percent, but the value increased 32 percent. This change was caused by wide use in 1960 of a 1958 regulation affecting the purchase of hand-cobbed mica by GSA. Previously, mica sold as hand-cobbed was purchased by GSA on a basis of quality and quantity at a maximum price of $600 per ton. The seller might receive less than $600 if the mica, after trimming, was not up to required quality and quantity.

The new regulation gave the buyer the option, after the mica was trimmed by GSA, to pay a fixed charge per pound for trimming labor and sell the mica as full trimmed. Under the new regulation it was to the seller's advantage to deliver the highest possible quality of hand-cobbed mica to the GSA depot. Careful sorting of hand-cobbed mica before delivery to GSA was largely responsible for the decrease in quantity of hand-cobbed mica. More producers found it profitable to sell high-quality mica as hand-cobbed under the new regulation. Hand-cobbed mica sold in 1960 had an average value of $0.50 per pound as compared with $0.30 in 1959. Slightly less scrap and more punch and washer mica were sold to industry than in 1959. Most of the mica was produced in Grafton and Cheshire Counties, although small quantities were reported from Merrimack and Sullivan Counties. The Keyes, Palermo, Ruggles, and Hoyt Hill mines were the principal mica producers in Grafton County, but 19 other mines also contributed to the total. The Big mine was the leading producer in Cheshire County, where mica was recovered from 12 mines during 1960. Three mica mines were worked in Mer-

rimack County and one in Sullivan County. Production of wet-ground mica was lower than in 1959, but the average price per ton was higher. Mica ground to 325-mesh was used in paint and wallpaper, whereas coarser material (160-mesh) was used as a mold lubricant in the manufacture of rubber goods. Three quarters of the crude scrap mica used for grinding was imported from India; the rest was of domestic origin.

Peat.—A small quantity of humus peat for use as a soil conditioner was produced in Belknap County.

Sand and Gravel.—Production of sand and gravel increased for the sixth consecutive year, and sand and gravel continued to be the State's leading mineral commodity. Output of sand and gravel for building and paving by commercial producers in 1960 was virtually the same as in 1959. A large increase was reported for commercially produced sand and gravel sold for fill and miscellaneous uses. A small quantity of sand was sold for use as engine sand and as a filter medium, and more than 4,000 tons of gravel was sold for railroad ballast. Non-commercial output of sand and gravel for highway construction was higher by 20 percent in tonnage and more than 40 percent in value.

Merrimack, Grafton, and Cheshire Counties led the State in total tonnage; commercial and Government-and-contractor production was reported for all counties. As in 1959, 71 percent of commercial and 3 percent of non-commercial tonnage was washed, screened, or otherwise prepared. The only sand and gravel shipped by rail was used for railroad ballast. The Manchester Highway Department in Hillsboro County and the Concord Commissioner of Public Works in Merrimack County reported production of sand and gravel for highway construction and maintenance by their crews.

Commercial sand and gravel operations employed 106 production workers for 200,000 man-hours during the year, with a productivity rate of 10 tons per man-hour.

TABLE 2.—Sand and gravel, and stone production by Government-and-contractor operations, by counties

(Short tons)

County	Sand and gravel		Stone	
	1959	1960	1959	1960
Belknap	139,573	102,539	----------	1,920
Carroll	355,693	105,547	----------	----------
Cheshire	429,931	302,023	----------	4,444
Coos	414,804	243,483	279	998
Grafton	289,758	518,844	206	12,880
Hillsboro	307,867	367,181	375	1,027
Merrimack	812,583	1,007,533	1,914	11,353
Rockingham	267,679	250,588	----------	206
Strafford	205,912	131,453	----------	----------
Sullivan	160,349	448,432	8,250	223
Total	3,384,149	3,477,623	11,024	33,051

Stone.—Stone production increased 27 percent in tonnage and 22 percent in value over 1959. Dimension granite accounted for most of the value of output by the stone industry in the State, although

the tonnage was small. The John Swenson Granite Co., Inc., produced dressed architectural stone, curbing, and a small quantity of riprap from granite quarried at its Swenson Gray quarry near Concord. Rough blocks were freed on three sides by flame cutting and broken loose from the floor by light blasting. Crude granite from the nearby Gray quarry, as well as pink and green granite from Swenson Co. quarries in southern Maine, was dressed at the company's stone plant in Concord.

The New Hampshire Department of Public Works and Highways reported production of noncommercial granite from all counties except Carroll and Strafford. The quantity produced in 1960 was about the same as that reported in 1958 but represented a large increase over 1959.

Miscellaneous stone mined by the Iafolla Crushed Stone Co., Portsmouth, was prepared and sold for use in concrete, highway construction, and riprap.

METALS

Beryllium.—The quantity of hand-cobbed beryl recovered from mines in New Hampshire was lower in 1960 than in 1959. Beryl sold at the GSA Purchase Depot at Franklin had an average value of 27.7 cents per pound and an average grade of 11.2 percent beryllium oxide. Grafton was the leading county with six mines producing 91 percent of the State total. Production was reported from three mines in Cheshire County and one mine each in Merrimack and Rockingham Counties.

REVIEW BY COUNTIES

Belknap.—Tilton Sand & Gravel, Inc., Tilton, produced building and paving sand and gravel, sand for fill, and miscellaneous gravel.

Perkins Peat Bog recovered humus peat near Barnstead and sold the material in bulk form.

Carroll.—Paving sand and gravel was produced near Conway by Alvan J. Coleman.

Topaz, quartz crystals, and other gem and mineral specimens were recovered near North Conway and on Hurricane and Baldface Mountains.

Cheshire.—Paving sand and gravel, and gravel for fill was produced by Cold River Sand & Gravel Corp. near North Walpole. Keene Sand & Gravel, Inc., Swanzey, produced sand and gravel, mainly for building and paving, and a quantity of gravel for use as fill.

Cheshire County continued to rank second in sheet mica production, although quantity and value decreased 30 and 37 percent, respectively. Twelve producers recovered full-trim, hand-cobbed, and some scrap mica from mines near Alstead, Gilsum, Alexandria, Grafton, Orange, and Danbury. Most of the mica was sold to the Government through the GSA purchase depot at Franklin, but some was shipped to the Spruce Pine, N.C., and Custer, S. Dak., purchase depots.

Despite a continued decline in the quantity and value of feldspar production in 1960, Cheshire County remained the leading source for

TABLE 3.—Value of mineral production in New Hampshire, by counties

County	1959	1960	Minerals produced in 1960, in order of value
Belknap	(1)	(1)	Sand and gravel, stone, peat.
Carroll	$128,579	$83,020	Sand and gravel, gem stones.
Cheshire	848,032	709,442	Sand and gravel, mica, feldspar, gem stones, stone, beryl.
Coos	153,928	177,713	Sand and gravel, stone.
Grafton	1,148,080	1,226,395	Mica, sand and gravel, clays, stone, feldspar, beryllium, gem stones.
Hillsboro	(1)	(1)	Sand and gravel, stone.
Merrimack	(1)	1,374,698	Sand and gravel, stone, mica, beryllium.
Rockingham	(1)	323,641	Sand and gravel, stone, clays, beryllium.
Strafford	(1)	(1)	Sand and gravel.
Sullivan	163,331	222,389	Sand and gravel, gem stones, stone, mica.
Undistributed [2]	[3] 2,279,855	1,199,609	
Total	4,722,000	5,317,000	

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes value of beryllium, gem stones, mica, and sand and gravel not assigned to specific counties and value indicated by footnote 1.
[3] Revised figure.

this material in the State. Golding Keene Co. recovered crude potash feldspar from the Colony mine near Alstead. The material was ground at the local company-owned grinding mill for use chiefly in pottery, floor tile, sanitary ware, and insulators. The Golding Keene Co. Kidder mine near Alstead was idle during the year. Foote Mineral Co. discontinued production of ground feldspar in its mill at Cold River early in 1960. During most of the year the mill was used to grind imported petalite (lithium aluminum silicate) for use in ceramics.

Green tourmaline, aquamarine, beryl, quartz crystals, and fluorite gem and mineral specimens were recovered, mainly near Alstead and Gilsum.

The quantity and value of beryl output decreased, with two mines operating during the year compared with three in 1959. Both producers sold their output to GSA.

Coos.—Building, paving, and fill sand and gravel, and gravel for use as railroad ballast were produced in the county. Pits were operated during 1960 by Lessard Sand & Gravel Co. (Gorham), Fred Corrigan (Randolph), and Clyde B. Gray and Maine Central Railroad Co., both near Colebrook.

Grafton.—Grafton County ranked second in value of mineral production in the State. The county continued to lead in sheet mica production despite declines of 32 percent and 14 percent in quantity and value, respectively. Twenty-five mica producers operated 23 mines during the year, mainly near Groton, Grafton, and Orange. All hand-cobbed and full-trim sheet mica was sold to the Government in 1960. The average price was $13.01 per pound of full trim, including hand cobbed converted to full trim, compared with $10.37 per pound in 1959. Some scrap mica was also produced. The Ruggles mine near Grafton Center was sold by Whitehall Co., Inc., to A. S. Wahlstrom and mined for mica by Ruggles Mining Co.

Commercial sand and gravel production was reported near Campton, Littleton, and West Lebanon. The material was used mainly for building and paving.

Densmore Brick Co., Lebanon, mined and processed miscellaneous clay for manufacturing building brick.

A stockpile of crude potash-soda feldspar was sold by Ruggles Mining Co., Grafton, to the Golding Keene Co. and shipped to the latter company's grinding plant at Alstead (Cheshire County) for processing.

Grafton remained the leading beryl producing county, despite a decline in production and value, with six active producers in 1960, compared with five in 1959. Hand-cobbed beryl containing an average of 11.2 percent beryllium oxide was recovered from mines near Wentworth, Grafton, and North Groton. The entire output was sold to GSA at Franklin.

Gem and mineral enthusiasts were active during the year searching waste dumps and outcrops of the many pegmatites. Among the large variety of mineral specimens collected were clevelandite, aquamarine, perthite, torbernite, autunite, and gummite.

Hillsboro.—Commercial sand and gravel, used chiefly for building and paving, was produced by four operators near Manchester and Peterborough.

Merrimack.—Manchester Sand, Gravel & Cement Co., Inc., Hooksett, reported output of building and paving sand and gravel and engine sand. Frank Palazzi & Sons, Inc., produced sand and gravel for use as fill material.

The John Swenson Granite Co., Inc., Concord, quarried granite and produced dressed architectural stone and curbing. The company also sold granite for riprap.

The quantity and value of sheet mica produced in the county was higher as the number of producers increased from three in 1959 to five in 1960. The Brownell Prospect and Danbury mines (both near Danbury) and the North Star mine near Wilmot were active during the year. Wilbur L. Brownell recovered limited quantities of hand-cobbed and full-trim sheet mica and beryl at the Brownell Prospect mine near Danbury. All mica and beryl were purchased by the Government.

Rockingham.—Structural sand and gravel and fill gravel were produced near Exeter by L. Chester and Clayton W. Simpson.

Iafolla Crushed Stone Co., Portsmouth, quarried and prepared miscellaneous stone for riprap, concrete aggregate, and roadstone.

Miscellaneous clay, used for manufacturing building brick, was recovered from open pits by Eno Bros. Brick Co., Exeter, and W. S. Goodrich, Inc., Epping.

Beryl was recovered from the Chandler mine near Raymond by Albert F. Cebula and sold to GSA.

Strafford.—Structural sand and gravel and fill gravel were recovered commercially near Dover and Durham.

Sullivan.—Unprocessed sand and gravel for paving material was recovered near Grantham.

Hand-cobbed mica was recovered at the Sargeant mine near Claremont and sold to GSA.

Amateurs and dealers recovered gem and mineral specimens, principally from pegmatites.

The Mineral Industry of New Jersey

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the New Jersey Division of Planning and Development, Bureau of Geology and Topography.

By Joseph Krickich[1] and Stanley A. Feitler[1]

MINERAL production in New Jersey in 1960 was valued at $56.4 million—5 percent below 1959. The decline was attributed mainly to decreased shipments of iron ore, the State's third-ranking mineral commodity, although demand was less for most other minerals. The values of stone and sand and gravel, however, were greater than in 1959.

TABLE 1.—Mineral production in New Jersey[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----thousand short tons--	700	$1,895	664	$1,597
Gem stones----	(2)	6	(2)	7
Peat----short tons--	28,300	278	25,100	192
Sand and gravel----thousand short tons--	11,033	18,620	11,594	19,511
Stone----do----	10,079	22,133	10,202	22,814
Value of items that cannot be disclosed: Iron ore, lime, manganiferous residuum, magnesium compounds, marl (greensand) and uranium (1960). Excludes limestone and oystershell used in manufacturing lime.	----------	16,547	----------	12,288
Total, New Jersey----	----------	59,479	----------	56,409

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

Trends and Development.—Exploration and testing of ilmenite-bearing sands in Ocean County continued during the year. Glidden Co. began planning a concentrating plant; production of ilmenite concentrate was expected to begin in 1962. Minnesota Mining & Manufacturing Co., broke ground for a large integrated roofing granule plant near Belle Mead in Somerset County. The first shipment of uranium ore from New Jersey was made from a mine in Sussex County. Iron ore production was at low ebb with only two mines active. Output of beryllium oxide ceramic materials in Passaic County increased and research was expanded.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.

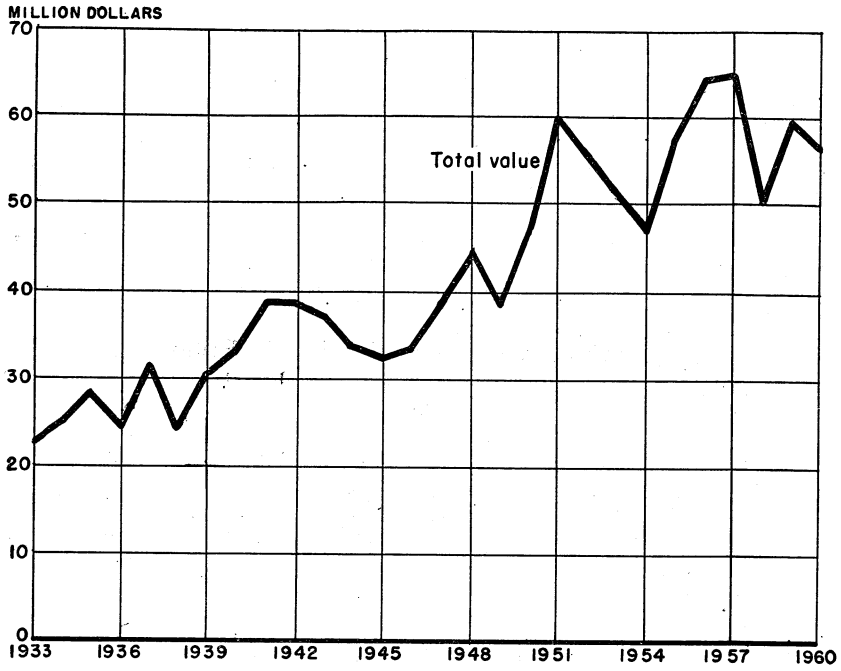

FIGURE 1.—Total value of mineral production in New Jersey, 1933–60.

New Jersey continued as an important center for processing concentrates of rare-earth minerals into a wide variety of alloys and pure elements. Production of tungsten and molybdenum began at the recently completed metallurgical plant of Wah Chang Corp., in Bergen County. Air Reduction Co., Inc., completed a new laboratory for research and pilot-scale testing of fuels and oxidizers in Gloucester County.

Employment and Injuries.—Preliminary data for the mineral industry in the State indicated that total man-hours worked increased 3 percent compared with 1959 and was attributed to increased employment at smelters. Employment (excluding office workers) declined in all other categories and are shown in table 2. Injury experience improved substantially over 1959. Although the number of fatalities (2) remained the same, total nonfatal injuries dropped sharply. The biggest improvement was in the stone industry, where nonfatal injuries dropped from 106 in 1959 to 59 in 1960.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Production of fire clay was the same as in 1959, but the output of miscellaneous clay was less, resulting in a 5-percent decrease in total clay output. Miscellaneous clay supplied most of the tonnage, but fire clay had a greater total value. Building brick, lightweight aggregate, and heavy clay products were manufactured from the miscellaneous clay. The largest volume of fire clay, produced in Mid-

TABLE 2.—Employment and injuries in the mineral industries

Industry	Active operations	Men working daily	Man-hours worked	Injuries		
				Fatal	Nonfatal	Per million man-hours
1959:						
Sand and gravel	85	998	2,076,696	----------	55	27
Quarries and mills	26	849	1,839,500	----------	106	58
Nonmetal mines [1]	22	61	72,640	----------	----------	----------
Metal mines and mills	10	604	1,243,082	2	38	32
Coke ovens and smelters	5	3,731	8,650,739	----------	62	7
Total	148	6,243	13,882,657	2	261	19
1960: [2]						
Sand and gravel	88	1,032	2,021,700	----------	21	10
Quarries and mills	29	918	1,780,310	----------	59	33
Nonmetal mines [1]	25	60	68,128	----------	4	6
Metal mines and mills	6	577	1,142,561	1	18	17
Coke ovens and smelters	4	3,614	9,300,330	1	74	8
Total	152	6,201	14,313,029	2	176	12

[1] Includes clay and greensand marl.
[2] Preliminary figures.

dlesex, Cumberland, and Camden Counties, was used for firebrick and block and in foundries and steel works. Moderate quantities of fire clay were used in fire clay mortar, linoleum and oil cloth, kiln furniture, heavy clay products and architectural terra cotta. Clay companies employed 56 miners at 23 pits for a total of 67,000 hours and reported 4 lost-time injuries during 1960. Productivity, in terms of clay recovered by pit employees, was 9.9 tons per man-hour.

Gem Stones.—Gem and mineral societies as well as many individual collectors obtained mineral specimens from various localities. Mine dumps at Franklin (Sussex County) continued to be the most productive area and yielded a large quantity and variety of mineral specimens.

Gypsum.—Crude gypsum from out-of-State mines was calcined at plants in Bergen, Burlington, and Essex Counties for use in manufacturing plaster, lath, sheathing, and wallboard. Barrett Division, Allied Chemical Corp. began production at its new automated plant in Bergen County. The new installation had facilities for unloading crude gypsum from ocean-going vessels and for calcining and manufacturing finished plaster building products.

Lime.—Both tonnage and value of lime production were 7 percent less than in 1959. One company in Sussex County burned lime for use in construction, agriculture, and chemical applications.

Magnesium Compounds.—Total output of magnesium compounds was less than in 1959. Magnesia for refractory uses was produced in Cape May County from sea water and out-of-State dolomite. Refined magnesium compounds, manufactured principally from purchased magnesium carbonate, were produced in Warren County.

Marl, Greensand.—Output of greensand marl in Burlington and Gloucester Counties was less than in 1959. The greensand was sold for use as fertilizer (for its content of available potash) and for use in water-softening equipment (for its glauconite content).

Perlite.—Crude perlite mined in southwestern States was shipped to plants in Middlesex, Passaic, Somerset, and Union Counties, where it was expanded for use in acoustical plaster, ultralightweight concrete, and as a soil conditioner.

Pigments.—A wide variety of metal-base pigments were manufactured at nine plants in five counties. Iron oxide pigments were manufactured in Essex, Mercer, and Middlesex Counties; lead pigment, in Middlesex County; and zinc pigment, in Middlesex and Bergen Counties. One plant each in Camden and Middlesex Counties produced titanium dioxide.

Sand and Gravel.—Both tonnage and value of sand and gravel produced were 5 percent greater than in 1959. Demand for commercially produced sand and gravel by the construction industry was higher during the year, but the total value was lower, because of a lower average price in 1960. The most important industrial applications were sand for molding, glass, and blast sand. The average price in these three categories was $3.37 per ton, $0.06 per ton higher than in 1959. Washed and screened sand also was used for filtration, engine, and fire or furnace applications.

Ground sand, used principally by foundries, as a filler and as an ingredient in glass, was produced in greater quantities than in 1959. Other uses for ground sand included abrasive, chemical, pottery, porcelain, tile, and metallurgical applications.

Cumberland County was the principal sand and gravel (2.4 million tons valued at $8.2 million) producing county in the State. Next in order of output were Morris, Burlington, and Ocean Counties, from which 1 million or more tons each was reported. Commercial producers washed and screened 89 percent of the tonnage sold, the same percentage as in 1959. Of the material delivered to consumers, 84 percent was delivered by truck; 14 percent by railroad; and 2 percent by waterway. Commercial sand and gravel producers employed 1,032 men who worked 2,022 hours and produced 5.7 tons of finished sand and gravel per man-hour. Construction and maintenance crews of the Atlantic County Road Department and the Camden County Highway Department produced less sand and gravel than in 1959.

Stone.—Stone production had a higher total value (40 percent of the State total) than any other mineral commodity produced in New Jersey in 1960. Tonnage and value increased 1 percent and 3 percent, respectively, compared with 1959. Stone used as concrete aggregate and roadstone furnished 86 percent of the tonnage and 81 percent of the value of all stone produced.

Basalt (traprock) made up 88 percent of the total stone tonnage and 82 percent of the value. Principal applications for basalt were as concrete aggregate and roadstone but some was also used as riprap, railroad ballast, and for miscellaneous purposes. More than three-quarters of the basalt was produced in Somerset and Passaic Counties, but output also was reported for Bergen, Essex, Hunterdon, Mercer, and Union Counties. Limestone, mined only in Sussex County, was the second most important stone in terms of value. It was used principally as filler, agstone, concrete aggregate, roadstone, and additive in livestock food. Granite, mined at quarries in Morris and Hunterdon Counties, was used as concrete aggregate, roadstone, and riprap. Oystershell was recovered in Gloucester County, and marble was

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	3,489	$3,517	3,763	$3,694
Paving	2,108	1,923	2,116	1,812
Fill	137	74	134	68
Glass	604	2,377	(1)	(1)
Molding	1,313	3,866	1,546	4,731
Blast	126	521	131	546
Fire or furnace	(1)	(1)	14	35
Engine	20	62	21	67
Filtration	56	146	33	114
Other [2]	432	1,672	933	4,092
Gravel:				
Structural	1,742	3,215	1,775	3,016
Paving	768	1,055	866	1,093
Railroad ballast			(3)	(3)
Fill	67	32	133	79
Other	100	129	[4] 73	[4] 146
Total	10,962	18,589	11,538	19,493
Government-and-contractor operations:				
Sand:				
Paving	11	4	2	(5)
Fill			(6)	(5)
Other	5	2		
Gravel:				
Paving	50	23	54	18
Other	5	2		
Total	71	31	56	18
Grand total	11,033	18,620	11,594	19,511

[1] Included with "Other sand" to avoid disclosing individual company confidential data.
[2] Includes ground, other sand, and uses indicated by footnote 1.
[3] Included with "Other gravel" to avoid disclosing individual company confidential data.
[4] Includes railroad ballast gravel.
[5] Less than $1,000.
[6] Less than 1,000 tons.

produced in Warren County. Stone producers employed 918 men who worked 1,780,000 man-hours and produced 5.3 tons of finished stone per man-hour.

Roofing Granules.—The quantity and value of roofing granules from Bergen, Passaic, and Somerset Counties were greater than in 1959. The average price for natural (uncolored) granules was $0.49 per ton higher than in 1959, but artificially colored granules were $0.80 per ton lower in average value. Basalt (traprock) was the principal raw material for roofing granules, but some of the artificially colored product was made with aplite shipped into the State from Virginia. Minnesota Mining & Manufacturing Co. began constructing an integrated roofing granule plant near Belle Mead (Somerset County). Diabase from Sourland Mountain was to be used as raw material.

Sulfur.—Production, as measured by shipments of sulfur recovered as a byproduct in the liquid purification of gas, was reported from plants in Gloucester, Middlesex, and Union Counties. Output of 43,000 long tons and value of $1,077,000 represented increases of 26 and 27 percent, respectively, over 1959. Part of the sulfur was self-consumed in chemical processes, and the remainder was sold to sulfuric acid manufacturers.

Vermiculite.—Plants in Essex and Mercer Counties exfoliated crude vermiculite. Part of the crude material was of foreign origin, and part was mined in other States.

METALS

Base Metals.—Foreign and domestic base metal ores, intermediate products, and scrap were smelted and refined at a number of plants in the State. Copper and precious metals were produced at the smelting and refining plant of American Metal Climax, Inc., at Carteret. International Smelting & Refining Co., a subsidiary of The Anaconda Company, produced copper cathodes and furnace shapes at its Perth Amboy plant. Federated Metals Division of American Smelting & Refining Co. operated three metallurgical plants. At Perth Amboy, primary and scrap metals were refined and processed to produce aluminum and magnesium alloys, copper base alloys, and lead products; at Trenton and Newark, white-metal alloys, zinc die cast, zinc, and zinc dust were produced. Casswell, Strauss & Co., Inc. (Sewaren), and Revere Smelting & Refining Co. (Newark) produced lead, lead alloys, and briquetted copper from secondary metals. The State's only base metal mine (zinc), in Sussex County, was idle.

Ferroalloys.—Production of ferroalloys was about the same as in 1959. Shipments during 1960 were principally ferroalloys of columbium, titanium, vanadium, tantalum-columbium, and boron.

Indium.—High Purity Metals, Inc., Hackensack, and Federated Metals Division of American Smelting & Refining Co., Perth Amboy, produced high-purity indium and other rare and precious metals.

Iron Ore.—Production of crude ore decreased in 1960 because one of the iron ore mines active in 1959 was idle. Two mines (Morris County and Warren County) continued to produce magnetite ore by shrinkage and sublevel stoping. Crude ore was beneficiated magnetically and shipped principally for conversion to pig iron and steel, but quantities were sold for use in manufacturing iron powder and paint and as aggregate in dense concrete for radioactive shielding.

Iron and Steel.—John A. Roebling's Sons, Division of Colorado Fuel & Iron Corp., produced open-hearth steel in Burlington County. Crucible Steel Co. of America produced steel in electric furnaces at its mill in Essex County.

Iron and Steel Scrap.—The principal activity in iron and steel scrap centered about Camden, Jersey City, Port Newark, and Trenton. Inventories at the end of the year were slightly below those at the beginning of 1960. Shipments for exports were the principal factor in maintaining a good level of operation during the year. Exports supplied more than 60 percent of total shipments from yards. Foreign consumption was principally of No. 1 heavy melting steel; other grades for the export market in decreasing order of tonnage were

No. 2 heavy melting steel, No. 2 and all other bundles, and No. 1 electric furnace bundles. Grades in demand for domestic consumption in decreasing order of tonnage were No. 2 and all other bundles, No. 1 heavy melting steel, No. 2 heavy melting steel, and cast-iron scrap other than borings.

Rare-Earth Metals.—Separated rare-earth metals, misch metal, ferrocerium, and other compounds of rare-earth elements were produced in Bergen, Essex, and Passaic Counties. Continued research on processing methods made more of the rare-earth elements available in high-purity form.

Titanium.—Glidden Co. completed pilot-plant work to test recovery of ilmenite and other heavy minerals during the year. Most of the exploratory drilling at the company-owned deposit also was completed. Engineering and design of the concentration plant to be erected in Jackson Township, Ocean County, was well underway. In addition to producing ilmenite concentrate, the company planned to recover byproduct sand and gravel and associated heavy minerals, including zircon. American Smelting & Refining Co. and American Cyanamid Co. continued to hold other tracts of land containing titanium-bearing sand deposits.

Uranium.—A quantity of uranium ore mined in Sussex County was delivered at Salt Lake City, Utah, for processing. This was the first recorded production of uranium ore in the State although specimens containing uranium minerals had been collected over a period of years.

MINERAL FUELS

Coke and Coal Chemicals.—Koppers Co., Inc. (Hudson County), operated a merchant plant having an annual capacity of 1.1 million tons of coke. Quantities of monoammonium phosphate, crude coal tar, crude light oil, intermediate light oil, and naphthalene (under 74° C.) were recovered as byproducts.

Peat.—Both quantity and value of peat recovered were less than in 1959. The output, from bogs in Somerset, Sussex, and Warren Counties was sold principally in bulk for use as a soil conditioner.

Petroleum.—Seven refineries operated in two general areas, both accessible to tidewater; five plants were in the New York area (Middlesex, Union, and Hudson Counties); and two, near Philadelphia (Gloucester County). Total daily operating capacity of the active plants was 513,000 barrels of crude oil and 147,100 barrels of cracked and reformed gasoline. Four laboratories conducted petroleum research chiefly on production development, new processes, and product utilization. Over 4,000 persons were employed at the laboratories operated by Cities Service Research and Development Co., Cranberry; Esso Research and Engineering Center, Florham Park; Esso Research Center, Linden; and Socony-Mobil Oil Co., Paulsboro.

TABLE 4.—Capacities of petroleum refineries and cracking plants, January 1, 1960

(Barrels per day)

Company	Location	Type of plant [1]	Crude-oil capacity			Cracked- and reformed-gasoline capacity		
			Operating	Shutdown	Building [2]	Operating	Shutdown	Building [2]
	Gloucester County:							
Mobile Oil Co.	Paulsboro	S-C-K-L	87,000			26,400		
Texaco, Inc.	Westville	S-C	73,000			24,500	[3] 5,000	
	Middlesex County:							
California Oil Co.	Perth Amboy	S-C-A	100,000	15,500		25,500	200	
Hess Trading & Transport, Inc.[4]	Sewaren	S-C	45,000			8,000		
	Union County:							
Metropolitan Petroleum Corp.	Bayonne	S		20,000				
Esso Standard Division of Humble Oil & Refining Co.	do	S-A	25,000					
Do.	Linden	S-C-A	168,000		2,000	62,700	[3] 1,200	7,100
Cities Service Oil Co. (Pennsylvania).	do	S-A	15,000					
Total			513,000	35,500	2,000	147,100	6,400	7,100

[1] Type of plant: A—Asphalt, C—Cracking and/or reforming, K—Coke, L—Lube, and S—Skimming.
[2] Represents capacity under construction on January 1, 1960, which will add to existing capacity.
[3] Equipment considered inoperable without extensive reconditioning.
[4] January 1, 1959, capacity.

REVIEW BY COUNTIES

Atlantic.—Commercial output of sand and gravel decreased 15 percent from 1959 and totaled 100,000 tons. Seven operations were active, chiefly near Buena Vista, Folsom, Hammonton, Oceanville, and Port Republic. Production, mostly processed sand, was used for paving, building, and molding. Eighty-eight percent of the commercial output was shipped by truck and the remainder, by rail. Crews of the Atlantic County Road Department produced sand and gravel for paving and fill.

Bergen.—Crushed stone was produced in Bergen County for the first time in more than 5 years. Traprock excavated under contract with the Port of New York Authority was used for concrete aggregate, roadstone, and fill. The excavation provided access on the New Jersey side to the new lower deck of the George Washington Bridge. Production of sand and gravel, chiefly for building and paving purposes, decreased from 869,000 tons in 1959 to 790,000 tons in 1960. All of the material was processed and shipped by truck. Output was reported from four operations at Mahwah, Paramus, Ramsey, and Wyckoff. Alluvial clays, used in manufacturing building brick, were recovered from a pit near Carlstadt by Tri-County Brick Corp.

Construction was completed, and production was begun at the gypsum-calcining mill of Barrett Division, Allied Chemical Corp. in Edgewater. The calcined gypsum was used in manufacturing gypsum plaster building products at the company adjacent Shadyside plant. Royce Chemical Co. (Carlton Hill) manufactured zinc oxide and leaded zinc oxide pigment. Artificially colored roofing granules were produced by The Flintkote Co. at its East Rutherford plant.

TABLE 5.—Value of mineral production in New Jersey by counties [1]

County	1959	1960	Minerals produced in 1960 in order of value
Atlantic	$183,629	$202,926	Sand and gravel.
Bergen	1,307,403	2,431,090	Stone, sand and gravel, clays.
Burlington	1,140,883	1,222,531	Sand and gravel, greensand marl, clays.
Camden	1,091,670	1,208,620	Sand and gravel, clays.
Cape May	(2)	(2)	Magnesium compounds, sand and gravel, gem stones.
Cumberland	7,243,863	8,321,757	Sand and gravel, clays.
Essex	(2)	(2)	Stone.
Gloucester	578,500	540,020	Sand and gravel, greensand marl, stone.
Hunterdon	(2)	(2)	Stone.
Mercer	(2)	(2)	Stone, gem stones.
Middlesex	2,391,801	2,215,484	Clays, sand and gravel.
Monmouth	770,306	856,934	Sand and gravel.
Morris	13,495,987	10,706,757	Iron ore, sand and gravel, stone, clays.
Ocean	1,713,131	1,420,172	Sand and gravel.
Passaic	6,671,071	5,685,988	Stone, sand and gravel, clays.
Salem	11,650	(2)	Sand and gravel.
Somerset	9,760,060	9,593,389	Stone, clays, peat, gem stones.
Sussex	3,544,025	3,487,656	Stone, manganiferous residuum, sand and gravel, lime, peat, uranium, gem stones.
Union	(2)	(2)	Stone.
Warren	(2)	(2)	Iron ore, sand and gravel, stone, clays, peat.
Undistributed [3]	9,574,701	8,515,387	
Total	59,479,000	56,409,000	

[1] No production reported in Hudson County.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes value of gem stones not assigned to specific counties and values indicated by footnote 2.

Maywood Chemical Works, Maywood, produced a variety of rare-earth metals and compounds. High Purity Metals, Inc., Hackensack, a subsidiary of Accurate Specialities Co., Inc., began to produce high purity rare-earth metals. It continued to process and market ultra-pure indium, germanium, gold, and other materials, principally for electronic applications.

Burlington.—Sand and gravel, chiefly for building and paving, was produced at six operations—two each near Riverside and Mount Holly and one each near Burlington and East Riverton. Total county output decreased 3 percent from 1959. Truck, railroad, and waterway were used by producers to transport their material to market. Seventy-six percent of the output was processed material Limited quantities of molding and other sand were produced. National Soil Conservation, Inc., Medford, continued to produce greensand marl for sale as a natural fertilizer. Church Brick Co. manufactured building brick from miscellaneous clay produced near Fieldsboro. Crude gypsum was calcined for manufacturing finished building material at the Burlington plant of National Gypsum Co. A wide variety of open-hearth steels for wire and specialties was made at the Trenton plant of John A. Roebling's Sons, Division of Colorado Fuel & Iron Corp.

Camden.—Commercial production of sand and gravel increased from 583,000 tons in 1959 to 774,000 tons in 1960. Nine producers were active near Atco, Berlin, Gloucester Township, Grenloch, Pennsauken Township, Winslow, and Woodcrest. Output consisted chiefly of molding and other industrial sand and structural and paving material. Construction and maintenance crews of the Camden County Highway Department produced paving gravel. Eighty-nine percent of the commercial output was processed material. Pro-

ducers shipped their material by truck (79 percent) and railroad (21 percent).

Miscellaneous clay, used exclusively for manufacturing building brick, was produced near Winslow Junction by the New Jersey Division of Alliance Clay Product Co. Ward Sand and Materials Co., Delair, produced plastic fire clay and miscellaneous clay for use in refractories. The Camden coke plant of Public Service Electric & Gas Co. had been abandoned on May 14, 1959, and production of coke and byproduct coal chemicals discontinued. New Jersey Zinc Co. produced titanium dioxide (titanium white) at its Gloucester City pigment plant, where expanded facilities were completed in 1960.

Cape May.—Northwest Magnesite Co. produced refractory magnesia from sea water and dolomite at its Cape May plant. Tuckahoe Sand and Gravel Co. and Courtland Sand and Gravel Co. processed building sand and gravel near Tuckahoe and Cape May Court House, respectively. John F. Gandy, using portable equipment, mined sand and gravel near Marmora for highway construction. All of the material was shipped to consumers by truck.

Cumberland.—Cumberland County continued to be the leading sand and gravel producing county and supplied 42 percent of the State's total valuation of sand and gravel. Output of sand and gravel totaled 2,438,796 short tons, a 12-percent increase over 1959. Production was reported from 14 operations in the county and consisted mainly of molding and glass sand. Blast, fire, filter, and engine sand as well as building, paving, and other sand and gravel also were produced. National Glass Sand Corp. and Pennsylvania Glass Sand Corp., both of Millville, and Port Silica Sand Co., Inc., Port Elizabeth, produced ground sand that was used as foundry, abrasive, and filler sand, and for enamel, glass, pottery, porcelain, and other purposes. Daniel Goff Co., Inc. (Millville), mined plastic fire clay for use as a binder for foundry sand. William Edge discontinued the grinding of oystershell near Dorchester.

Essex.—Basalt for construction material and riprap was mined at West Orange by Orange Quarry Co. and at South Orange by M. L. Kernan Quarry. Part of the output was sold to nearby communities for use in road maintenance and repair. Crude vermiculite, imported from Africa, was exfoliated at the Newark plant of Vermiculite Industrial Corp. for use in insulation and plaster, and as an aggregate in ultralightweight concrete. A limited quantity of crude gypsum was calcined at the Newark plant of Barrett Division, Allied Chemical Corp., and transferred to the company plaster board plant at Edgewater, Bergen County. In March, the Newark plant was dismantled and sold; production facilities were replaced by a newly constructed calcining plant adjacent to the Edgewater plant.

Iron oxide pigment (hydrated ferric oxide) was produced at the Newark plant of E. I. duPont de Nemours & Co., Inc. Ronson Metals Corp., successor to New Process Metals, Inc. (Newark), continued to produce individual rare-earth metals, ferrocerium, and misch metal for lighter flints. The company continued research to improve methods of separating the rare-earth elements and on the metallurgy of the individual metals. Crucible Steel Co. of America made special steel in arc-melting and induction furnaces at its Spaulding Works, Harrison.

Gloucester.—Production of sand and gravel was reported from four operations, at Bridgeport, Downer, Mt. Royal, and Gibbstown. Output of sand and gravel declined 9 percent from a high of 418,000 tons in 1959. Dredging was the principal method used to extract sand and gravel in the county. A small quantity was sold as unprepared material. Inversand Co. recovered greensand marl from its pit near Sewell; the glauconite (natural zeolite) content of the greensand was used to soften water for domestic and industrial use. Joseph Bauder & Sons (Franklinville) recovered oystershell for use as poultry grit. Freeport Sulphur Co. recovered byproduct sulfur at its Eagle Point (Westville) plant. Mobil Oil Co. also recovered byproduct sulfur at its Paulsboro refinery. Shieldalloy Corp., Newfield, used the thermite process in manufacturing ferroalloys of titanium, vanadium, columbium, columbium-tantalum, and other metals.

Hudson.—Koppers Co., Inc., produced coke and coal chemicals at its Kearney plant, which had 165 Koppers and 65 Koppers-Becker slot-type byproduct coke ovens. The company also recovered hydrogen sulfide by the hot-vacuum process at its nearby Seaboard plant.

Hunterdon.—Basalt for use chiefly as concrete aggregate and roadstone was produced by Lambertville Quarry Co. (Lambertville) and Houdaille Construction Materials, Inc. (Oldwick). Granite for concrete roadstone and riprap and miscellaneous stone for rough dimension stone were also produced during 1960.

Mercer.—Diabase (traprock) was quarried near Pennington by the Pennington Quarry Co., and basalt was mined by inmates of the Mercer County Workhouse (Trenton). The output from both quarries was used as concrete aggregate and roadstone. Golding-Keene Co. (Trenton) ground potash feldspar from crude ores produced at its mines in New Hampshire and Quebec, Canada. The ground material was sold for use in enamel, tile, insulators and pottery, and as an abrasive in soap. Principal markets were in Massachusetts, New Jersey, and Connecticut. Golding-Keene Co. sold its Trenton plant October 24, 1960; after that date customers were supplied from its New Hampshire grinding plant. Columbian Carbon Co. (Trenton) continued to manufacture black, brown, red, and yellow iron oxide pigments by chemical treatment of scrap iron. Crude vermiculite from out of State was exfoliated at a plant in Trenton.

Middlesex.—Middlesex County continued as the leading clay-producing area, supplying 66 percent of the State tonnage. County output of 438,000 tons, a 5-percent decrease from 1959, was mainly miscellaneous clay used for manufacturing heavy clay products and lightweight aggregate. Most of the fire clay produced in the county was used in manufacturing a variety of refractory products. Production was reported by 12 companies, mainly along the Atlantic seaboard.

The combined output of eight sand and gravel producers in the county totaled 777,000 tons, a 19-percent increase over 1959. Output, mainly construction sand, was used for building and paving purposes. Industrial sands in limited quantity were produced for blast, molding, engine, and other uses. Sand and gravel was transported from plants by truck, waterway, and railroad.

Anlin Co. recovered byproduct sulfur by the modified Claus process of gas purification at Perth Amboy. Perlite expanded by Coralux

Perlite Corp., Metuchen, was sold for use in acoustical plaster and ultralightweight concrete. Columbian Carbon Co. (Monmouth Junction) and Stabilized Pigments, Inc. (New Brunswick), continued to calcine copperas to produce a red iron oxide pigment. National Lead Co. (Sayreville) manufactured titanium dioxide, white lead, red lead, and litharge at its Perth Amboy plant. American Smelting & Refining Co. continued to produce zinc chloride at its Perth Amboy plant. The refractories division of the Carborundum Co. (Perth Amboy) produced synthetic mullite from alumina and silica by treating these raw materials in a high-temperature kiln. The mullite was used in manufacturing brick, block, and special shapes for use principally as refractories in high-temperature applications at steel mills and glass plants.

Federated Metals Division of American Smelting and Refining Co. (Perth Amboy) smelted and refined foreign and domestic copper matte and concentrates. Electrolytic copper; oxygen-free copper; refined gold, silver, and platinum-group metals; selenium; tellurium; metal powders; and solders were produced at the Carteret plant of United States Metals Refining Co., a unit of American Metal Climax, Inc. Coppers, brass, bronze, and cupronickel tubing and pipe were produced at the new plant of Phelps Dodge Copper Products Corp. in South Brunswick. Production of aluminum castings was started late in 1960 at a new die-casting plant, part of the Edison Works of Aluminum Co. of America (Metuchen). This large modern facility was planned to supplant gradually the company smaller plants at Garwood (Union County), and Bridgeport (Conn.). Metal and Thermit Corp., Carteret, manufactured ferroboron and ferrotitanium by the thermite process.

Monmouth.—Production of sand and gravel from eight operations, mainly along the Atlantic seaboard, totaled 883,000 tons, a 23-percent increase over 1959 and a 4-percent increase over the previous high in 1955. Building sand and gravel and paving gravel, sold to local and State government agencies, were the principal types produced.

Morris.—Alan Wood Steel Co. continued to mine and beneficiate iron ore at its Scrub Oaks mine near Dover. The concentrate was shipped to the company steel plant at Conshohocken, Pa. Shahmoon Industries, Inc., did not operate its Mt. Hope iron-ore mine but made shipments from stock during 1960. Alan Wood Steel Co. continued to ship mine waste and mill tailings for use as concrete aggregate and roadstone. Shahmoon Industries, Inc., opened a new granite quarry for production of aggregate. Samuel Braen's Sons mined and prepared granite for use as riprap, concrete aggregate, and roadstone at its Riverdale Quarry. The Richard Mine plant (Wharton) of Wharton Sand & Stone Co. ceased operating when the granite mine tailing from the idle Richard Mine had been consumed. Morris County continued to rank second in valuation of sand and gravel output among the 15 producing counties in the State. Output from eight operations totaled 2,219,901 tons a 22-percent increase over 1959 and a 2-percent increase over the previous high in 1956. Ninety-six percent of the sand and gravel produced was processed and sold for building and paving uses. Logansville Pottery, Inc., mined clay near Bernardville for use in manufacturing flowerpots.

Ocean.—Despite a decline in both tonnage and value, Ocean County ranked third in valuation of sand and gravel production in 1960. The output, as in the past, was used mainly for building and paving materials. New Jersey Pulverizing Co. near Bayville produced industrial sands for molding, blast, engine, and other industrial uses as well as a quantity of ground sand for abrasive, filler, and foundry purposes. Glidden Co. completed its pilot-plant work for recovering ilmenite. Construction of a concentrating plant, scheduled for completion in 1962, was planned. The plant was to be built in Jackson Township near Ridgeway. Output of ilmenite concentrate from the new plant will be shipped by rail to the company's titanium dioxide plant in Baltimore, Md. Byproduct sand and gravel will be sold locally.

Passaic.—Passaic County continued to be the second largest source of crushed stone in the State although the value of production was 8 percent below 1959. The reduced value was caused by lower prices; the tonnage was about the same as in 1959. Basalt was produced by Samuel Braen's Sons (Haledon and Hawthorne), Sowerbutt Quarries (Prospect Park), Union Building & Construction Corp. (Clifton), Great Notch Corp. (Little Falls), and Houdaille Construction Materials, Inc. (Montclair). Most of the basalt produced was for concrete and roadstone, but part of the output was used for riprap and roofing granules. Passaic Crushed Stone Co., Inc., produced concrete aggregate and roadstone from gneiss mined at a quarry near Pompton Lakes. Sand and gravel, chiefly for structural materials, was processed at four plants near Wayne. Miscellaneous clay for manufacturing brick was produced by Paterson Brick Co. (Wayne).

PerAlex of New Jersey, Inc., Paterson, expanded crude perlite, mined in Nevada, for use in lightweight concrete and acoustical plaster, and as a soil conditioner. Natural roofing granules for mineral-surfaced roofing and siding were produced by H. B. Reed Corp. (Passaic) and Great Notch Granule Co. (Little Falls). Facilities for producing beryllium oxide ceramic materials were expanded at National Beryllia Corporation's Haskell plant. Rare-earth metals and compounds were produced by Davison Chemical Division of W. R. Grace & Co., Pompton Plains.

Salem.—A. W. Davis Lumber Co. discontinued its sand and gravel operations December 15. Only a limited quantity of building sand was produced by the company during 1960.

Somerset.—Basalt production of 4.3 million tons valued at $9.4 million made Somerset County the leading stone-producing county in the State. Tonnage was lower than in 1959, but value was about the same because of increased prices. Basalt was mined at six quarries: Houdaille Construction Materials, Inc. (Millington and Bound Brook), Fanwood Stone Crushing & Quarry Co. (Watchung), Kingston Traprock Co. (Kingston), Somerset Crushed Stone, Inc. (Bernardsville), and Dockwatch Quarry Pit, Inc. (Martinsville). Output was sold mostly for concrete aggregate and roadstone, but quantities were also used for riprap and railroad ballast. Peapack Limestone Quarry Co., Inc., was inactive. Miscellaneous clay was produced by New Jersey Shale Brick & Tile Corp. (Somerville) and Natco Corp. (Middlebush). Output was used for manufacturing building brick and other heavy clay products. Mt. Bethel Humus Co. (Mt. Bethel)

produced humus peat for sale in bulk. Industrial Insulation Division of Johns-Manville Corp. (Manville) expanded perlite for use in manufacturing pipe insulation and for loose fill. The crude material was mined in Colorado by Johns-Manville Perlite Corp.

Central Commercial Co. produced natural and artificially colored roofing granules at its Bound Brook plant.

Sussex.—Farber White Limestone Co. (Franklin) and Limestone Products Corp. of America (Newton) mined, crushed, ground, and sized limestone for a wide variety of uses. On a basis of tonnage consumption, the principal uses were for agstone, concrete aggregate, roadstone, and as a filler in flooring, rubber, and asphalt. The limestone was also used in manufacturing lime, as an additive in livestock feed, for poultry grit, filter medium, and roofing granules. Limestone Products Corp. burned limestone at its Lime Crest plant and produced hydrated lime for use in construction and agricultural and chemical applications. The principal consuming areas for the hydrated lime were New Jersey, New York, and Pennsylvania; small quantities were shipped to Connecticut, Maine, Massachusetts, and Vermont. The Sterling Hill mine (zinc) near Ogdensburg was idle but shipments of manganiferous residuum were made from stockpiles at the Palmerton (Pa.) smelter.

The combined sand and gravel output of four companies totaled 226,000 tons, a 70-percent increase over 1959. Reed-sedge peat was produced from bogs and sold packaged and in bulk by Hyper-Humus Co. (Newton); bulk peat sales only were reported by Netcong Natural Products (Stanhope). Becmo, Inc., produced and sold uranium ore from a deposit in the southern part of the county. Old mine dumps near Franklin continued to attract thousands of amateur gem and mineral collectors. Specimens collected were chiefly calcite, franklinite, willemite, and zincite.

Union.—Basalt was mined, crushed, and screened by Houdaille Construction Materials, Inc., at its Summit plant for use as concrete aggregate and roadstone. Hydrogen sulfide was recovered by diethanolamine treatment at the Bayway refinery of Esso Standard Oil Co. The gas shipped to a nearby plant of General Chemical Div., Allied Chemical Corp., where sulfur was recovered and used by General Chemical. Certified Industries Products, Inc., Hillside, expanded perlite, mined in Colorado, for use in acoustical plaster and concrete aggregate, and as a soil conditioner.

Warren.—Alan Wood Steel Co. mined and beneficiated magnetite ore at its Washington mine to supply part of the iron-ore requirements of its steel plant at Conshohocken, Pa. Houdaille Construction Materials, Inc. (Carpenterville), and Steckel Concrete Co. (Phillipsburg) processed structural sand and gravel materials, and Van Horn Sand & Gravel Co. (Belvidere), using portable equipment, produced only gravel for construction purposes. Royal Green Marble Co. (Phillipsburg) quarried and crushed marble exclusively for terrazzo. The Port Murray clay pit and brick plant of Natco Corp. was active during the year after being idle in 1959. Tamarock Humus Co. (Buttzville) recovered peat from a nearby bog for bulk sales. Magnesium compounds, including acetate, chloride, nitrate, oxide, sulfate, and phosphate, were produced by J. T. Baker Chemical Co. at its Phillipsburg plant.

The Mineral Industry of New Mexico

By F. J. Kelly,[1] William H. Kerns,[1] and D. H. Mullen [1]

THE RECOVERY of certain segments of the mineral industry of New Mexico from production cutbacks during 1957–59, was indicated by an overall 10-percent increase in the value of output for 1960 ($652.2 million), compared with 1959 ($592.5 million).

Beryllium, manganese, and molybdenum in the metals group, and fluorspar, magnesium compounds, sheet mica, perlite, pumice, and sand and gravel in the nonmetals category were the only commodities for which a lower output was recorded in 1960. The drop in total value for these products, $8.7 million, was more than offset by large production gains reported for other minerals.

The spectacular 33-percent advance in the value of metals output can be attributed to uninterrupted operations following the settlement of labor strikes that occurred in the copper industry in 1959 and to a general increase in the production of uranium ore. Metals accounted for 17 percent of the value of mineral production.

The output of mineral fuels increased 7 percent in value in 1960 as the result of greater overall production. However, the contribution of the fuels group to the total value of all mineral production dropped from 70 percent in 1959 to 68 percent.

Although the value of some nonmetals produced and sold in 1960 advanced substantially, the overall increase for this group was only 3 percent above 1959. Higher values for potash, stone, lime, and gypsum were nearly offset by a $6.1 million decline in the value of sand and gravel and pumice output. The value of nonmetal production was 15 percent of the $652.2 million recorded for all minerals.

The expansion of the construction-materials segment of the minerals industry was highlighted in 1960 with the initial operation in May of a wallboard plant between Santa Fe and Albuquerque and the completion and start of operation of a second wallboard plant at Albuquerque. A new mica-grinding mill was constructed at Tesuque, and a new perlite grinding mill at No Agua replaced one destroyed by fire.

[1] Commodity-industry analyst, Bureau of Mines, Denver, Colo.

TABLE 1.—Mineral production in New Mexico [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	320	$6	492	$10
Beryllium concentrate—short tons, gross weight	11	6		
Carbon dioxide (natural)—thousand cubic feet	(2)	(2)	230,115	(2)
Clays [3]—thousand short tons	45	77	56	132
Coal—do	149	837	295	1,747
Copper (recoverable content of ores, etc.)—short tons	39,688	24,369	67,288	43,199
Fluorspar—do	200	7		
Gem stones	(4)	39	(4)	40
Gold (recoverable content of ores, etc.)—troy ounces	3,155	110	5,423	190
Gypsum—thousand short tons			55	193
Helium—thousand cubic feet	16,903	264	43,494	684
Iron ore (usable)—thousand long tons, gross weight	(2)	(2)	1	27
Lead (recoverable content of ores, etc.)—short tons	829	191	1,996	467
Lime—thousand short tons	16	209	36	496
Manganese ore and concentrate (35 percent or more Mn)—short tons, gross weight	27,528	2,248		
Mica:				
Scrap—short tons	210	7	235	7
Sheet—pounds	247	2	(2)	(5)
Natural gas—million cubic feet	739,660	73,966	798,928	85,485
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	264,133	16,859	321,667	20,412
LP gases—do	552,257	22,320	645,116	28,788
Perlite—short tons	240,642	2,121	240,593	2,119
Petroleum (crude)—thousand 42-gallon barrels	195,692	301,394	[6] 107,940	[6] 307,491
Potassium salts—thousand short tons, K_2O equivalent	2,189	74,117	2,440	80,023
Pumice—thousand short tons	493	1,023	365	827
Salt—do	36	322	39	331
Sand and gravel—do	12,460	13,332	7,419	7,459
Silver (recoverable content of ores, etc.)—thousand troy ounces	159	144	304	275
Stone—thousand short tons	461	542	1,277	1,692
Uranium ore—short tons	3,269,826	53,463	3,793,494	61,827
Zinc (recoverable content of ores, etc.)—do	4,636	1,066	13,770	3,553
Value of items that cannot be disclosed: Cement, fire clay, magnesium compounds, manganiferous ore, molybdenum, vanadium, and values indicated by footnote 2		3,771		5,266
Total New Mexico [7]		[8] 592,535		652,200

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Excludes fire clay; included with "Value of items that cannot be disclosed."
[4] Weight not recorded.
[5] Less than $1,000.
[6] Preliminary figure.
[7] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.
[8] Revised figure.

Employment and Injuries.—Preliminary data compiled by the Federal Bureau of Mines for employment and injuries in the mineral industries in New Mexico in 1960, excluding the petroleum industry, are shown in table 2. The uranium and potash industries each furnished approximately one-third of the total man-hours worked (excluding the petroleum industry). Nonferrous metal mines and smelters supplied approximately one-quarter of the total. Uranium mines reported 14 fatal injuries and over half the nonfatal injuries; potash mines reported the State's only other fatality and one-third of the nonfatal injuries.

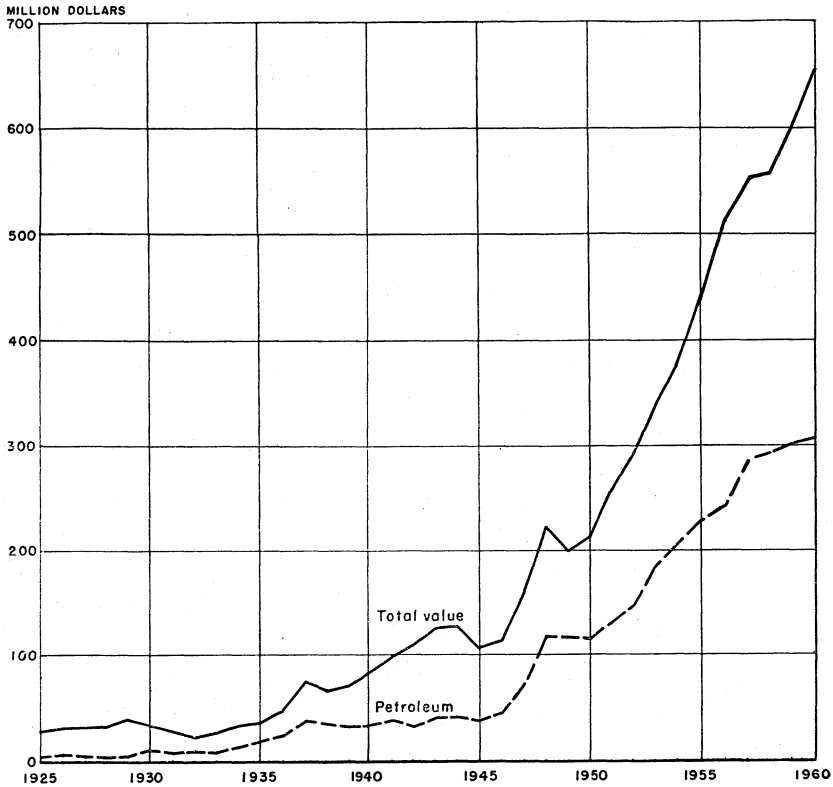

FIGURE 1.—Value of petroleum production and total value of all minerals produced in New Mexico, 1925–60.

TABLE 2.—Employment and injuries in the mineral industries[1] in 1960[2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Non-fatal	
Nonferrous metal mines and smelter	66	2,098	5,238,392	--------	135	25.8
Metal mines (other)	2	26	30,744	--------	8	260.2
Uranium mines	61	3,727	9,016,768	14	501	57.1
Potash mines	6	2,829	7,133,024	1	295	41.5
Nonmetal mines (other)	43	460	739,574	--------	12	16.2
Quarries	28	184	338,382	--------	4	11.8
Sand and gravel plants	128	615	999,352	--------	10	10.0
Coal mines	26	1,726	326,193	--------	16	49.0
Total	360	11,665	23,822,429	15	981	41.8

[1] Excludes petroleum industry
[2] Preliminary figures.

Legislation and Government Programs.—The Office of Minerals Exploration (OME) signed a contract on January 27 with Tri-State Metals Corp. to explore for beryl and tantalum. OME was to participate to the extent of 50 percent of approved costs not to exceed $23,360.

One small shipment of hand-cobbed mica was made to the Government purchase depot at Custer, S. Dak. Contracts for the purchase of uranium oxide concentrate from two of the State's six processing plants were revised by the Atomic Energy Commission (AEC) to extend the termination date to December 31, 1966, and stipulated the quantities of concentrates to be purchased.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of the mineral fuels (carbon dioxide, coal, helium, natural gas, natural gas liquids, and petroleum) was 7 percent greater than in 1959 and represented 68 percent of the total value of all mineral production in the State.

Carbon Black.—Carbon black was produced from natural gas at three plants in Lea County. The quantity of carbon black recovered was 4 percent below that of 1959, and 47.7 billion cubic feet of natural gas was consumed.

Carbon Dioxide.—Production of carbon dioxide from wells in Harding County increased 23 percent in quantity and 15 percent in value over that of 1959. The gas was marketed to consumers as dry ice and liquid carbon dioxide.

Coal.—Production of coal, from 19 mines (18 underground, 1 strip) in 5 counties, was double that of 1959. Output from the Koehler mine in Colfax County, operated by the Kaiser Steel Corp. supplied the increase. The Pittsburg & Midway Coal Co., Pittsburg, Kans., began stripping overburden from a coalbed west of Gallup. Coal production was scheduled to begin January 1962; output will be used at a 110-megawatt thermal-electric generating plant at Joseph City, Ariz., to be built by Arizona Public Service Co. The plant will consume an estimated 380,000 tons of coal annually. Official approval was granted by the U.S. Department of the Interior for constructing a 350-megawatt thermal-electric generating plant on the Navajo Indian Reservation. Arizona Public Service Co. will build and operate the plant, to be named the Four Corners powerplant, on a 1,250-acre site, 10 miles southeast of Shiprock, leased from the Navajo Tribal Council. Fuel for the plant will be mined by Utah Construction & Mining Co. from 24,320 acres of undeveloped tribal lands which were leased from the tribal council and which contain a large reserve of sub-bituminous coal. Coal requirements were expected to be 4,200 tons a day; the Navajo tribe was to receive a royalty of 15 cents a ton, based on a minimum production of 800,000 tons in 1963, increasing to 2.5 million tons in 1975.

Helium.—The helium plant at Shiprock, operated by the Federal Bureau of Mines, was active throughout the year; helium recovered from natural gas was more than double that of 1959.

TABLE 3.—Coal production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1959		1960	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Colfax	82,359	$6.29	212,114	$6.10
McKinley	50,316	4.62	69,584	5.44
Rio Arriba	7,830	5.91	7,398	5.58
Sandoval	1,245	3.11	1,457	6.50
San Juan	6,800	5.40	4,209	5.75
Total	148,550	5.64	294,762	5.93

[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 the coal had been sold commercially.)

Natural Gas.—Marketed natural gas from oil wells and dry gas wells was 8 percent greater than in 1959. Production came from 13,476 oil wells and 6,047 gas wells. Southeastern counties supplied 55 percent of the output. Although 64 percent of production was from dry gas wells, 83 percent of the total output was processed at natural gas plants for recovering natural gas liquids. Data published by the

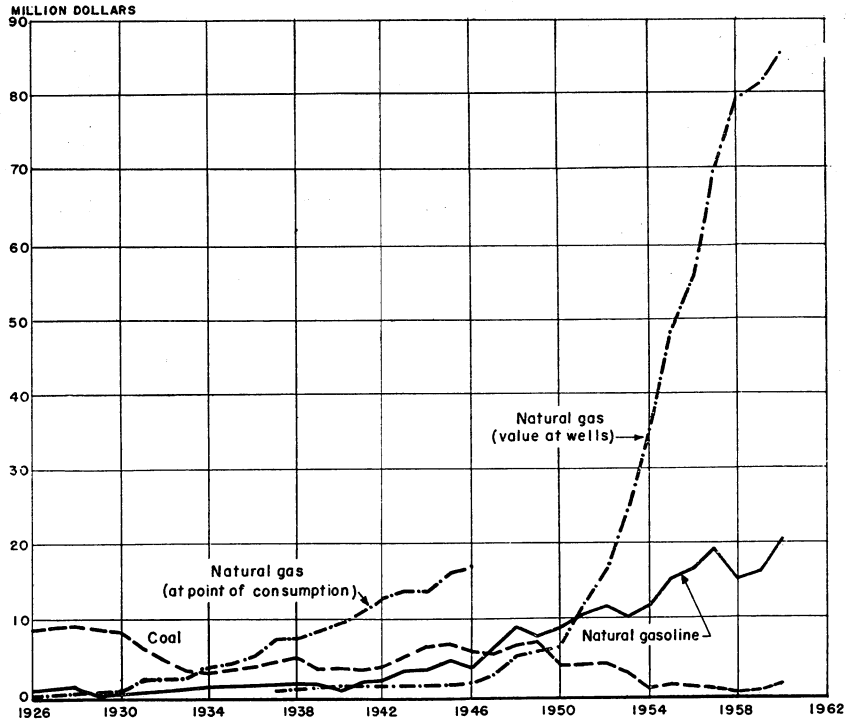

FIGURE 2.—Value of natural gas, natural gasoline, and coal in New Mexico, 1926–60.

New Mexico Oil and Gas Conservation Commission [2] showed a total production of 821 billion cubic feet of gas—293.4 billion cubic feet from oil wells and 528.5 billion cubic feet from gas wells.

Natural Gas Liquids.—Natural gasoline and cycle products, butane, and propane recovered from 26 processing plants increased 18 percent in quantity and 25 percent in value compared with 1959. Natural gas from oilfields in southeastern and northwestern counties, totaling 662.5 billion cubic feet, was processed with the recovery of natural gasoline and isopentane (7.3 million barrels), butane (6.4 million), propane (7.8 million), butane–propane mixture (0.5 million), and isobutane (0.7 million). Residual gas was used for plant fuel (42.3 billion cubic feet), lease fuel (4 billion), manufacture of carbon black (48 billion, of which 29 billion was residue gas and 19 billion was from other sources), sales to pipelines (601.7 billion), and repressuring (9 billion). Skelly Oil Co. completed and began operating a new $3 million gas-treatment plant near Loco Hills in Eddy County in May. Pan American Petroleum Corp. completed its Empire Abo gas-treatment plant 13 miles southeast of Artesia in November. The plant was designed to process 20 million cubic feet of gas a day; initial compressor capacity was 10 million cubic feet. Gas for processing came from 146 wells in the Empire Abo field.

Petroleum.—Petroleum production again exceeded 100 million barrels and increased 2 percent above that of 1959. Output was from 14,286 wells—12,840 in the southeastern counties (Chaves, Eddy, Lea, and Roosevelt) and 1,446 in the northwestern counties (McKinley, Rio Arriba, Sandoval, and San Juan). Major production, 86 percent of the total, came from the southeastern counties. The number of wells completed (1,850) was below that of 1959 (2,077), but the total footage drilled was greater. Exploratory drilling resulted in 38 discoveries (30 oil, 8 gas) from 250 wells completed for a success ratio of 15.20 percent. Development drilling was 87.25 percent successful with 984 oil wells and 412 gas wells from 1,600 wells completed.

TABLE 4.—Crude petroleum production, by counties [1]

(Thousand barrels)

County	1959	1960 [2]	Principal fields in 1960 in order of production
Chaves	4,125	3,653	Caprock.
Eddy	8,180	11,599	Square Lake, Red Lake, North Mason.
Lea	78,720	76,607	Denton, Gladiola, Monument, Hobbs, Vacuum, Langlie.
McKinley	126	115	Hospah.
Rio Arriba	898	903	South Blanco, Escrito.
Roosevelt	452	1,195	Milnsand.
Sandoval	14	14	Otero.
San Juan	13,177	13,854	Bisti, Horseshoe Verde Cha Cha, Totah, Gallegos.
Total	105,692	107,940	

[1] Based on New Mexico Oil Conservation Commission county data adjusted to Bureau of Mines total.
[2] Preliminary figures.

[2] New Mexico Oil & Gas Engineering Committee, Annual Report: Volumes I and II, 1960, 470 pp.

TABLE 5.—Wildcat- and development-well completions in 1960, by districts and counties

District and county	Crude	Conden-sate	Gas	Dry	Service	Total	Footage
West New Mexico:							
Wildcat:							
Catron				1		1	5,400
McKinley	2			8		10	26,900
Rio Arriba	3		1	11		15	53,000
Sandoval				4		4	9,300
San Juan	3			33		36	144,600
Socorro				1		1	4,800
Valencia				3		3	14,400
Total	8		1	61		70	258,400
Development:							
McKinley	2			1	5	8	3,600
Rio Arriba	27	4	153	10		194	1,002,800
Sandoval	2		1	2		5	8,700
San Juan	158	28	196	22	4	408	2,034,600
Total	189	32	350	35	9	615	3,049,700
East New Mexico:							
Wildcat:							
Chaves	2			30		32	70,500
Colfax				1		1	6,000
De Baca				2		2	11,000
Eddy	7	2	1	50		60	263,100
Harding				4		4	5,500
Lea	10	3	1	55		69	541,900
Lincoln				1		1	800
Otero				2		2	7,900
Quay				1		1	5,300
Roosevelt	3			5		8	66,800
Total	22	5	2	151		180	978,800
Development:							
Chaves	34		1	13	2	50	121,100
Eddy	315	4	11	79	1	410	1,805,700
Lea	417	5	9	59	3	493	2,703,700
Roosevelt	29			3		32	308,600
Total	795	9	21	154	6	985	4,939,100
Total all drilling	1,014	46	374	401	15	1,850	9,226,000

Source: Oil and Gas Journal.

METALS

Beryllium.—Exploration and development was conducted at the Harding mine, Taos County, but no shipments were made.

Copper.—Copper production increased 70 percent in quantity (27,600 tons) and 77 percent in value ($18.8 million) compared with 1959, as a result of a major increase in output from the State's leading copper producer, Chino mine, operated by Chino Mines Division, Kennecott Copper Corp. The entire operation, except for leaching of dump material, had been idled by a labor strike from early August to late December 1959. The value of copper produced increased more than the quantity because the weighted average price for copper rose from 30.7 cents per pound for 1959 to 32.1 cents for 1960. Three mines, Chino and Bayard (Continental) in Grant County and Bonney-Miser's Chest in Hidalgo County, supplied 98 percent of copper production in the State in 1960.

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)
1951–55 (average)	58	3	8,014	2,996	$105	298	$269
1956	75	1	8,752	3,275	115	393	356
1957	60		8,060	3,212	112	309	280
1958	20		5,873	3,378	118	159	144
1959	30		4,686	3,155	110	159	144
1960	33		7,804	5,423	190	304	275
1848–1960			[3]	2,229,479	51,366	72,340	57,095

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	69,824	$39,864	3,999	$1,256	25,010	$8,058	$49,552
1956	74,345	63,193	6,042	1,897	35,010	9,593	75,154
1957	67,472	40,618	5,294	1,514	32,680	7,582	50,106
1958	55,540	29,214	1,117	261	9,034	1,843	31,580
1959	39,688	24,369	829	191	4,636	1,066	25,880
1960	67,288	43,199	1,996	467	13,770	3,553	47,684
1848–1960	2,260,234	905,444	332,950	46,335	1,209,334	227,257	1,287,497

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, 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.
[3] Data not available.

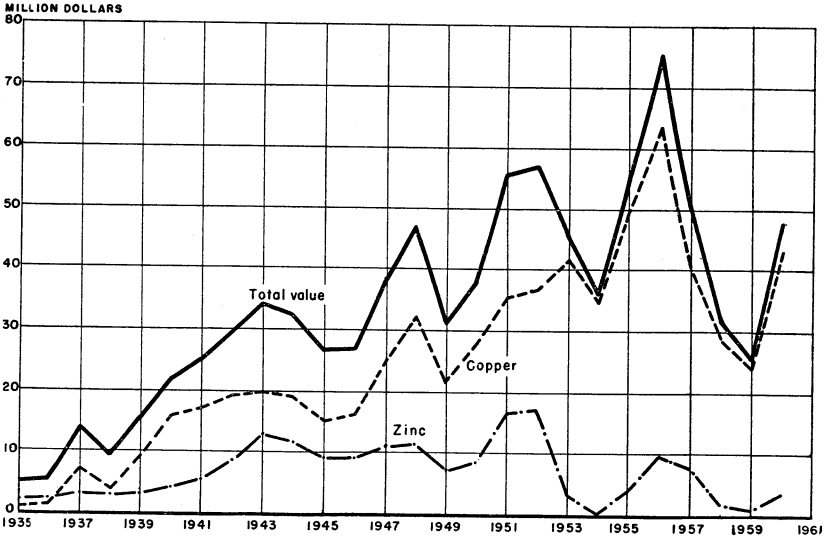

FIGURE 3.—Value of mine production of copper and zinc and total value of gold, silver, copper, lead, and zinc in New Mexico, 1935–60. The value of gold, silver, and lead produced annually has been relatively small.

Major developments at the Chino operation included starting of construction on a $2 million skip hoist on the side of the open-pit mine to lift the ore and waste material from the pit, enlargement and improvement of the precipitation system to remove copper from waste material, continuation of the stripping program to extend the mining area of the open pit, and completion of a new 16,000-kw. powerplant.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1960, by counties, in terms of recoverable metals

County	Mines producing (lode)[1]	Lode material sold or treated[2] (short tons)	Gold		Silver		Copper		Lead		Zinc		Total value
			Troy ounces	Value	Troy ounces	Value	Short tons	Value	Short tons	Value	Short tons	Value	
Grant	15	7,631,818	2,342	$81,970	78,308	$70,873	64,660	$41,511,977	536	$125,506	11,545	$2,978,494	$44,768,820
Hidalgo	5	131,421	2,996	104,860	176,755	159,972	2,554	1,639,732	113	26,372			1,930,936
Lincoln	1	3			159	144							144
Otero	1	11	1	35	3	3	[3]	193					231
Sandoval	1	277			99	90	6	3,403	[3]	12			3,505
Santa Fe	2	288	19	665	504	456	19	12,005					13,126
Sierra	3	1,231			5,947	5,382	22	14,317	51	11,957	35	9,082	40,738
Socorro	5	38,614	65	2,275	42,128	38,128	27	17,270	1,296	303,217	2,190	565,084	925,974
Total:													
1960	33	7,803,663	5,423	189,805	303,903	275,048	67,288	43,198,897	1,996	467,064	13,770	3,552,660	47,683,474
1959	30	4,685,815	3,155	110,425	158,925	143,835	39,688	24,368,432	829	190,670	4,636	1,066,280	25,879,642

[1] Operations at various cleanups not counted as producing mines.
[2] Does not include tonnage of precipitates shipped.
[3] Less than 1 ton.

Gold.—Five mines, Chino and Bayard (Continental), Grant County, and Atwood-Henry Clay, Bonney-Miser's Chest, and Eighty-Five in Hidalgo County, supplied 97 percent of the gold production. More than half of the output was recovered as a byproduct of copper ore from the Chino, Bayard, and Bonney-Miser's Chest mines. The remainder came chiefly from gold-silver ore from the Atwood-Henry Clay and Eighty-Five mines.

Iron Ore.—Magnetite ore containing 65 percent iron was produced from the Kearney Iron Pit in Grant County by White & Mathis and shipped to Clarence Moore, Albuquerque, for use as a high-density concrete aggregate.

Lead.—Three mines, Linchburg in Socorro County and American and Hanover in Grant County, accounted for 89 percent of the lead production. Output more than doubled, mainly as a result of in-

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc in 1960, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold-silver	4	51,843	2,125	142,530	1,472,000	237,700	9,000
Dry silver	6	1,764	1	8,531	62,700	108,700	71,200
Total	10	53,607	2,126	151,061	1,534,700	346,400	80,200
Copper	16	7,526,259	3,189	71,827	83,628,300		84,700
Lead	2	8,176	35	30,013	4,100	706,800	36,700
Lead-zinc and zinc [2]	5	211,121	73	50,890	101,600	2,904,300	27,338,400
Lead barite	1	4,500		112		34,500	
Total	24	7,750,056	3,297	152,842	83,734,000	3,645,600	27,459,800
Other "lode" material:							
Copper precipitates	2	30,401			49,307,300		
Total "lode" material	33	7,834,064	5,423	303,903	134,576,000	3,992,000	27,540,000

[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.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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: [1] Ore	3,266	151,538	83,197,900	3,596,600	27,446,500
Direct-smelting:					
Ore	2,157	152,365	1,905,800	395,400	93,500
Copper precipitates			49,307,300		
Total	2,157	152,365	51,213,100	395,400	93,500
Other:					
Leaching of copper ore			165,000		
Grand total	5,423	303,903	134,576,000	3,992,000	27,540,000

[1] Includes lead-barite ore concentrate.

creased production from the Linchburg mine, owned by Empire Zinc Division, The New Jersey Zinc Co., and operated by L. A. Patten, lessee.

Manganese Ore and Concentrate.—When the quota was filled under the Government manganese ore and concentrate carlot-purchase program on August 5, 1959, the State's manganese industry came to a near standstill. In 1960, shipments of manganese ore were reduced to zero. Luck Mining Co. shipped ferruginous manganese ore containing 11 percent manganese and 32 percent iron from the Boston Hill mine in Grant County to The Colorado Fuel and Iron Corp. steel plant at Pueblo, Colo.

Molybdenum.—The entire production of molybdenum came from molybdenum concentrate produced by Chino Mines at its Chino concentrator at Hurley, Grant County, as a byproduct of copper ores.

The Molybdenum Corp. of America continued for the fifth year an exploration and development program, partly financed by a Defense Minerals Exploration Administration (DMEA) contract, at the Questa mine in Taos County. Work consisted of drifting, crosscutting, and diamond drilling. The company announced that the work had confirmed the existence of a large molybdenum deposit of major significance but that no decision would be made for mining the ore until the exploration program was completed. The 50-ton-per-day mill at Questa could be expanded to 200 tons by adding new crushing capacity.

Silver.—Silver production was almost double that of 1959. Output from the six leading silver-producing mines supplied 89 percent of the total. These mines in order of descending production of silver were the Eighty-Five and Atwood-Henry Clay (Hidalgo County), Linchburg (Socorro), Bonney-Miser's Chest (Hidalgo), and American and Chino (Grant). Half of the output came from gold-silver and silver ores; one-quarter came from copper ore; and one-quarter from lead, lead-zinc, and zinc ores. A small quantity was recovered as a byproduct of lead-barite ore.

Uranium.—Production of uranium ore, from 78 operations in 5 counties (McKinley 65, Valencia 9, San Juan 2, and 1 each in Sierra and Socorro), was 3.8 million tons, an increase of 16 percent over 1959. The average grade of ore shipped was unchanged—0.21 percent U_3O_8 (4.2 pounds per ton). The six processing plants were operated the entire year. Contracts for the purchase of uranium oxide concentrate at two of the plants were amended by the Atomic Energy Commission (AEC). The contract with Homestake–Sapins Partners was extended to December 31, 1966, and provided for the delivery of approximately 4 million pounds of uranium oxide concentrate between July 1, 1960, and April 1, 1962, and 10.7 million pounds between April 1, 1962, and December 31, 1966. It also provided for processing ores from qualified independent producers. The contract with Kermac Nuclear Fuels Corp. was amended to provide for delivery of approximately 31 million pounds of uranium oxide concentrate between November 1, 1960, and December 31, 1966, and for processing ores produced by independent operators. At yearend the contract with Homestake-New Mexico Partners had not been extended beyond April 1, 1962; however, negotiations were in progress.

Vanadium.—Some uranium ores in the Carrizo Mountains of San Juan County contained significant amounts of vanadium and were shipped to Durango, Colo., for processing, where vanadium was recovered as a byproduct. The quantity recovered was 53 percent greater than in 1959. Also, the installation of a vanadium-recovery unit at the Navajo uranium plant of Kerr-McGee Oil Industries, Inc., at Shiprock was completed late in 1959; operation began early in 1960.

Zinc.—Zinc production increased twofold over that of 1959. Output came mostly from the two leading zinc-producing mines, Hanover and Linchburg. Of the total, 83 percent was recovered from material classed as zinc ore and 16 percent from lead-zinc ores.

NONMETALS

Barite.—Galbar, Inc., continued to mine barite-lead ore from its Mex-Tex mines near Bingham. The company shipped 492 tons of ground barite for use as a constituent in oil-well drilling mud.

Cement.—Shipments of portland and masonry cements nearly doubled in 1960 with the first full year of operation at the Tijeras plant of Ideal Cement Co. Although some portland cement was sold in contiguous States, the principal market was in New Mexico. A 1.25-million-barrel addition to the cement plant was completed and placed in operation in December 1960. The expansion consisted of a 375-foot kiln and auxiliary equipment.

Clays.—A number of factors affected clay production in New Mexico in 1960, resulting in a 24-percent increase in the output of miscellaneous clay or shale and a 50-percent decrease in production of fire clay. Reduced production of miscellaneous clay by Kinney Brick Co., Inc., Albuquerque, and El Paso Brick Co. near El Paso, Tex., was more than offset by clay mined and used by Ideal Cement Co. in manufacturing cement. U.S. Mining Corp. (formerly Olsen Mud Service Co.) and W. M. Snyder, operating the Blanco Clay pit, reported the production of small quantities of miscellaneous clay. Fire-clay output declined because of reduced production from clay pits operated by Phelps Dodge Corp. and Gallup Brick & Tile Co.

Fluorspar.—No fluorspar was produced or shipped from stock during 1960.

Gem Stones.—The value of gem and ornamental stones collected remained virtually the same as in 1959. Luna County was the principal source of material collected, and agate furnished most of the total value.

Gypsum.—The first gypsum building products manufactured at the Kaiser Gypsum Co., Inc., Rosario plant were shipped on May 24. During the third quarter, American Gypsum Co. began trial runs at its Albuquerque wallboard plant, and actual operations began in late December. Kaiser Gypsum mined its own gypsum. White Mesa Gypsum Corp. (partly owned by American Gypsum Co.) supplied crude gysum to the Albuquerque wallboard plant. Duke City Gravel Products Co. of Albuquerque mined gypsum for use at the Tijeras plant of Ideal Cement Co. Output was 55,000 tons valued at $193,000. No gypsum was mined in 1959.

Lime.—Kennecott Copper Corp. operated its Chino limekiln and used 36,000 tons of lime in the processing of copper ores.

Magnesium Compounds.—The Carlsbad plant of International Minerals & Chemical Corp. (IMC) produced the only magnesium compounds in the State. These compounds, recovered as a byproduct of potash refining, were consumed by the electrical, fertilizer, uranium, and chemical industries.

Mica.—The recovery of sheet mica from hand-cobbed mine production declined. Scrap-mica production increased significantly. L. W. Tietgen produced the hand-cobbed mica, and Los Compadres Mica Co. ground scrap mica at its Ojo Caliente mill. The feed for this mill came principally from old mine dumps near Ojo. The ground mica was sold for use in manufacturing roofing paper. Clute Corp.

constructed a mica grinding plant at Tesuque. Although no ground mica was shipped during 1960, test work indicated the possibility of shipments beginning early in 1961. Sericite mica from mines north of Tesuque will provide the mill feed, and output will be ground for the paint and oil-well drilling industries.

TABLE 10.—Mica sold or used by producers

	1956	1957	1958	1959	1960
Hand-cobbed mica,[1] total: Pounds	174,367	52,150	97,780	14,828	81
Sheet mica:[1]					
Full trimmed:					
Pounds	11		176	59	
Value	$256		$2,654	$676	
Average per pound	$23.27		$15.08	$11.46	
From hand-cobbed mica:					
Pounds	6,236	2,134	1,615	188	(2)
Value	$52,310	$15,645	$15,743	$922	(2)
Average per pound	$8.39	$7.33	$9.75	$4.90	(2)
Total:					
Pounds	6,247	2,134	1,791	247	(2)
Value	$52,566	$15,645	$18,397	$1,598	(2)
Average per pound	$8.41	$7.33	$10.27	$6.47	(2)
Scrap mica:					
Short tons	767	1,347	787	210	235
Value	$22,213	$46,865	$24,466	$6,562	$6,780
Average per ton	$28.96	$34.79	$31.09	$31.25	$28.85
Total sheet and scrap mica:					
Short tons	770	1,348	788	210	(2)
Value	$74,779	$62,510	$42,863	$8,160	(2)

[1] Sold to the Government through GSA.
[2] Figure withheld to avoid disclosing individual company confidential data.

Perlite.—New Mexico was the leading producer of perlite in the United States, supplying 77 percent of the total output. The Seven Hills of Taos area was the principal producing region; mining and milling operations were conducted by Great Lakes Carbon Corp., Johns-Manville Perlite Corp., and United Perlite Corp. After a fire destroyed the mill of Johns-Manville Perlite Corp., a working agreement between Johns-Manville and Great Lakes Carbon supplied ground perlite to Johns-Manville customers until the mill could be rebuilt. A new plant, with a rated annual capacity of 150,000 tons of processed material, was completed and placed in operation late in December. Great Lakes Carbon Corp. formulated plans to shut down its Socorro mine, mill, and expanding plant, and to center all mining and grinding operations at No Agua. The Socorro expanding

TABLE 11.—Crude perlite sold or used by producers

Year	Short tons	Value (thousands)
1956	167,705	$1,271
1957	187,259	1,568
1958	202,046	1,790
1959	240,642	2,121
1960	240,593	2,119

furnaces were to be moved to Colorado, where a larger expanding plant was to be erected at the Antonito railhead. United States Gypsum Co. continued to mine and mill perlite at its Grants operation at about the same rate reported in 1959.

Potash.—Mine production of potash-bearing ores (sylvinite and langbeinite) rose to 15.1 million tons, containing 2.8 million tons of potash salts. These totals are 8 and 10 percent greater, respectively, than 1959 output. Southwest Potash Corp. recorded the largest percentage increase in mine production, chiefly because of ore shipments to National Potash Co. The average K_2O content of ore mined in New Mexico rose from 18.57 percent in 1959 to 18.85 percent. From this ore, 4.1 million tons of potash, containing 2.4 million tons of K_2O, was recovered. Total stocks of potash products held by producers rose 10 percent to 458,252 tons. Shipments of potash (from Eddy and Lea Counties) reached 4.1 million tons (2.4 million tons, K_2O equivalent) valued at $78.7 million. The average price for material sold declined from $20.08 per ton in 1959 to $19.24.

Five major potash producers in the Carlsbad area and one at Searles Lake, Calif., established a foundation for international potash research to develop programs for efficient and beneficial use of potash.

Mining on the 800-foot level of the IMC potash mine, inactive since 1948, was resumed. The company installed a new-type shuttle car on the 900-foot level. The new car was lower and wider than older cars but carried the same quantity of ore.

Work continued on two shafts at a new production site for Duval Sulphur & Potash Co. A 14-foot hoisting shaft and a 9-foot escape shaft were nearing completion by yearend. The two 1,000-foot concrete-lined shafts will develop two sources of sylvite ore and will open new ore reserves discovered by surface drilling. The company reported that the new ore body is distinct from the ore body being mined.

Southwest Potash Corp. announced a $3 million expansion program for its Carlsbad operation. It also planned to construct a $7 million nitrate of potash and chlorine plant at Vicksburg, Miss. Muriate of potash produced at Carlsbad was to be shipped to the Mississippi plant.

TABLE 12.—Potassium salts production and sales

(Thousand short tons)

Year	Crude salts; [1] mine production		Marketable potassium salts					
			Production			Sales		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value [2] (thousands)	Gross weight	K_2O equivalent	Value (thousands)
1956	11,941	2,305	3,384	1,997	$75,122	3,279	1,931	$72,802
1957	12,893	2,430	3,528	2,080	77,197	3,353	1,977	73,243
1958	12,224	2,309	3,355	1,978	69,106	3,650	2,157	75,343
1959	13,933	2,588	3,707	2,189	74,117	3,821	2,258	76,725
1960	15,071	2,841	4,138	2,440	80,023	4,092	2,412	78,707

[1] Sylvite and langbeinite.
[2] Derived from reported value of "Sold or used."

Pumice.—Sales of crude and prepared pumice and scoria declined 26 percent in volume and 19 percent in value from 1959. A 28-percent drop in the use of pumice and scoria in manufacturing building block and a 24-percent decrease in the demand for railroad ballast were the major causes for the decline in sales. The Santa Fe mill of James H. Rhodes & Co. continued to prepare pumice for use as cleansing compounds, abrasives, acoustic plaster, and other uses such as water filtration, catalysts, matches, and paint. Scoria was the most important product mined under this classification, and block manufacturing consumed the entire output. Twin Mountain Rock Co. (Union County), Volcanic Cinder Co. (Dona Ana), Lava-Pumice, Inc. (Sandoval), Edgar D. Otto & Son, Inc. (Bernalillo), and Crego Block Co., Inc. (Santa Fe), were the chief producers of scoria. Pumice was mined and processed by General Pumice Corp. (Rio Arriba County), Pyramid Pumice Co., Inc. (Sandoval), and Copar Pumice Co. (Santa Fe).

Salt.—The continued growth of the salt industry was shown by an 8-percent increase in output—reaching 39,000 tons valued at $331,000. The Quemado solar-evaporation facility of Curtis Salt Co. was purchased by the Rocky Mountain Salt Co. in June. The salt harvest from this operation, 8 percent above that of 1959, was sold to feed dealers, water-softener manufacturers, State and county highway departments, and cattle and sheep ranchers in Arizona and New Mexico. The Carlsbad region of Eddy County continued to be the principal source of salt. The processing of the salt tailings from potash refining resulted in production of 18 percent more rock salt than in 1959. Salt Supply Co., New Mexico Salt Co., and Pioneer Salt Co. were the major producers; the livestock industry was the principal consumer.

Sand and Gravel.—Continued reduction in mileage under construction on the Federal interstate highway system again caused a substantial decline in the output of sand and gravel. Production of aggregate dropped 40 percent, to 7.4 million tons. Of the 31 counties producing sand and gravel in 1959 and 1960, only McKinley, Roosevelt, San Juan, Santa Fe, and Sierra Counties recorded small gains in output. There were 112 commercial and 40 Government-and-contractor operations in 1959, but in 1960 the number of operations dropped to 71 and 36, respectively. Bernalillo County led in output, supplying 28 percent of the total production. From July 1, 1956, to December 31, 1960, New Mexico completed [3] 197.3 miles of road to full or acceptable interstate standards and improved 94 miles to standards adequate for existing traffic, for a total of 291.3 miles open to traffic. On the basis of this mileage, the State ranked 14th. However, in terms of work in progress on the interstate system, New Mexico ranked 42d, with 104.5 miles in construction, engineering, or right-of-way status. New Mexico had completed to full or acceptable interstate standards only 20 percent of the 1,003 miles of highway allocated to the State.

[3] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960, press release BPR 61–6, Feb. 22, 1961.

TABLE 13.—Sand and gravel production in 1960, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Bernalillo	2,051	$1,738	Otero	265	$228
Catron	13	25	Quay	113	92
Chaves	503	635	Rio Arriba	395	338
Colfax	43	112	Roosevelt	291	380
Curry	11	15	Sandoval	48	77
De Baca	39	27	San Juan	402	420
Dona Ana	293	410	San Miguel	71	129
Eddy	186	208	Santa Fe	476	587
Grant	116	101	Sierra	11	11
Guadalupe	38	59	Socorro	57	40
Harding	45	65	Taos	51	104
Hidalgo	11	7	Torrance	94	111
Lea	43	71	Union	5	11
Lincoln	7	7	Valencia	86	91
Luna	49	40	Undistributed	906	881
McKinley	670	354			
Mora	30	85	Total	7,419	7,459

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	1,195	$1,312	929	$1,043
Paving	188	230	103	102
Fill	18	11	(1)	(1)
Other	35	19	89	57
Total sand	1,436	1,572	1,121	1,202
Construction gravel:				
Building	1,358	1,730	986	1,378
Paving	7,217	7,355	3,084	2,645
Railroad ballast	(1)	(1)		
Fill	(1)	(1)	55	48
Other	53	26	(2)	(3)
Miscellaneous gravel	52	35	110	75
Total gravel	8,680	9,146	4,235	4,146
Total sand and gravel	10,116	10,718	5,356	5,348
Government-and-contractor operations:				
Sand:				
Building	24	29	22	31
Paving	70	44	15	14
Total sand	94	73	37	45
Gravel:				
Building	86	117	39	77
Paving	2,164	2,424	1,987	1,989
Total gravel	2,250	2,541	2,026	2,066
Total sand and gravel	2,344	2,614	2,063	2,111
All operations:				
Sand	1,530	1,645	1,158	1,247
Gravel	10,930	11,687	6,261	6,212
Grand total	12,460	13,332	7,419	7,459

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Less than 1,000 short tons.
[3] Less than $1,000.

Stone.—A substantial increase in the production of crushed miscellaneous stone by the New Mexico State Highway Commission and crushed limestone used for manufacturing cement and lime by Ideal Cement Co. and Kennecott Copper Corp. largely accounted for the nearly threefold increase in output of all types of stone quarried. Bernalillo and Lea Counties led in output. Ideal Cement Co. was the major producer in Bernalillo County. The New Mexico State Highway Commission reported producing 410,000 tons of crushed miscellaneous stone used in road construction in Lea County.

Sulfur.—El Paso Natural Gas Co. closed its sulfur recovery plant at Eunice Nov. 30, 1960. No production or shipments of sulfur were reported from this plant during the year. Pan American Petroleum Corp. placed a 12-ton-per-day sulfur-recovery unit in operation at its Empire Abo gasoline plant 13 miles southeast of Artesia. Shipments were substantially greater than in 1959.

Vermiculite.—Southwest Vermiculite Co. exfoliated vermiculite at its plant in Albuquerque. Sales were 47 percent greater than in 1959, and lightweight aggregate was the principal use for the mill output. The company continued to use crude vermiculite from Libby, Mont.

TABLE 15.—Stone production in 1960, by counties

County	Short tons	Value	County	Short tons	Value
Bernalillo	[1]	[1]	Lincoln	22,646	$55,858
Chaves	14,318	$21,212	Mora	21,000	27,300
Colfax	7,918	16,750	Otero	53,844	103,359
Curry	94,325	81,173	Roosevelt	[1]	[1]
De Baca	161,958	199,792	San Miguel	10	180
Eddy	82,837	143,729	Socorro	45	690
Grant	77,292	65,516	Valencia	375	1,250
Lea	411,370	512,799	Other counties	328,682	462,768
			Total	1,276,620	1,692,376

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."

TABLE 16.—Stone sold or used by producers, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1956			10,915	$9,100	350	$4,900	[1]	[1]
1957			9,300	6,100			715,900	$1,147,400
1958	26,100	$24,500	9.075	9,000	200	2,500	795,077	801,487
1959			1,000	5,200	37	732	224,501	298,648
1960	1,869	2,492	9,418	21,750			696,268	927,717

	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956	685,129	$532,017	571,841	$725,820	1,268,235	$1,271,837
1957	615,060	456,845	8,100	7,200	1,348,360	1,617,545
1958	900,033	669,790			1,730,485	1,507,277
1959	175,315	179,996	60,362	57,376	461,215	541,952
1960	64	1,105	569,001	739,312	1,276,620	1,692,376

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other stone."

REVIEW BY COUNTIES

Bernalillo.—Cement output and clay and limestone used in manufacturing cement provided most of the income from mining and mineral processing in the county. Ideal Cement Co. operated its Tijeras plant throughout the year and reported completion of its No. 2 kiln and auxiliary equipment in December. Kinney Brick Co., Inc., supplied the entire miscellaneous clay output and used it for brick or other heavy clay products manufacture. Scoria for use in manufacturing building block and associated products was mined by Edgar D. Otto & Son, Inc., and Lavaland Heights Block Co. Sand and gravel production was reported from 15 operations that produced 2.1 million tons of aggregate; Albuquerque Gravel Products Co. and Springer Transfer Co., Inc., and contractors for the State highway department were the principal producers. Duke City Gravel Products Co. supplied crude gypsum to Ideal Cement Co. for use as a cement retarder.

Chaves.—Petroleum production from 702 wells was 11 percent below that of 1959; natural gas was recovered from 2 wells. Of 32 exploratory wells drilled, 2 were successful. Fifty development wells were completed, but only 35 were successful.

W. M. Snyder reactivated the Blanca clay pit and produced 75 tons of miscellaneous clay.

Colfax.—Coal production was more than double that of 1959 and furnished 81 percent of the total of all mineral output. The increase resulted from greater production by Kaiser Steel Corp. at the Koehler mine on the Raton seam. The entire production at the Koehler was washed; 94 percent of the output was shipped to California for manufacturing coke at Kaiser's Fontana steel plant. Rodman Coal Co. operated the Sonchar mine on the Old Yankee seam, and Julius Seidel operated the Franks mine on the Sugarite seam.

Dona Ana.—Associated Materials Co., Maynez Block Co., and Volcanic Cinder Co. supplied all the scoria mined. El Paso Brick Co. continued to be the only producer of clay. Building and paving sand and gravel totaling 293,500 tons was mined by three commercial operators and two governmental contractors. No shipments of manganese ore and concentrate were reported.

Eddy.—As in 1959, increased sales of petroleum and potash furnished nearly all the $15.1 million rise in value of mineral output.

Petroleum production, from 3,255 wells, exceeded 11 million barrels and was 42 percent above that of 1959. Natural gas was produced from 50 wells. Sixty exploratory wells were completed, of which 10 (7 oil, 2 condensate, and 1 gas) were successful. From 410 development wells completed, there were 315 oil, 4 condensate, and 11 gas wells.

Four natural gas plants recovered natural gasoline, butane, and propane. Throughput exceeded 7 billion cubic feet of gas, from which 297,000 barrels of natural gasoline, 48,000 barrels of butane, and 228,000 barrels of propane were recovered. Three billion cubic feet of residual gas was marketed through pipelines to consumers. Continental Oil Co. operated its 17,000-barrel-per-day refinery at Artesia,

TABLE 17.—Value of mineral production in New Mexico, by counties [1]

County	1959	1960 [2]	Minerals produced in 1960 in order of value
Bernalillo	$4,954,799	$6,364,524	Cement, sand and gravel, stone, clays, gypsum, pumice, gem stones.
Catron	303,625	38,422	Sand and gravel, salt, gem stones.
Chaves [3]	12,917,600	11,062,962	Petroleum, sand and gravel, stone, clays, gem stones.
Colfax	1,036,955	1,422,502	Coal, sand and gravel, stone.
Curry	162,800	96,473	Stone, sand and gravel.
De Baca	83,500	226,392	Do.
Dona Ana	845,811	525,339	Sand and gravel, pumice, clays.
Eddy [4]	93,244,773	108,373,611	Potassium salts, petroleum, magnesium compounds, salt, sand and gravel, stone.
Grant	26,428,748	46,093,287	Copper, zinc, molybdenum, lime, manganiferous ore, lead, sand and gravel, gold, silver, stone, iron ore, pumice, gem stones.
Guadalupe	448,845	59,300	Sand and gravel.
Harding	(5)	(5)	Sand and gravel, carbon dioxide (natural).
Hidalgo	991,698	1,945,201	Copper, silver, gold, lead, sand and gravel, clays, gem stones.
Lea [4]	230,733,978	227,546,168	Petroleum, potassium salts, stone, sand and gravel.
Lincoln	66,405	63,352	Stone, sand and gravel, gem stones, silver.
Luna	484,665	45,010	Sand and gravel, gem stones.
McKinley [3]	39,662,610	49,191,539	Uranium ore, coal, sand and gravel, petroleum, clays, gem stones.
Mora	118,431	112,400	Sand and gravel, stone.
Otero	1,076,200	331,490	Sand and gravel, stone, copper, gold, silver.
Quay	112,830	92,500	Sand and gravel.
Rio Arriba [4]	3,345,132	3,067,710	Petroleum, sand and gravel, pumice, coal, gem stones, mica (scrap).
Roosevelt [3]	1,629,900	3,795,674	Petroleum, sand and gravel, stone.
Sandoval [3]	237,627	261,311	Pumice, sand and gravel, petroleum, gypsum, coal, copper, gem stones, silver, lead.
San Juan [4]	[6] 38,254,270	40,620,000	Petroleum, helium, sand and gravel, coal, vanadium, uranium ore, gem stones.
San Miguel	165,550	129,680	Sand and gravel, stone.
Sante Fe	537,350	948,786	Sand and gravel, pumice, gypsum, copper, gold, silver, gem stones.
Sierra	422,382	54,222	Copper, lead, sand and gravel, zinc, silver, gem stones, uranium ore.
Socorro	2,073,645	1,153,005	Zinc, lead, perlite, sand and gravel, silver, copper, barite, gold, stone, gem stones, uranium ore.
Taos	1,755,891	(5)	Perlite, sand and gravel.
Torrance	618,932	111,200	Sand and gravel.
Union	815,660	292,752	Pumice, sand and gravel.
Valencia	(5)	(5)	Uranium ore, perlite, sand and gravel, stone, gem stones.
Undistributed [7]	[6] 129,702,325	151,525,506	
Total [8]	[6] 592,535,000	652,200,000	

[1] Los Alamos is not listed because no production was reported.
[2] Petroleum value is preliminary.
[3] Excludes natural gas.
[4] Excludes natural gas and natural gas liquids.
[5] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[6] Revised figure.
[7] Includes natural gas, natural gas liquids, and some sand and gravel (1960), gem stones, and mica (scrap and sheet—1960), and values indicated by footnote 5.
[8] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime and marketed potassium compounds.

and Pan American Petroleum Corp. recovered byproduct elemental sulfur at its Empire Abo gasoline plant.

Mines and refineries near Carlsbad produced most of the State's output of potash.

Grant.—Copper output supplied 90 percent of the value of mineral production. Most of the copper, all of the molybdenum, and part of the gold and silver output came from ore produced from the Chino open-pit copper mine at Santa Rita operated by Chino Mines Division, Kennecott Copper Corp. In its annual report, the company stated that 7.3 million tons of ore was mined and milled at the Chino operation in 1960, compared with 4.5 million tons in 1959. Copper produced at Chino from all sources, including that recovered from

the ore milled and material leached, was 62,725 tons, compared with 37,535 tons in 1959. In 1960, the mine operated 12 months, whereas it was closed 5 months in 1959 because of a labor strike. Installation of a $2 million skip hoist, expected to be completed in October 1961, was begun in 1960. The new hoist will permit removal of 18,000 tons of material daily up a 30° incline from the lower levels of the open pit (600 feet deep at present); it will also allow the use of truck haulage and eliminate almost 9 miles of railroad. Stripping to extend the mining area of the open pit was continued, and the 16,000-kilowatt powerplant was completed. Chino enlarged and improved its leaching and precipitation system for recovering copper from mine dumps. In 1960, 19,000 tons of low-cost copper was recovered by this system, 20 percent more than in 1959. The leaching operation had been active throughout 1959 despite the labor strike.

Bayard (Continental) mine, owned by the United States Smelting Refining and Mining Co., the second largest copper producer in the county and the third largest in the State, was operated by lessees, Patten & Galassini and L. A. Patten. According to the owner, the Bayard mill processed 89,695 tons of copper ore from the Bayard mine during the year. No zinc ore was mined; however, the workings were maintained for future mining should the price of zinc improve.

The Hanover mine, operated by the Empire Zinc Division of The New Jersey Zinc Co., was the principal zinc producer in the county and State. The Hanover mill was operated throughout the year on ore supplied from the Hanover mine and from the Linchburg mine (Socorro County) owned by the company and operated by lessee, L. A. Patten.

Of the remaining 12 mines, where gold, silver, copper, lead, or zinc was produced, the Paola (Mathis & White) and Zuniga (Douglas B. White) were the chief copper producers, and the American mine (Gibralter Minerals Co.) was the county's leading lead producer. In addition, 32 operations recovered copper from the water of Santa Rita Creek below the Chino Santa Rita open-pit copper mine, by precipitation.

After a 3-year shutdown, the Kearney zinc mine near Hanover and the Peru concentrator near Deming were reactivated as a joint venture between Hydrometals, Inc. (parent company of Peru Mining Co.), and American Zinc, Lead and Smelting Co. The Kearney mine was dewatered, all drifts were cleaned, and pipelines and powerlines were replaced. An extensive underground development program, consisting of several thousand feet of drifting and raising and a considerable amount of underground and surface diamond drilling, was completed. Some diamond drilling also was done at the company's Pewabic zinc mine nearby. Mining at the Kearney mine was to begin early in 1961.

Magnetite ore was produced from the Kearney iron pit by White & Mathis and shipped to Clarance Moore, Albuquerque, for use as a high-density concrete aggregate. Ferruginous manganese ore containing 32 percent iron and 11 percent manganese was produced from the Boston Hill mine by the Luck Mining Co. and shipped to The Colorado Fuel and Iron Corp., Pueblo, Colo.

Hidalgo.—Copper output, mostly from the Bonney-Miser's Chest mines of Banner Mining Co., the State's second largest copper producer, supplied 84 percent of the county's total value of mineral production. In addition, byproduct gold and silver was recovered from the ore produced from these mines. According to the company annual report, the mines were operated the full year at near capacity, producing 79,726 tons of ore, an increase of 34,880 tons over 1959. The metal content of the 6,640 tons of concentrate produced from the ore milled in 1960 was 888 ounces of gold, 34,615 ounces of silver, and 3,752,248 pounds of copper. Exploration and development work during the year included 1,757 feet of drifting, 174 feet of raising, 1,130 feet of diamond drilling, and 92 feet of shaft-sinking. Late in 1960 sinking operations were begun at the Bonney shaft below the 1,560-foot level to bring the 1,700-foot level into production during 1961.

Brannan & Fuller produced gold-silver ore containing some recoverable copper and lead from the Atwood-Henry Clay and Eighty-Five mines near Lordsburg and shipped it to the American Smelting and Refining Co. (Asarco), El Paso, Tex., copper smelter. The Henry Clay shaft was deepened from the 700 to the 800 level and an additional 50 feet was sunk for sump purposes.

Lea.—Petroleum output from 8,830 wells was 3 percent below that of 1959. However, the county continued to lead in petroleum production with 71 percent of the total, led in production of natural gas (from 1,212 wells) with 51 percent of the total. Exploratory drilling resulted in 69 completed wells, of which 14 (10 oil, 3 condensate, 1 gas) were successful. Of the 493 development wells completed, 417 were oil wells, 5 were condensate wells, and 9 were gas wells. Natural gas was processed at 21 extraction plants and 1 fractionation plant. Throughput was 399 billion cubic feet of gas, from which 7 million barrels of natural gasoline, 5 million barrels of butane, and 2 million barrels of propane were recovered; 303 billion cubic feet of residual gas was marketed through pipelines to consumers. Three plants used 48 million cubic feet of natural gas for producing carbon black. Famariss Oil & Refining Co. operated its 1,700-barrel-per-day refinery at Monument.

National Potash Co. mined and refined potash at its facilities southeast of Carlsbad. It continued to purchase ore from Southwest Potash Corp. in Eddy County for blending with its Lea County ore. No salt-processing operations were reported.

Luna.—The value of mineral production declined substantially below that of 1959 because of inactivity in the manganese industry. This industry had been at a virtual standstill since 1959, when the quota was filled under the Government carlot manganese ore and concentrate purchase program.

McKinley.—McKinley County led in production of uranium ore, and output in 1960 was 27 percent greater than in 1959. Many of the production difficulties caused by underground water were solved, and production was near capacity at the 65 mining operations. Kermac Nuclear Fuels Corp. and Phillips Petroleum Co. operated processing mills in the Ambrosia Lake area. Major mine producers included Kermac Nuclear Fuels Corp., Phillips Petroleum Co., Homestake-Sapin Partners, The Hidden Splendor Mining Co. (formerly Rio De

Oro Mines, Inc.), Ambrosia Lake Uranium Co., Homestake Mining Co.-Lance Corp., and Calumet & Hecla, Inc.

A new method in shaft sinking was developed by Kermac Nuclear Fuels Corp., using oil-well techniques and equipment. Previously, several ventilation shafts were sunk by drilling a pilot hole and reaming to a diameter of 44 inches with a specially constructed bit. The shaft being sunk on one of the company properties was 90 inches in diameter. It was the first time a rotary well rig had been used for so large a shaft.

Coal output during the year came from eight mines and was 38 percent above that of 1959. Major production was by Navajo Tribal Enterprises, operating the Window Rock underground mine, and Roberts Coal Co., operating the Roberts strip mine. Petroleum production from 55 wells declined 9 percent. Ten exploratory wells were completed, of which 2 were successful. Of 8 development wells completed, 2 were successful. Drilling totaled 30,529 feet. El Paso Natural Gas Co. operated its fractionation plant at Wingate, processing natural gas liquids from company-owned plants in Utah and northwestern New Mexico and from its 9,000-barrel-per-day Cinzia refinery near Gallup.

Rio Arriba.—Coal production from the Caranta No. 2 and New mine, operated by Caranta Brothers, Inc., and the Rainbow mine, operated by Inez Erler, was 6 percent below that of 1959. Petroleum production from 132 wells was 1 percent above that of 1959. Natural gas was produced from 1,183 wells. Fifteen exploratory wells were completed, of which 4 (3 oil, 1 gas) were successful; and of 194 development wells completed, 184 (27 oil, 4 condensate, 153 gas) were successful. Southern Union Gas Co. produced natural gas at its plant in Lybrook. Throughput was 14 billion cubic feet of gas, from which 79,934 barrels of natural gasoline, 131,072 of butane, and 241,106 of propane were recovered; 13.8 billion cubic feet of residual gas was marketed through company pipelines to consumers.

No hand-cobbed mica was mined, although some scrap mica was produced by Mineral Resources Co., Inc. Los Compadres Mica Co. at its Ojo Caliente grinding mill produced ground mica for a roofing paper manufacturer; mill feed was obtained by working mine dumps. General Pumice Corp. continued to mine pumice from its Cullum mine. The pumice was used by building-block manufacturers and a pumice grinding plant at Santa Fe.

Roosevelt.—Petroleum production from 53 wells rose to 1.2 million barrels and was more than double that of 1959. Eight exploratory wells were drilled and completed; three were successful. Of the 32 development wells completed, 29 were producers.

Sandoval.—Pumice, sand and gravel, and gypsum furnished 79 percent of the $261,000 value of total mineral output. For the first time in the history of the county, commercial quantities of crude gypsum were mined. White Mesa Gypsum Corp. produced gypsum from a deposit near San Ysidro and shipped it to the American Gypsum Co. wallboard plant at Albuquerque.

Coal production from the Padilla underground mine was 17 percent above that of 1959. Petroleum production from 14 wells and natural gas production from 1 well were approximately the same as in 1959.

Four exploratory wells and five development wells were completed; three of the development wells were producers.

The closing of the Government purchase program eliminated the market for manganese ore, and no mines were active. No uranium ore was produced at the Warm Springs mine. Five tons of copper and a small quantity of lead and silver were recovered from ore produced from the San Miguel mine.

San Juan.—San Juan County ranked second in petroleum production, from 1,245 wells, and in natural gas output, from 3,598 wells. Petroleum output was 5 percent above that of 1959. Thirty-six exploratory wells were completed (3 successful). Of 408 development wells completed, 158 oil wells, 28 condensate wells, and 196 gas wells were successful. Natural gas was processed at the Southern Union Gas Co. Kutz Canyon plant and at the El Paso Natural Gas Co. San Juan plant. Gas intake at the plants was 310.4 billion cubic feet of gas, from which 2.7 million barrels of natural gasoline, 3.3 million barrels of butane, and 3 million barrels of propane were recovered. Residual gas (285 billion cubic feet) was marketed through company-owned pipelines to consumers. Beeline Refining Co., Division of Frontier Refining Co., operated a 1,400-barrel-per-day refinery at Farmington; and Plateau, Inc., operated a 2,500-barrel-per-day refinery at Bloomfield.

The Federal Bureau of Mines operated the Navajo helium plant at Shiprock. Helium-bearing natural gas was obtained from wells in the Hogback field. The quantity of helium shipped was nearly three times greater than in 1959; the plant was operated for only 5 months in 1959.

Coal production from the Hogback No. 11 mine operated by Frank Pashlakai, the Hogback No. 12A mine operated by Simpson Coal Co., and the Hogback No. 13 mine operated by George R. Simpson & Hollis L. Tate was 38 percent below that of 1959. House heating with coal had declined substantially because of the availability of oil at a competitive price. Uranium ore, containing a significant quantity of vanadium, was shipped to a mill at Durango, Colo., for processing. Kerr-McGee Oil Industries, Inc., processed ores from deposits in Arizona at its Navajo uranium mill at Shiprock. A new vanadium-recovery unit, installation of which was completed late in 1959, was operated throughout the year.

Santa Fe.—Increased production of sand and gravel and the addition of gypsum to the list of commercial minerals produced in the county raised the total value of mineral output to $949,000. Four commercial operations produced 202,000 tons of sand and gravel, and construction crews and contractors for the AEC and the State highway department supplied 274,000 tons of aggregate. Kaiser Gypsum Co. mined crude gypsum adjacent to its Rosario wallboard plant, which was the first operation of its kind in the State. Pumice and scoria production was 29,400 tons, compared with 35,600 tons in 1959. Copar Pumice Co., Inc., was the major producer; its plant was near Espanola. Crego Block Co., Inc., mined and consumed scoria in the manufacture of building blocks. James H. Rhodes & Co. operated its Santa Fe grinding plant, using crude pumice mined by General Pumice Corp. (Rio Arriba County).

Small quantities of copper ore containing gold and silver were shipped to Asarco (El Paso, Tex.) copper smelter from two mines operated by Tom B. Scartaccini and Greenrock Mining Co.

Sierra.—The county's entire lead and zinc and most of the silver and copper output came from ore shipped to the Asarco (El Paso, Tex.) lead and copper smelters from the Prospectors Delight mine operated by Sierra Minerals & Milling Corp. Small quantities of copper and silver ore were produced and marketed by L. W. Cady and Wittie & McDonald, respectively. No manganese ore was mined or shipped. Uranium ore from the Pitchblend Watercan mine was shipped to a plant at Ambrosia Lake for processing.

Socorro.—After leading the State with output of manganese ore valued at $1.4 million in 1959, the manganese mines in Socorro County were inactive during 1960 because of the termination of the Government manganese purchase program. Five mines produced gold, silver, copper, lead, and zinc. L. A. Patten, operating the Linchburg mine under lease from Empire Zinc, was by far the leading producer. The lead-zinc ore produced was shipped to the Empire Zinc Hanover mill for concentration.

Galbar, Inc., treated lead-barite ore from the Mex-Tex mine near Bingham at its mill south of San Antonio and produced barite and lead concentrates. The lead concentrate, containing a small quantity of silver, was shipped to the Asarco (El Paso, Tex.) lead smelter.

Small quantities of gold, silver, copper, lead, and zinc also were recovered from ores produced from the Copper Gold No. 10, Queen Group, and Waldo mines. Uranium ore from the Lucky Don Sec. 35 mine was shipped to a plant at Ambrosia Lake for processing.

The perlite mine, mill, and expanding plant of Great Lakes Carbon Corp. were operative, but by yearend plans had been formulated to shut down the operation and concentrate production at the company's No Agua (Taos County) facilities.

Taos.—Perlite from the No Agua area (Seven Hills of Taos) operations of Great Lakes Carbon Corp., Johns-Manville Perlite Corp., and United Perlite Corp. supplied most of the mineral production in the county. A contractor for the State department of highways produced some sand and gravel for road use. No beryl, copper, or gold was mined during the year.

Valencia.—Uranium ore production, from nine operations, was 8 percent below that of 1959, but the county continued to be the leading producer. The decline was largely because operations at the Jackpile mine, operated by The Anaconda Company, were curtailed to adjust the recovery of uranium oxide at its mill at Bluewater to the requirements of the revised purchase contract with AEC. Anaconda reported that exploration and development of the Laguna concession had disclosed an ore body larger than that at the Jackpile mine. The new ore body, called the Paguate, was reported to be higher grade than the Jackpile, but cannot be mined until after 1966 because of AEC regulations. St. Anthony Uranium Unit, American Metal Climax, Inc., operated the M 6 mine, formerly called the Cebolleta Grant mine. Rare Metals Corp. began production at its San Mateo mine.

Homestake-New Mexico Partners operated its 750-ton-per-day mill, and Homestake-Sapin Partners operated the adjacent 1,500-ton-per-day mill throughout the year.

United States Gypsum Co. operated its Grants perlite mine and grinding plant, but at a lower level of activity. The crushed perlite was shipped to co-owned expanding plants throughout the United States.

The Mineral Industry of New York

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the New York State Science Service.

By Joseph Krickich,[1] Robert W. Metcalf,[1] and Madaline P. Stewart[2]

MINERAL output in New York in 1960 established a new high of $254.7 million, 9 percent greater than 1959, and $10.6 million more than 1957, the previous record year. Among noteworthy developments were gains in output of metals, mainly zinc, iron ore, and titanium concentrate. In addition, heavier demands by the construction industry resulted in larger output of cement, stone, and sand and gravel. Construction of the $720-million Niagara Power project and highway construction throughout the State had favorable effects upon New York's mineral industry. Nationally, the State ranked fifth in cement shipments, fourth in salt, and sixth in gypsum.

TABLE 1.—Mineral production in New York[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,310	$1,714	1,172	$1,717
Emery—short tons	8,555	150	8,169	142
Gem stones	(2)	8	(2)	9
Gypsum—thousand short tons	919	4,663	755	3,928
Iron ore (usable)—thousand long tons, gross weight	2,044	28,050	2,484	32,377
Lead (recoverable content of ores, etc.)—short tons	481	111	775	181
Natural gas—million cubic feet	2,915	889	4,990	1,542
Peat—short tons	12,875	138	10,042	146
Petroleum (crude)—thousand 42-gallon barrels	1,970	8,353	[3] 1,801	[3] 8,357
Salt—thousand short tons	4,011	30,958	4,008	30,763
Sand and gravel—do	27,944	31,415	30,687	35,152
Silver (recoverable content of ores, etc.) thousand troy ounces	52	47	49	45
Stone—thousand short tons	28,640	46,556	29,802	46,955
Zinc (recoverable content of ores, etc.)—short tons	43,464	9,997	66,364	17,122
Value of items that cannot be disclosed: Abrasive garnet, beryl (1960), lime, talc, titanium concentrate, and wollastonite		76,904		81,831
Total New York[4]		[5] 234,642		254,713

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Preliminary figure.
[4] Total adjusted to eliminate duplicating value of clays and stone.
[5] Revised figure.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical clerk, Bureau of Mines, Pittsburgh, Pa.

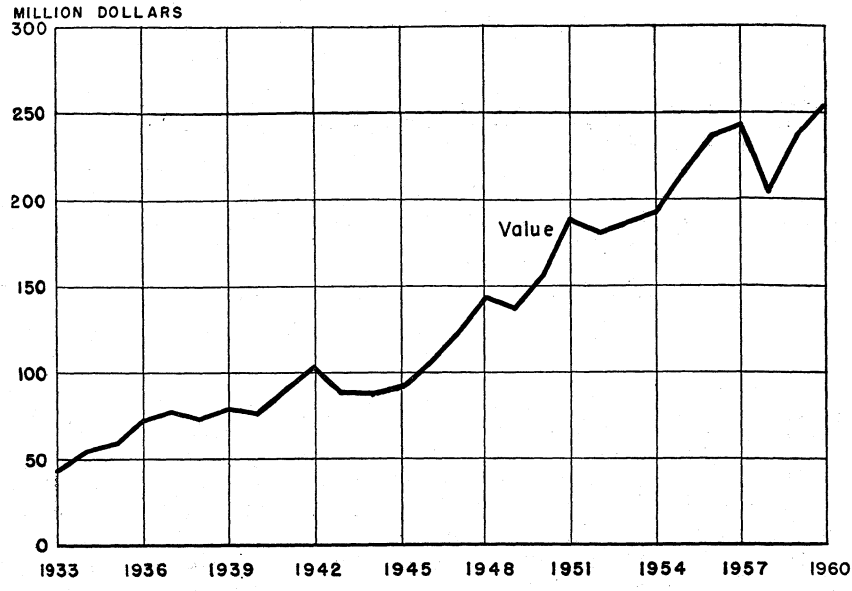

FIGURE 1.—Total value of mineral production in New York, 1933–60.

Employment and Injuries.—Injury record in metal and nonmetal mineral industries in the State improved over the preceding year. One less fatality and 53 fewer nonfatal injuries were recorded. Statewide, the number of injuries per million man-hours decreased 20 percent. The most notable improvements were at quarries and mills and at clay mines.

TABLE 2.—Employment and injuries in selected mineral industries [1]

Industry	Men working daily	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:					
Cement	1,764	4,365,532		19	4.55
Clays [2]	77	130,242		5	38.39
Coke ovens and smelters	1,981	4,381,008	1	99	22.83
Metal mines and mills	1,972	3,181,578	1	32	10.37
Nonmetal mines [3]	753	1,644,305		28	17.03
Quarries and mills [4]	2,390	4,903,300		134	27.33
Sand and gravel	1,785	3,323,271	1	57	17.45
Total	10,722	21,929,236	3	374	17.37
1960: [5]					
Cement	1,901	4,341,562	1	37	8.75
Clays [2]	92	145,960			
Coke ovens and smelters	1,727	4,898,257		120	24.50
Metal mines and mills	2,301	3,935,933	1	42	10.92
Nonmetal mines [3]	705	1,495,253		37	24.74
Quarries and mills [4]	2,699	5,457,140		64	11.73
Sand and gravel [6]	1,857	3,053,581		21	6.88
Total	11,282	23,327,686	2	321	13.85

[1] Production employees.
[2] Mines only.
[3] Includes emery, garnet, gypsum, salt, talc, mineral pigments and wollastonite.
[4] Includes lime plants having no quarry operations.
[5] Preliminary figures.
[6] Commercial producers only.

Trends and Developments.—The New York State Power Authority continued constructing the Niagara Power project at Niagara Falls. Scheduled for completion in 1962, power will start flowing to industry early in 1961 on an increasing scale until full production is reached. The first of the 13 giant water wheel generators was installed by yearend. Each of these generators weighs over 500 tons and has a rated capacity of 150,000 k.w. Many new facilities, especially in the chemical and metallurgical industries were planned to utilize the new power that will become available.

The Strategic Materials Corp. large-scale pilot plant demonstrated the electrical processing of steel from waste copper slag in December. From about 25.5 tons of slag this process was said to yield 1 ton of steel, 25 pounds of copper, 150 tons of zinc oxide, and other by-products. The first domestic smelter to use the new process was planned for Anaconda, Mont., where the Anaconda Copper Company has an accumulated pile of waste copper slag, totaling about 40 million tons. This slag analyzes about 33 percent iron, 0.6 percent copper, and 2 percent zinc.

A large user of the newly available electric power at Niagara Falls will be Hooker Chemical Corp. This firm planned a $10-million installation of Hoechst-Uhde mercury-type electrolytic cells during 1960–61 to increase its capacity to manufacture caustic soda, caustic potash, and chlorine. Other companies were attracted to this area or were expanding existing plants because of the ready availability of low-cost power and favorable industrial climate. One of those was the $3-million highly automated powdered-iron facility of Pyron Co., a unit of the Amco Division of American Metal Climax, Inc. This firm produced iron powder for structural parts, especially for the automobile industry.

The use of the oxygen-lance burning process created a serious red-oxide dust problem in many iron- and steel-producing areas. A $5 million dust control program was underway at yearend by Bethlehem Steel Co. in the Niagara Falls area. The installation of electrostatic precipitators was expected to reduce reddish oxide dust dissemination by 98 percent at the company's plants in Lackawanna, South Buffalo, West Seneca, Orchard Park, and Hamburg.

Reynolds Metals Co., one of two primary aluminum producers at Massena, St. Lawrence County, completed installing its $88 million reduction plant. Two additional potlines were installed during the year to complete the 100,000-ton plant (one potline rated at 33,000 tons was put on stream in late 1959).

Toward yearend, seven New York utility companies—Niagara-Mohawk Power Corp., Syracuse; Long Island Lighting Co., Mineola, Long Island; New York State Electric Gas Corp., Binghamton; Consolidated Edison Co. of New York, New York City; Rochester Gas and Electric Corp., Rochester; Central Hudson Gas and Electric Corp., Poughkeepsie; and Orange and Rockland Utilities, Inc., Nyack—joined with General Electric Co. and General Atomics Division of General Dynamics Corp. to sponsor research on nuclear reactors aimed at making nuclear-generated power competitive with steam-generated power. The seven utilities will contribute $5.75 million of a total $8 million construction cost for a boiling-water reactor to be built

615629—61——46

at the General Electric Vallecitos, Calif., research center and $4.5 million toward the $8.7 million cost of a gas-cooled graphite-uranium reactor to be built by General Atomics. The participating companies organized a new company—Empire State Atomic Development Associates, Inc.—to conduct the research.

Two firms purchased abandoned brick yards along the Hudson River for conversion to the manufacture of lightweight aggregate in the New York City-Albany area. The New York Trap Rock Co., subject to the proving of adequate clay and shale reserves, was scheduled $2 million on a plant at Beacon, Dutchess County, Hudson Valley Lightweight Aggregate Co., at Glasco, Ulster County, was capitalized for $1 million. The Solite Corp. of Richmond, Va., a lightweight aggregate producer in the Southeast is one of the principals in the latter firm.

New kilns, grinding mills, packaging plants, and silos have been added to portland cement plants at Alsen, Greene County, and Glens Falls, Warren County.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement continued to be the leading mineral commodity in New York. Portland, masonry, and natural cements were produced. Production of portland cement increased 10 percent, but shipments increased only 6 percent, reflecting higher stocks at yearend. Shipments of masonry cement decreased 69,000 barrels from 1959; shipments of natural cement nearly doubled. The average value per barrel of portland cement dropped from $3.37 in 1959 to $3.32; the average value of masonry and natural cements increased from $3.57 to $3.61 and $3.50 to $3.55, respectively. In terms of value, Greene County continued to lead in cement output. Other cement-producing counties, in decreasing order of value, were Erie, Columbia, Ulster, Warren, Schoharie, and Onondaga. Natural cement was produced only in Ulster County.

Portland cement manufacturing used 2.9 million tons of limestone and 2.3 million tons of cement rock. In addition, the following tonnages of raw materials were used: Clay and shale, 351,000; gypsum, 124,000; sand and slag, 56,000; and iron materials, 24,000. Quantities of carbon black, air-entraining compounds, and grinding aids also were utilized. Types of portland cement produced included general use (types I–II), high-early-strength (type III), oil-well, portland slag, and high-sulfate-resistance (type V).

Portland cement was shipped to consumers in New York, 21 other States, the District of Columbia, and foreign countries. Sixty-six percent of the shipments went to New York, 32 percent to New England States, 1 percent to New Jersey, and 1 percent to Pennsylvania and other States. Distribution of portland cement shipments, by types of customers, were as follows: Ready-mixed concrete companies, 58 percent; highway and other contractors, 22 percent; building-material dealers, 10 percent; concrete-product manufacturers, 10 percent. Less than one-half percent was shipped to Federal, State, and

local Government agencies, and other customers. Most of the finished portland cement was shipped by truck; the remainder was shipped by rail and water. Of the total shipments, 87 percent were in bulk; the remainder were in containers, mainly paper bags.

Annual finished-cement capacity in the State was 24,381,000 barrels, a 589,000 barrels increase over 1959. Fifty-six percent of the capacity was wet-process and 44 percent was dry-process. Cement plants used 464 million kw.-hr. of electrical energy, of which 89 percent was purchased from public utility companies.

During the year, Lehigh Portland Cement Co. began operating a new 400-foot kiln at its Alsen plant. The kiln replaced four 125-foot kilns that had been installed in 1939. Two kilns installed in 1953 were retained. Other improvements at the plant included new raw and finished grinding mills, 20 new cement storage silos, a scale house and hoppers for loading trucks, and a truck garage.

At the Alsen plant of North American Cement Corp., 10 silos, each with 18,000 barrel capacity, were erected. The company resumed barge shipments in addition to its regular rail and truck shipments.

Early in 1960, a new $3 million finish grinding mill was completed at the Glens Falls plant of Glens Falls Portland Cement Co., Division of The Flintkote Co. A new $75,000 laboratory also was completed. In addition, construction was begun on a $2.3 million packaging and bulk loading department.

Clays.—Output of miscellaneous clay and shale decreased mainly because of a 20-percent drop in demand for raw material used in manufacturing building brick. Decreased demand for clays in cement, pottery, stoneware, and artificial abrasives also was reported for the year. Clay and shale for manufacturing lightweight aggregate totaled 204,000 tons, a 20-percent increase over 1959. The increase reflected a continuing trend toward greater use of the material for concrete masonry units and other structural applications. Clay production was centered mostly in Erie, Albany, Ulster, Orange, and Onondaga Counties. There were 24 active operations in 12 counties compared with 20 operations in 10 counties in 1959.

Emery.—Three emery mines in Westchester County continued to produce the entire U.S. output of emery. Output declined in 1960. The ore was shipped to consumers in New York and Massachusetts for processing and sold as aggregate for heavy-duty nonslip floors and for general abrasive uses.

Garnet.—New York continued as the leading garnet-producing State. Abrasive garnet was mined in Essex and Warren Counties. Garnet produced in Warren County was used in manufacturing sandpaper and for grinding and polishing glass; garnet (andradite) recovered as a byproduct of wollastonite mining in Essex County, was used in sand blasting and for polishing glass.

Gem Stones.—Quarries and mine dumps continued to attract thousands of gem collectors. Various mineral specimens including garnet, quartz, hematite, and magnetite were collected. Warren County was the leading area for gem material and mineral specimens.

Graphite, Manufactured.—Great Lakes Carbon Corp. and National Carbon Co., Division of Union Carbide Corp., manufactured graphite

at Niagara Falls (Niagara County). Output was used in anodes, electrodes, lubricants, and foundry and other specialties.

Gypsum.—Output of crude gypsum from five underground mines decreased 18 percent. Nationally, New York ranked sixth in crude production compared with fifth in 1959, but continued to lead in producing calcined gypsum. Seven plants calcined gypsum in Bronx, Erie, Genesee, Monroe, Richmond, and Rockland Counties. Most of the crude gypsum mined in Erie, Genesee, and Monroe Counties was calcined and processed at nearby company-owned plants for use in manufacturing building materials such as plaster and gypsum lath. Some was used as a cement retarder.

TABLE 3.—Crude gypsum production

(Thousand short tons and thousand dollars)

Year	Active mines	Quantity	Value	Year	Active mines	Quantity	Value
1951-55 (average)	5	1,155	$3,949	1958	5	834	$3,869
1956	5	1,140	4,817	1959	5	919	4,663
1957	5	864	3,749	1960	5	755	3,928

Lime.—The quantity and value of lime produced declined from the record high of 1959. Output consisted chiefly of quicklime produced in Erie, Niagara, and Onondaga Counties for chemical and industrial applications. Small quantities of hydrated lime for agricultural, chemical, and industrial uses were produced in Clinton County. Eighty-eight percent of the State output was captive; the remainder was sold chiefly to consumers in New York and the New England States. Some lime was exported to Canada.

Magnesium Compounds.—Carborundum Metals Co., Division of the Carborundum Co., recovered magnesium chloride as a byproduct of zirconium production at its Akron (Erie County) plant.

Nitrogen Compounds.—Atmospheric nitrogen was recovered at Niagara Falls (Niagara County) by E. I. du Pont de Nemours & Co., Inc., and Olin-Mathieson Chemical Corp. The nitrogen was used in making anhydrous ammonia which was used in fertilizers, explosives, and numerous other chemical and industrial applications.

Perlite.—Perlite was expanded at six plants—three in Erie County and one each Bronx, Genesee, and Onondaga Counties from crude material shipped from western States. Production dropped from 21,000 tons in 1959 to 18,000 in 1960; value decreased from $995,000 to $886,000. Eighty-five percent of the output was used for building plaster; the remainder was used for loosefill insulation, concrete aggregate, soil conditioner, filler, filtering, and other uses.

Salt.—New York continued to rank second in value among the 16 salt-producing States. Total salt production was virtually the same as in 1959. Decreased output of evaporated salt and brine was recorded; rock salt output increased. Rock salt was used mainly for manufacturing chlorine and for controlling ice on highways. Evaporated salt, recovered mainly by the vacuum-pan process, was used mostly for manufacturing chemicals. Salt was produced in Livingston, Onondaga, Schuyler, Tompkins, and Wyoming Counties. Brine

recovered in Onondaga County was used exclusively for manufacturing chemicals.

In December, International Salt Co. announced that it would close the Ludlowville refinery and consolidate its production equipment with that of the Watkins Glen Refinery by mid-1962. During the year, the company introduced the use of pneumatic-tired vehicles at its underground Retsof mine as part of its plan to convert from mine railroad haulage to trackless mining at the mine. In addition, the company expected to drive a slope to a lower bed of rock salt early in 1961.[3]

TABLE 4.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951-55 (average)	3,490	$19,724	1958	3,896	$30,609
1956	3,873	27,545	1959	4,011	30,958
1957	3,691	28,002	1960	4,008	30,763

Sand and Gravel.—Output of sand and gravel increased for the second consecutive year, reflecting continued construction activity throughout the State. Most of the increase was by Government-and-contractor operations and consisted chiefly of paving and fill material used for road construction, maintenance, and repair. Commercial sand and gravel output increased 3 percent chiefly because of increased demand for paving and fill material. Demands for all other sand and gravel decreased.

A total of 356 commercial operators (43 more than in 1959) were active. One plant produced over 2 million tons, and two others produced over 1 million tons of sand and gravel. In addition, 7 plants produced between 500,000 and 1 million tons: 145—100,000 to 499,999 tons; 88—25,000 to 99,999 tons; and 113—less than 25,000 tons. Commercial sand and gravel was shipped by truck (85 percent), water (13 percent), and railroad and other (2 percent). Eighty-six percent of the commercial sand and gravel output was processed material compared with 48 percent of Government-and-contractor production.

Sand and gravel was produced in 57 of the 62 counties in the State. The five leading counties, in decreasing order of output, were Suffolk, Nassau, Erie, Monroe, and Rockland.

Stone.—Stone output increased for the second consecutive year, reflecting increased demand for crushed stone used as aggregate in the construction industry. Demand for crushed and broken stone for concrete aggregate rose, and output of stone for riprap, agstone, and other uses also increased. Demand for crushed stone for flux and railroad ballast decreased. Although dimension stone output decreased in tonnage, it increased 9-percent in value. Stone was quarried in 40 counties.

Limestone supplied 91 percent of the total stone output and consisted entirely of crushed and broken stone used chiefly for concrete aggregate and roadstone. All major uses except flux and railroad

[3] International Salt Co., 1960 Annual Report.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	8,859	$11,001	8,398	$10,592
Paving	3,630	4,160	4,003	4,704
Fill	501	313	701	231
Molding	199	774	190	715
Filtration	25	42	19	32
Other	601	532	688	692
Undistributed [1]	44	52	37	54
Gravel:				
Building	4,629	7,238	4,433	6,957
Paving	3,134	3,516	3,727	4,497
Railroad ballast	48	60	19	27
Fill	649	350	1,211	606
Other	1,673	1,489	1,390	1,169
Total sand and gravel	23,992	29,527	24,816	30,276
Government-and-contractor operations: [2]				
Sand:				
Building	14	12	11	16
Paving	233	126	434	291
Fill	993	653	310	193
Other	220	88	279	73
Gravel:				
Building	58	20	93	81
Paving	2,191	848	3,516	3,191
Fill	238	139	1,191	1,010
Other	5	2	37	21
Total sand and gravel	3,952	1,888	5,871	4,876
Grand total	27,944	31,415	30,687	35,152

[1] Includes engine sand and railroad ballast sand.
[2] Includes data for State, counties, municipalities, and other government agencies.

TABLE 6.—Sand and gravel production by Government-and-contractor operations, by counties

(Short tons)

County	1959	1960	County	1959	1960
Albany	418,591	79,920	Oneida	135,000	126,000
Broome		297,488	Onondaga		80,908
Cattaraugus	54,300	22,890	Ontario	34,700	28,751
Cayuga	810	3,699	Orange	119,375	71,960
Chautauqua	229,977	239,851	Orleans	12,566	12,852
Chemung	3,420	22,050	Oswego	41,850	54,000
Chenango		117,378	Otsego	32,500	121,565
Clinton	627,117	624,658	Rensselaer	50,585	76,130
Columbia		(1)	St. Lawrence	232,312	351,201
Cortland	5,145		Saratoga	452,008	552,352
Delaware	23,400	79,451	Schenectady	138,686	121,504
Dutchess	11,400	36,139	Schoharie		12,575
Erie	165,438		Schuyler	43,068	37,376
Essex	56,087	14,128	Seneca		17,660
Franklin	182,941	502,728	Steuben	194,872	108,700
Fulton	770		Suffolk	41,865	(1)
Genesee	32,010	49,711	Sullivan		285,632
Greene	35,025	180,380	Warren	81,182	238,167
Hamilton	21,000	5,000	Washington	176,595	115,188
Herkimer	24,527	34,039	Wayne	31,971	75,983
Jefferson	23,603	658,521	Yates	58,000	18,000
Lewis	63,467	56,170	Undistributed		[2] 283,466
Livingston	65,150	15,000			
Montgomery	10,324	30,081	Total	3,951,636	5,870,612
Niagara	19,999	11,360			

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes data unspecified by counties and data indicated by footnote 1.

ballast increased. Niagara County continued as the leading limestone-producing area; over 5.5 million tons of limestone was produced for use as riprap, concrete aggregate, stone sand, and dike filter material on the Niagara Power project. Other leading limestone-producing areas were, in decreasing order of output, Onondaga, Dutchess, Greene, Ulster, and Columbia Counties. Limestone was produced by Government-and-contractor operations in Erie, Jefferson, Lewis, and St. Lawrence Counties.

Basalt (traprock), produced in Rockland County, continued as the State's second ranking stone although output decreased. Crushed and broken basalt was marketed as riprap, concrete aggregate and roadstone, railroad ballast, and for other uses.

Sandstone, sold both as dimension and crushed stone, continued to rank third. The quantity of dimension sandstone produced was about the same as in 1959, but the value increased 9 percent. Dimension sandstone was sold mainly for construction, sawed and dressed architectural stone, curbing, and flagging. Part of the apparent increase in crushed and broken sandstone output resulted from increased statistical coverage of the industry. Crushed sandstone was used chiefly for riprap and concrete aggregate. Sandstone was produced in 10 counties, led by Delaware, Sullivan, and Broome Counties, in decreasing order of value.

Granite replaced slate as the fourth ranking stone. Dimension granite for construction and architectural uses, curbing, and flagging was produced in Westchester County. Crushed granite for concrete aggregate and other uses was produced in Warren County.

Output of slate fell sharply owing to the closing of a roofing-granule plant in Washington County, the center of the State's slate industry. Dismantling of the plant was begun. Demand for dimension slate, used mainly for roofing and flagging, increased slightly.

Miscellaneous stone was produced in Clinton and Rensselaer Counties; marble was produced in Dutchess, St. Lawrence, and Westchester Counties. Miscellaneous stone was used chiefly for concrete aggregate; marble was used mainly for terrazzo and cast stone.

TABLE 7.—Crushed and broken limestone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1959		1960	
	Quantity	Value	Quantity	Value
Riprap	109	$159	245	$357
Concrete aggregate and roadstone	17,198	26,735	18,328	28,745
Fluxing stone	78	145	78	170
Agricultural	463	2,288	499	1,466
Railroad ballast	431	633	400	647
Cement and lime	5,245	4,965	5,544	5,213
Miscellaneous uses	2,176	4,169	1,881	3,224
Total	25,700	39,094	26,975	39,822

Talc.—New York continued as the leading talc-producing State. Two companies operated three underground mines in St. Lawrence County and ground talc at nearby company-owned mills. The ground

talc was used principally in ceramics and paint manufacturing; other uses were in manufacturing paper, building materials, rubber, floor and wall tile, and various other purposes.

METALS

Aluminum.—The Reynolds Metals Co. placed the second of 3 potlines in operation during the year at its reduction plant at Massena, St. Lawrence County. The third was installed but not in operation at the end of the year. The first potline was put on stream in 1959. All three potlines were of 33,000-ton primary-reduction capacity. Combined total capacity of Reynolds Metals Co. and Aluminum Company of America (the operator of the other large reduction plant at Massena) represented about 10 percent of the U.S. primary aluminum production potential. Production of aluminum in 1960 increased substantially over that of 1959.

Beryllium.—General Astrometals Corp., with offices, plant, and laboratory at Yonkers was organized to produce and sell beryllium metal and other beryllium products under license from Pechiney of France. At first, the company will receive beryllium flake or powder from Pechiney, but later may refine ore concentrates in its Yonkers plant. It will also produce cements and ceramics for high temperature and nuclear applications. Production was expected to start early in 1961.

For the first time a small quantity of beryl was gathered in New York, at the Bedford quarries, Westchester County, and sold through General Services Administration.

Ferroalloys.—Shipments of ferroalloys declined 22 percent to 137,000 short tons valued at $31.4 million. The value of shipments was the lowest in recent years and production was less than in 1959. Large decreases in production and value of shipments of ferrochromium alloys and silvery pig iron were the chief contributing factors. Shipments of ferrotitanium alloys also were smaller. On the other hand, shipments of ferromanganese, silicomanganese, ferrotungsten, and ferrocolumbium gained substantially. Ferroalloys shipped included, in addition to the aforementioned, ferrosilicon and other silicon alloys, ferrovanadium, ferroboron, ferroaluminum, zirconium alloy, and ferrotantalum-columbium. Included among ferrochromium

TABLE 8.—Ferroalloy producers in 1960

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	FeMn, SiMn, FeSi, FeCr, silvery pig iron.
Titanium Alloy Mfg. Div. of National Lead Co.	do	do	FeTi, FeB, FeZr, other ferroalloys.
Union Carbide Metals Co.	do	do	FeMn, FeCr, FeTi, FeW, FeB, FeCb, FeCbTa, SiMn, FeSi.
Vanadium Corp. of America	do	do	FeMn, FeSi, FeCr, FeTi, other ferroalloys, SiMn.
Transition Metals & Chemical Co.	Ulster County, Wallkill	Thermit	FeCb.

[1] Symbols: FeMn, ferromanganese; SiMn, silicomanganese; FeSi, ferrosilicon; FeCr, ferrochromium; FeTi, ferrotitanium; FeW, ferrotungsten; FeB, ferroboron; FeCb, ferrocolumbium; FeCbTa, ferrocolumbium-tantalum; FeZr, ferrozirconium.

alloys were ferrochromium and chromium briquets, chromium alloy V-5, and ferrochromium silicon.

Iron and Steel.—Pig iron production and shipments increased compared with 1959. Over 75 percent of the production was basic pig iron; other types, in decreasing order of production, were malleable, foundry, low phosphorus, Bessemer, and direct casting. Over 4.5 million tons of iron ore (84 percent domestic, 16 percent foreign) was received at New York plants. Foreign ores came from Canada (mainly Labrador), Chile, Liberia, and Peru. Manganiferous ore was shipped from Brazil and Labrador. Other raw materials consumed in blast furnaces included limestone and dolomite, mill cinder and roll scale, flue dust, open-hearth and Bessemer slag, coke, and ferrous scrap. Five firms operated blast furnaces (6 plants—17 stacks), four in Erie County, and one each in Niagara and Rensselaer Counties. Steel was produced at nine plants: three open-hearth and six electric. All open-hearth furnaces were in Erie County.

Iron and Steel Scrap.—Consumption of ferrous scrap and pig iron totaled over 6.5 million tons, 9 percent greater than in 1959. Slightly more than half was pig iron. Consumption of scrap was 6 percent higher than in 1959, and pig iron 13 percent higher. At yearend stocks of ferrous scrap in the hands of consumers had dropped over 160,000 tons (22 percent), whereas pig iron stocks had risen nearly 195,000 tons (62 percent), compared with stocks at the end of 1959.

Iron Ore.—Shipments of usable iron ore totaled 2.5 million long tons valued at $32.4 million, 21 percent higher than in 1959. Most of the ore produced was magnetite; a small quantity was hematite used for pigment. Agglomerate comprised over 80 percent of the shipments, and the remainder was concentrate. The hematite was processed by drying and pulverizing before shipment. The agglomerated material was largely sinter. As in 1959, magnetite was mined by three companies from three mines in Essex County and one each in Clinton and St. Lawrence Counties. The hematite was produced at one underground mine in Oneida County. About 85 percent of the magnetite was mined from open pits.

Lead.—After 2 low years, production of lead recovered to the highest point since 1957. Output came from the Balmat mine in St. Lawrence County.

National Lead Co. produced red lead and litharge at a plant in Brooklyn. Black lead oxide was manufactured by Electric Auto-Lite Battery Corp., Niagara Falls.

TABLE 9.—Mine production of silver, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Material sold or treated (short tons)	Silver		Lead		Zinc		Total value (thousands)
			Troy ounces	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951-55 (average)	2	579,434	44,520	$40	1,256	$378	46,086	$12,360	$12,778
1956	2	657,445	84,158	76	1,608	505	59,111	16,196	16,777
1957	2	660,638	63,880	58	1,667	477	64,659	15,001	15,536
1958	2	563,644	66,738	60	579	136	53,014	10,815	11,011
1959	2	438,769	51,588	47	481	111	43,464	9,997	10,155
1960	2	701,197	49,324	45	775	181	66,364	17,122	17,348

TABLE 10.—Mine production of silver, lead, and zinc in 1960, 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	4,939	61	5,588	August	3,912	34	5,746
February	4,379	51	5,914	September	4,522	34	5,321
March	4,515	76	6,061	October		61	5,299
April	4,628	64	5,532	November	4,720	134	4,458
May	4,544	63	5,938	December	4,615	127	4,991
June	4,626	33	5,679				
July	3,924	37	5,837	Total	49,324	775	66,364

Silver.—Production of silver was 4 percent less than in 1959. Output was recovered as a byproduct of lead-zinc ore from the Balmat mine, St. Lawrence County.

Titanium Concentrate (Ilmenite).—Production and shipments of ilmenite were substantially greater. The titanium concentrate, used mostly for pigments, was recovered from a mill treating titaniferous magnetite ore at Tahawus, Essex County.

Uranium.—Carborundum Co., Niagara Falls, began synthesizing and fabricating uranium carbide and plutonium carbide, which were combined into a new fuel for nuclear power reactors.

Zinc.—New York was second in zinc production. After a year in which a 4-months strike occurred, tonnage and value of recoverable zinc both rose to new highs. Production totaled 66,364 tons valued at $17,122,000—3 percent higher in quantity than the previous peak year, 1957. Production came from the Balmat and Edwards mines in St. Lawrence County.

Zirconium.—No commercial zircon was produced in New York; however, zirconium sponge and various zirconium products were manufactured. Production of zirconium-sponge metal by Carborundum Metals Corp., Division of Carborundum Corp., Akron (Erie County) contributed to the 1960 record output. Union Carbide Metals Co., continued to manufacture zirconium ferroalloys at its Niagara Falls plant. Zirconium oxide was made by Norton Co., and Titanium Alloy Manufacturing Division, National Lead Co., both in Niagara Falls, and a new producer in 1960, Harbison-Carborundum Corp., Falconer, Chautauqua County. Output totaled 13,813,000 pounds. Harbison-Carborundum Corp. and Corhart Refractories Co., Corning, Steuben County, were two of the major producers of zircon and zirconia refractories. Zirconium tetrachloride was produced in the Niagara Falls area by Stauffer Chemical Co.

MINERAL FUELS

Coke and Coal Chemicals.—Production of oven-coke totaled 3.1 million short tons valued at $52.9 million, a small increase in both quantity and value over 1959, but much less than in other years. New York was the 6th largest producing State in 1960, compared with 7th in 1959. Average value per ton was $17.21, $0.30 higher than in 1959. Three companies produced coke and coal chemicals at one merchant and two furnace plants in Erie County.

Of the 3.5 million tons of coke used in New York, 415,000 tons was received from other States. Of this total, 94 percent was destined for blast furnaces, and most of the remainder went to foundries and other industrial plants; less than 1 percent was used for residential heating, about the same percentage as the national average. In addition to coke used in New York, nearly 240,000 tons of coke breeze was destined for New York consumption.

TABLE 11.—Number, type, and capacities of coke-oven plants, Dec. 31, 1960

Company	Location	Classification of plant	Number and type of ovens	Annual coke capacity (thousand short tons)
Allied Chemical Corp.	Erie County: Buffalo	Merchant	60 Semet-Solvay	326
Bethlehem Steel Co.	Lackawanna	Furnace	171 Koppers-Becker; 60 Semet-Solvay; 304 Wilputte	2,952
Donner-Hanna Coke Corp.	Buffalo	do.	184 Koppers; 66 Koppers-Becker	1,022

Fuel Briquets and Packaged Fuel.—No production or consumption of fuel briquets or packaged fuel in New York was reported in 1960. Export of fuel briquets through the Buffalo customs district rose slightly to 2,078 short tons. No fuel briquets were exported through the St. Lawrence custom district. A small quantity, however, was exported from New York City.

Natural Gas.—Natural gas output rose 71 percent to 4,990 million cubic feet and came mostly from wells in Oriskany and Medina sandstones. According to the American Gas Association, the proved reserve of natural gas at yearend was 96,201 million cubic feet, a reduction of more than 10 billion cubic feet from 1959. Of the total reserve, 62 percent was stored in underground reservoirs; virtually all the remainder was in nonassociated storage, such as free gas not in contact with crude oil in reservoirs.

Oil and gas companies were active in exploration and leasing. Of the 15 natural gas field wells completed during the year, 4 were 1,250 to 2,500 feet deep and 11 were 2,500 to 3,000 feet deep; of the 13 gas wildcats, 5 were drilled to depths of 1,250 to 2,500 feet; 6—2,500 to 3,750 feet; and 2—5,000 to 7,500 feet.

Peat.—Peat was produced by three companies in three counties, the same as in 1959—Orange, Seneca, and Westchester. The value of output rose 5 percent to $146,000 although the quantity produced dropped 22 percent. Moss, reed-sedge, and humus peat were produced. Sales were largely in bulk, although a sizable quantity was packaged before sale. Producers reported that consumption of peat in New York totaled 38,903 short tons, compared with 34,709 tons in 1959.

Petroleum.—Production of petroleum decreased 9 percent in quantity, but remained at about the same value, resulting in a 9-percent rise in average value per barrel. The average quoted value of crude oil in New York in 1960 was $4.69 per barrel, except for Allegany County, where producers received 8 cents less. Most of the petroleum was produced in southwestern New York, in Allegany, Cattaraugus,

and Steuben Counties. The number of productive wells at yearend was estimated to be 18,579. Of these, 14,000 were artificial lift oil wells, 1,090 were gas wells, and 5 were condensate gas wells. Pennsylvania refineries continued to process virtually all of the New York crude oil.

The proved reserve of crude petroleum at the end of 1960, as calculated by the American Petroleum Institute, was 32.4 million barrels, about 2 percent less than in 1959. Because there were no extensions or revisions in existing fields and no new discoveries, the reduction in proved reserve represented 1960 production. New York ranked 23d among crude oil-producing States.

All the new wells drilled during the year were cable-tool wells. The average depth was 1,697 feet. All field oil wells and service wells were drilled to comparatively shallow depths—1,250 to 2,500 feet. All except one of the dry field wells were also in the 1,250 to 2,500 feet range. No crude oil wildcats were reported. Most of the dry wildcat wells ranged from 2,500 to 7,500 feet in depth and one was drilled deeper than 7,500 feet.

Refineries and cracking plants increased capacity slightly to 90,500 barrels and 32,300 barrels of crude petroleum per day compared with 90,000 and 31,800 barrels per day, respectively, in 1959. Frontier Oil Refining Corp., Division of Ashland Oil & Refining Co., at Tonawanda, Erie County; and Mobile Oil Co., with plants in Buffalo, Erie County, and in Brooklyn, Kings County, operated during the year. The plants at Tonawanda and Buffalo were skimming, cracking, and asphalt plants; the other had skimming and cracking facilities only. The Gulf Oil Co., skimming plant at Gulfport (Richmond County), closed in 1959, was discontinued.

TABLE 12.—Petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Average value per barrel	Year	Quantity	Value	Average value per barrel
1951-55 (average)	3,691	$14,728	$3.99	1958	1,763	$7,457	$4.23
1956	2,748	12,091	4.40	1959	1,970	8,353	4.24
1957	2,677	12,662	4.73	1960 [1]	1,801	8,357	4.64

[1] Preliminary figures.

TABLE 13.—Well completions and drilling footage for field wells and wildcats in 1960

Type of well	Field wells		Wildcats		Total	
	Well completions	Drilling footage	Well completions	Drilling footage	Well completions	Drilling footage
Crude	126	170,340			126	170,340
Gas	15	40,005	13	42,586	28	82,591
Dry	29	36,986	31	109,119	60	146,105
Service	86	110,132			86	110,132
Total	256	357,463	44	151,705	300	509,168

Source: Oil and Gas Journal, vol. 59, No. 5, Jan. 30, 1960.

Texaco, Inc., employed about 1,000 persons at its Beacon (Dutchess County), research laboratory. Fundamental and applied research on the use of fuels, lubricants, and greases, and nuclear research, petrochemical and process development, and improvement of existing and development of new products were undertaken.

REVIEW BY COUNTIES

Mineral output was reported from all except five counties. Value of mineral production increased in 34 of the 57 mineral-producing counties. The largest increase in value ($13.8 million) was in St. Lawrence County and was attributable chiefly to increased output of zinc and iron ore. St. Lawrence, Erie, Onondaga, Essex, and Greene Counties, in decreasing order of value, were the principal producers.

Albany.—Callanan Road Improvement Co. produced limestone for riprap, blast-furnace flux, concrete aggregate, and railroad ballast at South Bethlehem. A limited quantity of dimension sandstone, used for flagging and rough-dressed construction work, was produced near East Berne. Sand and gravel, used mainly for building and paving, was recovered by three producers. Albany Gravel Co., Inc., the leading producer, recovered material from pits near Albany, Bethlehem, and Colonie. James H. Maloy, Inc., produced gravel near Albany. Processed molding sand was recovered from pits in Selkirk and Slingerland, by Whitehead Bros. Co.

Albany County dropped to second place among the State's clay-producing counties. Output of miscellaneous clay decreased from 250,000 to 228,000 tons. Powell & Minnock Brick Works, Inc., Sutton & Suderly Brick Co., and Roah Hook Brick Co., all near Coeymans, mined miscellaneous clay for manufacturing building brick. Northern Lightweight Aggregates, Inc. (Cohoes), mined shale for manufacturing expanded lightweight aggregate by the rotary kiln process. Rex Clay Products Co., Inc., mined clay near Albany for use in manufacturing artificial abrasives, pottery, and flowerpots.

Allegany.—Sand and gravel was produced by Alfred Atlas Gravel and Sand Corp. and Buffalo Slag Co., Inc. (both near Alfred), Nick Codispoti (Belmont), and Thomas Moogan (Friendship). Output was processed mainly for building and paving purposes.

Bronx.—National Gypsum Co. produced calcined gypsum at its Bronx plant. The company also expanded perlite shipped from Colorado for use in manufacturing building plaster. The material was shipped mostly to other company plants for manufacturing building plaster; the remainder was used at the Bronx plant.

Broome.—Commercial sand and gravel output increased and consisted chiefly of processed building and paving material. Producers were Barney and Dickenson, Inc., Winnie and Son, Inc., Bob Murphy, Inc., all near Vestal, and Binghamton Sand & Crushed Stone Corp. and Weber's Sand and Gravel, both near Binghamton. Corbisello Quarries produced crushed and broken sandstone for concrete aggregate and riprap near Binghamton. Dimension sandstone (bluestone) was quarried and shipped to Delaware County for fabrication. Mis-

TABLE 14.—Value of mineral production in New York, by counties[1 2 3]

County	1959	1960	Minerals produced in 1960 in order of value
Albany	(4)	(4)	Stone, sand and gravel, clays.
Allegany	$733,266	$395,059	Sand and gravel.
Broome	(4)	(4)	Sand and gravel, stone, clays.
Cattaraugus	763,721	827,940	Sand and gravel.
Cayuga	(4)	(4)	Stone, sand and gravel.
Chautauqua	275,943	309,369	Sand and gravel.
Chemung	(4)	235,975	Sand and gravel, clays.
Chenango	147,447	(4)	Sand and gravel.
Clinton	(4)	(4)	Iron ore, sand and gravel, stone, lime.
Columbia	(4)	(4)	Cement, sand and gravel, stone, clays.
Cortland	142,996	----------	
Delaware	727,467	(4)	Stone, sand and gravel.
Dutchess	(4)	(4)	Stone, sand and gravel, clays.
Erie	22,287,034	21,430,132	Cement, stone, gypsum, sand and gravel, lime, clays.
Essex	(4)	(4)	Iron ore, ilmenite, wollastonite, sand and gravel, garnet.
Franklin	250,732	(4)	Sand and gravel, stone.
Fulton	90,585	77,157	Sand and gravel.
Genesee	(4)	2,981,712	Gypsum, stone, sand and gravel.
Greene	(4)	(4)	Cement, stone, sand and gravel, clays.
Hamilton	28,858	5,000	Sand and gravel.
Herkimer	(4)	(4)	Stone, sand and gravel, gem stones.
Jefferson	(4)	(4)	Stone, sand and gravel.
Lewis	(4)	(4)	Do.
Livingston	(4)	(4)	Salt, sand and gravel, stone.
Madison	433,699	(4)	Stone, sand and gravel.
Monroe	2,995,933	3,184,620	Stone, sand and gravel, gypsum.
Montgomery	(4)	(4)	Stone, sand and gravel.
Nassau	7,674,693	7,413,033	Sand and gravel, clays.
Niagara	8,581,940	10,693,100	Stone, lime, sand and gravel.
Oneida	2,970,962	2,561,882	Stone, sand and gravel, iron ore, gem stones.
Onondaga	(4)	(4)	Lime, salt, cement, stone, sand and gravel, clays.
Ontario	(4)	(4)	Stone, sand and gravel.
Orange	1,630,244	1,432,480	Sand and gravel, clays, stone, peat.
Orleans	(4)	(4)	Stone, sand and gravel.
Oswego	(4)	(4)	Sand and gravel.
Otsego	(4)	(4)	Stone, sand and gravel.
Putnam	(4)	(4)	Stone, sand and gravel, gem stones.
Queens	----------	6,282	Sand and gravel.
Rensselaer	(4)	(4)	Stone, sand and gravel.
Rockland	(4)	(4)	Do.
St. Lawrence	27,678,013	41,489,959	Iron ore, zinc, talc, sand and gravel, stone, lead, silver.
Saratoga	(4)	(4)	Sand and gravel, stone.
Schenectady	445,329	(4)	Sand and gravel.
Schoharie	(4)	(4)	Cement, stone, clays, sand and gravel.
Schuyler	(4)	(4)	Salt, sand and gravel.
Seneca	(4)	(4)	Peat, sand and gravel.
Steuben	533,762	(4)	Sand and gravel.
Suffolk	6,440,796	6,719,375	Do.
Sullivan	(4)	(4)	Stone, sand and gravel.
Tioga	(4)	300,306	Sand and gravel.
Tompkins	(4)	(4)	Salt, sand and gravel, stone.
Ulster	(4)	(4)	Cement, stone, sand and gravel, clays.
Warren	(4)	(4)	Cement, garnet, stone, sand and gravel, gem stones.
Washington	891,704	431,456	Stone, sand and gravel.
Wayne	(4)	(4)	Do.
Westchester	765,100	773,812	Stone, emery, sand and gravel, peat, beryl.
Wyoming	(4)	(4)	Salt, stone.
Yates	20,300	6,300	Sand and gravel.
Undistributed [5]	148,131,448	153,438,020	
Total	234,642,000	254,713,000	

[1] Bronx, Kings, New York, and Richmond Counties are not listed because no production was reported.
[2] Fuels, including natural gas and petroleum, not listed by counties, value included with "Undistributed."
[3] Excludes value of clays and stone used in manufacturing lime and cement.
[4] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[5] Includes natural gas and petroleum, some gem stones and sand and gravel (1960) that cannot be assigned to specific counties, and value indicated by footnote 4.

cellaneous clay for manufacturing building brick was produced by Binghamton Brick Co., Inc. (Binghamton).

Cattaraugus.—Commercial production of sand and gravel totaled 684,000 tons, a 9-percent increase over 1959. Eight pits, three near Allegany and one each near Franklinville, Gowanda, Limestone,

Onoville, and Red House were active. Output consisted mainly of processed building and paving material and was shipped to consumers principally by truck. Limited quantities of sand were produced for filtration and ice control.

Cayuga.—General Crushed Stone Co. (Auburn) quarried and crushed limestone for concrete aggregate, roadstone, riprap, and asphalt filler. Processed sand and gravel, used chiefly for building and paving, was produced at Auburn by J. J. Harrington and Jay W. Robinson & Son. Stanley Jablonski produced bank-run gravel for fill near Mentz.

Chautauqua.—Production of commercial sand and gravel came principally from pits near Bemus Point, Irving, Jamestown, and Stow. Output was used mainly for building and paving.

Chemung.—Commercial sand and gravel, used chiefly for building and paving, was produced by Dalrymple Gravel & Contracting Co., Inc. (Elmira), Elmira Transit Mix, Inc. (Horseheads), and Frank Treat (Breesport). Miscellaneous clay for manufacturing building brick was produced by Consolidated Brick Co. (Horseheads).

Chenango.—Commercial sand and gravel was produced by B&B Builders Supplies, Inc. (Greene), and Bundy Concrete Co. (Sherburne). Output consisted chiefly of building material.

Clinton.—Magnetite iron ore was mined by Republic Steel Corp. at its Chateaugay underground and open-pit mine near Dannemora (Lyon Mountain). Because of reduced demand for steel, this mine was closed from June 10 through October 3 and from November 12 to the end of the year. Sinter was consumed mostly in manufacturing pig iron and steel. A small quantity of concentrate was prepared. At the mine, a fairly active exploration and development program was carried out, which included raising, tunneling, drifting, cross cutting, and percussion drilling. In the open-pit part of the mine, a sizable quantity of overburden was removed. Open-pit mining was done on two benches, averaging 30 feet high and 70 feet wide. Gneiss (miscellaneous stone) was recovered from tailings and sold as concrete aggregate, railroad ballast, and stone sand.

International Lime & Stone Corp. (Chazy) continued to produce limestone for construction, agricultural, and metallurgical purposes and for manufacturing lime at its nearby plant. Quicklime and hydrated lime were produced for a variety of chemical, industrial, and agricultural uses. Lime output was consumed in New York, New England States, and Canada. Plattsburgh Quarries, Inc. (formerly Lancaster Development Corp.), quarried limestone near Plattsburgh for concrete aggregate and roadstone. Sand and gravel, mainly for building and paving, was produced by Bero Construction Corp. (Morrisonville). The company also produced sand for fill and ice control and gravel for drainage use.

Columbia.—Columbia County continued to rank third among cement-producing counties. Lone Star Cement Corp. (Greenport) and Universal Atlas Cement Division of United States Steel Corp. (Hudson) produced portland and masonry cements, using chiefly limestone and clays mined nearby as raw materials. Most of the finished cement was shipped to consumers in New York and New England States. Catskill Mountain Stone Corp. quarried limestone at Hudson for use

as concrete aggregate and roadstone. Sand for paving and ice control and gravel for paving was produced at pits near Claverack, Copake, Hudson, and Livingston. Columbia Sand & Gravel (Claverack) was renamed Cairo Ready-Mix.

Cortland.—The Cortland sand and gravel operations of Cortland Ready Mix, Inc. (formerly Cortland Ready Mix Concrete), was idle in 1960.

Delaware.—Delaware County continued to lead in value of sandstone (bluestone) production. Output was valued at $838,000—a 17-percent increase over 1959. Except for a limited quantity of broken stone used for riprap, county output consisted of dimension stone for construction and architectural purposes, curbing, and flagging. Fabricating yards processed stone quarried in Delaware County, surrounding New York counties, and bordering Pennsylvania counties. Bluestone fabricators were W. R. Strong & Son and Willis Hankins (both near Deposit), Johnston & Rhodes Bluestone Co. (East Branch), Paul Thompkins Estate (Hancock), and American Bluestone Co. (Masonville). The stone was used in constructing schools, churches, hospitals, dams, and other buildings in New York and Connecticut. Sand and gravel came from Government-and-contractor operations.

Dutchess.—The county continued to lead in value of commercial limestone. New York Trap Rock Corp. (New Hamburg) and Dutchess Quarry & Supply Co., Inc. (Pleasant Valley), produced limestone used chiefly for concrete aggregate and roadstone. White Marble Corp. produced marble near Wingdale. Commercial production of sand and gravel totaled 490,000 tons—a 16-percent increase over 1959. Output consisted chiefly of building and paving material and was recovered from 13 operations. Dennings Point Brick Works, Inc., mined clay and shale from pits near Beacon and used it for manufacturing building brick.

Erie.—Portland and masonry cements were produced at Buffalo by Lehigh Portland Cement Co. and Penn-Dixie Cement Corp. Raw materials used at these cement plants included limestone, shale, clay, gypsum, sand, iron ore, mill scale, and pyrite sinter. Finished cement was shipped mostly to consumers in New York and Pennsylvania. Output of limestone by commercial producers totaled 1.4 million tons, 4 percent greater than in 1959. Most of the limestone was crushed for use by the construction industries. Producers were Buffalo Crushed Stone Corp. (Bowmansville), County Line Stone Co., Inc., (Akron), Federal Crushed Stone Corp. (Cheektowaga), and Lancaster Stone Products Corp. (Lancaster). Substantial quantities of limestone were produced under contract to the State of New York, Department of Public Works, and used chiefly as backfill for sewers.

Universal Atlas Cement Co., Bestwall Gypsum Co., and National Gypsum Co. mined crude gypsum underground near Clarence Center. Universal Atlas shipped its output to company-owned plants for use as a portland cement retarder. Bestwall Gypsum Co. shipped the crude gypsum to its Akron, N.Y., plant where it was calcined and processed into finished building materials. The company also expanded crude perlite shipped from Nevada and Colorado. National

Gypsum Co. calcined the crude gypsum and expanded crude perlite shipped from other States at its nearby plant. Buffalo Perlite Corp. (Cheektowaga) expanded perlite shipped from western States. The expanded perlite was used mainly as plaster aggregate; quantities also were used for loose-fill insulation, concrete aggregate, soil conditioning, filler, and filter purposes.

The county continued to rank third in tonnage and value of commercial sand and gravel. Output, by 9 producers, totaled 1.3 million tons compared with 1.7 million tons in 1959. Seventy-seven percent of the county output was processed material, and all was shipped by truck. Quicklime for metallurgical purposes was produced at the Buffalo plant of Kelley Island New York Corp. Erie County ranked first in clay production. Clay, principally for manufacturing building brick, was mined and processed near Lakeview and West Falls. Anchor Concrete Products, Inc. (Jewettsville), produced lightweight aggregate by the rotary kiln process from miscellaneous clay mined nearby. Substantial quantities of clay were mined for manufacturing cement. Small quantities were mined near Buffalo for manufacturing flowerpots.

Essex.—The Republic Steel Corp. Fisher Hill and Old Bed-Harmony mines near Mineville operated only in the first half of the year because of the lessened demand for steel. About 250 miners were idled. Approximately an equal number of men were employed at the company Troy plant, where most of the sinter and concentrate was consumed. Regular and random pillars were used to support openings at the Fisher Hill mine. At the Old Bed-Harmony mines 90 percent of the ore was mined by sublevel stoping and the remainder by open stoping, using casual pillars. Exploration and development at the Fisher Hill mine consisted of raising and drifting; at the Old Bed-Harmony mines it consisted of raising, drifting, and diamond and percussion drilling. The ore from the Fisher Hill mine was treated at the same plant where the Old Bed-Harmony ore was processed. National Lead Co. operated the MacIntyre underground titaniferous magnetite mine at Tahawas, the second largest iron ore mine in New York. The ore was processed by heavy-medium separation, flotation, magnetic separation, and sintering. Sizable tonnages of ilmenite also were recovered at Tahawas. Iron ore produced in Essex County was used chiefly for pig iron and steel, cement, and as a heavy-medium in mineral dressing separation.

Cabot Minerals Division, Cabot Corp. (formerly Cabot Carbon Co.), mined wollastonite and byproduct abrasive garnet (andradite) at its Willsboro mines. The wollastonite was crushed and ground for use as a filler in paints, ceramics, and plastics. Adirondack Development Corp. began exploratory drilling near Lewis on a newly discovered wollastonite deposit. Development was expected to begin in 1961. Sand and gravel was recovered from pits near Elizabethtown, Keesville, and Saranac Lake. Output consisted mainly of processed material for building and paving.

Franklin.—Commercial output of sand and gravel totaled 114,000 tons and came from pits near Bombay, Malone, St. Regis Falls, and Westville. Sandstone for rough construction in flagging was quarried near Malone by Adirondack Stone Quarries, Inc. Dressed architec-

615629—61——47

tural sandstone was quarried and fabricated near Burke. The sandstone quarried at Malone was used in constructing buildings in Pennsylvania, New York, and Massachusetts.

Fulton.—Commercial output of sand and gravel totaled 62,000 tons, compared with 73,000 tons in 1959. Seven producers, mainly near Gloversville, Broadalbin, and Johnstown, were active.

Genesee.—United States Gypsum Co. produced crude and calcined gypsum at its Oakfield plant. Limestone used chiefly for concrete aggregate and railroad ballast was quarried by General Crushed Stone Co. (North Le Roy), Genesee Stone Products Corp. (Stafford), and LeRoy Lime and Crushed Stone Corp. (Le Roy). Sand and gravel used chiefly for structural purposes was produced by Frey Sand and Gravel Corp. (Alexander), and Batavia Washed Sand & Gravel Co., Inc., Western New York Gravel & Concrete Corp., and B. R. DeWitt, Inc., all near Batavia.

Greene.—Greene County continued to lead in value of cement output. Alpha Portland Cement Co. (Catskill), Lehigh Portland Cement Co., and North American Cement Corp. (both near Alsen) produced portland and masonry cements. These companies also quarried limestone nearby as the main cement raw material. In addition, North American Cement Corp. mined clay near its cement plant. Gypsum, iron ore, and shale also were used as cement raw materials. The finished cement was shipped mostly to consumers in New York and New England. A small quantity was exported. Sandstone was quarried and crushed for concrete aggregate and roadstone near Cairo by Catskill Mountain Stone Co., Inc. Whitehead Bros. Co. produced molding sand near Catskill and Coxsackie, and Coxsackie Sand & Gravel Co., Inc. (Coxsackie), produced building and paving sand.

Hamilton.—Sand and gravel was produced by Government-and-contractor operations.

Herkimer.—General Crushed Stone Co. produced limestone for aggregate, agstone, and asphalt filler at its Jordanville quarry. The limestone quarry of Newport Quarries Corp. (Newport) was idle for the second consecutive year. Material Sand and Gravel Corp. (Gravesville) produced sand and gravel principally for building purposes. Quartz crystals were recovered as mineral specimens near Middleville.

Jefferson.—Limestone for concrete aggregate, agstone, asphalt filler, and railroad ballast was quarried at Watertown by General Crushed Stone Co. The highway departments of the towns of Cape Vincent and Hounsfield produced limestone for concrete aggregate and roadstone. Multi-Color Sandstone Co. quarried stone for flagging and architectural uses at Redwood. Commercial output of sand and gravel totaled 237,000 tons, a 58-percent increase over 1959. Seven producers, mainly near Adams, Belleville, Gouverneur, and Watertown, were active.

Lewis.—Limestone, used chiefly as an industrial filler, was quarried and crushed by Carbola Chemical Co., Inc. (Natural Bridge). The highway department of the town of Lowville quarried and crushed limestone for concrete aggregate and roadstone. Commercial production of sand for ice control and gravel for paving was reported near Lowville.

Livingston.—Livingston County continued to lead in salt production. Output of rock salt from the Retsof underground mine of the International Salt Co. was used mainly in manufacturing chemicals (principally chlorine) and for controlling ice on highways. Rock salt was shipped to consumers principally in New York and other northeastern States; some was exported to Canada. Sand and gravel, principally for building purposes, was recovered from pits near Avon, Conesus, Dansville, and Scottsville. Limestone for concrete aggregate and asphalt filler was quarried near Rochester by General Crushed Stone Co.

Madison.—Limestone was quarried by Munnsville Limestone Corp. (Munnsville) and Worlock Stone Co., Inc. (Perryville). Sand and gravel was produced from pits near Hamilton and Canastota.

Monroe.—Dolomite Products Co. quarried limestone near Gates and Penfield. Output was used for concrete aggregate and agstone. Limestone also was quarried by Central Materials Corp. at Brockport. Sand and gravel output, by 12 producers, totaled 1.1 million tons compared with 850,000 tons in 1959, and was used mainly for building and paving material. Fifty-four percent of the county output was processed material and the entire output shipped to consumers by truck. Ruberoid Co. mined gypsum at Wheatland and shipped it to Caledonia for processing into gypsum building products.

Montgomery.—Cushing Stone Co., Inc., and Crushed Rock Products, Inc., both near Amsterdam, produced limestone for the construction industry. St. Johnsville Supply Co., Inc. (St. Johnsville), processed sand and gravel, chiefly for building and paving material.

Nassau.—Although tonnage and value both dropped, Nassau County remained second in sand and gravel output. A total of 5.4 million tons was produced compared with 5.6 million tons in 1959. Value decreased 4 percent. Output, from eight operations, consisted entirely of processed material used mainly for building and paving purposes and was shipped to consumers principally by truck and barge. Nassau Brick Co., Inc. (Farmingdale), mined clay for manufacturing brick.

Niagara.—Production of limestone for the Niagara Power project totaled 5.5 million tons, compared with 3.2 million tons in 1959. Limestone, which was dug from a mile-long channel, was crushed at a nearby aggregate plant. Output from the crushing plant was used chiefly for concrete. Quantities also were used as riprap and as dike filter material. In addition, limestone was produced by three commercial producers, Niagara Stone Division, Olsker-McLain Industries, Inc. (Niagara Falls); Frontier Stone Products, Inc., (Lockport); and Royalton Stone Corp. (Gasport). Gasport Sand & Gravel Co., Inc. (Lockport), produced processed sand and gravel used mainly as structural material.

Oneida.—Eastern Rock Products, Inc., produced limestone for aggregate, agstone, railroad ballast, and riprap at at its Prospect No. 6 and Oriskany Falls No. 5 quarries. Commercial sand and gravel output totaled 596,000 tons, compared with 643,000 tons in 1959. Output came from 10 operations and consisted chiefly of processed material for building, paving, and molding purposes. Clinton Metallic Paint Co. mined crude red iron oxide pigment (hematite) from its Brim

field underground mine near Clinton. Output increased in 1960 and was consumed in making red paints. Mining was by longwall (long-face) methods, with entry by vertical shafts. Dynamite was used as the blasting agent. Specimens of hematite were obtained by a mineral collector near Clinton. The Utica plant of Zonolite Co. continued to be the only plant exfoliating vermiculite in the State. Crude material shipped from company-owned mines in Montana and South Carolina was processed at the plant.

Onondaga.—Onondaga County ranked second in value of production of commercial limestone. Limestone for highway construction and maintenance was produced at the Jamesville quarry of General Crushed Stone Co. Solvay Process Division, Allied Chemical Corp., quarried limestone at Jamesville for use mainly in manufacturing quicklime for producing alkalies. Some was used as concrete aggregate, agstone, and railroad ballast. In addition, the company operated wells at Tully and a plant in Syracuse for producing evaporated salt and brine. The brine was used with the lime in manufacturing soda ash. The evaporated salt, produced in vacuum pans, was used mainly for manufacturing chemicals. Portland and masonry cements were produced at Jamesville by Alpha Portland Cement Co. The company mined shale nearby for use as a cement raw material. Other raw materials included limestone (cement rock), sand, gypsum, and iron ore. The entire output of portland and masonry cements was shipped to consumers within the State, chiefly by truck in bulk.

Commercial production of sand and gravel totaled 856,000 tons, compared with 824,000 in 1959. Sixty-six percent of the output was processed material, used chiefly for structural and paving material. Twelve operations were active, compared with nine in 1959.

Onondaga Brick Corp. (Warners) produced lightweight aggregate by the sintering process from shale mined nearby. Red clay for manufacturing pottery and flowerpots was mined near Camillus by Syracuse Pottery Co., Inc. The Cicero clay pit of Syracuse Brick Corp. was idle during the year. Minerals Processing Corp. (Syracuse) expended perlite shipped from Colorado and Utah. The expanded perlite was used principally for soil conditioning and as a plaster and concrete aggregate.

Ontario.—General Crushed Stone Co. produced limestone for highway and railroad construction and maintenance at Geneva. Commercial output of sand and gravel totaled 369,000 tons, a 44-percent increase over 1959. Production was centered near Clifton Springs, Geneva, Manchester, Oaks Corners, Phelps, and Victor.

Orange.—Commercial sand and gravel output was reported from nine operations and totaled 647,000 tons, a 6-percent decrease below 1959. Ninety-seven percent of the county output was processed. Sand and gravel was used principally for structural and paving purposes. Jova Brick Works mined clay near Roseton for manufacturing building brick. Limestone for concrete aggregate and roadstone was quarried by Dutchess Quarry & Supply Co. Inc. (Goshen). Reed-sedge peat was recovered from a bog near Tuxedo by Sterling Forest Peat Co., Inc. The output was sold in packages and in bulk.

Orleans.—Limestone for concrete aggregate and roadstone was produced at Clarendon by Clarendon Stone Co., Inc. Sand and gravel

production by commercial operations increased 14 percent and consisted chiefly of bank-run material. Production was centered near Albion, Barre, Medina, and Shelby.

Oswego.—Commercial sand and gravel was recovered from pits near Lacona and Oswego. Molding sand was produced near Pulaski.

Otsego.—Limestone for concrete aggregate and roadstone was quarried at Richfield Springs by Barrett Division, Allied Chemical Corp. Sandstone (bluestone) for construction and architectural uses was quarried near Oneonta. Sand and gravel was produced by Seward Gravel Co. (Milford) and Unadilla Concrete Products Co. (Unadilla).

Putnam.—Patterson Mineral Corp. (Patterson) quarried limestone for mineral filler and agstone. Sand and gravel was produced by Leemac Sand & Stone Corp. (Phillipstown) and Harlem Valley Crusher Co., Inc. (Patterson). Specimens of magnetite were gathered by an amateur gem collector near Brewsters.

Queens.—The Long Island Railroad Co. produced engine sand and railroad ballast gravel near Jamaica.

Rensselaer.—Miscellaneous stone for concrete aggregate and roadstone was quarried at the Campbell Mountain quarry (Cropseyville) of Fitzgerald Bros. Construction Co., Inc. Commercial sand and gravel output totaled 237,000 tons, compared with 205,000 tons in 1959. Material was recovered from seven pits. The clay pit of Champlain Brick Co. (Mechanicville) was inactive during the year.

Richmond.—United States Gypsum Co. calcined gypsum at its New Brighton plant for manufacturing finished building products.

Rockland.—Rockland County ranked second in value of stone produced. New York Trap Rock Co. produced limestone at Tompkins Cove and quarried basalt at Haverstraw and West Nyack. It was the major producer of basalt in the State. Output from these quarries was marketed as concrete aggregate, roadstone, stone sand, and riprap. Most of the company's output from the Tompkins Cove and Haverstraw quarries was shipped by barge to consumers in the metropolitan New York area; most of the West Nyack quarry output was transported by truck. Suffern Stone Co. (Suffern) also quarried basalt for concrete aggregate.

Sand and gravel output totaled 943,000 tons, a 36-percent increase over 1959. Producers were Graney Building Material Corp. (Sparkill), Mt. Ivy Sand & Gravel Co., Inc. (Mt. Ivy), Ramapo Sand & Gravel Corp. (Hillburn), Ward Pavements, Inc. (Thiells), and Elinor Allison (Stony Point). Crude gypsum was calcined and processed into finished building products at the Stony Point plant of United States Gypsum Co.

St. Lawrence.—The largest iron ore mine in New York in 1960 was the Benson open-pit mine near Star Lake in southern St. Lawrence County, operated by Jones & Laughlin Steel Corp. This mine was active the entire year. Mining was conducted on three benches averaging 50 feet high and 700 feet wide. In addition to the ore handled, more than 4 million long tons of overburden was removed. The concentrate and sinter produced was consumed mostly for pig iron and steel. About the middle of the year, Jones & Laughlin began building new crushing, screening, and cooling facilities for the sinter

plant. The new facilities, being installed by Dravo Corp., Pittsburgh, included a vertical shaft stationary cooler, the first of its type in the United States. The capacity of this unit is rated at 3,800 gross tons per day. The crusher, cooler, and auxiliary equipment will serve the two 6-foot-wide sinter machines already in use.

Zinc, lead, and silver were recovered from the Balmat mine and zinc was recovered from the Edwards mine, operated by St. Joseph Lead Co. Both mines were in production the entire year. Safety records improved for each mine and were better than the national average for underground metal mines in both frequency and severity ratios. The Edwards surface operations had completed 5 years without a lost-time accident. After a long series of tests of mechanical flotation machines that indicated savings in power and reagent costs and higher zinc recovery, the zinc flotation circuit in the Balmat mill was completely converted to this method of treatment and was performing satisfactorily at yearend. Exploration and development at the Edwards mine consisted of 1,883 feet of raising, 3,763 feet of drifting, and 6,994 feet of underground diamond drilling. Development at the Balmat mine consisted of 36 feet of shaft sinking, 6,190 feet of raising, 10,583 feet of drifting, and 28,861 feet of underground diamond drilling. Zinc concentrate from both mines was shipped to the St. Joseph Lead Co. smelter at Josephtown, Pa., for recovery of zinc. Lead concentrate from the Balmat mine and lead residue from the Josephtown smelter were shipped to the company Herculaneum (Mo.) smelter for recovery of lead and silver.

International Talc Co., Inc., mined crude talc from underground mines near Balmat and Talcville. Gouverneur Talc Co., Inc., mined crude talc from its underground mine at Balmat. Both companies operated crushing and grinding plants. Ground talc was sold for a variety of uses. Commercial sand and gravel production dropped slightly from 1959. Most of the output was prepared material for the construction industry and came from pits near Colton, Fine, Gouverneur, Nicholville, Potsdam, and Rossie.

Barrett Division, Allied Chemical Corp. (Norwood), and McConville, Inc. (Ogdensburg), produced limestone used chiefly for concrete aggregate and roadstone. The St. Lawrence County Highway Department also quarried limestone for road maintenance and repair. Balducci Crushed Stone Co. (Gouverneur) produced marble for agstone and concrete aggregate.

Saratoga.—Commercial sand and gravel output totaled 175,000 tons, compared with 186,000 tons in 1959. Output consisted chiefly of processed molding sand and was shipped by rail and truck to consumers. Ten operations were active during the year. Glens Falls Portland Cement Co., Division of The Flintkote Co., quarried limestone at Glens Falls for its cement plant in Warren County. Limestone for concrete aggregate, riprap, and agstone was produced by Pallette Stone Corp. (Saratoga Springs).

Schenectady.—Output of commercial sand and gravel increased and came from operations near Rotterdam, Schenectady and Scotia. The material was used principally for structural purposes.

Schoharie.—North American Cement Co. produced portland and masonry cements at its Howes Cave plant. Limestone and shale

(mined nearby), gypsum, and iron ore were used as cement raw materials. Finished cement was shipped to consumers mainly in New York and New England. Output was shipped principally by truck in bulk. Other limestone producers were Cobleskill Stone Products Division, Allied Materials Corp. (Cobleskill), and Masick Soil Conservation Co. and Schoharie Stone Corp., both near Schoharie. Paving gravel was produced by the New York State Department of Public Works.

Schuyler.—International Salt Co., Inc., and Watkins Salt Co., Inc., both near Watkins Glen, produced evaporated salt mostly by the vacuum-pan process. Some of the salt was sold in pressed blocks. Output was used chiefly by the chemical industry in New York and other northeastern States. Limited quantities were exported to Canada and other foreign countries. D. & T. Franzese Bros. produced sand and gravel near Watkins Glen.

Seneca.—Finger Lakes Peat Moss Co., Inc., recovered moss peat from bogs near Junius. Output was sold in bulk. Crews of the Seneca County Highway Department produced sand for ice control and gravel for paving.

Steuben.—Commercial sand and gravel production was reported near Bath, Cohocton, and Corning. Output decreased from 1959.

Suffolk.—Suffolk County continued to rank first in sand and gravel production. Although commercial output (5.6 million tons) decreased 6 percent in quantity, the value increased to $6.7 million, compared with $6.4 million in 1959. Of 23 active sand and gravel producers, 4 produced over 500,000 tons. One of these produced over 1 million tons. Ninety percent of the commercial output was processed material, compared with 88 percent in 1959. The material was shipped to consumers by truck, water, and rail transportation.

Sullivan.—Concrete aggregate and stone sand were produced from sandstone quarried by Sullivan Highway Products Co. at its Bridgeville and Kenoza Lake quarries. Sandstone (bluestone) produced in the county was shipped to Delaware County for fabrication as architectural stone and flagging. Sand and gravel was produced near Liberty, Masten Lake, Mongaup Valley, and Summitville. The entire county output was shipped to consumers by truck, mainly as processed material for building and paving.

Tioga.—Sand and gravel, mainly for building and paving, was produced by Central Materials Corp. (Tioga), Herman E. Bunce (Barton), C. & C. Ready-Mix Corp. (Owego), and A. O. Swanson (Waverly).

Tompkins.—Cayuga Rock Salt Co., Inc., recovered rock salt from an underground mine near Myers for use mostly in ice removal on highways and by the chemical industry, mainly within the State. Evaporated salt was produced at the Ludlowville refinery of International Salt Co., Inc. The salt was recovered in vacuum pans; some was sold in pressed blocks. Evaporated salt was sold to a wide variety of consuming industries, mainly in New York and other northeastern States.

Finger Lakes Stone Co., Inc., produced dimension sandstone (mainly architectural) at its University quarry near Dryden. Out-

put was used in school construction in Ithaca and bridge construction in Niagara Falls. Rumsey-Ithaca Corp. and University Sand & Gravel, both near Ithaca, processed sand and gravel, chiefly for building purposes.

Ulster.—Hudson Cement Co. Division, Colonial Sand and Stone Co., Inc., produced portland cement at its Kingston plant. Limestone quarried nearby was the principal cement raw material. Finished portland cement was shipped mainly to consumers in New York for ready-mixed concrete. Century Mfg. Co., Inc., produced natural and masonry cements from stone quarried nearby. Masonry cement was shipped to consumers in New York, New Jersey, Pennsylvania, Connecticut, and Rhode Island. Callanan Road Improvement Co. produced limestone for concrete aggregate and roadstone at its No. 3 plant near Esopus. Output was shipped to consumers mainly by barge.

Sand and gravel used mainly as structural and paving material was produced by Dutchess Quarry & Supply Co., Inc. (Wawarsing), Hurley Sand & Gravel Co., Inc. (Hurley), James J. Van Vliet & Son, Inc. (Marlboro), and James Ricker, Inc. (Connelly). Ulster County was the third largest clay-producing county. Hutton Co. and Star Brick Corp., both near Kingston, mined miscellaneous clay for manufacturing building brick.

Warren.—Glens Falls Portland Cement Co., Division of The Flintkote Co., produced portland and masonry cements at its Glens Falls plant, mainly from limestone (cement rock) quarried in Saratoga County. Gypsum, sand, and iron ore also were used as cement raw materials. Finished cement was shipped to consumers principally by truck and in bulk. Limestone was quarried near Glens Falls by Jointa Lime Co., Inc. Warren Aggregates, Inc., quarried and crushed granite near Chestertown for use as asphalt aggregate and stone sand, and processed building and paving sand.

Abrasive garnet was mined and processed at the North Creek plant of Barton Mines Corp. The refined garnet was used in manufacturing sandpaper and for grinding and polishing glass and metal lapping. The county continued to lead in the value of gem and mineral specimens collected. Crude and finished garnets valued at nearly $4,000 were recovered and processed near North Creek.

Washington.—The New York slate industry continued to be centered in Washington County. Production was reported from 11 operations and was centered mainly near Granville, Middle Granville, and Whitehall. Output was used chiefly as roofing and flagging material. The production of ground slate for manufacturing natural and artificially colored roofing granules was discontinued when the Central Commercial Co. plant closed at the end of 1959. The plant was being dismantled. Bank-run gravel was produced from pits near Clemons, Fort Ann, and Eagle Bridge. Bank-run sand used for ice control was recovered from a pit near Hebron.

Wayne.—Limestone for concrete aggregate and agstone was quarried near Sodus by General Crushed Stone Co. Commercial sand and gravel was recovered from pits near Galen, Macedon, and Palmyra. The output was mostly bank-run material used for general construction work.

Westchester.—Lake Street Granite Quarry, Inc. (White Plains), and DiRienzo Bros. and Baratta & D'Amato (both near Yonkers) quarried dimension granite mainly for construction work. Dolomitic marble was quarried and crushed at the Thornwood plant of Universal Marble Products Corp. The crushed stone was used mainly for terrazzo, cast stone, stucco, and agricultural lime. DiRubbo & Ellis mined emery at the Kingston mine near Croton. Output was used for general abrasive purposes. DeLuca Emery mine produced emery from mines near Croton and Peekskill for use as aggregate in heavy-duty nonslip floors and pavements.

Sand and gravel was recovered at five operations, principally near Somers and Peekskill. Most of the output was processed material; all of the output was shipped to consumers by truck. Humus peat was produced near Armonk by Stone Age Humus Corp. A very small quantity of beryl, recovered at the Bedford feldspar quarries (inactive for many years), was sold through GSA.

Wyoming.—Morton Salt Co. produced evaporated salt by open-pan processes at its Silver Springs plant. Some of the salt was sold in pressed blocks. Sawed and dressed architectural sandstone (bluestone) was produced at the Ambluco quarry (Portageville) of American Bluestone Co. The stone was used in constructing interiors of schools in New York City and other buildings in Buffalo.

Yates.—Road maintenance crews of the town of Jerusalem produced sand and gravel.

The Mineral Industry of North Carolina

This chapter has been prepared under a cooperative agreement for collecting mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of North Carolina.

By James L. Vallely,[1] Jasper L. Stuckey,[2] and Mildred E. Rivers [3]

MINERAL production set a new record for North Carolina in 1960 of nearly $45 million, exceeding the previous peak year of 1954 by $3.3 million and 1959 by $4.2 million. In order of value, stone, sand and gravel, copper, feldspar, mica, clays, and tungsten were the principal minerals mined. North Carolina was first in the Nation in producing feldspar, sheet and scrap mica, olivine, and lithium minerals, second in tungsten, and third in talc production.

Metals accounted for 12 percent of the total value. Output of copper increased more than 25 percent; tungsten mining was resumed; and byproduct lead, gold, and silver were recovered in considerable quantities. Lithium production was much lower than in 1959. Stone increased in tonnage and value; sand and gravel was up 2 percent in tonnage but was little changed in value; and feldspar, mica, talc, and pyrophyllite decreased in tonnage and value.

TABLE 1.—Mineral production in North Carolina [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones [2]—thousand short tons	(3)	$5	(4)	$2
Clays [5]—do	2,524	1,522	2,476	1,548
Feldspar—do	(6)	(6)	271	2,781
Gem stones	(4)	9	(4)	4
Gold (recoverable content of ores, etc.)—troy ounces	965	34	1,826	64
Lead—short tons	----------	----------	424	99
Mica:				
Scrap—thousand short tons	48	1,212	47	1,100
Sheet—pounds	505,623	1,755	430,193	1,411
Sand and gravel—thousand short tons	8,580	7,426	8,801	7,453
Silver (recoverable content of ores, etc.)—troy ounces	16,319	15	212,368	192
Stone—thousand short tons	12,859	20,302	14,721	23,296
Talc and pyrophyllite—do	127	647	101	549
Value of items that cannot be disclosed: Abrasive stone (millstones, 1959), asbestos, copper, feldspar (1959), iron ore, kaolin, lithium minerals, olivine, tungsten, and values indicated by footnote 6	----------	7,862	----------	6,469
Total North Carolina	----------	40,789	----------	44,968

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Grinding pebbles and tubemill liners (1959) and millstones (1960).
[3] Less than 1,000 tons.
[4] Weight not recorded.
[5] Excludes kaolin; included with "Value of items that cannot be disclosed."
[6] Figure withheld to avoid disclosing individual company confidential data.

[1] Commodity-industry analyst, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, North Carolina Geological Survey, Raleigh, N.C.
[3] Statistical assistant, Bureau of Mines, Knoxville, Tenn.

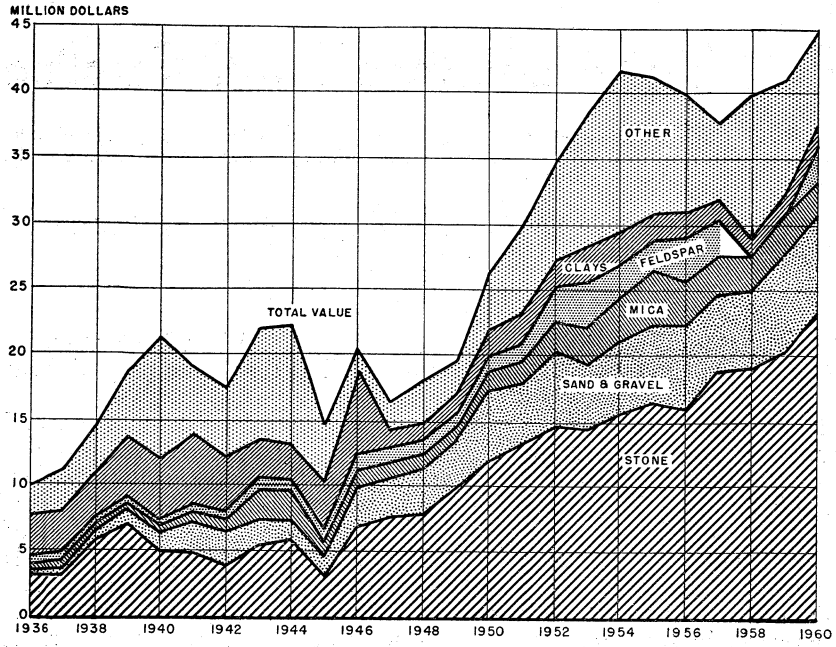

FIGURE 1.—Value of stone, sand and gravel, mica, feldspar, clays, and total value of mineral production in North Carolina, 1936–60.

Employment and Injuries.—Table 2 figures, except for quarries and mills, and sand and gravel mines, are not comparable for 1959 and 1960, as certain smelters and manufacturing operations are not included in 1960. Although there were 86 active quarries and mills compared with 74 in 1959, the total man-hours worked varied only slightly from the previous year. Sand and gravel mines totaled 115, 6 less than in 1959, but man-hours decreased 16 percent. Closing of many small mica mines accounted in a large measure for the decrease in man-hours worked in nonmetal mines.

Injury experience was lower than in 1959; only 2 fatalities were recorded in 1960, compared with 3 in 1959; nonfatal injuries totaled 336 against 402. Injuries per million man-hours showed improvement in all categories except sand and gravel mines where injuries per million man-hours increased from 14 in 1959 to 23 in 1960.

Trends and Developments.—Considerable activity in mining exploration was noted during the year. Tennessee Copper Co. began reconditioning the shaft of the old Silver Hill lead-zinc mine near Lexington preparatory to examining the mine; the Whitney Reduction Co., a new corporation, began the reopening of the old Whitney mine near Gold Hill in Cabarrus County in search of sulfide ores. Exploration and development in metal mines included: 721 feet of shaft sinking, 3,771 feet of raising, 5,151 feet of drifting and crosscutting, and 11,788 feet of diamond drilling.

Exploration drilling was underway in Beaufort County to mine phosphate rock hydraulically. Water was pumped underground through pipes in an attempt to force the phosphate to the surface

TABLE 2.—Employment and injuries in the mineral industries

Year and Industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:							
Nonmetal mines	291	3,719	227	6,755,712	1	169	25
Quarries and mills	74	2,026	222	3,601,747	1	140	39
Sand and gravel mines	121	817	227	1,486,766	----------	21	14
Metal mines [1]	5	936	350	2,622,497	1	72	28
Total	491	7,498	241	14,466,722	3	402	28
1960: [2]							
Nonmetal mines	200	2,432	261	5,083,807	2	115	23
Quarries and mills	86	2,080	217	3,612,592	----------	94	26
Sand and gravel mines	115	689	227	1,251,787	----------	29	23
Metal mines	6	559	246	1,100,877	----------	98	89
Total	407	5,760	240	11,049,063	2	336	31

[1] Includes aluminum smelters.
[2] Preliminary figures.

through other pipes. Phosphate beds are 30 to 40 feet thick and as deep as 150 feet below the surface.

The North Carolina Board of Conservation and Development granted a 25-year lease on State-owned lands in the southeastern part of the State to Roderick A. Stamey who planned to drill 40 oil test wells in the area.

Ideal Cement Co. announced plans to construct a 1.5-million-barrel-per-year cement plant at Wilmington on the Cape Fear River, the State's first cement plant. Florida Steel Corp. announced it would build a $3.3 million steel plant near Charlotte; furnace and rolling mill were to have a capacity of 50,000 tons of rolled sheet per year.

Triangle Brick Co. put into operation its new plant near Durham; Boren Clay Products was building a new $1 million brick plant at Pleasant Gerden; Cunningham Brick Co., Thomasville, planned a $1.3 million expansion program; and Cherokee Brick planned to increase the capacity of its Moncure plant by adding a new tunnel kiln.

Legislation and Government Programs.—The Government Mica Purchasing Depot under the General Services Administration (GSA) at Spruce Pine operated throughout the year. No Office of Mineral Exploration (OME) contracts were in force in 1960.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Millstones were produced in Rowan County; no grinding pebbles or tubemill liners were reported in 1960.

Asbestos.—Powhatan Mining Co. mined amphibole asbestos in Transylvania and Yancey Counties. Production was considerably higher than in 1959.

Clays.—Production of kaolin increased 6 percent in tonnage, but decreased 5 percent in value; however, miscellaneous clay decreased 2 percent in tonnage and increased 2 percent in value. Harris Clay Co., in Avery County, was the only kaolin producer. Miscellaneous clay was mined by 28 companies from 32 pits in 20 counties for manu-

facturing lightweight aggregate, brick, tile, and other clay products. Principal producers were: Borden Brick & Tile Co., Boren Clay Products Co., Mount Gilead Brick Co., Pine Hall Brick & Pipe Co., Carolina Tuff-Lite Corp., and Southern Lightweight Aggregate Corp.

Feldspar.—Crude feldspar production, including flotation concentrates, was 271,000 long tons valued at $2.8 million, somewhat lower than in 1959. The unit value, however, increased from $10.05 to $10.27 per long ton. Flotation concentrates made up 85 percent of the total crude production. The Feldspar Corp. (Spruce Pine plant), International Minerals & Chemicals Corp. (Kona and Spruce Pine plants), and Lawson-United Feldspar & Minerals Co. (Minpro plant) mined alaskite rock and recovered feldspar concentrates in Mitchell County. Foote Mineral Co. recovered byproduct feldspar at its lithium plant in Cleveland County. Crude lump feldspar from Mitchell, Swain, Yancey, and other counties made up the balance of production.

Sales of ground feldspar were 275,000 short tons valued at $3.1 million, a decrease of 2 percent in tonnage and 5 percent in value. The value of ground feldspar for pottery changed little, but the quantity increased almost 9 percent over 1959. Glass and enamel uses declined in tonnage and value.

Gem Stones.—Gem stones and gem materials were collected in 18 or more counties in 1960. Among the minerals reported were: Actinolite, beryl, garnet, almandite, rhodolite, rhodonite, agate, amethyst, hyalite, corundum, sapphire, and topaz.

Lithium.—Foote Mineral Co. mined and processed spodumene at Kings Mountain, and Lithium Corp. of America converted spodumene to lithium chemicals at Bessemer City. Production and value declined for the second straight year primarily because of the cancellation of Atomic Energy Commission contracts in mid-1959.

Texas Gulf Sulphur Co. continued economic and engineering studies to determine whether or not to exercise its option on spodumene properties of Basic Atomics, Inc., between Lincolnton and Bessemer City, N.C.

Mica.—Sheet and scrap mica output declined in quantity and value from 1959. Sheet mica was down 15 percent in quantity and 20 percent in value; and scrap declined 1 percent in tonnage and 9 percent in value. Production of sheet and scrap mica was reported from 142 mines in 13 counties, compared with 218 mines in 19 counties in 1959. A considerable tonnage could not be identified by county or mine of origin. Mitchell County, with 47 mines, accounted for 53 percent of the total value of production; Avery, Cleveland, Macon, and Yancey, 44 percent; and 8 or more other counties, the remaining 3 percent. Leading producers of sheet mica were: Abernathy Mining Co. (Abernathy mine), McBee Mining Co. (McBee mine), Mitchell Lumber Co. (Banner mine), Mountain Mining Co. (Jimmy Cut mine), P & H Mining Co. (Gudger and Deer Park mines), and Sink Hole Miners (Sink Hole mine). Principal scrap producers were: Deneen Mica Co., Harris Clay Co., Industrial Mica, Inc., and Kings Mountain Mica Co., Inc. Output of ground mica was 4 percent higher, but value decreased 9 percent below 1959; 10 mica grinders were active during the year.

TABLE 3.—Sheet mica sold or used by producers, by counties

County	1959		1960	
	Pounds	Value	Pounds	Value
Avery	15,342	$178,171	5,773	$72,678
Buncombe	266	562		
Caldwell	(1)	(1)		
Catawba	3	76		
Cleveland	765	8,374	(1)	(1)
Haywood	(1)	(1)		
Iredell	(1)	(1)		
Jackson	309	2,688	1,480	10,446
Macon	3,373	44,672	14,887	108,522
Mitchell	153,661	1,342,431	110,135	1,102,477
Rutherford	2,316	2,257		
Stokes	5,479	77,754	(1)	(1)
Yancey	13,913	57,551	15,734	64,585
Undistributed [2]	310,196	40,778	282,184	52,732
Total	505,623	1,755,314	430,193	1,411,440

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes Ashe, Burke, Gaston, Lincoln, Transylvania, and Wilkes Counties, and counties indicated by footnote 1.

TABLE 4.—Mica sold or used by producers, by kinds

Kind	1959		1960	
	Quantity	Value	Quantity	Value
Sheet mica:				
Uncut punch and circle—pounds	373,271	$35,372	322,588	$20,923
Larger uncut mica—do	1,336	1,468	7,209	4,431
Full-trim purchased by GSA [1]—do	131,016	1,718,474	100,396	1,386,086
Total sheet mica—do	505,623	1,755,314	430,193	1,411,440
Scrap mica: Total—short tons	47,736	1,211,721	47,281	1,099,502
Grand total (sheet and scrap)—do	47,989	2,967,035	47,496	2,510,942

[1] Includes full-trimmed mica equivalent of hand-cobbed mica.

TABLE 5.—Ground mica sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Roofing	16,512	$407,186	$24.66	18,135	$470,312	$25.93
Paint	6,369	958,952	150.57	6,022	834,451	138.57
Rubber	3,384	480,328	141.94	3,362	407,450	121.19
Wallpaper	189	26,406	139.71	192	24,155	125.81
Plastics	403	54,510	135.26	(1)	(1)	(1)
Other uses [2]	12,338	519,530	42.11	13,180	482,237	36.59
Total	39,195	2,446,912	62.43	40,891	2,218,605	54.26

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes joint cement and miscellaneous uses, welding rods, and well drilling compounds.

Olivine.—Production of olivine was lower in tonnage and value than in 1959; mines were operated by Harbison-Walker Refractories Co., Jackson County, and Wiseman Mining Co., Yancey County.

Perlite.—Carolina Perlite Co., Inc., expanded perlite at Gold Hill from crude material shipped into North Carolina. Tonnage and value of output has consistently increased since 1957.

Quartz.—Byproduct quartz was recovered from feldspar flotation plants in Mitchell County. Production data are included under stone.

Sand and Gravel.—Sand and gravel was the second-ranking commodity in the State in both tonnage and value of production. Commercial sand and gravel supplied 68 percent of the tonnage and 80 percent of the value, compared with 67 and 80 percent, respectively, in 1959. Commercial sand increased 9 percent in tonnage and 6 percent in value, whereas Government-and-contractor sand decreased 6 percent in both tonnage and value. Commercial gravel was up 2 percent in tonnage, but was 3 percent lower in value. However, Government-and-contractor gravel increased 29 and 51 percent in tonnage and value, respectively. Sand and gravel was produced in 80 counties. Commercial sand and gravel was produced in 13 counties; gravel only, in 5 counties; and sand only, in 13 counties. Forty-two companies operated 51 pits in 31 counties, compared with 46 pits in 30 counties in 1959. Government-and-contractor output of sand only came from 67 counties, gravel from 1 county, and sand and gravel from 5 others. Leading producers were: Becker County Sand & Gravel Co., W. R. Bonsal Co., Inc., Grove Stone & Sand Branch of B. V. Hedrick Gravel & Sand Co., lessees of B. V. Hedrick Gravel & Sand Co., McCrary Construction Service, and the State highway department.

TABLE 6.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Alamance	2,500	$1,250		
Alexander	43,000	13,975	47,090	$15,812
Anson	2,037,752	2,337,741	1,706,590	1,859,027
Ashe	11,000	5,500	50,000	40,000
Avery	41,066	31,178	(1)	(1)
Beaufort	(1)	(1)	(1)	(1)
Bertie	6,000	3,000	1,620	486
Bladen	108,000	56,000	108,500	59,675
Brunswick	18,000	18,000	15,000	4,500
Buncombe	566,824	669,631	745,884	802,365
Burke	202,933	109,088	165,620	130,143
Cabarrus	118,000	43,683		
Caldwell	16,921	12,829	123,837	125,589
Camden	3,500	1,050	3,000	900
Carteret	3,500	1,575	3,000	1,440
Caswell	38,000	19,000	41,900	41,900
Catawba	57,537	19,376	53,423	17,904
Chowan	1,800	950	2,800	840
Clay			36,489	25,626
Cleveland	43,771	17,508	(1)	(1)
Columbus	80,600	42,350	82,000	45,100
Craven	(1)	(1)	(1)	(1)
Cumberland	(1)	(1)	(1)	(1)
Currituck	30,100	9,030	17,500	5,250
Dare	7,000	2,100	77,500	23,250
Davidson	190,650	95,325	195,200	97,600
Davie	83,000	49,800	95,000	57,000
Duplin	(1)	(1)	8,150	2,525
Edgecombe	2,500	1,325	42,290	41,636
Forsyth	(1)	(1)	107,824	65,090
Franklin	4,000	2,000	4,000	2,000
Gaston	36,823	14,729	32,400	12,960
Gates	7,500	2,250	5,500	1,650
Granville	7,110	5,332	10,100	6,060
Greene	60,000	27,000	52,000	24,960
Guilford	3,450	3,450	6,000	6,000
Halifax	5,600	3,000	1,200	660
Harnett	(1)	(1)	(1)	(1)

See footnote at end of table.

TABLE 6.—Sand and gravel sold or used by producers, by counties—Continued

County	1959		1960	
	Short tons	Value	Short tons	Value
Haywood	213,291	$263,839	(1)	(1)
Hertford	13,500	4,225	21,996	$6,598
Hoke	83,401	103,697	(1)	(1)
Hyde	1,400	740	1,500	450
Iredell	(1)	(1)	(1)	(1)
Johnston	33,500	33,500	34,235	31,835
Jones	41,886	20,979	(1)	(1)
Lee	75,180	40,000	58,340	32,087
Lenoir	169,754	133,851	(1)	(1)
Lincoln	37,037	14,814	27,050	10,820
Macon	(1)	(1)	4,050	3,000
Madison			2,000	2,000
Martin	17,000	5,370	3,700	1,110
McDowell	(1)	(1)	(1)	(1)
Mecklenburg	12,000	9,000		
Mitchell	25,386	19,410		
Montgomery	77,200	27,020	75,000	26,250
Moore	416,146	216,647	254,931	152,456
Nash	(1)	(1)		
New Hanover	11,600	11,600	11,800	7,600
Northampton	(1)	(1)	(1)	(1)
Onslow	5,000	5,000	6,000	1,800
Pamlico	8,000	3,600	4,000	1,920
Pasquotank	3,000	900	15,000	4,500
Pender	4,000	4,000	6,000	1,800
Perquimans	10,000	3,000	17,500	5,250
Person	12,900	9,675	4,930	3,697
Pitt	(1)	(1)	(1)	(1)
Richmond	9,650	4,825	25,000	13,250
Robeson	(1)	(1)	161,000	88,550
Rockingham	3,185	3,185	2,859	2,859
Rowan	41,250	20,625	40,500	20,250
Rutherford	175,967	149,572	204,482	172,692
Sampson	9,000	9,000	10,000	3,000
Stanly	4,000	1,400		
Stokes	95,000	57,000	140,000	84,000
Surry	10,960	21,266	15,805	8,693
Transylvania	(1)	(1)	1,180	1,315
Union			12,500	9,375
Vance	2,000	1,000	2,000	1,000
Wake	5,068	3,040	3,100	1,610
Washington	48,000	25,440	11,000	3,300
Watauga	11,475	6,997	(1)	(1)
Wayne	(1)	(1)	(1)	(1)
Wilkes	33,425	17,700	12,475	6,861
Wilson	77,625	64,841	61,377	56,455
Yadkin	16,175	8,570	29,775	16,376
Yancey	33,500	27,805	(1)	(1)
Undistributed	2,893,977	2,453,955	3,678,175	3,152,597
Total	8,579,875	7,426,113	8,800,677	7,453,304

[1] Figure withheld to avoid disclosing individual company confidential data; Included with "Undistributed."

TABLE 7.—Sand and gravel sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Paving	3,260,641	$1,804,447	$.55	2,818,986	$1,519,476	$.54
Structural	1,726,292	1,284,202	.74	2,247,311	1,599,621	.71
Fill	39,474	23,514	.60	19,943	12,375	.62
Other	7,600	7,600	1.00	[1] 73,476	[1] 55,912	.76
Gravel:						
Paving	1,948,823	2,247,899	1.15	2,094,226	2,079,887	.99
Structural	1,329,248	1,698,848	1.28	1,301,160	1,799,605	1.38
Railroad ballast	26,325	19,338	.73	[2]	[2]	[2]
Fill				4,606	4,309	.94
Other	[3]	[3]	[3]	240,969	382,119	1.59
Total sand and gravel	[4] 8,579,875	[4] 7,426,113	[4] .86	8,800,677	7,453,304	.85

[1] Includes railroad ballast sand.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Other gravel."
[3] Included with "Total sand and gravel."
[4] Includes filter and railroad ballast sand and uses indicated by footnote 3.

TABLE 8.—Crushed granite sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Alamance	[1]	[1]	[1]	[1]
Alleghany	50,000	$62,000		
Bladen			3,500	$8,750
Buncombe	19,732	29,590	[1]	[1]
Cabarrus	60,000	60,000	99,204	121,392
Caswell	408,435	627,948	348,977	546,424
Catawba	[1]	[1]	[1]	[1]
Cherokee	15,000	37,500	[1]	[1]
Columbus			4,700	11,750
Cumberland			2,900	7,250
Forsyth	[1]	[1]	1,921,150	2,268,980
Gaston	[1]	[1]	[1]	[1]
Guilford	[1]	[1]	[1]	[1]
Harnett			20,500	51,250
Henderson			[1]	[1]
Iredell			[1]	[1]
Jackson			[1]	[1]
Lincoln			63,215	88,500
Macon			[1]	[1]
Mecklenburg	[1]	[1]	[1]	[1]
New Hanover	[1]	[1]		
Orange	11,873	17,809	21,281	31,921
Randolph	168,595	252,892	165,720	264,657
Robeson			4,000	10,000
Rockingham	[1]	[1]	[1]	[1]
Rowan	[1]	[1]	[1]	[1]
Surry	[1]	[1]	[1]	[1]
Swain			[1]	[1]
Transylvania	135,000	189,000	[1]	[1]
Vance	[1]	[1]	643,600	856,000
Wake	[1]	[1]	[1]	[1]
Wilkes	[1]	[1]	271,500	253,000
Wilson	[1]	[1]	[1]	[1]
Yadkin	[1]	[1]	239,000	370,000
Undistributed	7,591,862	10,634,815	6,911,005	10,384,439
Total	8,460,497	11,911,554	10,720,252	15,274,313

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Stone.—Output of stone, the principal mineral product of the State, increased 14 percent in tonnage and 15 percent in value. Crushed stone production was up 15 percent in tonnage and 17 percent in value, whereas dimension stone decreased 33 percent in quantity and 3 percent in value.

Stone was quarried in 47 counties, as follows: Granite in 32, limestone in 8, marble in 1 (Cherokee), quartz in 1 (Mitchell), slate in 2 (Davidson and Montgomery), and traprock in 10. Commercial stone, excluding quartz, was produced by 19 operators from 66 quarries—48 granite, 8 limestone, 2 slate, 7 traprock, and 1 marble. The State highway department crushed stone from 13 granite, 1 limestone, and 5 traprock quarries. Leading crushed stone producers were: W. E. Graham & Sons, a division of Vulcan Materials Co.; Superior Stone Co., a division of American Marietta Co.; and Nello L. Teer Co. Principal producers of dimension stone were: Columbia Marble Co., Harris Granite Quarries, and North Carolina Granite Co.

Talc and Pyrophyllite.—Combined production of crude talc and pyrophyllite decreased 21 percent in tonnage and 15 percent in value primarily because of lower sales to consumers of crude pyrophyllite. Crude talc production was little changed from 1959. Ground talc and pyrophyllite increased 3 percent in tonnage, but decreased 1 percent in value. Sawed talc (crayons) was considerably higher in tonnage, with a somewhat smaller increase in value. Ground talc was sold principally for textile use and toilet preparations. Ground pyrophyllite was used principally in ceramics, refractories, insecticides, and rubber. Talc was mined in Cherokee County and pyrophyllite in Alamance, Montgomery, Moore, Orange, and Randolph Counties.

Vermiculite.—Zonolite Co. operated an exfoliating plant at High Point using crude vermiculite shipped into the State.

METALS

Gold, Silver, Copper, and Lead.—Copper production increased 28 percent in tonnage and 34 percent in value. Appalachian Sulphides, Inc., mined and concentrated sulfide ore from the Ore Knob mine at West Jefferson, and Tungsten Mining Corp. recovered copper and lead by flotation of accumulated tailings from its tungsten mill in Vance County. Gold and silver were recovered from the smelting of concentrates of both companies. Appalachian Sulphides, Inc., reported a reserve of 400,000 tons of ore, sufficient for less than 2 years of operation.

Iron Ore.—Cranberry Magnetite Corp., Avery County, continued development and produced a small tonnage of iron ore.

Silicon.—High-purity silicon was produced by E. I. du Pont de Nemours & Co., Inc., at Brevard.

Tungsten.—Tungsten Mining Corp. resumed mining at the Hamme mine in Vance County in May and maintained production for the balance of the year.

TABLE 9.—Mine production of gold and silver, 1799–1960

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1799-1880	963,794	$19,931,573			963,794	$19,931,573
1881	5,564	115,000			5,564	115,000
1882	9,192	190,000	19,231	$25,000	28,423	215,000
1883	8,079	167,000	2,308	3,000	10,387	170,000
1884	7,596	157,000	2,692	3,500	10,288	160,500
1885	7,354	152,000	2,308	3,000	9,662	155,000
1886	8,466	175,000	2,308	3,000	10,774	178,000
1887	10,885	225,000	3,846	5,000	14,731	230,000
1888	6,580	136,000	2,692	3,500	9,272	139,500
1889	7,102	146,795	2,983	3,878	10,085	150,673
1890	5,733	118,500	5,967	7,757	11,700	126,257
1891	4,909	101,477	4,973	6,465	9,882	107,942
1892	4,364	90,196	49,728	64,646	54,092	154,842
1893	3,411	70,505	13,400	17,420	16,811	87,925
1894	2,561	52,927	352	458	2,913	53,385
1895	2,622	54,200	400	520	3,022	54,720
1896	2,143	44,300	500	646	2,643	44,946
1897	1,674	34,600	200	259	1,874	34,859
1898	4,064	84,000	700	905	4,764	84,905
1899	1,669	34,500	300	388	1,969	34,888
1900	1,379	28,500	11,200	14,481	12,579	42,981
1901	2,685	55,500	20,300	26,246	22,985	81,746
1902	4,390	90,700	20,900	27,022	25,290	117,722
1903	3,411	70,500	11,000	14,222	14,411	84,722
1904	5,994	123,900	14,800	8,584	20,794	132,484
1905	5,994	123,900	13,200	8,052	19,194	131,952
1906	4,397	90,900	24,700	16,719	29,097	107,619
1907	3,807	78,700	25,200	16,600	29,007	95,300
1908	4,716	97,500	1,300	700	6,016	98,200
1909	1,519	31,400	400	200	1,919	31,600
1910	3,120	64,500	8,300	4,500	11,420	69,000
1911	3,400	70,282	943	500	4,343	70,782
1912	8,031	166,014	4,854	2,985	12,885	168,999
1913	6,117	126,448	1,812	1,114	7,929	127,562
1914	6,344	131,141	1,524	843	7,868	131,984
1915	8,321	172,001	1,465	743	9,786	172,744
1916	1,269	26,237	663	436	1,932	26,673
1917	590	12,187	1,110	915	1,700	13,102
1918	79	1,631	17	17	96	1,648
1919	1	20	38	42	39	62
1920	55	1,147	11	12	66	1,159
1921	154	3,179	18	18	172	3,197
1922	94	1,939	9	9	103	1,948
1923	53	1,102	79	65	132	1,167
1924	220	4,540	31	21	251	4,561
1925	897	18,540	108	75	1,005	18,615
1926	79	1,631	21	13	100	1,644
1927	49	1,015	5	3	54	1,018
1928	114	2,366	19,051	11,145	19,165	13,511
1929	244	5,054	21,106	11,249	21,350	16,303
1930	705	14,582	30,054	11,571	30,759	26,153
1931	368	7,598	20,333	5,897	20,701	13,495
1932	367	7,591	10,045	2,832	10,412	10,423
1933	725	18,522	11,492	4,022	12,217	22,544
1934	509	17,779	9,710	6,277	10,219	24,056
1935	2,176	76,145	7,584	5,451	9,760	81,596
1936	2,037	71,301	5,575	4,318	7,612	75,619
1937	949	33,203	5,538	4,284	6,487	37,487
1938	1,878	65,730	5,500	3,556	7,378	69,286
1939	495	17,325	3,961	2,689	4,456	20,014
1940	1,943	68,005	6,480	4,608	8,423	72,613
1941	3,244	113,540	7,439	5,290	10,683	118,830
1942	4,077	142,695	8,259	5,873	12,336	148,568
1943	131	4,585	7,169	5,098	7,300	9,683
1944	21	735	1,461	1,039	1,482	1,774
1945-48						
1949	13	455			13	455
1950-53						
1954	214	7,490	438	396	652	7,886
1955	190	6,650	181	164	371	6,814
1956	882	30,870	753	682	1,635	31,552
1957	1,373	48,055	12,347	11,174	13,720	59,229
1958	876	30,660	15,157	13,718	16,033	44,378
1959	965	33,775	16,319	14,835	17,284	48,610
1960	1,826	63,910	212,368	192,203	214,194	256,113
Total	1,171,249	24,564,248	717,216	622,850	1,888,465	25,187,098

TABLE 10.—Mine production of gold and silver, 1799–1960, by counties

County	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
Anson	1	$34			1	$34
Ashe	4,297	148,006	66,901	$60,539	71,198	208,545
Burke	1,162	24,806	200	118	1,362	24,924
Cabarrus	2,709	60,249	1,005	723	3,714	60,972
Caldwell	105	2,281	17	10	122	2,291
Catawba	1,994	41,917	502	291	2,496	42,208
Chatham			97	68	97	68
Cherokee	55	1,154	1	1	56	1,155
Cleveland	54	1,132	4	2	58	1,134
Davidson	386	9,580	3,208	2,030	3,594	11,610
Dawson	3	71			3	71
Franklin	508	11,693	25	17	533	11,710
Gaston	675	18,429	208	137	883	18,566
Granville	14	290	3,845	2,538	3,859	2,828
Guilford	1,144	24,309	1,124	585	2,268	24,894
Halifax	2,250	78,590	2,068	1,860	4,318	80,450
Henderson	3	66	253	132	256	198
Iredell	1	24			1	24
Jackson	147	3,140	671	406	818	3,546
Macon	23	505	6	4	29	509
McDowell	152	3,444	19	11	171	3,455
Mecklenburg	7,462	228,058	1,855	1,370	9,317	229,428
Montgomery	56,763	1,174,085	67,558	77,339	124,321	1,251,424
Moore	25	576	16	12	41	588
Nash	148	3,171	13	8	161	3,179
Orange	59	1,242			59	1,242
Person	78	1,632	17,436	10,089	17,514	11,721
Polk	37	803	8	4	45	807
Randolph	397	9,515	178	121	575	9,636
Rowan	5,783	119,740	55,834	35,635	61,617	155,375
Rutherford	1,425	31,865	148	88	1,573	31,953
Stanly	636	17,022	143	79	779	17,101
Swain	2,576	73,388	171,073	88,210	173,649	161,598
Union	11,012	354,830	7,062	4,972	18,074	359,802
Vance	166	5,810	189,632	171,626	189,798	177,436
Warren	41	825	4	4	45	829
Wilkes	1	42			1	42
Yadkin	76	1,586	14	8	90	1,594
Undistributed	1,068,881	22,110,338	126,088	163,813	1,194,969	22,274,151
Total	1,171,249	24,564,248	717,216	622,850	1,888,465	25,187,098

TABLE 11.—Leading gold mines, 1881–1960

Mine	County	Total production
Iola	Montgomery	$991,900
Howie	Union	348,915
Rudisill	Mecklenburg	161,365
Ore Knob	Ashe	148,006
Uwara	Montgomery	93,802
Gold Hill	Rowan	91,897
Fontana	Swain	72,898
Enfield	Halifax	71,085
Capps	Mecklenburg	59,235
Rich Cog	Montgomery	49,573
Shuford	Catawba	35,516
Phoenix	Cabarrus	31,334
Biggerstaff	Rutherford	24,607
Gardner Hill	Guilford	17,384
Union	Rowan	16,538
Sally Coggins	Montgomery	15,377

REVIEW BY COUNTIES

Ninety-four of the 100 counties in North Carolina reported mineral production; Mitchell, Ashe, Guilford, Vance, and Cleveland were the leaders. In addition to the detailed county production listed in table

12, considerable crude feldspar and sheet and scrap mica were produced—all of undetermined county origin.

Alamance.—Superior Stone Co., a division of American-Marietta Co. (Burlington and Mebane quarries), and North Carolina State Highway and Public Works Commission (Bason quarry) crushed granite for concrete and roads. Boren & Harvey (Snow Camp mine) mined pyrophyllite for refractory and ceramic uses. Hanford Brick Co., Inc., mined miscellaneous clay for heavy clay products.

Alexander.—The State highway commission mined 47,000 tons of paving sand. Ruth P. Stanley collected a small quantity of gem stones (topaz, white sapphire, smoky quartz, rock crystals, hiddenite, and emerald).

Alleghany.—Ararat Products Co. crushed traprock for concrete and roads.

Anson.—Lessees of B. V. Hedrick (Lilesville mine), W. R. Bonsal Co. (Bonsal mine), and the State highway commission mined 1,707,000 tons of structural, paving, railroad ballast, metallurgical, and fill sand and gravel. The State highway commission crushed traprock for concrete and roads at the Sugartown and Hendley quarries.

TABLE 12.—Value of mineral production in North Carolina, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Alamance	(2)	(2)	Granite, talc, miscellaneous clay.
Alexander	$14,360	$18,417	Sand and gravel, gem stones.
Alleghany	62,030	(2)	Traprock.
Anson	2,382,641	1,887,129	Sand and gravel, traprock.
Ashe	(2)	(2)	Copper, gold, sand and gravel, silver, mica.
Avery	(2)	(2)	Mica, kaolin, sand and gravel, iron ore.
Beaufort	(2)	(2)	Sand and gravel.
Bertie	3,000	468	Do.
Bladen	56,000	68,425	Sand and gravel, granite.
Brunswick	18,000	4,500	Sand and gravel.
Buncombe	(2)	(2)	Sand and gravel, granite.
Burke	)2)	130,693	Sand and gravel, mica, gem stones
Cabarrus	103,683	121,392	Granite.
Caldwell	(2)	125,589	Sand and gravel.
Camden	1,050	900	Do.
Carteret	1,575	1,440	Do.
Caswell	646,948	588,324	Granite, sand and gravel.
Catawba	(2)	(2)	Granite, miscellaneous clay, sand and gravel.
Chatham	388,173	340,531	Miscellaneous clay, traprock.
Cherokee	(2)	(2)	Marble, talc, granite. gem stones.
Chowan	950	840	Sand and gravel.
Clay	70	25,626	Do.
Cleveland	(2)	(2)	Lithium minerals, limestone, mica, sand and gravel, feldspar.
Columbus	42,350	56,850	Sand and gravel, granite.
Craven	(2)	(2)	Limestone, sand and gravel.
Cumberland	(2)	(2)	Sand and gravel, miscellaneous clay, granite.
Currituck	9,030	5,250	Sand and gravel.
Dare	2,100	23,250	Do.
Davidson	(2)	(2)	Sand and gravel, slate, miscellaneous clay.
Davie	49,800	57,005	Sand and gravel, gem stones.
Duplin	(2)	2,525	Sand and gravel.
Durham	(2)	(2)	Traprock, miscellaneous clay.
Edgecombe	1,325	41,636	Sand and gravel.
Forsyth	(2)	2,334,070	Granite, sand and gravel.
Franklin	2,000	2,000	Sand and gravel.
Gaston	(2)	(2)	Granite, sand and gravel, miscellaneous clay, mica.
Gates	2,250	1,650	Sand and gravel.
Granville	5,332	6,135	Sand and gravel, gem stones.
Greene	27,000	24,960	Sand and gravel.
Guilford	(2)	(2)	Granite, miscellaneous clay, sand and gravel.
Halifax	(2)	(2)	Miscellaneous clay, sand and gravel.
Harnett	(2)	(2)	Sand and gravel, granite, miscellaneous clay.
Haywood	(2)	(2)	Sand and gravel, gem stones.
Henderson	342,846	(2)	Limestone, granite, miscellaneous clay.
Hertford	4,225	6,598	Sand and gravel.
Hoke	103,697	(2)	Do.
Hyde	740	450	Do.
Iredell	(2)	(2)	Granite, sand and gravel, gem stones.

See footnotes at end of table.

TABLE 12.—Value of mineral production in North Carolina, by counties[1]—Con.

County	1959	1960	Minerals produced in 1960 in order of value
Jackson	(2)	(2)	Granite, olivine, mica.
Johnston	(2)	(2)	Traprock, sand and gravel.
Jones	$20,979	(2)	Sand and gravel.
Lee	(2)	$312,369	Miscellaneous clay, sand and gravel.
Lenoir	133,851	(2)	Sand and gravel.
Lincoln	15,521	99,702	Granite, sand and gravel, gem stones, mica.
Macon	(2)	(2)	Mica, granite, sand and gravel, gem stones.
Madison	----------	2,000	Sand and gravel.
Martin	5,370	1,110	Do.
McDowell	(2)	(2)	Sand and gravel, limestone.
Mecklenburg	(2)	(2)	Granite.
Mitchell	(2)	(2)	Feldspar, mica, sandstone, gem stones.
Montgomery	(2)	(2)	Miscellaneous clay, sand and gravel, slate, talc.
Moore	(2)	(2)	Talc, sand and gravel, miscellaneous clay, gem stones.
Nash	(2)	----------	
New Hanover	(2)	34,582	Limestone, sand and gravel.
Northampton	(2)	(2)	Sand and gravel.
Onslow	(2)	(2)	Limestone, sand and gravel.
Orange	(2)	(2)	Talc, granite.
Pamlico	3,600	1,920	Sand and gravel.
Pasquotank	900	4,500	Do.
Pender	4,000	1,800	Do.
Perquimans	3,000	5,250	Do.
Person	9,675	3,697	Do.
Pitt	(2)	(2)	Do.
Polk	1,200	----------	
Randolph	(2)	(2)	Granite, traprock, talc, gem stones.
Richmond	4,825	13,250	Sand and gravel.
Robeson	(2)	98,550	Sand and gravel, granite.
Rockingham	(2)	(2)	Granite, miscellaneous clay, traprock, sand and gravel.
Rowan	2,079,165	1,958,684	Granite, miscellaneous clay, sand and gravel, abrasive stones.
Rutherford	152,189	172,742	Sand and gravel, gem stones.
Sampson	26,278	18,936	Miscellaneous clay, sand and gravel.
Stanly	267,235	312,506	Miscellaneous clay, traprock.
Stokes	(2)	(2)	Miscellaneous clay, sand and gravel, mica.
Surry	(2)	(2)	Granite, traprock, sand and gravel, gem stones.
Swain	(2)	(2)	Limestone, granite, feldspar.
Transylvania	(2)	(2)	Granite, asbestos, sand and gravel, mica.
Union	(2)	(2)	Traprock, miscellaneous clay, sand and gravel.
Vance	(2)	(2)	Tungsten, granite silver, lead, copper, gold, sand and gravel.
Wake	(2)	(2)	Granite, sand and gravel.
Washington	25,440	3,300	Sand and gravel.
Watauga	6,997	(2)	Sand and gravel, gem stones.
Wayne	(2)	(2)	Do.
Wilkes	(2)	260,029	Granite, sand and gravel, mica, gem stones.
Wilson	(2)	(2)	Granite, sand and gravel.
Yadkin	(2)	408,146	Granite, limestone, sand and gravel.
Yancey	302,339	(2)	Mica, sand and gravel, olivine, asbestos, feldspar, gem stones.
Undistributed[3]	33,455,261	35,378,256	
Total	40,789,000	44,968,000	

[1] Graham, Scotland, Tyrrell and Warren Counties are not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes value of feldspar and mica that cannot be assigned to specific counties and values indicated by footnote 2.

Ashe.—Ashe County ranked second in value of mineral production. Appalachian Sulphides, Inc. (Ore Knob mine), recovered copper gold, and silver. B C H & W Mining Co. (Duncan mine) and Joe L. Snyder (Brown mine) mined mica. The State highway commission mined 50,000 tons of paving gravel.

Avery.—Mica was produced at 26 mines. The leading producers of sheet mica were Joe L. Snyder (Charlie Ridge and other mines), Dewey Watson (Abe Beam mine), J. E. Wilson (Ground Hog and other mines). The only producer of scrap mica was Harris Clay Co. (Kaolin and Gusher Knob mines.) Harris Clay Co. (Gusher Knob and Kaolin mines) mined kaolin for whiteware, floor and wall title, electrical porcelain, abrasives, plastics, and other uses.

Cranberry Magnetite Corp. continued development work and mined a small quantity of magnetite at the Cranberry mine. McCrary Construction Service and the State highway commission mined paving gravel.

Beaufort.—J. D. McCotter, Inc., and the State highway commission mined structural and paving sand.

Bertie.—The State highway commission mined 1,600 tons of paving sand.

Bladen.—The State highway commission mined 3,500 tons of granite and 109,000 tons of sand for concrete and roads.

Brunswick.—The State highway commission mined 15,000 tons of paving sand.

Buncombe.—Six operators mined structural, paving, and railroad ballast sand and gravel. The leading producers were Grove Stone & Sand Branch of B. V. Hedrick Gravel & Sand Co. (Grove mine) and McCrary Construction Service (Barnardsville and Swannanoa mines). Asheville Construction Co. and the State highway commission (Weaverville quarry) crushed granite for concrete and roads.

Burke.—McCrary Construction Service (Lake James mine), A. P. Causby Sand & Stone Co., and the State highway commission mined paving sand and gravel. Stokes Buchanan mined a small quantity of mica at the Emma mine. Herby Bolick collected a small quantity of gem stones (zeolites). Great Lakes Carbon Corp. manufactured carbon and graphite products at its plant in Morganton.

Cabarrus.—Lee White Gravel Pit and the State highway commission crushed 99,000 tons of granite for concrete and roads.

Caldwell.—Miller Bros. Co. and the State highway commission mined 124,000 tons of sand and gravel for structural and paving uses.

Camden.—The State highway commission mined 3,000 tons of paving sand.

Carteret.—The State highway commission mined 3,000 tons of paving sand.

Caswell.—W. E. Graham & Sons, a division of Vulcan Materials Co. (Danville quarry), and the State highway commission (Ivy Bluff quarry) crushed granite for concrete and roads. The State highway commission mined 42,000 tons of paving sand.

Catawba.—Superior Stone Co. (Hickory quarry) crushed granite for concrete and roads. Statesville Brick Co. mined miscellaneous clay for heavy clay products. The State highway commission mined 53,000 tons of paving sand.

Chatham.—Pomona Terra Cotta Co., Boren Clay Products Co. (Gulf mine), Chatham Brick and Tile Co. Inc., and Cherokee Brick Co. (Brickhaven mine) mined miscellaneous clay for heavy clay products. The State highway commission (Goldston quarry) crushed 71,000 tons of traprock for concrete and roads.

Cherokee.—Columbia Marble Co. (Pleasant Valley quarry) quarried dimension marble; rough block, sawed and cut interior stone; cut, dressed monumental stone; and crushed marble for terrazzo and other uses. Hitchcock Corp. (Nancy Jordan mine) and Minerals & Metals Corp. (Mulberry Gap mine) mined talc for ceramics, crayons, textiles, toilet preparations, and other uses. J. L. Colville Construction Co. and the State highway commission (Dockery quarry) crushed

granite for concrete and roads. Harley Hines collected a small quantity of mineral specimens (talc).

Chowan.—The State highway commission mined 2,800 tons of paving sand.

Clay.—Nantahala Talc & Limestone Co. mined 36,000 tons of paving gravel.

Cleveland.—Cleveland County ranked fifth in value of mineral production. Superior Stone Co. (Kings Mountain quarry) crushed limestone for concrete and roads. Ten mica mines were operated in 1960. The leading producer of sheet mica was Joe L. Snyder (Workman and Huskins mines). Kings Mountain Mica Co. Inc. (Patterson and Moss mines), Industrial Mica, Inc., and Foote Mineral Co. (Kings Mountain mine) produced scrap mica.

Foote Mineral Co. mined and processed lithium minerals at Kings Mountain and also produced a small quantity of crude feldspar. Lithium Corp. of America processed lithium minerals. Shelby Sand & Stone Co. and the State highway commission mined structural and paving sand.

Columbus.—The State highway commission mined 82,000 tons of sand and 4,700 tons of granite for concrete and roads.

Craven.—Superior Stone Co. (New Bern quarry) crushed limestone for concrete and roads. Southern Sand Co., Inc., and the State highway commission mined structural and paving sand.

Cumberland.—Becker County Sand & Gravel Co. (Fayetteville mine) and the State highway commission mined sand and gravel for structural, paving, and railroad ballast uses. Ideal Brick Co. (Linden mine) mined 54,000 tons of miscellaneous clay for heavy clay products. The State highway commission crushed 2,900 tons of granite for concrete and roads.

Currituck.—The State highway commission mined 18,000 tons of paving sand.

Dare.—The State highway commission mined 78,000 tons of paving sand.

Davidson.—Jacob's Creek Flagstone Co., Inc. (Flagstone quarry) quarried dimension slate for structural millstock and flagging. Cunningham Brick Co. (Thomasville mine) mined miscellaneous clay for heavy clay products. The State highway commission mined 195,000 tons of paving sand and gravel.

Davie.—The State highway commission mined 95,000 tons of paving sand. Ruth P. Stanley collected a small quantity of gem stones (almandite garnets).

Duplin.—James W. Kelley and the State highway commission mined 8,100 tons of structural, paving, and fill sand.

Durham.—Nello L. Teer Co. crushed traprock for concrete and roads. Borden Brick & Tile Co. and Tri-Angle Brick Co. mined miscellaneous clay for heavy clay products.

Edgecombe.—O. H. Woolard Sand & Gravel Co., Tar River Sand & Gravel Co., and the State highway commission mined structural, paving, and fill sand and gravel.

Forsyth.—W. E. Graham & Sons crushed granite for concrete and roads at the South Fork, No. 421, Piedmont, and North quarries. Paul Miller and the State highway commission mined 108,000 tons of structural and paving sand.

Franklin.—The State highway commission mined 4,000 tons of paving sand.

Gaston.—Superior Stone Co. crushed granite for concrete and roads. Kendrick Brick & Tile Co. (Mount Holly mine) mined miscellaneous clay for heavy clay products. Millard Townsend (Huskins mine) mined a small quantity of sheet mica. The State highway commission mined 32,000 tons of paving sand.

Gates.—The State highway commission mined 5,500 tons of paving sand.

Granville.—The State highway commission mined 10,000 tons of paving sand. Blue Ridge Minerals collected a small quantity of gem stones (agate-chalcedony and jasper).

Greene.—The State highway commission mined 52,000 tons of paving sand.

Guilford.—Guilford County ranked third in value of mineral production. Superior Stone Co. (Pomona, Jamestown, Buchanan, and McLeansville quarries) and W. E. Graham & Sons (Stokesville quarry) crushed granite for concrete and roads. Boren Clay Products Co. (Pleasant Garden mine) mined miscellaneous clay for heavy clay products. The State highway commission mined paving sand. Zonolite Co. exfoliated vermiculite at the High Point plant.

Halifax.—Nash Brick Co. (Ita mine) mined miscellaneous clay for heavy clay products. The State highway commission mined paving sand.

Harnett.—Becker County Sand & Gravel Co. (Senter mine), Nello L. Teer Co., and the State highway commission mined structural, paving, and miscellaneous sand and gravel. Norwood Brick Co. (Lillington mine) mined miscellaneous clay for heavy clay products. The State highway commission crushed granite for concrete and roads.

Haywood.—Sale & Alexander (Waynesville mine) mined structural and paving sand and gravel. Fred O. Scruggs collected a small quantity of gem stones (corundum sapphire).

Henderson.—Cogdill Limestone Co., Inc. (Cogdill quarry), and Fletcher Limestone Co. (Fletcher quarry) crushed limestone for concrete, roads, and other uses. J. L. Colville Construction Co. crushed granite for concrete and roads. Fletcher Brick Co., Inc. (Fletcher mine) mined miscellaneous clay for heavy clay products.

Hertford.—The State highway commission mined 22,000 tons of paving sand.

Hoke.—Pleasants Sand & Supply Co. (Ashley Heights mine), Cumberland Gravel & Sand Co. (Vass mine), and the State highway commission mined sand and gravel for structural and paving purposes.

Hyde.—The State highway commission mined 1,500 tons of paving sand.

Iredell.—Superior Stone Co. (Statesville quarry) crushed granite for concrete and roads. Tarheel Construction Co. and the State highway commission mined paving sand. Ruth P. Stanley and Harley Hines collected a small quantity of gem stones (zircon, pink star sapphire, actinolite in talc, and limonite).

Jackson.—Six mines produced mica. The leading producers of sheet mica were Roy H. Fouts (Henry and Long Branch mines) and B & H Mining Co. (Stovall mine). The only producer of scrap mica was Roy H. Fouts (Henry mine). Harbison-Walker Refractories Co. (Addie mine) mined olivine for refractories. Rock Products, Inc.,

and J. L. Colville Construction Co. crushed granite for concrete and roads.

Johnston.—Nello L. Teer Co. (Princeton quarry) crushed traprock for concrete and roads. The State highway commission mined 34,000 tons of paving sand.

Jones.—Simmons Marl & Lime Co. and the State highway commission mined paving and fill sand and gravel.

Lee.—Sanford Brick & Tile Co. (Colon mine), Borden Brick & Tile Co. (Sanford mine), Lee Brick & Tile Co., and Hanford Brick Co. mined miscellaneous clay for heavy clay products. The State highway commission mined 58,000 tons of paving sand.

Lenoir.—Barrus Construction Co. (Kinston mine) and the State highway commission mined sand and gravel for structural, paving, and fill purposes.

Lincoln.—Duke Power Co. crushed granite for concrete, roads, and stone sand. Edward McNeil (J. C. Willis mine) and Joe L. Snyder (Caggle mine) mined a small quantity of sheet mica. The State highway commision mined 27,000 tons of paving sand. Green's Mineral & Gift Shop collected a small quantity of gem stones (amethyst).

Macon.—Seventeen mines produced mica. The leading producers were Roy H. Fouts (Almond Cove mine), Jamaco Minerals Development Corp. (Lyle Knob mine), and Jess Gentry (Rock Cut and Iotla-Bowers mines). The leading producer of scrap mica was A & C Mining Co. (Sheppard Knob mine).

J. L. Colville Construction Co. crushed granite for concrete and roads. Hays Block Co. (Franklin mine) mined structural sand. R. A. Campbell, Harley Hines, and Andrew W. Reed collected small quantities of gem stones (corundum and rhodolite garnet).

Madison.—The State highway commission mined 2,000 tons of paving sand.

Martin.—The State highway commission mined 3,700 tons of paving sand.

McDowell.—Becker County Sand & Gravel Co. (Marion mine) and McCrary Construction Service (Woodlawn mine) mined sand and gravel for structural, paving, and railroad ballast uses. The State highway commission (Woodlawn quarry) crushed limestone for concrete and roads.

Mecklenburg.—Superior Stone Co. (Charlotte and Pineville quarries) crushed granite for concrete and roads.

Mitchell.—Mitchell County ranked first in value of mineral production. Eleven mines produced crude feldspar. The leading producers were International Minerals & Chemical Corp. (Hawkins and Kona mines), The Feldspar Corp. (Wiseman, Poteat, and Sullins mines), and Lawson-United Feldspar & Minerals Co. (Minpro mine). Forty-seven mines produced mica: 35 produced sheet only (full-trimmed and/or hand-cobbed), 6 scrap only, and 6 both sheet and scrap. The leading producers of sheet mica were McBee Mining Co. (McBee mine), Sink Hole Miners (Sink Hole mine), and Abernathy Mining Co. (Abernathy and Abernathy No. 2 mines). The leading producers of scrap mica were The Feldspar Corp. (Poteat and Wiseman mines), International Minerals & Chemical Corp. (Kona, Bartlette, and Jeff Buchanan mines), and De-Weld Mica Co. (Sparks Strip mine).

International Minerals & Chemical Corp., The Feldspar Corp., and Lawson-United Feldspar & Minerals Co. recovered crushed sandstone (quartz) from feldspar milling. Blue Ridge Minerals, Herby Bolick, Ruth P. Stanley, Roby Buchanan, and Harley Hines collected small quantities of gem stones (hyalite on matrix, actinolite in talc, massive rhodonite, almandite garnet, fluorescent calcite, and beryl).

Montgomery.—Mt. Gilead Brick Co. mined miscellaneous clay for heavy clay products. Jacob's Creek Flagstone Co. (Edenboro quarry) quarried dimension slate for structural millstock and flagging. T & H Clay Co. Inc. (Auman mine) mined pyrophyllite for ceramics. The State highway commission mined 75,000 tons of paving sand.

Moore.—Standard Mineral Co., Inc. and Carolina Pyrophyllite Co., Inc., mined pyrophyllite for ceramics, insecticides, paint, rubber, plaster, refractories, and other uses. Pleasants Sand & Supply Co., Monroe Sand Pit, Aberdeen Sand & Gravel Co., and the State highway commission mined structural, paving, and fill sand. T & H Clay Co. (Hancock mine) mined miscellaneous clay for heavy clay products. Harley Hines collected a small quantity of gem stones (pyrite in pyrophyllite).

New Hanover.—W. E. Graham & Sons crushed limestone for concrete and roads. Robbins Sand Pit and the State highway commission mined paving and fertilizer filler sand.

Northampton.—Superior Stone Co. (Garysburg mine) and the State highway commission mined structural and paving sand and gravel.

Onslow.—Superior Stone Co. (Belgrade quarry) crushed limestone for concrete and roads. The State highway commission mined 6,000 tons of paving sand.

Orange.—Piedmont Minerals Co., Inc. (Hillsboro mine), mined pyrophyllite for asphalt filler, ceramics, and refractories. Duke University, (Hillsboro quarry) quarried dimension granite for rough construction use. The State high commission (Bacon quarry) crushed granite for concrete and roads.

Pamlico.—The State highway commission mined 4,000 tons of paving sand.

Pasquotank.—The State highway commission mined 15,000 tons of paving sand.

Pender.—The State highway commission mined 6,000 tons of paving sand.

Perquimans.—The State highway commission mined 17,500 tons of paving sand.

Person.—The State highway commission mined 5,000 tons of paving sand.

Pitt.—Concrete Products Co., White Concrete Co. (Munford mine), and the State highway commission mined structural, paving, and fill sand and gravel.

Randolph.—The State highway commission (Glenola and Parks Cross Roads quarries) crushed granite for concrete and roads. Superior Stone Co. crushed traprock for concrete and roads. Carolina Pyrophyllite Co. (Gerhardt mine) mined pyrophyllite for ceramic and insecticide uses. Herby Bolick and Harley Hines collected a small quantity of mineral specimens (pyrophyllite).

Richmond.—The State highway commission (McLeod mine) mined 25,000 tons of paving sand and gravel.

Robeson.—The State highway commission mined 4,000 tons of granite and 161,000 tons of sand for concrete and roads.

Rockingham.—Superior Stone Co. (Reidsville quarry) crushed granite for concrete and roads. Webster Brick Co., Inc. (Draper mine), mined miscellaneous clay for heavy clay products. Garland W. & Morris Hall (Kings quarry) crushed traprock for concrete and roads. The State highway commission mined paving sand.

Rowan.—Seven quarries produced dimension granite for use as rubble, rough and dressed construction stone, rough and dressed architectural stone, rough monumental stone, paving blocks, and curbing and flagging. The leading producer was Harris Granite Quarries Co. (Collins, Balfour, and Shuping quarries). Superior Stone Co. (Woodleaf quarry) crushed granite for concrete and roads. Gardner Granite Works produced millstones.

Carolina Tufflite Co. and Isenhour Brick & Tile Co. (East Spencer mine) mined miscellaneous clay for lightweight aggregate and heavy clay products. The State highway commission mined paving sand. Carolina Perlite Co., Inc., expanded perlite at the Gold Hill plant.

Rutherford.—A. R. Thompson, contractor, and the State highway commission mined sand and gravel for paving and other uses. Green's Mineral and Gift Shop collected a small quantity of gem stones (fuchsite).

Sampson.—Crumpler Brick Co., Inc., Sampson Brick Co., Inc., and Patterson Brick Co. mined miscellaneous clay for heavy clay products. The State highway commission mined 10,000 tons of paving sand.

Stanly.—Southern Lightweight Aggregate Corp. (Aquadale mine), Stanly Shale Products, Inc. (Norwood mine), and Yadkin Brick Yards, Inc., mined miscellaneous clay for lightweight aggregates and heavy clay products. The State highway commission crushed traprock for concrete and roads at the McManus quarry. Carolina Aluminum Co. produced aluminum metal at Badin.

Stokes.—Pine Hall Brick & Pipe Co. (No. 1 mine) mined miscellaneous clay for heavy clay products. Snow Hill Mining Co. (Spencer mine), J. E. Wilson (Hawkins and Steel mines), and Preacher Mining Co. (Old Shelton mine) mined sheet mica. The State highway commission mined 140,000 tons of paving sand.

Surry.—North Carolina Granite Corp. (Mount Airy quarry) quarried dimension granite for rubble, rough and dressed construction stone, rough and dressed architectural stone, rough and dressed monumental stone, curbing, flagging, and paving blocks. North Carolina Granite Corp. (Mount Airy quarry) and W. E. Graham & Sons (Mt. Airy and Elkins quarries) produced granite for riprap, poultry grit, concrete, and roadstone. Ararat Products Co. crushed traprock for concrete and roads. The State highway commission mined paving sand. Ruth P. Stanley collected a small quantity of gem stones (Carnellian and oriental sapphire).

Swain.—Nantahala Talc & Limestone Co. (Hewitt quarry) crushed limestone for concrete, roadstone, and agstone. The Feldspar Corp. (Alexander and McCracken mines) mined crude feldspar. J. L. Colville Construction Co. crushed granite for concrete and roads.

Transylvania.—Macon Construction Co., Inc. (Penrose quarry), crushed granite for concrete and roads. Powhatan Mining Co. (Kilpatrick mine) mined asbestos. Siniard Brothers and Coleman Scott mined structural sand. Jeter C. Kitchen (Toxaway mine) mined

a small quantity of sheet mica. E. I. du Pont de Nemours & Co., Inc., produced high-purity silicon at Brevard.

Union.—Kendrick Brick & Tile Co. (Monroe mine) mined miscellaneous clay for heavy clay products. Superior Stone Co. (Bakers quarry) and the State Highway commission (Monroe quarry) crushed traprock for concrete and roads. The State highway commission mined paving sand.

Vance.—Vance County ranked fourth in value of mineral production. Tungsten Mining Corp. mined tungsten ore at the Hamme mine and recovered gold, silver, copper, and lead from mill tailings accumulated in previous years. W. E. Graham & Sons crushed granite for concrete, roadstone, and railroad ballast at the Greystone quarry. The State highway commission mined paving sand.

Wake.—Superior Stone Co. (Crabtree and Rolesville quarries) and Nello L. Teer Co. (Raleigh quarry) crushed granite for concrete, roadstone, and railroad ballast. The State highway commission mined paving sand.

Washington.—The State highway commission mined 11,000 tons of paving sand.

Watauga.—Maymead Lime Co., Inc., and the State highway commission mined paving gravel. Jesse Miller collected various types of gem stones.

Wayne.—Nello L. Teer Co. and the State highway commission mined structural and paving sand. Harley Hines collected a small quantity of gem stones (petrified wood).

Wilkes.—W. E. Graham & Sons crushed granite for concrete and roads. Joe L. Snyder (Higgins mine) mined a small quantity of sheet mica. The State highway commission mined paving sand. Blue Ridge Minerals collected a small quantity of gem stones (jasper agate).

Wilson.—Superior Stone Co. (Neverson and Elm City quarries) crushed granite for concrete and roads. Five mines produced structural, paving, and fill sand. The leading producers were Gray Concrete Pipe Co., Inc., and the State highway commission.

Yadkin.—W. E. Graham & Sons crushed granite for concrete and roads at the Cycle quarry. E. R. Short & Sons crushed limestone for concrete and roads. The State highway commission mined paving sand.

Yancey.—Twenty-four mines produced mica; 21 produced sheet only (full-trimmed and/or hand-cobbed), 3 scrap only. The leading producers of sheet mica were Gouge & Allan (Barber mine) and Ledford & Baker (Green Mountain mine). The leading producer of scrap mica was Deneen Mica Co. (Young Mica mine).

The Feldspar Corp. (Webb Strip mine) and Yates Laws (Anglin mine) mined crude feldspar. C. R. Wiseman mined olivine at the Wray mine. Powhatan Mining Co. mined asbestos at the Blue Rock mine. McCrary Construction Service and Yancey Sand & Gravel Co. (Fox mine) mined paving sand and gravel. Floyd Wilson and Robert A. Campbell collected various types of gem stones.

The Mineral Industry of North Dakota

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of North Dakota.

By D. H. Mullen [1]

NORTH DAKOTA'S 1960 mineral production was valued at $78.3 million, a gain of 16 percent over 1959. The mineral fuels—coal (lignite), natural gas, natural gas liquids, and crude petroleum—represented 91 percent of the total value of all mineral production in the State and as a group, rose 17 percent in value over the preceding year. Production gains were recorded for all of the mineral fuels. Of particular interest was the second annual increase in the output of lignite, following the steady decline that had begun in 1956.

Although exploratory and development drilling was at a lower rate than in 1959, the number of exploratory wells completed was only two less. Six new fields and a new producing horizon were discovered. Wider well spacing (160 and 320 acres) resulted in fewer development wells completed, but development of the fields was accelerated and greater production was achieved with fewer wells.

TABLE 1.—Mineral production in North Dakota [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	61	$79	102	$129
Coal (lignite) do	2,413	5,426	2,525	5,790
Gem stones	(3)	1	(3)	1
Natural gas million cubic feet	17,915	1,774	19,483	2,221
Petroleum (crude) thousand 42-gallon barrels	17,824	49,907	[4] 21,954	[4] 59,495
Sand and gravel thousand short tons	9,883	6,516	8,648	6,904
Stone do	48	84	28	44
Value of items that cannot be disclosed: Clays (bentonite and fire clay, 1960), natural gas liquids, and salt (1960)	----------	3,555	----------	3,691
Total North Dakota	----------	[5] 67,342	----------	78,275

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite and fire clay (1960); included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Preliminary figure.
[5] Revised figure.

[1] Commodity-industry analyst, Bureau of Mines, Denver, Colo.

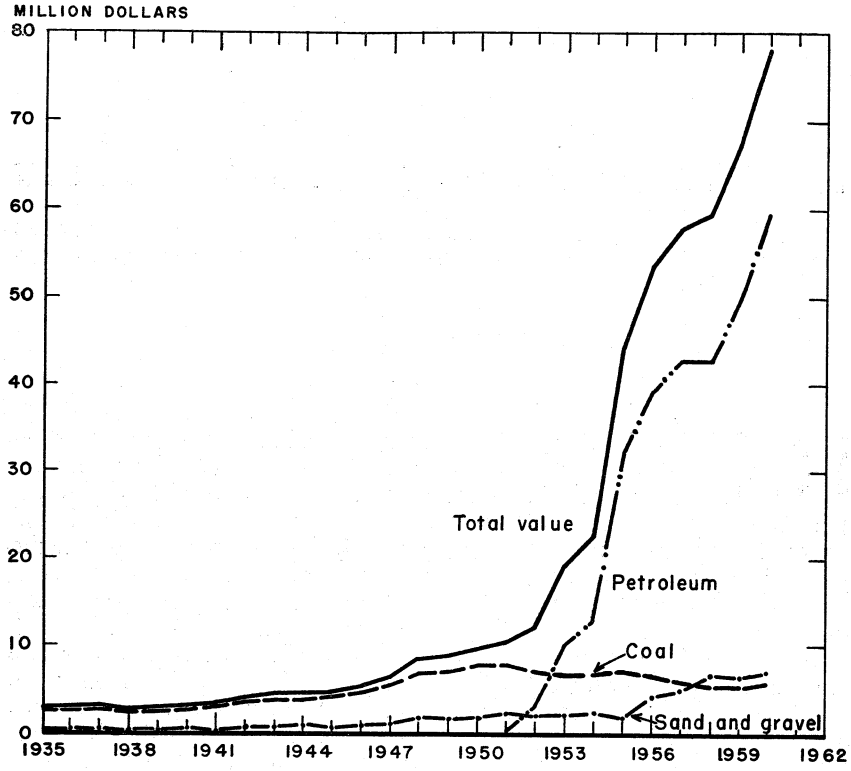

FIGURE 1—Value of sand and gravel, petroleum, and coal, and total value of mineral production in North Dakota, 1935–60.

Gains were recorded in the production and value of all of the nonmetal commodities except sand and gravel and stone. A significant development was the beginning of salt production by hydraulic mining from wells in Williams County, a mining activity that will create storage facilities for liquid-petroleum gases.

Employment and Injuries.—Employment and injuries data in the mineral industry, excluding petroleum, collected during the Bureau of Mines annual canvass, are shown on table 2.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Lignite).—Coal production from 32 mines (31 strip, 1 underground) continued to increase, gaining 5 percent in quantity and 7 percent in value over 1959.

North Dakota Nitrogen, Inc., abandoned plans to produce nitrogen fertilizer from the lignite stored at the Garrison Dam or from natural gas. The Otter Tail Power Co. new 53.5-megawatt Hoot Lake steam-generating plant at Fergus Falls, Minn., was the largest in the United States using North Dakota lignite as fuel. Although pul-

verizing and handling equipment and boiler-furnace volume had to be larger than would be required for bituminous coal, the use of lignite resulted in a substantially lower unit-production cost. A group of five utility companies commissioned consultants to survey the power-supply needs in the general North Dakota area and to investigate the sources and availability of lignite. Midwest Electric Consumers Association discussed plans to form a giant cooperative that would include constructing five lignite-fuel, 200-megawatt steam-generating plants in North and South Dakota. The plan included using Bureau of Reclamation transmission lines and constructing a 345-kilovolt transmission line from Garrison to Watertown, S. Dak. The power generated would be marketed in parts of Montana, North and South Dakota, Minnesota, and Iowa. Generators Nos. 4 and 5 completed at the Garrison Dam brought capacity to the designed total of 400 megawatts.

TABLE 2.—Employment and injuries in the mineral industries[1] in 1960[2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
Coal mines	40	370	576,189	1	18	33.0
Nonmetal mines	6	81	105,016	----------	3	28.6
Quarries	5	5	7,888	----------	----------	----------
Sand and gravel plants	147	892	1,035,742	2	11	12.6
Total	198	1,348	1,724,835	3	32	20.3

[1] Excludes petroleum industry.
[2] Preliminary figures.

TABLE 3.—Coal (lignite) production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1959		1960	
	Short tons	Average value per ton[1]	Short tons	Average value per ton[1]
Adams	20,310	$3.53	11,787	$3.80
Bowman	157,609	1.77	147,279	1.74
Burke	399,297	2.33	406,600	2.27
Burleigh	14,382	3.31	14,132	3.33
Divide	207,370	2.88	227,720	2.57
Dunn	6,135	2.91	5,793	3.00
Grant	24,305	3.23	21,181	3.03
Hettinger	6,811	3.39	5,000	3.30
McLean	91,560	3.24	76,099	3.33
Mercer	925,057	1.95	1,019,039	2.18
Morton	24,066	2.50	21,844	2.59
Oliver	10,748	2.46	8,748	2.25
Stark	62,953	1.81	75,224	1.95
Ward	458,764	2.33	482,106	2.33
Williams	3,251	4.72	2,403	4.71
Total	2,412,618	2.25	2,524,955	2.29

[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.)

Investigation into the gasification and use of lignites was continued by the Federal Bureau of Mines at the Charles R. Robertson Lignite Research Laboratory at Grand Forks. A research team at the laboratory perfected a device to produce synthesis gas that would be useful in manufacturing chemicals. A report [2] describing results of some of the research activities was published.

Natural Gas.—Dry natural gas from 28 wells in 2 fields in Bowman County and residual gas from the Tioga gasoline plant in Williams County were marketed through pipelines of the Montana-Dakota Utilities Co. to consumers in North and South Dakota, Montana, and Wyoming. Production of dry natural gas from Bowman County was 21 percent above that of 1959, and the quantity of residual gas marketed through pipelines increased 16 percent. According to State geologist reports,[3] total production of oil-well gas was 26.8 billion cubic feet, and that of dry natural gas was 396.3 million cubic feet.

Natural Gas Liquids.—Natural gasoline, butane, propane, and sulfur were recovered from oil-well gas at the Tioga gasoline plant operated by Signal Oil and Gas Co. in Williams County. Production statistics [4] compiled by the State Geological Survey showed that 17.6 billion cubic feet of gas was processed, and 21 thousand barrels of crude oil, 12.0 million gallons of natural gasoline, 21.1 million gallons of butane, 35.9 million gallons of propane, and 18,000 long tons of sulfur were recovered. Residual gas marketed through pipelines of the Montana-Dakota Utilities Co. totaled 9.3 billion cubic feet.

Petroleum.—Petroleum production from 1,592 wells in 77 fields in 12 counties was 23 percent above that of 1959. A total of 282 exploratory and development wells was completed, compared with 436 in 1959. Exploratory drilling proceeded at about the same rate as in 1959; only two less exploratory wells were completed. The decline was entirely in development drilling. The establishment of 160- and 320-acre spacing in some fields resulted in more rapid development of the pools, with fewer wells; 201 development wells were completed, compared with 352 in 1959. Two counties were added to those producing oil, Dunn County from the Lost Bridge field discovered late in 1959 and McHenry County from the Pratt field discovered in 1960. The State geologist [5] reported that 62 exploratory wells were completed, 7 of which were successful; 12 outpost wells completed, 5 successful; 32 extension, 23 successful; and 158 development, 122 successful. The total drilled was 1.7 million feet, compared with 2.7 million feet in 1959. The success ratio for exploratory drilling was 11.3 percent, and the overall success ratio was 59.5 percent. In addition to the discovery in McHenry County, new fields were discovered in Billings, Bottineau, Bowman, Burke, McKenzie, and Renville Counties.

---

[2] Fowkes, Walter W., and Hoeppner, Jerome J., Sulfur in Lignite: Form and Transformations on Thermal Treatment: Bureau of Mines Rept. of Investigations 5626, 1960, 15 pp.

[3] Laird, Wilson M., Oil in North Dakota, First Half 1960: North Dakota Geol. Survey Bull., January 1961, 111 pp.
Laird, Wilson M., Oil in North Dakota, Second Half 1960: North Dakota Geol. Survey Bull., April 1961, 109 pp.

[4] Work cited in footnote 3.

[5] Work cited in footnote 3.

TABLE 4.—Crude petroleum production, by counties [1]

(Thousand barrels)

County	1959	1960 [2]	Principal fields in 1960 in order of production
Billings	366	477	Rocky Ridge, Fryburg, Scoria.
Bottineau	1,965	2,184	Newburg, Wiley, South Westhope, North Westhope, North Haas.
Bowman	12	53	Cedar Creek, Little Missouri.
Burke	2,934	3,982	Rival, North Tioga, Lignite, Portal, Flaxton.
Divide	287	469	North Tioga, Baukol-Noonan, Noonan.
Dunn	----------	40	Lost Bridge.
McHenry	----------	8	Pratt.
McKenzie	5,031	6,097	Blue Buttes, Antelope, Charlson.
Mountrail	1,479	1,557	Tioga, White Earth, East Tioga.
Renville	199	900	Glenburn, Sherwood, Eden Valley.
Stark	6	8	Dickinson.
Williams	5,545	6,179	Beaver Lodge, Tioga, Capa.
Total	17,824	21,954	

[1] Based on North Dakota Geological Survey county data adjusted to Bureau of Mines total.
[2] Preliminary figures.

TABLE 5.—Wildcat- and development-well completions in 1960, by counties

County	Crude	Condensate	Dry	Total	Footage
Wildcat:					
Billings	1	----------	1	2	20,200
Bottineau	1	----------	13	14	56,000
Bowman	1	----------	----------	1	8,400
Burke	1	----------	12	13	90,100
Cavalier	----------	----------	1	1	1,700
Divide	----------	----------	8	8	59,300
Dunn	----------	----------	4	4	48,500
McHenry	1	----------	9	10	37,400
McKenzie	2	----------	5	7	81,900
Mountrail	----------	----------	2	2	19,100
Pierce	----------	----------	2	2	6,200
Ramsey	----------	----------	1	1	2,000
Renville	2	----------	11	13	59,000
Rolette	----------	----------	2	2	5,600
Stark	----------	----------	1	1	9,100
Walsh	----------	----------	1	1	2,500
Total	9	----------	73	82	507,000
Development:					
Billings	2	----------	1	3	29,000
Bottineau	35	----------	15	50	193,200
Bowman	2	----------	----------	2	16,800
Burke	42	----------	16	58	377,700
Divide	7	----------	----------	7	54,500
McHenry	----------	----------	1	1	4,400
McKenzie	34	----------	[1] 8	[1] 42	390,500
Renville	20	----------	7	27	113,800
Williams	8	1	2	11	119,900
Total	150	1	[1] 50	[1] 201	1,299,800
Total all drilling	159	1	[1] 123	[1] 283	1,806,800

[1] Includes 1 service-well completion.

Source: Oil and Gas Journal.

NONMETALS

Clays.—Miscellaneous clay for manufacturing building brick, drain-tile, other heavy clay products, and lightweight aggregate was produced in Adams, Divide, and Morton Counties. Fire clay produced in Stark County was used for manufacturing heavy clay products.

A small quantity of bentonite in Morton County—67 percent greater than in 1959—was produced for manufacturing mortar.

Gem Stones.—Gem stones and gem material (agate, agatized wood, chalcedony, jasper, and quartzite) were collected by individuals, mostly in Billings, Morton, and Stark Counties.

Salt.—Salt mining and processing began in North Dakota in June, with opening of the $2 million plant of Dakota Salt & Chemical Co. near Williston in Williams County. Salt was recovered by hydraulic mining from beds 230 feet thick at a depth of 8,000 feet. The brine pumped from the wells was processed in vacuum pans.

Sand and Gravel.—Sand and gravel production, from 49 of the State's 53 counties, was 13 percent below that of 1959. Production was reported by 35 commercial operators in 20 counties and at 80 Government-contractor operations in 46 counties. State and county crews produced sand and gravel in 24 counties; contractors furnished the remainder of the noncommercial production.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	310	$376	341	$395
Paving	202	192	34	48
Fill	96	67	9	8
Other	2	1	1	(1)
Total sand	610	636	385	451
Construction gravel:				
Building	514	834	390	706
Paving	3,291	2,132	2,171	1,224
Railroad ballast	190	85	180	58
Fill	44	21	106	42
Other	11	18	28	13
Miscellaneous gravel			31	24
Total gravel	4,050	3,090	2,906	2,067
Total sand and gravel	4,660	3,726	3,291	2,518
Government-and-contractor operations:				
Sand:				
Building			7	9
Paving	138	70	420	243
Total sand	138	70	427	252
Gravel:				
Building	44	27	47	64
Paving	5,041	2,693	4,883	4,070
Total gravel	5,085	2,720	4,930	4,134
Total sand and gravel	5,223	2,790	5,357	4,386
All operations:				
Sand	748	706	812	703
Gravel	9,135	5,810	7,836	6,201
Grand total	9,883	6,516	8,648	6,904

[1] Less than $1,000.

Commercial firms supplied 38 percent of the total production of sand and gravel, which was used for building, paving, railroad ballast, fill, and other purposes. Noncommercial production was used entirely for road construction. Major production came from Stutsman (748,800 tons), Ward (492,500 tons), Walsh (391,300 tons), McKenzie (324,300 tons), Barnes (315,500 tons), and Cavalier (314,000 tons) Counties.

Construction of the National System of Interstate and Defense Highways continued. Because the Bureau of Public Roads changed its method of reporting progress in 1960, no comparable data exist for 1959; however, a report [6] showed that from July 1, 1956, to December 31, 1960, 137.7 miles of the Interstate System had been completed to full standards; 59.3 miles had been improved to standards adequate for current traffic; 31.3 miles were under construction; and engineering and right-of-way acquisition had started on 19.5 miles. Total designated mileage of the system in North Dakota was 567.9 miles, leaving 320.1 miles to be planned and built. Under the Federal-aid program for primary, secondary, and urban highways, 1,684.1 miles were completed in 1960; and at yearend 610.5 miles were under construction.

Stone.—Crushed stone, produced by contractors for the State highway department for road construction, was 42 percent below that of 1959.

Sulfur.—Shipments of sulfur recovered from natural gas at the Tioga gasoline plant in Williams County totaled 20,339 long tons, a 45-percent increase over 1959. The value of sulfur recovered from processing plants was not included in the State totals of mineral production because the plant sources could not be determined.

Vermiculite.—Crude vermiculite from deposits in Montana was exfoliated at a plant in Ward County for use as insulation, lightweight aggregate, and soil conditioner.

METALS

Uranium.—The Atomic Energy Commission (AEC) approved for execution a contract with the International Resources Corp. of Casper, Wyo., for the purchase of uranium concentrate derived from uraniferous lignites, subject to two conditions: (1) that the city of Bowman, site of the proposed plant, make available adequate financing for constructing the plant (estimated to cost from $2 to $3 million); and (2) that Susquehanna Western, Inc., of Edgemont, S. Dak., enter into an agreement to manage and operate the plant and to supply working capital. Initial daily capacity of the plant was to be 200 tons of crude lignite. At yearend the conditions set forth had not been met fully.

REVIEW BY COUNTIES

Billings.—Petroleum production from 28 wells in 4 fields increased 30 percent compared with 1959. The major gain was from the Heath

[6] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960, press release BPR 61–6, Feb. 22, 1961.

formation in the Rocky Ridge and Fryburg fields. Production from the Madison limestone increased only slightly in the Fryburg field and declined in the Scoria field. The Black Tail field was discovered in August when the No. 1 Haag well was completed at a depth of 10,259 feet. Initial production was 70 barrels of petroleum per day on pump from the Fryburg formation at a depth of 9,915 to 9,925 feet.

Bottineau.—Production of petroleum from 225 wells in 17 fields was 11 percent greater than in 1959, and the county ranked fourth in output. Principal producing fields were the Newburg, from the Spearfish-Charles formation; Wiley, from the Madison limestone; and the South Westhope, from the Spearfish-Charles formation. Development was extensive at the Wiley field where 17 new wells were completed and at the South Westhope where 7 producers were drilled. Four successful development wells were completed at the Newburg field, the major producing field in the county. Great Northern Railway Co. began constructing a 110-mile crude-oil pipeline, the first segment of the lines to be between the Newburg field and Minot. Other segments were to serve fields in adjacent counties. From Minot the oil was to be shipped by rail to markets in the Minneapolis-St. Paul and Duluth-Superior areas.

Bowman.—Dry natural gas, from 28 wells, in the Eagle sandstone of the Cedar Creek and Little Missouri fields, was marketed through pipelines of the Montana-Dakota Utilities Co. Output was 20 percent more than in 1959.

Petroleum was produced from the Red River formation of the Little Missouri field. Two development wells were completed. Two producing horizons were discovered in the Cedar Creek field. The first, completed in February, pumped 41 barrels of petroleum per day from the Red River-Ordovician formation. The second, completed in July, flowed 50 barrels per day from the Madison limestone at a depth of 8,410 feet. These discoveries were at the eastern end of the Cedar Creek field that had produced dry natural gas from the Eagle sandstone for many years.

Coal production from the Peerless strip mine operated by the Knife River Coal Mining Co. was 7 percent below that of 1959. The county ranked fifth in coal production.

Burke.—The county ranked third in the production of coal and petroleum. Coal mined from the Kincaid strip mine, operated by Truax-Traer Coal Co., and the Bonsness, operated by LeRoy Bonsness, was 2 percent greater than in 1959.

Petroleum production came from 236 wells in 18 fields. Production was mostly from the Rival, North Tioga, Lignite, Portal, and Flaxton fields. One new field, the Gros Ventre, was discovered in March. The first production was 40 barrels of petroleum per day on pump from the Midale member of the Madison limestone at a depth of 7,580 to 7,590 feet. The discovery was 8.5 miles east of the North Tioga field. An extension well completed late in the year was a failure. Development continued at the Portal field (11 completions, all successful), Rival (6 completions, 2 failures), North Tioga (6 completions, 4 failures), and Flaxton (6 completions, 1 failure).

TABLE 7.—Value of mineral production in North Dakota, by counties [1]

County	1959	1960 [2]	Minerals produced in 1960 in order of value
Adams	$92,635	$148,791	Sand and gravel, coal, clays.
Barnes	361,700	315,600	Sand and gravel.
Benson	133,400	92,400	Do.
Billings	1,030,100	1,297,900	Petroleum, sand and gravel, gem stones.
Bottineau	5,503,200	5,726,500	Petroleum, sand and gravel.
Bowman [3]	317,713	401,945	Coal, petroleum.
Burke [4]	9,161,892	11,824,220	Petroleum, coal, sand and gravel.
Burleigh	451,743	379,046	Sand and gravel, coal.
Cass	452,700	180,800	Sand and gravel.
Cavalier	166,600	254,881	Sand and gravel, stone.
Dickey	78,700	30,800	Sand and gravel.
Divide	1,501,356	2,003,710	Petroleum, coal, sand and gravel, clays.
Dunn	24,155	174,779	Petroleum, sand and gravel, coal.
Eddy	221,300	(5)	Sand and gravel.
Emmons	158,100	18,700	Do.
Foster	----------	7,200	Do.
Golden Valley	5,000	800	Do.
Grand Forks	179,400	194,155	Sand and gravel, stone.
Grant	83,517	68,141	Coal, sand and gravel.
Griggs	8,000	5,400	Sand and gravel.
Hettinger	30,971	119,000	Sand and gravel, coal.
Kidder	(5)	15,400	Sand and gravel.
LaMoure	8,300	23,800	Do.
Logan	117,500	17,500	Do.
McHenry	104,500	(5)	Sand and gravel, petroleum.
McIntosh	207,200	2,000	Sand and gravel.
McKenzie [4]	14,122,600	16,814,200	Petroleum, sand and gravel.
McLean	437,518	262,277	Coal, sand and gravel.
Mercer	1,837,969	(5)	Do.
Morton	303,374	196,988	Clays, coal, sand and gravel, gem stones.
Mountrail [4]	4,193,500	4,236,100	Petroleum, sand and gravel.
Nelson	30,500	20,500	Sand and gravel.
Oliver	74,817	19,682	Coal.
Pembina	86,900	245,320	Sand and gravel, stone.
Pierce	23,200	37,200	Sand and gravel.
Ramsey	56,200	4,500	Do.
Ransom	23,800	61,900	Do.
Renville	561,100	2,447,000	Petroleum.
Richland	80,400	43,673	Sand and gravel, stone.
Rolette	31,800	39,800	Sand and gravel.
Sargent	71,300	68,100	Do.
Sheridan	30,200	53,100	Do.
Sioux	36,200	101,400	Do.
Stark	[6] 270,088	259,298	Coal, sand and gravel, petroleum, clays, gem stones.
Steele	91,500	98,400	Sand and gravel.
Stutsman	606,900	380,500	Do.
Towner	3,800	900	Do.
Traill	142,500	95,700	Do.
Walsh	119,500	227,700	Do.
Ward	1,436,465	1,644,081	Coal, sand and gravel.
Wells	148,200	64,700	Sand and gravel.
Williams [4]	[6] 15,759,845	17,141,662	Petroleum, sand and gravel, salt, coal.
Undistributed [7]	[6] 6,361,800	10,406,930	
Total	[6] 67,342,000	78,275,000	

[1] Slope County is not listed because no production was reported.
[2] Value of petroleum is preliminary.
[3] Excludes natural gas.
[4] Excludes natural gas, natural gas liquids, and recovered elemental sulfur.
[5] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[6] Revised figure.
[7] Includes natural gas liquids, natural gas, some sand and gravel, stone, gem stones (1960), and values indicated by footnote 5.

Sand and gravel for building and miscellaneous uses (33,500 tons) was produced by Sandberg Sand & Gravel, and sand and gravel for paving (91,500 tons) was produced by contractors for the State highway department and the Burke County Highway Department.

Divide.—Petroleum production from 29 wells in 3 fields was 63 percent greater than in 1959. Gains were recorded for the Baukol-Noonan and North Tioga fields. Six successful development wells

were completed in the North Tioga field. There was no production from the Writing Rock field. Eight exploratory wells, completed in the Baukol-Noonan and Writing Rock areas, were drilled to the Madison limestone and were dry. Coal production from the Baukol-Noonan strip mine was 10 percent above that of 1959. The county ranked fourth in coal production.

Miscellaneous clay was produced by Baukol-Noonan, Inc., for manufacturing lightweight aggregate. Sand and gravel (118,000 tons) was produced by Government crews and contractors, for the State highway department, the Divide County Highway Department, and the Tartuna Air Base, for use in building and road construction.

Dunn.—Petroleum production came from one well in the Lost Bridge field, discovered in 1960. Three wells completed in and to the south of the field were failures. Coal production from the Pelton strip mine was 6 percent below that of 1959. Paving sand and gravel (60,300 tons) was produced by and for the State highway department.

McHenry.—McHenry County became the 12th to produce petroleum when the Pratt field was discovered in June. Initial production potential of the discovery well was 96 barrels per day on pump from the Mission Canyon member of the Madison limestone at a depth of 4,201 to 4,213 feet.

Sand and gravel (118,000 tons) for use in building and road construction was produced by Government crews and contractors, for the State highway department, the Divide County Highway Department, and the Tartuna Air Base.

McKenzie.—The county ranked second in petroleum production and fourth in sand and gravel production. Petroleum output, from 389 wells in 17 fields, was 21 percent above that of 1959. Most of the production was from the Blue Buttes, Antelope (four horizons), Charlson, and Clear Creek fields. New producing horizons (Duperow and Silurian) were discovered at the Antelope field in March. The discovery well flowed 250 barrels of petroleum per day from the Duperow at a depth of 10,728 to 10,778 feet and 79 barrels per day from the Silurian at a depth of 11,727 to 11,826 feet. Another exploratory well (field unnamed), completed in September, pumped 12 barrels of petroleum per day from the Heath sandstone at a depth of 8,140 to 8,146 feet. Development drilling included 17 completions at the Blue Buttes field with 2 failures; Antelope, 5 completions with 1 failure; Charlson, 6 completions with 2 failures; Rough Rider, 3 completions with 1 failure; and Clear Creek, 5 successful completions.

Sand and gravel for road construction (324,300 tons) was produced by the McKenzie County Highway Department and by contractors for the State highway department.

McLean.—Coal extraction by Burns & Wretling Coal Co., Underwood Coal Co., and Truax-Traer Coal Co., operating the Custer strip mine, was 17 percent below that of 1959. Sand and gravel for road construction (14,500 tons) was produced by contractors for the State highway department, the Federal Bureau of Reclamation, and several townships.

Mercer.—The county continued to lead in coal production. Output from four strip mines was 10 percent above that of 1959. Major producers were the Knife River Coal Mining Co. operating the Beulah mine, The North American Coal Corp. operating the Indian Head,

and Truax-Traer Coal Co. operating the Dakota Star. Missouri River Sand & Gravel produced sand and gravel for building, paving, and fill; contractors produced paving gravel for the State highway department.

Morton.—Coal production from four mines declined 9 percent below that of 1959. Major producers were Kaelberer Coal Co. and Timpe & Nilles Coal Co. Miscellaneous clay was produced by the Hebron Brick Co. for manufacturing building brick, tile, and other heavy clay products. The company also produced a small quantity of bentonite used in manufacturing prepared mortar. Molite, Inc., acquired by Baukol-Noonan, Inc., in October, produced miscellaneous clay for manufacturing lightweight aggregate. Sand and gravel for building, paving, and fill was produced by Helm Bros., Inc. Sand and gravel (46,800 tons) for building and paving was produced by the State highway department, contractors for the county highway department, the city of Mandan, and the Federal Bureau of Reclamation. Standard Oil Co. of Indiana operated its 43,000-barrel-per-day refinery at Mandan. Throughput was 14.4 million barrels of crude oil, a 6-percent increase over 1959.

Mountrail.—Mountrail County ranked fifth in petroleum production. Output from three fields was 5 percent above that of 1959. That part of the Tioga field lying in Mountrail County furnished 86 percent of the county production. Great Northern Railway Co. produced gravel for building and ballast.

Renville.—Although petroleum production, from 3 fields, increased more than fourfold over that of 1959, the gain was centralized in the Glenburn field where 25 development wells (of which 20 were successful) were completed. The field was extended into Bottineau County, where six successful development wells were completed. One well, classified as a discovery but, later combined with the Glenburn field, was completed in February. Initial production was 160 barrels of petroleum per day from the Mission Canyon formation at a depth of 4,506 to 4,517 feet. One new field, Eden Valley, was discovered in April. Initial production was 37 barrels of petroleum per day on pump from the Mission Canyon formation at a depth of 4,182 to 4,186 feet.

Stark.—Petroleum production from the Heath and Madison pools in the Dickinson field was 33 percent above that of 1959. The Queen City refinery at Dickinson, closed for nearly 4 years, was purchased by Pacific State Oil Co. of Billings, Mont., in bankruptcy proceedings; articles incorporating a new company, Great Plains Refinery, were filed in preparation for reopening. The corporation was authorized to issue 2.75 million shares of stock. Planning called for increasing the daily capacity of the refinery from 2,000 to 2,500 barrels. The plant was to produce jet fuel on a Government contract. Coal production from three mines was 19 percent above that of 1959. Dickinson Coal Mining Co. operated the Dickinson and Lehigh strip mines. Additional tonnage was drawn from the Walter coal mine. The entire output of the Lehigh mine was used in manufacturing briquets. Dic-Kota Clay Products Co. produced fire clay for manufacturing building brick, tile, and other heavy clay prod-

ucts. Fisher Sand & Gravel Co. produced 50,400 tons of sand and gravel for building, road construction, and fill.

Stutsman.—Stutsman County led in output of sand and gravel. Dakota Aggregates Co., Inc., produced building and paving sand and gravel. Contractors produced building and paving sand and gravel for the State highway department and the Federal Bureau of Reclamation.

Walsh.—Walsh County ranked third in production of sand and gravel. Cudmore, Spoonland, Cudmore; Minneapolis, St. Paul & Sault Ste. Marie Railroad Co.; and Ellingson Gravel Co. produced 135,800 tons of sand and gravel for building, paving, railroad ballast, and fill. Contractors produced 238,900 tons of building and paving sand and gravel for the State and county highway departments and the city of Grafton.

Ward.—The county ranked second in production of coal and sand and gravel. Coal output from three strip mines was 5 percent above that of 1959. Traux-Traer Coal Co. operated the Velva mine; Sawyer Fuels, Inc., the Miller mine; and Valley Coal Co., the Valley mine. Sand and gravel (171,200 tons) for road construction was produced by and for the State and county highway departments. Atlas Sand & Gravel Co. and Minot Sand and Gravel Co. produced sand and gravel for building, paving, and fill. Railroad ballast and fill material were produced by Great Northern Railway Co. and Minneapolis, St. Paul & Sault Ste. Marie Railroad Co.

Williams.—Williams County continued to lead in the production of petroleum, from 508 wells in 11 fields. Output was 11 percent more than in 1959. Three fields furnishing 94 percent of the total were Beaver Lodge from Mississippian (Madison), Devonian, and Silurian formations, 57 percent; Tioga from the Madison limestone, 24 percent; and Capa, also from the Madison limestone, 13 percent. Extensive prior development of these fields precluded the need for broad development drilling; of four wells completed in the Beaver Lodge field to Devonian formations, three were successful. Westland Oil Co. operated its 3,000-barrel-per-day refinery at Williston. Throughput was 620 thousand barrels of crude oil, 19 percent below that of 1959.

Signal Oil and Gas Co. operated its natural gasoline plant at Tioga. The completed 14-inch high-pressure gathering line to the plant from the Beaver Lodge area will accommodate gas from high-pressure wells expected to go into production late in 1961. The company also planned further expansion of the plant and gathering system. Oil-Chem Corp. of Dallas, Tex., announced plans to construct a $4 million natural gas plant in the McGreagor area. The plant, to employ about 40 people, will process 20 million cubic feet of gas per day and recover about equal quantities of natural gasoline and liquid-petroleum gases.

Coal production from the Black Diamond mine, the only underground operation in the State, was 26 percent below that of 1959.

Salt mining and operation of the $2 million evaporation plant at Williston by Dakota Salt and Chemical Co., a wholly owned subsidiary of General Carbon and Chemical Corp. of Lake Forest, Ill., began on June 15. The plant was officially dedicated on October 7.

The salt bed, 230 feet thick, was mined hydraulically at a depth of 8,000 feet through wells drilled to the bed. The wells were the deepest in the United States, and the salt was extremely pure. The company planned to use the caverns created by mining the salt for the storage of liquid-petroleum gases. Storage facilities for 130,000 barrels of liquid-petroleum gases will be available for lease to producers and distributors in the area. For every 50,000 tons of salt mined, storage space for about 140,000 barrels of liquid-petroleum gases is created.

Sand and gravel (144,700 tons) for road construction was produced by contractors for the State and county highway departments. Building sand and building and paving gravel were mined by George Mockel and Borsheim Builders Supply Co.

The Mineral Industry of Ohio

By Joseph Krickich,[1] Stanley A. Feitler,[2] and Roy H. Davis [2]

THE VALUE of mineral production in Ohio in 1960 declined 2 percent from the record year, 1959, and totaled $389.8 million. The decrease was attributed mainly to lower output of bituminous coal, petroleum, and cement. Salt, natural gas, and peat, in contrast with the downward trend of other minerals in the State, increased in output and value. Expansion of the State's mineral-producing capacity continued, notably in the lime and salt industries. Ohio continued to lead the Nation in output of ferroalloys, clays and lime and was an important producer of coal, beryllium, iron and steel, and salt.

TABLE 1.—Mineral production in Ohio [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones—short tons	1,081	$101	(2)	(2)
Cement				
Portland—376-pound barrels	18,140,723	60,560	16,752,121	$58,470
Masonry—do	853,328	3,374	728,036	3,008
Clays—thousand short tons	5,479	15,346	5,165	14,325
Coal—do	35,112	135,729	33,957	130,877
Gem stones	(3)	2	(3)	3
Lime—thousand short tons	3,190	45,121	3,117	44,403
Natural gas—million cubic feet	34,664	8,042	36,074	8,477
Peat—short tons	5,813	73	6,755	93
Petroleum (crude)—thousand 42-gallon barrels	5,978	17,157	[4] 4,960	[4] 14,731
Salt—thousand short tons	2,858	20,486	3,108	24,149
Sand and gravel—do	38,604	45,138	[5] 37,943	[5] 44,979
Stone [6]—do	36,155	59,326	35,856	59,479
Value of items that cannot be disclosed: Gypsum, dimension limestone (1960), marl (calcareous), and values indicated by footnote 2		2,029		1,826
Total Ohio [7]		[8] 397,326		389,828

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Weight not recorded.
[4] Preliminary figure.
[5] Final figure; supersedes figure given in commodity chapter.
[6] Excludes certain stone; included with "Value of items that cannot be disclosed."
[7] Totals adjusted to eliminate duplicating value of limestone, clays, and calcareous marl used in manufacturing cement and lime.
[8] Revised figure.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical assistant, Bureau of Mines, Pittsburgh, Pa.

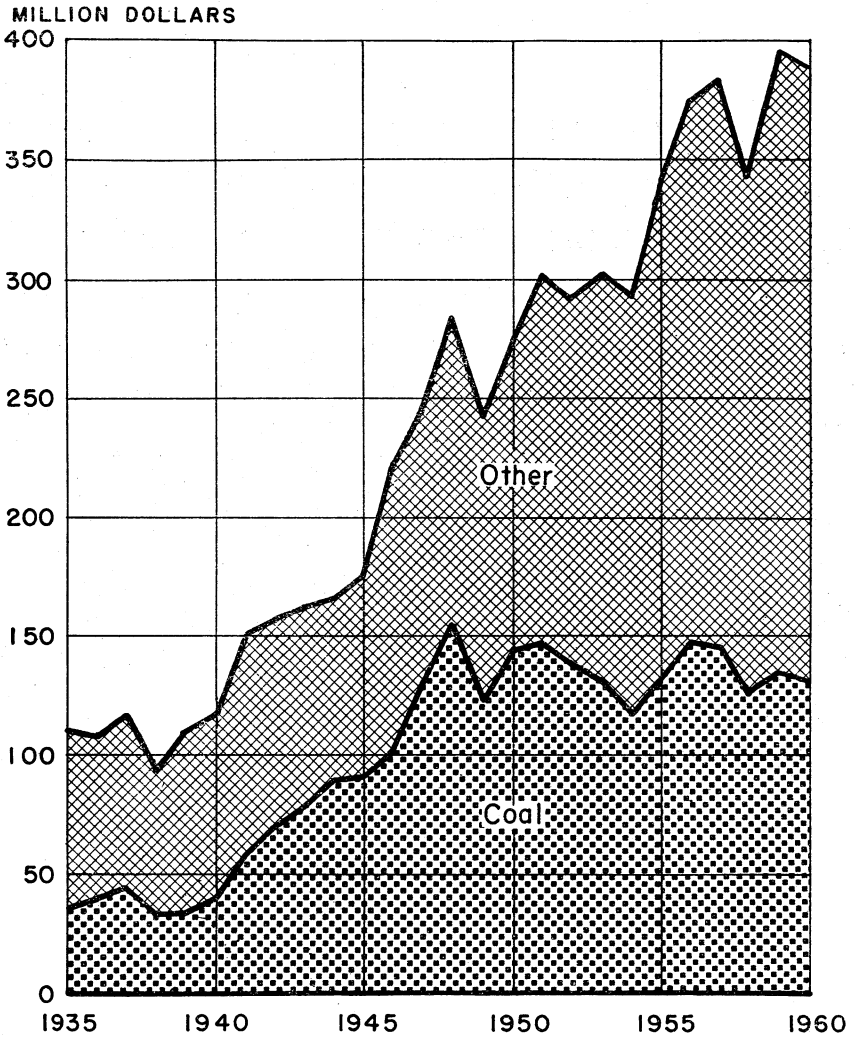

FIGURE 1.—Value of coal and total value of mineral production in Ohio, 1935–60.

Employment and Injuries.—Preliminary data for the mineral industry indicated that man-hours worked decreased in 1960 in most categories. The number of fatalities decreased to 10, but the number of injuries per million man-hours was virtually the same as in 1959. In the coal industry, fatalities per million short tons (0.24) were the lowest in the Nation, despite an increase in the number of fatalities. Of the 8 coal mine fatalities, 5 were at strip mines and 3 at underground mines (2 underground and one on the surface).

The Jonathan mine, Zanesville, operated by Columbia Cement Corp. won top honors in the nonmetal group of the 1960 National

Safety Competition. The company was awarded a Sentinels of Safety trophy. In the same group of National Safety Competition, the Ironton mine (Lawrence County) operated by Alpha Portland Cement Co. ranked fifth for the second consecutive year and worked 160,528 man-hours in 1960 without a lost-time injury. The company was awarded a Certificate of Achievement in Safety.

TABLE 2.—Employment and injuries for selected mineral industries [1]

Industry	Men working daily	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:					
Cement	1,894	4,599,411		12	2.61
Clay [2]	761	1,202,244		42	34.93
Coal	9,158	16,042,887	5	325	20.57
Coke ovens	2,374	6,249,809	1	17	2.88
Nonmetal mines [3]	168	290,620		4	13.76
Quarries and mills [4]	4,636	10,574,448	3	159	15.32
Sand and gravel	2,865	5,739,108	2	77	13.77
1960: [5]					
Cement	1,970	4,530,000		8	1.77
Clays [2]	167	1,068,000	1	39	37.45
Coal	8,200	14,650,000	8	385	26.83
Coke ovens	2,281	6,674,542		16	2.40
Nonmetal mines [3]	196	289,000		9	31.14
Quarries and mills [4]	4,094	9,400,000	1	67	7.23
Sand and gravel [6]	2,318	4,295,000		41	9.55

[1] Production employees.
[2] Mines only.
[3] Includes abrasives, gypsum, and salt.
[4] Includes lime plants having no quarry operations.
[5] Preliminary figures.
[6] Commercial producers only.

Trends and Development.—Expansions continued in the mineral industries of Ohio. Significant developments in the beryllium, lime, salt, aluminum, petroleum and natural gas, gypsum, and cement industries were reported. A major expansion program to increase vacuum-cast beryllium billet capacity at the Elmore plant of Brush Beryllium Co. was announced. A new lime plant to serve the steel industry in the Cleveland area was constructed. Although completion was delayed for nearly a year when water-bearing strata and high gas concentrations were found in sinking the shafts, development of an underground salt mine in the same area continued. Plans were announced to construct a plant to produce aluminum sulphate from coal-mine wastes in the eastern part of the State. Wildcat drilling for petroleum and natural gas continued at record pace throughout the State.

A new gypsum-calcining and building products plant was completed at Lorain and placed on stream in 1960. The plant will utilize crude gypsum mined outside the State. Although a cement plant in Erie County discontinued operating during the latter part of 1960, expansions and improvements in capacities and operating efficiency continued among Ohio's other cement plants.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Production and value of grindstones decreased compared with 1959 because one less producer was active in 1960. Output came from Washington County near Constitution and from Lorain County near Kipton. Constitution Stone Co. (Washington County) discontinued operations at the end of 1959. During 1960, the plant and all equipment were scrapped.

Cement.—Production, shipments, and value of portland and masonry cements dropped; plants operated at 72 percent of capacity compared with 77 percent in 1959. Shipments of portland cement decreased 8 percent; stocks at mills on December 31, were 24,000 barrels higher than at the end of 1959. The average value for both portland and masonry cements increased. Greene and Lawrence, in decreasing order of value, were the leading cement-producing counties.

Approximately 4.6 million tons of limestone, cement rock, and calcareous marl were used for manufacturing portland cement. In addition, the following quantities of other raw materials were used: Clay and shale, 752,000 tons; gypsum, 136,000 tons; sand and sandstone, 41,000 tons; and iron materials 26,000 tons. The companies also used grinding aids and air-entraining compounds. Types of portland cement produced were Types I–II (general use), Type II (high-early-strength), and waterproof.

Portland cement was shipped to consumers in Ohio (75 percent), Indiana (11 percent), and West Virginia (7 percent). The remainder was shipped to Kentucky, Michigan, Pennsylvania, Virginia, and Wisconsin. Distribution of portland cement shipments, by types of customers, were as follows: Ready-mixed concrete companies, 55 percent; highway and other contractors, 18 percent; concrete product manufacturers, 16 percent; and building material dealers, 10 percent. Approximately 1 percent was shipped to Federal, State, local government agencies, and other customers. Eighty-five percent was shipped by truck; the remainder, by rail or used by the producers. Of the total shipments, 90 percent was in bulk; the remainder was in containers, mainly paper bags.

Annual finished cement capacity on December 31 was 23.5 million barrels, compared with 23.4 million barrels in 1959. Seventy-one percent of the total capacity was by the wet process and 29 percent was by the dry process. The plants reported consuming 415.1 million kilowatt hours of electrical energy, of which 53 percent was purchased from public utility companies.

Late in 1960, Medusa Portland Cement Co. permanently closed its Bay Bridge (Erie County) plant because of obsolete machinery and equipment. The plant built in 1892, was the company's first plant. Its cement storage silos were converted to a distribution facility and were to continue to serve company customers in the area. The company also had under construction a new bulk-loading station in the Cleveland area. During the year, Universal Atlas Cement Division, United States Steel Corp., installed a filtering system to recover gas and dust from its cement-making operation. The $775,000 project will necessitate lowering two stacks from 180 feet to 60 feet high.

TABLE 3.—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	
1951–55 (average)	9	12,591	12,568	$33,303	837
1956	10	15,722	15,151	46,342	1,293
1957	10	16,291	15,454	49,115	1,974
1958	10	15,191	14,960	50,092	2,115
1959	11	18,028	18,141	60,560	[1] 1,938
1960	11	16,850	16,752	58,470	1,962

[1] Stock adjustment.

Clays.—Output of clays decreased compared with 1959, owing chiefly to a 6-percent drop in demand for heavy clay products (mainly building brick). In addition, demand for refractory materials used by the steel, glass, and foundry industries decreased 3 percent and clay for cement manufacture declined 10 percent. Clays used for heavy clay products, cement, and refractories supplied 93 percent of the total output. Fifty-five percent of the total was miscellaneous clay or shale; the remainder was fire clay used principally in heavy clay products and refractories. Tuscarawas and Stark Counties led and ranked second, respectively, in output among 17 fire clay-producing counties. Miscellaneous clay was produced in 43 counties; Cuyahoga and Stark Counties led in output.

TABLE 4.—Clays sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Columbiana	(1)	(1)	310,115	$2,066,466
Cuyahoga	353,570	$311,574	312,503	281,890
Delaware	73,317	97,638	51,207	73,032
Gallia			2,030	3,857
Hocking	44,635	151,945	37,856	126,848
Holmes	92,943	255,955	105,367	320,614
Huron			144	288
Jackson	133,465	(1)	121,667	706,795
Jefferson	129,000	866,650	142,179	940,211
Lawrence	153,391	816,695	224,667	987,410
Madison	(1)	(1)	1,050	1,050
Marion	202,800	254,200	135,340	169,260
Muskingum	14,578	20,558	110,207	119,041
Paulding	25,026	45,182	(1)	126,217
Perry	322,014	774,361	344,520	832,613
Putnam	23,920	26,862	26,694	30,568
Scioto	(1)	(1)	11,088	47,737
Seneca	18,500	22,500	25,000	30,000
Stark	614,539	1,690,007	654,852	1,734,064
Summit	(1)	(1)	109,411	173,096
Tuscarawas	1,063,636	3,926,496	988,556	3,184,507
Van Wert	8,477	14,984	7,340	12,790
Vinton	28,391	85,204	32,383	131,778
Undistributed [2]	2,176,394	5,985,032	1,410,524	2,224,898
Total	5,478,596	15,345,843	5,164,700	14,325,030

[1] Figures withheld to avoid disclosing individual company confidential data.

[2] Includes data for the following counties: Ashland, Athens, Auglaize (1960), Carroll, Darke, Erie (1960), Franklin, Greene (1960), Hancock, Harrison, Henry, Highland, Lake (1960), Lucas (1960), Mahoning, Medina, Noble, Portage, Richland, Washington (1959), Wayne, Williams, Wood, and Wyandot; clays used in cement manufacturing not apportioned by counties (1959); and data indicated by footnote 1.

Gem Stones.—Mines and quarries throughout the State continued to attract gem and mineral specimen collectors; value increased for the second consecutive year. Specimens recovered included calcite, celestite, flint, jasper, pyrite, selenite, and sphalerite. Wood and Summit Counties were the principal areas of mineral collecting activity.

Gypsum.—Production and value of crude gypsum continued to decline. Output came from two underground mines in Ottawa County, the only source of gypsum in the State. The crude material was calcined at nearby plants for use in manufacturing finished building products. In March the calcining and gypsum product plant of National Gypsum Co. at Lorain was completed. Crude gypsum mined outside the State at company-owned mines was processed at this plant during the last half of the year.

Iron Oxide Pigments.—Minnesota Mining & Manufacturing Co. at Copley (Summit County) produced red iron oxide pigments, principally from pyrite cinder shipped from Delaware.

Lime.—Total lime output decreased mainly because of decreased demand for building and refractory lime used by the construction and steel industries. Demand for lime for chemical and industrial applications increased; output of agricultural lime decreased for the seventh consecutive year. Eighty-four percent of the lime output was quicklime; the remainder was hydrated lime used chiefly by the construction industry. Twenty plants in twelve counties were active, the same as in 1959. Sandusky County continued as the leading producer, supplying 29 and 34 percent of the total tonnage and value, respectively. Most operators used shaft-type kilns; hydrators were both batch and continuous types. Anthracite and bituminous coal, coke, natural gas, producer gas, and carbon monoxide were used as fuels at plants. Lime was shipped to the District of Columbia and all States except Alaska, Hawaii, Oregon, Idaho, and Utah. Exports were made chiefly to Canada, Chile, and Mexico, with lesser amounts to Argentina, Bahama Islands, and India.

The $1.5 million lime plant of Cuyahoga Lime Co. at Cleveland was constructed and completed by the end of 1960. The 144,000-ton-per-year plant will produce quicklime in 4-shaft kilns and use natural gas as fuel. The company will use limestone quarried in Michigan and shipped by boat to the plant. Production was expected to begin early in 1961.

TABLE 5.—Lime sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Year	Agricultural (burned)		Building		Chemical and other industrial		Refractory		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	lue	Short tons	Value
1951–55 (average)	53	$642	583	$8,623	779	$6,989	1,191	$16,464	2,606	$32,718
1956	37	542	577	9,575	968	8,612	1,413	22,076	2,995	40,805
1957	35	482	510	9,049	918	8,411	1,300	20,441	2,763	38,383
1958	34	481	474	7,539	1,007	9,977	896	14,474	2,411	32,471
1959	31	427	492	9,249	1,563	17,484	1,104	17,961	3,190	45,121
1960	30	449	425	8,288	1,604	18,516	1,057	17,150	3,117	44,403

Perlite (Expanded).—Crude perlite shipped from western States was expanded at plants in Cuyahoga and Summit Counties for plaster and concrete aggregate, soil conditioner, and other purposes.

Salt.—Total output of salt in Ohio reached a record high as production exceeded 3 million tons for the first time. Production rose 9 percent, because of increased rock salt and evaporated salt output. Brine production declined and was used by producers mainly for manufacturing chlorine and soda ash. Evaporated salt, manufactured chiefly by the vacuum pan process, was sold for a wide variety of uses; some was marketed as pressed blocks. The productive capacity of the salt industry in the State increased, and totaled 4.1 million tons. Producers operated at 75 percent of capacity, compared with 74 percent in 1959. Salt-producing counties, in decreasing order of output, were Lake, Summit, Wayne, and Meigs.

International Salt Co. continued to develop its underground salt mine near Cleveland. During the year the production and service shafts were sunk through water-bearing strata, and unexpected water and high gas concentrations were found that required extensive grouting and delayed completion of the shafts approximately a year. The company expected to reach the salt bed at 1,765 feet by the end of May 1961, and to begin limited production at the end of that year. Surface structures at the mine were completed in 1959. In 1960, the company shipped several thousand tons of bulk rock salt from its Detroit mine to the Cleveland mine to test its processing and packaging machinery. International Salt planned to use a continuous miner to recover salt at the Cleveland mine.[3]

Sand and Gravel.—Tonnage and value, including Government-and-contractor operations, were 2 percent and less than 1 percent lower, respectively, than the record high of 1959. Output by commercial producers decreased 3 percent. More than 31 million tons of sand and gravel was consumed in building and highway construction. Production of industrial sand amounted to 1 million tons valued at $4.1 million. Major uses were for molding, glass making, and furnace construction and repair. Industrial sand also was used in making ferrosilicon, and for railroad engines, blasting, filtration, grinding, and as a filler.

Commercial sand and gravel was produced at 357 pits; 17 less than in 1959. Three operations produced more than 1 million tons and four operations produced between 500,000 and 1 million tons. Operators washed, screened, or otherwise prepared 94 percent of the output of commercial sand and gravel and made deliveries by truck (91 percent), railroad (6 percent), and waterway (3 percent). Hamilton and Franklin Counties with more than 3.7 million tons each had the largest production. Output in Montgomery, Butler, and Portage Counties was from 2 to 3 million tons, each. These 5 counties furnished 43 percent of the sand and gravel produced in the State.

[3] International Salt Co., 1960 Annual Report.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	6,118	$7,267	6,410	$7,252
Paving	6,912	7,081	6,654	6,989
Fill	973	680	793	629
Molding	434	1,637	(1)	(1)
Filtration	20	50	(1)	(1)
Railroad ballast			1	1
Other [2]	1,036	3,073	1,249	4,203
Gravel:				
Building	5,774	7,066	5,369	6,782
Paving	11,819	13,673	11,691	13,774
Railroad ballast	209	170	162	125
Fill	845	596	628	417
Other	2,076	2,856	2,133	3,037
Total sand and gravel	36,216	44,149	35,090	43,209
Government-and-contractor operations:				
Sand:				
Building			25	34
Paving	253	144	341	364
Other	86	19		
Gravel:				
Building			379	341
Paving	930	671	572	479
Fill	1,119	155	1,536	553
Total sand and gravel	2,388	989	2,853	1,770
Grand total	38,604	45,138	37,943	44,979

[1] Figures withheld to avoid disclosing individual company confidential data.
[2] Includes the following sands: Glass, grinding and polishing, blast, fire or furnace, engine, ferrosilicon, ground, and other; and data indicated by footnote 1.

Slag (Iron-Blast Furnace).—Production of processed iron-blast-furnace slag increased nearly 1 million tons over 1959 and totaled 6.4 million tons. Value increased to $12.4 million, compared with $10.7 million in 1959. Of the total processed slag, 84 percent was screened, air-cooled slag; the remainder consisted of granulated and lightweight (expanded) slag. Processing plants were chiefly near the steelmaking centers of Cleveland, Middletown, and Youngstown. Ohio continued to rank second among the 16 slag-processing States and supplied 22 percent of the National total.

Stone.—Value of stone production was about the same as in 1959; tonnage decreased 1 percent. Limestone furnished more than 95 percent of the quantity and over 85 percent of the value. Other types of stone mined were standstone and calcareous marl. Value of limestone for principal uses (construction, cement, and lime) changed little compared with 1959, but the value of limestone for metallurgical flux decreased 24 percent and that for agstone increased 21 percent. Consumption was lower for most other uses (glassmaking, whiting, stone sand, and asphalt filler).

Sandstone production and value changed little and, as in previous years, most of the value was in material quarried and sawed for

architectural applications and for firestone used in steelmaking furnaces. Sandstone was mined and crushed for ganister (refractory), aggregate, riprap, and other uses.

Production of calcareous marl declined in Erie County as Medusa Portland Cement Co. exhausted its deposit and discontinued mining. A small tonnage of calcareous marl was mined for agstone in Darke County.

Stone production was reported from 63 counties; 2 more than in 1959. Limestone was mined in 55 counties; Sandusky, Franklin, and Seneca, in order of decreasing tonnage, led in production.

Of the 14 counties producing sandstone, Scioto led in value and Lorain in tonnage.

TABLE 7.—Crushed and broken limestone sold or used by producers, by uses

Use	1959		1960	
	Short tons	Value	Short tons	Value
Riprap	156,694	$132,217	1,280,717	$1,893,165
Concrete aggregate and roadstone	16,742,509	21,904,098	17,255,250	22,473,417
Fluxing stone	4,947,164	7,560,302	3,696,452	5,743,590
Agriculture	1,871,609	3,145,579	2,242,483	3,818,393
Railroad ballast	992,521	1,191,701	1,051,591	1,279,700
Miscellaneous uses	10,720,823	16,897,269	9,602,303	16,043,837
Total	35,431,320	50,831,166	35,128,796	51,252,102

Sulfur (Recovered Elemental).—Sun Oil Co. recovered elemental sulfur by catalytic oxidation of hydrogen sulphide at its Toledo refinery.

Vermiculite (Exfoliated).—Archer-Daniels-Midland Co., Federal Foundry Supply Division, exfoliated vermiculite at Cleveland (Cuyahoga County). Crude material shipped from Montana, Union of South Africa, and Canada was processed for loose-fill insulation and concrete and plaster aggregate.

MINERAL FUELS

Coal.—Ohio continued to rank fifth in output of bituminous coal. Coal production decreased 3 percent and was 1.2 million tons less than in 1959. The average value per ton ($3.85) was slightly below that of 1959. Strip mines supplied 70 percent of output; the remainder came from underground (27 percent) and auger (3 percent) mines. A total of 470 mines producing 1,000 tons or more were active—6 less than in 1959. The active number of underground mines decreased from 159 to 149 and auger mines from 59 to 56; strip mines increased from 258 to 265.

Strip mine production was 23.9 million tons, 3 percent less than in 1959. Harrison, Jefferson, and Morgan Counties, in decreasing order of output, were the leading stripping areas. The average value per ton increased from $3.61 to $3.64. A total of 603 power shovels and draglines, 53 carryall scrapers, 524 bulldozers, and 179 power drills were used at the strip mines. Most of the diesel-powered shovels and draglines had dipper capacities of less than 3 cubic yards; 14 shovels and 7 draglines had capacities over 12 cubic yards.

Underground mines were active in 18 counties, compared with 20 counties in 1959. Belmont and Harrison Counties furnished 74 percent of the State's underground production. The average value per ton of underground coal dropped from $4.56 to $4.49 per ton. Almost the entire underground output was cut by machines; 33 percent was cut by continuous mining machines. Of the underground production, 92 percent was mechanically loaded. The number of continuous mining machines increased by 3 to 38; output increased from 2.8 million tons in 1959 to nearly 3 million tons in 1960.

Output of coal recovered by auger mining in 16 counties decreased 7 percent and totaled 867,000 tons. The average value per ton decreased from $3.43 in 1959 to $3.10. Jefferson and Harrison Counties supplied 38 percent of the auger-mined tonnage.

Coal was cleaned at 22 preparation plants (1 less than in 1959). Over 15 million tons of coal was cleaned; 47 percent by jigs, 52 percent by wet washing other than jigs, and 1 percent by pneumatic methods. Ohio coal also was processed by crushing and by treating with antifreezing and dust allaying materials. A total of 13.1 million tons of coal was crushed, and 4.7 million tons was treated, mainly with calcium chloride and oil.

Fifty-one percent of the output was shipped by rail or water, 37 percent by truck, and the remainder by other means, mainly pipeline. Coal production by captive operations furnished 12 percent of the State output.

TABLE 8.—Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	35,846	$133,516	1958	32,028	$126,241
1956	38,934	148,650	1959	35,112	135,729
1957	36,862	146,134	1960	33,957	130,877

Coke and Coal Chemicals.—Ohio continued to rank second among the 21 oven-coke-producing States. Quantity and value of coke (8.4 million tons and $142.1 million) declined 5 and 4 percent, respectively, compared with 1959. The average value per ton increased to $16.87 from $16.73 in 1959 but still was $1.51 below the national average. Over 11.7 million tons of bituminous coal was carbonized; the coke yield increased from 71.03 percent in 1959 to 71.75 percent. Fifty-one percent of the coking coal delivered to Ohio plants came from West Virginia; the remainder came from Pennsylvania (34 percent), Kentucky (8 percent), and Virginia (7 percent). Seventy-three percent of the coal received was high-volatile, 24 percent low-volatile, and 3 percent medium-volatile. At the end of 1960, 14 plants operated 2,368 ovens (all slot type), 22 less ovens than 1959. Most of the coke output (88 percent) was consumed by producing companies, largely in blast furnaces. The remainder represented commercial sales to blast furnaces, foundries, other industrial consumers, and for residential heating. Output of coke breeze, the principal coproduct, totaled 502,000 tons valued at $3.7 million. The producing companies used 264,000 tons of coke breeze in steamplants, agglomerating plants, and for other industrial uses. Other coke coproducts included coke-

oven gas (118,426 million cubic feet), ammonium sulfate (81,000 tons), ammonium liquor (NH_3 content, 3,300 tons), coke-oven tar (97.1 million gallons), and crude light oil (32.2 million gallons). Over 17.1 million gallons of benzene, 3.5 million gallons of toluene, 1.3 million gallons of xylene, and 554,000 gallons of solvent naphtha were derived from the light oil.

Fuel Briquets and Package Fuel.—Fuel briquets consumed in Ohio totaled 42,000 tons, 15 percent less than in 1959. Production of packaged fuel at five active plants was 1,293 tons, valued at $28,000—two less plants and $61,000 less than in 1959. Ohio supplied 5 percent of the national total, and the average value per ton was 7 percent less than the national average. No fuel briquets (coal and coke) were exported from the Ohio Customs District.

Peat.—Production of peat increased 16 percent owing mainly to an increase in the number of active operations; 13 producers were active, 2 more than in 1959. Value also increased because more peat was sold in packages, which have a higher unit value. Of the total output, 85 percent was sold in bulk (92 percent in 1959); the remainder was sold in packages. Consumption in Ohio totaled 32,000 tons, compared with 27,000 tons in 1959. Richland, Miami, and Stark Counties, in order of decreasing output, led among the eight producing counties.

Petroleum and Natural Gas.—The year was highlighted by increased wildcat activities, although total well completions decreased from 1,133 to 1,099 (including 454 oil, 260 gas, 304 dry holes, and 81 service wells). Total footage was 2,764,000; the average footage declined to 2,515 from 2,576. Wildcat completions (3 oil, 11 gas, and 41 dry) increased from 39 to 55. Wildcat-well activity was reported in 30 counties; Ashtabula and Trumbull Counties with 10 and 5 wells, respectively, were the principal drilling areas. A total of 1,044 development completions were made; Wayne County led with 120 wells. Other leading areas were Ashland (81), Hocking (69), and Medina (62) Counties. Ninety-six percent of the total well completions were drilled with cable tools, compared with the United States average of 26 percent.[4]

According to American Petroleum Institute and the American Gas Association, proved reserves, December 31, were natural gas, 765,553 million cubic feet (14.65 p.s.i.a., at 60° F.); crude petroleum, 74.7 million barrels; natural gas liquids, 1.3 million barrels. Reserves of natural gas and crude petroleum increased 16,787 million cubic feet and 540,000 barrels, respectively. Natural gas liquids reserves decreased. The total capacities of active petroleum refineries and cracking plants were 436,000 and 177,000 barrels per day of crude oil and gasoline, respectively, slightly higher than in 1959. Refineries were at Canton, Cincinnati, Cleveland, Cleves, Lima, Newark, Toledo (4), and Weston.

METALS

Aluminum.—Production of primary aluminum increased over 1959, but total value declined. Ormet Corp., owned jointly by Olin Mathieson Chemical Corp. and Revere Copper & Brass, Inc., pro-

[4] Oil and Gas Journal, vol. 59, No. 5, Jan. 30, 1961.

duced aluminum at its recently completed reduction plant at Omal near Clarington (Monroe County), from alumina produced at its Burnside, La., plant from imported Surinam bauxite. Annual capacity at the plant was 180,000 tons.

North American Coal Corp. announced plans to build a $1 million plant for producing aluminum sulfate from coal-mine wastes. The 40,000-ton-per-year plant would use a new process developed under a joint program with Strategic Materials Corp. Pilot-plant studies for producing aluminum sulfate from coal wastes, shales, and other raw materials were underway. Adequate reserves of coal, shale, and electric power were available at the plant site near Powhatan where the company operated coal mines. Production at the plant was scheduled to begin in June 1961.

Beryllium.—Beryllium metal, alloys, and compounds for nuclear and other applications were produced at Elmore by The Brush Beryllium Co. Research for new applications for the metal was continued by the company. A $6 million expansion program was well underway to increase vacuum-cast beryllium billet capacity from 12,500 pounds per month to about 25,000 pounds. The company also started constructing a $3 million plant at Cleveland to finish, fabricate, and machine beryllium metal. In May, 100 tons of beryl ore from Bombay, India, was received at the Elmore plant, the first shipment of its kind to be sent through the Port of Toledo. Beryl also was used in manufacturing ceramic products at the Lisbon plant of Delta Star Electric Division, H. K. Porter Co.

Ferroalloys.—Ohio continued as the leading producer of ferroalloys and supplied 29 percent of the U.S. production. Output totaled 619,000 tons—16 percent higher than in 1959. However, 1960 shipments increased only 1 percent in tonnage to 554,000 tons; value decreased 13 percent to $122.3 million. The decline in value was due to lower unit values for ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, and chromium briquets. As in 1959, these ferroalloys, represented 97 percent of the tonnage and 91 percent of the value of all ferroalloys shipped from plants in Ohio. Of these listed ferroalloys, only ferrosilicon and ferromanganese shipments increased.

TABLE 9.—Ferroalloy producers in 1960

Company	Location	Type of furnace	Ferroalloys produced [1]
Interlake Iron Corp.	Beverly	Electric	SiMn, FeSi, FeCr.
Do.	Jackson	Blast and electric	Silvery pig iron, FeSi.
Jackson Iron & Steel Co.	do.	Blast	Silvery pig iron.
Ohio Ferro-Alloys Corp.	Brilliant	Electric	FeSi, FeCr.
Do.	Philo	do.	FeMn, SiMn, FeSi, other miscellaneous ferroalloys.
Do.	Powhatan Point	do.	FeSi, other miscellaneous ferroalloys, and Si.
Union Carbide Metals Co.	Marietta	do.	FeMn, SiMn, FeSi, FeCr, Spiegeleisen, other miscellaneous ferroalloys.
Do.	Ashtabula	do.	FeMn, SiMn, FeSi, FeCr.
Vanadium Corp. of America	Vancoram	do.	FeCr, FeSi.
Do.	Cambridge	do.	FeMn, FeTi, FeV, FeB, FeCb, other miscellaneous ferroalloys.

[1] Symbols used: FeMn, ferromanganese; SiMn, silicomanganese; FeSi, ferrosilicon; FeCr, ferrochromium; FeTi, ferrotitanium; FeB, ferroboron; FeCb, ferrocolumbium; FeV, ferrovanadium; Si, silicon.

Iron and Steel.—Pig iron production increased 2 percent over 1959 and totaled 11.8 million tons. However, total shipments and value decreased 3 percent; stocks at furnaces on December 31, were nearly double those at yearend 1959. Basic, Bessemer, malleable, foundry, low-phosphorous, direct-casting, and other pig iron was produced at 19 plants (48 stacks). Basic and Bessemer pig iron predominated and totaled 9.1 and 1.9 million tons, respectively. Domestic iron ore shipped to plants increased 57 percent; foreign iron ore shipments increased 7 percent. Consumption of foreign ore in blast furnaces increased 16 percent; consumption of domestic ore decreased 11 percent. Other materials consumed in blast furnaces were 4.7 million tons of domestic sinter, 2.9 million tons of pellets, 773,000 tons of mill cinder and roll scale, 36,000 tons of flue dust, 758,000 tons of home and purchased scrap, 125,000 tons of slag scrap, 668,000 tons of open-hearth and Bessemer slag, 9.1 million tons of coke, and 3.2 million tons of limestone and dolomite. Scrap and slag production at blast furnaces totaled 176,000 tons and 4.9 million tons, respectively. Recovered materials included 862,000 tons of flue dust.

Construction of a two-furnace basic oxygen shop continued at the Cleveland Works of Jones & Laughlin Steel Corp. The furnaces will be capable of producing steel at the rate of 200 tons an hour. Completion of the shop was expected in July 1961. Also a $10 million oxygen plant was being constructed by Air Products, Inc., to supply 500 tons of pure oxygen per day to the Cleveland plant. In August, the No. 1 blast furnace of Wheeling Steel Corp. (Steubenville Works) was taken out of service for a $3 million rebuilding and capacity-increasing project. The company also took out of service a battery of 51 coke ovens for rebuilding at a cost of $4.5 million.

Lead and Zinc Pigments.—Black lead oxide pigments were produced at the Cleveland (Cuyahoga County) plant of Willard Storage Battery Co. E. I. duPont de Nemours & Co., Inc., manufactured zinc pigments (chlorides) at Cleveland. Zinc oxide was manufactured at Columbus (Franklin County) by American Zinc Oxide Co.

Titanium.—Titanium sponge was produced by sodium reduction of titanium tetrachloride at Ashtabula by Reactive Metals, Inc. (formerly Mallory-Sharon Metals Corp), and Union Carbide Metals Co., Division of Union Carbide Corp. Republic Steel Corp., Massilon and Canton, and Reactive Metals, Inc., Niles, melted titanium. Titanium Metals Corp. of America, Toronto, and Reactive Metals, Inc., Niles, rolled and fabricated titanium metal.

Zirconium.—Reactive Metals, Inc., produced hafnium-free zirconium sponge at Ashtabula and zirconium ingot in Niles. The Union Carbide Metals Co. (Ashtabula) and Vanadium Corp. of America (Cambridge) continued to produce zirconium ferroalloys. The Chas. Taylor Sons Co., Cincinnati, Ohio, produced zircon and zirconia refractories.

REVIEW BY COUNTIES

Fulton County continued as the only county from which no mineral production was reported. Although increasing in 37 of the 87 mineral-producing counties, value declined in the other counties (mainly

coal-producing) resulting in a decrease in the State value of mineral production in 1960. Harrison, Belmont, Greene, and Lake Counties, in decreasing order of value, continued as the leading mineral-producing areas. In addition, eight other counties reported mineral production exceeding $10 million. Sand and gravel was produced by Government-and-contractor operations, mainly for the State of Ohio Highway Department, in 14 counties. Details of petroleum and natural-gas operations in producing counties were not available and were excluded from the county review section.

Adams.—Davon, Inc., mined, crushed, and screened limestone at its Plum Run quarry near Peebles. The prepared stone, used for agstone, cement, coal-mine dusting, and railroad ballast, was delivered by truck and railroad. Adams County road crews mined limestone for road construction and maintenance.

TABLE 10.—Value of mineral production in Ohio, by counties [1 2]

County	1959	1960	Minerals produced in 1960 in order of value
Adams	$495,609	$589,817	Stone.
Allen	862,538	767,802	Do.
Ashland	(3)	(3)	Sand and gravel, clay.
Ashtabula	(3)	(3)	Lime, sand and gravel.
Athens	2,544,012	2,160,416	Coal, stone, clay, sand and gravel.
Auglaize	(3)	(3)	Sand and gravel, stone, clay.
Belmont	27,650,404	(3)	Coal, stone.
Brown	96,890	42,243	Stone, sand and gravel.
Butler	2,951,839	3,311,573	Sand and gravel.
Carroll	1,973,515	1,907,670	Coal, clay, sand and gravel, stone.
Champaign	310,108	336,943	Sand and gravel.
Clark	(3)	(3)	Sand and gravel, lime, stone.
Clermont	908,575	720,555	Sand and gravel.
Clinton	1,091,162	666,439	Stone, sand and gravel.
Columbiana	(3)	7,754,903	Coal, clay, sand and gravel, stone.
Coshocton	7,868,583	8,703,319	Coal, stone, sand and gravel.
Crawford	(3)	(3)	Stone, sand and gravel.
Cuyahoga	1,204,653	1,298,182	Sand and gravel, clay.
Darke	(3)	(3)	Sand and gravel, clay, stone.
Defiance	(3)	(3)	Sand and gravel.
Delaware	1,828,307	1,463,252	Stone, lime, clay, sand and gravel.
Erie	6,406,165	4,609,124	Stone, cement, sand and gravel, clay.
Fairfield	456,015	345,932	Sand and gravel.
Fayette	887,841	914,242	Stone, gem stones.
Franklin	9,215,449	8,339,263	Sand and gravel, stone, lime, clay.
Gallia	(3)	3,498,991	Coal, sand and gravel, stone, clay.
Geauga	(3)	(3)	Sand and gravel, stone.
Greene	(3)	(3)	Cement, sand and gravel, stone, clay.
Guernsey	1,337,057	1,077,929	Coal, stone.
Hamilton	4,935,010	5,814,598	Sand and gravel, stone.
Hancock	(3)	(3)	Stone, clay, gem stones.
Hardin	(3)	(3)	Stone.
Harrison	33,218,717	31,743,348	Coal, stone, clay.
Henry	(3)	(3)	Sand and gravel, clay.
Highland	(3)	(3)	Stone, sand and gravel, clay.
Hocking	502,206	468,464	Coal, clay, sand and gravel.
Holmes	1,122,095	1,086,580	Stone, clay, coal, sand and gravel.
Huron	70,700	(3)	Sand and gravel, peat, clay.
Jackson	(3)	2,567,699	Coal, clay, sand and gravel, stone.
Jefferson	14,833,932	13,960,503	Do.
Knox	(3)	(3)	Sand and gravel, stone.
Lake	(3)	(3)	Salt, cement, lime, sand and gravel, clay.
Lawrence	10,302,141	10,564,390	Cement, coal, clay, sand and gravel, stone.
Licking	630,780	662,391	Sand and gravel, gem stones.
Logan	(3)	310,917	Stone, sand and gravel.
Lorain	(3)	(3)	Stone, sand and gravel, abrasives.
Lucas	(3)	(3)	Cement, stone, sand and gravel, clay.
Madison	(3)	(3)	Sand and gravel, stone, clay.
Mahoning	(3)	(3)	Coal, stone, clay, sand and gravel, peat.
Marion	(3)	(3)	Stone, sand and gravel, clay.
Medina	(3)	(3)	Sand and gravel, clay.
Meigs	(3)	(3)	Sand and gravel, coal, salt.
Mercer	(3)	(3)	Stone.
Miami	(3)	(3)	Stone, sand and gravel, peat.
Monroe	(3)	(3)	Sand and gravel, stone.

See footnotes at end of table.

TABLE 10.—Value of mineral production in Ohio, by counties [1] [2]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Montgomery	$4,091,738	$4,057,432	Sand and gravel, stone, lime.
Morgan	(3)	(3)	Coal, sand and gravel.
Morrow	254,465	129,100	Sand and gravel.
Muskingum	(3)	(3)	Cement, coal, stone, sand and gravel, clay.
Noble	(3)	(3)	Coal, stone, clay.
Ottawa	8,097,381	7,764,195	Lime, stone, gypsum, gem stones.
Paulding	(3)	(3)	Cement, stone, clay.
Perry	(3)	(3)	Coal, sand and gravel, clay, stone.
Pickaway	(3)	(3)	Sand and gravel.
Pike	(3)	(3)	Stone, sand and gravel.
Portage	4,313,569	4,438,268	Sand and gravel, stone, coal, clay, peat.
Preble	(3)	(3)	Lime, sand and gravel, stone.
Putnam	442,115	415,804	Stone, clay.
Richland	(3)	(3)	Sand and gravel, clay, peat.
Ross	(3)	841,654	Sand and gravel, stone.
Sandusky	17,941,560	17,019,936	Lime, stone, sand and gravel.
Scioto	(3)	(3)	Stone, clay, sand and gravel.
Seneca	(3)	(3)	Lime, stone, clay.
Shelby	(3)	426,504	Sand and gravel, stone.
Stark	11,857,316	10,767,157	Cement, coal, clay, sand and gravel, stone, peat.
Summit	12,292,033	(3)	Salt, lime, cement, sand and gravel, clay, stone, peat, gem stones.
Trumbull	225,257	246,840	Sand and gravel.
Tuscarawas	14,050,236	13,056,405	Coal, clay, sand and gravel, stone.
Union	(3)	(3)	Stone, sand and gravel.
Van Wert	(3)	(3)	Stone, clay.
Vinton	(3)	1,226,809	Coal, clay, stone.
Warren	315,611	689,971	Sand and gravel.
Washington	(3)	(3)	Coal, sand and gravel, abrasives.
Wayne	(3)	(3)	Salt, sand and gravel, coal, clay.
Williams	(3)	(3)	Sand and gravel, clay.
Wood	(3)	(3)	Stone, clay, gem stones.
Wyandot	(3)	(3)	Stone, lime, sand and gravel, peat, clay.
Undistributed [4]	[5] 189,740,822	213,060,441	
Total	397,326,000	389,828,000	

[1] Fulton County not listed as no production was reported.
[2] Natural gas and petroleum not listed by counties as data are not available; included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Includes natural gas and petroleum, some gem stones and sand and gravel (1960) that cannot be assigned to specific counties and value indicated by footnote 3.
[5] Revised figure.

Allen.—Suevers' Stone Co., Delphos; Bluffton Stone Co., Bluffton, and Western Ohio Stone Co. and National Lime & Stone Co., both near Lima, produced limestone for roadstone, concrete aggregate, railroad ballast, and agstone. Bluffton Stone Co. installed an automatic feeder to improve operating efficiency.

Ashland.—Sand and gravel was recovered near Ashland, Loudonville, and Polk. Most of the output was processed gravel used for road maintenance and repair. The E. Bigelow Co. mined shale near New London for manufacturing heavy clay products.

Ashtabula.—Sand and gravel used in building and highway construction was recovered near Ashtubula, Conneaut, Kingsville, and Richmond. Processed molding sand was produced at Conneaut.

Athens.—Output of coal decreased; 14 mines (12 underground and 2 strip) were active, compared with 16 mines in 1959. Gem Coal Co. cleaned coal by wet washing at its No. 255 plant. Diamond Stone Quarries, Inc., and Shamrock Quarries, Inc., both near Albany, continued to quarry limestone for concrete aggregate and roadstone. Ball & Ball mined limestone for concrete aggregate, roadstone, and agstone at a quarry near Amesville. Plastic fire clay was mined near

Nelsonville and shipped to plants in Hocking County for manufacturing building brick and other heavy clay products. Athens Building Material Co. (Athens) and Slater Sand & Gravel (The Plains) produced sand and gravel for building and paving purposes.

Auglaize.—Sand and gravel used chiefly for structural and paving purposes was produced by Wapak Sand & Gravel Co., Western Ohio Stone Co., and Quality Sand & Gravel & Ready Mix Co., all near Wapakoneta. Bank run gravel for paving was produced near Jackson Center. Limestone was mined and prepared for use as concrete aggregate, roadstone, railroad ballast, and agstone by National Lime & Stone Co. at its Buckland quarry. Sandkuhl Tile Co. mined clay near Spencerville for manufacturing heavy clay products.

Belmont.—Belmont County continued as the second ranking coal-producing area with an output of 6 million tons. Seventy percent of the production came from 16 underground mines; the remainder came from 22 strip and 8 auger mines. Seven cleaning plants processed 3.8 million tons of coal. In addition, 2.7 million tons were crushed, and 365,000 tons were treated with calcium chloride or oil. George and C. H. McCort (Malaga) and Somerton Crushing Co. (Somerton) continued to mine limestone for use as concrete aggregate, roadstone, and agstone.

Brown.—The Brown County Highway Department mined and prepared limestone for road construction and maintenance. Howard S. Watson (Georgetown) produced bank-run gravel.

Butler.—Butler County continued to rank fourth in sand and gravel production. Commercial output from 11 sand and gravel plants totaled 2.6 million tons, compared with 2.5 million tons in 1959. Output by Government-and-contractor operations dropped from 497,000 tons in 1959 to 107,000 tons.

Carroll.—Coal production totaled 493,000 tons, 16 percent higher than in 1959. Sixteen mines (9 strip, 4 underground, and 3 auger) were active, compared with 18 mines in 1959. Plastic fire clay and shale were mined from four pits near Magnolia. Mineral City Sand Co. produced molding and other sand at Mineral City. The Ames crushed stone plant (Cadiz) of the Hanna Coal Co., Division of Consolidation Coal Co., remained idle, but a small quantity of stone was shipped from stockpiles.

Champaign.—American Aggregates Corp. produced paving sand and gravel and railroad ballast gravel at Urbana. Sand and gravel also was recovered by Miller Excavating Service (Urbana) and Walter Dorsey (Springhill).

Clark.—Sand and gravel, chiefly processed material for construction and paving, was recovered at 9 operations. Output was centered near Springfield, New Carlisle, and Enon. Moores Lime Co. mined limestone at Durbin for use as blast-furnace flux, aggregate, agstone, and raw material for manufacturing lime and dead-burned dolomite. The four coal-fired shaft kilns produced dead-burned dolomite for refractory uses and both quicklime and hydrated lime for construction, agriculture, and a variety of chemical and industrial applications. The output was shipped to 24 States and exported to Canada and India.

Clermont.—Ohio Gravel Co. processed sand and gravel at its Miamiville plant.

Clinton.—Melvin Stone Co. quarried limestone near Melvin. The prepared stone was sold for aggregate, open-hearth flux, agstone, and riprap. Delivery was made by waterway and railroad. Melvin Stone Co. produced sand and gravel for building and highway construction at Melvin. Other sand and gravel producers were Clinton Gravel Co. (Clarksville) and Dick Curtis Gravel Pit (Wilmington).

Columbiana.—Coal production totaled 1.4 million tons, compared with 1.6 million tons in 1959. Fifty-one mines (36 strip, 8 auger, and 7 underground) were active compared with 42 mines in 1959. Columbiana County, with eight active pits in the eastern part of the county continued to rank second in value of clays. Fire clay and miscellaneous clay were recovered. Sand and gravel was recovered from three operations near Leetonia and one near Salem. Sandstone was mined and crushed for use as roadstone by Sandy Beaver Stone Co., Hanoverton.

Coshocton.—Coal output increased 5 percent and totaled 1.8 million tons. Nineteen mines were active; the same number as in 1959. Seven companies operated crushing plants. Blocks of sandstone were produced at four quarries by Brier Hill Stone Co., Glenmont. The blocks were sawed for architectural applications and for use as firestone in steel mills. Sandstone blocks also were produced by Variegated Quarries Division, Nicholl Stone Company; sawing was done at the company-owned fabricating plant in Holmes County. Sand and gravel output totaled 483,000 tons, a slight increase over that of 1959. Output consisted chiefly of processed material used for paving.

Crawford.—Limestone produced at the Spore quarry by National Lime & Stone Co., Bucyrus, was crushed and prepared for use as aggregate, metallurgical stone, agstone, and railroad ballast. About half was shipped by truck and half by railroad. Crawford County Highway Department also produced limestone for road building and maintenance. Sand and gravel for building, paving, and fill purposes was produced by Galion Gravel Co. (Galion).

Cuyahoga.—Commercial sand and gravel production totaled 791,000 tons, a 23-percent increase over 1959. Output by Government-and-contractor operations dropped from 150,000 tons to 46,000 tons. Commercial production was mostly processed material and came from nine operations. Miscellaneous clay and shale, produced at seven operations, was used mainly for manufacturing building brick and lightweight aggregate. Crude perlite that was shipped from Colorado, Nevada, and New Mexico was expanded at the Cleveland plant of Cleveland Gypsum Co. Output was used as plaster and concrete aggregate and for soil conditioning. Cuyahoga Lime Co. completed its $1.5 million lime plant and planned to begin operating it early in 1961.

Darke.—Seven sand and gravel operations were active during the year. American Aggregates Corp. (Fort Jefferson) was the leading producer. Output was used mostly for highway construction. Darke County Tile Co. (Greenville) and R. E. Clark (Versailles) mined clay for manufacturing heavy clay products. Calcareous marl mined and prepared by Woodrow Gary near New Madison was sold for agricultural purposes.

Defiance.—Sand and gravel was produced by Ohio Materials, Inc. (Hicksville), and Northwest Materials, Inc. (Defiance).

Delaware.—Marble Cliff Quarries Co. (Powell), The Owens Stone Co. (Ostrander), and Penry Stone Co. (Radnor) produced limestone for concrete aggregate, roadstone, agstone, and riprap. Scioto Lime & Stone Co., Delaware, mined limestone for a company-owned lime plant and crushed stone for sale as concrete aggregate, roadstone, and railroad ballast. Both quicklime and hydrated lime, produced in a coal-fired rotary kiln, were sold, principally for metallurgical use in open-hearth furnaces and for the treatment of sewage and water. Some hydrated lime was sold for agricultural purposes and construction. The lime was consumed mostly in Ohio, but shipments were made to West Virginia and Indiana.

Delaware Clay Co. (Westerville) and The Galena Shale Tile & Brick Co. (Galena) mined shale for manufacturing building brick. Sand and gravel was produced by Government-and-contractor operations for the State of Ohio Highway Department.

Erie.—Cement manufacturing at the Bay Bridge plant of Medusa Portland Cement Co. was discontinued September 30 because of the depletion of the calcareous marl deposit, which had served as a source of raw material since the plant was built in 1892. In addition, the plant had become obsolete. New loading and unloading equipment was installed to provide facilities for using the cement silos for bulk warehousing of cement manufactured at other Medusa plants. Portland and masonry cements were manufactured during the first 9 months of the year from calcareous marl and shale that was mined by the company and limestone that was purchased. Output was consumed in Ohio, Michigan, and Indiana.

Sandusky Crushed Stone Co., Inc. (Parkertown), Wagner Quarries Co. (Sandusky), and Castalia Quarries Co. (Castalia) produced limestone used principally for concrete aggregate, roadstone, and railroad ballast. The stone also was used for agstone, stone sand, riprap, filter beds, fill, and cement manufacture. Foundry sand was produced by Ohio Foundry Sand Co. (Shinrock) and Keener Sand & Clay Co. (Huron).

Fairfield.—Output of sand and gravel, used mainly for highway and building construction, decreased 25 percent from that of 1959. Most of the production came from operations near Lancaster and Reynoldsburg.

Fayette.—Limestone, produced from quarries near Washington Court House by Sugar Creek Stone Co., Fayette Limestone, Inc., and Blue Rock, Inc., was used for building and highway construction, agstone, railroad ballast, and riprap. Specimens of pyrite and sphalerite were recovered from the Blue Rock quarry.

Franklin.—Franklin County was replaced by Hamilton County as the leading sand and gravel producer. Commercial output decreased 18 percent and totaled 3.7 million tons. Twelve operations, mainly near Columbus, were active. Limestone mined by Marble Cliff Quarries Co. (Columbus) was used for concrete aggregate, roadstone, riprap, agstone, railroad ballast, blast-furnace flux, and lime manufacture. The company manufactured quicklime and hydrated lime principally for chemical and other industrial uses, but part of the

output was sold for mason's lime and agricultural use. Most of the lime was consumed in Ohio. The Columbus Clay Manufacturing Co. and The Claycraft Co., both near Blacklick, mined shale for manufacturing heavy clay products.

Gallia.—Coal production totaled 868,000 tons, a slight increase over 1959. The number of active mines (16 underground, 8 strip, and 5 auger) increased from 26 to 29. Construction sand and gravel and blast sand were produced near Gallipolis. Molding sand was recovered near Kerrs. James Merry Stone Co. (Bidwell) quarried limestone for concrete aggregate, roadstone, and riprap. Jess Brammer mined shale near Waterloo for manufacturing floor and wall tile.

Geauga.—Construction and industrial sand, and ground sand, were produced at Thompson by R. W. Sidley, Inc. Other construction sand was produced near Aurora, Newbury, Novelty, and Parkman. Quartzite was produced near Thompson by Harbison-Walker Refractories Co. for use in making refractory brick.

Greene.—Greene County continued to rank first in cement production. Producers were Southwestern Portland Cement Co. and Universal Atlas Cement Division of United States Steel Corp., both near Fairborn. Both companies mined limestone and clay, and Universal also mined sand as raw materials for cement. Types I–II (general use) and Type III (high-early-strength) portland cement and masonry cement were made by both companies; Southwestern also made waterproof portland cement. Shipments were principally to destinations in Ohio, Indiana, and Kentucky. A bag filter system was installed at the Universal Atlas Cement Co. plant to eliminate the discharge of dust through the stacks. Greene County commercial sand and gravel output totaled 1.1 million tons, 20 percent less than in 1959. Government-and-contractor production increased and totaled 42,000 tons. Commercial production came from 11 operations.

Guernsey.—Coal output decreased slightly from 1959 and totaled 242,000 tons. Eleven mines (7 strip and 4 underground) were active, the same number as in 1959. A & N Mining, Inc., cleaned coal by jigs at its Montgomery cleaning plant. John Gress Co. mined and crushed dolomite for roadstone at its New Concord quarry.

Hamilton.—Hamilton County was the leading sand and gravel producer. Commercial output increased 9 percent and totaled 3.8 million tons; production by Government-and-contractor operations increased 57 percent. Twelve commercial producers were active. Ohio Gravel Co. mined and crushed dolomitic limestone for agstone at its Newtown and Camp Dennison quarries. Southwestern Portland Cement Co. purchased a tract of land near Addyston for a distribution plant.

Hancock.—Pifer Stone Co. produced limestone from a quarry near Williamstown, and two limestone quarries near Findlay were operated by The Tarbox-McCall Stone Co. and National Lime & Stone Co. Stone was sold for concrete aggregate, roadstone, railroad ballast, and agstone. Miscellaneous clay was mined at Findlay by Hancock Brick & Tile Co. Calcite specimens were recovered near Van Buren by an amateur collector.

Hardin.—Dolomitic limestone was mined by The Hardin Quarry Co. (Dunkirk) and Herzog Lime & Stone Co. (Forest) for concrete

aggregate, roadstone, blast-furnace and open-hearth flux, agstone, and railroad ballast.

Harrison.—Harrison County continued to lead the State's 25 coal-producing counties. Output totaled 7.4 million tons, 3 percent less than in 1959. Sixty-four percent of the output came from nine strip mines; the remainder came from six underground and four auger mines. Most of the coal was cleaned at the Georgetown plant of Hanna Coal Co. Division, Consolidation Coal Co., and the Nelms plant of Youghiogheny & Ohio Coal Co. In addition, a substantial quantity of coal was crushed and treated for dust preventative and antifreezing. Hanna Coal Co. Division, Consolidation Coal Co., Cadiz, continued to quarry dolomitic limestone for concrete aggregate, roadstone, and agstone. Bowerston Shale Co. (Bowerston) mined shale for manufacturing farm draintile.

Henry.—Sand and gravel was produced by Turkey Foot Sand and Gravel and Napoleon Sand & Gravel Co., both near Napoleon. August Honeck & Son (Malinta) and Napoleon Brick & Tile Works (Napoleon) mined clay for manufacturing draintile.

Highland.—Limestone was mined for construction and agricultural uses by Highland Stone Division, Davon, Inc. (Hillsboro), Ohio Asphaltic Limestone Co., Inc. (New Vienna), and Marshall Quarry (Marshall). Sand and gravel was recovered from pits near Greenfield and Hillsboro. Miscellaneous clay for manufacturing draintile and building brick was mined by Mowrystown Brick & Tile Co. (Mowrystown).

Hocking.—Coal output totaled 63,000 tons and came from six underground, five strip, and two auger mines. Plastic fire clay and miscellaneous shale used entirely for manufacturing brick were mined by General Hocking Brick Co. (Logan). Natco Corp. manufactured brick and heavy clay products at its Haydenville plant. Building sand and gravel was produced near Logan by Donahey Bros. The Enterprise plant of F. H. Brewer Co. was idle.

Holmes.—Briar Hill Stone Co. quarried sandstone for architectural use at three localities near Glenmont and one near Killbuck. Variegated Quarries Division, The Nicholl Stone Co. produced sandstone blocks at its Richland Township quarry and operated a plant at which it sawed the material as well as sandstone blocks produced at Gobblers Knob in Coshocton County. The output was used for architectural stone. Holmes Clay Division of The Holmes Limestone Co., Berlin, mined and crushed dolomitic limestone for agstone. Clay was recovered near Berlin and Baltic. Output consisted mainly of plastic fire clay used for manufacturing building brick and refractories and as rotary-drilling mud. Production of coal decreased from 95,000 tons in 1959 to 83,000 tons. One underground and five strip mines were active. Construction sand and gravel was recovered from two pits near Millersburg and one pit near Berlin.

Huron.—Mainly paving sand and gravel was produced at the Willard plant of Huron Sand & Gravel Co. Humus peat was recovered from bogs near Willard by Mel-lo Peat Co. Salisbury Pottery, Inc., mined clay for manufacturing pottery near Monroeville.

Jackson.—Coal output from 11 strip and 6 underground mines totaled 314,000 tons, 19 percent greater than in 1959. Waterloo Coal

Co. cleaned coal by wet washing at its Waterloo plant. Fire clay used chiefly for refractory purposes was recovered at four operations near Oak Hill. Pennsylvania Glass Sand Corp. produced industrial sands for a wide variety of uses near Jackson. Other sand and gravel also was produced near Jackson. Waterloo Coal Co., Oak Hill, mined and crushed limestone for building and highway construction.

Jefferson.—Output of coal was virtually the same as in 1959; the number of active mines remained at 50. Jefferson County continued to rank third in coal output. Seventy percent of the coal was strip-mined, 24 percent was mined underground, and 6 percent came from auger mines. Coal was cleaned at the Piney Fork plant of Hanna Coal Co. Division, Consolidation Coal Co. and the Jennie plant of North American Coal Corp. Coal produced by Yougiogheny & Ohio Coal Co. was shipped to the Dorothy cleaning plant (company-owned) in Belmont County. Fire clay and miscellaneous clay and shale were recovered principally near Irondale and Toronto. Output from seven operations was used mainly for firebrick and block and for manufacturing vitrified sewer pipe. Duquesne Sand Co. operated a sand and gravel dredge on the Ohio River near Brilliant. Freeport Quarries, Inc., Stuebenville, produced sandstone rubble at its quarry near Hammondsville for use in a dam at Stratton.

Knox.—Sand and gravel production totaled 750,000 tons, a 23-percent decrease from 1959. Seven producers were active and recovered mainly construction material. Blast and molding sand was produced near Howard. Briar Hill Stone Co. quarried sandstone near New Castle, Cavallo, and Brinkhaven. The output was sawed and dressed for architectural stone and for use as firestone in steel mills.

Lake.—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, and Type III, high-early-strength portland cement, and masonry cement were produced in the four-kiln plant. Output was consumed in Ohio and Pennsylvania. Diamond Alkali Co. also operated a lime plant at Painesville where quicklime made in coke-fired shaft kilns and salt brine from nearby wells were used in manufacturing chlorine and alkalis. Morton Salt Co. completed its first full year of production at its Fairport underground salt mine near Painesville. Sand and gravel output from 11 operations increased sharply. Most of the sand and gravel was used for paving and fill.

Lawrence.—Marquette Cement Manufacturing Co. mined limestone and shale near Bear Run to supply its cement plant at Superior. Cement rock (shaley limestone) and sandstone were mined by Alpha Portland Cement Co. for making cement at its Ironton plant. Both companies used the dry process to make regular and air-entrained portland cement and masonry cement. Output of both companies was consumed in Ohio, West Virginia, Kentucky, and Virginia. The Alpha Portland Cement Co. Ironton mine was awarded a Certificate of Achievement in Safety by the Federal Bureau of Mines. Mine employees worked 160,528 man-hours in 1960 without a lost-time injury. Limestone was mined and crushed for roadstone by O. K. Limestone Co. at a quarry near Pedro. Lawrence County Highway Department mined and crushed limestone for road construction and

repair. Over 449,000 tons of coal was recovered from four strip mines. Output of clay (mostly fire clay) was reported from 10 operations principally near Ironton, Blackfork, and Pedro. Sand and gravel was produced at Chesapeake by Wilson Sand & Gravel Co.

Licking.—Output of sand and gravel increased 6 percent to 648,000 tons. Thirteen sand and gravel operations were active, mainly near Newark and Granville. Amateur mineral collectors reported recovering 200 pounds of jasper and 25 pounds of Ohio flint near Flint Ridge.

Logan.—Northwood Stone & Asphalt Co. (Belle Center) and C. E. Duff & Son, Inc. (Huntsville), quarried limestone chiefly for concrete aggregate and roadstone. Part of the production was used for asphalt filler, agstone, and riprap. The East Liberty quarry of National Lime & Stone Co. was idle, but shipments were made from stock. Sand and gravel was recovered at five operations and used chiefly for construction.

Lorain.—Lorain County ranked second in value of sandstone production, most of which was sawed for architectural and refractory applications. Cleveland Quarries Co., Amherst, and The Nicholl Stone Co., Kipton, quarried and sawed sandstone into blocks for use as wall stone, ashlar, and furnace lining. The latter company also produced grindstones. Stone & Equipment, Inc., Amherst, mined and crushed sandstone for concrete aggregate, roadstone, filler, and riprap. Construction sand and gravel was recovered near Amherst and Lorain. Crude gypsum was calcined for finished building materials at the newly completed Lorain plant of National Gypsum Co.

Lucas.—Medusa Portland Cement Co. mined limestone, sand, and miscellaneous clay for use in making cement at its plant near Toledo. Types I–II, general use, portland cement were manufactured and shipped to consumers in Ohio, Michigan, Indiana, and Wisconsin. Maumee Stone Co. (Maumee), Toledo Stone & Glass Sand Co. (Sylvania), and the France Stone Co. (Waterville) mined and crushed limestone principally for use as concrete aggregate and roadstone. Small quantities were sold for agstone, railroad ballast, and riprap. The Toledo House of Correction near Whitehouse produced a small quantity of rough blocks, rubble, and riprap from its limestone quarry. Construction sand and gravel was produced near Toledo.

Madison.—Construction sand and gravel was produced by The West Jefferson Sand & Gravel Co. (West Jefferson) and McMullen Sand & Gravel Co. (Mt. Sterling). Madison Stone Co., Inc., Galloway, produced dolomitic limestone for concrete aggregate and roadstone. A small quantity of limestone was sold for agstone and riprap. Miscellaneous clay for manufacturing building brick and draintile was produced.

Mahoning.—Coal output totaled 907,000 tons, a slight increase over that of 1959. Sixteen strip mines were active, compared with 17 in 1959. Carbon Limestone Co. mined and crushed limestone at a quarry near Lowellville for open-hearth flux and other metallurgical uses, concrete aggregate, roadstone, and agstone. Stone also was sold for coal-mine dusting, additive in livestock feed, paint filler, and poultry grit. Output of clays produced near Beloit, Canfield, and Youngstown, was used in refractories and for manufacturing building brick. Construction sand and gravel was produced by Gurlea Sand & Gravel

Co. at Salem. Reed-sedge and humus peat were recovered from bogs near Damascus and Beloit, respectively.

Marion.—National Lime & Stone Co. and J. M. Hamilton & Sons Co., both of Marion, and Tri-County Stone Co., LaRue, quarried limestone for concrete aggregate, roadstone, agstone, and railroad ballast. Sand and gravel used chiefly for building was produced near Prospect. Clays were produced by Marion Brick Corp. (Iberia) and LaRue Tile Co. (LaRue).

Medina.—Sand and gravel was produced near Lodi, Medina, Seville, and Wadsworth. Wadsworth Brick & Tile Co. (Wadsworth) mined fire clay and shale for manufacturing brick.

Meigs.—Tri-State Materials, Corp. (Pomeroy), Richards & Son, Inc. (Apple Grove), and Goeglein Gravel Co. (Middleport) produced construction sand and gravel. Twelve coal mines (seven underground, three strip, and two auger) were active. Output totaled 197,000 tons, less than half of the 1959 output. Evaporated salt was produced in open pans at the Pomeroy operation of Excelsior Salt Works, Inc.

Mercer.—The John W. Karch Stone Co. (Selina), and Rockford Stone Co. (Rockford) mined limestone principally for use as concrete aggregate and roadstone; small quantities were sold for agstone and riprap.

Miami.—Armco Steel Corp. produced limestone at its Piqua quarry. The stone was used principally for metallurgical flux and building and highway construction; smaller quantities were used for agstone, filler in rubber and putty, riprap, additive in livestock feed, and various other uses. Sand and gravel output totaled 564,000 tons, 6 percent higher than in 1959. Production was reported near Covington, Ludlow Falls, Piqua, Troy, and Vandalia. Humus peat was produced by Skinner's Soil Conditioners (New Carlisle).

Monroe.—Blaney Sand & Gravel Co., Inc. (Clarington), and Witten Gravel Pit (Woodsfield) produced sand and gravel used exclusively for paving purposes. Christman Quarry Co., Woodsfield, produced limestone for concrete aggregate and roadstone.

Montgomery.—Commercial output of sand and gravel decreased 9 percent and totaled 2.9 million tons; however, Montgomery County continued as the third largest sand and gravel producer. Twenty-six operations, mainly near Dayton, were active. Ninety-one percent of the output was processed material, and nearly all was shipped by truck. Limestone was quarried principally for concrete aggregate and roadstone by Carey Brothers Stone Co. (Dayton), Laura Gravel & Stone Co. (Phillipsburg), and Limestone-Dayton Division of American Aggregates Corp. (Dayton). Laura Gravel & Stone Co. sold part of its production for riprap, blast-furnace flux, and agstone. The City of Dayton Water Department recovered lime in a rotary kiln from waste sludge and the recarbonation of water in a purification and softening process. Surplus lime was sold to other municipalities.

Morgan.—Output of coal decreased 5 percent and came principally from two strip mines. One underground mine, also operated. Most of the output was cleaned at the Roberts and Schaefer plant of

Central Ohio Coal Co. Construction sand and gravel was produced by Stockport Sand & Gravel Co. (Stockport).

Morrow.—Chesterville Sand & Gravel Co. (Chesterville) produced construction sand and gravel.

Muskingum.—Sidwell Bros. (Zanesville) and Chesterhill Stone Co. (East Fultonham) produced limestone for concrete aggregate, roadstone, agstone, and riprap. Chesterhill Stone Co. began constructing an entirely new plant at the same location. Columbia Cement Corp. used limestone mined underground and shale recovered from an open pit for manufacturing cement at its East Fultonham plant. The entire cement output was shipped to consumers in Ohio and West Virginia. Coal production was 591,000 tons, 30 percent more than in 1959. Eight underground, six strip, and three auger mines were active. Sand and gravel was produced by Zanesville Gravel Co. and Muskingum River Gravel Co. Miscellaneous clay was mined near Dresden and Frazeysburg. Clay for stoneware was mined near East Fultonham and Roseville.

Noble.—Coal production increased 23 percent and totaled 1.8 million tons. Nine strip and three auger mines were active. Central Ohio Co. operated its Cumberland cleaning plant. James Merry Stone Co. (Caldwell) and Herman Zerger, Jr. (Woodsfield) mined limestone principally for concrete aggregate and roadstone. Shale for manufacturing face brick was produced near Ava by Ava Brick Corp.

Ottawa.—Limestone, mostly for concrete aggregate, roadstone, blast-furnace flux, sinter stone, and a small quantity for agstone, was produced by Chemstone Corp. Division of Minerals & Chemicals Philipp Corp. at its Marblehead quarry. Stone for construction came from Chemstone's newly developed bed of aggregate-quality limestone underlying the metallurgical limestone. United States Gypsum Co., Genoa, produced limestone for making lime at its nearby plant and for sale as concrete aggregate and roadstone. Most of the lime was sold hydrated for construction, agriculture, refractory, chemical, and other uses. Basic, Inc., Clay Center, mined dolomite for making dead-burned dolomite and lime and for sale as concrete aggregate and roadstone. The Basic plant used a coal-fired shaft and rotary kilns. Output was consumed principally for refractory uses. Celotex Corp. (Port Clinton) and United States Gypsum Co. (Gypsum) mined crude gypsum for calcining at nearby plants. Mineral specimens of celestite were collected near Clay Center.

Paulding.—Peninsular Portland Cement Division, General Portland Cement Co., mined limestone and shale near Paulding and purchased sand and gypsum for use in manufacturing portland cement at its nearby plant. Peninsular used the wet process to produce general use and high-early-strength portland cement and masonry cements. Output was consumed in Indiana, Ohio, and Michigan. Some of the limestone mined at the Peninsular Portland Division quarry was shipped to the company's plant in Michigan, and some was sold to France Co. (Paulding) for processing and sale for concrete aggregate, roadstone, railroad ballast, and agstone. Auglaize Stone Co., Oakwood, mined limestone for concrete, roadstone, agstone, and blast-furnace flux. Haviland Clay Works Co. (Haviland), and Baugh-

man Tile Co., and Dangler Drain Tile Co., both near Paulding, mined clay for manufacturing draintile.

Perry.—Coal production totaled 1.6 million tons, 26 percent below the 1959 output. Most of the production came from 12 strip mines; 8 underground and 2 auger mines also were active. Peabody Coal Co. (formerly Sunnyhill Coal Co.) operated the Sunnyhill No. 8 and Sunnyhill No. 9 cleaning plants. Sidwell Bros. operated its McNally Norton plant. Central Silica Co. (Glenford) mined sand for foundry, glass, and ceramic uses. Keener Sand & Clay Co. produced foundry sand near New Lexington. Clay (65 percent miscellaneous clay and 35 percent fire clay) was produced at 10 operations. Output was used mainly for building brick, vitrified sewer pipe, glaze structural tile, roofing tile, other heavy clay products, and lightweight aggregate. Production was centered near Gore, Junction City, New Lexington, Saltillo, Somerset, and Shawnee. Maxville Stone Co., Logan, and Beiter Stone Co., Rushville, quarried limestone principally for use in building and highway construction; small quantities were sold for railroad ballast and agstone.

Pickaway.—Construction sand and gravel and railroad ballast gravel were produced at Circleville by The Sturm & Dillard Co.

Pike.—Ralph Rogers & Co. of Ohio, Inc., Latham, produced concrete aggregate, roadstone, and agstone from dolomitic limestone. Cambria Clay Products Co., Jackson, mined sandstone for silica brick at the Big Rock quarry. The Beaver standstone quarry of Harbison-Walker Refractories Co. was idle. Construction sand and gravel was produced at Sargents by The Standard Slag Co. Pyro Refractories Division, A. P. Green Firebrick Co. (formerly Durex Refractories Co.), produced sand and gravel for refractories, and molding and glass sand. Construction gravel also was produced at Lucasville and Waverly.

Portage.—Sand and gravel output increased from 1.8 million tons in 1959 to 2.1 million tons. Most of the output was processed material and came from 25 operations; Ravenna and Mantua were the principal centers. Industrial sand for a wide variety of uses was produced at Aurora, Garrettsville, and Brady Lake. Kaiser Refractories & Chemical Division, Kaiser Chemical & Aluminum Corp.; Harbison-Walker Refractories Co.; and General Refractories Co. (Nelson Ledge) mined quartzite for silica brick. Limestone for highway construction was produced at the Deerfield quarry of City Asphalt & Paving Co. Peterson Coal Co. was the only coal operator (strip mine) active during the year. Output was processed at the company Atwater cleaning plant. United States Concrete Pipe Co. mined shale near Palmyra. Green Oaks Peat Moss Co. and Portage Peat, both near Ravenna, produced peat for sale in bulk.

Preble.—Limestone was mined by Marble Cliff Quarries Co. to supply its Lewisburg lime plant and for agstone, concrete aggregate, roadstone, and blast-furnace flux. Both quicklime and hydrated lime were produced principally for chemical and other industrial uses. White Gravel Co. (Camden), Steiners Sand & Gravel Co., and Blue Bank Gravel Co., both near West Alexandria, produced construction sand and gravel.

Putnam.—Limestone used principally for aggregate was produced by Ottawa Stone Co. (Blanchard Township), National Lime & Stone Co. (Columbus Grove), and The Putnam Stone Co. (Ottawa). Miscellaneous clay used exclusively for draintile was produced by Etter Tile & Coal Co. (Dupont), Glandorf Tile Co. (Glandorf), Miller Bros. Clay Works, Inc. (Ottoville), and Leipsic Clay Products Co. (Leipsic).

Richland.—Four operators produced construction sand and gravel; two near Bellville, and one each near Killbuck and Lexington. Shale for manufacturing brick was produced by Ohio Brick & Supply Co. and Richland Shale Brick Co., both near Mansfield. The county led in output of peat; producers were Reynolds Farms, Inc. (Ganges), and Swank Peat Moss Sales (Shiloh).

Ross.—Sand and gravel for building and highway construction was produced at two plants near Chillicothe, and one each near Bainbridge and Richmondale. Limestone was mined for construction and agstone by the Paint Valley Sand & Gravel Co. near Bainbridge. Southern Silica, Inc. (Richmondale), quarried sandstone for foundry use, glass manufacture, and furnace lining.

Sandusky.—Although totals were lower than in 1959, Sandusky County continued to lead in production and value of limestone. Sandusky County also was first in lime production (including dead-burned dolomite) with output of 904,000 tons valued at $14.9 million. Limestone was produced at nine pits, three each near Gibsonburg and Woodville, and one each near Bellevue, Fremont, and Millersville. Of the 3.1 million tons of limestone mined, 59 percent was used in making lime, 19 percent for concrete aggregate and roadstone, 10 percent for metallurgical flux, and 12 percent for all other uses including agstone, glassmaking, and filler. More than half the lime was dead-burned dolomite used as a refractory by the steel industry. The rest was used in construction, agriculture, chemical, and other industrial applications. Haulage from the National Gypsum Co. Gibsonburg quarry to the lime plant was converted from a combination system, using locomotive and truck, to through haulage by diesel truck. Lime was shipped to all States except Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, Utah, Washington, and Wyoming. Building sand was dredged by the Home Sand & Coal Co. near Fremont.

Scioto.—Scioto County led in value of sandstone produced. Sandstone was quarried and sawed for furnace brick and architectural purposes by Waller Bros. Stone Co. and The Taylor Stone Co., both of McDermott. General Refractories Co. mined and crushed sandstone at the Deever quarry near Portsmouth for use as ganister in silica brick. Fire clay was produced at mines near Minford, Portsmouth, and South Webster. Bank-run sand and gravel was produced near Lucasville.

Seneca.—Tonnage and value of limestone was higher than in 1959, and Seneca County continued to rank second in limestone production. Basic, Inc., made dead-burned dolomite in nine coal-fired rotary kilns at its Maple Grove plant from dolomite mined at its nearby quarry. Dolomite also was sold for concrete aggregate, roadstone, blast-furnace, open-hearth, other metallurgical uses, and agstone. The France Co. (Bloomville) mined limestone for construction, blast-

furnace flux, railroad ballast, and agstone. Northern Ohio Stone Co. (Flat Rock) and Webster Stone Co. (Bloomville) produced rubble and irregular-shaped stone as well as washed limestone for construction and agstone. St. Stephen Tile Co. (St. Stephen) and J. A. Miller Tile Co. (Bascom) produced clay for manufacturing draintile.

Shelby.—Construction sand and gravel was produced by Sidney Sand & Gravel Co. (Sidney), Spring Creek Gravel Co. (Fort Loramie), and The Ernst Gravel Co. (Houston). Miami River Quarries, Inc. (Sidney), produced crushed and broken limestone for construction.

Stark.—Limestone and shale were mined by Diamond Portland Cement Co., Division of The Flintkote Co., for making cement at its Middle Branch plant. Types I–II (general use) and Type III (high-early-strength) portland cements and masonry cement were produced for consumption mainly in Ohio; small quantities were shipped to Pennsylvania and West Virginia. East Ohio Limestone Co. (Hartville), Elmco Limestone & Coal Co. (Canton), and Alliance Stone Co. (Alliance) quarried limestone principally for construction. Coal production increased from 602,000 tons in 1959 to 695,000 tons. Eighteen (seventeen strip and one auger) mines were active during the year. Stark County continued as one of the State's leading clay-producers. Most of the output was fire clay used for refractories and heavy clay products. Seventeen operations were active during the year. Stark County was one of the leading sand and gravel-producing counties, with output exceeding 1.3 million tons. Nineteen operations were active mainly near Canton, Massillon, Navarre, and Uniontown. Some industrial sand was produced at Canal Fulton. Lab Nursery & Peat Moss, Lantz Peat Moss, Inc., and Sanders Peat Moss Co., all near Canton, produced peat for sale in bulk.

Summit.—Diamond Crystal Salt Co. produced evaporated salt and brine from wells at Akron. Evaporated salt was produced in both open and vacuum pans; some was marketed as pressed blocks. Columbia-Southern Chemical Corp., a subsidiary of Pittsburgh Plate Glass Co. (Barberton), used brine pumped from salt wells in manufacturing soda ash and chlorine and to make evaporated salt. The company also produced limestone from its underground mine principally for manufacturing cement and lime at its nearby plants. General use and high-early-strength portland cements were produced in a single rotary kiln by the wet process and consumed mostly in Ohio. Lime, produced in coal and coke-fired shaft kilns, was used by the company in manufacturing chemical products. Columbia-Southern also mined and crushed sandstone in Norton Township for manufacturing glass and for use as concrete aggregate. Sand and gravel output totaled 977,000 tons, 6 percent higher than in 1959. Twelve operations were active, producing mostly construction material. Clay was recovered from three pits, two near Mogadore, and one near Greentown. H. W. Codding & Sons Co. (Copley) mined and packaged reed-sedge peat. An amateur mineral collector reported collecting 300 pounds of celenite crystals near Barberton. Crude perlite shipped from Colorado was expanded at the Akron plant of J. P. Loomis Concrete Supply Co.

Trumbull.—Construction sand and gravel was produced by Kinsman Sand & Gravel Co. (Kinsman) and Harry Miller Excavating Co., Inc. (Warren).

Tuscarawas.—Coal production decreased 4 percent and totaled 2.4 million tons in 1960. Output came from 53 mines (31 strip, 18 underground, and 4 auger). Coal was cleaned by diaphragm jigs and air tables at the Midvale mine of Columbia-Southern Chemical Corp. The county continued to lead in output and value of clay. Seventy-eight percent of the fire clay produced was used for heavy clay products, refractories, and wall tile. Miscellaneous clay was used mainly for manufacturing heavy clay products. Of the 26 active clay mines, 21 were open pit, 4 were undergound, and 1 was a combination open pit and underground mine. Eight sand and gravel operations were active during the year, producing mostly construction material. Industrial sands were produced at plants near Dundee and Gnadenhutten. Limestone for concrete aggregate and roadstone was produced near Dover by Kimball Limestone Co. and near Strasburg by Limestone Aggregates, Inc. Bonum Lime Co. mined limestone at Sugar Creek for agstone. Yoder Stone Co. (Dundee) quarried sandstone in rough blocks for architectural uses.

Union.—L. G. Rockhold & Sons (York Center) and Union Limestone, Inc. (Ostrander), quarried limestone for construction and agstone. Marysville Concrete & Materials, Inc. (Marysville), produced mainly paving sand and gravel.

Van Wert.—Limestone, used principally for concrete aggregate and roadstone was produced by the Union Quarries Co. (Scott), Ridge Township Stone Quarry (Van Wert), and Delphos Quarries Co. (Delphos).

Vinton.—Coal production decreased from 270,000 tons in 1959 to 235,000 tons in 1960. Fourteen mines (seven underground, six strip, and one auger mines) were active. Benedict, Inc., continued operaing its Econocoal cleaning plant. The McArthur Brick Co. mined plastic fire clay and shale for building brick near McArthur. The Zaleski clay pit and plant of Hope Fire Clay Co. was idle. McArthur Stone & Coal Co., McArthur, mined and crushed limestone for concrete aggregate, roadstone, and agstone.

Warren.—Sand and gravel output totaled 637,000 tons, more than double that of 1959. Construction materials chiefly were recovered from eight operations, mainly near Franklin, Loveland, Morrow, Lebanon, and Waynesville.

Washington.—Output of coal decreased 12 percent and totaled 262,000 tons. Most of the output came from two strip mines; three auger mines also were active. Construction sand and gravel was recovered near Little Hocking, Marietta, New Matamoras, and Waterford. The Hall Grindstone Co. (Constitution) produced abrasive stone (grindstone). All operations of the Constitution Stone Co. (Constitution) were terminated. During the year the plant and equipment were scrapped. Plant No. 4 of Chesterhill Stone Co. near Waterford was idle.

Wayne.—Morton Salt Co. produced evaporated salt at Rittman by vacuum and open pans; some was marketed as pressed blocks. Sand and gravel was produced near Doylestown, Marshallville, Rittman,

and Wooster. Most of the output was processed material used for building and paving material. Output of coal from two strip mines decreased. Clay was produced by Medal Brick & Tile Co. (Wooster) and Orrville Tile Co. (Orrville).

Williams.—Sand and gravel was recovered near Blakeslee, Edgerton, Edon, and Pioneer. Stryker Drain Tile Co. mined clay near Stryker.

Wood.—Limestone was produced at five quarries in Milton Township, North Baltimore, West Millgrove, Luckey, and Bowling Green principally for use as concrete aggregate and roadstone. Quantities also were used for agstone and riprap. Perrysburg Brick & Tile Co. (Perrysburg) mined miscellaneous clay for manufacturing building tile and draintile. Calcite crystals and celestite were recovered near Custar by amateur mineral collectors.

Wyandot.—Limestone for aggregate, metallurgical flux, lime, railroad ballast, agstone, and other uses was mined and prepared at the Carey plant of National Lime & Stone Co. The company produced quicklime, principally for glass, in its coal fired-shaft kilns and shipped the output to 21 States and Canada. Small quantities of lime were used for construction, agriculture, and chemical and industrial applications. Limestone also was produced by J. L. Foucht Quarry near Upper Sandusky for concrete aggregate, roadstone, and agstone. Sand and gravel was recovered from pits mainly near Upper Sandusky. The Humus Co. (Carey) mined humus peat for sale in packages and bulk. Shale for manufacturing building brick was produced at the Upper Sandusky operation of The Claycraft Co.

The Mineral Industry of Oklahoma

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey.

By Robert B. McDougal,[1] Peter Grandone,[1] and William E. Ham [2]

FOURTEEN minerals and 5 mineral fuels produced in 76 of 77 counties in 1960 were valued at $779.1 million, $13.7 million more than in 1959. Nationally, Oklahoma ranked fourth as a producer of crude petroleum and third as a producer of natural gas and natural gas liquids. Cement, coal, gypsum, sand and gravel, and stone were produced in large quantities. Output of lead and zinc, which had been lagging in recent years, increased appreciably.

Value of the mineral fuels—petroleum, natural gas, natural gas liquids, coal, and helium—represented 95 percent of the total value of minerals produced. Only 5 percent of the total value was furnished by nonmetals and metals. Petroleum and natural gas were produced individually or together in 68 of 77 counties, nonmetals in 70 counties, and metals (lead and zinc) in Ottawa County only. Oil and natural gas were produced in a broad belt extending from the northeastern to the southwestern and western parts of the State; helium was recovered in Cimarron County. Nonmetals were mined in widely distributed parts of the northeast, north-central, and central regions, and in the southern part in the Arbuckle and Wichita Mountain areas.

Employment and Injuries.—Mineral industries in Oklahoma employed 45,100 persons in 1960, a 5-percent decline from 1959. Under the Oklahoma Employment Security Act, which covers establishments that employ four or more persons, the mineral industries paid $256.4 million in wages to 43,500 persons in 1960.

Consumption and Markets.—A significant part of the mineral output was processed by Oklahoma industries into semifinished and finished products for intrastate use or interstate shipments. These industries included oil refineries; natural gasoline and cycle plants which stripped condensable liquids from natural gas; a helium extraction plant; zinc smelters that reduced zinc concentrate mined partly in Oklahoma; brick, tile, pottery, glass, and cement plants that used clays, shales, silica sands, and limestone mined in Oklahoma; and producers of building materials made of Oklahoma gypsum. Large quantities of natural gas and petroleum were transmitted by pipelines

[1] Commodity-industry analyst, Bureau of Mines, Bartlesville, Okla.
[2] Geologist, Oklahoma Geol. Survey, Norman, Okla.

to industrial areas of the Eastern and North Central States. Ammonia was produced from natural gas, carbon black from petroleum distillate, and high-energy fuel from petroleum hydrocarbons reacted with sodium and boric acid.

TABLE 1.—Mineral production in Oklahoma [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	966	$970	734	$739
Coal do	1,525	10,272	1,342	9,113
Helium thousand cubic feet	98,749	1,619	289,069	4,691
Lead (recoverable content of ores, etc.) short tons	601	138	936	219
Natural gas million cubic feet	811,508	81,151	824,266	98,088
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	448,353	29,443	531,995	33,074
LP gases do	675,869	27,070	762,258	32,409
Petroleum (crude) thousand 42-gallon barrels	198,090	578,423	[3] 192,288	[3] 561,481
Salt thousand short tons	(4)	(4)	3	16
Sand and gravel do	6,002	5,927	6,424	7,468
Stone do	12,683	14,980	[5] 14,054	[5] 16,098
Zinc (recoverable content of ores, etc.) short tons	1,049	241	2,332	602
Value of items that cannot be disclosed: Asphalt (native), bentonite, cement, gem stones, gypsum, lime, pumice, stone (crushed granite), tripoli, and values indicated by footnote 4		18,156		16,756
Total Oklahoma [6]		[7] 765,439		779,116

[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."
[3] Preliminary figure.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Excludes crushed granite; included with "Value of items that cannot be disclosed."
[6] Total adjusted to eliminate duplicating value of clays and stone.
[7] Revised figure.

TABLE 2.—Annual average employment in the mineral industries

(Thousands)

Industry	1951–55 (average)	1956	1957	1958	1959 [1]	1960 [2]
Oil and gas drilling and production	44.54	49.4	48.8	45.8	45.0	42.4
Coal mining	1.48	1.1	1.1	.9	.9	.8
Other mining	2.42	2.4	1.9	1.8	1.8	1.9
Total	48.44	52.9	51.8	48.5	47.7	45.1

[1] Revised figures.
[2] Preliminary figures.

Source: Oklahoma Employment Security Commission, Handbook of Oklahoma Employment Statistics, 1939–60, 48 pp.

Demand for Oklahoma crude petroleum continued to decline and at yearend the total produced was about 3.4 million barrels less than in 1959. Under State regulatory control, the output maintained a close balance with demand and stocks.

Continued low prices kept lead and zinc mines closed throughout 1960. However, miners in the Tri-State District received some encouragement in December when both American Zinc, Lead & Smelting Co. and The Eagle-Picher Co. announced plans to reopen their custom

mills early in 1961. The Eagle-Picher Co. treated only slimes in its Bird Dog mill in 1960.

Total construction (residential, nonresidential, and public works) increased 5 percent over 1959 as a result of a favorable showing in construction activity in the fourth quarter of 1960. Public works construction volume was 6 percent below 1959 despite increases attributed to the new State office building, the pipeline from the Atoka Reservoir, and a small increase in highway construction. Demands for sand and stone increased, whereas those for cement and gypsum decreased. The demand for lime, used primarily as a chemical by the Pryor industries and by municipal water-treating plants, declined for the third consecutive year.

Trends and Developments.—Recoverable petroleum reserves continued to decline though the outlook remained promising. Gas reserves continued to increase. Another successful oil- and gas-discovery year was recorded as a result of widespread drilling; 213 of 700 exploratory wells proved productive. Kingfisher County was the most prolific with 21 new discoveries; Beaver County was next with 15, and Carter, Cleveland, McClain, and Osage Counties had 10 each. The Anadarko basin in western Oklahoma was the site of much drilling activity for oil and gas. The new gas reserve of the Arkoma basin in southeastern Oklahoma was further developed by the completion of seven exploratory and six field wells.

The Sunray Mid-Continent Oil Co. new gas-products plant in the Criner area of McClain County underwent a $750,000 expansion to increase its throughput capacity from 5 million to nearly 30 million cubic feet of gas per day. This plant was placed onstream in 1959.

In April, D–X Sunray Oil Co. began a $1.6 million, two-phase modernization program at its Duncan refinery. The first phase consisted of a new steam generator and modification of the catalytic cracking unit; the second phase improved the efficiency of the gas recovery unit. Propane-proplyene and butane-butylene hydrocarbons were produced by the unit. The company announced plans to erect a new 85,000-barrel-per-day crude oil distillation unit at its Tulsa refinery, scheduled to go onstream in 1962, and designed to reduce costs and increase efficiency. It will replace five old crude oil units with a combined capacity of 75,000 barrels per day. A $1 million petrochemical plant to produce 610 barrels of benzene and up to 1,100 barrels of toluene daily was placed in operation at the company Tulsa refinery during 1960—its first entry into the petrochemical field.

Mid-Continent Pipeline Co. completed a 100-mile crude oil gathering pipeline in northwest Oklahoma early in the year. About 100 oil leases in Alfalfa and Grant Counties were served by the line.

Mid-America Pipeline Co. completed its LP gas pipeline from Hobbs, N. Mex., through the Oklahoma Panhandle, to the Conway storage facility near McPherson, Kans., as part of a system extending into Minnesota and Wisconsin. The entire system was controlled from Tulsa.

At Ponca City, Continental Oil Co. began operating a $1 million petrochemical plant to produce over 20 million gallons of cyclohexane annually. The company also announced plans for a $2.2 mil-

lion expansion of its Ponca City research and development facilities to be completed by early 1962.

Two wells of British American Oil Producing Co. in southern Oklahoma were reported to hold world records for the deepest, successful, hydraulic-fracturing treatment. In the Knox-Bromide field of Grady County the company's No. 1 Baker was treated in the Second and Third Bromide sands at a depth of 15,758 feet. In the Stephens County sector of the Knox-Bromide field, the company's No. 1 Brickel was treated in the same formation at a depth of 15,824 feet.

Dewey Portland Cement Co., division of American-Marietta Corp., continued construction of its $12 million plant near Tulsa. At Pryor, Oklahoma Cement Co. put its $8 million plant onstream and made its first shipment in July—about 14 months after start of construction. The company had purchased the assets of the defunct Ozark Portland Cement Co., which in 1956 was erecting a plant at Locust Grove. (See Minerals Yearbook, 1956, Volume III, p. 912.)

At Muskogee, an addition to the plant of Corning Glass Works raised the plant capacity about 50 percent.

The U.S. Army Corps of Engineers, Tulsa District, had three multimillion dollar public works projects in progress—the Eufaula dam on the South Canadian River between Haskell and McIntosh Counties, the Oologah dam on the Verdigris River in Rogers County, and the Keystone dam on the Arkansas River in Tulsa County.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Oklahoma continued as an important producer of natural gas and crude petroleum and furnished a major supply of refined petroleum products in 1960. A substantial quantity of low-ash bituminous coal was produced.

Coal.—Output of coal declined 11 percent, partly because of the closing of the Lone Star Coal Co. Pittsburg County facilities in August. Twenty-two operators mined coal in nine counties. Haskell, Rogers, and Sequoyah Counties each reported output exceeding $1 million in value. Of the 1.3 million short tons produced, 13 operators supplied 82 percent from 15 strip mines, and 10 operators supplied the remainder from 11 underground mines.

Helium.—The new helium plant operated by the Federal Bureau of Mines at Keyes extracted 293.6 million cubic feet of helium from natural gas. Shipments totaled 289.1 million cubic feet valued at $4,690,833.

Natural Gas.—Oklahoma ranked third in marketed output of natural gas. Production was reported from 65 counties, of which Texas, Garvin, Beaver, Harper, and Grady Counties led, in that order. Searching for more reserves, the industry completed 434 gas wells of 4,802 wells of all types drilled, according to The Oil and Gas Journal. Exploratory drilling alone resulted in 65 gas discoveries from 700 exploratory tests. Interest in the Anadarko and Arkoma basins continued to run high throughout the year. In the Anadarko basin

(northwest area), Kingfisher County was the Nation's busiest single drilling locality. Nearly 80 locations were being drilled in the oil and gas boom area where the success ratio of test wells was in the 90-percent range. Prolific, multizone completions highlighted the rapid development of Mississippian and Pennsylvanian reservoirs. The southeast Oklahoma Arkoma basin was emerging as a big new source of natural gas, and 1960 exploration set the stage for important developments in 1961. Opening of a new gas pool was reported early in 1960 in Dewey County; in Grady County, a new producing zone for the Southeast Harness pool was indicated.

TABLE 3.—Coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	2,133	$12,744	1958	1,629	$10,858
1956	2,007	12,341	1959	1,525	10,272
1957	2,195	14,165	1960	1,342	9,113

TABLE 4.—Marketed production of natural gas [1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1951–55 (average)	584,815	$37,704	1958	696,504	$70,347
1956	678,603	54,288	1959	811,508	81,151
1957	719,794	59,743	1960	824,266	98,088

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

The natural gas industry had six gas-storage fields in six Oklahoma counties as reported by The Oil and Gas Journal. The underground storage facilities had a total capacity of 99.9 billion cubic feet of working-gas volume (above minimum working pressure) and 83.5 billion cubic feet of cushion-gas volume (below minimum working pressure). The available storage capacity permitted continuous production and conservation of casing-head gas from oil wells during low demand periods for gas.

TABLE 5.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Product	Proved reserves, Dec. 31, 1959	Changes in proved reserves, due to extensions and new discoveries in 1960	Proved reserves, Dec. 31, 1960 (production was deducted)	Changes from 1959, percent
Crude oil—thousand barrels	1,864,749	115,405	1,790,500	−4
Natural gas liquids [1]—do	367,569	−773	338,313	−8
Natural gas—million cubic feet	16,651,292	1,640,802	17,311,402	+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: Vol. 15, Dec. 31, 1960, pp. 11, 12, 21.

Natural Gas Liquids.—Output of natural gas liquids, recovered by 68 natural gasoline plants and 4 cycling plants, reached a new record of 1,294 million gallons and represented an increase of 15 percent above the 1959 figure. Of the 68 natural gas processing plants reported in 1960, 2 were sold (1 was being dismantled), 3 were shut down, and 3 plants were dismantled. The increased output, mostly in LP gases (propane and butane), was due to increased processing of commercial gas from the productive gasfields in the Panhandle area and separation of more LP gases from plant liquids to meet the rising demand. Natural gasoline and cycle products supplied 41 percent of the quantity and 51 percent of the value; LP gases furnished the balance. Use of LP gases for domestic heating fuels and for production of petrochemicals, particularly polyethylene, continued to grow.

Underground storage capacity for LP gases at four sites totaled 333,000 barrels. The sites comprised two salt layers in Beaver and Beckham Counties, abandoned oil wells in Pontotoc County, and a shale mine shaft in Seminole County. A fifth site, in limestone, was under construction near Ponca City, Kay County, for Continental Oil Co. This facility, when completed in April 1961, will increase the total storage capacity 300,000 barrels.

TABLE 6.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	443,978	$27,625	419,144	$13,843	863,122	$41,468
1956	489,963	26,543	579,101	23,427	1,069,064	49,970
1957	460,644	25,329	587,140	21,824	1,047,784	47,153
1958	440,798	26,029	657,114	25,822	1,097,912	51,851
1959	448,353	29,443	675,869	27,070	1,124,222	56,513
1960	531,995	33,074	762,258	32,409	1,294,253	65,483

Petroleum.—Oklahoma remained the fourth largest petroleum producing State. The Oklahoma Corporation Commission, under the Interstate Oil Compact, placed the allowable output for January at 540,000 barrels per day, which was based upon a 20-barrel daily rate per well. In February, the allowable was increased to about 560,000 barrels per day—an average-basic-per-well rate of 22 barrels daily. Then, in March, the allowable was cut to about 532,000 barrels, to maintain a balance between output and demand and to reduce the growing inventory of Oklahoma crude oil. Thereafter, a steady decline occurred until July when an estimated allowable of 488,000 barrels per day was set. This average basic well rate of 12 barrels daily on allocated pools—lowest in Oklahoma history—remained in effect until October when the allowable was raised to 506,000 barrels per day, based upon basic well rate of 15 barrels daily. The November rate was unchanged from October. In December the crude allowable was raised to 515,000 barrels per day for a basic well rate of 17 barrels per day.

Petroleum from 83,594 wells was reported from 64 counties, of which Osage, Stephens, Carter, Garvin, and Creek Counties led as producers

in order named. Of the State output, 47 percent was from nonallocated fields, which included secondary-recovery projects and stripper fields.

TABLE 7.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	193,708	$519,410	1958	200,699	$594,069
1956	215,862	600,096	1959	198,090	578,423
1957	214,661	650,423	1960 [1]	192,288	561,481

[1] Preliminary figures.

TABLE 8.—Crude petroleum production, indicated demand and stocks, in 1960, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Oklahoma	Month	Production	Indicated demand	Stocks originating in Oklahoma
January	17,340	17,282	18,471	September	15,028	16,405	16,082
February	16,159	16,196	18,434	October	16,013	15,500	16,595
March	16,692	15,689	19,437	November	15,801	15,491	16,905
April	15,923	16,148	19,212	December	16,239	16,138	17,006
May	16,233	14,715	20,730				
June	15,367	16,418	19,679	Total:			
July	15,652	16,515	18,816	1960 [1]	192,288	193,695	----------
August	15,841	17,198	17,459	1959	198,090	197,085	----------

[1] Preliminary figures.

The Interstate Oil Compact Commission reported that on January 1, 1960, Oklahoma had 68,836 stripper wells which produced over 91 million barrels of oil in 1959. Oil reserves of these totaled 1,242 billion barrels, or 69 percent of the overall proved oil reserve in Oklahoma as of January 1.

The average price per barrel of Oklahoma crude petroleum at the wellhead was $2.92, unchanged from 1959.

Again, Oklahoma ranked third in test-well drilling with 700 test wells (148 oil productive and 65 gas productive) compared with 827 in 1959. Test-well drilling totaled 3,592,838 feet—each well averaged 5,133 feet, compared with 4,953 feet in 1959. The 4,102 field-development wells drilled totaled 13,838,691 feet, or an average of 3,374 feet per well compared with an average of 3,574 feet in 1959.

Although major interest in drilling was directed to field wells, several counties continued to attract attention for exploratory drilling. In the south-central section, Cleveland and McClain Counties, 58 exploratory tests yielded 20 oil wells; in the northeastern section, Osage and Kay Counties, 85 exploratory tests yielded 13 oil wells and 3 gas wells; in the central section, Lincoln and Kingfisher Counties, 58 exploratory tests yielded 22 oil wells and 8 gas wells; and west of the Arbuckle Mountains, Stephens County, 31 exploratory tests yielded 6 oil wells and 2 gas wells.

TABLE 9.—Crude petroleum production by fields[1]

(Thousand barrels)

Field	1956	1957	1958	1959	1960[2]
Allen	1,638	1,608	1,590	1,676	1,525
Bebee	745	707	625	606	697
Bradley	3,169	3,053	2,741	2,898	2,631
Burbank	13,519	14,280	14,548	14,463	15,676
Cache Creek	661	721	827	910	1,041
Cement	4,372	4,061	4,405	4,222	3,836
Cumberland	1,944	1,812	1,474	1,407	1,219
Cushing	2,549	2,650	2,702	2,585	2,515
Davenport	1,338	1,289	959	855	613
Dilworth	921	677	517	453	(3)
Doyle	3,056	2,798	2,421	2,241	1,798
Elk City	5,326	4,078	2,806	2,113	1,741
Eola	3,566	3,886	3,188	3,863	3,470
Fitts	785	723	800	910	950
Garber	862	849	826	876	761
Glenn Pool	1,901	2,259	2,773	3,164	3,200
Golden Trend	20,204	17,245	13,106	10,627	11,071
Healdton	2,347	2,260	2,331	2,256	2,154
Hewitt	3,495	3,240	3,084	2,977	2,938
Holdenville-East	1,117	628	476	412	(3)
Hoover-Northwest	2,063	1,863	2,417	2,039	1,329
Knox	1,291	1,232	1,045	941	2,206
Loco	1,606	1,542	1,372	1,290	1,309
Lucien	951	817	743	749	710
Moore-West	----------	3,250	2,553	1,527	1,275
Naval Reserve	1,102	1,409	1,498	1,667	2,353
Oklahoma City	3,743	3,482	3,290	3,050	2,851
Olympic	1,752	1,573	1,341	1,101	967
Payson-East	786	467	(3)	423	893
Ringwood	484	(3)	(3)	(3)	(3)
Seminole:					
Bowlegs	685	655	619	665	905
Little River	571	478	430	390	388
St. Louis	1,486	1,443	1,410	1,379	1,422
Seminole	827	912	876	797	696
Sho-Vel-Tum	29,717	29,008	25,823	25,175	24,227
West Edmond	1,945	1,292	1,153	1,013	1,407
Witcher	378	(3)	(3)	(3)	(3)
Yale-Quay	1,322	1,765	1,927	1,700	1,254
Other fields[4]	91,638	94,649	92,003	94,670	90,260
Total	215,862	214,661	200,699	198,090	192,288

[1] Based on Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Preliminary figures.
[3] Included with "Other fields."
[4] Bureau of Mines figures.

TABLE 10.—Oil and gas wells drilled in 1960, by counties

County	Proved field wells				Exploratory wells			Total
	Oil	Gas	Service	Dry	Oil	Gas	Dry	
Alfalfa	17	6	-------	6	1	-------	9	39
Atoka	-------	-------	-------	2	-------	-------	7	9
Beaver	68	99	-------	58	7	8	9	249
Beckham	4	4	1	1	-------	2	2	14
Blaine	-------	2	-------	1	-------	-------	3	6
Bryan	-------	1	-------	-------	-------	-------	4	5
Caddo	50	-------	-------	10	-------	2	8	70
Canadian	1	-------	-------	-------	1	1	1	4
Carter	182	2	1	32	10	-------	11	238
Cherokee	-------	-------	-------	-------	-------	-------	2	2
Cimarron	3	8	-------	9	-------	-------	2	22
Cleveland	28	4	-------	9	10	-------	26	77
Coal	1	-------	1	1	2	1	2	8
Comanche	9	1	-------	13	-------	1	8	32
Cotton	5	-------	3	8	-------	-------	5	21
Creek	105	6	103	30	2	-------	5	251
Custer	-------	2	-------	-------	-------	-------	1	3
Delaware	-------	-------	-------	-------	-------	-------	1	1

See footnotes at end of table.

TABLE 10.—Oil and gas wells drilled in 1960, by counties—Continued

County	Proved field wells				Exploratory wells			Total
	Oil	Gas	Service	Dry	Oil	Gas	Dry	
Dewey	3	3		4	2		7	19
Ellis	4	12		6	3	3	4	32
Garfield	18		3	20	6	1	5	53
Garvin	49	3	1	21	3		8	85
Grady	5	1			1		2	9
Grant	47	9	1	12	4		4	77
Greer				1			8	9
Harmon							1	1
Harper	16	35		15	2	1	9	78
Haskell		3		1		3	2	9
Hughes	16	5	7	15	2	1	6	52
Jackson							1	1
Jefferson	21	1	4	9	2		19	56
Johnston							1	1
Kay	82	4	3	27	3	3	26	148
Kingfisher	85	11		4	18	3	5	126
Kiowa	11	2		17			18	48
Latimer						2		2
Lincoln	24	13	8	36	4	5	23	113
Logan	6	8	1	5	1	3	9	33
Love	13			10	3		8	34
Major	16	6		7	4	2	3	38
Marshall	18	2	1	14			3	38
Mayes							1	1
McClain	89	5		13	10		12	129
McCurtain							6	6
McIntosh				8		3	7	18
Murray	5		1	3	2		8	19
Muskogee	41	1	5	14	1		3	65
Noble	40	6		17	3	1	9	76
Nowata	36	5	10	30				81
Okfuskee	79	12	5	43	4	1	12	156
Oklahoma	12	3		9	5		4	33
Okmulgee	86	8	34	34	1	4		167
Osage	151	2	86	87	10		43	379
Pawnee	16	1	9	15			3	44
Payne	16	1	5	10	1		6	39
Pittsburg	1	2		2		1	9	15
Pontotoc	34	4	14	28			8	88
Pottawatomie	39	1	2	13	7		11	73
Pushmataha							2	2
Roger Mills							2	2
Rogers	42		29	21				92
Seminole	116	8	8	57	2		9	200
Sequoyah		1				1		2
Stephens	88	6	22	35	6	2	23	182
Texas	33	25	1	26	2	5	8	100
Tillman	9		1	8			6	24
Tulsa	110	4	50	46				210
Wagoner	5	2	2	13				22
Washington	250	7	118	37				412
Washita		1		1	1			3
Woods	3	3		6	1	4	11	28
Woodward		8		5	1	1	6	21
Total:								
1960	[1] 2,208	369	540	985	[1] 148	65	487	4,802
1959	[1] 2,666	319	112	1,435	[1] 117	73	637	5,359

[1] Includes distillate wells.

Source: Oil and Gas Journal, vol. 59, No. 5, Jan. 30, 1961, pp. 164–165.

Oklahoma had 15 refineries with a total daily capacity of 401,680 barrels of crude oil and 151,375 barrels of cracked gasoline. In 1960 the refineries processed 68 percent of the State production. Crude oil runs to stills, compared with total receipts, intrastate receipts, and yearend stocks at Oklahoma refineries, in thousand barrels, were as follows:

Year	Runs to stills	Total receipts	Intrastate receipts	Stocks Dec. 31
1959	134,577	134,799	93,747	2,786
1960	131,042	130,820	93,073	2,522

NONMETALS

Nonmetals output was valued at $39.4 million, a new record and exceeding the previous record high established in 1959 by $2.3 million. The gain was attributed entirely to increases in production of stone and sand and gravel.

Asphalt (Native).—Output of native rock asphalt for road surfacing, reported from Murray County, dropped 87 percent below the 1959 production.

Cement.—Cement production decreased 20 percent from 1959. Shipments of cement into the State decreased 13 percent. Plants at Ada, Pontotoc County; Dewey, Washington County; and Pryor, Mayes County were active during the year. The newest cement producer, Oklahoma Cement Co., made the first shipment from its $8 million plant at Pryor in July, about 14 months after construction started. The limestone reserve at the plant site was sufficient to supply the plant for over 200 years at the 1960 rate of production. The Pryor plant had a reported annual capacity of 1.25 million barrels. Construction continued throughout 1960 on the new Dewey Portland Cement Co. $12 million plant east of Tulsa.

TABLE 11.—Destination of shipments of portland cement to Oklahoma from mills

Year	Oklahoma (thousand barrels)	Change, percent	
		In Oklahoma	In United States
1951-55 (average)	4,349		
1956	4,814	+1	+6
1957	4,886	+1	−6
1958	5,131	+5	+6
1959	5,374	+5	+9
1960	4,669	−13	−7

Clays.—Clay was produced primarily for manufacturing brick and tile and, to a lesser extent, for portland cement and lightweight expanded-clay products. Brick and tile were made in Creek, Custer, Garfield, Greer, Lincoln, Oklahoma, Pittsburg, Pontotoc, Seminole, and Tulsa Counties; lightweight aggregate was made in Oklahoma and Rogers Counties. Pottery was manufactured in Creek County. Bentonite, produced in Dewey County, was used for filtering and as an absorbent.

Gem Stones.—A small quantity of gem stones, essentially crystalline specimens of quartz, barite, calcite, and marcasite, from Cleveland, Ottawa, Pontotoc, and McCurtain Counties, was collected by individuals.

TABLE 12.—Clays sold or used by producers[1]

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	565	$757	1958	576	$579
1956	705	701	1959	966	970
1957	641	642	1960	734	739

[1] Excludes bentonite.

Gypsum.—Output of gypsum was 13 percent below that of 1959 because of decreased construction. Most of the crude gypsum was produced in Blaine County, where United States Gypsum Co. operated quarries and a plant at Southard to manufacture wallboard and plaster products. Gypsum also was produced in Caddo and Washita Counties.

Lime.—Lime, produced by St. Clair Lime Co. in Sequoyah County, declined 21 percent from 1959. It was used mostly by chemical plants at Pryor and by municipal water plants.

Pumice.—An increase in the output of pumice from Beaver County was noted. Principal use was for abrasive-type cleaners.

Salt.—Salt was produced in 1960 in Woods County from surface incrustations on the Big Salt Plain of the Cimarron River, and in Harmon County, by solar evaporation of brine from springs. Stock food and recharging of water softeners were the major uses. Minor uses included herbicides and salinity control of oil-well drilling fluid.

Sand and Gravel.—Sand and gravel was produced in 55 counties; Johnston, Tulsa, Pontotoc, Oklahoma, Kay, Pushmataha, and Murray Counties supplied over half the total value.

TABLE 13.—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
1951–55 (average)	2,876	$2,868	1,860	$841	4,736	$3,709
1956	3,417	3,886	2,530	957	5,947	4,843
1957	3,297	3,608	1,663	899	4,960	4,507
1958	4,245	4,417	2,987	1,442	7,232	5,859
1959	4,376	4,988	1,626	939	6,002	5,927
1960	4,823	6,544	1,601	924	6,424	7,468

Most of the sand and gravel produced was used as concrete aggregate. Next in importance in terms of tonnage and value, was high-purity glass sand produced at two plants in Johnston and Pontotoc Counties, in the Arbuckle Mountain district. A small quantity of high-purity sand was used as foundry sand, in making sodium silicate, and in pottery and tile.

Stone.—Tulsa, Comanche, Murray, and Ottawa Counties supplied over half the 14.1 million tons of stone produced in 36 counties. Twenty producers at 30 quarries and the State highway department reported output of crushed limestone. The material was used prin-

cipally for cement, concrete aggregate, and road construction. Smaller quantities were used for agricultural limestone and the manufacture of glass.

Chat.—Chat, tabulated with miscellaneous stone, is the coarse tailing from milling lead and zinc ores. The material is mainly chert (microcrystalline silica) with small quantities of limestone, sphalerite, galena, marcasite, and pyrite. Railroad ballast, concrete aggregate, and road surfacing consumed most of the chat sold during the year. Operators in Ottawa County reported 18 percent more tonnage than in 1959.

TABLE 14.—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
1956	[1] 5	[1] $523	[2] 8,626	[1] $10,603	153	$227	1,763	$1,064	10,547	$12,417
1957	[1] 5	[1] 557	[2] 10,238	[1] 12,041	306	373	1,467	1,093	12,016	14,064
1958	31	569	9,383	10,833	275	264	1,105	566	10,794	12,232
1959	[1] 5	720	11,242	13,455	222	241	1,214	564	12,683	14,980
1960	[3] 5	620	11,995	13,852	784	870	1,270	756	[3] 14,054	[3] 16,098

[1] Crushed granite included with "Other stone."
[2] Dimension limestone included with "Other stone."
[3] Excludes crushed granite.

Granite.—The dimension-granite industry was centered in the Wichita Mountains in the southwest part of the State, where four producers operated five quarries in Greer and Kiowa Counties.

Production came from Precambrian granites, which are predominantly pink and red. Dimension granite was used mostly for monumental stone and to some extent for exterior trim. Most of the stone was finished in plants in the Wichita Mountains, although some was shipped as rough rock to other States.

Limestone and Dolomite.—Limestone and dolomite were quarried in 26 counties; the greatest output came from Tulsa, Comanche, and Murray Counties.

Chemical-grade limestone quarried at Marble City, Sequoyah County, was used for limemaking, for use as a flux in glass manufacturing, and in fertilizers and mineral food. Nearly 2,400 short tons of dimension limestone was quarried for building stone in Pontotoc, Johnston, Caddo, and Jackson Counties. Limestone for portland cement was quarried in Washington, Pontotoc, and Mayes Counties.

Dolomite was produced in Johnston County for use as flux in glassmaking and for soil conditioning.

Sandstone.—Dimension sandstone was quarried in Pushmataha and Okmulgee Counties for use as building and veneer stone. The stone was cut in slabs 1½ to 6 inches thick from shallow, open-face quarries.

Tripoli.—Output of tripoli in eastern Ottawa County increased 12 percent over that of 1959. The crude material was shipped to Seneca, Mo., processed by the American Tripoli Division of the Carborundum Co., and sold primarily for buffing compounds and in minor quantities for foundry use.

Vermiculite.—Zonolite Co. exfoliated vermiculite in Oklahoma County from ores mined in Montana and South Carolina. The product was used mainly in concrete and plaster.

METALS

Output of metals increased over 1959, halting the decline in lead and zinc production.

Lead.—Most mines in Ottawa County remained closed throughout 1960 due to a depressed market; however, the 936 short tons of recoverable lead mined in the county was 56 percent more than in 1959.

The price of lead, New York, at the beginning of the year was 12 cents per pound; it remained unchanged until December 13, when it fell to 11 cents.

Zinc.—Output of recoverable zinc in Ottawa County was 2,332 short tons, more than double that of 1959. Percentage of metal recovery from the ore was considerably higher as mining was more selective. Again, most mines remained closed. At the beginning of the year, the price of zinc metal was 12.5 cents per pound, East St. Louis, but effective January 8 the price increased to 13 cents. It remained unchanged until December 13, then dropped to 12.5 cents and, on December 19 to 12 cents per pound for the balance of the year.

TABLE 15.—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)
1951–55 (average)	18,772	$3,459	85,281	$8,003	13,869	$4,230	45,299	$12,983
1956	17,971	3,225	52,993	4,485	12,350	3,878	27,515	7,539
1957	10,198	1,896	27,702	2,288	7,183	2,054	14,951	3,469
1958	5,213	689	9,791	594	3,692	864	5,267	1,074
1959	905	118	2,090	134	601	138	1,049	241
1960	1,687	155	4,715	344	936	219	2,332	602
Total, 1891–1960	1,675,398	162,834	9,738,365	482,610	1,284,688	194,411	5,134,496	772,582

[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 borne in mind that value given for concentrate is that actually received by producer, whereas value of lead and zinc is calculated from average price for all grades.

TABLE 16.—Tenor of lead-zinc ore milled and concentrates produced [1]

Product	1959	1960
Total material milled ---------- short tons	15,365	19,700
Recovery of concentrate and metal from quantity milled:		
Galena ---------- do	412	534
Sphalerite ---------- do	989	2,010
Galena ---------- percent	2.68	2.71
Sphalerite ---------- do	6.44	10.20
Lead [2] ---------- do	2.13	1.73
Zinc [2] ---------- do	3.36	5.28
Average lead content of galena concentrate ---------- do	81.07	64.98
Average zinc content of sphalerite concentrate ---------- do	58.14	57.56
Average value per ton:		
Galena concentrate ----------	$155.93	$114.19
Sphalerite concentrate ----------	66.71	76.38

[1] Lead-zinc concentrates from accumulated slimes excluded.
[2] Figures represent metal content of crude ore (dirt) as recovered in concentrate. Data on tailing losses not available.

TABLE 17.—Mine production of lead and zinc in 1960, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January ----------	59	174	August ----------	66	218
February ----------	----------	----------	September ----------	57	227
March ----------	203	313	October ----------	72	147
April ----------	55	188	November ----------	71	147
May ----------	110	281	December ----------	73	147
June ----------	104	249			
July ----------	66	241	Total ----------	936	2,332

Custom Mills and Smelters.—Three horizontal-retort zinc plants were operated throughout 1960: American Metal Climax, Inc., at Blackwell, Kay County; National Zinc Co. at Bartlesville, Washington County; and The Eagle-Picher Co. at Henryetta, Okmulgee County. Ores and concentrates of domestic and foreign origin were treated at these smelters. Federated Metals Division of the American Smelting and Refining Co. operated a secondary zinc plant in Sand Springs, Tulsa County.

American Zinc, Lead & Smelting Co. announced plans to recondition and reopen by March 1961 its Barbara J. mill near Cardin. The mill has been closed for 3 years because of depressed zinc prices. Soon thereafter, The Eagle-Picher Co. announced plans to reopen its Central Mill north of Commerce sometime in March 1961; the mill had been closed since mid-1958.

National Zinc Co. recovered sulfuric acid as a byproduct from imported zinc ores processed at its plant in Bartlesville, Washington County.

TABLE 18.—Quoted prices on 60 percent zinc concentrate and 80 percent lead concentrate at Joplin, Mo., in 1960

Zinc concentrate		Lead concentrate	
Effective date	Price per short ton	Effective date	Price per short ton
Jan. 1–Jan. 7	$76.00	Jan. 1–Nov. 9	$141.72
Jan. 8–Dec. 12	80.00	Nov. 10–Dec. 21	139.56
Dec. 13–Dec. 18	76.00	Dec. 22–Dec. 31	125.16
Dec. 19–Dec. 31	72.00		

Source: E&MJ Metal & Mineral Markets.

TRI-STATE DISTRICT

Depressed lead-zinc markets, which led to a general shutdown in mid-1958 of all major mining operations in the Tri-State District, continued in 1960. However, the quantites of lead and zinc concentrates recovered were up 93 percent and 119 percent, respectively, over the 1959 figures. Oklahoma produced 54 percent of the district's lead concentrate and 53 percent of its zinc concentrate, and Kansas produced 46 percent of the district's lead concentrate and 47 percent of the zinc concentrate. No output was reported from southwest Missouri in 1960.

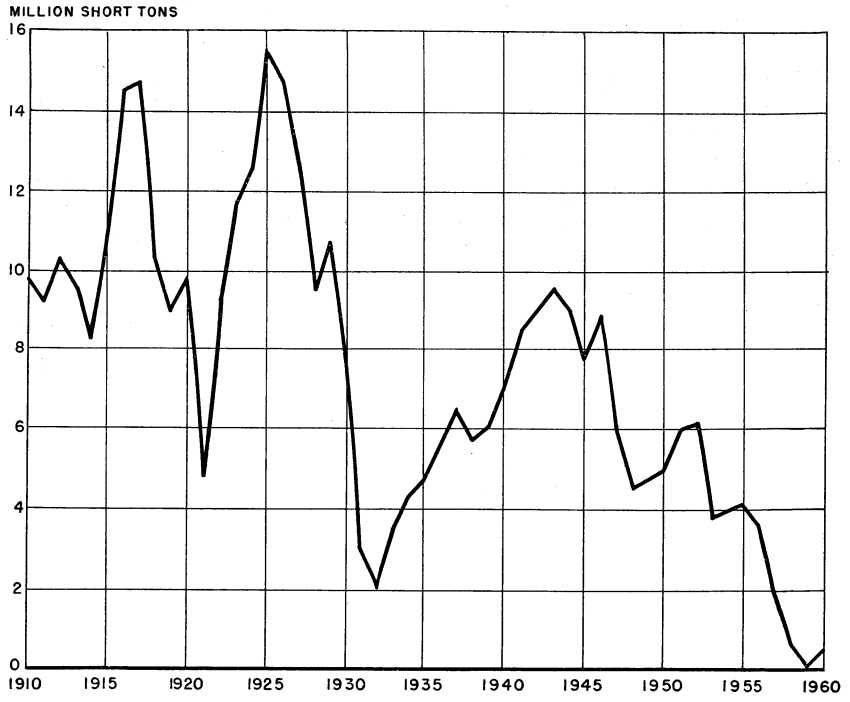

FIGURE 1.—Quantity of crude ore (rock) milled in the Tri-State District, 1910–60.

Three smelting companies maintained ore buyers in the Tri-State District. All production was purchased f.o.b. mill by the brokers; no metal concentrates were stockpiled at the mines. Deliveries of mined ore were so small that the mills were operated only part time.

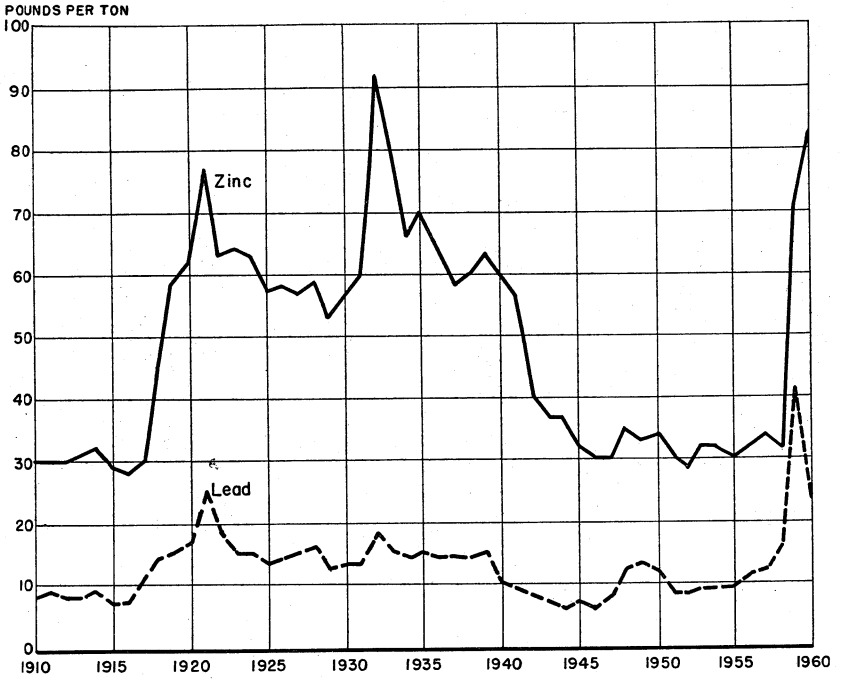

FIGURE 2.—Metal recovered per ton of crude ore (rock) milled in the Tri-State District, 1910–60.

TABLE 19.—Mine production of lead and zinc concentrates in the 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)
1951-55 (average)	28,305	$5,337	139,727	$13,311	21,106	$6,496	74,362	$21,446
1956	28,597	5,282	107,997	9,335	20,373	6,397	57,215	15,677
1957	15,930	2,928	57,052	4,604	11,462	3,278	30,895	7,168
1958	7,041	931	18,001	1,093	4,991	1,168	9,688	1,976
1959	1,607	211	4,061	282	1,082	249	2,066	475
1960:								
Kansas	1,411	129	4,162	314	781	183	2,117	546
Southwest Missouri								
Oklahoma	1,687	155	4,715	344	936	219	2,332	602
Total: 1960	3,098	284	8,877	658	1,717	402	4,449	1,148

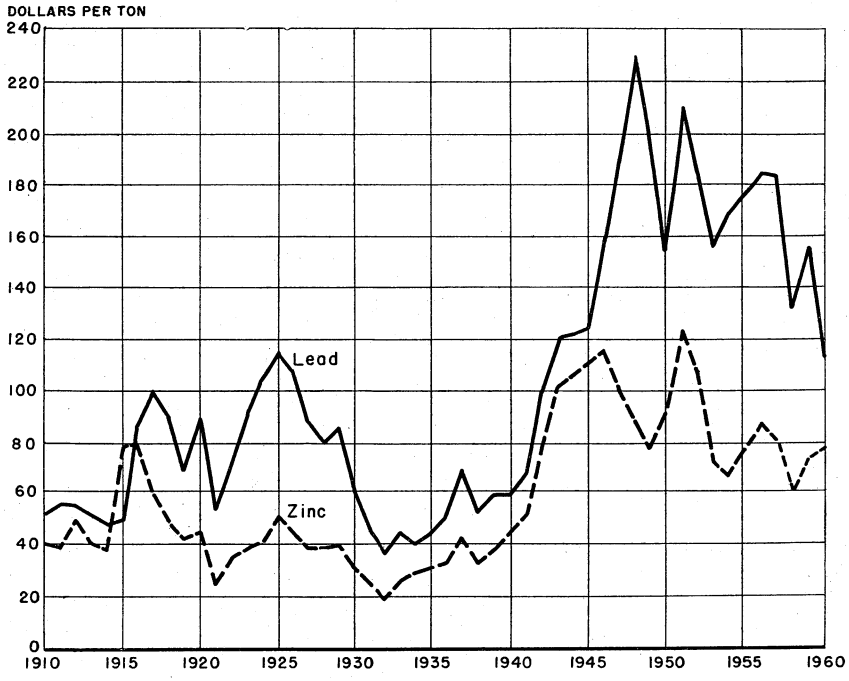

FIGURE 3.—Average prices received by sellers per tons of concentrate in the Tri-State District, 1910–60.

TABLE 20.—Tenor of lead and zinc ore milled and concentrate produced in the Tri-State District

Product	1956	1957	1958	1959 [1]	1960 [1]
Total material milled: Crude ore----short tons--	3,584,902	1,836,942	611,556	31,750	51,972
Recovery of concentrate and metal from material milled:					
Galena----percent-	0.80	0.87	1.15	2.58	1.85
Sphalerite----do----	3.01	3.11	2.94	6.71	7.79
Lead [2]----do----	.57	.62	.82	2.05	1.18
Zinc [2]----do----	1.60	1.68	1.58	3.54	4.13
Average lead content of galena concentrate-do----	72.69	73.46	72.35	81.17	64.86
Average zinc content of sphalerite concentrate percent-	58.87	60.16	59.76	58.54	58.88
Average value per ton of concentrate:					
Galena----	$184.72	$183.80	$132.29	$154.95	$113.62
Sphalerite----	86.44	80.70	60.74	73.49	78.40

[1] Lead-zinc concentrates from accumulated slimes excluded.
[2] Figures represent metal content of the crude ore (dirt) as recovered in concentrate.

REVIEW BY COUNTIES

Output of metals, nonmetals, and mineral fuels was reported from 76 of 77 counties.

Alfalfa.—Petroleum and natural gas were produced. Construction sand and gravel was produced by Earl Kirkpatrick, and paving sand was produced by the State highway department.

Atoka.—Limestone was mined and crushed at the Southwest Stone Co. quarry near Stringtown for use as railroad ballast, road base, and aggregate in concrete. Sand and gravel was produced by the State highway department. A small quantity of petroleum was produced.

TABLE 21.—Value of minerals produced in Oklahoma, by counties [1]

County	1959	1960	Minerals produced in 1960 in order of value
Adair	$7,508	$39,285	Petroleum, stone.
Alfalfa	2,920,168	3,334,573	Petroleum, natural gas, sand and gravel.
Atoka	(2)	(2)	Stone, sand and gravel, petroleum.
Beaver	11,067,671	17,795,969	Natural gas, petroleum, natural gas liquids, pumice, sand and gravel.
Beckham	12,562,040	12,365,055	Petroleum, natural gas liquids, natural gas, sand and gravel.
Blaine	1,520,832	(2)	Gypsum, natural gas, petroleum.
Bryan	1,836,429	2,237,537	Petroleum, stone, natural gas, sand and gravel.
Caddo	16,155,728	16,471,129	Petroleum, stone, natural gas, gypsum, sand and gravel.
Canadian	342,176	229,827	Natural gas, petroleum.
Carter	63,382,585	64,858,981	Petroleum, natural gas liquids, natural gas, sand and gravel.
Cherokee	(2)	(2)	Stone.
Choctaw	149,860	(2)	Sand and gravel, stone.
Cimarron	3,145,389	7,051,135	Helium, natural gas, petroleum.
Cleveland	17,683,675	16,005,003	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coal	2,099,592	1,798,431	Petroleum, stone, natural gas, sand and gravel.
Comanche	(2)	3,007,061	Stone, petroleum, natural gas, sand and gravel.
Cotton	4,519,744	4,743,088	Petroleum, sand and gravel, natural gas.
Craig	618,786	338,294	Coal, petroleum, natural gas.
Creek	31,341,550	31,172,983	Petroleum, natural gas liquids, natural gas, clays.
Custer	677,811	1,129,320	Stone, natural gas liquids, clays, sand and gravel, natural gas, petroleum.
Dewey	72,674	199,666	Petroleum, bentonite, natural gas.
Ellis	94,746	134,515	Petroleum, natural gas.
Garfield	6,811,660	6,308,117	Petroleum, natural gas liquids, natural gas, clays.
Garvin	89,624,608	84,713,972	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Grady	19,247,979	25,578,739	Petroleum, natural gas, natural gas liquids, sand and gravel.
Grant	4,139,550	5,219,353	Petroleum, natural gas.
Greer	296,935	341,303	Petroleum, sand and gravel, stone, natural gas, clays.
Harmon	(2)	(2)	Salt, sand and gravel.
Harper	5,732,046	11,214,280	Natural gas, natural gas liquids, petroleum.
Haskell	2,138,279	2,816,179	Coal, natural gas, stone, sand and gravel.
Hughes	6,119,448	5,633,133	Petroleum, natural gas, sand and gravel.
Jackson	708,646	613,369	Petroleum, stone, sand and gravel, natural gas.
Jefferson	4,182,015	4,193,250	Petroleum, natural gas, stone, sand and gravel.
Johnston	1,664,006	(2)	Sand and gravel, stone.
Kay	13,418,268	15,407,352	Petroleum, natural gas liquids, stone, natural gas, sand and gravel.
Kingfisher	1,496,619	3,265,307	Petroleum, natural gas, sand and gravel, natural gas liquids.
Kiowa	2,293,493	1,714,050	Stone, petroleum, sand and gravel, natural gas.
Latimer	40,488	112,653	Natural gas, petroleum.
LeFlore	2,494,294	1,757,413	Coal, natural gas, stone, sand and gravel.
Lincoln	22,635,578	22,563,876	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Logan	10,044,549	8,030,637	Petroleum, natural gas, natural gas liquids, sand and gravel.
Love	2,048,075	2,760,583	Petroleum, natural gas, sand and gravel.
Major	2,457,018	3,412,514	Petroleum, natural gas, natural gas liquids, sand and gravel.
Marshall	7,296,208	7,528,199	Petroleum, natural gas liquids, stone, natural gas, sand and gravel.
Mayes	(2)	(2)	Cement, stone, clays, petroleum.
McClain	20,483,762	26,153,229	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain	132,718	175,746	Sand and gravel, stone, gem stones.
McIntosh	(2)	(2)	Coal, natural gas, petroleum, sand and gravel.
Murray	3,628,991	2,442,220	Stone, petroleum, sand and gravel, natural gas, asphalt.
Muskogee	1,765,821	1,316,853	Petroleum, sand and gravel, natural gas.
Noble	8,580,757	8,801,597	Petroleum, natural gas, natural gas liquids, stone.
Nowata	9,609,416	7,528,374	Petroleum, coal, stone, natural gas.
Okfuskee	9,329,496	9,499,315	Petroleum, natural gas liquids, natural gas, sand and gravel.
Oklahoma	28,006,001	23,030,983	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.

See footnotes at end of table.

TABLE. 21.—Value of minerals produced in Oklahoma, by counties[1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value
Okmulgee	$7,511,803	$7,614,094	Petroleum, stone, natural gas, coal, sand and gravel.
Osage	76,231,418	74,773,593	Petroleum, natural gas liquids, stone, natural gas.
Ottawa	1,025,116	1,672,554	Stone, zinc, lead, tripoli.
Pawnee	6,628,247	6,077,290	Petroleum, sand and gravel, natural gas liquids, natural gas, stone.
Payne	11,807,252	9,428,090	Petroleum, natural gas, stone, natural gas liquids.
Pittsburg	(2)	(2)	Coal, natural gas, sand and gravel, clays.
Pontotoc	19,585,783	18,460,813	Petroleum, cement, stone, sand and gravel, natural gas liquids, clays, natural gas.
Pottawatomie	12,408,635	12,511,830	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Pushmataha	(2)	(2)	Sand and gravel, stone.
Roger Mills	7,500	7,500	Sand and gravel.
Rogers	5,969,481	5,157,031	Petroleum, coal, clays, natural gas.
Seminole	30,798,035	28,372,529	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Sequoyah	2,258,323	2,356,081	Coal, lime, stone, natural gas, sand and gravel.
Stephens	68,836,909	67,697,587	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Texas	24,534,528	24,181,240	Natural gas, natural gas liquids, petroleum, sand and gravel.
Tillman	2,549,190	2,295,482	Petroleum, sand and gravel, natural gas.
Tulsa	7,162,916	7,407,258	Petroleum, stone, sand and gravel, clays, natural gas.
Wagoner	2,151,505	1,653,218	Petroleum, sand and gravel, natural gas.
Washington	21,020,963	22,045,392	Petroleum, cement, stone, clays, natural gas.
Washita	1,086,541	1,399,421	Natural gas, petroleum, sand and gravel, gypsum.
Woods	556,997	765,120	Natural gas, petroleum, sand and gravel, salt.
Wooodward	35,182	474,747	Natural gas, petroleum, sand and gravel.
Undistributed	6,647,982	9,721,476	
Total	[3] 765,439,000	779,116,000	

[1] Delaware county is not listed because no production was reported.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Revised figure.

Beaver.—Natural gas, petroleum, and natural gas liquids were produced. The Mocane gas area was the largest in the county. LaRue-Axtell Pumice Co. mined volcanic ash near Gate. The State highway department produced sand and gravel.

Beckham.—Petroleum, natural gas liquids, and natural gas were produced, mostly from the Elk City field. Shell Oil Co. operated its Elk City cycling plant throughout 1960. Sand and gravel was produced by the State highway department.

Blaine.—Gypsum was produced northeast of Watonga by Universal Atlas Cement Co. and west of Okeene by Walton Gypsum Co. United States Gypsum Co. quarried and crushed gypsum and operated a large calcining, wall board, and plaster plant at Southard. Minor quantities of natural gas and petroleum were produced.

Bryan.—Petroleum and natural gas were produced from the Aylesworth, S.E. field. Limestone was quarried and crushed for highways. Sand and gravel for construction was produced from pits near Colbert, and elsewhere for paving by the State highway department.

Caddo.—Petroleum and natural gas were produced. Cement, the largest field, produced 3.8 million barrels of oil. At Cyril, the 10,000-barrel-a-day refinery of Anderson-Prichard Oil Corp. operated throughout the year. Dimension limestone, crushed limestone, and crushed sandstone were produced. Gypsum for portland cement and agricultural uses was produced near Lindsay by Harrison Gypsum Co. Construction sand and gravel was produced by two operators; paving sand was produced by the State highway department.

Carter.—Carter County ranked fourth in value of minerals and mineral fuels produced. Petroleum and natural gas came from numerous

fields, of which Fox-Graham, Healdton, Hewitt, and Sho-Vel-Tum were the largest. Natural gas liquids were recovered by five plants. The 12,000-barrel-a-day refinery of Ben Franklin Refining Co. at Ardmore operated during the year. Sand and gravel was produced for building and paving by one operator and for paving by the State highway department.

Cimarron.—Petroleum and natural gas were produced from several fields in the Keyes area. The Federal Bureau of Mines recovered helium from natural gas at its Keyes helium extraction plant, which began operating in 1959. Keyes gas for processing was supplied to the plant by Colorado Interstate Gas Co.

Cleveland.—Petroleum and natural gas were produced. Natural gas liquids were recovered by plants of Continental Oil Co. and Sunray Mid-Continent Petroleum Corp. Sand and gravel was produced by the State highway department.

Coal.—Petroleum and natural gas valued at about $1.6 million were produced. Crushed limestone was produced near Bromide by Dolese Co. and paving sand and gravel by the State highway department.

Comanche.—Crushed limestone was produced by Dolese Co. from its Richard Spur quarry north of Lawton. Paving sand was produced by the State highway department. Petroleum and natural gas were produced from a group of small fields (comprising three districts) and the Fort Sill Reservation field.

Cotton.—Petroleum and natural gas were produced from a group of fields in the Walters and Cache Creek districts and from several other fields. Sand and gravel was produced by the State highway department.

Craig.—Coal was strip mined at three pits by two operators. Minor amounts of petroleum and natural gas were produced.

Creek.—Petroleum and natural gas were produced from numerous fields; of these, the prolific Cushing and Glenn Pool fields furnished over 5.7 million barrels of petroleum during the year. Natural gas liquids were recovered by four plants, one of which, the Pure Oil Co. Glenn Pool plant at Sapulpa, was shut down on November 1. The Boswell-Frates Co. plant in the Edna field was dismantled. At Sapulpa, clay for manufacturing brick and tile was produced by Sapulpa Brick & Tile Co. and for pottery by Frankoma Pottery Co.

Custer.—Clay for brick and tile manufacturing was produced by Acme Brick Co. Stone, sand and gravel, natural gas liquids, natural gas, and petroleum were produced.

Garfield.—Petroleum and natural gas were produced. Natural gas liquids were recovered by Sinclair Oil & Gas Co. at Covington. The Sterling Oil Co. natural gas liquids plant in the Spring Valley field was dismantled. The 32,000-barrel-a-day Enid refinery of Champlin Refining Co. operated throughout the year. Enid Brick & Tile Manufacturing Co. continued production of clay for brick manufacturing.

Garvin.—Garvin County retained first position in total value of minerals and mineral fuels produced and ranked fourth in petroleum production. Petroleum and natural gas were produced from numerous fields which furnished 17 million barrels of petroleum. Natural gas liquids were recovered by six plants. The 17,500-barrel-a-day refinery of Kerr-McGee Oil Industries, Inc., at Wynnewood operated

throughout the year. Construction sand was mined by one operator from deposits east of Pauls Valley; paving sand and gravel and crushed sandstone were produced for highways by various producers and the State highway department.

Grady.—Petroleum and natural gas were produced. Natural gas liquids were recovered by two gasoline plants and two cycling plants. Warren Petroleum Corp. dismantled its Marlow field natural gasoline plant. Sand and gravel for construction and paving was obtained from pits near Tuttle by Dolese Co.

Greer.—Petroleum and natural gas were produced from the Lake Creek district. Granite was quarried by Century Granite Co. near the town of Granite. Sand and gravel was produced by three operators. Mangum Brick & Tile Co. mined clay south of Mangum.

Harper.—Natural gas and petroleum were produced. Gas from the big Laverne gasfield was processed at the Sun Oil Co. gasoline plant to recover natural gas liquids.

Haskell.—Haskell County ranked first in value of coal produced. Coal was mined underground by McAlpine and Dock Coal Co. and strip mined by five other producers. Natural gas was produced from Quinton and Kinta districts, where drilling interest continued. A minor quantity of sand and gravel was produced by the State highway department. The U.S. Army Corps of Engineers, Tulsa District, was constructing the Eufaula dam on the South Canadian River between Haskell and McIntosh Counties.

Hughes.—Petroleum and natural gas were produced from numerous fields. The Grimes Gasoline Co. closed its Wetumka natural gas liquids plant during the year. Paving gravel was produced for highways.

Jackson.—Small amounts of petroleum and natural gas were produced from fields southeast of Altus. Crushed granite was produced by H. D. Youngman Co. at Hedrick for the Altus Air Base. Dimension limestone was quarried by Masters Stone Co. Building sand was produced by one operator.

Jefferson.—Petroleum and natural gas were produced. Sandstone was quarried and crushed by various producers. Sand for road construction was produced by the State highway department.

Johnston.—Pennsylvania Glass Sand Corp. of Oklahoma produced sand for glass and ground silica from pits north of Mill Creek. Construction sand from a pit east of Tishomingo and paving gravel were used for highways. Ada Stone Co. mined dimension limestone for building near Pontotoc and Rock Products Co. crushed dolomite for flux in glassmaking.

Kay.—Petroleum and natural gas were produced from numerous fields; natural gas liquids were recovered by plants of Cities Service Oil Co. and Underlich Development Co. Petroleum refineries of Cities Service Oil Co. and Continental Oil Co. at Ponca City operated throughout the year. The petrochemical units of the Continental Oil Co. refinery continued to produce benzene, toluene, and propylene hydrocarbons and carbon black. An underground LP gas-storage site in limestone was being mined near Ponca City for Continental Oil Co. Capacity of the facility will be 300,000 barrels when completed in April 1961. Crushed limestone was produced by Cookson

Stone Co. from its quarry and plant northeast of Ponca City. Sand was produced for construction and paving by two operators and by the State highway department. Blackwell Zinc Co., Inc., a division of American Metal Climax, Inc., operated a zinc smelter throughout the year.

Kingfisher.—Petroleum, natural gas, and natural gasoline were produced. Natural gas liquids were recovered by the Trindle plant of Sohio Petroleum Co. Construction and paving sand were produced near Dover by Dolese Co. and paving sand by the State highway department.

Kiowa.—Dimension granite was quarried near Snyder by three operators and near Hobart by Century Granite Co. Construction sand and gravel and crushed limestone for highways were produced by two operators. Petroleum and natural gas were produced.

LeFlore.—Coal was mined by eight operators, one at an open pit and the others at underground mines. The county ranked sixth in coal output. Sand and gravel and crushed sandstone were produced for highway surfacing. Natural gas was produced, mainly from three fields.

Lincoln.—Petroleum and natural gas were produced from numerous fields. Natural gas liquids were recovered by five plants. The Allied Materials Corp. 3,500-barrel-a-day refinery at Stroud operated throughout the year. Sand was produced for highways. Stroud Clay Products Co. produced clay for building brick.

Logan.—Petroleum and natural gas were produced from numerous fields and natural gas liquids were recovered by plant No. 3 of Eason Oil Co. Construction sand was produced by one operator.

Love.—Petroleum and natural gas were produced. Sand and gravel was produced by the Gulf, Colorado and Santa Fe Railway Co.

Major.—Petroleum and natural gas were produced, mostly from the Ringwood field. Natural gas liquids were recovered by Warren Petroleum Co. at Ringwood. Construction sand was produced by one operator.

Marshall.—Petroleum and natural gas were produced from several fields; the most important was the Cumberland field which yielded 1.2 million barrels of oil. Natural gas liquids were recovered by plants of Warren Petroleum Corp. and Service Gas Products Co. Near Madill, sulfur from sour gas was recovered by Central Chemical Co. Crushed limestone and sand and gravel were produced for highways.

Mayes.—Limestone and clay were produced for cement manufacture by Oklahoma Cement Co. at its new $8 million plant southeast of Pryor. Crushed limestone was quarried for roadstone, concrete aggregate, and agriculture. A small amount of petroleum was produced.

McClain.—Petroleum and natural gas were produced from numerous small fields and natural gasoline was recovered at the Criner plant of Sunray Mid-Continent Oil Co. Sand and gravel for highway paving was produced.

McIntosh.—Coal was strip mined by Magic City Coal Co. Small amounts of petroleum and natural gas were produced, mostly from the Coalton and Stidham fields. Sand was produced for highways. The U.S. Army Corps of Engineers, Tulsa District, was constructing

the Eufaula dam on the South Canadian River between Haskell and McIntosh Counties.

Murray.—Asphaltic limestone and sandstone were produced near Dougherty by United States Asphalt Corp. Limestone was mined and crushed at the Rayford and Big Canyon quarries of Dolese Co.; elsewhere by other producers. Structural and paving sand and gravel were produced by Makin Sand & Gravel Co. and sand and gravel for highways by the State highway department. Petroleum and natural gas were produced from two fields.

Muskogee.—Petroleum and a small quantity of natural gas were produced. Sand and gravel was dredged from the Arkansas River by two producers and the State highway department. At Muskogee, Fansteel Metallurgical Corp. operated its columbium-tantalum plant. Callery Chemical Co. continued to make high-energy fuels at its Muskogee plant. The Corning Glass Works announced that it would construct an addition to its Muskogee plant to increase its glassmaking capacity 50 percent.

Noble.—Petroleum and natural gas were produced from numerous fields; natural gas liquids were recovered by the Lucien unit of Gasoline Plant Management Co. Sandstone was quarried and crushed by several producers.

Nowata.—Petroleum and natural gas were produced from six fields. Crushed limestone was produced by Peerless Rock Co. Coal was strip mined by Markley Coal Co. and Patch Coal Co.

Okfuskee.—Petroleum and natural gas were produced from numerous fields. The productive Olympic field furnished about 1 million barrels of crude oil. Natural gas liquids were recovered by two plants of Grimes & Grimes and by the Laffoon plant of Kerr-McGee Oil Industries, Inc. Sand and gravel was produced by the State highway department.

Oklahoma.—Petroleum and natural gas were produced from numerous fields; Oklahoma City field yielded 2.8 million barrels of oil. Natural gas liquids were recovered by Patton & Swab, Inc.; Champlin Oil & Refining Co.; Phillips Petroleum Co. (two plants); and Cities Service Oil Co. The Oklahoma City plant of Monarch Refineries, Inc., was inactive during the year. Structural and paving sand was produced by four operators, and paving sand was produced by the State highway department. Clay for manufacturing brick and tile was obtained from pits in the west part of Oklahoma City by Acme Brick Co. and United Brick & Tile Co. Near Choctaw, clay for lightweight aggregate was produced by Oklahoma Lightweight Aggregate Corp.

Okmulgee.—Petroleum and natural gas were produced from numerous fields. The Phillips Petroleum Co. refinery at Okmulgee was in operation. Coal was mined underground near Henryetta by Ben Hur Coal Co. and Consolidated Coal Co. Sandstone was quarried near Henryetta by the Ada Stone Co. Paving sand was produced for highways.

Osage.—Osage, with many fields yielding oil and gas, was the leading oil-producing county. The Burbank field, under an extensive waterflooding program, produced 15.7 million barrels of oil and remained one of the most prolific fields. Natural gas liquids were recovered by

Phillips Petroleum Co. in two plants. Crushed limestone was produced by Burbank Rock Co., Blake Stone Co., and Cookson Stone Co.

Ottawa.—All of the Oklahoma lead and zinc output and a major part of the Tri-State district output was supplied from mines in Ottawa County. Because of depressed metal markets, all major mining operations remained idle during the year. At Miami, the Rare Metals plant of The Eagle-Picher Co. operated during the year. Chat was supplied by five producers. Tripoli was quarried in east central Ottawa County by American Tripoli Division and processed in its plant at Seneca, Mo. Mineral specimens of sphalerite and galena were collected and sold as gem stones.

Pawnee.—Petroleum and natural gas were produced from numerous fields; natural gas liquids were recovered by Frame Natural Gasoline Co. Construction and paving sand and gravel were produced by two operators. Limestone was quarried and crushed by several producers.

Payne.—Petroleum and natural gas were produced from numerous fields; Yale-Quay, with a production of 1.3 million barrels of oil, was the largest in the county. Gas Products Corp. recovered natural gas liquids at the Norfolk field plant, formerly owned by Boswell-Frates Co. The refineries of Kerr-McGee Oil Industries, Inc., and Midland Cooperatives, Inc., at Cushing operated throughout the year. Crushed limestone was produced by Cookson Stone Co. at the Cushing quarry and sand was mined by the Payne County highway department.

Pittsburg.—Pittsburg County ranked fourth in value of coal produced. The underground coal mine of Lone Star Steel Co. closed in August. Natural gas was produced from three fields near Quinton. Sand was produced for highway construction. Clay for manufacturing brick and tile was produced by the Oklahoma State Penitentiary west of McAlester.

Pontotoc.—Petroleum and natural gas were produced from many fields, and natural gas liquids were recovered by plants of Humble Oil & Refining Co. and Kerr-McGee Oil Industries, Inc. However, the Fitts field plant of Kerr-McGee was closed on July 31. Building limestone was quarried near Fittstown by Townsend Quarry. Shale, clay, and limestone were quarried near Lawrence by Ideal Cement Co. for use in its Ada plant. Mid-Continent Glass Sand Co. produced glass sand and molding sand. Paving sand and gravel was produced by Dolese Co. and the State highway department. Ideal Cement Co. operated its new Ada plant throughout the year and retained its old plant on standby status.

Pottawatomie.—Petroleum and natural gas were produced from numerous fields. St. Louis field was the largest producer. Natural gas liquids were recovered by the St. Louis plant of Sinclair Oil & Gas Co. The Warren Petroleum Corp. plant in the Maud field, sold to Sinclair Oil & Gas Co., was being dismantled. Paving gravel was produced by the State highway department; construction sand was mined by one producer.

Rogers.—Rogers County ranked second in coal production. Coal was strip mined by McNabb Coal Co. and Sinclair Coal Co. Shale was produced by Chandler Materials Co. as raw material for its

lightweight aggregate plant. Petroleum and natural gas were produced from three fields. The Chelsea district produced most of the oil. The U.S. Army Corps of Engineers, Tulsa District, was constructing the Oologah Dam on the Verdigris River. The Public Service Co. of Oklahoma was building its Oologah hydroelectric power plant.

Seminole.—Petroleum and natural gas were produced from numerous fields; Seminole City field was the most prolific. Natural gas liquids were recovered at the plants of Redco Corp., Sinclair Oil & Gas Co., and Phillips Petroleum Co. Clay for manufacturing brick and tile was obtained west of Wewoka by Wewoka Brick & Tile Co. Sand and gravel was produced for highways.

Sequoyah.—The total value of coal, mined from open pits by Sallisaw Stripping Co., was third highest in the State. Limestone was mined and crushed north of Marble City at the St. Clair Lime Co. quarry; part of the limestone was burned at Sallisaw in the company kilns; and the remainder was used for glassmaking, soil conditioning, and highway construction and maintenance. Other operators produced limestone for riprap. Natural gas was produced from a small field. Sand and gravel was produced by one operator and the State highway department.

Stephens.—Stephens County ranked second in petroleum production and produced considerable natural gas. Natural gas liquids were recovered by four plants. The D–X Sunray refinery at Duncan was being modernized at a cost of $1.6 million. Crushed sandstone and paving gravel were produced for highways.

Texas.—Natural gas, from the vast Hugoton gasfield, and petroleum were produced during the year. Natural gas liquids were recovered near Guymon by Cities Service Oil Co. and Hugoton Plains Gas & Oil Co., and elsewhere by Dorchester Corp. and Excelsior Corp. Construction sand and gravel was produced by three operators.

Tillman.—Petroleum and a small quantity of natural gas were produced. The Granfield refinery of Bell Oil & Gas Co. operated throughout the year. Construction sand was produced by two operators. Century Granite Co. operated a granite-finishing plant at Frederick.

Tulsa.—Petroleum and natural gas were produced. Brick and tile were manufactured by Acme Brick Co. and United Brick & Tile Co. in Tulsa, and by United Brick & Tile Co. in Collinsville. East of Tulsa, near Garnett, crushed limestone was produced by Anchor Stone Co., Chandler Materials Co., and Standard Industries, Inc. (two quarries). Also east of Tulsa, Dewey Portland Cement Co. continued constructing its $12 million plant; initial capacity will be 1.25 million barrels of cement yearly. Construction and paving sand were produced by nine operators. At west Tulsa, refineries of The Texas Co. and of D–X Sunray operated throughout the year. D–X Sunray was installing an 85,000-barrel-a-day crude oil distillation unit and a $1 million petrochemical unit to produce benzene and toluene. The U.S. Army Corps of Engineers, Tulsa District, was constructing the Keystone dam on the Arkansas River.

Washington.—Petroleum and natural gas were produced from five districts. Dewey Portland Cement Co. quarried limestone and clay

near Dewey for manufacturing portland cement. Crushed limestone was produced east of Bartlesville by M. E. Stewart & Sons. The Bartlesville smelter of National Zinc Co. operated throughout the year; sulfuric acid, as a byproduct from imported zinc ores, was produced in addition to zinc.

Washita.—Petroleum and natural gas were produced from several small fields and from part of the prolific Elk City field. Sand and gravel was produced for highways. Agricultural gypsum was quarried near Colony by Agricultural Gypsum Co.

Woods.—Natural gas and petroleum were produced from several small fields. Construction sand was produced near Waynoka by Waynoka Sand & Gravel Co. Ezra Blackmon recovered salt by solar evaporation from water basins adjacent to the Cimarron River, west of Freedom.

Woodward.—Natural gas and petroleum were produced. Sand and gravel was produced by Klines Sand Pit and by the State highway department.

The Mineral Industry of Oregon

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Oregon Department of Geology and Mineral Industries.

By Frank B. Fulkerson,[1] William N. Hale,[1] and Norman S. Petersen [1]

MINERAL output in Oregon advanced to a record high in 1960, mainly because of increased values for stone and cement. Production value of sand and gravel, nickel ore, clays, and lime also gained. Output of uranium and mercury decreased markedly. The State value of production, which had recorded increases annually for 5 consecutive years, was 9 percent greater than in 1959. Unit values generally were steady, and the increase was due to the greater tonnages produced. Sand and gravel, stone, cement, and nickel ore continued to supply most of the State value.

An index of the physical volume of production rose 10 percent from 1959 to 1960. The index, which was obtained by averaging the relative changes in the volume of production for all commodities, weighted by their 1960 values, was 110 in 1960 (1959=100).

A favorable development in the primary aluminum industry was the announcement that a new plant would be built in Oregon or Washington by Harvey Aluminum, Inc. The same company expanded the capacity of The Dalles aluminum plant during 1960.

TABLE 1.—Mineral production in Oregon [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays---thousand short tons	294	$308	318	$370
Copper (recoverable content of ores, etc.)---short tons	----------	----------	6	4
Gold (recoverable content of ores, etc.)---troy ounces	686	24	835	29
Mercury---76-pound flasks	1,224	278	513	108
Nickel (content of ore and concentrate)---short tons	12,374	(2)	13,115	5,246
Sand and gravel---thousand short tons	18,087	15,506	17,673	16,170
Silver (recoverable content of ores, etc.)---troy ounces	242	(3)	284	(3)
Stone---thousand short tons	13,341	16,126	16,864	19,620
Value of items that cannot be disclosed: Asbestos, carbon dioxide, cement, diatomite, gem stones, iron ore (pigment material) 1959, lime, pumice, uranium, and values indicated by footnote 2	----------	[4] 18,607	----------	14,124
Total [5]	----------	[4] 49,843	----------	54,419

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Less than $500.
[4] Revised figure.
[5] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

[1] Commodity-industry analyst, Bureau of Mines, Albany, Oreg.

New distribution facilities were completed by Calaveras Cement Co. at Springfield and by Ideal Cement Co. at Eugene.

Consumption, Trade and Markets.—The bulk of the mineral output was for local consumption. Oregon business conditions improved slightly in 1960. These improvements occurred despite a continued depression in the production of lumber and wood products, the main manufacturing industry. Personal income and factory payrolls gained, and monthly average unemployment, although fairly high, was less than in the preceding year. Construction gained due to greater activity in nonresidential building and stepped-up work on the highways, which more than offset lower residential construction. Building permits in the principal cities, contracts awarded, and monthly average employment all increased 3 percent. Average weekly hours of construction workers would have been higher than in 1959 except for inclement weather in 2 months which curtailed work.

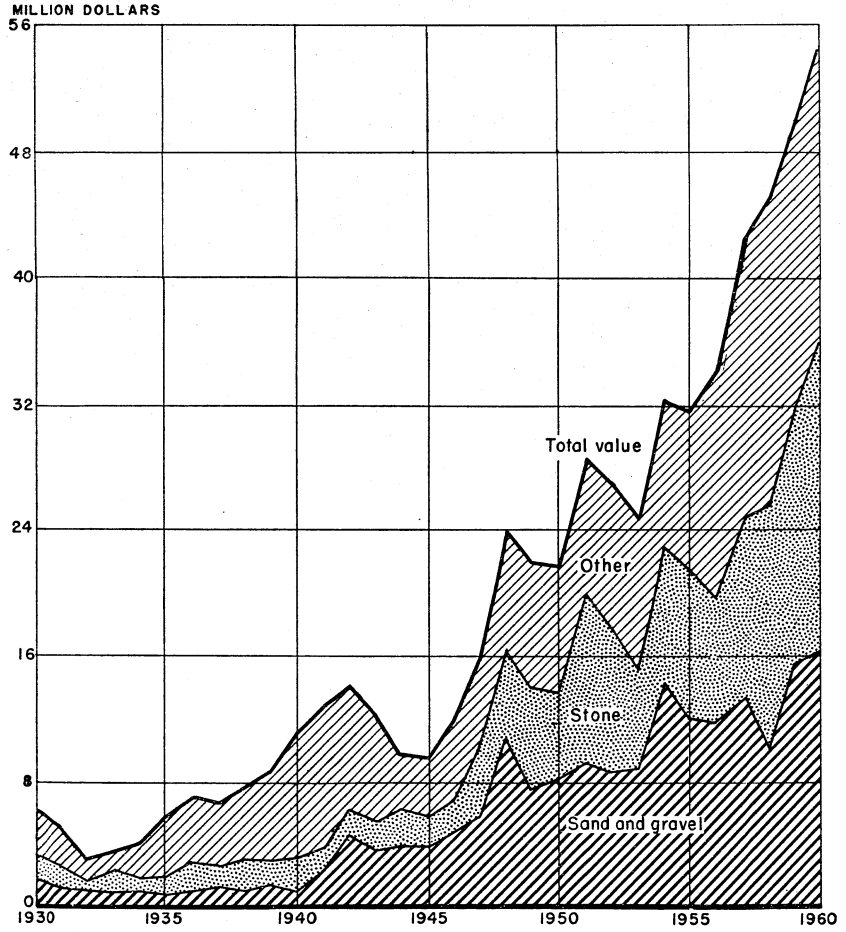

FIGURE 1.—Value of sand and gravel, stone, and total value of mineral production in Oregon, 1930–60.

TABLE 2.—Selected Oregon economic statistics

	1959	1960	Change, percent
Personal income:			
Total millions	$3,842.0	$4,036.0	+5
Per capita	$2,188.0	$2,276.0	+4
Construction activity:			
Building permits millions	$191.3	$196.2	+3
Contracts awarded do	$354.8	$364.9	+3
Cement shipments to Oregon destinations thousand 376-pound barrels	2,898.0	3,097.0	+7
Average monthly employment	25,300.0	26,000.0	+3
Average weekly hours of construction workers	36.7	36.0	−2
Lumber industry:			
Average monthly employment production workers	68,600.0	65,200.0	−5
Production, Douglas fir region of Oregon and Washington billion board feet	8.5	8.0	−6
Factory payrolls millions	$766.6	$770.6	+1
Average monthly total labor force	703,800.0	715,000.0	+2
Average monthly unemployment	36,900.0	36,400.0	−1

Source: Survey of Current Business, Oregon Business Review, Grow with Oregon, Oregon's Labor Market, Oregon Covered Employment & Payrolls, F. W. Dodge Corp., and Bureau of Mines.

Employment and Injuries.—Employment in the mineral industries was higher by 4 percent than in 1959 due to more workers in concrete, gypsum, and plaster products manufacturing, and in steelmaking. Employment in mining, at iron and steel foundries, and in nonferrous metals smelting and refining was slightly less than in 1959. From 1955 to 1960, employment in primary metals gained at an average rate of 7 percent annually, making these industries one of the fastest growing manufacturing sectors in Oregon. Table 4 gives data on injuries in mining industries.

TABLE 3.—Employment and payrolls in mineral-industry establishments subject to Oregon unemployment-compensation law, by industries

Industry	1959		1960	
	Employment	Payrolls (thousands)	Employment	Payrolls (thousands)
Mining	1,227	$6,955	1,181	$6,662
Stone, clay, and glass products:				
Glass and pottery	282	1,783	317	1,949
Hydraulic cement	454	2,761	451	2,893
Structural clay products	210	1,051	192	1,027
Concrete, gypsum, and plaster products	1,451	7,917	1,746	9,999
Cut-stone and stone products	36	209	49	300
Miscellaneous	119	620	105	572
Total	2,552	14,341	2,860	16,740
Primary metals:				
Blast furnaces, steelworks, rolling and finishing mills	1,123	8,357	1,344	9,819
Smelting and refining of nonferrous metals	2,046	12,546	1,995	12,937
Iron and steel foundries	2,035	12,140	1,952	11,772
Nonferrous foundries	228	1,194	240	1,287
Miscellaneous	218	1,349	220	1,313
Total	5,650	35,586	5,751	37,128
Industrial chemicals	437	2,683	477	2,970
Products of petroleum and coal	325	1,866	319	1,816
Grand total	10,191	61,431	10,588	65,316

Source: Oregon Employment Department. Industries may vary from those in the Bureau of Mines canvass.

TABLE 4.—Injury experience in the mineral industries

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:						
Quarries and mills [1]	909	215	1,562,867		79	51
Nonmetal mines and mills	219	214	373,858		11	29
Sand and gravel operations	752	206	1,241,315		16	13
Metal mines and mills	357	148	421,771	1	19	47
Coal mines	7	41	2,313		1	432
Total	2,244	201	3,602,124	1	126	35
1960: [2]						
Quarries and mills [1]	831	209	1,392,663		61	44
Nonmetal mines and mills	192	216	331,787		5	15
Sand and gravel operations	826	191	1,264,784	2	20	17
Metal mines and mills	173	165	227,823		6	26
Coal mines	5	29	1,145			
Total	2,027	198	3,218,202	2	92	29

[1] Includes cement- and lime-processing plants.
[2] Preliminary figures.

Government Programs.—Two contracts involving mercury were active under the program of the Office of Minerals Exploration (OME), U.S. Department of the Interior. These contracts covered work at the Nisbet mine (A. O. Bartell, Clackamas County) and the Big Muddy prospect (Oregon Cinnabar Mines, Inc., Jefferson County). The amounts were $14,920 and $47,910, respectively, with Government participation of 50 percent.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—A small quantity of chrysotile asbestos (shorts) was shipped by Oregon Asbestos Co., Mount Vernon, Grant County, to a California market.

Cement.—Production and shipments of cement were 18 and 15 percent greater, respectively, than in 1959. As in previous years, output was from three plants—one each in Baker, Clackamas, and Jackson Counties. Shipments were made chiefly within the State; out-of-State shipments were mainly to Idaho and Washington, with smaller quantities to northern California and Alaska. Trucks continued to be the principal method of transport; however, water and rail movement increased. The ratio of bulk to container (bag) shipments from producing plants was greater than in 1959.

Combined production from nine cement plants in Oregon and Washington was 8,244,300 barrels (376 pounds each) of finished portland cement; the same plants shipped 8,319,400 barrels of cement. The average value of portland cement shipped by producers in Oregon and Washington was $3.52 per barrel, f.o.b. plant, compared with $3.50 in 1959.

Calaveras Cement Co. placed in operation a 2,350-barrel-capacity bulk-cement transfer plant at Springfield. The plant was to be supplied by rail shipments from Calaveras plants in California. Ideal

Cement Co. constructed a 2,000-barrel-capacity distribution terminal at Eugene. The terminal, which was equipped to receive bulk or packaged cement by rail or truck, was to be supplied from the Ideal plant at Gold Hill.

Clays and Shale.—Clays sold or used by producers in Oregon advanced 8 percent over 1959 because of increased production of clay for cement. Miscellaneous clay production used in making heavy clay products, principally building brick and agricultural draintile, was 15 percent less than in 1959. Miscellaneous clay was produced in Benton, Clackamas, Klamath, Malheur, Marion, Multnomah, Polk, Tillamook, Union, Washington, and Yamhill Counties. Clay and shale used at cement plants were produced in Baker and Jackson Counties.

Production of shale for processing to expanded aggregate declined. The raw shale was expanded at plants of Smithwick Concrete Products Co. and Northwest Aggregate, Inc., in Washington County. Output was marketed mainly for use as a lightweight-concrete aggregate; the expanded product also was used as pozzolan additive to concrete used in constructing the John Day Dam.

Central Oregon Bentonite Co. increased production and shipments of bentonite from the Silver Wells operation southeast of Prineville, Crook County. The ground bentonite was used mainly as a binder for pelletized livestock feed and for sealing earth-lined irrigation canals and reservoirs. Smaller quantities were used in oil-well drilling muds and for insecticide dusts.

Diatomite.—Production and shipments of prepared diatomite were 6 percent lower than in 1959. Output was from the quarry and preparation plant of Great Lakes Carbon Corp., Mining & Mineral Products Division, near Terrebonne, Deschutes County. The prepared product was marketed chiefly for filter, filler, and insulation uses.

A. M. Matlock continued to explore diatomite deposits in the Silver Lake area of Lake County. A small tonnage of crude ore was produced and stockpiled.

Lime.—Output of lime at the Baker plant of Chemical Lime Co. was slightly greater than in 1959. Electroprocess, metallurgical, and paper plants in the Pacific Northwest continued as the principal markets for the quicklime and hydrated lime produced.

Pacific Carbide & Alloys Co. quarried limestone from the Black Marble quarry near Enterprise, Wallowa County, to supply the company limekilns at Portland, Multnomah County. Quicklime production was utilized by the firm to manufacture calcium carbide.

Perlite.—Output of expanded perlite by Supreme Perlite Co., Portland, Multnomah County, was 9 percent lower than in 1959. Nevada mines supplied the crude perlite processed at the plant. The expanded product was marketed chiefly as a building plaster aggregate; smaller quantities were sold for soil conditioning and for concrete aggregate use.

Pumice and Volcanic Cinder.—The quantity of pumice and pumiceous materials (volcanic cinder and scoria) sold or used by producers in Oregon was 4 percent lower than in 1959. Production was from three operations in Deschutes County.

The quantity of pumice sold or used remained substantially the same as in the previous year; however, volcanic cinder and scoria output declined moderately. Pumiceous materials produced were used mainly as lightweight-concrete aggregate. Smaller tonnages of cinder were used for surfacing roads and as roofing rock, and a small quantity of pumice was utilized for insulation purposes.

Sand and Gravel.—Total output of sand and gravel was 17.7 million tons—a decline of 2 percent from the record high of 18.1 million tons produced in 1959. The principal cause of the decline was curtailed requirements for sand and gravel by the U.S. Forest Service and the U.S. Army Corps of Engineers. The quantity of sand and gravel used at State highway department projects remained substantially the same (2.9 million tons) as the year before. Sand and gravel output by commercial producers was 7.4 million tons, compared with 7.2 million tons in 1959. Noncommercial (Government-and-contractor) production was 10.3 million tons—a decline of 6 percent from the 10.9 million tons produced in 1959. Production was reported from 33 of the 36 counties. Output exceeding 1 million tons was reported from Clackamas, Lane, Multnomah, and Gilliam Counties.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	2,360	$2,829	2,313	$2,706
Concrete and roadstone	4,369	4,657	3,852	4,513
Other [1]	484	401	1,237	865
Total	7,213	7,887	7,402	8,083
Government-and-contractor operations:				
Building	5,284	2,031	3,734	2,583
Concrete and roadstone	5,589	5,588	4,582	4,757
Other [1]			1,954	747
Total	10,874	7,619	10,271	8,087
All operations:				
Building	7,644	4,861	6,047	5,289
Concrete and roadstone	9,958	10,245	8,434	9,270
Other [1]	484	401	3,191	1,612
Grand total [2]	18,087	15,506	17,673	16,170

[1] Includes special sands, railroad ballast, and sand and gravel used for miscellaneous purposes.
[2] Owing to rounding, the individual items may not add to totals shown.

Stone.—Output of stone for all purposes reached a record of 16.9 million tons, an increase of 26 percent over 1959. The rise resulted from increased quantities of crushed stone used at State and Federal road projects. Stone output by commercial concerns was 4.2 million tons, and noncommercial (Government-and-contractor) production was 12.7 million tons, compared with 4.8 and 8.5 million tons, respectively, in 1959. In tonnage, basalt continued to be the principal stone quarried. Output was used for roadstone, ballast, and riprap.

The quantity of limestone quarried was 1.2 million tons, an in-

crease of 10 percent. Greater production of limestone for cement manufacture accounted for the increase. Producers reported that the largest tonnage was used by the cement industry, followed by the lime, sugar, paper, calcium carbide, and metallurgical industries, and agriculture. Limestone for industrial uses was quarried in Baker, Josephine, Polk, and Wallowa Counties.

Bristol Silica Co. continued to produce industrial silica (quartz) near Rogue River, Jackson County. Crushed silica was marketed for manufacturing silicon carbide, ferrosilicon, and refractories, and for other industrial purposes. The processing plant had to be relocated during the year because of highway construction. A new crushing and screening facility was built adjacent to rail and truck transportation routes west of Gold Hill. Sampling and evaluating of the Rannells silica deposit on Quartz Mountain northeast of Roseburg, Douglas County, continued and the deposit was the subject of an article.[2]

TABLE 6.—Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1959		1960	
	Quantity	Value	Quantity	Value
Building (dimension stone)	(1)	(1)	4	$37
Concrete, roadstone, and screening	9,018	$11,860	12,062	14,266
Riprap	2,855	2,161	2,879	2,886
Railroad ballast	(1)	(1)	309	328
Other [2]	1,468	2,105	1,610	2,104
Total [3]	13,341	16,126	16,864	19,620

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Used at sugar refineries, in manufacturing paper and cement, at metallurgical and chemical plants and for other unspecified purposes; and items indicated by footnote 1.
[3] Owing to rounding, individual items may not add to total shown.

Rough building-stone production increased sharply as new quarries were brought into production. Dimension stone was quarried in Baker, Deschutes, Lake, Marion, and Multnomah Counties.

Stone was produced from operations in all 36 counties, and output exceeded 1 million tons in Baker, Jackson, and Lane Counties.

Talc and Soapstone.—Soapstone mined in northwestern Washington was ground at Portland plants of Stauffer Chemical Co. and Miller Products Co. Output of ground soapstone, which was used as a carrier in insecticides and fungicides, declined sharply from 1959.

Vermiculite (Exfoliated).—Production and shipments of exfoliated vermiculite were moderately higher than in 1959. Vermiculite from Montana and the Union of South Africa was utilized at Portland plants of Vermiculite Northwest, Inc., and Supreme Perlite Co., respectively. The exfoliated product was marketed as a loose-fill insulation, as a lightweight aggregate for plaster and concrete, and as a soil conditioner.

[2] Ramp, Len, The Quartz Mountain Silica Deposit: Oregon Dept. of Geol. and Min. Ind., The Ore-Bin, vol. 22, No. 11, November 1960, pp. 109–114.

METALS

Aluminum.—In April, Harvey Aluminum, Inc., announced that it would expand the annual capacity of its primary aluminum plant at The Dalles from 60,000 to 75,000 tons. Fabricating and billet-casting facilities also were planned at The Dalles, along with additions to the company mill at Torrance, Calif. The Harvey concern planned to construct another plant in Oregon or Washington with an annual capacity of 75,000 tons of primary aluminum, increasing primary annual capacity of the company in the Pacific Northwest to 150,000 tons. In July, the Harvey company entered into an agreement with Bonneville Power Administration for a peak load delivery of 75,000 kilowatts of firm power and 80,000 kilowatts of secondary power, to begin by January 1963.

Chromium.—No chromium ore or concentrate was produced in 1960; chromite mines and mills were closed in mid-1958 upon completion of the Federal chromite stockpiling program. Southwest Oregon beach sand containing chromite was the subject of a report.[3]

Copper.—Concentrate from the Standard mine, Grant County, the source of small quantities of copper in recent years, was shipped to the Tacoma (Wash.) smelter; production also was recorded at the Copper Eagle and other mines in Josephine County late in the year.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals[1]

Year	Mines producing		Material sold or treated[2] (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1951–55 (average)	15	23	2,078	6,030	$211	9,133	$8
1956	15	15	1,991	2,738	96	13,542	12
1957	25	18	2,594	3,381	118	15,924	14
1958	17	33	1,947	1,423	50	2,728	2
1959	10	27	356	686	24	242	(3)
1960	13	34	1,231	835	29	284	(3)
1852–1960	----------	----------	(4)	5,792,000	130,670	5,373,000	4,928

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	6	$3	3	$1	1	(3)	$224
1956	7	6	5	2	----------	----------	116
1957	23	14	5	1	----------	----------	148
1958	10	5	1	(3)	----------	----------	58
1959	----------	----------	----------	----------	----------	----------	24
1960	6	4	----------	----------	----------	----------	33
1852–1960	12,474	4,709	823	99	173	23	140,430

[1] Includes recoverable metal content of gravel washed (placer operations), old tailings retreated, ore milled, and ore shipped to smelters during calendar year indicated. Owing to rounding, individual items may not add to total shown.
[2] Does not include gravel washed.
[3] Less than $500.
[4] Data not available.

[3] Hunt, J. F., Beneficiation of Southwest Oregon Beach Sands by High Tension and Magnetic Dry Processing: Raw Materials Survey, Ser. 60, Issue 4, August 1960, pp. 5–7.

A geologic report on copper-cobalt deposits was placed on open file for public inspection at the Spokane (Wash.) office of the Federal Geological Survey.[4]

Gold.—Gold output increased 149 ounces over the 1959 record low. Placer mines in Josephine County supplied 63 percent of the 835 ounces (lode and placer) produced. In Grant County, lode gold was recovered principally from the Buffalo (gold ore) and Standard (copper ore) mines; over 65 percent of the State lode output was mined in this county.

Some gold mines were developed in the Cracker Creek district, Baker County. Emerald Empire Mining Co., Corvallis, leased the Champion, Musick, and Helena group claims (Bohemia district) from Lane Minerals, Inc. Work was done at these properties and at mines in the Blue River district late in 1960. Lane Minerals, Inc., Cottage Grove, was developing mines near Fairview Peak (Central Bohemia district), Lane County, where access to the Bohemia district was improved by county and Federal road projects.

Mercury.—Mercury production was 513 flasks, a decline of 58 percent from 1959. The Bretz mine (Arentz Mining Venture), Malheur County, and the Bonanza mine (Bonanza Mine & Oil Corp.), Douglas

TABLE 8.—Gold production at placer mines

Year	Mechanical and hydraulic methods			Small-scale hand methods [1]			Total		
	Number	Material treated (thousand cubic yards)	Gold (troy ounces)	Number	Material treated (thousand cubic yards)	Gold (troy ounces)	Number	Material treated (thousand cubic yards)	Gold (troy ounces)
1951–55 (average)	15	1,808	4,775	10	11	134	25	1,820	4,909
1956	10	52	314	5	3	40	15	56	354
1957	10	34	126	8	7	53	18	41	179
1958	24	258	489	9	6	56	33	264	545
1959	19	54	396	8	4	54	27	58	450
1960	[2] 14	226	610	20	5	58	34	231	668

[1] Includes surface and underground (drift) placers.
[2] Includes 12 hydraulic mines, 1 nonfloating-washing plant, and 1 skid-mounted washing plant.

TABLE 9.—Mine production of gold, silver, and copper in 1960, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)
Lode ore:					
Dry gold	10	889	135	137	----------
Copper	3	342	32	46	12,000
Total lode	13	1,231	167	183	12,000
Gravel (placer operations)	34	(1)	668	101	----------
Grand total	47	1,231	835	284	12,000

[1] 230,865 cubic yards of placer gravel washed.

[4] Vhay, John S., Copper-Cobalt Deposits of the Quartzburg District, Grant County, Oreg.

County, yielded 63 and 36 percent, respectively, of the total output; mines in Crook and Jackson Counties accounted for the remainder. Of the 11,631 tons of ore processed, 72 percent was beneficiated by flotation before furnacing. The Bonanza mine, one of the major Oregon producers in past years, was abandoned on October 1.

Nickel.—Nickel silicate ore, totaling 874,318 tons and averaging 1.5 percent nickel, was hauled by tramway and diesel trucks from the Nickel Mountain open-pit mine (Hanna Mining Co.) to the smelter (Hanna Nickel Smelting Co.) near Riddle. The latter company, using the d'Ugine process to recover nickel from the ore, produced 22,229,000 pounds of nickel contained in 48,728,000 pounds of ferronickel. Commercial marketing of ferronickel was one of numerous projects being considered to keep the Hanna nickel plant operating after completion of the Federal stockpiling program in 1962.

The Hanna nickel operation was the subject of three reports in 1960.[5]

Silver.—Silver was recovered as a byproduct of lode and placer gold operations; output increased 42 ounces over the 1959 record low of 242 ounces.

Seventy-one percent of the placer silver production was reported from Josephine County, and over 70 percent of the lode silver output was from Grant County, where the Buffalo mine accounted for 54 percent of the State lode total.

Steel.—In Portland, Oregon Steel Mills, Inc., the only producer of rolled-steel products in Oregon, reduced prices April 1 in an effort to offset increased competition from foreign producers of merchant bars and structural items.

Uranium.—Production of uranium ore was recorded late in 1960 from the Lucky Lass claims, Lake County, and the Rocky Ridge claims, Crook County. The White King mine, Lake County, leased by Lakeview Mining Co., did not produce in 1960. The company returned the property to the owners, and later it was leased to Vance Thornburg, Grand Junction, Colo. Uranium ores from Alaska and Nevada, in addition to the Lucky Lass and Rocky Ridge ore, were processed at the Lakeview Mining Co. mill at Lakeview. The company contracted with the Atomic Energy Commission to process uranium ores until November 1963.

Other Metals.—Wah Chang Corp. installed rolling-mill equipment to shape ingot to rod, sheet, plate, and other forms at its refractory metals plant at Albany. The company produced zirconium, columbium, tantalum, and hafnium metals from ores and concentrates, and employment rose to a high of more than 500 during the year. Oregon Metallurgical Corp., also at Albany, received a $430,000 Government contract to produce high-purity vanadium for atomic energy applications. Other metals processed by the company were zirconium, titanium, tungsten, and molybdenum. Employment fluctuated during the year and reached 325 at peak production.

---

[5] Bogert, John R., How Ferronickel Is Produced From Low-Grade Laterite by the Ugine Process: Min. World, vol. 22, No. 11, October 1960, pp. 33–37.
Coleman, E. E., and Vedensky, D. N., Production of Ferronickel at Riddle, Oreg.: Pres. ann. meeting of AIME, New York, N.Y., Feb. 15–18, 1960.
Mollard, Earl S., Nickel: Min. Cong. Jour., vol. 46, No. 2, February 1960, pp. 110–111.

MINERAL FUELS

Carbon Dioxide.—Natural carbon dioxide recovered from mineral waters pumped at wells of the Gas-Ice Corp., Ashland, Jackson County, was reduced sharply from 1959. Carbon dioxide was processed to dry ice at the company's Ashland plant.

Coal.—Pacific Power & Light Co. mined and shipped a 60-ton sample of coal from the Eden Ridge field in Coos County to the Colorado School of Mines for testing. The testing was part of an extensive evaluation program begun by the company in 1956 to determine the feasibility of basing a steam-electric generation plant on the coal reserves of the Eden Ridge field.

Natural Gas.—Additional supplies of natural gas were made available to consumers in the State through construction of a 120-mile pipeline from Camas, Wash., to Eugene, Lane County. The pipeline, constructed for El Paso Natural Gas Co., made available natural gas to the Eugene area for the first time. Approval of the Canadian Government, the Federal Power Commission, and the Public Utilities Commissions of California, Oregon, and Washington was obtained for construction of a 36-inch, 1,404-mile pipeline from Alberta (Canada) fields to markets in northern and central California. The pipeline, which was to traverse eastern and central Oregon, would bring natural gas to Bend, Klamath Falls, Medford, and Rogue River Valley points. The project was scheduled for completion in 1961.

Petroleum.[6]—The Oregon Department of Geology and Mineral Industries issued seven new drilling permits in 1960—five in Polk County and two in Lake County—compared with three permits issued in 1959. A total of 22,802 feet was drilled in 1960, compared with 5,192 feet the previous year.

Humble Oil & Refining Co. in southern Lake County drilled to a depth of 12,093 feet before abandoning the well. This was the second-deepest hole drilled in Oregon in search for oil and gas; the deepest was a 12,880-foot dry well by Sinclair Oil & Gas Co. (1955) in Lane County. At yearend, the Humble company was drilling a second well, the "Leavitt No. 1," in southern Lake County 4 miles south of Lakeview.

REVIEW BY COUNTIES

Baker.—Increased production of cement, lime, sand and gravel, stone, and clay advanced the value of mineral production in the county over that of the previous year. The Oregon Portland Cement Co. plant at Lime continued, in terms of value, to be the principal mineral-industry activity. Portland cement output increased substantially over 1959 when dam construction in the region was curtailed because of a nationwide steel strike. Limestone for the plant was supplied from the nearby Limerock quarry, and shale was obtained from the company Gales Creek quarry. Chemical Lime Co. continued production of quicklime and hydrated lime at a plant north of Baker. Limestone for the plant was obtained from the company Marble Creek quarry northwest of Baker.

[6] Oilwell drilling data were obtained from The Ore.-Bin, a monthly publication of Oregon Department of Geology and Mineral Industries.

TABLE 10.—Value of mineral production in Oregon, by counties

(Thousand dollars)

County	1959	1960	Minerals produced in 1960 in order of value
Baker	(1)	(1)	Cement, stone, lime, sand and gravel, clays, gold, silver.
Benton	$471	$384	Sand and gravel, stone, clays.
Clackamas	(1)	(1)	Cement, sand and gravel, stone, clays.
Clatsop	141	1,205	Stone, sand and gravel.
Columbia	252	389	Do.
Coos	292	868	Stone, sand and gravel, gold.
Crook	252	340	Stone, sand and gravel, clays, mercury, uranium.
Curry	251	699	Stone, sand and gravel.
Deschutes	1,210	1,461	Diatomite, sand and gravel, pumice, stone.
Douglas	6,576	7,011	Nickel, sand and gravel, stone, mercury, gold, silver.
Gilliam	75	878	Sand and gravel, stone.
Grant	96	42	Stone, gold, asbestos, copper, silver.
Harney	112	68	Stone, sand and gravel.
Hood River	197	151	Do.
Jackson	4,185	3,347	Cement, stone, sand and gravel, clays, carbon dioxide, gold, mercury, silver.
Jefferson	87	430	Stone, sand and gravel.
Josephine	763	231	Stone, sand and gravel, gold, copper, silver.
Klamath	240	226	Stone, sand and gravel, clays.
Lake	(1)	320	Stone, sand and gravel, uranium.
Lane	5,427	7,844	Sand and gravel, stone, gold, silver.
Lincoln	439	363	Stone, sand and gravel.
Linn	2,563	457	Do.
Malheur	1,008	457	Stone, sand and gravel, mercury, gold.
Marion	382	846	Sand and gravel, stone, clays.
Morrow	188	282	Stone.
Multnomah	3,411	4,008	Sand and gravel, stone, lime, clays.
Polk	475	428	Stone, sand and gravel, clays.
Sherman	345	587	Stone, sand and gravel.
Tillamook	175	255	Stone, sand and gravel, clays.
Umatilla	1,059	1,171	Stone, sand and gravel.
Union	663	380	Stone, sand and gravel, clays.
Wallowa	138	270	Stone.
Wasco	815	426	Stone, sand and gravel.
Washington	777	1,016	Stone, clays, sand and gravel.
Wheeler	188	98	Stone, sand and gravel.
Yamhill	198	92	Sand and gravel, clays, stone.
Undistributed [2]	17,399	18,642	
Total [3]	[4] 49,843	54,419	

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes value of mineral production that cannot be assigned to specific counties and values indicated by footnote 1.
[3] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.
[4] Revised figure.

Limestone for industrial and agricultural uses was quarried near Durkee by Oregon Portland Cement Co.

Crushed roadstone output (chiefly basalt) increased substantially over the previous year owing to greater requirements by the State highway department.

In July, fire destroyed the plant and stone-processing equipment of Northwestern Granite Co., near Haines. The company was a producer of monumental stone.

Some of the old workings at the E & E, Columbia, Ibex, and North Pole gold mines near Bourne, along with gold properties of Cracker Creek Mining Co., Cracker Creek district, were operated in early 1960. Bourne Mines, Inc., revamped a 120-ton ball mill at the E & E mine to mill gold ore from some of these properties.

Clackamas.—In terms of value, the county again ranked first in the State for mineral production. Oregon Portland Cement Co. continued cement production at Oswego at about the 1959 rate. Sand and gravel output was 4 percent lower than in 1959, and crushed

stone production also declined. Three firms mined clay for making heavy clay products; production was 4 percent lower than in 1959.

The OME approved a loan to explore a mercury deposit (the Nisbet mine, A. O. Bartell) in Clackamas County; government participation was 50 percent of $14,920.

Coos.—A pilot plant capable of concentrating 50 tons of ore a day was under construction by Bolivar Copper Co. at a property 28 miles from Powers.

Columbia.—Stone and sand and gravel were produced. Stone production increased sharply over 1959, mainly because of greater demand for roadstone at State and county highway projects. The C. K. Williams & Co., Western Division, operation near Scappoose (crude iron oxide pigment) was inactive.

Crook.—Central Oregon Bentonite Co. continued production of bentonite from the Silver Wells operation southeast of Prineville. Ground bentonite shipments increased fourfold over 1959, the first year of operation. Stone and sand and gravel for road use also were produced in the county.

Werdenhoff Mining Co. began open-pit mining at a cinnabar deposit in the Lookout Mountain area near Prineville. A 40-ton Hershoff furnace, 48 condensers, a crusher, conveyor, and other facilities to extract mercury from the ore were installed at the property.

Deschutes.—Diatomite, pumice, sand and gravel, and stone were produced by mineral industries. Diatomite was quarried, processed, and shipped by Great Lakes Carbon Corp. from an operation near Terrebonne. Three producers supplied the State production of pumice and cinder in 1960.

Douglas.—Machinery and equipment were being salvaged from the Bonanza mine (Bonanza Oil & Mine Corp.) near Sutherlin, following its closure in October. The company was considering sending the rotary furnace and related equipment to a quicksilver operation in Ecuador.

Additional mining benches were developed on the north and east side of the open-pit nickel mine (Hanna Mining Co.) at Riddle. Attention was given also to the relocation of main haulage roads for future operations.

A tramway used by Hanna Mining Co. to transport nickel ore from the mine to the smelter was damaged in an accident and shut down for several weeks; during that time ore was delivered to the smelter by large diesel trucks.

Grant.—A lower adit was driven at the Buffalo mine in the Granite district. The level was 250 feet below previous workings and was driven to tap an ore body that had yielded shipping- and milling-grade ore for many years.

Jackson.—The Gold Hill cement plant of Ideal Cement Co. continued to be the principal mineral-industry activity. Production of cement was slightly less than in 1959. Limestone used at the plant was obtained at a quarry in Josephine County, and shale was supplied from the company Gold Hill quarry.

Bristol Silica Co. continued quarrying and crushing silica (quartz) for industrial uses; the firm also quarried and crushed granite for

poultry grit. Gas-Ice Corp. recovered natural carbon dioxide from ground waters pumped at wells near Ashland. The quantity of carbon dioxide recovered declined sharply from 1959. Crushed stone and sand and gravel output remained substantially the same as in the previous year.

Jefferson.—Oregon Cinnabar Mines, Inc., was granted an OME loan for exploration at the Big Muddy prospect; Government participation was 50 percent of $47,910.

Josephine.—Sharply reduced requirements for road materials by the State highway department and the U.S. Forest Service caused a drop in value of mineral production. The Marble Mountain quarry was operated by Ideal Cement Co. to supply limestone requirements of the company cement plant at Gold Hill, Jackson County. Moderately lower production of limestone for this use also contributed to the decline.

Harry Commers of Grants Pass shipped two carloads of copper ore to the Tacoma smelter in October; the ore was mined at the Copper Eagle (Brass Ledge) mine in the Galice district.

The War Eagle quicksilver mine was being examined by David Chase of Medford. A 10-ton Gould-type rotary furnace and other equipment were moved from the nearby Bonita mine to the War Eagle property where small amounts of ore were tested. The possibility of beneficiating a mercury-bearing coal on War Eagle property was considered.

Lake.—In July, Humble Oil & Refining Co. began drilling its 250,000-acre lease block in southern Lake County. A test hole northwest of Lakeview, the Thomas Creek No. 1, was drilled to a depth of 12,093 feet before the well was abandoned. At yearend, the company was drilling a second test well 4 miles south of Lakeview.

Lane.—The county ranked first in production of sand and gravel (6.3 million tons) and stone (3.1 million tons). Most of the output was utilized by the U.S. Army Corps of Engineers at dam-construction projects. Sand and gravel produced by commercial firms was 1.7 million tons, compared with less than 1 million tons in 1959. Output of stone by commercial concerns during the year dropped to 835,000 tons, a decline of 31 percent from the 1.2 million tons produced in 1959.

Linn.—Two electron-beam melting furnaces and four rolling mills were installed by Wah Chang Corp. in 1960. Strip, slab, sheet, foil, and rod were made at the new rolling mill where metal ingots shipped from various customers throughout the United States, and the ingots produced at Wah Chang, were processed. Facilities of Wah Chang Corp. included separation, refining, melting, and fabrication plants for the four refractory metals—zirconium, hafnium, columbium, and tantalum. The company marketed sponge, ingot, and fabricated products of these metals.

Oregon Metallurgical Corp., in addition to preparing ingots and castings of titanium, molybdenum, tungsten, vanadium, and zirconium, experimented with casting spent uranium for use as a counterweight in supersonic aircraft. The company installed additional furnaces and auxiliary equipment for melting refractory metals.

Multnomah.—Chemical and metallurgical plants in Portland pro-

duced calcium carbide, ferrosilicon, ferromanganese, silicomanganese, caustic soda, chlorine, and rolled and cast steel products.

Oregon Steel Mills, Inc., Portland, reduced extras and lowered the price of merchant bar (10- to 20-ton orders) and structural steel (over 10-ton orders) by $15 a ton. The other two steel producers in the Pacific Northwest (Bethlehem Steel Corp., Pacific Coast Division, and Northwest Steel Rolling Mills, Inc., Seattle, Wash.) lowered prices in areas where they competed with the Portland firm. Oregon Steel Mills, Inc., operated three electric furnaces with an annual steel capacity of 150,000 ingot tons.

Portland was the port of entry for foreign base-metal ores and concentrates transshipped to smelters in Idaho and Montana. During a 7½-month labor dispute at The Bunker Hill Co. operations, Kellogg, Idaho, a shortage of storage space at the smelter required stockpiling more than 20,000 tons of lead and zinc ores and concentrates at Portland dock terminals.

Aluminum oxide from Japan was received at Portland for reduction to aluminum at the Harvey Aluminum, Inc., plant at The Dalles.

Sand and gravel, stone, clay, and lime were the mineral commodities produced. Output of sand and gravel rose to 3.3 million tons, an increase of 9 percent over 1959. Increased requirements for this commodity by county, State, and Federal agencies was the principal reason for the greater production. Columbia Brick Works manufactured building brick from clay mined at the company pit southeast of Gresham. Limestone quarried in Wallowa County was processed to quicklime by Pacific Carbide & Alloys Co. of Portland. The quicklime was utilized by the firm to manufacture calcium carbide.

Perlite, vermiculite, and soapstone were shipped from out-of-State mines to processing plants in the county. Perlite mined in Nevada was expanded by Supreme Perlite Co., Portland. Vermiculite was exfoliated at Portland plants of Vermiculite Northwest, Inc., and Supreme Perlite Co. Soapstone mined in Washington was ground by Stauffer Chemical Co. and Miller Products Co. for use in manufacturing insecticide dusts.

Polk.—Limestone was quarried near Dallas by Oregon Portland Cement Co. for use at the company Oswego cement plant. Output of limestone was lower than in the previous year. Clay mined near Monmouth was used to make draintile by Monmouth Brick & Tile Co. Sand and gravel and crushed roadstone also were produced.

Washington.—Shale quarried near Banks and Vernonia was expanded at plants of Northwest Aggregate, Inc., and Smithwick Concrete Products Co., respectively. Scholls Tile Co. continued clay production at about the 1959 rate from a pit near Scholls. Output was utilized at the company plant to manufacture agricultural draintile.

Metals, Inc., a new industry established in Beaverton, planned to recover silver, gold, and platinum from industrial wastes. Silver was to be recovered primarily from photographic film and developing solutions collected from hospitals, clinics, and industrial plants in the Pacific Northwest. Gold and platinum were to be reclaimed on a small scale from discarded jewelry.

The Mineral Industry of Pennsylvania

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey.

By Robert D. Thomson,[1] Mary E. Otte,[2] and Robert E. Ela[3]

PENNSYLVANIA'S mineral output in 1960 was adversely affected by decreased markets. The index of general business activity in Pennsylvania varied from 205 in February (1947–49=100) to 180 in December, the latter being 3 points below the annual index for 1959. The index of industrial activity also declined from 125 in February to 106 in December. Output of several mineral products declined as construction activity decreased. This slowdown in the

TABLE 1.—Mineral production in Pennsylvania[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	41,270	$143,054	36,374	$124,122
Masonry—do	2,086	7,864	1,946	7,641
Clays—thousand short tons	3,466	17,196	[2] 3,557	[2] 16,536
Coal:				
Anthracite—do	20,649	172,320	18,817	147,116
Bituminous—do	65,347	345,332	65,425	345,971
Cobalt (content of ore)—pounds	280,098	(3)	(3)	(3)
Gem stones	(4)	3	(4)	4
Lime—thousand short tons	1,263	18,261	1,120	16,277
Natural gas—million cubic feet	99,366	29,015	113,928	36,229
Natural gas liquids:				
Natural gasoline—thousand gallons	2,884	184	1,399	85
LP gases—do	1,484	36	1,580	138
Peat—short tons	26,948	262	30,837	325
Petroleum (crude)—thousand 42-gallon barrels	6,160	25,872	[5] 6,258	[5] 28,474
Sand and gravel—thousand short tons	14,257	23,233	13,011	21,204
Stone—do	43,682	77,420	42,136	74,168
Zinc[6] (recoverable content of ores, etc.)—short tons	16,718	3,828	13,746	3,559
Value of items that cannot be disclosed: Copper, gold, graphite, iron ore, mica, pyrites, sericite schist, silver, soapstone, tripoli, and values indicated by footnote 3	----------	15,812	----------	17,429
Total Pennsylvania[7]	----------	[8] 862,150	----------	824,493

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producer).
[2] Excludes kaolin; included with "Value of items that cannot be disclosed."
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Weight not recorded.
[5] Preliminary figure.
[6] 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.
[7] Total adjusted to eliminate duplicating value of clays and stone in manufacturing lime and cement.
[8] Revised figure.

[1] Supervisory commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical clerk, Bureau of Mines, Pittsburgh, Pa.
[3] Statistical assistant, Bureau of Mines, Pittsburgh, Pa.

State as well as in the Nation was one of the principal factors affecting mineral production in 1960. All major mineral industries except bituminous coal, natural gas, petroleum, and iron ore declined in value of output. Value of mineral production (fuels, metals, and nonmetals) totaled $824 million, a 4-percent decrease.

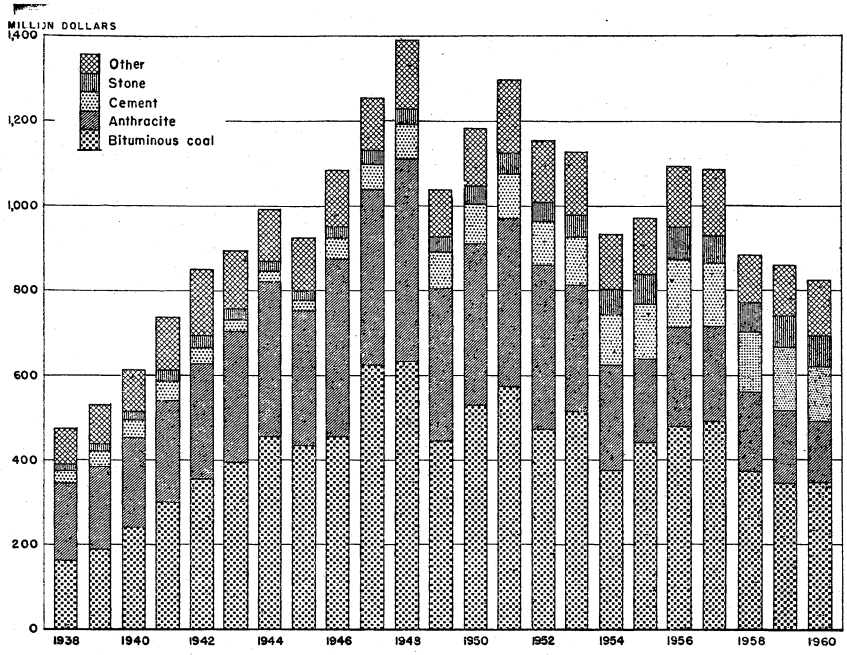

FIGURE 1.—Value of bituminous coal, anthracite, cement, and stone, and total value of mineral production in Pennsylvania, 1938–60.

Employment and Injuries.—Employment in selected mineral industries as shown in table 2 was about 11 percent less than in 1959. Injury experience was much better. A total of 66 fatalities was reported, compared with 89 for 1959, and 2,974 nonfatal lost-time injuries were reported, compared with 3,464 for 1959. The cement industry (including captive-mining operations) had the lowest frequency rate, reporting no fatalities and 20 nonfatal lost-time injuries for a total of 9.8 million man-hours.

The safety record of the bituminous coal industry was better than in 1959; the number of fatalities decreased from 36 to 28 and the number of nonfatal lost-time injuries decreased from 1,208 to 1,150. The number of fatalities per million man-hours was 0.60 compared with 0.69 in 1959. Per million short tons, the frequency rate was 0.43 compared with 0.55 in 1959. The number of nonfatal injuries per million man-hours was 24.77, compared with 23.17 in 1959. Of the fatalities, 25 occurred underground and 3 at strip operations. Roof, rib, and face falls accounted for 12 of the underground fatalities. Of the remaining 13 fatalities at underground mines, 2 were caused by falls of roof from equipment knocking out support; 3, from

TABLE 2.—Employment and injuries for selected mineral industries

Industry	1959		1960[1]				
	Average number of men working	Total man-hours	Average number of men working	Total man-hours	Total number of lost-time injuries		Number of injuries per million man-hours
					Fatal	Nonfatal	
Anthracite	23,294	29,371,307	19,051	24,452,382	35	1,401	58.73
Bituminous coal	36,594	52,146,059	28,100	46,430,000	28	1,150	25.37
Cement[1]	4,342	10,262,697	4,375	9,821,281	--	20	2.04
Clays	662	1,082,302	669	1,032,996	2	156	152.95
Lime[1]	1,445	3,013,844	1,325	2,747,833	--	30	10.92
Sand and gravel	1,391	2,848,893	1,391	2,515,835	--	15	5.96
Stone[2 3]	3,972	7,697,737	4,001	7,823,614	1	202	25.95

[1] Includes quarries or pits producing raw materials used in manufacturing cement or lime for captive operations.
[2] Includes quarry or open-pit employees as well as crushing and screening and rock-dressing operations.
[3] Excludes quarries or pits producing limestone from captive operations used in manufacturing cement or lime.

haulage; 2, from electricity; 5, from machinery; and 1, from mine fires. One of the strip mine fatalities was caused by machinery and the other two resulted from miscellaneous causes.

The anthracite industry in 1960 reported 35 fatalities compared with 47 in 1959. The number of nonfatal lost-time injuries decreased from 1,723 to 1,401. The number of injuries per million man-hours of exposure was 1.43 for fatalities and 57.30 for nonfatalities, compared with 1.60 and 58.66, respectively, for 1959. The number of fatalities per million short tons was 1.85; the number of nonfatalities was 73.98. Of the 35 fatalities 28 occurred underground, 3 at surface operations of underground mines, and 4 at stripping operations. Falls of roof, face, and rib caused 18 (64 percent) of the underground fatalities. Of the remaining 17 fatalities, underground haulage and transportation accounted for 4; bump, 1; rush of materials, 2; fall of persons, 2; and explosives, 1. Causes of the seven fatalities that occurred on the surface were: Squeezed between railroad cars, 1; run over by auto truck, 1; suffocated under rush of culm, 1; transportation at strip mines, 2; rolling rock from high wall, 1; and electrocution at strip mine, 1.

Huber Colliery of Glen Alden Corp. in Luzerne County was the trophy winner of the National Safety Competition for anthracite mines in 1960. The mine was operated for 763,202 man-hours, at an injury-severity rate of 1,741.348. Winners of a Certificate of Achievement in Safety for anthracite mines included Good Springs mine, Penag Coal Co.; Sugar Notch Colliery, Glen Alden Corp.; Tremont mine, Herb and Reed Coal Co.; and Woodward Colliery, Glen Alden Corp. The Maple Creek mine in Washington County was operated by United States Steel Corp. without a lost-time injury and received a Certificate of Achievement in Safety for the bituminous coal group. The Hillsville quarry operated by Michigan Limestone Division, United States Steel Corp. and the Bessemer quarry operated by The Bessemer Limestone and Cement Co. were among the five top contenders for the trophy of the quarry group. Both mines, in Lawrence County, operated in 1960 without lost-time injuries.

Legislation and Government Programs.—In June, the U.S. Supreme Court ruled that depletion allowances for the cement industry could not be computed on the basis of the finished product. Almost simultaneously, Congress passed a law which established kiln feed as a cut-off point for computing percentage depletion for 1960 and subsequent years. Cement companies were given the option to settle open years on the basis of kiln feed or take a chance on final outcome of further litigation. Most cement companies choose the kiln-feed method.

The Pennsylvania State Superior Court reversed a decision of the Public Utility Commission by approving the transfer of cement in bulk and bags by truck from cement plants in eastern Pennsylvania to customers within the State. Previously, trucks could not deliver cement to consumers having rail sidings.

Control facilities provided under the joint Federal-Pennsylvania anthracite mine-water control program at the end of 1960 totaled 11 pumping projects and 13 surface-drainage improvements. The 11 pumping projects required 29 large-capacity deep-well pumps with an average capacity of 143,000 gallons per minute. The 13 surface-drainage improvements consisted of backfilling abandoned strip mines, constructing steel and concrete flumes, and reestablishing surface-drainage over mined areas.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Anthracite.—The downward trend in anthracite output continued, with production totaling 18.8 million short tons, a reduction of 9 percent from 1959. The index of anthracite production (1947–49=100) ranged from a high of 42 in March to a low of 35. The low was 3 points less than that reported in 1959 and 7 points below that of 1958.

Thirty-eight percent of the anthracite was mined from strip pits compared with 34 percent in 1959, and 41 percent was mined from underground mines, compared with 46 percent in 1959. Output from culm banks and dredging remained approximately the same.

Fifty-three percent of the coal produced underground was mechanically loaded; however, 14 percent less coal was mechanically loaded than in 1959—4 million tons in 1960 compared with 4.7 million tons in 1959. A total of 3.7 million tons was hand-loaded compared with 4.7 million tons in 1959. In all, 114 scraper loaders (72 less than in 1959), 45 mobile loaders (1 less than in 1959), and 754 conveyors and pit-car loaders (115 less than in 1959) were used to mechanically load coal mined underground.

Slightly more anthracite was mined from strip pits than in 1959. The 1960 output was 7.1 million tons. A total of 170 power shovels and 222 draglines was used in stripping Pennsylvania anthracite and in recovering culm banks, compared with 168 and 233, respectively, in 1959.

Production from culm banks totaled 3.3 million tons compared with 3.4 million tons in 1959. Operations were active in the Lehigh, Schuylkill, and Wyoming regions and in Sullivan County; the largest output came from the Schuylkill region (1.6 million tons).

Anthracite was produced by dredging the Lehigh, Schuylkill, and Susquehanna Rivers. Production by dredges totaled 712,000 tons, 5,000 tons less than in 1959. Of the total production, 22,700 tons was recovered from the Lehigh River, 23,600 from the Schuylkill River, and 665,800 from the Susquehanna River.

Apparent consumption continued to decrease. A total of 13.8 million tons was shipped outside the producing regions; 5 million tons was sold to local trade; and the remainder was used as colliery fuel. Average value per ton of anthracite was $7.91 for shipments outside the producing regions, $7.60 for local sales, and $5.96 for colliery fuel, compared with $8.53, $7.80, and $5.97, respectively, in 1959.

The average number of men working daily totaled 19,051—4,243 less than in 1959. Of the total, 9,041 were employed at underground mines; 3,470, at strip pits; 585, at culm banks; 3,145, at preparation plants; 2,682, at other surface operations; and 128, at dredging operations. The average number of days active was 176, compared with 173 in 1959. Output per man per day for all types of operations was 5.60 compared with 5.12 in 1959. Output at all operations, excluding dredges, was 5.43, and at dredging operations, 26.40.

Schuylkill County continued to be the principal center for producing anthracite—6.9 million tons in 1960. Luzerne County ranked second with production of 5.7 million tons, followed by Northumberland and Lackawanna Counties. Production also was reported from Carbon, Columbia, Dauphin, Lancaster, Lebanon, Northampton, Snyder, Sullivan, Susquehanna, and Wayne Counties.

Bituminous Coal.—Output from the Pennsylvania bituminous coalfields increased slightly over 1959, despite a 1-percent decrease in production from underground mines. The number of mines in operation decreased 101 in 1960, totaling 1,282 mines producing 1,000 tons or more. The number of active underground mines totaled 680, a decrease of 76 compared with 1959. Strip mines decreased 36 mines to a total of 553; auger mines increased 11, to a total of 49 mines.

Approximately 67 percent of the bituminous coal output came from underground mines, 1 percent or 572,000 tons less than in 1959. Of the total underground production, 43.2 million tons was cut by machines, including that mined by continuous miners; the remainder was cut by hand or shot from the solid. In all, 1,032 cutting machines and 337 continuous miners were used. Locomotives (2,046), animals (439), mother conveyors (338), shuttle cars (1,013), and rope hoists (623) were used for underground haulage. Pennsylvania underground production continued to be highly mechanized; 98 percent of the underground output was mechanically cut, using 1,032 cutting machines, and 94 percent was mechanically loaded by 1,097 machines. Mobile loaders were the principal moving device, loading 10.8 million tons into shuttle cars, 1.9 million tons into mining cars, and 484,000 tons onto conveyors. Handheld and post-mounted drills totaled 805 and drilled 10.2 million tons of coal; 118 mobile drills were used to drill 5.4 million tons of coal.

Output from strip mines increased 3 percent or approximately 569,000 short tons. Bituminous coal was stripped and loaded using electrical, diesel-electric, diesel, and gasoline power shovels and draglines. Of the 936 power shovels in use (38 less than in 1959), 864 had a

capacity of less than 3 cubic yards; 68, 3 to 5 cubic yards; 1, 6 to 12 cubic yards; and 3, more than 12 cubic yards. A total of 362 draglines was used (23 less than in 1959); 148 had a capacity of less than 3 cubic yards; 128, 3 to 5 cubic yards; 76, 6 to 12 cubic yards; and 10, more than 12 cubic yards. Twenty carryall scrapers (one less than in 1959) were used; four had a capacity of 3 cubic yards; one, 3 to 5 cubic yards; nine, 6 to 12 cubic yards; and six, over 12 cubic yards. In addition, 809 bulldozers (68 less than in 1959), 145 horizontal power drills, and 146 vertical power drills were used.

The number of auger mines increased from 38 to 49 in 1960, resulting in a 20-percent increase in tonnage.

Bituminous coal produced from underground mines was shipped chiefly by rail (38.4 million short tons) and by truck (3.9 million short tons). The value per ton of coal produced underground averaged $6.07 ($0.06 greater than in 1959). Underground coal sold on the open market averaged $5.34 per ton. Truck shipments of strip coal to consumers totaled 8.1 million tons, and shipments by rail or water totaled 12.7 million tons. The value per ton of strip-mine coal averaged $3.68 ($0.05 lower than in 1959). Strip-mine coal sold on the open market was valued at $3.68 per ton, ($0.02 less than in 1959). Of the auger mine production, 55 percent was shipped by truck and 44 percent by rail or water. The value of auger-mine coal sold on the open market averaged $3.22 per ton, $0.03 greater than in 1959.

TABLE 3.—Bituminous coal production, by types of mining and counties in 1960

(Exclusive of mines producing less than 1,000 tons annually)

County	Underground		Strip		Auger	
	Number of mines	Short tons	Number of mines	Short tons	Number of mines	Short tons
Allegheny	25	4,633,157	22	566,532		
Armstrong	54	1,220,194	39	1,413,167	10	110,759
Beaver	(1)	(1)	(1)	(1)		
Bedford	(1)	(1)	(1)	(1)		
Blair	(1)	(1)	(1)	(1)		
Bradford			(1)	(1)		
Butler	24	222,941	37	1,790,127	5	51,190
Cambria	86	6,144,416	23	497,690	4	7,273
Cameron			1	106,896		
Centre	11	37,343	17	686,195	2	18,969
Clarion	10	53,578	35	2,673,658	1	9,849
Clearfield	82	1,110,046	106	5,030,090	9	103,338
Clinton	4	10,250	5	469,490		
Elk	16	131,216	10	129,007	(1)	(1)
Fayette	37	1,877,037	30	342,184	1	1,071
Greene	19	9,950,778	1	2,260		
Huntingdon	4	12,984	4	45,661		
Indiana	74	4,285,740	28	744,035	4	49,635
Jefferson	29	218,955	30	919,705	5	35,258
Lawrence	(1)	(1)	21	903,094	(1)	(1)
Lycoming	3	11,399	3	48,604		
McKean			(1)	(1)		
Mercer	3	20,626	6	689,778		
Somerset	101	909,706	43	1,166,224	1	1,331
Tioga	3	22,982	6	278,341		
Venango			11	588,189		
Washington	21	9,864,925	22	991,455	(1)	(1)
Westmoreland	48	3,189,692	20	252,308	(1)	(1)
Undistributed	26	142,595	33	540,843	7	90,499
Total	680	44,070,560	553	20,875,533	49	479,172

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Eighty-four preparation plants were active, compared with 85 in 1959. A total of 39.6 million tons of coal was cleaned, of which 35.5 million came from underground mines and 4.1 million from strip mines. Of the mine production mechanically cleaned, 34.5 million tons was wetwashed (6.9 million tons by jigs and 27.6 million tons by other methods), and 5.1 million tons was cleaned by pneumatic methods.

At mines having crushing facilities, 31.4 million tons was crushed; this represented 67 percent of the tonnage produced at these mines. Of the total production at these mines, 6.6 million tons was treated—820,000 tons with calcium chloride, 4.4 million tons with oil, 351,000 tons with both calcium chloride and oil, and 991,000 tons with other materials.

Strip mines were active in all 28 counties, underground mines in 24 counties, and auger mines in 14 counties. Greene County replaced Washington County as the leading producer from underground mines; other leading counties in decreasing order were Washington, Cambria, Allegheny, Indiana, Westmoreland, Fayette, Armstrong, and Clearfield. Clearfield County continued as the leading producing county from strip mines, followed by Clarion, Butler, Armstrong, and Somerset. Armstrong County continued to lead in output from auger mines, followed by Clearfield and Indiana Counties.

Coke and Coal Chemicals.—Pennsylvania continued as the leading producing State for beehive and oven coke. Production from oven-coke operations increased 3 percent, principally because of a 6-percent increase in the use of this type of coke in blast furnaces. Production of beehive coke decreased 4 percent mainly because of a 17-percent decline in the use of beehive coke in blast furnaces and a 57-percent decrease in use by foundries.

Fourteen plants, operating 3,792 slot-type ovens (341 less than in 1959), carbonized 20.4 million short tons of coal to produce 14.1 million tons of oven coke. Yield of coke from coal was 69.27 percent, slightly greater than in 1959. The average value of oven coke at the ovens was $17.14 per ton, compared with $16.56 in 1959. Of the oven-coke produced, 96 percent was used in blast furnaces and 1 percent each for foundries and other industrial uses. The remainder was used by producing companies for sundry purposes and for industrial heating.

Thirty-three plants, two less than in 1959, operated 6,208 beehive coke ovens (128 ovens more than in 1959) to produce 684,250 tons of beehive coke. Yield of coke from coal increased from 62.52 to 62.86 percent. The average value of beehive coke at the ovens was $14.18, 42 cents less than that reported in 1959. The beehive coke was used in blast furnaces (73 percent), by foundries, for residential heating, and for sundry industrial uses (26 percent).

Coal produced in Kentucky, Pennsylvania, Virginia, and West Virginia was used at oven-coke plants in Pennsylvania. Of the total, 58 percent came from mines in Pennsylvania and 36 percent from mines in West Virginia. Seventy-seven percent of the coal used at oven-coke plants was high volatile, 8 percent medium volatile, and 15 percent low volatile.

A total of 214 billion cubic feet of coke-oven gas was produced; 40 percent was used in heating ovens, 59 percent was surplus used or sold, and 1 percent was wasted. Thirteen plants produced coke-oven ammonia, totaling 200,873 short tons of sulfate equivalent. A total of 198 million gallons of coke-oven tar was produced; 137 million gallons was used by producers for refining or topping; 17 million gallons, for fuel; and 309,000 gallons, for sundry uses; and 48 million gallons was sold for refining into tar products. Crude light oil, totaling 64 million gallons, was produced at 14 oven-coke plants. Oven-coke plants also produced benzene (36 million gallons), toluene (9 million gallons), xylene (2.7 million gallons), and solvent naphtha (1.9 million gallons).

Peat.—Pennsylvania ranked fourth among the 21 peat-producing States. Tonnage and value of production increased 14 and 24 percent, respectively, compared with 1959. Producers of humus and reed-sedge were active in Erie, Lawrence, Luzerne, and Wayne Counties. Luzerne was the leading county.

Petroleum and Natural Gas.—Output of crude petroleum increased 2 percent in quantity and 10 percent in value. Pennsylvania ranked 20th in the production of petroleum. The average value of crude petroleum at yearend was $4.80 from the Northern or Bradford district, $4.52 from the Middle or Venango district, and $4.25 from the Southwestern district.

Pennsylvania ranked 11th out of the 28 gas-producing States. Output increased 15 percent in quantity and 25 percent in value, compared with 1959.

Exploration resulted in the discovery of one new gasfield, eight new gas pools, and one deeper gas pool.[4] Also several gas-producing areas were extended and a new producing depth record was established for the State. The new producing depth record was established by the Robert I. Snyder No. 1 well in Somerset County when gas was found at 8,574 feet. The outstanding discoveries were the DuBois and Helvetia pools in Clearfield County in the Punxsutawney-Driftwood field and the Baldwin pool of Westmoreland County in the Johnstown field. The greatest density of deep drilling occurred in Clearfield County where 46 gas wells were drilled. As in 1959, Armstrong County had the greatest number of shallow-sand completions outside the secondary-recovery area with the drilling of 54 new gas wells. After drilling a dry hole to the Gatesburgh formation (Upper Cambrian) in each of its two offshore blocks in Lake Erie, the New York State Natural Gas Corp. surrendered its acreage.

Well completions totaled 860 or 212 more than in 1959. Of these, 840 were field wells and 20 wildcat wells. Of the 840 field wells, 256 were oil; 264, gas; 76, dry holes; and 244, service wells. Of the wildcat wells, 5 were gas wells and 15, dry holes. Total footage for completed wells was 2,416,950—an average of 2,810 feet. Footage for completed field wells was 2,297,806 and for wildcat wells, 119,144. Ninety-three percent of the wells were drilled with cable tools and the remainder, by rotary.

[4] Lytle, Wm. S., Bergsten, John M., Cate, Addison, S., and Wagner, Walter R., Oil and Gas Developments in Pennsylvania in 1960: Pennsylvania Topographic and Geol. Survey, Progress Report 158, 1961, 50 pp.

TABLE 4.—Production of crude petroleum by counties

County	1959		1960	
	Number of producing wells	Production (Barrels)	Number of producing wells	Production (Barrels)
Allegheny	415	128,783	407	123,008
Armstrong	177	12,961	175	12,763
Beaver	150	11,116	141	9,824
Butler	2,611	172,090	2,528	162,702
Clarion	1,025	52,880	1,011	47,908
Crawford	618	29,391	519	25,180
Elk	677	25,632	644	22,736
Fayette	5	277	5	370
Forest	1,000	92,369	1,025	53,325
Greene	315	60,346	313	58,087
Jefferson	91	4,183	91	3,833
McKean	29,323	4,344,379	28,535	4,552,726
Mercer	227	3,650	227	3,549
Potter	418	79,442	418	65,417
Tioga	16	1,532	16	1,197
Venango	17,945	422,177	16,860	373,682
Warren	8,465	274,452	8,117	256,530
Washington	861	180,160	864	177,686
Total	64,339	5,895,820	61,896	5,950,523

Source: Pennsylvania Bureau of Statistics, Department of Internal Affairs.

The proved recoverable crude-oil reserve in Pennsylvania was estimated at 107.6 million barrels on December 31—5.9 million barrels less than was reported at yearend 1959. The proved recoverable reserve of natural gas was 1,192,480 million cubic feet on December 31, 140,000 million more than on December 31, 1959. Of the natural-gas reserve, 714,941 million cubic feet was nonassociated reserve, 22,940 million was dissolved, and 454,599 million was stored in underground reservoirs.

Natural Gas Liquids.—Natural gas liquids produced in Pennsylvania totaled 2,979,000 gallons, valued at $223,000. Output consisted of liquefied petroleum gas and ethane (manufactured at natural-gasoline plants), totaling 1,580,000 gallons, and natural-gasoline and cycle products, totaling 1,399,000 gallons. Average value for liquefied petroleum gases was $0.087 per gallon and for natural-gasoline and cycle products $0.061. Reserves of natural gas liquids on December 31 were estimated at 2.1 million barrels—1.6 million barrels less than at the end of 1959.

NONMETALS

Cement.—Production of cement decreased 9 percent. Output of portland cement decreased 10 percent, that of masonry cement declined 2 percent; shipments of portland and masonry cements decreased 12 percent and 7 percent, respectively.

Kilns operated at approximately 66 percent of capacity and produced 37 million barrels of portland cement. Of the 24 active plants, 64 percent of capacity was dry process and 34 percent, wet process. The industry consumed 919 million kilowatts of electrical energy, about 55 million kilowatts less than in 1959. Seventy-two percent of the electrical energy was purchased from public utility companies, compared with 68 percent in 1959. Stocks of portland cement increased slightly during the year, totaling 5.8 million tons at yearend.

The principal raw materials used for manufacturing portland cement were cement rock and lime. Totals of 7.3 million short tons of cement rock and 3.1 million of limestone were used. In addition, the following tonnages of raw material were used: Gypsum, 316,135; sand, 184,020; clay, 178,104; and iron materials, 63,310. Slag, slate, carbon black, air-entraining compounds, and grinding aids also were used.

Portland cement was shipped to consumers in Pennsylvania, 40 other States, the District of Columbia, and to foreign countries. Thirty-five percent of the shipments went to Pennsylvania; 22 percent to New Jersey; 20 percent to New York; 6 percent to Ohio; 5 percent to Connecticut; 3 percent to Maryland; 2 percent each to Massachusetts and West Virginia; and 1 percent to Virginia.

Distribution of portland cement shipments by use was as follows: 21 million tons to ready-mixed concrete companies, 7.2 million tons to concrete product manufacturers, 5.4 million tons to building material dealers, 248,000 to miscellaneous consumers, 267,000 to other contractors, and 48,000 to Federal, State, and local government agencies.

Masonry cement was shipped to 24 States and the District of Columbia. Forty percent was consumed in Pennsylvania, 18 percent in New Jersey, 15 percent in New York, and 11 percent in Ohio.

TABLE 5.—Portland cement shipments, by counties

County	Number of plants in 1960	1959		1960	
		Barrels	Value	Barrels	Value
Lehigh	4	6,859,370	$23,411,844	6,800,637	$22,739,563
Northampton	12	[20,388,750	70,617,280	[17,308 898	58,327,559
Allegheny	2	7,086,699	23,991,959	6,323,448	21,754,945
Lawrence	2				
Berks	1	6,935,310	25,032,809	5,940,519	21,299,445
Butler	1				
Montgomery	1				
York	1				
Total	24	41,270,129	143,053,892	36,373,502	124,121,512

Clays.—Pennsylvania ranked second in output of clay, yielding 7 percent of the U.S. tonnage and over 10 percent of the total value. The State also ranked second in fire clay production, fifth in kaolin production, and seventh in the tonnage of miscellaneous clay produced.

Production of fire clay, the most important clay produced in 1960, increased 3 percent over 1959, representing 52 percent of the State clay tonnage and 70 percent of total value. Fire clay was used principally in manufacturing refractory firebrick and block, and heavy clay products; smaller quantities were used in producing other refractories and architectural terra cotta. Thirty-seven percent of the fire clay sold and used was mined underground.

Miscellaneous clay production was 4 percent higher than in 1959. Most of the clay was used in producing heavy clay products; but smaller quantities were used in manufacturing lightweight aggregate, portland cement, art pottery, refractories, and linoleum and oilcloth filler. All of the miscellaneous clay came from open pits.

Output of koalin had declined for 10 years, and 1960 production was well below the 75,415 short tons produced in 1951.

Kaolin used to produce firebrick and block and for manufacturing portland cement was produced in Cumberland and Blair Counties.

TABLE 6.—Clays sold or used by producers, by kinds and uses

(Short tons)

Use	Fire clay		Miscellaneous clay		Kaolin	
	1959	1960	1959	1960	1959	1960
Pottery and stoneware:						
Art pottery, flowerpots, and glaze slip			(1)	12,310		
Refractories:						
Firebrick and block	716,258	837,233	622	(1)	4,745	(2)
Fire-clay mortar	20,575	21,307				
Clay crucibles	(1)	19,511				
Foundries and steelworks	101,747	107,908	(1)	(1)		
Heavy clay products	795,058	748,298	1,309,546	1,306,110		
Portland and other hydraulic cements			202,359	152,126	24,862	(2)
Other uses		13	(1)	(1)		
Undistributed	[3] 169,531	[3] 123,711	[4] 121,058	[4] 228,901		
Total	1,803,169	1,857,981	1,633,585	1,699,447	29,607	(2)

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes floor and wall tile, high-alumina brick, glass refractories, other refractories, and items indicated by footnote 1.
[4] Includes floor and wall tile, lightweight aggregate, linoleum and oilcloth, and items indicated by footnote 1.

TABLE 7.—Clays sold or used by producers in 1960, by counties

County	Short tons	Value	Types of clay
Adams	72,255	$36,665	Miscellaneous clay.
Allegheny	132,144	860,092	Do.
Armstrong	216,599	2,116,379	Fire clay.
Beaver	302,812	1,500,715	Fire clay, miscellaneous clay.
Cambria	50,913	265,431	Do.
Chester	81,855	102,319	Miscellaneous clay.
Clarion	99,666	436,204	Fire clay, miscellaneous clay.
Clearfield	541,548	2,997,578	Do.
Columbia	16,416	29,548	Miscellaneous clay.
Fayette	150,016	1,085,171	Fire clay, miscellaneous clay.
Greene	1,600	2,000	Miscellaneous clay.
Lawrence	317,313	793,952	Fire clay, miscellaneous clay.
Luzerne	49,830	99,660	Miscellaneous clay.
Montgomery	87,224	142,188	Fire clay, miscellaneous clay.
Somerset	95,693	889,054	Fire clay.
Washington	29,190	45,236	Miscellaneous clay.
Undistributed [1]	1,312,354	5,134,158	
Total [2]	3,557,428	16,536 350	

[1] Includes Berks, Blair, Bucks, Butler, Centre, Clinton, Cumberland, Dauphin, Elk, Huntingdon, Indiana, Jefferson, Lancaster, McKean, Monroe, Northumberland, Schuylkill, Snyder, and York Counties.
[2] Incomplete total; excludes kaolin produced in Blair and Cumberland Counties.

Gem Stones.—The value of gem stones, including mineral specimens, was higher than in 1959. Eastern Pennsylvania continued to be the most popular source of gem materials. Gem stones were reported to be found in Adams, Chester, Berks, Lancaster, Lehigh, Montgomery, and Northampton Counties. Chester County was the leading county for mineralogical interest, followed by Montgomery County. Most

of the mineral specimens were collected by members of Pennsylvania and out-of-State mineral and lapidary clubs.

Graphite.—Crystalline graphite was recovered from schist in Chester County; production increased in 1960. The processed material was marketed as crucible flake and fine flake for use in manufacturing crucibles and foundry facings. Manufactured (artificial) graphite powder and products were produced at a plant in St. Marys. The graphite powder was sold to steel manufacturers, foundries, and chemical producers.

Iron Oxide Pigments.—Sulfur mud continued to be the only crude iron oxide pigment produced in Pennsylvania; output continued to decrease both in tonnage and value. Production came from Cambria and Elk Counties, mostly from Cambria County.

Pennsylvania continued to be the leading State in producing finished natural and manufactured iron oxide pigments. Output decreased 9 percent in tonnage and 10 percent in value owing chiefly to lower output of natural red iron oxide, manufactured red iron oxide, Venetian red, pyrite sinter, and magnetite. Principal natural iron oxide pigments, based on value, were brown iron oxide, burnt umber, red iron oxide, and burnt sienna. Leading manufactured iron oxide pigments were red, yellow, and black. The finished natural and manufactured iron oxide pigments were produced at one plant in Carbon County and two plants in Northampton County.

Lime.—Production of quicklime and hydrated lime decreased 11 percent as all major uses decreased, compared with 1959. Shipments of chemical and industrial lime were down 12 percent; building lime, down 3 percent; agricultural lime, down 13 percent; and refractory lime, down 14 percent. Of the total lime sold or used, 75 percent was quicklime compared with 78 percent in 1959.

In 1960, 21 companies, 1 more than in 1959, operated 24 plants in 17 counties. Centre County continued as the leading producer with 45 percent of the State's lime production. Centre, York, Lebanon, Chester, Montgomery, and Butler Counties, in decreasing order, each produced over $1 million. Most of the lime output in Pennsylvania was consumed within the State (62 percent), but large quantities were shipped to Maryland (9 percent), New Jersey (7 percent), Ohio (6 percent), New York (6 percent), Delaware (3 percent), and Maine (2 percent).

TABLE 8.—Lime sold or used by producers, by uses

Year	Agricultural		Building		Chemical and industrial		Refractory		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1951-55 (average)	125, 970	$1, 466	120, 665	$1, 644	854, 965	$9, 896	143, 403	$1, 984	1, 245, 003	$14. 990
1956	360, 718	5, 140	110. 344	1, 456	972, 368	11, 686	(1)	(1)	1, 443, 430	18, 282
1957	286, 720	4, 469	110, 815	1, 874	900, 866	12, 063	(1)	(1)	1, 298, 401	18, 406
1958	193, 433	3, 077	112, 437	1, 839	697. 188	9. 245	(1)	(1)	1, 003, 058	14, 161
1959	253, 313	4, 023	121. 308	2. 166	888, 559	12, 072	(1)	(1)	1, 263, 180	18, 261
1960	221, 449	3, 478	117, 196	2, 051	781, 818	10, 748	(1)	(1)	1, 120, 463	16, 277

[1] Included with "Agricultural" to avoid disclosing individual company confidential data.

TABLE 9.—Lime sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Armstrong	816	$11,466	(1)	(1)
Centre	600,951	8,069,886	504,024	$6,898,746
Dauphin	8,700	121,800	8,400	134,400
Franklin	1,887	14,241	2,301	17,487
Fulton	874	7,866	227	2,043
Juniata	2,200	22,000	2,100	21,000
Lebanon	201,000	2,810,000	176,000	2,493,500
Mifflin	6,670	75,278	4,315	46,363
Northumberland	400	4,000	475	4,000
Snyder	1,289	9,793	(1)	(1)
Undistributed [2]	438,393	7,114,506	422.621	6,658,973
Total	1,263,180	18,260,836	1,120,463	16,276,512

[1] Figure withheld to avoid disclosing individual company confidential data
[2] Includes Bedford, Blair (1960), Butler, Chester, Lancaster, Montgomery, and York Counties, and counties indicated by footnote 1.

Magnesium Compounds.—Decreased demand for magnesium compounds, chiefly as magnesium oxide for insulation and for use in manufacturing rubber, contributed to the decline in output of magnesium compounds from Pennsylvania plants. Magnesium carbonate, produced at Plymouth Meeting from raw dolomite, was used in producing precipitated magnesium oxide.

Mica.—Output of scrap mica increased owing to a greater demand for ground mica by the paint and rubber industries. The mica was mined and processed near Glenville.

Block and film mica was fabricated by Sylvania Electric Products, Inc., at its Titusville plant. Mica splittings were consumed by General Electric Co., Erie, and Westinghouse Electric Co., Pittsburgh, to produce built-up mica.

Mullite, Synthetic.—Synthetic mullite, essentially $3Al_2O_3 \cdot 2SiO_2$, was produced by Remmey Division of A. P. Green Firebrick Co. at a plant in Philadelphia. Production increased compared with 1959.

Perlite (Expanded).—Perlite mined in western States was expanded at plants in Allegheny, Delaware, Lehigh, Montgomery, and York Counties. Sales of expanded perlite totaled 17,434 tons, valued at $1,092,161, and less was marketed than in 1959, mainly because of decreased demand in building plaster and loose fill installation. The expanded perlite also was used as a concrete aggregate, soil conditioner, filler, and as a filter aid.

Pyrite.—A much greater tonnage of pyrite was produced than in 1959. Pyrite concentrate, obtained as a byproduct of iron ore mining in eastern Pennsylvania, was processed to recover pyrite and cobalt.

Sand and Gravel.—Sand and gravel production totaled 13,011,176 tons valued at $21,204,193 and was 9 percent below 1959 in both tonnage and value. More than 86 percent of the commercial output was used as building and paving sand and gravel and totaled 11,227,586 tons; 55 percent was consumed as building material and 31 percent as paving material. Industrial sand produced in 16 counties

represented 18 percent of the total sand produced. The largest concentration of industrial sand was in the south-central part of Pennsylvania, chiefly in Huntingdon and Mifflin Counties. Less than 2 percent of the total sand and gravel produced reached consumers as unprepared material.

The number of operations extracting sand and gravel totaled 110, of which 32 in 24 counties produced over 100,000 tons. Production from these 32 plants totaled 10,321,029 tons valued at $17,093,452, representing 80 and 81 percent, respectively, of the State total. Pennsylvania ranked 18th in tonnage of sand and gravel produced and furnished 2 percent of the U.S. total.

Commercial production of sand and gravel was reported from 45 of the 67 counties. Clinton County was the only county reporting Government-and-contractor operations during the year. Despite a substantial decrease in both tonnage and value, Bucks County continued as the leading producer. Of the total commercial sand and gravel tonnage, 65 percent was transported by truck; 9 percent, by railroad; and the remainder, by waterway and other means.

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

Class of operation and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Molding	173,104	$483,130	(1)	(1)
Building	3,824,920	5,476,084	3,802,203	$5,461,055
Paving	2,148,497	3,218,653	2,063,029	3,106,240
Fire or furnace	105,868	380,094	141,183	395,826
Engine	77,213	192,675	(1)	(1)
Fill			101,233	117,341
Undistributed [2]	1,355,703	4,566,873	1,241,546	4,394,246
Total	7,685,305	14,317,509	7,349,194	13,474,708
Gravel, Construction:				
Building	4,037,098	5,385,540	3,369,786	4,557,919
Paving	2,200,930	3,270,382	1,992,568	2,877,280
Fill			102,029	89,725
Undistributed [3]	301,295	247,053	29,034	32,436
Gravel, miscellaneous			84,710	70,039
Total	6,539,323	8,902,975	5,578,127	7,627,399
Total sand and gravel	14,224,628	23,220,484	12,927,321	21,102,107
Government-and-contractor operations:				
Sand: Building	50	180		
Total	50	180		
Gravel: Fill	32,336	12,385	83,855	102,086
Total	32,336	12,385	83,855	102,086
Total sand and gravel	32,386	12,565	83,855	102,086
Grand total	14,257,014	23,233,049	13,011,176	21,204,193

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes glass, grinding and polishing, blast, ferrosilicon (1960), ground, and other sand.
[3] Includes railroad ballast and other uses.

TABLE 11.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Allegheny	(1)	(1)	121,113	$257,290
Armstrong	(1)	(1)	1,516,924	3,096,258
Bedford	7,015	$19,993	(1)	(1)
Blair	(1)	(1)	42,822	101,093
Bradford	46,500	63,000	(1)	(1)
Butler	133,780	193,618	161,200	221,400
Cambria	8,000	26,000	7,950	7,950
Carbon	224,523	331,898	(1)	(1)
Clearfield	4,000	9,000		
Clinton	32,336	12,385	83,855	102,086
Crawford	142,330	179,678	103,616	164,174
Cumberland	171,778	313,370	175,180	302,582
Erie	260,322	342,261	(1)	(1)
Fayette	162,000	397,000	166,928	280,106
Franklin	145,311	216,946	(1)	(1)
Jefferson			18,857	7,911
Lancaster	(1)	(1)	229,846	491,678
Luzerne	450,930	553,192	428,859	542,523
Mercer	(1)	(1)	314,821	484,178
Monroe	(1)	(1)	63,187	70,888
Northampton	(1)	(1)	425,168	498,163
Northumberland	6,978	8,853	6,853	8,096
Philadelphia	607,047	485,637	(1)	(1)
Schuylkill	105,639	319,161	118,443	284,564
Snyder			102,940	102,801
Somerset	990	2,870	(1)	(1)
Susquehanna	478,500	287,100		
Venango	302,616	560,750	(1)	(1)
Wayne	(1)	(1)	2,678	2,411
York	414,261	566,943	279,647	395,222
Undistributed [2]	10,552,158	18,343,394	8,640,289	13,782,819
Total	14,257,014	23,233,049	13,011,176	21,204,193

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes Beaver, Berks, Bucks, Columbia, Dauphin, Elk, Forest, Fulton, Huntingdon, Lackawanna (1960), Lawrence, Lycoming, McKean, Mifflin, Montgomery, Montour (1960), Warren, and Wyoming Counties, unspecified counties (1960), and counties indicated by footnote 1.

Slag (Iron-Blast Furnace).—Output of blast furnace slag increased from 7,240,000 in 1959 to 7,804,000 short tons. However, the value of output decreased $196,000, totaling $11,651,000. Pennsylvania continued to be the leading producer of blast-furnace slag with 27 percent of the U.S. tonnage. Of the slag processed in Pennsylvania, 76 percent was screened air-cooled slag used chiefly as an aggregate in portland cement concrete construction, bituminous construction of various types, highway and airport construction, and railroad ballast.

Stone.—Production of stone (including slate and oystershell) decreased in both tonnage and value (4 percent each). The decline was due mainly to a lower demand for dimension building stone and crushed and broken stone for railroad ballast, concrete aggregate, and refractory material. The demand for curbing and flagstone, riprap, flux, and agricultural stone, increased.

Stone (comprised of basalt, granite, miscellaneous stone, sandstone, limestone, slate, and oystershell) was produced in 50 of the 67 counties. New operations were reported in Cambia, Lackawanna, Philadelphia, and Washington Counties. Northampton County was the leading stone-producing county. Counties producing over $3 million, in decreasing order were: Northampton, Montgomery, Lawrence,

York, Adams, Chester, Centre, Berks, and Lancaster. In addition, Bucks, Dauphin, Delaware, Lebanon, and Lehigh Counties each produced over $2 million worth of stone, and Blair, Butler, Huntingdon, Mifflin, and Westmoreland Counties produced over $1 million, each.

Output of limestone, the leading stone produced, decreased 3 percent in both tonnage and value, chiefly because of a drop in demand for crushed and broken stone as a raw material for producing lime and cement, asphalt filler, stone sand, and dimension building stone. Increases were reported in the use of limestone as flux 11 percent, railroad ballast doubled, riprap 20 percent, and agricultural stone 7 percent. Crushed limestone was produced in 37 counties—2 more than in 1959; new operations were reported in Washington and Westmoreland Counties. Northampton County continued to lead in output of crushed limestone, with 5 million tons compared with 5.8 million tons in 1959 followed in decreasing order by counties producing over 2 million tons—Montgomery, Lawrence, York, Lancaster, Lehigh, and Berks. Dimension limestone production continued in Bucks County. No production of dimension stone was reported for Lancaster County.

Output of basalt (diabase), the stone that ranked second in Pennsylvania, decreased 22 percent in tonnage and 28 percent in value, mainly because of a 16-percent decrease in the demand for its use as concrete aggregate and a 40-percent decline in its use as railroad ballast. Less basalt also was used as building stone and for miscellaneous purposes. More basalt was used than in 1959 for riprap and dimension stone. Use of basalt for curbing and flagging stone was reported as a new use in 1960. Crushed basalt was reported in seven counties, one less than in 1959. No production was reported from Westmoreland County. Delaware was the leading county followed by Chester, Berks, Bucks, and Montgomery Counties. Dimension basalt was produced in Bucks, Chester, and Montgomery Counties; Montgomery County was the leading area.

Sandstone ranked third as stone in Pennsylvania tonnage-wise, and led in value. It was marketed as both dimension and crushed stone. Output was greater than in 1959, increasing 21 percent in tonnage and 13 percent in value. Crushed sandstone production increased 23 percent over that in 1959; more was used as concrete aggregate and for miscellaneous uses; and less was used for riprap, railroad ballast, and as refractory material. Production of dimension sandstone, based on value, decreased slightly. Greater quantities of dimension stone were used as rough architectural stone, rubble, and curbing and flagging; less was used as rough and dressed construction building stone and sawed or dressed building stone. Crushed sandstone was produced in 20 counties and dimension sandstone, in 11 counties. New operations were reported in Adams, Berks, Cambria, Chester, and Lackawanna Counties. Westmoreland was the leading county for crushed sandstone based on tonnage, and Carbon County led, based on value. Other leading counties were Adams, Blair, Huntingdon, Luzerne, Montgomery, Schuylkill, Susquehanna, and Wayne. No production of dimension stone was reported from Mercer County. Noncommercial production of crushed stone was reported in Wayne County.

Granite was prepared and marketed both as dimension stone and as crushed stone. Production of dimension granite was less than in 1959 because of a lower demand for building stone. New production of granite as crushed stone was reported in Montgomery County. Granite also was crushed by the Pennsylvania Highway Department in Philadelphia.

The tonnage of miscellaneous stone as dimension stone and as crushed stone increased. Output of dimension stone increased 6 percent, owing mainly to a greater demand for rough and dressed construction stone, although less was used for rubble and curbing and flagging. Production of crushed miscellaneous stone increased because of a greater demand in concrete aggregate. Crushed miscellaneous stone production continued in Bucks and Montgomery Counties. Dimension miscellaneous stone was produced in Delaware, Lycoming, Montgomery, Potter, and Westmoreland Counties; most of the output came from Delaware County.

Oystershell was again collected in Berks County and processed for agricultural use.

Output of slate was slightly less than in 1959. However, Pennsylvania continued to lead in slate production. Sales of dimension slate decreased 5 percent below 1959. Use of slate for roofing, blackboards and bulletin boards, billiard tabletops, and flagging declined, but structural and sanitary, school slates, and miscellaneous uses increased. The demand for slate granules and flour was slightly greater than in 1959. Dimension slate was produced by 1 company in Lehigh County and 11 companies in Northampton County. The dimension slate came mostly from Northampton County. Crushed slate was marketed from Lycoming, Northampton, and York Counties. York County led in production. The three producers in Northampton County and one producer in Lycoming County also produced dimension slate.

Output of natural and artificially colored roofing granules decreased in both tonnage and value compared with 1959, owing mainly to a decreased demand for natural granules. Of the total production,

TABLE 12.—Stone sold or used by producers, by uses

Use	1959		1960	
	Short tons	Value	Short tons	Value
Dimension stone:				
Building stone	176,989	$1,344,896	153,304	$1,142,813
Curbing and flagging	12,118	289,281	12,493	306,897
Other uses	50,134	3,320,679	48,834	3,165,132
Total	239,241	4,954,856	214,631	4,614,842
Crushed and broken stone:				
Riprap	10,032	11,657	51,842	74,834
Concrete and road metal	20,443,307	31,491,790	20,363,634	31,284,466
Furnace flux (limestone)	5,076,505	9,393,129	5,637,623	10,657,545
Railroad ballast	736,546	1,196,019	569,253	913,223
Agricultural	888,123	2,518,380	950,509	2,852,574
Other uses [1]	16,287,967	27,854,836	14,348,797	23,770,386
Total	43,442,480	72,465,811	41,921,658	69,553,028
Grand total	43,681,721	77,420,667	42,136,289	74,167,870

[1] Includes "refractory."

artificially colored granules represented 76 percent, compared with 74 percent in 1959 and 87 percent in 1958. Plants were active in Adams, Beaver, and York Counties.

TABLE 13.—Stone sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Adams, Cumberland, Franklin	2,906,992	$6,260,476	(1)	(1)
Berks	2,911,256	3,922,354	2,559,740	$3,431,652
Blair, Huntingdon	1,153,003	3,110,245	1,196,838	3,107,357
Bucks	1,714,805	2,962,656	(1)	(1)
Butler	877,883	1,757,108	829,202	1,647,700
Cambria			4,800	15,400
Carbon, Monroe, Schuylkill	431,930	1,814,413	497,376	1,901,063
Centre	2,120,484	4,275,778	1,889,695	3,806,576
Chester	2,506,541	5,347,571	2,341,341	4,770,842
Dauphin	(1)	(1)	1,467,521	2,332,238
Fayette, Somerset	633,560	1,336,633	530,651	1,135,453
Franklin	(1)	(1)	608,415	994,155
Juniata, Mifflin, Snyder	(1)	(1)	798,124	1,539,381
Lackawanna			5,072	10,144
Lancaster	2,508,298	3,763,864	2,292,968	3,263,486
Lawrence	2,884,686	5,155,072	2,912,743	5,017,918
Lebanon	1,853,672	3,126,445	1,669,667	2,816,853
Lehigh, Northampton	8,047,822	11,152,655	7,257,026	9,470,565
Luzerne	211,109	345,458	195,248	310,969
Mercer	13,235	49,690	14,211	49,971
Montgomery	3,661,015	6,326,769	4,006,352	7,129,105
Northumberland	53,400	94,280	43,880	77,159
Philadelphia			11,350	28,815
Snyder	77,999	135,935	(1)	(1)
Tioga	115	2,800	(1)	(1)
Union	282,028	464,487	278,933	461,463
Wayne	(1)	(1)	199,124	357,299
Westmoreland	567,190	1,068,130	567,955	1,023,678
Wyoming	(1)	(1)	2,161	50,400
Undistributed [2]	8,264,698	14,947,848	9,955,896	19,418,228
Total	43,681,721	77,420,667	42,136,289	74,167,870

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes Allegheny, Armstrong, Bedford, Clarion, Clinton, Delaware, Fulton, Lycoming, Montour, Perry, Potter, Susquehanna, Washington (1960), and York Counties, and counties indicated by footnote 1.

Sulfur.—Byproduct sulfur continued to be recovered in the liquid purification of oil refinery gases obtained from domestic and foreign sources. Production was less than that reported in 1959. The Sinclair Refining Co., Marcus Hook refinery and the Gulf Oil Corp., Philadelphia refinery, used the Claus process to recover sulfur.

The Atlantic Refining Co. (Philadelphia) recovered hydrogen sulfide by the Girdler process and burned it to sulfur dioxide for use in making sulfuric acid at the local plant. Sulfur also was recovered at the Sun Oil Co., Marcus Hook refinery, using a two-stage catalytic oxidation of hydrogen sulfide.

Output of byproduct sulfuric acid (100 percent H_2SO_4) at zinc smelters and zinc roasters totaled 323,519 short tons, valued at $4,990,000. New Castle Chemical Co., which for 50 years furnished sulfuric acid mainly for the Youngstown, Ohio, steel industry, ceased business in 1960.

Talc.—Output of pyrophyllite (sericite-schist) and soapstone decreased, mainly because of a lower demand for these materials as a filler in asphaltic compounds, insecticides, and joint cement. The sericite-schist was processed at Aspers, and the soapstone was trans-

ported to a plant near Marriottsville, Carroll County, Md., for processing.

Tripoli.—Lower demand for buffing compounds and filler material contributed to decreased production of tripoli (rottenstone). The crude material was ground at two plants in Lycoming County.

Vermiculite (Exfoliated).—Crude vermiculite from other States and foreign countries was exfoliated at plants in Lawrence and Bucks Counties. The exfoliated vermiculite was used in building plaster, lightweight concrete, loose-fill installation, and other applications.

METALS

Cadmium.—Primary metallic cadmium was produced from flue dust recovered at the St. Joseph Lead Co., Josephtown plant and the New Jersey Zinc Co., Palmerton smelter.

Cobalt.—Production of cobalt as a byproduct of iron ore mined in Pennsylvania increased over that produced in 1959.

Copper.—Production of copper from ores produced in Pennsylvania increased over that of 1959. The copper was recovered in concentrate produced at the Lebanon concentrator. The concentrate was shipped to a smelter at Laurel Hill, N.Y.

Ferroalloys.—Production and shipments of ferroalloys were greater than in 1959, increasing 38 percent and 11 percent, respectively. Shipments totaled 476,865 short tons valued at $116,212,148 and consisted chiefly of ferromanganese, spiegeleisen, ferromolybdenum, and ferrocolumbium. In addition, smaller quantities of ferrotungsten, ferroboron, nickel-columbium, aluminum-vanadium, nickel-tungsten, molybdenum-aluminum, and ferrovanadium were shipped.

Gold and Silver.—Output of gold and silver increased over 1959. These metals were recovered from a copper concentrate produced at the Lebanon concentrator.

Iron Ore.—Iron ore production increased over 1959. Magnetite ore from the Cornwall and Grace underground mines was shipped to the Lebanon and Morgantown concentrators, respectively, for processing. Concentrate from the Lebanon concentrator and a small quantity of concentrate fines from the Morgantown concentrator were processed in the agglomerating plant at the Lebanon concentrator. Shipments from the Lebanon plant consisted of concentrate and agglomerates (sinter and pellets), for use in producing pig iron and steel. Shipments from the Morgantown concentrator consisted principally of concentrate for direct use in producing pig iron and steel. In order to treat the ore mined from the Cornwall mine more efficiently, construction work was started on a new concentrating and agglomerating plant in Cornwall. The new facilities will replace the existing treatment plant at Lebanon.

Iron and Steel Scrap.—Ferrous scrap was collected and prepared chiefly in Coatesville, Conshohocken, Glassport, Harrisburg, Philadelphia, Pittsburgh, and Sharpsburg. Plants reporting monthly averaged 62, which represented only a small part of the industry. Stocks on hand at the yards for dealers, brokers, and automobile wreckers totaled 191,000 short tons on December 31. The leading varieties of scrap processed and shipped were No. 1 heavy melting steel,

No. 2 and all other bundles, cast-iron scrap and other borings, and No. 1 and electric furnace bundles. A total of 13,501,711 short tons of ferrous scrap was reported as consumed by companies in Pennsylvania. Stocks of ferrous scrap held by all consumers at yearend were 1,899,850 short tons.

TABLE 14.—Pig iron and ferrous scrap consumption by type of furnace

(Short tons)

Type of furnace and raw material	1959	1960	Type of furnace and raw material	1959	1960
Open-hearth furnaces:			Air furnaces:		
Pig iron	13,301,590	13,807,676	Pig iron	47,064	47,307
Scrap	9,960,128	9,543,920	Scrap	148,385	153,956
Total	23,261,718	23,351,596	Total	195,449	201,263
Bessemer converters: [1]			Blast furnaces:		
Pig iron	752,653	1,009,202	Scrap	1,027,609	1,124,042
Scrap	275,731	339,546	Total	1,027,609	1,124,042
Total	1,028,384	1,348,748	Miscellaneous uses:		
Electric steel furnaces: [2]			Pig iron (direct casting)	1,116,514	1,197,319
Pig iron	27,047	24,729	Scrap [3]	86,648	70,419
Scrap	1,774,097	1,723,268	Total	1,203,162	1,267,738
Total	1,801,144	1,747,997	Total:		
Cupola furnaces:			Pig iron	15,489,188	16,295,129
Pig iron	244,320	208,896	Scrap	13,866,340	13,501,711
Scrap	593,742	546,560	Total	29,355,528	29,796,840
Total	838,062	755,456			

[1] Includes scrap and pig iron consumed in the basic oxygen converter.
[2] Includes small quantity used in crucible furnaces.
[3] Includes ferroalloy, reforging, and rerolling.

Lead and Zinc Pigment.—Red lead and litharge were manufactured by National Lead Co., in Philadelphia, and black oxide was produced by Electric Storage Battery Co., in Philadelphia, and Price Battery Corp., in Hamburg. Zinc oxide for pigment purposes was manufactured by New Jersey Zinc Co., Palmerton; St. Joseph Lead Co., Josephtown; Superior Zinc Corp., Bristol; and Rohm and Haas Co., Bristol. In addition, New Jersey Zinc Co. produced leaded zinc oxide.

Molybdenum.—Molybdenite concentrate was converted to molybdic oxide by Climax Molybdenum Co. at its Langeloth plant, Washington County, and by Molybdenum Corporation of America at its Washington plant, Washington County. Both firms produced ferromolybdenum and other molybdenum products at these plants. The molybdenite concentrate consumed by Climax Molybdenum Co. was from the firm's operation in Climax, Colo., and that consumed by Molybdenum Corporation of America was obtained mainly from the Utah Copper Division of Kennecott Copper Corp. Molybdenum Corporation of America produced ammonium molybdate and other molybdenum compounds at its York plant, York County.

Pig Iron.—Contrary to expectations for a near-record year, the demand for steel products was reduced owing to reduction of inventories and gradual reduction for steel in important areas such as construc-

tion, heavy machinery, and containers. Despite this, pig iron production totaled 16.5 million short tons, a 9-percent increase over 1959. The pig iron was produced at 21 plants having 73 stacks. Basic, Bessemer, foundry, low-phosphorous, malleable, and direct-casting types of pig iron were produced.

More basic and Bessemer pig iron were produced than other classes; basic represented 87 percent of the total or 14.5 million short tons. Shipments of pig iron totaled 16.2 million tons valued at $973,815,000. In blast furnaces, raw material consumption totaled 7.4 million tons of domestic iron ore, 5.5 million tons of foreign iron ore, 4.2 million tons of limestone and dolomite, 846,000 tons of mill cinder and roll scale, 17,000 tons of flue dust, 1.3 million tons of open-hearth Bessemer slag, 12.3 million tons of coke, 153,000 tons of pig iron and 922,000 tons of home and purchased scrap, 180,000 tons of slag scrap, 9.6 million tons of sinter, 953,000 tons of pellets, and 329,000 tons of foreign agglomerates. In addition, manganiferous ore, coke breeze, anthracite, self-fluxing agglomerates, briquets, and other miscellaneous materials were consumed in making pig iron. A total of 3.7 million tons of domestic iron ore, 290,000 tons of mill cinder and roll scale, 1.4 million tons of flue dust, and quantities of foreign iron ore, manganiferous ore, limestone and dolomite, coke breeze, and anthracite were consumed in agglomerating plants in Pennsylvania to produce sinter and self-fluxing agglomerates.

Smelters.—The Palmerton and Josephtown smelters were active; however, production at Palmerton was adversely affected by a strike. The Palmerton plant of New Jersey Zinc Co. processed concentrate from company operations at Friedensville, Pa.; Austinville, Va.; Jefferson City, and Treadway, Tenn.; Canyon City, Colo.; and other domestic and foreign sources. Zinc was the primary product of the smelter. From May 19 to July 13, improvements at this plant involved converting the vertical retort furnaces, refineries, and metal oxide furnaces to natural gas fuel from fuel formerly made from coal. Savings in operating costs were reported to be substantial. The Josephtown plant of St. Joseph Lead Co. processed zinc concentrate received from the company's Edwards and Balmat, N.Y., and Indian Creek, and Leadwood, Mo., operations, as well as material from other States and foreign countries. The Josephtown smelter operated 48 hours per week during the entire year. The zinc content of the metal produced at the smelter was 146,732 tons for the year, compared with 128,670 tons for 1959. Scrap zinc materials made up a large part of the smelter feed in 1960. To handle this, a new secondary materials plant was built and became fully operative in July.

Zinc.—Production of zinc concentrate was adversely affected by a strike which closed the Friedensville mine from August 5 to November 26. Production declined 18 percent in tonnage during the year. The ore produced at the Friedensville mine was concentrated at a nearby plant, and the concentrate was shipped to the Palmerton smelter for processing. Mine drainage was still a major problem. Rerouting of water made ore available from the 600-foot level, and limited production was done below the water table from the 600- and 800-foot levels. The 700- and 800-foot levels were developed further to facilitate drainage and haulage.

REVIEW BY COUNTIES

Adams.—Total stone output increased 23 percent over 1959. Bethlehem Limestone Co., subsidiary of Bethlehem Steel Co., quarried and crushed limestone at a quarry and plant west of Hanover, chiefly for blast furnace flux, road material, and stone sand. Liberty Stone & Supply Co., Inc. (Fairfield), quarried and crushed limestone for concrete aggregate and roadstone. The Funkhouser Mills Division of the Ruberoid Co. crushed basalt from the Charmian quarry east of Charmian in Adams County; and quartzite was crushed from a quarry nearby for use as roofing granules, tennis court surfacing, and stone dust as an asphaltic filler. Teeter Stone, Inc., subsidiary of H. T. Campbell Sons' Corp., quarried traprock in Gettysburg for use as concrete aggregate and roadstone.

Liberty Stone Co. produced soapstone at a pit near Fairfield and transferred the crude material to its Marriottsville, Md., plant for processing. Summit Industries, Inc., recovered sericite-schist at the Heller No. 3 mine, 3 miles west of Bendersville. The crude material was trucked to the company plant at Aspers to be crushed, screened, and ground, chiefly for use as a filler in asphaltic compounds and joint cement. The crude material at this mine was depleted during the year, and mining was started in Cumberland County.

Production of miscellaneous clay was almost the same as in 1959. Clay recovered from open pits by Alwine Brick Co. (New Oxford) and Gettysburg Drain Tile Works (Gettysburg) was used to manufacture building brick and draintile.

Allegheny.—Bituminous coal was produced from underground and strip mines; underground tonnage comprised 89 percent of the output. Twenty-five underground mines were active—four less than in 1959. A total of 86 cutting machines cut 4.6 million tons of coal, and about the same quantity of coal was mechanically loaded. Of the mechanically cleaned coal, 99 percent was washed, with jigs representing 28 percent. Twenty-two strip mines, five less than in 1959, produced coal, using 32 power shovels and 7 draglines. The capacity of most draglines and shovels was less than 3 cubic yards.

Shipments of cement again declined. Green Bag Cement Co. (formerly Pittsburgh Coke & Chemical Co.) manufactured mostly portland-pozzolan cement and some masonry cement by the wet process. It operated three 175-by-10-foot rotary kilns at its plant at Neville Island. Universal Atlas Cement, Division of U. S. Steel Corp., produced general-use and moderate-heat portland cement and mortar cement by the dry process at the company plant at Universal. Shipments were mostly intrastate and to West Virginia and Ohio.

Output of miscellaneous clay declined for the third consecutive year and was only 3 percent above the previous low of 1956. Milliken Brick Co., Inc., mined clay from an open pit near Wilkinsburg and continued as the largest of seven clay producers in the county. Miscellaneous clay was mined from other pits near Bridgeville, Creighton, McKeesport, Pitcairn, and Pittsburgh. Rebuilding and remodeling kept the Allegheny Brick Co. inactive, but the company plans to resume operations in 1961.

TABLE 15.—Value of mineral production in Pennsylvania[1 2 3]

County	1959	1960	Minerals produced in 1960 in order of value
Adams	(4)	(4)	Stone, sericite-schist, clays, soapstone.
Allegheny	$43,462,995	(4)	Coal, cement, clays, sand and gravel, stone.
Armstrong	(4)	(4)	Coal, sand and gravel, clays, lime, stone.
Beaver	(4)	(4)	Clays, coal, sand and gravel.
Bedford	(4)	(4)	Stone, coal, lime, sand and gravel.
Berks	13,690,800	$13,229,516	Cement, iron ore, stone, clays, sand and gravel.
Blair	2,218,760	(4)	Stone, coal, clays, sand and gravel, lime.
Bradford	87,881	(4)	Sand and gravel, coal.
Bucks	(4)	(4)	Sand and gravel, stone, clays.
Butler	14,803,739	14,099,030	Coal, cement, lime, stone, sand and gravel, clays.
Cambria	42,242,812	40,686,920	Coal, clays, stone, sand and gravel, iron ore (pigment material).
Cameron	171,706	292,965	Coal.
Carbon	(4)	(4)	Coal, stone, sand and gravel.
Centre	(4)	(4)	Lime, coal, stone, clays.
Chester	(4)	(4)	Stone, lime, clays, graphite, gem stone.
Clarion	(4)	(4)	Coal, stone, clays.
Clearfield	26,836,053	27,526,100	Coal, clays.
Clinton	2,708,633	2,343,929	Coal, stone, clays.
Columbia	(4)	(4)	Coal, sand and gravel, clays.
Crawford	179,678	164,174	Sand and gravel.
Cumberland	(4)	(4)	Stone, sand and gravel, sericite-schist, clays.
Dauphin	3,317,375	3,918,994	Stone, coal, clays, sand and gravel, lime.
Delaware	2,608,524	(4)	Stone.
Elk	1,370,674	1,243,645	Coal, sand and gravel, clays, iron ore (pigment material).
Erie	(4)	(4)	Sand and gravel, peat.
Fayette	(4)	(4)	Coal, clays, stone, sand and gravel.
Forest	(4)	(4)	Sand and gravel.
Franklin	(4)	(4)	Stone, sand and gravel, lime.
Fulton	(4)	(4)	Do.
Greene	61,165,085	63,349,280	Coal, clays.
Huntingdon	4,931,074	4,834,112	Sand and gravel, stone, coal, clays.
Indiana	(4)	(4)	Coal, clays.
Jefferson	(4)	(4)	Coal, clays, sand and gravel.
Juniata	(4)	(4)	Stone, lime.
Lackawanna	19,614,830	(4)	Coal, sand and gravel, stone.
Lancaster	(4)	(4)	Stone, coal, sand and gravel, clays, lime, gem stone.
Lawrence	(4)	(4)	Cement, stone, coal, clays, sand and gravel, peat.
Lebanon	16,449,766	16,272,894	Iron ore, lime, copper, stone, cobalt, pyrite, gold, coal, silver.
Lehigh	(4)	(4)	Cement, zinc, stone, gem stone.
Luzerne	(4)	(4)	Coal, sand and gravel, stone, peat, clays.
Lycoming	1,806,045	1,489,284	Stone, sand and gravel, coal, tripoli.
McKean	436,981	439,400	Clays, coal, sand and gravel.
Mercer	2,585,092	3,156,941	Coal, sand and gravel, stone.
Mifflin	(4)	(4)	Sand and gravel, stone, lime.
Monroe	(4)	(4)	Stone, clays, sand and gravel.
Montgomery	13,964,287	14,071,756	Stone, cement, lime, clays, sand and gravel, gem stone.
Montour	(4)	(4)	Stone, sand and gravel.
Northampton	(4)	(4)	Cement, stone, sand and gravel, coal, gem stone.
Northumberland	(4)	(4)	Coal, clays, stone, sand and gravel, lime.
Perry	(4)	(4)	Stone.
Philadelphia	485,638	(4)	Sand and gravel, stone.
Potter	(4)	(4)	Stone.
Schuylkill	65,530,404	54,881,224	Coal, stone, sand and gravel, clays.
Snyder	548,014	614,357	Clays, coal, stone, sand and gravel, lime.
Somerset	(4)	(4)	Coal, clays, stone, sand and gravel.
Sullivan	81,311	97,845	Coal.
Susquehanna	(4)	(4)	Stone, coal.
Tioga	1,217,688	(4)	Coal, stone.
Union	464,487	461,463	Stone.
Venango	2,616,378	(4)	Coal, sand and gravel.
Warren	(4)	(4)	Sand and gravel.
Washington	64,510,269	(4)	Coal, stone, clays.
Wayne	(4)	(4)	Stone, peat, coal, sand and gravel.
Westmoreland	19,643,023	19,823,493	Coal, stone.
Wyoming	(4)	(4)	Sand and gravel, stone.
York	15,875,371	13,814,831	Cement, stone, lime, sand and gravel, clays, mica.
Undistributed	[5] 416,524,816	527,680,429	
Total	[5] 862,150,000	824,493,000	

[1] Pike County is not listed because no production was reported.
[2] Excludes value of production for LP gases, natural gasoline, petroleum, natural gas, and some gem stone and sand and gravel unspecified by counties; included with "Undistributed".
[3] Excludes value of clays and stone used in manufacturing lime and cement.
[4] Included with "Undistributed" to avoid disclosing individual company confidential data.
[5] Revised figure.

The only industrial sand produced in southwestern Pennsylvania came from plants near Acmetonia and Pittsburgh. Output of construction sand and gravel and industrial sand totaled 121,113 tons and marked the second consecutive year that a substantial increase had been reported over the preceding year.

Malli Mines, Jefferson Borough, produced dimension sandstone for use as flagging and as irregular-shaped building stone. Nick Gioia quarried dimension sandstone in Elizabeth Township for use as rubble.

Panacalite Perlite Co. (Pittsburgh) and Perlite Manufacturing Co. (Carnegie) expanded perlite obtained from Nevada and New Mexico. The material was sold or used mainly in building plaster and loose-fill insulation.

Armstrong.—Fifty-four bituminous coal underground mines, 39 strip mines, and 10 auger mines were active. This represented an increase of three strip mines and one auger mine, and a decrease of four underground mines. Slightly more coal was produced from strip mines than from underground mines. Fifty-six power shovels and 20 draglines were operated; 51 of the power shovels had less than 3-yard capacity; 10 draglines had 3-yard capacity; and 6 had between 3- and 5-yard capacity. Of underground production, 86 percent was mechanically loaded, and 35 percent was mechanically cleaned. Pneumatic and other washing methods were used for cleaning the coal.

Armstrong County remained the largest sand and gravel producing county in western Pennsylvania and continued to rank second in the State in total quantity and value. The output from four plants was used mainly as building and paving material. Shipments to consumers were made by truck, waterway, and railroad.

Combined output of clay from six underground mines—one each at Adrian, Freeport, New Bethlehem, and Templeton, and two at Kittanning—and two open pits—one each at Craigsville and Worthington—totaled 217,000 tons. The fire clay was used to manufacture firebrick and block, building brick, and vitrified sewer pipe. Haws Refractories Co. did not operate its Bridgeburg underground mine during the year.

Three lime companies (all near Kittanning) produced hydrated lime for agricultural purposes. Limestone, quarried and crushed at two operations near Kittanning, was used solely for manufacturing lime.

Beaver.—Despite a 21-percent decrease Beaver County continued to rank second as a clay-producing county. Four underground mines yielded 90,000 tons of fire clay, which was used chiefly in manufacturing building brick. Fire clay from open pits was used for firebrick and block, clay crucibles, foundries and steelworks, building brick, and vitrified sewer pipe. Miscellaneous clay produced from an open pit near New Brighton was used to manufacture heavy clay products. Friedl-Elverson Pottery Co. discontinued mining and purchased material from an outside source. McQuiston Coal Co. completed mining operations near Darlington and began to backfill its property.

Ninety-eight percent of the bituminous coal production came from strip mines. The remainder was obtained from underground mines. Twenty-four power shovels, 13 draglines, and 17 bulldozers were used at the stripping operations. At underground mines, three cutting

machines and two loading machines were used; 59 percent of the production was mechanically loaded. None of the coal was mechanically cleaned.

Iron City Sand & Gravel Corp. dredged sand and gravel from newly acquired property in Beaver County and established the area as the third largest in the State. Other producers were Lee Block Co. near Industry, and Shippingport Sand & Gravel Co. near Shippingport.

Bedford.—Two companies produced and crushed limestone near Everett and Hyndman for use as concrete aggregate, roadstone, agricultural stone, asphalt filler, dust for coal mines, and lime manufacture. Leap Ganister Rock Co. produced ganister rock at its Leap No. 1 quarry near Madley. The stone was crushed and sized at a local plant for use as furnace or converter linings. Martin Quarries produced and crushed sandstone at a quarry near Bechtelsville.

Sixty-three percent of the bituminous coal production came from underground mines. Of the underground production, 40 percent was mechanically loaded, and none was mechanically cleaned. At the strip mines, three power shovels, two draglines, four bulldozers, and two horizontal power drills were used.

New Enterprise Lime & Stone Co. produced and sold hydrated agricultural lime at its Ashcom plant near Everett. J. Mason Kerr (Hyndman) operated a one-pot kiln and sold quicklime for agricultural purposes.

Building sand was processed by Feight Bros. and transported by truck to consumers.

Berks.—General-use and moderate-heat and high-early-strength portland and masonry cements were produced by the dry process at the No. 1 five-kiln plant of Allentown Portland Cement Co. (Evansville). Output was shipped mostly in bulk by railroad to ready-mixed concrete companies. Shipments were largely intrastate, but significant quantities also were shipped to New York, New Jersey, and Connecticut.

Bethlehem Cornwall Corp., subsidiary of Bethlehem Steel Co., continued to produce crude iron ore at its Grace underground mine near Morgantown by block caving, open stope, and shrinkage stoping. The crude ore was processed at the local company concentrator by flotation and magnetic concentration.

Tonnage and value of stone decreased 12 percent and 13 percent, respectively. Four companies continued operating six limestone quarries—two near Evansville, and one each near South Temple, Sinking Spring, Kutztown, and Oley. Output was sold or used mostly as concrete aggregate, roadstone, and in manufacturing of cement. Eighty-six percent of the stone produced was shipped by truck. Basalt, crushed or broken for use as railroad ballast and road material, was recovered from the Clingan quarry near Birdsboro by The John T. Dyer Quarry Co. Two new operators, Pottstown Trap Rock Quarries, Inc., Douglasville, and Bradford Hills Quarry, Inc., Morgantown, quarried diabase solely for use as roadstone. Reading Poultry Food Co., Reading, crushed oystershell for use as poultry grit and mineral food.

Miscellaneous clay and shale taken from open pits by the Reading Shale Division and Shoemakersville Division of Glen-Gery Shale Brick Corp. was used to manufacture building brick.

Prepared sand and gravel by two producers, one near Sinking Spring, and the other near Temple, was hauled to consumers by truck.

Blair.—Production and value of stone was slightly less than in 1959. Six companies continued operating seven quarries near Roaring Springs, Canoe Creek, Hollidaysburg three, Altoona, and Claysburg. Output was used chiefly as concrete aggregate and roadstone, and for agricultural purposes. The leading producer was New Enterprise Stone & Lime Co. Quartzite was quarried and crushed for use in making silica brick by General Refractories Co., Frankstown, and J. L. Hartman, Sproul. General Refractories Co. discontinued operations at its Claysburg quarry. Basalt Traprock Co. produced and crushed quartzite at its quarry and stationary plant near Williamsburg, chiefly for railroad ballast and road material.

Coal production came mostly from strip operations.

Blair County was one of two counties producing kaolin. Kaolin mined at the Grannas No. 1 mine near Williamsburg was used to manufacture refractories. Miscellaneous clay and plastic fire clay were also produced in limited quantities.

Building sand was recovered from two pits in the southern part of the county near Hollidaysburg. Material mined near Frankstown was processed and used as building gravel.

Chimney Rocks Lime & Stone Co. (Hollidaysburg) produced hydrated lime for agricultural use.

Bradford.—Two plants near Towanda were able to supply the increased demands for building and paving sand and gravel.

Bituminous coal also was produced.

Bucks.—Output of sand and gravel (all processed) declined sharply from that of 1959; however, the county continued to lead in tonnage and value of output. Shipments of construction sand and gravel, for use chiefly as building and paving material were made by waterway, truck, and railroad. The following leading producers each produced more than 100,000 tons: Amico Sand & Gravel Co. (Morrisville), B & M Sand & Gravel, Inc. (Upper Black Eddy), and Warner Co. (Philadelphia).

Crushed limestone was produced by four companies operating quarries near Buckingham, Eureka, Rushland, and New Hope, solely for use as concrete aggregate and roadstone. Edward Karpinski (Langhorne) produced dimension limestone for use in rough construction work. Dimension diabase for use as rough and dressed construction stone and crushed or broken diabase as road material was quarried by Edison Quarry (Edison). Coopersburg Granite Co., east of Coopersburg in Bucks County, quarried dimension stone for dressed architectural and monumental stones, and rubble. Four operators near Quakertown, Weisel, Telford, and Ottsville quarried and crushed diabase solely for concrete aggregate and roadstone.

Samuel M. Yoder Estate operated the Blooming Glen quarry and crushing plant, producing redstone and bluestone, and George Wiley operated Wiley's quarry (bluestone) near Point Pleasant. Both companies quarried and crushed sandstone for use as concrete aggre-

gate and roadstone. Better Materials Corp., Penns Park, produced crushed and broken miscellaneous stone (argillite) and sold or used the stone as concrete aggregate and roadstone.

Quakertown Brick & Tile Co., Inc., mined miscellaneous clay for building brick from an open pit near Quakertown.

Butler.—Bituminous coal was produced from 24 underground mines, 37 strip mines, and 5 auger mines, representing 1 additional strip mine, 2 auger mines, and 4 less underground mines than in 1959. Thirty-eight cutting machines and 16 loading machines were used in the underground mines; 58 percent of the production was mechanically loaded. Fifty-nine power shovels, 33 draglines, 1 carryall, and 53 bulldozers were used at the strip mines. Only 26 percent of the coal was mechanically cleaned, all by jigs.

General-use and moderate-heat and high-early-strength portland cement and some mortar cement were manufactured by the wet process by Penn-Dixie Cement Corp. at its No. 9 plant, West Winfield. Two 250 feet by 10 feet 6 inches rotary kilns were fed crushed captive limestone. Cement was shipped intrastate, mostly by truck in bulk to ready-mixed concrete companies. Small quantities were shipped to New York, West Virginia, and Ohio.

Quicklime and hydrated lime were produced by Mercer Lime & Stone Co. at its plant one-half mile west of Branchton, and marketed for chemical and industrial uses. Some hydrated lime was sold for agricultural purposes.

Output of limestone was slightly less than in 1959, although four companies continued to produce from quarries near West Winfield, Harrisville, and Branchton. The stone was crushed for use as concrete aggregate, roadstone, cement manufacture, and agricultural purposes.

Highway Sand & Gravel Co., Inc., produced building sand and gravel for local and general sales. H. W. Cooper produced sand and gravel and processed sand for fill and gravel for miscellaneous uses.

Miscellaneous clay output was used in manufacturing cement and building brick. Having ceased mining at the beginning of the year, McCrady Refractories, Inc., used clay from its stockpile and clay purchased from outside sources. Glenn R. Boosel, after mining a small quantity of flint fire clay, discontinued operations June 1. Pittsburgh & Erie Coal Co. was liquidated during 1960.

Cambria.—Eighty-six underground mines, 23 strip mines, and 4 auger mines were worked for bituminous coal. This was six less underground mines, four less strip mines, and three more auger mines than were worked in 1959. Ninety-two percent of the production came from underground mines, 7 percent from strip mines, and the remainder from the auger mines. One hundred and forty-two cutting machines and 182 loading machines were used in the underground operations; 96 percent of the underground production was mechanically loaded. Forty-eight power shovels, 14 draglines, 30 bulldozers, 7 horizontal power drills, and 6 vertical power drills were used at the strip mines. Approximately 73 percent of the coal production was mechanically cleaned, about 60 percent by pneumatic methods.

The Hiram Swank's Sons, Inc., Swank No. 24 mine remained the only active underground clay mine in the county at the end of the

year; however, lack of orders caused periods of limited production throughout the year. Patton Clay Manufacturing Co. discontinued operating its No. 1 underground mine September 1, and leased the property to Joseph Shero. Triangle Clay Products Co. became the leading clay producer in the county. Miscellaneous clay produced by Triangle Clay Products Co. at its open pit near Johnstown was used in manufacturing building brick. North Cambria Fuel Co. produced plastic fire clay for manufacturing vitrified sewer pipe.

Nicosia Stone Quarry, Johnstown, produced crushed sandstone for making silica brick and for road material. Parry Sand & Gravel Co. near Johnstown supplied sand and gravel for home construction. Lanzendorfer Minerals Co. produced iron oxide pigments of the sulfur mud variety from its No. 31 mine near Nanty Glo. The material was sold for use in making paint pigments.

Cameron.—The entire production of bituminous coal came from one strip mine. Three power shovels, one dragline, and three bulldozers were used at this mine.

Carbon.—Anthracite from underground mines, strip pits, and culm banks totaled 661,165 short tons. Seventy-five percent of the output was shipped outside the producing region; the remainder was sold locally. The principal producers of anthracite were Pollock Trucking Co., Sullivan Trail Coal Co., and Coaldale Mining Co.

Valuewise, Carbon County led in producing sandstone; output increased slightly over that of 1959. Quartzite used in making silica brick was produced at the Little Gap quarry and crushed at the Palmerton plant of North American Refractories. Crushed and broken sandstone used mainly for road material was quarried at the Red Rock quarry near Nesquehoning by James and Paul Fauzio.

Alliance Sand Co., producing only sand for use as building and paving material and for manufacturing cement, ranked 16th in the State for total sand and gravel production. Two other companies produced sand and gravel for construction material.

Centre.—Despite decreases of 16 percent in quantity and 15 percent in value, Centre County remained the leading lime-producing area. Three producers operated rotary limekilns near Bellefonte. Quicklime and hydrated lime were marketed chiefly for chemical and industrial uses; smaller quantities were sold for agricultural and building uses.

Two auger mines, 11 underground mines, and 17 strip mines produced bituminous coal. Strip mines produced 92 percent of the county output; 34 power shovels, 13 draglines, and 28 bulldozers were used. At the underground operations, four cutting machines, three loading machines were used; 32 percent of underground production was loaded mechanically. None of the coal was mechanically cleaned.

Both tonnage and value of limestone (the only stone produced in the county) declined 11 percent. Chief uses of the limestone were for concrete aggregate, roadstone, lime manufacture, open-hearth flux, glassmaking, and dust for coal mines. Six companies produced crushed and broken stone, principally from quarries near Bellefonte, Pleasant Gap, and State College.

Fire clay produced by Harbison-Walker Refractories Co. was used in manufacturing firebrick and block.

Chester.—Total output of stone was slightly less than in 1959. Bradford Hills Quarry, Inc., crushed limestone at a quarry and plant near Downingtown for use as road material. Some of the stone was sold to local government agencies for road construction. The Cedar Hollow plant at Devault, operated by Warner Co., Bellefonte Division, yielded crushed limestone for use as road material, blast-furnace flux at chemical plants, agricultural purposes, and in manufacturing refractories and lime. Quicklime and hydrated lime chiefly for sewage and trade-waste treatment, paper manufacture, and agricultural use were produced at the Cedar Hollow plant. The company's Johnson quarry and plant near Paoli yielded limestone solely for use as concrete aggregate and roadstone. Valley Forge Stone Co. (Malvern) produced crushed limestone for use as road material. Limestone was sold to local government agencies as roadstone.

V. DiFrancesca, Devault, quarried and crushed diabase for use as road material. Keystone Trappe Rock Co., Glenmoore, produced crushed and broken diabase for road material and railroad ballast. In addition to crushed and broken diabase for use as riprap, French Creek Granite, Saint Peters, produced dimension dressed architectural stone, ornamental stone for monuments and mausoleums, and curbing. Some of the dimension stone was used on the exterior of the Federal Office Building in Richmond, Va.

John Fecondo & Sons, Albert Rotunno, and Abram T. Minor, all near Avondale, quarried dimension sandstone (bluestone) as irregular-shaped construction stone, rubble, and flagging. Dimension sandstone for use as irregular-shaped construction stone and rubble was quarried by Bacton Hill Quarry, Malvern. The stone from the Bacton Hill quarry was used on the exterior of the Allstate Insurance Building (King of Prussia, Montgomery County) and Kaufmann's Department Store (Monroeville, Allegheny County).

Quicklime and hydrated lime chiefly for sewage and trade-waste treatment, paper manufacture, and agricultural use were produced at the Cedar Hollow plant of Warner Co. Hydrated lime also was sold for building lime.

Graphite Corp. of America produced crystalline flake graphite near Chester Springs for use in crucibles and foundry facings.

McAvoy Vitrified Brick Co. used miscellaneous clay and shale produced from an open pit at Phoenixville to manufacture building brick.

Clarion.—Clarion County again ranked second in strip mining bituminous coal, with 13 percent of the State's strip-mine tonnage. Seventy-four power shovels, 32 draglines, and 46 bulldozers were used at the 35 (4 more than in 1959) active strip mines. Smaller quantities were produced by 10 underground mines and 1 auger mine. Forty-three percent of the coal was mechanically cleaned, 58 percent by jigs, and 42 percent by other wet methods.

Allegheny Mineral Corp. crushed limestone for concrete aggregate, roadstone, and agricultural purposes at a quarry and plant east of Parker.

Flint fire clay produced from four underground operations was used exclusively for refractories. Plastic fire clay was mined from two open pits for use in manufacturing heavy clay products.

615629—61——56

Harbison-Walker Refractories Co. abandoned its Lucinda underground clay mine.

Clearfield.—Clearfield County led in production of bituminous coal from strip mines. One hundred and six active strip mines, the same number as in 1959, yielded 5 million tons. Two hundred and fifteen power shovels, 81 draglines, 4 carryalls, 178 bulldozers, 36 horizontal power drills, and 40 vertical power drills were used at strip operations. Production from 82 underground mines, 6 less than in 1959, totaled 1.1 million tons. Of the coal mined underground, 1 million tons was cut by 112 cutting machines, and 710,000 tons was mechanically loaded. A total of 489,000 tons of coal was wetwashed, and 584,000 tons was cleaned, using pneumatic methods.

Clearfield continued as the principal clay-producing area in the State; the total output of 542,000 short tons was 13 percent above 1959 but 6 percent below the high of 577,000 short tons established in 1957. Clay-mining, by 12 companies, was all from open pits. Eight companies produced under contract or marketed their entire production of plastic and flint fire clays for manufacturing refractory firebrick and block. Miscellaneous clay produced by Robinson Clay Products, Inc., and Williams Grove Clay Co. was used in manufacturing heavy clay products. Hiram Swank's Sons, Inc., conducted exploration and development work at its Swank No. 27 underground mine. This work was limited to tunneling and crosscutting. Due to economic conditions, the company ceased underground mining operations December 16.

Clinton.—Bituminous coal was mined from four underground mines and five strip mines, one less strip mine than in 1959. Strip mines used 12 power shovels and 7 draglines to produce 469,000 tons of coal. Only one cutting machine was used underground, and none of the production was mechanically loaded. Only 36 percent of the county production was mechanically cleaned.

Crushed and sized limestone for use as concrete aggregate, roadstone, and railroad ballast was produced by Lycoming Silica Sand Co. (Salona). Some roadstone was sold to the Pennsylvania Department of Highways.

Union Mining Co., Inc., purchased the Kelsey Mining Co. on January 1. Diaspore-type fire clay, produced by the new owners, was marketed for use in manfacturing high-alumina brick. Miscellaneous clay mined under contract for Mill Hall Clay Products Co., Inc., was used in manufacturing heavy clay products.

Columbia.—Anthracite was mined from strip mines, underground mines, and culm banks. Leading producers were Jeddo-Highland Coal Co., Raven Run Coal Co., and Reading Anthracite Co.

Bloomsburg Sand & Gravel Co. produced building sand and gravel from a pit and processing plant near Bloomsburg.

The Alliance Clay Product Co. mined miscellaneous clay for manufacturing building brick on property near Mifflinville, leased from Lloyd E. Eister.

Crawford.—Sand and gravel production was 27 percent below the high of 142,000 tons produced in 1959. State and local governments and other consumers nearby used the output of four plants for ready-

mixed concrete, bituminous and antiskid material, road base and road repairs, highway drainage, and as building material.

Cumberland.—Crushed limestone for use as road material was produced by Valley Quarries, Inc. (Shippensburg), and Hempt Bros., Inc. (Camp Hill). Locust Point Stone Quarries (Mechanicsburg) produced roadstone and agricultural limestone.

The sand and gravel industry, consisting of three plants recorded its best year since 1955. Sand and gravel production totaled 175,000 tons and represented a 2-percent increase over 1959.

Summit Industries, Inc., recovered sericite schist from the Herman mine near Goodyear. The crude material was transported to the company mill at Aspers (Adams County) for processing.

Cumberland County was the leading of two kaolin-producing counties. Kaolin mined from an open pit near Mount Holly Springs by Philadelphia Clay Co. was used almost entirely in making white cement. Increased demands for kaolin, which began early in 1960, did not continue throughout the year, and production declined slightly below the 1959 level. The Penn Products Corp. sold a small quantity of stoneware clay for manufacturing floor and wall tile.

Dauphin.—Four companies reported crushing limestone at plants near Steelton, High Spire, Camp Hill, and northwest of Palmyra. Chief uses of the stone were for concrete aggregate, roadstone, blast-furnace flux, and stone sand. Taylor Lime & Stone Co. (Elizabethville) quarried and crushed stone for road material. The Pennsylvania Department of Highways purchased some stone for road construction.

Less than 20 percent of the anthracite mined from underground mines, strip pits, and culm banks was consumed by local trade.

Output of miscellaneous clay and shale was 5 percent below 1959. Bethlehem Limestone Co. recovered miscellaneous clay from an open pit near Steelton, and sold it for use in making foundry refractories and protective coating for pipes. Glen-Gery Shale Brick Corp. used shale from its open pits near Harrisburg and Royalton in manufacturing building brick.

Material processed by Highspire Sand & Gravel Co., Ltd., and Pennsylvania Supply Co. was used exclusively as paving sand and gravel.

H. E. Millard Lime & Stone Co. burned hydrated lime for agricultural use at its Swatara plant near Hershey.

Delaware.—In Delaware County, granite gneiss production decreased 29 percent in tonnage and 18 percent in value. V. DiFrancesca & Sons, Freeborn quarry (Havertown), Llanerch quarry and crusher (Llanerch), and General Crushed Stone Co., Glen Mills quarry, crushed granite gneiss for use as concrete aggregate and roadstone. In addition granite gneiss for railroad ballast was recovered at the Glen Mills quarry. Media Quarry Co. (Media) quarried dimension sandstone for rubble and rough construction. Dimension granite was recovered at two quarries, near Lima and Swarthmore, for use as dressed and irregular-shaped construction stone. Three quarries in the central part of the county near Media, Springfield, and Marple Township yielded dimension miscellaneous stone (mica schist) used as rough and dressed structural stone and rubble.

Perlite Products, Inc. (Primos), expanded perlite from crude material obtained from Colorado. The material was sold or used chiefly as building plaster and as a mix with asphalt for insulating material.

Fenix & Scisson, Inc., completed a liquid propane underground storage cavern for Sun Oil Co. The 400,000-barrel capacity cavern was blasted out of granite underlying the Sun Oil Marcus Hook Refinery. The company has two additional nearby caverns, each with a capacity of 250,000 barrels, for butane storage.

Elk.—Bituminous coal was produced at 16 underground mines (19 in 1959), 10 strip mines (7 in 1959), and an undisclosed number of auger mines. Slightly more coal was produced underground than from strip mines. Of the coal mined underground, 85 percent was cut by machine, and 82 percent was mechanically loaded. Only a small percent of the county production was mechanically cleaned; wet-washing methods were used.

Paving gravel and building sand and gravel were processed by Stone Haven Mix (Johnsonburg) and C. A. Hoffman Gravel Co. (Ridgway), respectively.

Plastic fire clay was produced by St. Marys Sewer Pipe Co. for making vitrified sewer pipe.

From the Brandy Camp mine (Brandy Camp) William DeSalve recovered sulfur mud, which was sold for manufacturing paint pigments.

Speer Carbon Co. (Saint Marys) manufactured graphite (artificial) for use by steel manufacturers and chemical companies.

Erie.—Erie County was one of three industrial sand-producing counties in northwestern Pennsylvania. The industry, consisting of four plants, used rail and truck transportation to supply consumers with building and paving sand and gravel, miscellaneous gravel, and molding sand.

Corry Peat Products Co. recovered reed-sedge and humus peat from a bog in the southeastern part of the county near Corry.

Fayette.—Bituminous coal was produced at 37 underground mines (41 in 1959), 30 strip mines (31 in 1959), and 1 auger mine. Thirty cutting machines and 36 loading machines were used underground; 94 percent of the output was cut by machines, and 66 percent was loaded mechanically. Three draglines, 27 power shovels, and 26 bulldozers were used at the strip mines. Fifty-eight percent of the total production from all mines was mechanically cleaned, using both wet-wash and pneumatic methods.

Combined output of clay from five open-pit mines continued upward and was only 6 percent below the high of 159,000 tons set in 1957. Miscellaneous clay and fire clay were produced by Layton Fire Clay Co. for use in making refractory firebrick and block, building brick, and other heavy clay products. Fire clay produced by Harbison-Walker Refractories Co., Kaiser Refractories & Chemical Division, Robert N. Matthews, and John Hustosky was used chiefly for manufacturing refractory firebrick and block.

Fry Coal & Stone Co., Division of American-Marietta Co., operated the Lake Lynn quarry (formerly owned by Vesco Corp.) and produced crushed, ground, and sized limestone for use as concrete aggregate,

roadstone, dust for coal mines, and for agricultural purposes. Crushed and ground ganister rock for making silica brick was produced at the Childs operation near Layton by General Refractories Co. Connellsville Bluestone Co., Connellsville, produced crushed and broken sandstone (bluestone) as road material and sold some of the stone to the Pennsylvania Department of Highways and various townships for road construction. Dimension sandstone (bluestone) for rough construction also was quarried near Connellsville.

McClain Sand Co., Inc., used truck, railroad, and waterways to transport its finished product to customers.

Small quantities of sand and gravel were sold to the U.S. Army Corps of Engineers and the Pennsylvania Department of Highways.

General Chemical Division of Allied Chemical Corp. produced cinder at its Newell plant for use in refractories and cement.

Forest.—Tionesta Sand & Gravel, Inc. (Tionesta), processed sand and gravel for construction uses. J. & J. Sand & Gravel Co. (Rimersburg), operating only 2 months, processed bank run material, mined from a pit near Clarington.

Franklin.—Production of stone totaled 608,000 short tons, a 15-percent decrease from 1959. Crushed limestone for use as concrete aggregate, roadstone, railroad ballast, for agricultural purposes, and for making lime, was reported by six companies operating seven quarries. Quarries were active near Mercersburg, Zullinger, Dry Run, Chambersburg, Williamson, and Shippensburg.

Building sand was the only sand product processed.

Frank L. Heinbaugh (Mercersburg) produced quicklime in its 3-shaft-kiln plant, and sold it for agricultural use. Bituminous coal was used as fuel.

Fulton.—H. B. Mellot Estate, Inc., produced limestone at the Morton quarry (Big Cove Tannery) and the Charlton quarry (Warfordsburg). The stone was crushed at local plants chiefly for use as concrete aggregate and roadstone, and a quantity was used for agricultural purposes. John P. Martz & Son crushed limestone for making lime at its Martz Draw Kiln near Hustontown. The lime was marketed for agricultural use.

Sand, produced by H. B. Mellot Estate, Inc. (Warfordsburg), was marketed chiefly as paving sand for highways.

Greene.—Greene was the leading county in output of bituminous coal from underground mines; production totaled 10 million tons. Nineteen underground mines were active, the same number as in 1959. All but a small fraction of the underground production was cut by machine and loaded mechanically. One strip mine was active. Seventy-three percent of the county production was mechanically cleaned, using jigs and other wet methods.

Greene County Clay Products Co. mined miscellaneous clay from an open-pit operation near Waynesburg. The clay was used to manufacture building brick.

Huntingdon.—Huntingdon County ranked third in value of sand and gravel and continued as the leading industrial sand-producing county in the State. Industrial sands produced at the Pennsylvania Glass Sand Corp., Keystone Works were used as glass, molding, and engine sand, and for other industrial uses. In addition, the company pro-

duced ground sand for use in making enamel, foundry molds, glass, pottery, and abrasives.

New Enterprise Stone & Lime Co. recovered limestone from the McConnelstown quarry for use as concrete aggregate and roadstone. Its Orbisinia quarry was not operated during the year. Warner Co., Bellefonte Division (Union Furnace) quarried and crushed limestone as concrete aggregate, roadstone, railroad ballast, and riprap. Harbison-Walker Refractories Co. (Mount Union) and North American Refractories Co. (Three Springs) quarried and crushed quartzite for making silica brick at local plants.

Bituminous coal was produced at four underground mines (nine in 1959) and four strip mines (five in 1959). Only 46 percent of the underground tonnage was cut by machine, and none was mechanically loaded. Eight power shovels and three draglines were used at the four strip pits. None of the output from the underground mines or the strip mines was mechanically cleaned.

Two companies produced fire clay for making refractories. That produced by Alexandria Fire Clay Co. was sold on the open market; output of Harbison-Walker Refractories Co. was captive.

Indiana.—Production of bituminous coal from 74 underground mines, 28 strip mines, and 4 auger mines totaled 5 million tons. Indiana County ranked fifth in output of coal from underground mines. One hundred and two cutting machines and 124 loading machines were used. Virtually the entire underground production was mechanically cut and loaded. At the 28 strip mines, 50 power shovels, 17 draglines, and 50 bulldozers were used. Seventy-two percent of the total output was mechanically cleaned, using jigs, other wet methods, and pneumatic methods.

In addition to the fire clay mined at its No. 6 underground mine, Hiram Swank's Sons, Inc., purchased fire clay produced at the L. H. Foehrenbach strip-mining operation near Clymer. The product from these mines was used to produce sleeves, nozzles, stoppers, and other refractory materials.

Jefferson.—Bituminous coal was produced from 29 underground mines (30 in 1959), 30 strip mines (29 in 1959), and 5 auger mines (4 in 1959). At the underground mines, 40 cutting machines and 18 loading machines were used; 47 percent of the coal was mechanically loaded. Only 7 percent of the county output was mechanically cleaned. Only jigs were used to clean the coal.

Flint and plastic fire clays were produced. Flint fire clay, mined underground by Henry O'Neill & Co., was used in manufacturing firebrick and block. Plastic fire clay, mined from two open pits near Brockway and from an underground mine near Summersville, was used to manufacture vitrified sewer pipe, building brick, and tile.

Gravel for building, paving, and railroad ballast was produced at the Brockway Sand & Gravel Co. plant near Brockway.

Juniata.—Limestone used for concrete aggregate and roadstone was quarried near Mifflintown by W. N. Quigley. Local and nearby government agencies purchased stone for road construction. Fulkroad Lime Quarry (McAllisterville) used its limestone output solely for producing lime for agricultural use, using anthracite as fuel. Kaiser

Aluminum & Chemical Corp. recovered quartzite and crushed it for making silica brick at the Van Dyke plant near Thompsontown.

Lackawanna.—Production of anthracite declined from 2.1 million tons in 1959 to 1.8 million tons. Despite the decline the county ranked fourth in tonnage and third in value. Operators producing over 100,000 tons were Hudson Coal Co. and Moffat Coal Co., Inc.

Contractors Sand & Gravel, Inc., supplied the Pennsylvania Department of Highways and contractors with building and paving materials. Keystone Pavement & Construction Co., Inc., used part of its output as a prime contractor and sold building and paving sand and gravel to the Pennsylvania Department of Highways and local consumers.

Crushed and broken sandstone was quarried for road material at the West Mountain quarry near Scranton by Stabler Construction Co.

Lancaster.—Production of dimension limestone ceased in the county. The tonnage and value of crushed and broken limestone decreased 9 percent and 13 percent, respectively; output totaled 2,293,000 short tons.

Thirteen companies operated 15 quarries and plants (each 1 less than in 1959) near Bainbridge, Morgantown, E. Petersburg, Ephrata, Gap, Lititz, Landisville, Rheems, Denver, Blue Ball, Quarryville, and Talmage. Leading producers were D. M. Stoltzfus & Son, Inc., Bradford Hills Quarry, Inc., and Ivan M. Martin, Inc. L. F. Zook & Sons (Bareville) discontinued operations during the year. Most of the crushed stone was sold or used for concrete aggregate and roadstone; smaller quantities were used for agricultural purposes, stone sand, asphalt fill, and lime manufacture. Much of the stone was sold to the Pennsylvania Department of Highways, local and nearby Government agencies, and the Maryland and Delaware State Highway Departments for road construction.

Anthracite was recovered by dredging.

A. T. Harris Sand Co. processed and sold industrial sand for use as fire or furnace material. Hempt Bros. (Elizabethtown) and Milton Grove Sand, Inc. (Milton Grove), continued to be the main sources of construction sands.

Output of both fire clay and miscellaneous clay continued to decline. Lack of orders forced the Whitaker Clay Co. to curtail mining during the second half of 1960. The Glen-Gery Shale Brick Corp., Ephrata Division, shut down its operation for approximately 3 months after a fire of undetermined origin swept through the plant May 15. Several of the nine kilns, drying rooms, a two-story processing building, and a conveyor bridge spanning the Reading Railroad track were damaged. Although much of the plant was destroyed, rebuilding was started immediately. Lancaster Brick Co. strip-mined clay for manufacturing building brick.

Hydrated lime for agricultural use was produced near Elverson by Amos K. Stoltzfus. Dead-burned dolomite for use as a refractory material was produced by J. E. Baker Co. at its rotary-kiln plant near Bainbridge.

Lawrence.—Shipments of portland and masonry cements decreased slightly in tonnage and value. Crushed captive cement rock was used to manufacture cement at the Bessemer plant of Bessemer Limestone

& Cement Co. Mostly Types I–II, air-entrained and non-air-entrained, and some Type III, non-air-entrained, portland cement was produced by the wet process. Some mortar cement also was produced. Three 235- by 10-foot rotary kilns and one 450- by 12-foot kiln were operated. Medusa Portland Cement Co. (Wampum) also manufactured mostly general-use and moderate-heat and high-early-strength portland cements and some masonry cement by the dry process. Two 390- by 12-foot rotary kilns were operated. A new regrinding and packing facility was completed at the Wampum plant. Major shipments from the Bessemer and Wampum plants were made by truck to ready-mixed concrete companies and concrete product manufacturers in Pennsylvania and Ohio.

Output of limestone was 2,913,000 tons, a slight increase over 1959; although value decreased slightly, the county ranked third in stone production. Five companies produced crushed limestone and cement rock, chiefly for blast-furnace flux, cement, concrete aggregate, roadstone, and dust for coal mines. The stone was quarried near Wampum, Hillsville, Bessemer, West Pittsburgh, and Mahoning Township. Mooney Bros. Supply Co. (West Pittsburgh) was a new limestone producer. Most of the county stone production was transported to consumers by rail.

Bituminous coal was mined from underground, strip, and auger mines. Thirty power shovels, 18 draglines and 25 bulldozers were used at the strip mines. Coal mined underground was mechanically loaded and mechanically cut; however, none of the production from the underground, strip, or auger mines was mechanically cleaned.

Lawrence County ranked fourth in clay output. Production of both fire clay and miscellaneous clay continued at a high rate and totaled 317,000 short tons, a 17-percent increase over 1959. Plastic fire clay, which was produced near Enon Valley by The Negley Fire Clay Co. and Natco Corp., was used in making refractories and heavy clay products. Metropolitan Brick, Inc., and Fenati Brick Co., Inc., produced both fire clay and miscellaneous clay for manufacturing building brick. Fenati Brick Co., Inc., curtailed operations for approximately 3 months following a fire in the machine room. The Bessemer Limestone & Cement Co. produced miscellaneous clay for use in manufacturing portland and other hydraulic cements; Keystone Loam & Clay Co. sold miscellaneous clay in bulk for use in foundries and steelworks.

Mooney Bros. Supply Co. produced sand and gravel for its own use. Superior Sand & Supply Co. and Mahoning Valley Sand Co. processed sand and gravel as building and paving materials.

D. M. Boyd produced humus peat from bogs near New Wilmington. Moore's Humus & Nursery recovered reed-sedge peat at a bog near Leesburg and sold the material in bulk.

Lebanon.—Bethlehem Cornwall Corp., subsidiary of Bethlehem Steel Corp., at the Cornwall underground mine 5 miles south of Lebanon, mined crude iron ore by block-caving and open-stope methods. The crude ore was processed at the Lebanon concentrator by flotation, magnetic concentration, and agglomeration, yielding iron ore, gold, silver, copper, cobalt, and pyrite.

Lebanon County ranked second in production and third in value of lime. H. E. Millard Lime & Stone Co. operated four rotary kilns and one continuous hydrator to produce quicklime and hydrated lime at its Annville plant. The quicklime and hydrated lime were sold chiefly for building, metallurgical, papermaking, and water purification uses; some quicklime was sold for agricultural purposes.

Limestone was crushed and sold or used chiefly for blast-furnace flux, manufacturing cement and lime, concrete aggregate, and roadstone. Total output was 1,670,000 short tons. Quarries were operated near Annville, Lebanon, and Cornwall.

Anthracite was recovered solely by dredging.

Lehigh.—Shipments from four cement manufacturers, declined slightly. Mostly captive cement rock was crushed and used for manufacturing general-use and moderate-heat, high-early-strength portland, and some mortar cements. Plants were operated near Coplay, Egypt, Fogelsville, and Cementon. Major shipments were by railroad, mostly in bulk to ready-mixed concrete companies, intrastate and to New Jersey, New York, and Ohio. Lehigh Portland Cement Co. installed an electrostatic precipitator at is Fogelsville plant at a cost of about $2 million. Giant Portland Cement Co. also installed dust-collecting equipment. A change in regulations permitted truck shipments, and cement companies were building truck-loading stations, storage silos for direct bulk loading into trucks, and other truck facilities.

Production and value of cement rock and limestone increased slightly; output totaled 2,234,000 short tons. The increase in production was attributed to a larger demand for limestone as road material. The Whitehall Cement Manufacturing Co. (Cementon), Giant Portland Cement Co. (Egypt), Lehigh Portland Cement Co. (Fogelsville), and Coplay Cement Manufacturing Co. (Coplay) produced and crushed cement rock or limestone at local plants solely for manufacturing cement. Lehigh Stone Co. (Ormrod) and Roy J. Kern (Guthsville), a new operator in the county, both operated stationary plants to produce crushed or broken limestone solely as concrete aggregate and roadstone. Some of the stone was sold to local Government agencies for road material. Penn Big Bed Slate Co. produced and processed slate at its No. 2 quarry near Slatedale, chiefly for structural and sanitary uses, blackboards and bulletin boards, and roofing slate.

Crude perlite mined in Colorado was expanded at the Pennsylvania Perlite Corp. Allentown plant and marketed for use as building plaster aggregate.

New Jersey Zinc Co. (Friedensville) mined crude zinc ore at its Friedensville underground mine by the room and pillar method. Zinc concentrate was shipped by truck to the company smelter at Palmerton. Operation of the mine was curtailed by a labor strike from August 5 to November 25.

Luzerne.—Luzerne County continued to rank second in production of anthracite. More than 70 percent of the anthracite produced from undeground mines, strip mines, and culm banks was shipped to consumers outside the producing region. Glen Alden Corp., Hudson

Coal Co., Jeddo-Highland Coal Co., Number One Contracting Co., and Susquehanna Collieries Co. were the leading producers.

Luzerne County ranked second as a sand and gravel producing county in northeastern Pennsylvania.

Sand and gravel sold principally for use as building or paving material totaled 429,000 tons and was processed at seven plants.

Four sandstone producers operated quarries at Kingston, Dupont, Sweet Valley, and White Haven. The output was crushed and sold or used solely as road material.

Blue Ridge Soil Pep Co., Inc., recovered humus peat from a bog near White Haven. Pennsylvania Peat Moss, Inc., produced moss, reed-sedge, and humus peat from bogs near White Haven.

Clay mined near Hazleton was used in manufacturing buff brick by Hazleton Brick Co.

Lycoming.—Lycoming Silica Sand Co. produced limestone from the Lime Bluff quarry (Muncy) and the Pine Creek quarry (Jersey Shore). The stone was crushed and sized at local plants chiefly for use as road material. In addition, limestone from the Pine Creek quarry was crushed and sold for agricultural purposes. A new pneumatic mill was installed at the Pine Creek plant. Susquehanna Quarry Co. operated a quarry and portable plant near Jersey Shore to produce limestone for road material. Both companies sold stone to nearby Government agencies for road construction. The Keystone Filler & Manufacturing Co. Muncy plant crushed and ground slate for use as flour. Callahan & Haines Stone Co. (Slate Run) produced dimension miscellaneous stone for flagging and rubble.

Lycoming Silica Sand Co. (Montoursville) produced building and paving sand and gravel, molding and engine sand, sand for use in preparing anthracite, and gravel for railroad ballast. J. A. Eck & Sons, Inc., produced building and paving material in Montoursville.

Bituminous coal was produced from three underground mines and three strip mines (one more strip mine than was active in 1959). The entire production from the underground mines was produced by hand methods. At the strip mines, three power shovels and two draglines were used. None of the coal produced was mechanically cleaned.

Tripoli (rottenstone) was quarried by Penn Paint & Filler Co. at the Sheddy quarry (Muncy) and by Keystone Filler & Manufacturing Co. at the Ramsey quarry (Antes Fort). The crude material was crushed, dried, and ground for use as an abrasive and filler.

McKean.—Plastic and burley fire clays produced by Kness Brothers (Mount Jewett) were marketed for use in manufacturing foundry refractories. Kaul Clay Products Co. used plastic fire clay from its Kaul stripping operation near Clermont to manufacture hot tops for steel mills. Hanley Co. recovered clay from an open pit at Lewis Run for use at a local plant in making building brick and marketed a small quantity for the production of floor and wall tile.

Bituminous coal was produced from strip mines. Six power shovels, one dragline, and six bulldozers were used at the strip mines. None of the coal produced was mechanically cleaned.

C. L. McGavern, Jr., produced and shipped molding sand from a plant near Eldred.

Mercer.—Three underground and six strip mines were active; 97 percent of the bituminous coal came from the strip mines. Five cutting machines and one loading machine were used underground; all the output was cut by machine, and 26 percent was loaded mechanically. None of the coal was mechanically cleaned.

Sand and gravel output totaled 315,000 tons in 1960. Sand and gravel processed as building and paving material and for miscellaneous uses was transported to local markets by truck.

White Rock Silica Sand Co. (Greenville) quarried and crushed sandstone principally for use as furnace or converter linings, road material, and in foundries. The Rock Kastle quarry (north of Volant) was not operated during the year.

Mifflin.—The Pennsylvania Glass Sand Corp. McVeytown plant processed sand for industrial uses. In addition to molding and engine sand, Miller Silica Sand Co., Burnham, and George E. Miller Coal Co. and James R. Klines Sons, both near Lewistown, processed construction material.

Bethlehem Limestone Co. operated the Naginey quarry near Milroy and crushed limestone chiefly for use as blast-furnace flux, concrete aggregate, roadstone, and stone sand. Ehrenzeller Lime Co. (McVeytown) and Honey Creek Lime Co. (Reedsville) quarried and crushed limestone for manufacturing lime. Quartzite, for use in manufacturing silica brick, was quarried near Hawstone by Haws Refractories Co.

Honey Creek Lime Co (Reedsville) operated a 10-pot kiln and a continuous hydrator to produce hydrated lime for agricultural purposes. Ehrenzeller Lime Co. burned and sold quicklime as agricultural lime at its 7-draw-kiln plant near McVeytown.

Monroe.—Hamilton Stone Co. (Bossardsville) quarried and crushed limestone for use as concrete aggregate, roadstone, and asphalt fill.

Universal Atlas Cement Division of U.S. Steel Corp. produced white clay near Kunkletown for use at its cement plant.

Output of sand and gravel declined in 1960. Sand, the major product, was used chiefly in cement and ready-mixed concrete.

Montgomery.—Production of stone in Montgomery County exceeded 4 million tons, a 9-percent increase over 1959, and the county continued to rank second in stone production. Two operators, near Conshohocken and Norristown, produced crushed and broken limestone for use as concrete aggregate and roadstone. Two quarries, near Plymouth Meeting and Bridgeport, yielded limestone principally for blast-furnace flux, concrete aggregate, roadstone, agricultural purposes, and manufacturing lime. Limestone quarried and crushed at a quarry near West Conshohocken was used for manufacturing cement. Fifty-three percent of the limestone was transported by truck and the remainder by rail and unspecified means.

Basalt, recovered from quarries near Perkiomenville and Saratoga, was crushed and broken for use as road material. Montgomery Stone Co., Inc., Montgomeryville, produced dimension basalt as dressed structural stone and crushed basalt for road material. Dimension sandstone for use as rough architectural blocks and refractory linings in steel-producing furnaces was quarried near Glenside by Fire Stone Products Co. Irregular-shaped rough construction dimension sandstone was quarried by Wm. Bambi & Sons, Inc. (Norristown). Vec-

chione Bros. (Glenside) produced dimension sandstone as irregular-shaped rough construction stone and rubble. Irvin B. Gill (E. Norriton Township) produced crushed and broken sandstone for road material.

Mignatti Construction Co., Inc. (Bethayres), produced crushed granite for use as concrete aggregate and roadstone and a small quantity of dimension stone for use as rubble. Marcolina Bros., Inc., operated the Hill Crest quarry near Laverock to produce dimension granite, which was used for building retaining walls. A. Manero & Sons (Glenside) produced miscellaneous dimension stone (mica schist) for use as rough and dressed construction stone. Spring House Quarry (Spring House) and M. & M. Stone Co. (Harleysville) quarried miscellaneous stone (argillite) solely for road material.

Allentown Portland Cement Co. continued to operate its West Conshohocken No. 2 plant, using captive cement rock and limestone to manufacture Types I–II general-use and moderate-heat, air-entrained and non-air-entrained portland cements and some masonry cement. Three rotary kilns were operated. The material was shipped by rail, mostly in bulk, chiefly to ready-mixed concrete companies.

Lime production increased 5 percent in quantity, but decreased 2 percent in value. G. & W. H. Corson, Inc., produced mostly hydrated lime for building and chemical and industrial uses, agricultural lime, and some dead-burned dolomite for refractory use. Six shaft kilns and three continuous hydrators were operated to produce the material.

Production of fire clay and miscellaneous clay totaled 87,000 tons, compared with 66,000 tons in 1959. Miscellaneous clay produced by the Keller-Whilldin Pottery Co. (North Wales), Norristown Brick Co. (Norristown), and Philadelphia Brick Co. (Trappe) was used at local plants to produce art pottery, flowerpots, building brick, and other heavy clay products. Robinson Clay Products Co. produced both plastic fire clay and shale at Pottstown to make vitrified sewer pipe at a local plant. Robinson Clay added six new 40-foot kilns for increased production of wedge lock-joint clay pipe.

The William Bambi & Sons, Inc., plant in Norristown, produced building sand and gravel.

Perlite mined in California and Nevada was expanded by The Philip Carey Manufacturing Co. (Plymouth Meeting) and Refractory & Insulation Corp. (Port Kennedy).

Montour.—Crushed and sized limestone was produced at a quarry and plant east of Milton by Lycoming Silica Sand Co. for use as road material and for agricultural purposes. Limestone, for use as concrete aggregate and roadstone, was quarried near Danville by Mausdale Quarry Co. Both companies sold road material to the Pennsylvania Department of Highways and to local municipalities and townships.

Construction sand and gravel was produced at the Thomas Sand & Gravel Co. Danville plant.

Northampton.—Northampton County continued as the leading cement-producing area, although the quantity and value of shipments decreased 15 percent and 17 percent, respectively. Ten companies operated 12 plants and manufactured cement from captive limestone

and cement rock, and from purchased materials. General-use, moderate-heat and high-early-strength portland cements and masonry cement were produced. Most of the cement was shipped by rail in bulk, mainly to ready-mixed concrete companies and manufacturers of concrete products. Plant operations were near Martins Creek, Northampton, Bethlehem, Bath, Sandts Eddy, Nazareth, and Stockertown. Keystone Portland Cement Co. (Bath) increased its storage capacity to 115,000 barrels by installing six new silos. A change in regulations permitted truck shipments and many of the cement companies built truck loading docks and storage facilities for finished cement.

Although tonnage declined 15 percent and value decreased 20 percent, Northampton County continued to lead in stone production. Twelve firms produced limestone and cement rock from 13 quarries: 4 near Nazareth, 2 near Bethlehem, 2 near Northampton, and 1 each near Bath, Sandts Eddy, Martins Creek, and Stockertown. The stone was used mostly at company plants for manufacturing cement, and as concrete aggregate, and roadstone. Smaller quantities were sold or used as stone sand, railroad ballast, and for agricultural purposes.

Northampton County was again the principal source of slate; production increased 8 percent in quantity and decreased 5 percent in value compared with 1959. Slate was recovered from 11 mines; 6 near Pen Argyle, 2 near Bangor, and 1 each near East Bangor, Bath, and Wind Gap. The processed slate was used chiefly for structural and sanitary ware, blackboards, standard roofing, and flagging.

Output of sand and gravel reached a new high as producers processed and shipped over 425,000 tons of material. Production was expected to go higher in 1961 when a new plant built by Saucon Sand Co., Inc., near Hellertown is completed. The plant was designed to meet specifications for fine aggregate for highways.

Anthracite was recovered by dredging.

Northumberland.—Anthracite production totaled 2,355,000 tons and was 13 percent of the State production. Fifty-six percent of the quantity produced was shipped outside the producing area, 44 percent was sold locally, and a very small quantity was consumed as colliery fuel. Leading producers were Reading Anthracite Co., Sayre Contracting Co., and Susquehanna Collieries Co.

Demand for shale was 14 percent greater than in 1959. Shale produced by Watsontown Brick Co. and Glen-Gery Shale Brick Corp., Watsontown Division, was used exclusively for manufacturing building brick. Watsontown Minerals Products Co. used shale from stock as a linoleum filler.

Limestone quarried near Herndon and Sunbury was crushed for use as road material, for agricultural purposes, and lime manufacture. Some of the roadstone was sold to local Government agencies.

M. E. Wallace Co. transported its entire output of molding sand by railroad. Trucks were used to transport building sand and sand for fill from Wilson's Sand Plant near Montandon.

Clyde Starook (Northumberland) burned quicklime for agricultural purposes in a pot kiln, using anthracite as fuel. The lime was sold to local consumers.

Perry.—Bradford Hills Quarry, Inc. (Newport), quarried and crushed limestone at its local plant for use as road material. Some of the stone was sold to local Government agencies and the Pennsylvania Department of Highways for road construction.

Philadelphia.—Dredging along the Delaware River by The Liberty Corp. (Philadelphia) yielded sand and gravel for use as building material.

Crushed noncommercial granite for riprap was produced by crews of the Philadelphia County Bureau of Highways.

Potter.—Dimension sandstone as curbing stone, irregular-shaped rough construction stone, and rough architectural blocks was recovered from two quarries near Austin. Carroll M. Winseck (Roulette) quarried dimension miscellaneous stone for use as flagging, and rough and dressed construction stone.

Schuylkill.—Schuylkill County continued as the leading anthracite-producing county. Anthracite production totaled 6,936,001 tons, compared with the 7,930,166 tons in 1959. Underground mines, strip pits, and culm banks were operated during the year. The five leading producers were Honeybrook Mines, Inc., Newkirk Mining Co., Mammoth Coal Co., Gilberton Coal Co., and Reading Anthracite Co.

Huss Contracting Co. (Andreas) and Pennsylvania Aggregates, Inc. (Summit Station) quarried and crushed limestone for use as road material. Stone was transported to consumers by truck. Quartzite, quarried and crushed for use in manufacturing silica brick, was produced at the Andreas quarry (Andreas) by Harbison-Walker Refractories Co.

Refractory Sand Co., Inc., transported its output of fire and furnace sand and sand for paving by railroad and trucks.

Various producers supplied Lehigh Materials Co. with shale for use in its lightweight aggregate plants. Auburn Brick Co. used its entire output of miscellaneous clay to manufacture building brick.

Snyder.—Output of shale increased slightly over that of 1959. Glen-Gery Shale Brick Corp., Beavertown Division, and Paxton Brick Co. used shale mined from open pits near Beavertown and Paxtonville, respectively.

Anthracite was produced by dredging.

National Limestone Quarry, Middleburg, quarried and sold crushed limestone for road material and agricultural purposes. Carton L. Comfort, Mount Pleasant Mills, quarried and crushed limestone solely for use in manufacturing lime. Quicklime, sold for agricultural purposes was burned at the company's local 6-pot kiln plant.

Central Builders Supply Co. processed and sold building sand and gravel from its stationary plant near Selinsgrove.

Somerset.—Somerset County again had the greatest number (101) of underground bituminous coal mines (2 less than in 1959). Underground production totaled 910,000 short tons; 84 percent was mechanically cut, and 51 percent was mechanically loaded, using 129 cutting machines and 82 loading machines. Approximately 16 percent of the output was mechanically cleaned, using wetwashing and pneumatic methods. Seventy-three power shovels and 31 draglines were used to produce 1.2 million tons of strip coal at the 43 active strip mines. One auger mine also was active in 1960, one less than in 1959.

Production of fire clay totaled 96,000 tons and was 18 percent higher than in 1959. Manufacturers used fire clay produced from two underground mines and three open-pit operations, mainly for refractories such as sleeves, nozzles, stoppers, and firebrick and block.

Keystone Lime Co. (Springs) quarried and crushed limestone locally for use as concrete aggregate and roadstone and for agricultural purposes. Somerset Limestone Co., Inc. (Bakersville), quarried and crushed limestone solely as road material.

Two plants near Boswell produced sand for general purposes. A third producer, near Springs, produced building sand and gravel for use in concrete products.

Sullivan.—Anthracite, the only mineral produced in the county, was mined underground and from strip pits. Output of anthracite increased substantially over that of 1959; however, the average value per ton declined from $8.69 in 1959 to $8.37 in 1960.

Susquehanna.—Dimension sandstone (bluestone) was quarried and sold or used mostly as flagging; smaller quantities were used for irregular-shaped rough construction stone and rubble. Seven quarries were operated near Springville, Kingsley, New Milford, Lakeside, Harford, and Brooklyn Township. Near Clifford crushed and broken sandstone for road material was recovered from the Bennett's quarry by Keelor Supply Co., Inc.

A small quantity of anthracite was produced.

Tioga.—Three underground mines and six strip mines produced bituminous coal. Sixteen power shovels and nine draglines were used at the strip mines.

Lyle R. Robinson (Elk Township) quarried dimension sandstone chiefly as flagging, and a small quantity for rubble.

Union.—Crushed limestone used mainly for concrete aggregate and roadstone was quarried near Mifflinburg and Winfield. Some roadstone was sold under contract to the Pennsylvania Department of Highways and to nearby townships and boroughs.

Venango.—Bituminous coal production from 11 strip mines (2 less than in 1959) totaled 588,000 short tons. Four draglines and 13 power shovels were used at the strip mines. Sixty-seven percent of the coal mined was mechanically cleaned, using jigs.

The Industrial Silica Division of the Pennsylvania Glass Sand Corp. produced molding sand and fire and furnace sand at its Venango works. Mrs. Ralph Vincent of Cambridge Springs, using portable equipment, processed bank-run gravel for sale to townships, boroughs, and builders. Oil City Sand & Gravel Co. dredged material near Oil City and processed it for sale as building and paving sand and gravel.

Warren.—Sand and gravel dredged by General Concrete Products Corp. was processed for use as building and paving material. Nelson & Ellberg produced construction sand and gravel at its plant near Warren.

Washington.—Washington County led in value of mineral output in the State; coal was the major commodity produced. Washington County led in both total and underground production of bituminous coal. Twenty-one underground mines produced 9.9 million short tons of coal. Virtually all the coal mined underground was mechanically cut and mechanically loaded. Twenty-two strip mines, one more than

in 1959, produced 991,000 short tons of coal. Ten draglines, 37 power shovels, and 48 bulldozers were used at the strip mines. Most of the coal mined and coal shipped in from Greene and other counties was mechanically cleaned. Maple Creek mine of U.S. Steel Corp. was reported to be the first underground mine to use alternating current in the State to power continuous mining equipment.

Limestone for concrete aggregate and roadstone was quarried near Washington by Westmoreland Clay Products Co.

Combined output of miscellaneous clay by Westmoreland Clay Products Co. (Washington) and Monongahela Clay Products, Inc. (Monongahela), was 29,000 tons, 28 percent less than in 1959. The entire quantity was used in manufacturing building brick. Donley Brick Co. produced red shale from its open pit near Washington. The Haas Refractories Co. completed major alterations required to convert its Canonsburg plant (formerly known as the W. S. George Pottery Co.) from producing pottery to manufacturing pouring-pit refractories.

Wayne.—Paul Thompkins Estate, W. R. Strong, and Walter C. Blum (Lookout) reported output of dimension sandstone chiefly for flagging. Wayne Concrete & Sand Works, Inc. (Lake Ariel), produced and sold crushed and broken sandstone solely for road material. Some noncommercial sandstone was produced for road material.

Wayne Peat Moss Co. recovered humus peat from bogs at the southern tip of the county near Gouldsboro.

Most of the anthracite produced was sold locally.

Willis R. Black supplied farmers in the area with building sand and gravel and gravel for fill.

Westmoreland.—Forty-eight underground bituminous coal mines, 20 strip mines, and 2 auger mines were active. Almost all the bituminous coal mined underground was cut and loaded mechanically. A total of 22 power shovels and 3 draglines were used at the strip mines to produce 252,000 tons of coal.

Penn Aggregates (Jeannette) produced crushed limestone solely for road material, and sold stone to the Pennsylvania Department of Highways for road construction. John C. Beaumont and Ray Brant-hoover (both near Belle Vernon) quarried dimension sandstone for rubble. Four producers operated quarries near Ligonier, Greensburg, and Baggaley to produce crushed and broken sandstone solely for road material. J. G. Robinson, Inc., produced and sold or used dimension sandstone for use as flagging. Dimension miscellaneous stone quarried at Lynn's Quarry, Belle Vernon, also was used as flagging.

York.—Medusa Portland Cement Co. remained the only cement producer in the county. Six rotary kilns were operated at the York plant to produce waterproof white and gray portland cements and mortar cement. The cement was shipped by rail, mostly in bulk, to ready-mixed concrete companies and manufacturers of concrete products. A new finish mill was completed in anticipation of enlarged production capacity.

Due to decreased tonnage and value (19 percent and 13 percent, respectively), York County dropped from third in 1959 to fourth in stone production. Limestone was quarried at 10 operations: 7

near York, and 1 each near Mount Wolf, Wrightsville, and Thomasville. The chief uses for the stone were as concrete aggregate, roadstone, lime and cement manufacture, and open-hearth and blast-furnace flux. Smaller quantities were sold or used for agricultural purposes and as railroad ballast. Slate was crushed and ground at the Delta plant of Funkhouser Mills, Division of The Ruberoid Co., and marketed as natural granules and flour. Some of the slate flour was exported.

York County ranked second in value of lime production, but tonnage and value decreased slightly compared with 1959. J. E. Baker produced dead-burned dolomite for refractory material at its York plant. Shipments were mostly to points in Pennsylvania, Maryland, Ohio, and Delaware, but some of the material was exported.

Combined output of three companies totaled 280,000 tons of sand and gravel. It was 33 percent below the high established in 1959.

Medusa Portland Cement Co. produced miscellaneous clay for its own use. Shale produced by the York Colonial Division, Glen-Gery Shale Brick Corp., was used to manufacture building brick.

General Mining Associates (Glenville) was the only mica producer in the State. The fine mica (sericite) schist was processed by drying and air separation and was used for filler purposes.

Pennsylvania Perlite Co. (York) expanded perlite shipped from Colorado.

615629—61——57

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 for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.

By Clinton Knox,[1] Leovigildo Vázquez,[2] and R. Y. Ashizawa [3]

PUERTO RICO

MINERAL production in Puerto Rico in 1960 was valued at $29.5 million, an increase of $9.8 million, or 50 percent, over 1959. A large part of the apparent gain was due to improved coverage of the mineral producers in Puerto Rico. Increases in cement, sand and gravel, and stone production offset decreases in clay, lime, and salt production. No metals or mineral fuels were produced.

Imports of mineral fuels, metals, and many other raw mineral materials used in oil refineries, steel mills, copper fabricating plants, and other plants manufacturing petrochemicals, fertilizers, ceramics, glass, cement, machinery, and hardware continued to increase in 1960, paralleling the rapidly expanding economy of the Commonwealth. About 65 percent of the total value of mineral imports was from the United States and 35 percent from foreign countries.

Exports from Puerto Rico in 1960 totaled $646 million compared with $503 million in 1959. Exports of minerals and products manufactured from minerals accounted for nearly 25 percent of the 1960 total or $161 million, of which 80 percent went to the United States and 20 percent to foreign destinations. Cement shipments to the United States and foreign countries declined in 1960, whereas Puerto Rican consumption increased.

The rate of increase in net income of mineral industries in Puerto Rico from 1955 to 1959 [4] was projected through 1960 at approximately the following rates: Mining 18 percent; stone, clay, and glass products 13 percent; machinery and other metal fabrications 5 per-

[1] Mine examination and exploration engineer, Bureau of Mines, Bartlesville, Okla.
[2] Geologist, Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.
[3] Statistical assistant, Bureau of Mines, San Francisco, Calif.
[4] Puerto Rico Statistical Yearbook—1959, Puerto Rico Planning Board, Bureau of Economics and Statistics, Office of the Governor, 190 pp.

TABLE 1.—Mineral production in Puerto Rico [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand, 376-pound barrels	5,392	$16,982	5,441	$14,546
Clays—thousand short tons	167	83	160	102
Lime—do	10	321	1	15
Salt—do	3	38		
Sand and gravel—do	530	888	8,996	8,669
Stone—do	2,063	2,878	4,219	7,661
Total Puerto Rico [2]		19,700		29,530

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Total adjusted to eliminate duplicating value of clays and stone.

cent; construction 15 percent; and petroleum refinery products and chemicals 9 percent.

Exploration for petroleum continued along the north and south coasts on large concessions previously granted by the Puerto Rico Mining Commission. Prospecting and exploration for copper, iron, gold, and molybdenum continued in the Island's interior mountains.

During 1960, Kewanee Inter-American Oil Co. completed drilling of the first three exploratory wells on the south coast and one well on the north coast but no oil discoveries were announced. Total drilling in the four completed wells amounted to 22,978 feet on concessions which aggregated about 2,500 square miles.

Three of five mining companies, holding grants of metallic mineral prospecting concessions aggregating some 4,200 square miles, reported activities on their extensive programs of diamond core drilling, surface trenching, and geological, geophysical, and geochemical surveys. Exploration work on the other two grants, recessed through 1960, was to be resumed in 1961. A sixth mining company planned an exploration project on a concession of about 1,200 square miles acquired and prospected after mid-1960.

Cooperative work by the Puerto Rico Economic Development Administration (PREDA) and the Federal Geological Survey resulted in publication of results obtained by core drilling and geologic mapping at the Keystone iron mine near Juncos.[5] The Geological Survey, working under a cooperative agreement with PREDA, completed geologic mapping of 16 quadrangles and started mapping 5 more. During 1960, geologic maps and reports on the Comerío,[6] Cayey,[7] and Central Aguirre [8] quadrangles and a series of six short papers [9] concerning research on certain geologic features of Puerto Rico, were published.

[5] Vázquez, Leovigildo, 1960, Geology and ore deposits of the Keystone iron mine near Juncos, P.R., Department of Industrial Research, Puerto Rico Economic Development Administration, Bull. 7, 29 pp. and map.
[6] Pease, M. H., Jr., and Briggs, P. R., Geology of the Comerío Quadrangle, P.R.: Geol. Survey Misc. Geol. Inv. Map I–320, 1960.
[7] Berryhill, H. L., Jr., and Glover, Lynn, 3d, Geology of the Cayey Quadrangle, P.R.: Geol. Survey Misc. Geol., Inv. Map. I–319, 1960.
[8] Berryhill, H. L., Jr., Geology of the Central Aguirre Quadrangle, P.R.: Geol. Survey Misc. Geol. Inv. Map I–318, 1960.
[9] Geological Survey, Short papers in the Geological Sciences: Geol. Survey Prof. Paper 400–B, 1960, pp. 356–371.

TABLE 2.—Portland cement produced and shipped in Puerto Rico

Year	Production (barrels)	Shipments	
		Barrels	Value (thousands)
1951–55 (average)	3,955,506	3,946,425	$10,655
1956	4,234,284	4,254,701	14,065
1957	5,500,553	5,552,357	17,232
1958	4,861,862	4,747,976	15,175
1959	5,324,188	5,392,312	16,982
1960	5,415,086	5,441,497	14,546

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments from the plants of Ponce Cement Corp. in the Ponce District, and Puerto Rico Cement Corp. in the San Juan District, accounted for nearly 50 percent of the value of all Puerto Rico mineral production in 1960. The combined output of the plants, producing only portland cement by the wet process, averaged 90 percent of rated capacity. Of 5.4 million barrels, 57 percent was shipped in bulk and 43 percent in bags. Total shipments increased 1 percent over 1959, but total value decreased 15 percent. As a result of construction gains in Puerto Rico during 1960, consumption by the building trades, cement products manufacturers, ready-mix concrete plants, and governmental agencies increased about 10 percent over 1959. In addition to consuming 73 percent, or 4 million barrels, of the domestic production, Puerto Rico imported about 400,000 barrels. About 25 percent of the 1960 cement production was exported to Florida and 2 percent to foreign countries. Except for gypsum, imported from the nearby Dominican Republic, all cement raw materials were mined near the plants of the two manufacturers.

Clays.—Most of the clay production was used in manufacturing cement. A small amount of clay was used in studio potteries and much of the production from deposits near Carolina in San Juan District was used in manufacturing heavy clay products. The total clay used by the two cement manufacturers and the clay products plant was about 4 percent less than the 1959 output. Several million tons of clay used in swamp reclamation, new highways, and other projects was not reported.

The PREDA Mineralogy and Geology Section, Industrial Research Laboratories, published the results of research on clays suitable for making lightweight aggregate.[10] The Federal Geological Survey published a paper[11] on occurrences of bauxitic clay in north-central Puerto Rico giving results of exploratory work done in cooperation with PREDA.

Lime.—South Puerto Rico Sugar Co. operated its limestone quarry and kiln in the southern part of the Mayaguez District about 3

[10] Cadilla, José F., A clay for a lightweight aggregate: Mineralogy and Geology Section, Department of Industrial Research, Puerto Rico Economic Development Administration, Technical Report, June 30, 1960, 62 pp.

[11] Hildebrand, F. A., Occurrences of Bauxitic Clay in the Karst Area of North-Central Puerto Rico, Geological Survey Research 1960—Short papers in the Geological Sciences, U.S. Geol. Survey Prof. Paper, 400–B, pp. B–368–371.

months to replenish its lime stocks for sugar refining and to supply the small market for chemical and sanitation needs of neighboring communities. Numerous sugar refineries and chemical, building, and other lime-consuming industries reportedly resorted to imports in 1960, owing to the increased cost of producing lime in Puerto Rico.

Salt.—Production of salt was negligible because of unseasonable rains during the late summer, when salt ordinarily is harvested. The three producers along the southern coast of the Mayaguez District obtained salt by solar evaporation of sea water in earthen pans. Late in 1960, Ponce Salt Industries Corp. developed facilities for producing about 60 tons of refined salt daily. The company planned to use the salt as raw material in a caustic soda and chlorine plant, beginning in 1961.

Sand and Gravel.—About 50 suppliers of sand and gravel in Puerto Rico were listed during a brief field survey in November 1960. Annual productive capacity of over 500,000 tons each was observed at some of the largest operations. As in previous years of increasing industrialization and construction in the Commonwealth, about 1 percent of the producers reported 1960 output. The production of the only large-scale operator that reported amounted to about 500,000 tons of sand and gravel, all sold as concrete aggregate. For a realistic figure, the 1960 sand and gravel production was estimated to total 9 million tons. The estimate is a composite of computations based in part on production reports and on consumption, employment, and other data obtained from private and governmental sources, and in part on field observations at representative operations and pertinent construction projects. Indexed to 1960 Puerto Rican cement consumption—about 4.4 million barrels after accounting for imports, domestic production, sales, exports, and stocks—at least 6.3 million tons of aggregate was used in concrete in the unprecedented 1960 building construction, highway, city, and airport paving projects, and emergency reconstruction programs in the wake of Hurricane Donna in September 1960. Sand and gravel comprised an estimated 80 percent, or 5 million tons of the concrete aggregate; the balance of about 1.3 million tons was crushed stone added to meet concrete specifications. The remaining 4 million tons of the production estimate was largely the excess sand from the numerous deposits worked along river valleys and from beaches. In addition to building plaster, the principal uses for sand were in fills; asphalt paving and road base; vertical drainages in swamp reclamation; slum clearance; airport expansion projects; grading access areas in the large Federal forest reservations, parks, and numerous U.S. Defense Department establishments in Puerto Rico; and for improving Commonwealth beaches and parks. Total sand and gravel production was estimated to have exceeded the 1959 output by about 10 percent. No sand and gravel was imported or exported.

Silica sand from deposits in the north central part of Puerto Rico was produced primarily for use in the nearby cement and glass plants, but unreported lesser amounts were consumed in potteries and foundries, and as an abrasive in commercial sand-blasting and marble-polishing operations. Puerto Rico Glass Corp. doubled its capacity by expanding silica sand washing, magnetite-separating,

and storage facilities late in 1960. Feldspar and other raw materials used in making glass were imported.

Stone.—Limestone, classified as marble in many of the deposits, was produced in all seven districts. Andesite, tuffaceous siltstone, and other volcanic stone was produced in Mayaguez, Aguadilla, Ponce, and San Juan Districts; granitic rock, in Humacao District. Except for small quantities of dimension limestone or marble, and some siltstone intermittently produced for building veneering, the stone output was about 83 percent crushed limestone and the rest granitic and miscellaneous stone. The two cement companies reported the largest production, totaling about 1.5 million tons of crushed limestone used in cement manufacture. South Puerto Rico Sugar Co. quarried and crushed limestone for lime making and one office of the Puerto Rico Land Authority reported production of agricultural limestone. Output of crushed limestone for concrete aggregate and road base was reported from quarries of the Arecibo and Humacao Districts of the Puerto Rico Department of Public Works. Other governmental agencies producing or using stone and about 80 commercial suppliers of stone were listed during a brief field survey in November 1960. Rated capacities at some of the stone quarries and crushing plants were observed to range up to 1,500 tons per day. Most of the smaller producers, however, operated only intermittently. The 1960 stone production was estimated to total 4.2 million tons. The total included 1.5 million tons of crushed limestone used for cement and an estimated 1.3 million tons of crushed limestone, granite, and miscellaneous stone for concrete aggregate. The additional 1.4 million tons was estimated in part on production reports and consumption, employment, and other data obtained from private and governmental sources, and in part on field observation at representative production operations and pertinent construction projects. A small output of dimension stone was used in buildings and in improving docks and harbors. The use of crushed stone was evidenced at new highway and airport expansion projects and in the emergency repair of hurricane damage. Based on estimates for both years, 1959 stone production was about 5 percent under 1960. Except for minor imports of monumental stone, Puerto Rico did not import or export stone.

TABLE 3.—Stone sold or used by producers in Puerto Rico

Year	Dimension limestone		Crushed limestone[1]		Miscellaneous stone		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1956	75,168	$143	2,001,285	$2,413	----------	----------	2,076,453	$2,556
1957	178,619	356	2,225,139	3,085	48,261	$64	2,452,019	3,505
1958	148,146	281	1,777,656	2,352	60,000	135	1,985,802	2,768
1959	10,322	23	1,980,840	2,693	72,000	162	2,063,162	2,878
1960	36,941	87	3,474,462	5,938	[2] 708,080	1,636	4,219,483	7,661

[1] Includes limestone for cement and lime.
[2] Includes crushed granite, andesite, and tuffaceous siltstone.

MINERAL FUELS

The oil refineries of Caribbean Refining Co. in Catano, San Juan District, and Commonwealth Oil Refining Co. in Guayanilla, Mayaguez District, continued to operate near capacity on imported crude oil. Their combined refining capacity was 94,500 barrels a day. Caribbean Refining Co. planned a $2.5 million plant expansion for early 1961. Large steam power plants of the Puerto Rico Water Resources Authority and petrochemical and other manufacturing industries near the refineries required many of the petroleum products.

The Penuelas (Mayaguez District) ethylene glycol plant of Union Carbide Caribe, Inc., processed raw ethylene from the nearby refinery of Commonwealth Oil Refining Co. Union Carbide Caribe, Inc., acquired 435 acres adjoining the Penuelas plant and began constructing a $30 million polyethylene plastic plant. Completion of the 700-million-pound-a-year plant was scheduled for mid-1962. Caribbean Alkali Corp., affiliate of Wyandotte Chemicals Corp., was constructing a $1 million electrolytic chlorine and caustic soda plant in Penuelas. Initial production was expected about mid-1961.

Early in 1960, Caribe Nitrogen, Inc., a unit of W. R. Grace & Co., acquired the large plant of Gonzales Chemical Industries, Inc., near Guanica Bay, Mayaguez District. Products of the plant were anhydrous ammonia, ammonium sulfate, and fertilizers.

In accordance with the plan to double the Commonwealth's previous 368,920 kilowatts of electrical power generating capacity by 1964, Puerto Rico Water Resources Authority put in operation two 82,500-kilowatt generating units of the new Palo Seco thermoelectric plant in the San Juan District. In Rincon, south of Ramey Air Force Base, Aguadilla District, the U.S. Atomic Energy Commission, jointly with the Puerto Rico Water Resources Authority, started construction of the first Latin American nuclear power plant. Completion of the $11 million plant was scheduled for late 1962. The plant will provide an additional 16,300 kilowatts of electrical generating capacity. The boiling water reactor will be fueled with uranium dioxide.[12]

METALS

Siderurgica Industrial, Inc., Catano, San Juan District, Puerto Rico's only steel mill, continued to produce steel reinforcing bars from domestic and imported scrap. The company announced that plant expansion, scheduled for completion in late 1961, would increase production of steel reinforcing bars from 20,000 to 65,000 tons a year. New York and San Juan interests announced that a newly formed organization, The Danrich Steel Co., Inc., would complete construction of a $3 million steel mill in Bayamon, San Juan District, in September 1961. Domestic and imported scrap would be used for the anticipated yearly production of about 25,000 tons of steel reinforcing bars for the growing construction market.

[12] Chemical and Engineering News, vol. 38, No. 4, Jan. 25, 1960, p. 33.

TABLE 4.—Value of mineral production in Puerto Rico by Districts

District	1959	1960	Minerals produced in 1960 in order of value
Aguadilla	$172,992	$1,090,308	Stone, sand and gravel.
Arecibo	22,751	803,509	Do.
Guayama	58,092	1,293,479	Do.
Humacao	547,670	643,580	Sand and gravel, stone.
Mayaguez	324,920	3,419,346	Sand and gravel, stone, lime.
Ponce	12,324,371	12,134,501	Cement, sand and gravel, stone, clays.
San Juan	6,169,795	9,910,510	Do.
Various	79,270	234,524	Stone.
Total	19,700,000	29,530,000	

PANAMA CANAL ZONE[13]

A 10-percent decrease in basalt production in the Panama Canal Zone was more than offset by an increase of 50,000 tons in sand and gravel output. Approximately 6 million cubic yards of clay, shale, sandstone, basalt, and other rock in the channel and hillsides was bench-quarried for the Panama Canal Co. during enlargement of the Canal from 300 to 500 feet in width and from 45 to 50 feet in depth through the Gaillard cut.[14]

VIRGIN ISLANDS[15]

Basalt in the Virgin Islands was quarried and crushed for concrete aggregate, roadstone, and other uses at a rate about equal to 1959. The U.S. Department of the Interior, in mid-1960, contracted for construction of a $2.5 million saline water conversion and electric turbogenerating plant in St. Thomas. The plant should be completed by mid-1961.

TABLE 5.—Mineral production in the Panama Canal Zone and Virgin Islands[1]

Mineral	1959		1960	
	Short tons	Value	Short tons	Value
Canal Zone:				
Sand and gravel	14,392	$20,500	65,000	$68,149
Stone[2]	223,348	270,085	203,355	305,914
Total Canal Zone		290,585		374,063
Virgin Islands: Stone (basalt)	14,429	50,616	14,895	51,287

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

[13] Prepared by Clinton Knox.
[14] Kincaid, C. G., Widening the Panama Canal: Compressed Air Mag., April 1961, pp. 10–11.
[15] Prepared by Clinton Knox.

TABLE 6.—Sand and gravel sold or used by producers in the Panama Canal Zone

Year	Short tons	Value
1951–55 (average)	42,085	$44,346
1956	40,095	48,673
1957		
1958	41,006	34,616
1959	14,392	20,500
1960	65,000	68,149

TABLE 7.—Crushed basalt and miscellaneous stone sold or used by producers in the Panama Canal Zone

Year	Short tons	Value
1951–55 (average)	134,068	$196,040
1956	177,250	229,750
1957	59,407	98,897
1958	140,464	236,848
1959	223,348	270,085
1960	203,355	305,914

TABLE 8.—Crushed basalt sold or used by producers in St. Croix Island, Virgin Islands

Year	Short tons	Value
1951–55 (average)	[1] 5,021	$21,647
1956	11,591	31,983
1957	11,500	31,000
1958	25,296	80,586
1959	14,429	50,616
1960	14,895	51,287

[1] Includes miscellaneous stone.

PACIFIC ISLAND POSSESSIONS [16]

REVIEW BY ISLANDS

American Samoa.—Substantial quantities of basalt and coral limestone were quarried and crushed by crews of the Government of American Samoa in 1960. Although some of the material was used as riprap and as concrete aggregate for roads and buildings, a far greater tonnage was used as fill.

Guam.—A multimillion-dollar project for extending the runway, taxiways, and parking aprons at an airfield near Agana, as well as other construction activities including roads, storage facilities, and Capehart housing, required large quantities of base course, concrete aggregate, and riprap material in Guam during 1960. Government crews and contractors and commercial producers quarried coral limestone by drilling and blasting. They also used either rippers and bulldozers or mechanical shovels to work deposits of well indurated coral sand known locally as "Sugar Coral." A small tonnage of beach sand was used by crews of the Public Works Department, Government of Guam, for road maintenance and fill.

[16] Prepared by R. Y. Ashizawa.

TABLE 9.—Mineral production in the Pacific Islands possessions

Area and mineral	1959		1960	
	Short tons	Value	Short tons	Value
American Samoa: Stone (crushed)	177,977	$219,091	523,161	$260,798
Canton:				
Sand	70	63	----	----
Stone (crushed)	434	585	----	----
Total	----	648	----	----
Guam:				
Sand	28,372	19,860	965	965
Stone (crushed)	567,657	1,109,496	961,818	2,193,557
Total	----	1,129,356	----	2,194,522
Johnston:				
Sand	----	----	1,300	3,800
Stone (crushed)	----	----	1,500	5,000
Total	----	----	2,800	8,800
Wake: Stone (crushed)	31,750	34,152	36,200	48,870

Johnston.—Crushed coral limestone and coral sand were used for concrete aggregate by a Government contractor during construction of the U.S. Coast Guard's LORAN (Long Range Navigation) Station at Johnston.

Midway.—Stockpiles of coral limestone quarried and processed in previous years were used for construction and maintenance purposes at Midway.

Wake.—More than 36,000 tons of coral limestone was quarried and processed by Government crews and contractors for building and road construction, and for paving the new aircraft taxiway and parking and fueling aprons at Wake.

Other Pacific Island Possessions.—No mineral production was reported for 1960 on the Islands of Canton, Enderbury, Jarvis, and Palmyra.

The Mineral Industry of Rhode Island

By Joseph Krickich [1]

MINERAL production in Rhode Island set a new record in 1960. The value of $5.7 million, more than doubled the previous record set in 1959. The high level of mineral output resulted mainly from constructing breakwater facilities at Newport, where 1.4 million tons of granite riprap was used. A new quarry was developed exclusively to supply the material.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Graphite.—Graphite Mines, Inc., discontinued production of natural amorphous graphite from a former meta-anthracite underground mine at Cranston. The deposit was not depleted, but the property was being converted to a housing development. Production was suspended in March 1959 after a roof-fall fatality in the mine.

Sand and Gravel.—Output of sand and gravel totaled 1.5 million tons, a 12-percent drop from 1959. Commercial output declined mainly because of less demand for paving material. Production by Government-and-contractor operations dropped from 124,000 tons in 1959 to 19,000 tons in 1960. Building sand and gravel supplied 45 percent of the State output. Paving material furnished 30 percent of the total output, compared with 45 percent in 1959. In ad-

TABLE 1.—Value of mineral production in Rhode Island, by counties [1]

(Thousand dollars)

County	1959	1960	Minerals produced in 1960, in order of value
Kent	1,180	(2)	Sand and gravel.
Newport	17	3,528	Stone, sand and gravel.
Providence	1,015	1,445	Do.
Washington	121	(2)	Sand and gravel, stone.
Undistributed		754	
Total	2,333	5,727	

[1] No production reported from Bristol County.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.

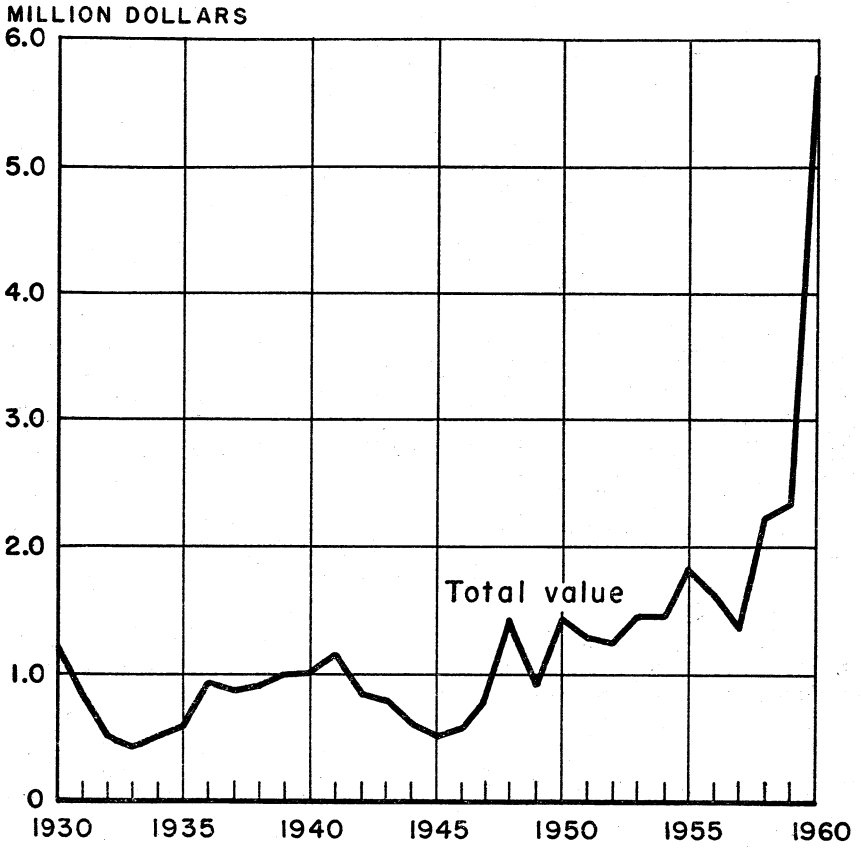

FIGURE 1.—Total value of mineral production in Rhode Island, 1930–60.

dition, quantities of sand as fill, molding sand, and sand and gravel for miscellaneous uses were produced. The average value per ton of commercial sand and gravel dropped from $0.93 in 1959 to $0.89 in 1960. Of the State's total output, 78 percent was processed material, compared with 70 percent in 1959. The number of commercial producers increased from 21 to 26; two had portable operations. An average of 145 production employees worked daily for a total of 237,000 man-hours. Five lost-time injuries were reported. The State's commercial plants in 1960 produced an average of 51 tons per man-shift compared with 59.8 tons the preceding year. Less than 1 percent of the commercial production was shipped by rail; the remainder was transported by truck.

Stone.—Over 1.8 million tons of stone valued at $4.4 million was produced in 1960—the highest production of stone on record. The sharp increase was due chiefly to development of a new granite quarry in Newport County for producing riprap used for constructing a breakwater on a Government project. In addition to granite, the quantity and value of limestone and miscellaneous stone produced also increased. Limestone used mainly as agstone was produced in

Providence County. Miscellaneous stone was quarried in Providence and Newport Counties and was used chiefly as concrete aggregate and roadstone. Production of crushed granite in Providence County was higher than in 1959. About the same quantity of dimension granite was produced in Washington County for construction and monumental purposes as in 1959. Dimension granite quarried in Massachusetts and other States was processed and fabricated at a yard in Providence County. A daily average of 83 production employees worked a total of 144,000 man-hours at the State's 6 stone quarries. No lost-time injuries were reported.

METALS

Washburn Wire Co. produced basic steel at four open-hearth furnaces at Philipsdale. Pig iron, scrap iron and steel, ferroalloys, and other raw materials were obtained from other States for consumption at the plant, which had a rated annual capacity of 93,000 tons of steel ingots. Cold-rolled strip steel was produced at two plants at Pawtucket. Combined capacity of these plants was 32,000 tons. Ferrous scrap dealers were active chiefly in Providence, Newport, Westerly, and Pawtucket. Shipments of scrap from their yards consisted mainly of Nos. 1 and 2 heavy melting steel, bundles, and cast iron scrap other than borings. Pig iron, pig lead, solder, babbitts, and caulking leads were smelted and refined at a plant near Providence from nonferrous scrap. Numerous foundries throughout the State produced aluminum, brass, bronze, gray iron, malleable and other castings.

REVIEW BY COUNTIES

Sand and gravel was produced under contract only in Providence County for the State of Rhode Island, Division of Roads and Bridges, Department of Public Works. Output was substantially below the previous year's level.

Kent.—Kent County again ranked second as a sand and gravel producing area despite inactivity of Government-and-contractor producers in the county. Although tonnage and value were below 1959 figures, the county continued to supply over one-third of the State sand and gravel production. Four commercial producers were active during the year. The output was used mostly for paving and building purposes. Molding sand was produced by Rhode Island Sand and Gravel Co., Inc., Warwick; and Whitehead Brothers Co., Washington. Other producers who operated stationary plants were Luigi Vallone, Inc., Warwick; and Barber Sand and Gravel, Coventry.

Newport.—Owing to the development of a new granite quarry by M. A. Gammino Construction Co. at Tiverton, the value of the county mineral output was a record high, even surpassing the previous State record for value of mineral output. The company produced 1.4 million tons of random and select riprap valued at $3.5 million for use at the U.S. Naval Base at Newport in constructing a breakwater. To facilitate transporting the stone, the company constructed a $400,000 loading dock, from which the stone was loaded onto a specially

designed scow which transported the material to the construction site. The company employed 35 men at the quarry.

Peckham Bros. Co., Inc., produced conglomerate stone and paving sand and gravel near Middletown. The stone was crushed for use as concrete aggregate and roadstone.

Providence.—Production of sand and gravel by commercial producers in the county decreased 17 percent compared with 1959; Government-and-contractor production declined 68 percent. Eighty-one percent of the commercial sand and gravel was washed, screened, or otherwise prepared; all of the Government-and-contractor material was processed. The sand and gravel was used mostly in highway building and maintenance and in construction of buildings. Principal producers were A. Cardi Construction Co., Inc., and Del Bonis Sand and Gravel Co., both of Cranston; L. Romano Construction Co., East Providence; Foster Sand and Gravel Co., Inc., Foster; Cormier Sand and Gravel, Inc., Lincoln; Courtois Sand and Gravel Co., Pawtucket; Joseph Santoro, and Valley Cement Block Co., both of Providence; Tasca Sand and Gravel Co., Smithfield; and Town Line Sand and Gravel, Slatersville.

M. A. Gammino Construction Co. continued development of its new quarry at Cranston. The company crushed stone and processed the material by wet-washing for use exclusively as concrete aggregate and roadstone. Low-magnesium limestone was quarried near Lincoln by Conklin Limestone Co., Inc. Output was used mainly for agricultural purposes; limited quantities were sold as blast-furnace flux, fertilizer filler, roofing gravel, and cast stone aggregate. Fanning and Doorley Construction Co., Inc., produced crushed and broken granite near Berkeley for riprap, concrete aggregate, and road material. Providence Granite Co. processed and fabricated building and architectural granite and granite for curbing at its yard in Providence. The company used granite quarried in Massachusetts by a subsidiary company as well as stone shipped from other States and foreign countries. Production of natural amorphous graphite at the Cranston mine of Graphite Mines, Inc., was discontinued and the mine was abandoned. The property was to be used for a housing development.

Washington.—Sand and gravel used mainly in road construction and maintenance and consisting primarily of processed material was produced by South County Sand and Gravel Co., Washington; Louis B. Schaeffer, Peace Dale; and J. Romanella and Sons, Westerly. Westerly Granite Corp., Bradford, quarried granite for rough construction work and monumental purposes. Oscar Larson quarried dimension granite for construction work at Hopkinton.

The Mineral Industry of South Carolina

This chapter has been prepared under a cooperative agreement for collecting mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey.

By Lawrence E. Shirley [1] and Laurence L. Smith [2]

RECORD PRODUCTION of crushed limestone, masonry cement, clays, feldspar, crushed sandstone (quartz), peat, and vermiculite highlighted the mineral industry of South Carolina in 1960. Total mineral output in the State decreased 2 percent and was $597,000 less than 1959. Leading commodities, in order of total value, were crushed granite, cement (masonry and portland), clays (kaolin and miscellaneous), sand and gravel, crushed limestone, and vermiculite; these six commodities accounted for 99 percent of the total value of mineral production in 1960.

South Carolina again ranked second in the Nation in output of kaolin, kyanite, and vermiculite. Leading companies mining and processing minerals were Carolina Giant Division of Giant Portland Cement Co. (portland and masonry cement, clays, and limestone); Campbell Limestone Co. (crushed granite and limestone); J. M. Huber Corp. (kaolin); Becker County Sand & Gravel Co. (sand and gravel); and Zonolite Co. (vermiculite).

TABLE 1.—Mineral production in South Carolina [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,160	$5,920	1,297	$6,201
Gem stones	(2)	(2)		
Mica (sheet)—pounds	251	3	101	1
Peat—short tons	4,194	(4)	(4)	(4)
Sand and gravel—thousand short tons	3,105	3,077	3,029	3,048
Stone [5]—do	6,248	8,647	5,994	8,178
Value of items that cannot be disclosed: Barite, cement, feldspar, kyanite, scrap mica, pyrites (1960), stone (limestone and sandstone, marl 1959, dimension granite 1960), vermiculite, and values indicated by footnote 4		13,640		13,559
Total South Carolina [6]		30,598		30,001

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than $1,000.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Excludes limestone and sandstone, marl (1959), and dimension granite (1960); included with value of items that cannot be disclosed.
[6] Total adjusted to eliminate duplicating value of clays and stone.

[1] Commodity-industry analyst, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, South Carolina Geological Survey, Columbia, S.C.

615629—61——58

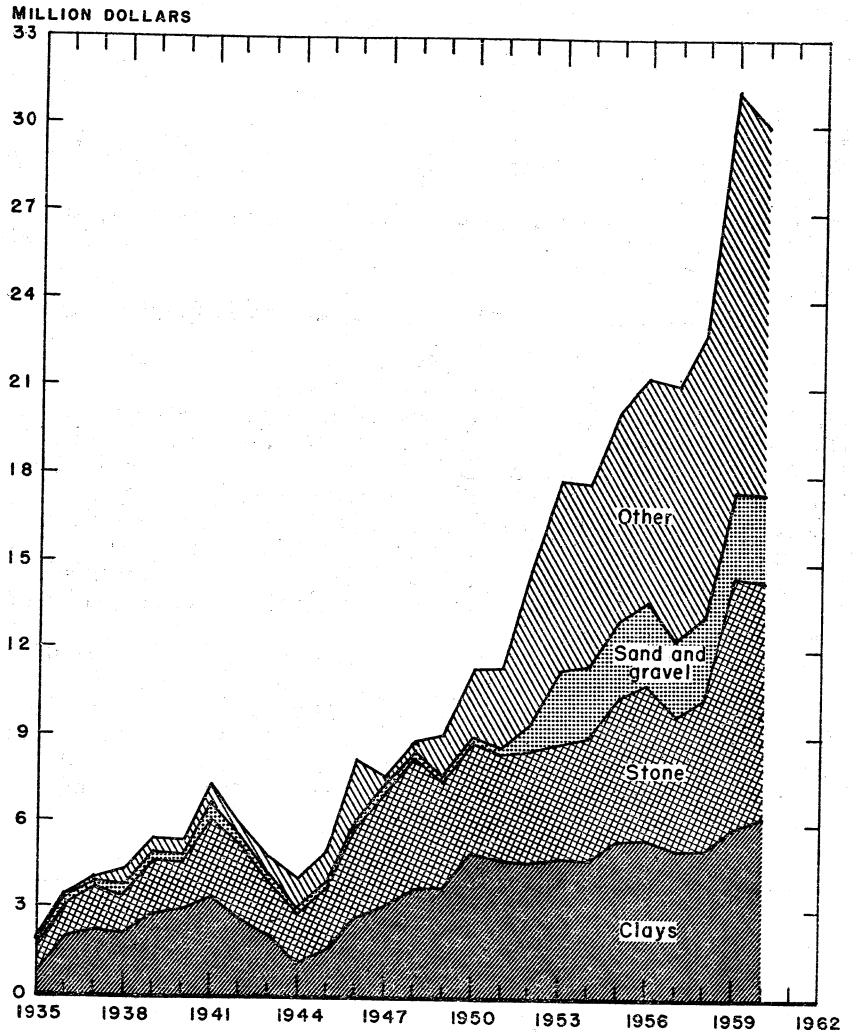

FIGURE 1.—Value of clays, stone, sand and gravel, and total value of minerals produced in South Carolina, 1935–60.

Employment and Injuries.—Reports submitted by producers in the mineral industries indicated that 2 percent less mines, mills, and quarries were active in 1960 than in 1959, and that employment decreased 7 percent. Employment decreased 12 percent in nonmetal mines; that in quarries and mills increased 5 percent. Employment in sand and gravel mines decreased 18 percent. Average active days worked were about the same as in 1959, and total man-hours worked in all mines, quarries, and mills decreased 7 percent.

The overall frequency rate for injuries per million man-hours decreased 8 percent. Nonfatal injuries decreased by 13 or 11 percent from 1959; in nonmetal mines, injuries decreased by 32, in quarries

TABLE 2.—Employment and injuries in the mineral industries

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man hours
1959:							
Nonmetal mines	41	1,173	263	2,470,039	1	66	27
Quarries and mills	20	762	266	1,621,090	1	41	26
Sand and gravel mines	41	278	260	579,541	----------	8	14
Total	102	2,213	264	4,670,670	2	115	25
1960: [1]							
Nonmetal mines	40	1,040	268	2,233,374	----------	34	15
Quarries and mills	18	801	262	1,679,336	----------	65	39
Sand and gravel mines	42	228	246	448,675	----------	3	7
Total	100	2,069	263	4,361,385	----------	102	23

[1] Preliminary figures.

and mills injuries increased by 24, and in sand and gravel mines injuries decreased by 5. There were no fatal accidents reported for the year, as compared with two in 1959.

Trends and Developments.—Value of foreign trade through South Carolina's ports of Charleston, Georgetown, and Port Royal reached the highest level in history in 1960, totaling over $244 million. Total trading through State ports had risen phenomenally—by almost $200 million—since 1947, when imports and exports were valued at $49.5 million. The State's large port construction program was nearing completion; in October, the biggest single project of the program, a $10 million terminal at Charleston was dedicated. At Charleston, expansion was underway at State Piers 2 and 4, which were expected to be completed in 1961. The port of Charleston ranked 14th among the Nation's ports for the year.

The growth of the State was reflected in expenditures for major construction of new facilities by the power companies in the area. Carolina Power & Light Co. completed in May its newest generating plant, a 250,000-h.p. steam-electric unit near Hartsville. The initial unit, operating at full power, consumed 2,340 tons of coal daily; since startup in May, expenditures for coal alone totaled more than $2.5 million. The plant was designed for eventual expansion to over 1.5 million horsepower.

South Carolina Electric & Gas Co. announced a 3-year, $73 million expansion program that included construction of a $41 million steam-electric generating facility at Canadys Station, near Walterboro, Colleton County. Future expansion plans included purchase of four package-type gas-fired generating units for peaking and emergency purposes and the installation of a second 137,500-kw. unit at the Canadys Station plant.

Carolinas Virginia Nuclear Power Associates, Inc., composed of Carolina Power & Light Co., South Carolina Electric & Gas Co., Duke Power Co., and Virginia Electric & Power Co., began construction of the first nuclear-powered steam generating plant in the Southeast at Parr Shoals, S.C., in June. This was the first time that private companies had invested in a reactor that will use heavy water

for cooling and moderating. The generating station was designed to produce 17,000 kw. of electric power and will feature pressure tubes installed in a relatively low-pressure tank, in place of the usual heavy steel vessel, to house the reactor core and its structural supports. The plant was scheduled for completion by mid-1962 and was 10 percent complete by the end of 1960.

A program of highway construction costing approximately $48 million was conducted by the South Carolina State Highway Department during the year, resulting in the award of contracts for construction and improvement of 1,240 miles of roads and numerous bridges. An expanded program, expected to reach $53 million, was outlined for 1961.

Contracts awarded to low bidders during the year involved work on 35 miles of Interstate System routes, 110 miles of primary and urban roads, 499 miles of secondary roads that receive Federal aid, and 18 miles of miscellaneous projects. Highway maintenance cost $15 million in 1960 compared with $14 million for the previous year. Contracts were awarded during 1960 for construction of 35 miles on the Interstate Highway System and involved $13.5 million in Federal and State aid funds.

About 200 miles of the new expressways had been opened to traffic, including the Cherokee and Spartanburg County sections of Interstate Highway 85 and the segments of Interstate Highway 26 extending from State Highway 33 near Orangeburg to U.S. Highway 276 in Laurens County and from Interstate Highway 85 in Spartanburg County to a point near the North Carolina line. Enlargements and additions in the State highway department were necessary to keep apace of new developments. Increased activity in road construction was reflected by increased use of materials, especially sand and gravel.

Carolina Giant Division of Giant Portland Cement Co., Harleyville, began construction on a $4 million expansion program by adding a fourth kiln with an annual cement capacity of 1.1 million barrels, increasing plant capacity to 4 million barrels. Eastern Brick & Tile Co., Sumter, completed construction of its new brick and tile plant, which was equipped to produce 70,000 to 100,000 brick per day and which cost $1 million. Guignard Brick Co., Columbia, added a new tunnel kiln and dryer that doubled its daily production of brick. Owens-Corning Fiberglas Corp. completed a new glass fiber plant at Aiken, comprising 10 direct melt furnaces with a total production capacity of 70 million pounds per year. Richland Shale Products Co., Columbia, announced plans for a $1 million addition to its plant, which would double capacity. American Lava Co., a wholly owned subsidiary of Minnesota Mining & Manufacturing Co., announced that a new technical ceramics plant would be built at Laurens.

Legislation and Government Programs.—E. I. du Pont de Nemours & Co., Inc., operated the Savannah River plant for the Atomic Energy Commission (AEC) under the second extension of a contract originally undertaken in 1950 at the request of the Government. Since 1950, total expenditures administered by Du Pont for construction operation and improvements under contract had been in excess of $1.9 billion. At the end of 1960 the operating force was about 6,600 and the construction force engaged in modifying and improving the

plant was about 1,100. The primary objective of the operation was production of plutonium and other special nuclear materials for national defense, but Du Pont also was being called upon to increase research devoted to AEC's projects on the peaceful use of atomic energy.

Initial operation of the Heavy Water Components Test Reactor under construction at AEC's Savannah River plant near Aiken was scheduled for 1961. The reactor, whose construction was approximately 45 percent complete at the end of 1960, was designed to permit simultaneous test irradiation of up to 12 full-sized natural uranium fuel elements at temperatures, pressures, and power densities similar to those encountered in operating power reactors. The test reactor will yield operating information on a heavy-water modulated system under conditions similar to those for power production. It will irradiate fuel elements and test other heavy-water reactor components.

AEC awarded a contract to the operator of the Savannah River plant, Aiken, for reprocessing nuclear fuels from a Hanford, Wash., production reactor.

The fiscal year 1961 appropriation for the Civil Works Program of the U.S. Army Corps of Engineers was announced and included $21.4 million for new construction at the Hartwell reservoir on the border between South Carolina and Georgia. The Corps of Engineers later awarded a $1.2 million contract for highway and railroad relocation necessary to divert the Seneca River around the Clemson College campus. The diversion will require relocation of a section of State Highway 37 and the line of the Chicago & North Western Railway Co. at the Seneca River crossing, about 2 miles south of the Clemson campus.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Industrial Minerals, Inc., Cherokee County, the only barite producer in the State, increased output 2 percent in quantity and 3 percent in value over 1959. The crude barite was ground for use as rubber filler and shipped out of State. Operations in 1961 were expected to improve as the result of new grinding equipment installed near the end of 1960.

Cement.—By value, cement was the second leading commodity in the State. Masonry cement continued to establish record output, with increases made each year since production began in 1957. Portland cement decreased in output for the first year since production began in 1949. Both types of cement were manufactured by Carolina Giant Division of Giant Portland Cement Co. near Harleyville, Dorchester County. Masonry output increased 13 percent in quantity and 14 percent in value; portland cement decreased 16 percent in quantity and 14 percent in value, compared with 1959. Limestone and clay used in the manufacture of masonry and portland cements decreased 14 percent each in quantity. During the year Carolina Giant began an expansion program to increase plant capacity to 4 million barrels of cement annually. The construction program, estimated to cost $4 million, entailed the addition of a fourth kiln with an annual capacity

of 1.1 million barrels and additional storage and shipping facilities. A new sales office was established in Raleigh, N.C. The plant had been enlarged twice since it went into operation in 1948.

TABLE 3.—Kaolin sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Rubber	229,442	$2,829,645	$12.33	220,846	$2,868,888	$12.99
Insecticides and fungicides	49,464	579,081	11.71	49,599	651,529	13.14
Other refractories	(1)	(1)	(1)	38,078	233,806	6.14
Firebrick and block	(1)	(1)	(1)	11,191	57,363	5.13
Plaster and plaster products	2,000	27,060	13.53	2,500	34,200	13.68
Saggers, pins, stilts, and wads	4,400	59,532	13.53			
Other uses [2]	160,780	1,796,779	11.18	124,406	1,656,556	13.32
Total	446,086	5,292,097	11.86	446,620	5,502,342	12.32

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes whiteware, art pottery, fire-clay mortar, paper filler, paper coating, linoleum and oilcloth, paint, fertilizers, other fillers, chemicals, exports, and other uses.

Clays.—By value, clay was the third leading commodity in the State. New high record outputs were established for kaolin and miscellaneous clay; South Carolina ranked second in the Nation in production of kaolin. Total clay output was 1.3 million tons, valued at $6.2 million. Kaolin production increased slightly over 1959 to 447,000 tons valued at $5.5 million, and miscellaneous clay increased 19 percent in quantity to 850,000 tons and 11 percent in value to $699,000. Kaolin, used for filler in rubber, insecticides and fungicides, and other fillers, and for refractories, pottery, and stoneware, was produced at 17 mines in Aiken and Richland Counties by 13 companies. Miscellaneous clay, used for cement and heavy clay products, including building brick, paving brick, draintile, sewer pipe, and kindred products was produced at 12 mines in Cherokee, Dorchester, Fairfield, Greenwood, Lexington, Marion, Marlboro, and Richland Counties by 12 companies. J. M. Huber Corp. (three mines), Dixie Clay Co., and National Kaolin Products Co., all of Aiken County, were the leading producers of kaolin, in that order, for the second consecutive year. The three leading producers of miscellaneous clay for the second consecutive year were Carolina Giant (Dorchester County), Columbia Brick & Tile Co. (Richland County), and Southern Brick Co. (Greenwood County).

Guignard Brick Co., Columbia, doubled its brick production with the installation of a new tunnel kiln and dryer, bringing plant production to 100,000 brick per day. The first brick was made at this plant by John Guignard in 1803.[3] Richland Shale Products, Columbia, had plans in the initial stages for a $1 million addition to its sewer pipe, draintile, and flue lining division, which will double production and enable production of larger pipe. In 1960, Richland Shale Products was producing 50,000 tons of 4-inch to 12-inch pipe annually. Since 1958, Columbia Brick & Tile Co., Columbia, had

[3] Brick and Clay Record, Complete Automation on Kiln at Guignard: Vol. 136, No. 6, June 1960, pp. 102–106.

duplicated its original plant at a cost of over $1 million and was equipped to produce in excess of 200,000 brick per day. A description of the new plant facilities was published.[4] Eastern Brick & Tile Co., Sumter, completed its plant at a cost of $1 million and was producing brick, although the plant was built basically to produce glazed structural tile. The plant was equipped to produce 70,000 to 100,000 brick per day. Southern Brick Co., Ninety Six, completed an extensive modernization program begun in 1956. Kiln and dryer units were installed in 1959, and a grinding room and clay storage shed were constructed in 1960. A description of the new facilities was published.[5]

Brief studies[6] were made during the year on the geology and mineral resources of clays as follows: Bentonitic clays of the Coastal Plain, preliminary appraisal of brick clay and bentonite in Jasper County, bentonitic clay in Orangeburg and Calhoun Counties, common clay in Charleston and Berkeley Counties, and kaolin in northwestern Sumter County. Articles on brick clays of Medway Plantation, Berkeley County, and on the use of a power auger to obtain information on clay as well as other resources were included.

The Federal Bureau of Mines at its Norris (Tenn.) Metallurgy Research Laboratory continued making tests and analyses on refractory and common clays from South Carolina as a part of its clay-testing program in the Southeastern States.

Feldspar.—Paco Products, Inc., produced feldspar for the second year from granite screenings mined by Campbell Limestone Co. at its Pacolet quarry; quantity and value increased substantially over 1959. The material was ground and shipped out of State for use by the glass industry.

Kyanite.—South Carolina ranked below Virginia, the only other kyanite-producing State. Output increased 11 percent in quantity and 8 percent in value over 1959. Commercialores, Inc., Henry Knob mine, York County, the only producer, mined, processed, and shipped the material to refractory producers; the company conducted extensive research to produce a better refractory material.

Mica.—Sheet mica was produced by four operators in two counties, and scrap mica by one operator in one county. Production of full-trimmed sheet mica, all from pegmatite deposits, declined 60 percent in quantity and 61 percent in value; the number of operators decreased from seven to four. Production and the number of operators had decreased for 3 successive years. Full-trim sheet mica was sold to the GSA Purchasing Depot, Spruce Pine, N.C., at an average of $11 per pound. Mineral Mining Corp., Kershaw, the only scrap mica producer in the State, recovered scrap mica from an opencut mica schist deposit in Lancaster County; output decreased 9 percent in quantity and 28 percent in value from 1959.

Pyrites.—Commercialores, Inc., York County, produced pyrites as a byproduct in the milling of kyanite and reported production for the

[4] Mohler, Neal, Columbia Brick & Tile Co. Now Producing 73 Million Brick a Year From Two Tunnel Kilns: Brick and Clay Record, vol. 137, No. 1, July 1960, pp. 37–40, 66.
[5] Harrel, George O., Southern Brick's Grinding-Storage Unit Completes Modernization: Brick and Clay Record, vol. 137, No. 6, December 1960, pp. 52–53.
[6] Johnson, H. S., Jr., Geologic Activities in South Carolina During 1960; Geologic Notes, Division of Geology, State Development Board, vol. 5, No. 1, January–February 1961, pp. 1–6.

first year. Production of pyrites in South Carolina had not been recorded by the Bureau of Mines since 1918; cumulative production for the period 1915–18 totaled 14,268 short tons valued at $98,671.

Sand and Gravel.—By value, sand and gravel was the fourth leading commodity in the State. Production decreased in 1960 because of slack periods of construction and adverse weather conditions; output decreased 2 percent in quantity and 1 percent in value below 1959. Sand and gravel was produced at 42 mines by 27 companies in 26 counties. All operations were commercial except that of the State highway department. The highway department produced paving sand at 11 mines in 11 counties, a decrease of 2 mines from 1959; 38,000 tons of sand valued at $17,000 was produced, a decrease of 15 percent in quantity and 20 percent in value from 1959. Twenty companies produced building sand in 13 counties; 9 companies paving sand in 7 counties; and 3 companies fill sand in 3 counties. Glass, molding, blast, fire or furnace, engine, filtration, and other industrial sand was produced by 16 companies in 12 counties. Construction gravel was produced by eight companies in eight counties and consisted of gravel for building, paving, railroad ballast, and other purposes. Leading sand and gravel producers for the second consecutive year were Becker County Sand & Gravel Co. in Chesterfield, Marlboro, and Sumter Counties, and Columbia Silica Sand Co. and Capital Sand Co., both in Lexington County. J. F. Cleckley & Co. produced paving sand in Beaufort, Charleston, Edgefield, and Horry Counties. Seventy-one percent of the material was processed by washing and the remainder was unprocessed or mine-run material. Shipments of sand and gravel were 54 percent by truck and 46 percent by railroad.

TABLE 4.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Aiken	(1)	(1)	(1)	(1)
Anderson	800	$360	5,000	$1,650
Beaufort			(1)	(1)
Charleston	(1)	(1)	(1)	(1)
Cherokee	(1)	(1)	(1)	(1)
Chester	4,845	1,938	4,111	1,644
Chesterfield	(1)	(1)	(1)	(1)
Dorchester	26,835	19,153	20,554	15,225
Edgefield			(1)	(1)
Florence	(1)	(1)	(1)	(1)
Greenville	89,599	39,502	79,121	36,370
Horry	(1)	(1)	(1)	(1)
Jasper	(1)	(1)	(1)	(1)
Kershaw	52,355	107,043	(1)	(1)
Lancaster	2,700	675	2,000	500
Laurens			(1)	(1)
Lexington	590,786	282,018	520,712	234,253
Marion	14,093	14,093	(1)	(1)
Marlboro	(1)	(1)	(1)	(1)
Oconee	5,352	2,408		
Orangeburg			(1)	(1)
Richland	152,978	57,387	(1)	(1)
Spartanburg	2,007	903	2,238	1,119
Sumter	(1)	(1)	(1)	(1)
Union	400	200	500	250
York	910	410	800	264
Undistributed	2,160,854	2,550,832	2,394,170	2,756,346
Total	3,104,514	3,076,922	3,029,206	3,047,621

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 5.—Sand and gravel sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Structural sand	1,179,287	$621,283	$0.53	1,221,014	$572,300	$0.47
Paving sand	449,519	154,965	.34	379,810	127,156	.33
Engine sand	23,040	43,858	1.90	(1)	(1)	(1)
Other sand and gravel [2]	1,452,668	2,256,816	1.55	1,428,382	2,348,165	1.64
Total	3,104,514	3,076,922	.99	3,029,206	3,047,621	1.01

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other sand and gravel."
[2] Includes glass, molding, fill, filtration, blast, fire or furnace, and other sands, and structural, paving, railroad ballast, other gravel, and uses indicated by footnote 1.

Whitehead Bros. Co. of New York, N.Y., one of the leading producers of foundry and industrial sands with plants in New Jersey, New York, and New England, moved into the Southeast with a modern new operation near Lugoff, Horry County. Most of the output was foundry sand, and shipments were made throughout the Southeast. A detailed description of the operation was published.[7] Owens-Corning Glass Co., Aiken, completed and placed in operation a new glass fiber plant, the largest of its kind in the United States, with a capacity of 70 million pounds of glass fiber per year. The company also had an operation at Anderson. American Lava Corp., Chattanooga, Tenn., wholly owned subsidiary of Minnesota Mining & Manufacturing Co., announced plans to build a technical ceramics plant at Laurens, as part of the company's decentralization program.

Stone.—By value, stone production led all commodities in the State. Record highs were established in 1960 for output of crushed limestone and crushed sandstone (quartz), offsetting decreases in crushed and dimension granite. Total stone sales, including crushed limestone, crushed sandstone (quartz), crushed granite, and dimension granite, increased slightly over 1959. Crushed limestone, following a trend discernible in 1959, increased in tonnage and value. Crushed sandstone (quartz) increased 308 percent in quantity and 355 percent in value; the quartz was recovered from granite screenings at the Pacolet quarry of Campbell Limestone Co. by Paco Products Co., Pacolet. Crushed granite output decreased 4 percent in tonnage and 1 percent in value; dimension granite decreased 1 percent in tonnage and 6 percent in value.

Crushed granite was produced from 12 quarries in 8 counties by 6 companies, 1 quarry more than operated during 1959. The largest crushed granite producers, responsible for 82 percent of the total tonnage were: Campbell Limestone Co., Greenville, Pickens, and Spartanburg Counties; Palmetto Quarries Co., Fairfield, Greenwood, and Richland Counties; and Weston & Brooker Co., Lexington County. Eighty-six percent of the total was used for concrete, roadstone, and

[7] Pit and Quarry, Whitehead's South Carolina Plant Opens New Foundry Sand Market in Southeastern States: Vol. 53, No. 5, November 1960, pp. 96–99.

screenings. The granite was transported 72 percent by truck and 28 percent by railroad. Dimension granite was quarried by two companies in Fairfield County and one company in Kershaw County. The largest producer was Winnsboro Granite Co., Rion, who accounted for over 70 percent of the total output. All of the material was used as monumental stone.

TABLE 6.—Crushed granite sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roadstone	5,346,058	$7,555,243	$1.41	5,196,290	$7,277,128	$1.40
Railroad ballast	(1)	(1)	(1)	354,925	476,021	1.34
Other [2]	886,871	714,632	.81	443,189	425,009	.96
Total	6,232,929	8,269,875	1.33	5,994,404	8,178,158	1.36

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes stone sand, riprap, other uses, and uses indicated by footnote 1.

Crushed limestone was produced by two producers, one in Cherokee County and one in Dorchester County. Forty-eight percent was used for cement manufacture, fertilizer filler, and local foundry use; 42 percent was used for concrete, roadstone, and screenings; and the remainder was used as agricultural lime. The material was transported 93 percent by truck and 7 percent by railroad. Crushed sandstone (quartz), showing considerable increase in output, was used for the manufacture of glass and other uses.

Comolli Granite Co. of Elberton, Ga., announced the opening of a new quarry near Kershaw, Kershaw County. The stone was to be sold under the name "Carolina Diamond Gray" and used primarily for mausoleums and for buildings. Bird & Sons, Inc., Charleston Heights, processed stone screenings from material produced in Georgia. The materials plant was adjacent to a roofing mill, which it supplied, and had been in operation since 1955. The Bird organization, originally founded in 1795, with general offices in East Walpole, Mass., was a longtime producer of roofing materials.

Vermiculite.—By value, vermiculite was the fifth leading commodity in the State. Record highs were again established in 1960 for crude vermiculite tonnage and value; new highs had been recorded each year since 1944, attesting to the rapid growth of the commodity. For the second consecutive year, the State ranked second in the Nation in crude ore production. Total output increased 3 percent in quantity and 12 percent in value over 1959. Zonolite Co., Enoree, continued to be the principal producer, mining crude ore in Laurens and surrounding counties and processing the ore at its Kearney plant, near Enoree, Laurens County. A description [8] of Zonolite's South Carolina operations, including mining and milling, with a flowsheet of the

[8] North, Oliver S., Vermiculite Sparkles in Modern Industry: Rock Products, vol. 63, No. 10, October 1960, pp. 95–97.

Kearney mill near Enoree, was published during the year. Zonolite shipped the processed ore to its own exfoliating plant near Travelers Rest and to out-of-State exfoliating plants. Patterson Vermiculite Co. mined crude ore and processed the material at its own plant nearby. American Vermiculite Co., Roan Mountain, Tenn., mined crude ore in Laurens and Spartanburg Counties and processed the material at its own exfoliating plant in the Enoree area, Laurens County. Most of the material was used as plaster and concrete aggregate, insulation fill, fertilizer conditioner, and floral needs. Research in developing new uses was in progress during the year.

METALS

Ferroalloys.—Virginia-Carolina Chemical Corp., Charleston County, operated an electric-arc-furnace plant, producing ferrophosphorous. Pittsburgh Metallurgical Co. Inc., Charleston County, operated an electric-arc-furnace near Charleston and produced ferromanganese, ferrosilicon, and ferrochromium.

Gold and Silver.—No gold and silver production had been reported to the Bureau of Mines in South Carolina since 1943. Nearly half of the total production of gold came from placer operations during the period 1829–80. The history of gold production in the State since 1880 was mainly the record of production of a single large gold mine, the Haile mine in Lancaster County. This mine operated during two periods, 1901–14 and 1933–42, and accounted for more than one-third of the total production of the State. Table 7 shows the production of gold and silver, 1829–1960.

Kershaw Mining Co., Kershaw, announced the reopening of the Lamar Gold mine, Kershaw County, in 1960, after a preliminary examination and sampling program.

Zirconium.—Orefraction Minerals, Inc., Georgetown County, continued operating its zircon processing plant near Andrews. The company used domestic ore from Florida and imported ores, and supplied granular and dry-milled zircon for the foundry, refractory, and ceramic and glass industries. During the year, Metal & Thermit Corp., New York, acquired the resources and facilities of Orefraction Minerals, Inc., thus expanding its activities in the minerals field. Metal & Thermit Corp. had diversified interests in chemicals, metals, alloys, minerals, and welding equipment and supplies, and owned or operated mining and ore processing facilities in Carteret, N.J., and Beaverdam, Va., and in Australia, and Mexico.

MINERAL FUELS

Peat.—Peat production reached a record high in South Carolina in 1960; total value increased 76 percent over 1959. Humus peat, for use as a soil conditioner, was produced from a single operation in Colleton County.

Petroleum.—Delhi-Taylor Oil Corp., Dallas, Tex., opened a new petrochemical terminal at North Charleston. The new terminal had 2-million-gallon storage capacity and was to be supplied by seagoing tankers; the Delhi terminal is accessible by truck, rail, barge, and

ocean tanker. Delhi-Taylor operated in 42 States and had sizable oil exploration interests in Central America and Australia.

Off-Shore Explorations, Houston, Tex., announced that construction had begun on an electronic survey tower off Hilton Head Island to aid in oil exploration. It was one of three towers to be constructed to

TABLE 7.—Mine production of gold and silver, 1829–1960

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1829–80	134,337	$2,776,604			134,337	$2,776,604
1881	1,693	35,000			1,693	35,000
1882	1,209	25,000			1,209	25,000
1883	2,733	56,500	386	$500	3,119	57,000
1884	2,758	57,000	386	500	3,144	57,500
1885	2,080	43,000			2,080	43,000
1886	1,814	37,500	386	500	2,200	38,000
1887	2,419	50,000	386	500	2,805	50,500
1888	1,887	39,000	154	200	2,041	39,200
1889	2,267	46,853	179	232	2,446	47,085
1890	4,838	100,000	400	517	5,238	100,517
1891	6,297	130,149	500	646	6,797	130,795
1892	5,993	123,881	400	517	6,393	124,398
1893	6,192	127,991	500	650	6,692	128,641
1894	4,778	98,763	305	397	5,083	99,160
1895	6,212	128,400	400	520	6,612	128,920
1896	3,062	63,300	300	388	3,362	63,688
1897	4,097	84,700	200	259	4,297	84,959
1898	5,041	104,200	300	388	5,341	104,588
1899	7,745	160,100	400	517	8,145	160,617
1900	5,854	121,000	400	517	6,254	121,517
1901	2,259	46,700	200	259	2,459	46,959
1902	5,896	121,900	300	388	6,196	122,288
1903	4,872	100,700	300	388	5,172	101,088
1904	5,892	121,800	500	290	6,392	122,090
1905	4,600	95,100	100	61	4,700	95,161
1906	3,609	74,600	100	68	3,709	74,668
1907	2,811	58,100	100	100	2,911	58,200
1908	2,598	53,700	200	100	2,798	53,800
1909	358	7,400			358	7,400
1910	1,829	37,800	5	3	1,834	37,803
1911	987	20,408	11	6	998	20,414
1912	818	16,915	47	29	865	16,944
1913	236	4,881			236	4,881
1914	356	7,360	33	18	389	7,378
1915	183	3,789	8	4	191	3,793
1916	15	320	28	18	43	338
1917	52	1,083	3	2	55	1,085
1918						
1919	4	81			4	81
1920	16	332			16	332
1921	2	50			2	50
1922	2	32			2	32
1923	15	313	1	1	16	314
1924–25						
1926	15	313			15	313
1927						
1928	10	197	1	1	11	198
1929–30						
1931	23	470			23	470
1932	71	1,468	6	1	77	1,469
1933	235	5,996	103	36	338	6,032
1934	642	22,439	487	315	1,129	22,754
1935	2,274	79,573	1,117	803	3,391	80,376
1936	287	10,059	50	39	337	10,098
1937	2,483	86,890	624	483	3,107	87,373
1938	11,681	408,835	3,951	2,554	15,632	411,389
1939	13,833	484,155	5,480	3,720	19,313	487,875
1940	13,076	457,660	8,047	5,722	21,123	463,382
1941	15,508	542,780	6,525	4,640	22,033	547,420
1942	7,824	273,840	5,064	3,661	12,888	277,441
1943	147	5,145	135	96	282	5,241
1944–60						
Total	318,825	7,562,125	39,508	31,494	358,333	7,593,619

TABLE 8.—Mine production of gold and silver, 1829–1960, by counties

County	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
Abbeville	153	$3,302	21	$13	174	$3,315
Cherokee	4,354	151,355	3,422	2,162	7,776	153,517
Chesterfield	699	18,492	59	39	758	18,531
Edgefield	6	215			6	215
Lancaster	97,574	2,894,440	29,004	20,885	126,578	2,915,325
McCormick	104	3,686	58	37	162	3,723
Oconee	6	157			6	157
Spartanburg	67	1,549	13	7	80	1,556
Union	56	1,683	11	4	67	1,687
York	2,500	78,305	938	599	3,438	78,904
Undistributed	213,306	4,408,941	5,982	7,748	219,288	4,416,689
Total	318,825	7,562,125	39,508	31,494	358,333	7,593,619

TABLE 9.—Leading gold mines, 1901–60

Mine	County	Total gold production
Haile	Lancaster	$2,875,244
Terry	Cherokee	136,725
Horn	York	27,522
Blackman	Lancaster	18,741
Dorothy	York	16,934
Terry	do	15,190
Brewer	Chesterfield	14,776
Darwin	York	10,099

guide survey ships gathering geological information off the coast; the other two towers were to be located near Townsend, Ga., and Jacksonville, Fla. The oil search will cover the entire coastal shelf, extending 40 to 50 miles offshore.

Transcontinental Pipe Line Co., Houston, Tex., and Dixie LPG Pipe Line Co. announced that they would build essentially parallel liquefied petroleum gaslines extending from Texas through Mississippi, Georgia, and South Carolina and into North Carolina. Transcontinental was planning a $63 million system, with a capacity of 60,000 barrels daily, and planned to use existing natural-gas pipeline right-of-way for its system; preliminary studies for the Dixie line called for a $35 million project with an initial capacity of 25,000 barrels daily. The planned new lines would be the first liquefied petroleum gaslines in the Southeast, which received its liquefied petroleum gas chiefly by truck and rail.

The Ethyl Corp. at Orangeburg completed an expansion program at its plant, producing methyl, ethyl, isobutyl aluminus, ethyl, and methyl aluminum halides.

REVIEW BY COUNTIES

Mineral production was recorded in 31 of the 46 counties in the State, 3 counties more than in 1959. Dorchester, Aiken, and Spartanburg Counties furnished more than 50 percent of the total mineral production value. The leading 10 counties, in order of value, all had output exceeding $1 million and furnished 89 percent of the total

value of mineral production; they were Dorchester, Aiken, Spartanburg, Richland, Lexington, Laurens, Fairfield, Pickens, Cherokee, and Marlboro Counties. Fifteen counties reported no mineral production.

Aiken.—For the fifth consecutive year, Aiken County was the second most important mineral-producing county in the State. Twelve mines operated by seven companies produced a total of 404,000 tons of kaolin valued at $5,304,000, a decrease of 1 percent in tonnage and an increase of 4 percent in value. Aiken County, as in 1959, was again the largest kaolin-producing county. The three largest producers of kaolin, all in Aiken, were J. M. Huber (Barden, Ideal, and Paragon mines); Dixie Clay Co. (McNamee mine); and National Kaolin Products Co. (Aiken mine). Other active operations were Southeastern Clay Co. (Johnson, Rodgers, Gardner, and Toole mines); International Clay Corp. (Graniteville mine); United Clay Mines Corp. (No. 7 mine); and Bell Clay Co. (Batesburg mine). Sand and gravel output in the county increased 5 percent in tonnage and 8 percent in value over 1959. Perry Sand & Gravel Co. (Marine Minerals mine) produced both sand and gravel, and the State highway department mined paving sand for use on county roads.

TABLE 10.—Value of mineral production in South Carolina, by counties[1]

County	1959	1960	Minerals produced in 1959 in order of value
Aiken	(2)	(2)	Kaolin, sand and gravel.
Anderson	$1,648	$2,669	Sand and gravel, mica.
Beaufort		(2)	Sand and gravel.
Charleston	(2)	(2)	Do.
Cherokee	(2)	(2)	Limestone, barite, sand and gravel, miscellaneous clay.
Chester	1,938	1,644	Sand and gravel.
Chesterfield	(2)	(2)	Do.
Colleton	(2)	(2)	Peat.
Dorchester	(2)	(2)	Cement, limestone, miscellaneous clay, sand and gravel.
Edgefield		(2)	Sand and gravel.
Fairfield	(2)	(2)	Granite, miscellaneous clay.
Florence	(2)	(2)	Sand and gravel.
Greenville	(2)	(2)	Granite, sand and gravel.
Greenwood	(2)	(2)	Granite, miscellaneous clay
Horry	(2)	(2)	Sand and gravel.
Jasper	(2)	(2)	Do.
Kershaw	164,642	(2)	Sand and gravel, granite.
Lancaster	(2)	(2)	Mica, miscellaneous clay, sand and gravel.
Laurens	(2)	(2)	Vermiculite, sand and gravel.
Lexington	(2)	(2)	Granite, sand and gravel, miscellaneous clay.
Marion	(2)	(2)	Miscellaneous clay, sand and gravel.
Marlboro	(2)	(2)	Sand and gravel, miscellaneous clay.
Newberry	875,000	62,978	Granite.
Oconee	2,708	2,681	Sand and gravel.
Orangeburg		(2)	Do.
Pickens	(2)	(2)	Granite.
Richland	(2)	(2)	Granite, kaolin, miscellaneous clay, sand and gravel.
Spartanburg	(2)	2,213,039	Granite, quartz, feldspar, vermiculite, sand and gravel, mica.
Sumter	(2)	(2)	Sand and gravel.
Union	(2)	250	Do.
York	(2)	(2)	Kyanite, pyrites, sand and gravel.
Undistributed	[3] 29,552,064	27,720,420	
Total	30,598,000	30,001,000	

[1] The following counties are not listed because no production was reported: Abbeville, Allendale, Bamberg, Barnwell, Berkeley, Calhoun, Clarendon, Darlington, Dillon, Georgetown, Hampton, Lee, McCormick, Saluda, and Williamsburg.

[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[3] Revised figure.

Anderson.—J. E. Wilson (Emma mine), Frank Holland (Holland mine), and Ben B. Williams (Williams mine) sold sheet mica from pegmatite deposits. The State highway department mined paving sand for its own use; tonnage and value were the highest since 1954.

Beaufort.—J. F. Cleckley & Co. (Beaufort mine) opened a new mine in the county and produced paving sand; this company was the only mineral producer in the county.

Charleston.—J. F. Cleckley (Charleston mine) opened a new mine and produced paving sand; Edisto Sand & Gravel Co. (Edisto mine) produced building and paving sand, and Sandrying Co. (North Charleston mine) produced sand for use as fertilizer filler. Output more than doubled in quantity and increased 61 percent in value over 1959.

Cherokee.—Cherokee County ranked ninth in the State in value of mineral production and was eighth in 1959. Industrial Minerals, Inc. (Kings Creek mine) mined barite; tonnage and value increased slightly over 1959, establishing a record year for Industrial Minerals since taking over operation of the mine in 1949. The company installed a new 30-inch vibrating ballmill, increasing capacity to 2 tons per hour, after experimenting with a 15-inch mill; feed is ½-inch ground barite ore, and product size is 99 percent minus 325-mesh. Campbell Limestone Co. (Blacksburg quarry) crushed limestone for concrete aggregate, roadstone, and agricultural use; tonnage decreased 12 percent, and value decreased 8 percent below 1959. Bennett Brick & Tile Co. (Kings Mountain mine) produced miscellaneous clay for manufacturing building brick; output was 22,000 tons valued at $11,000. Bennett reported production for the first year. Jobe Sand Co. (Blacksburg mine) mined engine sand; tonnage increased 13 percent and value 47 percent over 1959. The State highway department mined paving sand for its own use.

Chester.—Paving sand was mined by the State highway department for use in the highway program; production decreased from 1959.

Chesterfield.—Becker County Sand & Gravel Co. (Cash mine) mined sand and gravel for construction purposes and continued to increase output; tonnage and value increased 32 and 35 percent, respectively, over 1959. The State highway department mined paving sand for use in its road program; output increased considerably over 1959.

Colleton.—Ti-Ti Peat Humus Co., Inc., Green Pond, produced peat for use as a soil conditioner; quantity and value increased considerably over 1959 and 1960 was a record year for the company. This was the only mineral production reported in the county and the only peat producer in the State.

Dorchester.—For the fifth consecutive year, Dorchester County led the State in total value of mineral production; total value decreased 4 percent from 1959, principally because of a decrease in portland cement output. Masonry cement output had a record year. Carolina Giant Division of Carolina Giant Cement Co. manufactured portland and masonry cements and produced clay and crushed limestone for use in cement. Masonry cement output, the highest in the company's history, increased 13 percent in quantity and 14 percent in value over 1959. Portland cement output decreased 16 percent in quantity and 14 percent in value. The company produced miscel-

laneous clay at its Harleyville mine; tonnage decreased 14 percent, and value decreased 29 percent. Crushed limestone, previously classified as marl, was produced by Carolina Giant near Harleyville. The company began construction on a large expansion program announced in 1959. Volunteer Portland Cement Co., Agstone Division, mined agricultural limestone; output decreased from 1959. Salisbury Brick Corp. (Salisbury mine) mined 23,000 tons of miscellaneous clay valued at $13,254, a decrease from 1959. Murray Mines Division of Murray Mines Co., Summerville, produced 21,000 tons of building sand valued at $15,000.

Edgefield.—J. F. Cleckley & Co. (Edgefield mine, a new operation), reported production of paving sand for the first year. All of the material was transported by truck. This was the only mineral producer in the county.

Fairfield.—Fairfield County ranked seventh in the State in value of mineral production; the county had ranked fourth in 1959. Palmetto Quarries Co. (Blair quarry) and Rion Crushed Stone Co. (Rion quarry) crushed granite for concrete aggregate, roadstone, and screenings; the output of Palmetto Quarries decreased 20 percent in quantity and 15 percent in value from 1959. Comolli Granite Co. (Carolina Mahogany quarry) and Winnsboro Granite Co. (Winnsboro quarry) quarried dimension granite for the monument industry; output increased slightly. Richland Shale Products Co. (Richtex mine) mined miscellaneous clay and shale for use in its brick and tile plant; output decreased 17 percent in quantity and 18 percent in value.

Florence.—Coastal Sand Co. (Johnsonville mine) produced building, paving, and fill sand; output decreased slightly from 1959. Lanford Sand Co. (Florence mine), in its second year of operation, reported an increase in output of building sand.

Greenville.—Zupan Sand Co. (Greenville mine), W. M. Barber Sand Co. (Greenville mine), and Saluda Sand Co. (Garrison mine) produced building sand; total output of the three mines decreased 13 percent in quantity and 8 percent in value from 1959. Campbell Limestone Co. (Lakeside quarry) crushed granite for use in concrete, road material, railroad ballast, and stone sand; the company was the leading crushed granite producer in the State. The State highway department produced slightly more paving sand for use in its highway program than in 1959.

Greenwood.—Palmetto Quarries Co. (Stoney Point quarry) reported in 1959 as Greenwood quarry, crushed granite for use in concrete, roadstone, and screenings, and railroad ballast; tonnage and value increased 4 percent over 1959. Southern Brick Co. (Ninety-Six mine) produced 108,000 tons of miscellaneous clay valued at $81,000 for use in manufacturing building brick and tile. The company completed an extensive modernization program begun in 1956, by building a new 50- by 100-foot grinding room and an 80- by 280-foot shed providing storage for over 30 days' supply of clay. Southern used a mixture of one-third highly plastic alluvial clay and two-thirds friable and variable Precambrian shale as kiln feed. Angus Brick & Tile Co. (Ninety-Six mine) produced 22,000 tons of miscellaneous clay valued at $16,000 for use in manufacturing building brick; tonnage increased 6 percent, but value decreased.

Horry.—E. P. Pitts Sand Corp. (Pitts mine), listed as Locher Silica Corp. in 1959, produced glass sand for local consumption and out-of-State use; output increased slightly over 1959. J. F. Cleckley & Co. (Conway mine) produced paving sand; output decreased considerably from 1959.

Jasper.—Deerfield Sand & Mining Co. (Deerfield mine) produced paving sand; output decreased considerably from 1959. The sand was transported 84 percent by rail and 16 percent by truck. Deerfield Sand was the only mineral producer in the county.

Kershaw.—Whitehead Bros. Co. (Lugoff mine) produced molding sand for industrial uses in the Southeastern States; tonnage and value increased considerably. A description of the mining and processing of sand at the Lugoff operation was published.[9] Kershaw County Sand Co. (Camden mine) produced building sand; output decreased slightly from 1959. Kershaw Granite Co. (Kershaw quarry) quarried dimension granite for use by the monument industry; output decreased slightly from 1959.

Lancaster.—Mineral Mining Corp. (Kershaw Strip mine) recovered scrap mica from a mica schist deposit; the material was dry-ground and used in the manufacture of paint, plastics, pipeline enamel, and electrical insulation. Ashe Brick Co. (Van Wyck mine) mined 73,000 tons of miscellaneous clay valued at $64,000, an increase over 1959, for the manufacture of building brick in its own plant. The State highway department produced paving sand for use in the highway program.

Laurens.—Laurens County ranked sixth in the State in value of mineral production, moving up from the seventh ranking county in 1959. South Carolina ranked second in the Nation in vermiculite production. Most of the output was produced or processed in the Enoree Area of Laurens. Zonolite Co. (Enoree Area mines) mined and processed crude ore at its Kearney plant near Enoree. The processed crude ore was shipped to Zonolite's exfoliating plant at Travelers Rest and to exfoliating plants in surrounding States. The company published a description of its mining and milling operations in the Enoree Area.[10] Patterson Vermiculite Co. (Laurens County mine) mined crude vermiculite ore adjacent to its exfoliating plant. American Vermiculite Co., of Roan Mountain, Tenn., mined crude vermiculite ore and operated an exfoliating plant in the Enoree Area; material from an adjacent county was also exfoliated at this plant. McCrary Construction Co. (Joana mine) mined paving gravel for highway construction for the first year.

Lexington.—For the second consecutive year, Lexington County ranked fifth in the State in value of mineral production. Weston & Brooker Co. (Cayce quarry) crushed granite for use in concrete, roadstone, screenings, railroad ballast, and stone sand; tonnage and value decreased slightly from 1959. Guignard Brick Co. (Columbia mine) mined 94,000 tons of miscellaneous clay valued at $83,000; an increase of 35 percent in quantity and 33 percent in value over 1959. The company used the clay in manufacturing building brick at its own plant. Guignard installed a tunnel kiln and dryer, thus doubling

[9] Work cited in footnote 7.
[10] Work cited in footnote 8.

output to 100,000 brick per day. Columbia Silica & Sand Co. (Edmund mine) produced building, paving, blast, fire or furnace, engine, filtration, and fertilizer filler sand; output decreased from 1959. Capitol Sand Co. (Capitol mine) mined paving sand for road-base, surface, and bridges; output decreased from 1959. Foster Bros. Dixiana Sand Co. (Dixiana mine) mined building, blast, engine, filtration, and fertilizer filler sand; output decreased from 1959. Southeastern Sand Co. (Cayce mine) produced 46,000 tons of building sand and closed the operation in November. The State highway department mined paving sand for use in its highway program; 1,265 tons was mined compared with 18,500 tons in 1959.

Marion.—J. D. Murchison (Pee Dee mine) produced miscellaneous clay for use in manufacturing building brick; output decreased 16 percent in quantity and 18 percent in value. Sandy Bluff Sand Co. (Snipes mine) mined building sand; tonnage and value decreased considerably from 1959.

Marlboro.—Marlboro County, for the second consecutive year, was the first ranking county in sand and gravel and tenth in value of total mineral production. Becker County Sand & Gravel Co. (Marlboro mine), the leading producer of sand and gravel in the State, mined building sand; gravel for building, chemical, or metallurgical uses, and railroad ballast. Sand output increased 117 percent and gravel output decreased 7 percent from 1959. Lawrence Stone & Gravel Co. (Blenheim mine) mined building sand; output decreased from 1959. Palmetto Brick Co. (Irby mine) mined 50,000 tons of miscellaneous clay valued at $44,000 for use in manufacturing building brick at its own plant. Cheraw Brick Works (Cheraw mine) mined 54,000 tons of miscellaneous clay valued at $54,000, for use in manufacturing building brick at its own plant.

Newberry.—Clement Bros. (Pomaria quarry) of Hickory, N.C., crushed granite for use in the Interstate highway program; output was 50,000 tons valued at $63,000, a drastic drop from 1959. This quarry was opened to supply a nearby Interstate road contract; it was anticipated that when contract demands had been met, the quarry would be closed. Clement Bros. was the only company in the county reporting mineral production.

Oconee.—The State highway department produced 8,124 tons of paving sand valued at $2,681 for use in its highway program.

Orangeburg.—J. F. Cleckley & Co. (Orangeburg mine) reported production of paving sand for the first year from this county. All of the sand was transported by truck.

Pickens.—Pickens County ranked eighth in the State in value of mineral production and second in crushed granite output. Campbell Limestone Co. (Beverly quarry) largest crushed granite producer in the State, crushed granite for use in concrete, roadstone, screenings, and riprap; output increased 23 percent in quantity and 19 percent in value over 1959. Campbell was the only mineral producer in the county.

Richland.—Richland County ranked fourth in the State in value of mineral production, moving up from sixth in 1959. The county ranked second in refractory kaolin and miscellaneous clay production.

Refractory kaolin output increased 18 percent in quantity and 14 percent in value over 1959. Carolina Ceramics Co. (Pontiac mine), R. M. Stork Fire Brick Works (Stork mine), Eastern Brick & Tile Co. (601 mine), and Columbia Pipe Co. (Ridgewood mine) produced refractory kaolin for use in the manufacture of firebrick and block, mortar, and other refractories. Eastern Brick & Tile reported from the 601 mine for the first year. Columbia Brick & Tile Co. (Columbia mine) produced 149,000 tons of miscellaneous clay valued at $131,000; output increased 66 percent in quantity and 64 percent in value over 1959. Palmetto Quarries Co. (Columbia quarry) crushed granite for use in concrete, roadstone, screenings, railroad ballast, and stone sand; output increased 1 percent in quantity and 4 percent in value over 1959. Harrison Sand Corp. (Harrison mine) produced building, engine, and fertilizer filler sand; output increased over 1959. Strickland Sand Pit (Columbia mine) produced building and fill sand; output increased 33 percent in quantity and 67 percent in value over 1959.

Spartanburg.—For the fourth consecutive year, Spartanburg County ranked third in value of mineral production; the county led the State in crushed granite output for the second consecutive year. Campbell Limestone Co., the leading producer of crushed granite in the State, crushed granite at its Pacolet and Pelham quarries; the Fair Forest quarry, operated in 1959, was closed. Output of the two quarries decreased from 1959. Clement Bros. Construction Co. Inc. (Westview quarry), of Hickory, N.C., crushed granite for highway construction, reporting for the first year. Green Construction Co., Spartanburg, closed the Inman quarry, which operated during 1959, and opened the Woodruff quarry. The company reported substantial output from the new operation; the material was used to supply an Interstate highway contract in the area. Zonolite Co. operated an exfoliating plant at Travelers Rest, using vermiculite ore from the nearby Enoree Area. American Vermiculite Co. (Propst mine) of Roan Mountain, Tenn., mined crude vermiculite and transported the material by truck to its own exfoliating plant in the Enoree Area. Paco Products Co., in operation for its second year, produced quartz, crude feldspar, and ground feldspar from granite screenings produced at the Campbell Limestone Co. Pacolet quarry; the material was shipped out-of-State and used primarily by the glass industry. O. M. Gardner (Dove mine) produced a small amount of sheet mica. The State highway department mined 2,238 tons of paving sand, valued at $1,119 for use in its highway program.

Sumter.—Sumter County was the third largest sand and gravel producing county in the State, dropping from second in 1959. Becker County Sand & Gravel Co. (Camden mine), the largest sand and gravel producer in the State, was the only mineral producer in the county; output decreased 10 percent in quantity and 11 percent in value below 1959. The new brick and tile plant of Eastern Brick & Tile Co., near Sumter, was completed; the plant was equipped to produce 70,000 to 100,000 brick per day. The plant, representing a $1 million investment, was built, basically, to produce glazed structural tile, but was manufacturing building brick.

Union.—The State highway department mined paving sand for use in its highway program and was the only mineral producer in the county.

York.—Commercialores, Inc. (Henry Knob mine), the only producer of kyanite in the State, mined kyanite ore and produced kyanite concentrate for use in firebrick and tile; tonnage increased 11 percent and value 8 percent over 1959. The company, for the first year, also recovered pyrite as a byproduct from its milling of kyanite ore. The State highway department mined paving sand for use in its highway program; output decreased from 1959.

The Mineral Industry of South Dakota

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the South Dakota State Geological Survey.

By D. H. Mullen [1] and Allen F. Agnew [2]

MINERAL production in South Dakota in 1960 was valued at $46.8 million, a 4-percent decline from the record high of $48.5 million reached in 1959. The drop in total value resulted from lower production and value of some commodities, both metal and nonmetal, that represented major portions of the State's mineral output. Declines were noted in the value of gold, silver, uranium, clays, and sand and gravel, all of which were produced in substantial quantities. There were moderate to substantial gains in other commodities such as beryllium concentrate, cement, feldspar, gypsum, scrap mica, and stone, but these advances were not sufficient to offset the losses in those commodities that were produced in greater quantity.

The total value of the mineral fuels—coal (lignite) and petroleum—more than doubled over 1959. The value of the lignite declined, but represented only a small part of the State total.

Northern States Power Co. began building the Pathfinder nuclear powerplant near Sioux Falls early in the year, and by the end of December it was 42 percent complete. The 62,000-kw. reactor was designed to provide test and operating data on an integral boiling-superheating core with a superheater centrally located within the reactor core. The reactor was scheduled to go critical in June 1962.

Black Hills Power & Light Co. completed a 22,000-kw., $5.5 million, steam-electric generating plant at Rapid City. The plant was designed to burn ¼-inch coal in a cyclone furnace and discharge a liquid slag at 2,800° F.

Employment and Injuries.—Employment and injuries data in the mineral industry, excluding petroleum, collected by the Bureau of Mines on its annual canvass, are shown on table 2.

Government Programs.—Hand-cobbed mica and beryllium concentrate (beryl) were purchased by the Federal Government through the General Services Administration (GSA) purchase depot at Custer. Hand-cobbed mica was processed at the station by a contractor for GSA, and the recovered strategic sheet mica, as well as the beryllium concentrate purchased, was shipped to stockpiles of strategic and defense minerals.

[1] Commodity-industry analyst, Bureau of Mines, Denver, Colo.
[2] State geologist, South Dakota Geological Survey, Vermillion, S. Dak.

TABLE 1.—Mineral production in South Dakota [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate---short tons, gross weight	156	$84	167	$88
Clays [2]---thousand short tons	227	227	202	202
Coal (lignite)---do	22	88	20	83
Copper---short tons			1	1
Feldspar---long tons	30,825	196	45,588	292
Gem stones	(3)	20	(3)	20
Gold (recoverable content of ores, etc.)---troy ounces	577,730	20,221	554,771	19,417
Gypsum---thousand short tons	19	78	22	89
Mica: Scrap---short tons	158	5	205	10
Sheet---pounds	38,775	158	30,887	145
Petroleum (crude)---thousand 42-gallon barrels	151	(4)	[5] 281	(4)
Sand and gravel---thousand short tons	17,775	11,058	13,548	9,359
Silver (recoverable content of ores, etc.) thousand troy ounces	124	113	108	98
Stone---thousand short tons	2,721	7,243	3,149	7,909
Uranium ore---short tons	45,734	606	41,104	586
Value of items that cannot be disclosed: Cement, clays (bentonite), iron ore (1960), lime, lithium minerals, vanadium (1960), and values indicated by footnote 4		[6] 9,401		9,376
Total South Dakota [7]		[6] 48,553		46,780

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite; included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Preliminary figure.
[6] Revised figure.
[7] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

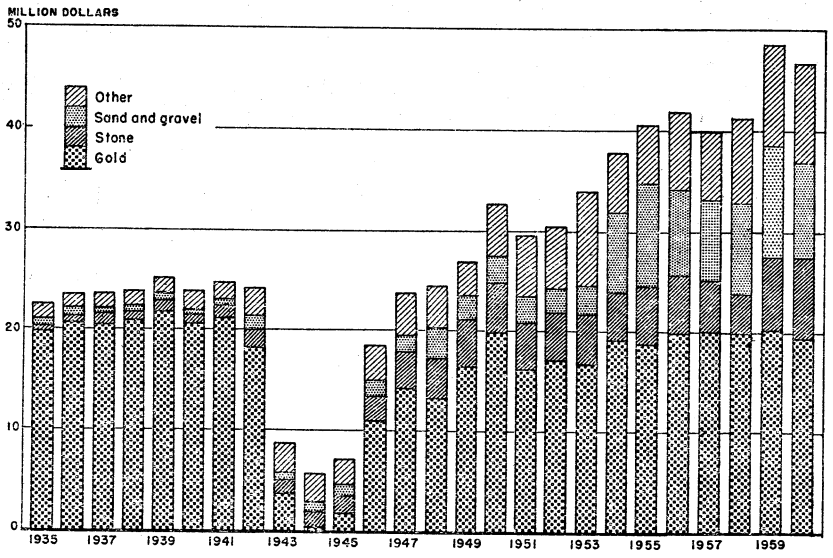

FIGURE 1.—Value of gold, dimension and crushed stone, sand and gravel, and total value of mineral production in South Dakota, 1935–60.

TABLE 2.—Employment and injuries in the mineral industries[1] in 1960[2 3]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
Metal mines	3	1,741	4,317,543	2	67	16.0
Uranium mines	54	269	369,024	----	21	56.9
Nonmetal mines[4]	135	282	356,904	1	5	16.8
Quarries	69	576	1,259,835	1	15	12.7
Sand and gravel plants	190	1,381	1,893,459	1	9	5.3
Coal mines	1	10	16,000	----	----	0
Total	452	4,259	8,212,765	5	117	15.0

[1] Excludes petroleum industry.
[2] Preliminary figures.
[3] Source: Federal Bureau of Mines data.
[4] Includes beryl.

The Office of Mineral Exploration (OME) approved one contract for the exploration of a deposit for beryl and columbium-tantalum in Custer County.

The Federal Bureau of Mines continued to investigate the recovery of beryllium from low-grade products obtained by beneficiating material from South Dakota pegmatite deposits. The investigations were primarily in the field of solvent extraction after leaching.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Portland and masonry cement shipments from the State-owned plant at Rapid City increased 6 percent in quantity and 11 percent in value over those of 1959. The average price of portland cement in 1960 was $3.14 a barrel compared with $3.01 in 1959; the price of masonry cement increased to $3.89 a barrel from $3.76.

Clays.—Production of bentonite was 48 percent below that of 1959 as known mineable deposits in the State approached exhaustion. Processing plants obtained crude material in greater amounts from deposits in Wyoming. The quantity of miscellaneous clay produced in Butte County for the manufacture of building brick, sewer tile, and heavy clay products and in Pennington County for the manufacture of cement and lightweight aggregates declined 11 percent below that of 1959.

Feldspar.—Feldspar production from 64 mines in Custer County and 8 in Pennington County was 48 percent greater than in 1959. Except for one operation, all feldspar was sold to International Minerals & Chemical Corp. (IMC) for grinding at its plant at Custer. The ground product was shipped to consumers throughout the United States, Canada, and Mexico for the manufacture of glass, pottery, enamel, porcelain, and other uses.

Gem Stones.—Gem stones and mineral specimens were collected in Custer, Fall River, Lawrence, and Pennington Counties. Most were sold to tourists as souvenirs. Better quality specimens of agate and onyx, and gem varieties of beryl and similar gem minerals were polished by processors.

Gypsum.—Gypsum for use as a retarder in portland cement was mined by the South Dakota State Cement Commission from deposits in Pennington County. Production was 16 percent above that of 1959.

Lime.—High-calcium limestone for manufacturing quicklime at a plant near Pringle was mined from deposits in Custer County. The entire output of lime was used within the State for metallurgical purposes.

Lithium.—Spodumene was produced at the Etta mine, and lepidolite and amblygonite were produced at The Bob Ingersoll mine, both near Keystone, and spodumene was produced at the Hunter-Louise mine on the county line between Custer and Pennington Counties. A portion of the amblygonite produced was shipped to Germany.

Mica.—Hand-cobbed mica produced from 28 mines in Custer County and 8 mines in Pennington County was 20 percent below that of 1959. Although the quantity mined in 1960 was less than in 1959, the quality and grade of recovered sheet mica was higher; consequently, the total value declined only 8 percent. The entire output was sold to GSA at Custer, where it was processed by a private contractor for the Government. Scrap mica was produced at two mines, one each in Custer and Pennington Counties. The quantity mined was 30 percent greater, and the value was double that of 1959. All scrap mica produced was sold to grinders in Illinois and Minnesota.

TABLE 3.—Production of hand-cobbed mica and yield of sheet mica

Year	Hand-cobbed mica	Total block mica recovered		Stained quality recovered		Good-stained and better quality recovered	
	Pounds	Pounds	Percent of hand cobbed	Pounds	Percent of total block	Pounds	Percent of total block
1956	216,802	12,238	5.64	7,420	60.63	253	2.07
1957	149,163	9,048	6.07	4,828	53.36	255	2.82
1958	257,198	16,681	6.49	9,552	57.26	471	2.82
1959	365,712	38,734	10.59	20,079	51.84	601	1.55
1960	286,043	30,887	10.80	18,662	60.42	461	1.49

Sand and Gravel.—The reported production of sand and gravel was 24 percent below that of 1959. State, county, and municipal governments engaged in road construction report production upon completion of construction contracts, and a decline in reported production does not necessarily indicate a decline in activity. Production was reported in 61 of the State's 67 counties; at 84 commercial operations in 35 counties; and at 101 Government-and-contractor operations in 56 counties.

Of the total sand and gravel output, 88 percent was used for paving and roadbuilding, most of which (66 percent) was produced by contractors for governmental agencies. The quantity of sand and gravel that was washed, sized, or otherwise prepared continued to increase; of the total produced in 1960, 75 percent was processed. The value per ton ranged from $0.439 for unwashed gravel produced by contractors to $1.012 per ton for washed material produced by commercial operators.

TABLE 4.—Mica sold or used by producers

	1956	1957	1958	1959	1960
Hand-cobbed mica, total:[1] pounds	216,802	149,163	257,198	365,712	286,043
Sheet mica:[1]					
Full trimmed:					
Pounds	256	45	94	41	----------
Value	$2,010	$756	$1,393	$593	----------
Average per pound	$7.85	$16.80	$14.82	$14.46	----------
From hand-cobbed mica:					
Pounds	12,238	9,048	16,678	38,734	30,887
Value	$65,043	$44,751	$66,489	$157,234	$145,154
Average per pound	$5.31	$4.95	$3.99	$4.06	$4.70
Total:					
Pounds	12,494	9,093	16,772	38,775	30,887
Value	$67,053	$45,507	$67,882	$157,827	$145,154
Average per pound	$5.37	$5.00	$4.05	$4.07	$4.70
Scrap mica:					
Short tons	1,268	1,626	1,003	158	205
Value	$31,224	$43,142	$24,241	$4,916	$9,748
Average per ton	$24.62	$26.53	$24.17	$31.11	$47.55
Total sheet and scrap mica:					
Short tons	1,274	1,631	1,011	177	220
Value	$98,277	$88,649	$92,123	$162,743	$154,902

[1] Sold to the Government through GSA.

Construction of the National System of Interstate and Defense Highways and Federal-aid projects continued at a high rate. During 1960 the Bureau of Public Roads changed its method of reporting progress, and strictly comparable data for 1959 and 1960 were not available. A report[3] of progress on the program showed that between July 1, 1956, and the end of 1960, 59.3 miles of the Interstate System had been completed to full standards, and 56.5 miles had been completed to standards adequate for current traffic. This represented a total of 115.8 miles open to traffic. At the end of the year, 93.7 miles were under construction, and engineering studies and right-of-way acquisition had begun on 185.7 miles. The total designated mileage of the System in South Dakota was 677.6 miles, leaving 282.4 miles yet to be planned and constructed. Under the Federal-aid (ABC) program, 1,138 miles were completed in 1960, and at the end of the year 445.5 miles were under construction.

Production of sand and gravel in excess of 500,000 tons was recorded in six counties: Brown (1,092,400), Brookings (658,500), Minnehaha (613,800), Day (599,400), Clark (574,400), and Lincoln (516,700). Leading commercial producers included Mannerud Construction Co., Hallett Construction Co., See Nel Construction Co., and Concrete Materials Co.

Stone.—Dimension granite was produced at 11 quarries in Grant County for architectural and monumental use. Of the total output, 62 percent was finished at plants at Cold Spring, Delano, Saint Cloud, and Sauk Centre, Minn. Crushed limestone, of which 61 percent was used in road construction and as a concrete aggregate, was produced in four counties. A substantial quantity was mined in Pennington County for the manufacture of cement. Other uses of limestone included riprap, railroad ballast, the manufacture of quicklime, and

[3] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960: Press release BPR 61–6, Feb. 22, 1961.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	478	$529	572	$689
Paving	377	351	212	195
Railroad ballast	45	24	(1)	(1)
Fill	22	11	9	12
Other	20	8	71	78
Industrial sand:				
Molding	1	5	4	16
Oil (hydrafrac)			3	21
Total sand	943	928	871	1,011
Construction gravel:				
Building	294	282	96	120
Paving	4,010	2,678	1,581	947
Railroad ballast	52	34	176	126
Fill	46	16	34	12
Other	(2)	(2)	123	94
Miscellaneous gravel	36	11	418	217
Total gravel	4,438	3,021	2,428	1,516
Total sand and gravel	5,381	3,949	3,299	2,527
Government-and-contractor operations:				
Sand:				
Building			2	1
Paving	445	300	520	343
Total sand	445	300	522	344
Gravel:				
Building	399	349	132	138
Paving	11,550	6,460	9,595	6,350
Total gravel	11,949	6,809	9,727	6,488
Total sand and gravel	12,394	7,109	10,249	6,832
All operations:				
Sand	1,388	1,228	1,393	1,355
Gravel	16,387	9,830	12,155	8,004
Grand total	17,775	11,058	13,548	9,359

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Less than 1,000 short tons

sugar refining. Crushed sandstone from quarries in Hanson and Minnehaha Counties was used for road construction, as a refractory stone, in foundries, for filters, for railroad ballast, and in the manufacture of ferrosilicon. Crushed miscellaneous stone, used entirely for road construction, was produced by commercial operators in 2 counties and by contractors in 47 counties. Total stone production in 1960 was 16 percent greater than in 1959.

METALS

Beryllium.—Beryllium concentrate (beryl) production from 71 mines in Custer and Pennington Counties was 7 percent above that of 1959. The greater portion (71 percent) was from Pennington County. The major output was sold to the GSA purchase depot

at Custer for the national stockpile and the remainder to Gladys Wells of Custer for resale to consumers. Production from individual mines ranged from a few pounds to 35 tons.

Copper.—Copper ore was shipped from a dump at the Maloney Blue Lead mine in Pennington County. The ore also contained an ounce of gold and a small quantity of silver. This was the first recorded production of copper in the State since 1944 when copper was recovered from a lead concentrate produced from claims operated by the Belle Eldridge Gold Mines, Inc., in Lawrence County.

Gold and Silver.—Production of gold and silver declined 4 and 13 percent, respectively, below that of 1959. Virtually all production was from the Homestake mine at Lead in Lawrence County. Although more ore was mined and milled than in 1959, the grade was slightly lower.

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)		Total value (thousands)
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)	
1951–55 (average)	4	1	1,447	509,386	$17,829	143	$130	[3] $17,963
1956	2	--	1,743	568,523	19,898	136	123	20,021
1957	2	--	1,779	568,130	19,885	135	122	20,007
1958	3	--	1,824	570,830	19,979	153	138	20,117
1959	2	--	1,778	577,730	20,221	124	113	20,334
1960	2	--	1,767	554,771	19,417	108	98	[4] 19,515
1876–1960	--	--	[5]	28,250,907	770,379	11,518	8,557	[6] 779,101

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes retreated, and ore or old tailings shipped directly to smelters during the calendar year indicated.
[2] Does not include gravel washed.
[3] Includes 14 short tons of lead valued at $3,956.
[4] Includes 1 ton of copper valued at $642.
[5] Data not available.
[6] Includes 107 short tons of copper valued at $37,108, 497 tons of lead valued at $71,752, and 265 tons of zinc valued at $56,406.

Iron Ore.—Iron ore was mined from the Iron Hill mine in Pennington County for use as an additive in the manufacture of cement.

Uranium.—Production of uranium ore was 10 percent below that of 1959; however, the number of operations increased from 36 to 48. The greatest production continued to be from Fall River County; Custer County ranked second. A small quantity of uranium ore was mined from the Fort Union formation in Harding County. The entire output was processed at the Edgemont plant operated by Mines Development, Inc. The average grade of the ore mined was 0.19 percent (3.8 pounds per ton) uranium oxide.

Vanadium.—During 1960 a vanadium-recovery circuit was added to the Edgemont uranium mill. The quantity of contained vanadium in the uranium ores from South Dakota and Wyoming was relatively small but was sufficient to warrant recovery. The unit began operating in November.

MINERAL FUELS

Coal (Lignite).—Production of coal (lignite) was 9 percent below that of 1959. The entire output came from the Dewey County Coal Co. operation of a strip mine on the Hellcreek seam. Other mines, producing less than 1,000 tons during the year, were operated in Dewey, Corson, and Perkins Counties.

Petroleum.—Petroleum production was 281,000 barrels, an increase of 86 percent over 1959 all from the Buffalo field in Harding County. The State geologist reported that 19 wells in the Harding field were producing at the close of the year. Thirteen wells, eight exploratory and five development, were completed during the year; three were producers.

REVIEW BY COUNTIES

Butte.—American Colloid Co. produced bentonite and operated its processing plant at Belle Fourche. The processed product was used in rotary drilling mud, in foundries and steel plants, for filters, and in other miscellaneous products. Eastern Clay Products Department, International Minerals & Chemical Corp. (IMC), operated a bentonite mill at Belle Fourche and processed crude material from deposits in Wyoming. Miscellaneous clay for the manufacture of building brick, draintile, and other clay products was produced by Black Hills Clay Products Co.

Crushed stone and sand and gravel for road construction and repairs were produced by contractors for the State department of highways and the Butte County Highway Department. The county ranked fifth in the value of mineral production.

Custer.—Beryllium concentrate (beryl), feldspar, and hand-cobbed and scrap mica from numerous pegmatite deposits represented 67 percent of the value of all minerals produced in the county. Beryl was recovered from 41 mines, feldspar from 64, and mica from 29. Major producers of beryl were Double R Mines at the Smith Dike, Bland Mining & Milling Co. at 5 mines, and J. D. Long at 12 mines.

IMC was the leading producer of feldspar and operated the Shamrock and White Elephant mines. Abingdon Potteries, Inc., produced feldspar at its mines and shipped the crude material to its grinding plant at Abingdon, Ill. All other feldspar produced was sold to IMC for grinding at its plant at Custer. Scrap mica was produced at the Old Mike mine. Hand-cobbed mica was sold to the GSA purchase depot at Custer. Major producers included York Minerals, at six mines; Merical Exploration Co., at the Red Fawn; Homestead Mining Co., at the GC Dike; and Marvin Kenoyer, at the Lillian Fraction.

High-calcium limestone was mined for manufacturing quicklime at a plant near Pringle. Crushed stone and sand and gravel were produced by contractors for the State department of highways for road construction. Gem stones and mineral specimens were produced and collected by Allen's Minerals and Mining, Scott's Rose Quartz Co., and others for sale to tourists as souvenirs. Uranium ore was produced at the Lucky Bud Nos. 1 and 2 mines by Bettenhausen & Wheeler, Susquehanna Western, Inc., and Triangle Enterprises, Inc., and processed at the uranium mill at Edgemont.

TABLE 7.—Value of mineral production in South Dakota, by counties

County	1959	1960 [1]	Minerals produced in 1960 in order of value
Aurora	$52,400	$208,190	Sand and gravel, stone.
Beadle	260,919	146,552	Do.
Bennett	42,600	[2]	Sand and gravel.
Bon Homme	145,200	217,400	Do.
Brookings	486,400	391,483	Sand and gravel, stone.
Brown	783,348	658,902	Do.
Brule	37,472	99,196	Do.
Buffalo	49,900	73,210	Do.
Butte	2,359,203	1,297,862	Clays, sand and gravel, stone.
Campbell	39,319	[2]	Sand and gravel.
Charles Mix	184,236	348,800	Do.
Clark	299,806	454,200	Do.
Clay	50,027	34,900	Do.
Codington	404,795	471,061	Sand and gravel, stone.
Corson	179,200	39,534	Do.
Custer	702,902	[3] 685,214	Feldspar, mica (sheet), uranium ore, lime, beryllium concentrate, sand and gravel, stone, gem stones, mica (scrap).
Davison	129,584	127,942	Sand and gravel, stone.
Day	280,946	378,900	Sand and gravel.
Deuel	45,685	91,100	Do.
Dewey	87,712	167,584	Coal, sand and gravel, stone.
Douglas	124,700	289,000	Sand and gravel.
Edmunds	38,600	42,000	Do.
Fall River	572,042	[3] 642,825	Uranium ore, sand and gravel, stone, gem stones.
Faulk	175,844	121,100	Sand and gravel.
Grant	3,077,096	3,004,488	Stone, sand and gravel.
Gregory	121,905	242,322	Sand and gravel, stone.
Haakon	70,536	169,777	Do.
Hamlin	45,400	7,959	Do.
Hand	28,197	22,277	Do.
Hanson	377,534	500,152	Stone, sand and gravel.
Harding	[2]	[3] 800,346	Petroleum, sand and gravel, uranium ore.
Hughes	481,400	420,990	Stone, sand and gravel.
Hutchinson	55,950	148,800	Sand and gravel.
Hyde	209,800	2,549	Stone.
Jackson	61,818	46,625	Sand and gravel, stone.
Jerauld	107,200	51,900	Sand and gravel.
Jones	----------	5,390	Stone.
Kingsbury	131,714	110,202	Sand and gravel, stone.
Lake	584,075	285,120	Do.
Lawrence	20,477,494	19,609,878	Gold, silver, stone, sand and gravel, gem stones.
Lincoln	179,118	355,940	Sand and gravel, stone.
Lyman	153,800	66,573	Do.
Marshall	146,000	258,115	Do.
McCook	10,800	39,285	Do.
McPherson	146,000	163,000	Sand and gravel.
Meade	76,500	156,151	Sand and gravel, stone.
Mellette	20,000	78,343	Do.
Miner	76,400	54,181	Do.
Minnehaha	1,816,926	1,842,250	Stone, sand and gravel.
Moody	113,500	180,064	Sand and gravel, stone.
Pennington	10,531,492	10,555,075	Cement, stone, sand and gravel, clays, gypsum, beryllium concentrate, iron ore, feldspar, mica (scrap), mica (sheet), gem stones, copper, gold, silver.
Perkins	92,500	21,818	Sand and gravel, stone.
Potter	119,844	7,939	Do.
Roberts	256,520	242,063	Do.
Sanborn	6,884	----------	
Shannon	49,500	10,144	Stone.
Spink	135,806	144,370	Sand and gravel, stone.
Stanley	334,800	131,345	Do.
Sully	35,800	22,400	Sand and gravel.
Todd	27,203	4,544	Stone.
Tripp	4,324	31,118	Sand and gravel, stone.
Turner	28,700	228,115	Do.
Union	262,083	236,653	Do.
Walworth	159,621	134,424	Do.
Washabaugh	150	----------	
Yankton	128,800	164,800	Sand and gravel.
Ziebach	6,900	12,375	Sand and gravel, stone.
Undistributed [4]	[5] 1,215,280	118,454	
Total [6]	[5] 48,553,000	46,780,000	

[1] Value of petroleum is preliminary.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Excludes vanadium.
[4] Includes production of lithium minerals, vanadium (1960), some sand and gravel and gem stones that cannot be assigned to specific counties and values indicated by footnote 2.
[5] Revised figure.
[6] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

The Office of Mineral Exploration (OME) approved a contract with Lithium Corp. of America, Inc., for exploration of the Black Diamond pegmatite deposit for beryl and columbite-tantalite by drilling. Total amount of the contract was $26,640, with Government participation limited to 50 percent.

Fall River.—Three-fourths of all uranium ore produced in the State came from 43 operations in Fall River County. Major producers included Walter L. McKenna, at five operations; Black Hills Uranium Co., at nine; and Chord Uranium Co., at seven. The entire production was processed at the Mines Development, Inc., mill at Edgemont. Improvements were made at the mill, and a circuit was added to recover vanadium oxide contained in uranium ores from South Dakota and Wyoming. Seventy-five percent of the ore processed at the mill was from Wyoming deposits.

Crushed stone and sand and gravel were produced for road construction by contractors for the State department of highways. Building and paving sand and gravel was produced at five locations. Leading producers were Oral Sand Co., Rounds Construction Co., and Flyte Rock Products Co.

Grant.—Mahogany-brown and deep-red granites of Grant County were produced at 11 quarries near Milbank and Big Stone City by 7 companies. One-half of the stone quarried was finished at plants in Minnesota. The color and texture of the granite makes it particularly desirable for building facings, interior decoration, and monuments; the finished stone was widely marketed.

Harding.—Petroleum production, entirely from wells in the Buffalo field in Harding County, was 86 percent greater than in 1959. At yearend 19 wells from the Red River formation were producing. According to data from the State geologist, 13 wells (8 exploratory, 5 development) were completed during the year; 3 were producing. Drilling totaled 87,878 feet. Sand and gravel was produced by contractors for the State department of highways for road construction. Uranium ore was produced at the Lonesome Pete claims and shipped to the processing plant at Edgemont.

Lawrence.—Homestake Mining Co. operated the Homestake mine and 4,800-ton-per-day amalgamation-cyanidation plant at Lead and continued to be the Nation's leading gold producer. The quantity of ore mined and milled was nearly 1.77 million tons, the highest in 83 years of operation. However, the recoverable value of gold and silver in the ore was only $11.02 a ton, a decrease of $0.50 from 1959, and the total value of bullion recovered was 4 percent below that of the previous year. The percentage recovery was 97.21 percent, the same as in 1959. Productivity increased from 3.41 tons per man shift in 1959 to 3.58 tons in 1960. No new blocks were added to the ore reserve; however, 92 percent of the ore mined in 1960 was offset by production from specific blocks in excess of the amounts previously estimated, and further development above the 5,000 level removed the discount formerly applied to reserves that had not been sufficiently delineated. Development between the 5,000 and 6,200 levels continued. The ore-bearing structures revealed, although smaller and less continuous, were comparable in grade and mineralogy to the ore bodies above the 5,000 level. Reserves below the 5,000 level were not to be

estimated until continuity between widely spaced exposures and more definite data concerning the grade were determined, according to the company. On the basis of available information, it appeared that a reserve of at least 2.5 million tons below the 5,000 level eventually would be established. The program was continued to provide adequate ventilation and to control high rock temperatures below the 4,800 level. Stripping of the Oro Hondo shaft began and was expected to be completed by mid-1961. This would complete the ventilation program and permit extensive development of the deep block at a greater rate. Plans were developed to mine ore in the deep block concurrently with the ore above the 5,000 level. A program to mine and mill 800 tons per day from the deep levels was begun. It would require skip hoisting below the 4,850 level, the addition of another grinding unit, and other minor changes in the mill. This program was to increase daily milling capacity to 5,600 tons.

TABLE 8.—Homestake mine ore milled, receipts, and dividends[1]

Year	Ore milled (thousand short tons)	Receipts for bullion product		Dividends (thousands)
		Total (thousands)	Per ton	
1956	1,628	$19,354	$11.89	$4,019
1957	1,660	19,479	11.74	4,019
1958	1,725	19,611	11.37	4,019
1959	1,746	20,120	11.52	4,019
1960	1,767	19,465	11.02	4,021

[1] From 1876 to 1960, inclusive, this mine yielded bullion and concentrates that brought a net return of of $698.0 million and paid $210.9 million in dividends.

Cole Construction Co. produced crushed limestone for road construction and railroad ballast, and for use in sugar refining. Crushed miscellaneous stone and sand and gravel were produced for road construction by contractors for the State department of highways, and the Lawrence County Highway Department produced sand and gravel for road repairs.

Pennington.—The county ranked second in the value of mineral production, and its mines, quarries, and mills produced a variety of minerals and mineral products. Beryllium concentrate (beryl) was produced at 30 mines. Major production was from the Peerless lode operated by Thomas M. Edson, Peerless Minerals, Inc., and Bland Mining & Milling Co.; the Hugo lode operated by Walter Hough; the Sackett Fraction lode operated by C. L. Myler; the White Cap operated by McCarty-Pullen Mines, Bland Mining & Milling Co., Northwest Defense Minerals, and C. O. Patterson; and the Ingersoll operated by Bland Mining & Milling Co. Northwest Defense Minerals installed new equipment in the Holy Terror mill at Keystone (previously operated as a cyanide mill for gold and silver ores and for the recovery of spodumene concentrate) for the recovery of beryl concentrate. Crude ore was to come from the dump at the White Cap pegmatite mine. The daily capacity of the mill was to be 100 tons, and the beryl was to be recovered by a flotation process developed at the Federal Bureau of Mines Research Laboratory at Rapid City.

Trial runs were made, but no production was reported. Hand-cobbed mica was recovered at eight mines and sold to GSA at Custer for processing. Principal producers were McCarty-Pullen Mines at the White Cap and R. W. Meiners at the Cobb. Scrap mica was produced at the Peerless lode by Thomas M. Edson. Crude feldspar was produced at eight mines and sold to IMC for grinding at its plant at Custer. Principal producers were Walter Hough at the Hugo and High Climb mines, McCarty-Pullen Mines at the White Cap, and Alfred V. Hazeltine at the Hesnard lode. The Etta mine near Keystone, operated by Maywood Chemical Co., was closed early in the year after being operated almost continuously since 1898. Unconfirmed reports indicated the mine had been sold to Clifford and Corde, operators of pegmatite mines in Custer and Pennington Counties. A shipment of copper ore was made from dump material at the Maloney Blue Lead mine. This was the first recorded production of copper in South Dakota since 1944.

Shipments of portland and masonry cements from the State-owned cement plant at Rapid City operated by the South Dakota State Cement Commission were 6 percent above those of 1959. The Commission produced the limestone, shale, gypsum, and sand used by the plant at deposits near Rapid City. Iron ore, also used at the plant as an additive, was produced by a contractor at the Iron Hill mine near Nemo. Bentonite clay was obtained from a bentonite processing mill at Belle Fourche. Cement clinker was used as a base in the manufacture of masonry cement. Shipments were made to consumers in South Dakota, North Dakota, Wyoming, Montana, Nebraska, Minnesota, Iowa, and Colorado. Miscellaneous clay, in addition to that used for cement, was produced from deposits near Rapid City for the manufacture of lightweight aggregate. Gem stones and mineral specimens were produced and collected by Scott's Rose Quartz Co., Allen's Minerals and Mining, and individuals, largely for sale to tourists as souvenirs. The better qualities of agate and gem varieties of beryl and similar minerals were polished.

Sand and gravel and crushed miscellaneous stone were produced by contractors for the State department of highways and for the Pennington County Highway Department for road construction and repairs. Building and paving sand and gravel was produced by four operators. Molding sand and oil sand (hydrafrac) was produced by the Black Hills Silica Sand Corp. Crushed limestone for riprap, road construction, concrete aggregate, and railroad ballast was produced by Hills Materials Co., L. G. Everist, Inc., Pete Lien & Sons, and The South Dakota Cement Plant. A general improvement program extending for 7 years was completed at the quarry and preparation plant of Pete Lien & Sons. The program consisted of a modern crushing, screening, and preparation plant in addition to replacement of the quarry equipment. The plant produced a complete range of sized- and blended-rock products for concrete aggregate, ready-mixed concrete, and base courses for highways and military construction. Because the production rate of 250 tons per hour was below design capacity, and shipments could be made at the rate of 500 tons per hour, plans were made to increase capacity of the plant to 500 tons per hour.

The Mineral Industry of Tennessee

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

By Avery H. Reed, Jr.,[1] William D. Hardeman[2] and Mildred E. Rivers[3]

RECORD production of crushed limestone, zinc, phosphate rock, copper, sand and gravel, and scrap mica highlighted the mineral industry of Tennessee in 1960. Tennessee led the Nation in production of ball clay, pyrite, and zinc; ranked second in output of phosphate rock and dimension marble; and third in the production of fuller's earth. The total value of mineral production increased 2 percent over 1959, the previous record year.

TABLE 1.—Mineral production in Tennessee[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry—thousand 376-pound barrels	772	$2,743	729	$2,696
Portland—do	8,381	26,191	7,517	24,688
Clays—thousand short tons	1,146	4,952	1,270	4,537
Coal—do	5,913	23,581	5,930	21,154
Copper (recoverable content of ores, etc.)—short tons	11,490	7,055	12,723	8,168
Gem stones	(2)	(3)	(2)	1
Gold (recoverable content of ores, etc.)—troy ounces	99	3	123	4
Iron ore—gross weight, long tons	21,346	111	(4)	(4)
Manganese ore (35 percent or more Mn) short tons, gross weight	7,586	589	283	15
Manganiferous ore (less than 35 percent Mn) short tons, gross weight	56	1	(4)	(4)
Natural gas—million cubic feet	52	9	63	11
Petroleum (crude)—thousand 42-gallon barrels	6	(4)	[5] 6	(4)
Phosphate rock—thousand long tons	1,755	13,255	1,939	15,424
Sand and gravel—thousand short tons	6,221	7,570	6,293	7,655
Silver (recoverable content of ores, etc.)—troy ounces	59,739	54	64,560	58
Stone—thousand short tons	18,767	29,094	20,074	29,942
Zinc (recoverable content of ores, etc.)—short tons	89,932	20,684	91,394	23,580
Value of items that cannot be disclosed: Barite, lime, scrap mica, pyrite, and values indicated by footnote 4		7,392		7,570
Total Tennessee [6]		140,738		143,439

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Less than $1,000.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Preliminary figure.
[6] Total adjusted to eliminate duplicating the value of clays and stone.

[1] Chief, Knoxville Field Office, Knoxville, Tenn.
[2] State geologist, Division of Geology, Department of Conservation and Commerce, Nashville, Tenn.
[3] Statistical assistant, Bureau of Mines, Knoxville, Tenn.

Leading industries were copper and zinc mining, stone quarrying, cement manufacturing, coal mining, and phosphate rock mining and processing, which together furnished 88 percent of the total value of production. Leading companies were Tennessee Copper Co. (gold, silver, copper, pyrite, and zinc), American Zinc Co. of Tennessee (zinc and limestone), New Jersey Zinc Co. (zinc and limestone), Volunteer Portland Cement Co. (cement, limestone, and clay), and Penn-Dixie Cement Corp. (cement, limestone, and clay).

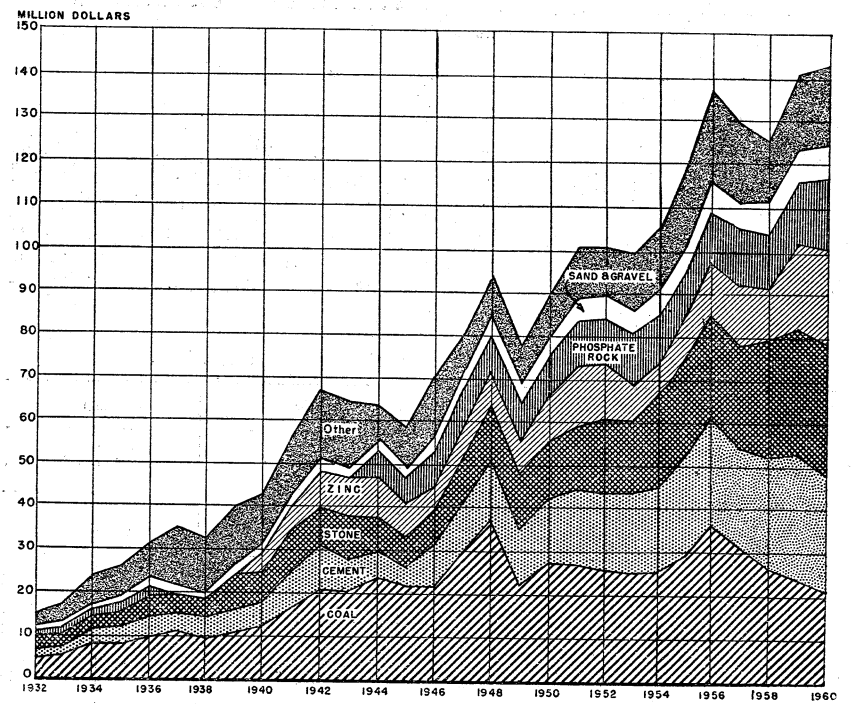

FIGURE 1.—Value of mineral production in Tennessee, 1932–60.

Employment and Injuries.—Total employment in the mineral industries decreased 2 percent below 1959. Employment decreased in all industries except metal mining, which increased 4 percent.

Injury experience was about the same. Lower frequency rates were recorded by nonmetal mines. There were 14 fatalities, compared with 25 in 1959 and 23 in 1958. There were no major disasters during the year.

The following were leading causes of injuries in the mineral industries: Handling materials, haulage, machinery, hand tools, and falls of persons. Causes of fatalities were: Falls of roof (8), falls of face (4), explosives (1), and drowning (1).

Tennessee Coal & Iron Division, United States Steel Corp., won the National Safety Competition award for underground metal mines at the Jefferson City mine. Tennessee Copper Co. placed second and fourth in the same contest at the Boyd and Calloway mines.

Trends and Developments.—Continued expansion of the East Tennessee zinc district was the outstanding development of the year. American Zinc Co. of Tennessee announced a contract with Tri-State

TABLE 2.—Employment and injuries in the mineral industries

Year and industry	Active operations	Men working daily	Average active days	Man-hours worked	Fatal injuries	Nonfatal injuries	Injuries per million man-hours
1959:							
Quarries and mills	123	3,378	264	7,139,869	2	219	31
Coal mines [1]	581	4,468	149	5,250,688	18	197	41
Coke ovens and smelters	3	6,141	360	17,683,379	----------	70	4
Metal mines and mills	25	1,543	242	3,001,253	2	75	26
Nonmetal mines and mills	44	1,752	192	2,693,804	2	73	28
Sand and gravel mines	44	698	279	1,556,865	1	23	15
Total	820	17,980	260	37,325,858	25	657	18
1960: [2]							
Quarries and mills	113	3,117	285	7,099,346	1	240	34
Coal mines [1]	474	4,124	155	5,112,625	10	230	47
Coke ovens and smelters	3	1,305	354	3,695,886	----------	9	2
Metal mines and mills	21	1,562	249	3,107,258	2	82	27
Nonmetal mines and mills	40	1,399	222	2,510.797	----------	30	12
Sand and gravel mines	45	640	268	1,372,697	1	26	20
Total	696	12,147	235	22,898,609	14	617	27

[1] Excludes officeworkers.
[2] Preliminary figures.

TABLE 3.—Injuries in the mineral industries, by causes [1]

Cause	Quarries and mills	Coal mines	Metal mines	Nonmetal mines	Sand and gravel mines	Coke ovens and smelters	Total
1959:							
Handling materials	----------	49	10	15	5	17	96
Haulage	----------	[2] 44	6	[3] 20	4	8	82
Machinery	----------	27	23	[3] 9	3	19	81
Hand tools	----------	10	4	4	1	7	26
Falls of persons	----------	4	11	12	4	7	38
Falls of roof	----------	[4] 39	[3] 10	1	----------	----------	50
Falling objects	----------	9	1	3	1	1	15
Falls of face	----------	[3] 7	3	----------	----------	----------	10
Explosions	----------	[5] 9	----------	----------	----------	----------	9
Electricity	----------	[3] 3	----------	2	----------	1	6
Explosives	----------	4	----------	----------	----------	----------	4
Miscellaneous	----------	10	9	9	[3] 6	10	44
Undetermined	[2] 221	----------	----------	----------	----------	----------	221
Total	221	215	77	75	24	70	682
1960: [6]							
Handling materials	87	70	22	5	10	1	195
Haulage	9	47	15	10	6	1	88
Machinery	30	31	9	3	1	1	75
Hand tools	21	20	5	3	6	----------	55
Falls of persons	21	2	18	3	2	4	50
Falls of roof	[3] 1	[7] 33	5	----------	----------	----------	39
Falling objects	11	6	1	1	1	1	21
Falls of face	4	[3] 8	[2] 4	----------	----------	----------	16
Electricity	2	----------	1	----------	----------	----------	3
Explosives	2	[3] 1	----------	----------	----------	----------	3
Miscellaneous	53	22	4	5	[3] 1	1	86
Total	241	240	84	30	27	9	631

[1] Includes officeworkers.
[2] 2 fatalities.
[3] 1 fatality.
[4] 5 fatalities.
[5] 9 fatalities.
[6] Preliminary figures.
[7] 7 fatalities.

Zinc, Inc. (wholly owned subsidiary of the Consolidated Gold Fields of South Africa Ltd., London, England), whereby American Zinc agreed for Tri-State to take over the development and operation of an area near New Market, Tenn., where American had discovered a substantial tonnage of high-grade zinc ore. Tri-State will start sinking shafts at an early date. Before the end of 1961 they expect to finish constructing a concentrating mill with a daily capacity of 3,600 tons. American Zinc will ship part of the ore mined from its Jefferson County mines to this mill until Tri-State has completed enough underground development to supply the new mill capacity.

The Tennessee Valley Authority (TVA) began constructing the new $34-million Melton Hill Dam in Loudon County. The dam, 32d in the TVA system, was expected to be finished by June 1963, and will furnish navigation upstream to Clinton.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Five operators mined crude barite from six mines in four counties for oil-well drilling muds, chemicals, and other uses. The leading producer was Baroid Division of National Lead Co. Production increased 42 percent but was 85 percent below 1941, the record year.

Cement.—Four companies produced masonry cement at five plants in five counties; the leading producer was Marquette Cement Manufacturing Co. Shipments decreased 6 percent and were 8 percent below 1955, the record year. Consumption in Tennessee was 58 percent, and shipments were made to North Carolina (20 percent), Georgia (8 percent), South Carolina (7 percent), Alabama (2 percent), Kentucky (2 percent), and other States (3 percent).

Four companies produced portland cement at six plants in six counties. The leading producer was Volunteer Portland Cement Co. Shipments decreased 10 percent below the record of 1959. Raw materials used in cement included cement rock and limestone (86 percent), clay and shale (8 percent), gypsum (3 percent), and other (3 percent). Consumption in Tennessee was 44 percent, and shipments were made to North Carolina (28 percent), Georgia (17 percent), South Carolina (3 percent), Virginia (3 percent), and other States (5 percent).

The end uses of portland cement were as follows: Ready-mixed concrete (56 percent), concrete products (19 percent), highway contractors (11 percent), building material dealers (10 percent), and other (4 percent).

Marquette Cement Manufacturing Co. started a $5-million modernization program at the Nashville plant. The remodeling job was scheduled for completion by the end of 1961.

Clays.—Five companies mined ball clay at six mines in Henry and Weakley Counties. Leading producers were H. C. Spinks Clay Co., Inc., and United Clay Mines Corp. Production decreased 7 percent below the 1959 record. Tennessee led the Nation in producing ball clay.

In Henry County, Southern Clay Co. Inc., and Tennessee Absorbent Clay Co. mined fuller's earth for absorbent uses. Production declined 29 percent and was 56 percent below the record of 1956. Among the States, Tennessee ranked third in producing fuller's earth.

TABLE 4.—Ball clay sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Whiteware, etc.	207,132	$2,833,601	$13.68	186,795	$2,555,302	$13.68
Floor and wall tile	56,236	775,395	13.79	48,578	665,946	13.71
Heavy clay products	3,456	34,560	10.00	(1)	(1)	(1)
Art pottery	180	2,376	13.20			
Other [2]	36,184	517,807	14.31	47,601	627,097	13.17
Total	303,188	4,163,739	13.73	282,974	3,848,345	13,60

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes enameling, firebrick and block, glass refractories, saggers, pins, stilts, and wads, exports, other uses, and uses indicated by footnote 1.

Thirteen companies mined miscellaneous clay at 15 mines in 10 counties for floor and wall tile, heavy clay products, lightweight aggregate, and cement. Leading counties were Knox and Davidson; leading producers were General Shale Products Corp. and W. G. Bush & Co. Inc. Production increased 19 percent but was 7 percent below the record of 1956.

Feldspar.—The Feldspar Corp. ground crude feldspar from North Carolina at its Erwin plant.

Gem Stones.—In Hawkins County, Willard Pratt collected barite specimens for sale as souvenirs.

Lime.—Standard Lime & Cement Co., Williams Lime Mfg. Co., and Victor Chemical Works produced quicklime and hydrated lime at Knoxville and Nashville for building, chemical, and industrial uses. Production decreased 11 percent. Consumption in Tennessee was 35 percent, and shipments were made to North Carolina (36 percent), Kentucky (15 percent), New York (4 percent), Georgia (3 percent), and other States (7 percent).

Mica.—International Minerals & Chemical Corp. recovered scrap mica from silt deposits in Davy Crockett Lake. Production increased 16 percent over 1959, the previous record year. Among the States, Tennessee ranked sixth in producing mica.

Perlite.—Tennessee Products & Chemical Corp. expanded crude perlite from Western States at the Nashville plant.

Phosphate Rock.—Nine companies mined and processed phosphate rock in Maury, Williamson, Giles, Davidson, and Hickman Counties. Leading producers were Monsanto Chemical Co. and Victor Chemical Works. Marketable production increased 10 percent, and was 2 percent above the record of 1958. Tennessee ranked third in the Nation in production of phosphate rock.

Hooker Chemical Corp. broke ground for a $6.4 million expansion of its Columbia, Tenn., phosphates plant. Addition of a third fur-

nace to reduce phosphate rock will increase Hooker's phosphorus capacity to 65,000 tons per year. Victor Chemical Works announced that it would construct a new kiln for producing nodulized phosphate rock to augment the two present kilns at its Mount Pleasant, Tenn., plant.

TABLE 5.—Phosphate rock sold or used by producers, by uses

Use	1959			1960		
	Long tons	Value		Long tons	Value	
		Total	Average per ton		Total	Average per ton
Elemental phosphorus	1,594,112	$11,747,085	$7.37	1,733,200	$13,588,388	$7.84
Ordinary superphosphate [1]	89,701	748,879	8.35	113,650	993,739	8.74
Direct application to the soil	69,600	591,636	8.50	64,157	599,736	9.35
Other [2]	21,882	178,738	8.17	16,495	137,626	8.34
Total	1,775,295	13,266,338	7.47	1,927,502	15,319,489	7.95

[1] Includes rock for phosphoric acid (wet process).
[2] Includes fertilizer filler, pig-iron blast furnace, and other uses.

Pyrite.—Tennessee Copper Co. recovered pyrite concentrate from sulfide ore mined in Polk County. Production was about the same as in 1957, the record year. Tennessee led the Nation in output of pyrite.

Sand and Gravel.—Thirty-eight companies mined sand and gravel at 45 mines in 28 counties. Leading counties were Shelby, Benton, and Davidson. Leading producers were Sangravl, Inc., Cumberland River Sand & Gravel Co., and Memphis Stone & Gravel Co., Inc. Production increased 1 percent over the 1959 record; 93 percent was washed. Of the total output, 70 percent was hauled by truck, 18 percent, by rail, and 12 percent, by water.

Construction began near Kingsport for a modern plate-glass plant. The $40 million facility for American-Saint Gobain Corp. will combine the ancient art of plate-glass manufacturing with the latest technological developments in electronic production and quality controls. The company was a major producer of flat glass products. Completion of the plant, which will cover almost 23 acres, was scheduled for 1962.

Stone.—Blue Ridge Stone Co. crushed 20,000 tons of granite in Carter County for concrete and roads. Seventy-six operators crushed limestone at 100 quarries in 55 counties. Leading counties were Davidson, Knox, and Hamilton. Leading producers were Lambert Bros. Division of Vulcan Materials Co. (Blount, Claiborne, Davidson, Hawkins, Humphreys, Knox, Roane, Sevier, Sullivan, and Williamson Counties), and Chattanooga Rock Products Division of Vulcan Materials Co. (Hamilton and Marion Counties). Production was 7 percent more than the 1959 record. Of the total production, 92 percent was hauled by truck and 8 percent, by rail.

John J. Craig Co., Appalachian Marble Co., and Knoxville Crushed Stone Co. crushed marble for terrazzo and other uses. Production decreased 9 percent and was 55 percent below the record of 1948. John J. Craig Co. (Hamil, Marmor, Crisp, and Lee quarries), Tennessee Marble Co. (Endsley, Eagle, and Luttrell No. 3 quarries), Gray Knox

Marble Co. (French Pink, Brown, and Gray Knox quarries), and Appalachian Marble Co. (Bond and Appalachian quarries) quarried dimension marble in Blount, Knox, and Union Counties. Production

TABLE 6.—Sand and gravel sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Benton	794,493	$1,284,016	702,788	$1,132,952
Carroll			(1)	(1)
Cumberland	55,000	68,940	55,000	67,000
Davidson	(1)	(1)	(1)	(1)
Decatur	(1)	(1)	(1)	(1)
Fayette	68,200	56,600	76,171	68,600
Franklin	52,801	88,900	54,964	87,423
Giles	67,500	56,025	290,250	190,000
Greene	35,477	53,798	26,980	32,418
Hamilton	(1)	(1)	280,063	436,487
Hardeman	18,870	14,660	21,890	16,490
Haywood	86,780	65,000	89,047	80,142
Henderson	(1)	(1)	(1)	(1)
Humphreys	(1)	(1)	(1)	(1)
Knox	(1)	(1)	(1)	(1)
Lauderdale	53,442	44,350	83,754	75,379
Loudon	20,103	26,170	5,649	7,061
McNairy	(1)	(1)	(1)	(1)
Monroe	9,740	11,883	12,599	18,886
Obion	124,900	103,600	102,200	92,000
Putnam	60,700	63,700	(1)	(1)
Shelby	1,734,113	1,716,982	1,711,898	1,502,531
Stewart	(1)	(1)	(1)	(1)
Sumner	101,000	37,500	65,000	32,500
Tipton	(1)	(1)	(1)	(1)
Unicoi	293,553	392,495	259,004	364,658
Warren	22,887	28,602	(1)	(1)
Wayne	(1)	(1)	(1)	(1)
Undistributed	2,621,434	3,457,084	2,455,610	3,450,873
Total	6,220,993	7,570,305	6,292,867	7,655,400

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 7.—Sand and gravel sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Vaule	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	1,883,801	$2,327,055	$1.24	1,877,627	$2,574,511	$1.37
Paving	469,031	498,639	1.06	385,940	435,982	1.13
Molding	266,949	784,440	2.94	215,836	636,314	2.95
Engine	660	825	1.25	864	1,080	1.25
Other	261,026	533,562	2.04	(1)	(1)	(1)
Total	2,881,467	4,144,521	1.44	(1)	(1)	(1)
Gravel:						
Structural	1,835,048	2,147,006	1.17	1,803,774	2,098,427	1.16
Paving	1,337,255	1,110,970	.83	1,572,104	1,268,575	.81
Fill				101,250	50,000	.49
Railroad ballast	109,999	111,623	1.01	(1)	(1)	(1)
Other	57,224	56,185	.98	(1)	(1)	(1)
Total	3,339,526	3,425,784	1.03	(1)	(1)	(1)
Total sand and gravel	6,220,993	7,570,305	1.22	6,292,867	7,655,400	1.22

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."

decreased 25 percent and was 33 percent below the 1957 record. Tennessee ranked second in production of dimension marble. During the year, Vermont Marble Co. purchased Gray Knox Marble Co.

White Silica Sand Co., and Major Sand Co., Inc., crushed 76,000 tons of sandstone for roadstone. Eleven companies quarried dimension sandstone at 11 quarries in Cumberland and Fentress Counties

TABLE 8.—Crushed limestone sold or used by producers, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Anderson	(1)	(1)	(1)	(1)
Bedford	(1)	(1)	(1)	(1)
Blount	409,346	$409,346	315,887	$455,133
Bradley	(1)	(1)	(1)	(1)
Campbell	(1)	(1)	(1)	(1)
Cannon	25,000	30,000	(1)	(1)
Carter	(1)	(1)	(1)	(1)
Claiborne			67,693	90,938
Cocke	42,000	48,480	42,318	48,828
Coffee	(1)	(1)	(1)	(1)
Cumberland	(1)	(1)	(1)	(1)
Davidson	2,275,800	2,727,495	2,363,647	2,664,980
Decatur	220,000	257,000	284,631	355,789
De Kalb	45,348	45,348	57,123	57,123
Dickson	(1)	(1)	(1)	(1)
Fayette	39,647	105,000		
Fentress	137,800	159,200	123,820	152,560
Franklin	634,332	733,669	711,572	815,680
Giles	240,000	336,000	240,000	336,000
Greene	(1)	(1)	(1)	(1)
Grundy	26,000	28,000	26,602	30,905
Hamblen	239,823	330,559	375,780	498,127
Hamilton	(1)	(1)	(1)	(1)
Hawkins	37,390	53,542	14,611	18,522
Humphreys	630,893	849,750	537,109	713,941
Jefferson	(1)	(1)	(1)	(1)
Johnson	(1)	(1)	(1)	(1)
Knox	1,820,464	2,073,257	1,780,342	1,981,132
Lincoln	(1)	(1)	71,933	92,074
Loudon			(1)	(1)
Macon	72,477	108,717	123,328	166,492
Marion	966,944	1,370,440	766,748	988,637
Marshall	(1)	(1)	(1)	(1)
Maury	(1)	(1)	(1)	(1)
McMinn	(1)	(1)	(1)	(1)
Meigs	(1)	(1)	(1)	(1)
Monroe	105,000	147,000	(1)	(1)
Montgomery	(1)	(1)	(1)	(1)
Perry	18,163	25,770		
Putnam	302,000	377,500	(1)	(1)
Rhea	(1)	(1)	(1)	(1)
Roane	(1)	(1)	(1)	(1)
Robertson	(1)	(1)	(1)	(1)
Rutherford	(1)	(1)	(1)	(1)
Sequatchie	(1)	(1)	(1)	(1)
Sevier	121,527	174,491	299,007	439,594
Smith	(1)	(1)	(1)	(1)
Stewart	(1)	(1)		
Sullivan	659,965	908,458	425,390	553,413
Sumner	(1)	(1)	(1)	(1)
Unicoi			36,615	46,867
Union			18,000	23,040
Warren	(1)	(1)	(1)	(1)
Washington	211,146	263,932	182,435	209,800
Wayne			(1)	(1)
White	(1)	(1)	(1)	(1)
Williamson	307,522	387,108	350,741	446,751
Wilson	492,451	541,994	649,061	547,497
Undistributed	8,455,636	10,980,438	10,008,619	13,002,812
Total	18,536,674	23,472,494	19,873,012	24,736,635

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

TABLE 9.—Crushed limestone sold or used by producers, by uses

Use	1959			1960		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	14,360,894	$18,109,353	$1.26	15,329,811	$19,101,191	$1.25
Cement and lime	2,257,092	2,479,139	1.10	2,123,524	1,994,259	.94
Agstone	1,118,476	1,617,692	1,45	1,304,610	1,984,169	1.52
Railroad ballast	243,019	311,574	1.28	587,318	759,831	1.29
Stone sand	164,154	240,967	1.47	208,767	306,516	1.47
Riprap	(1)	(1)	(1)	18,492	18,398	.99
Filter beds	2,400	5,400	2.25	(1)	(1)	(1)
Other [2]	390,639	708,369	1.81	300,490	572,271	1.90
Total	18,536,674	23,472,494	1.27	19,873,012	24,736,635	1.24

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Includes fluxing stone, glass, paper, asphalt filler, fertilizer filler, rock dust for coal mines, mineral food, other uses, and uses indicated by footnote 1.

TABLE 10.—Dimension marble sold or used by producers, by uses

Use	1959			1960		
	Cubic feet	Value		Cubic feet	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Building stone:						
Interior, cut, dressed	(1)	(1)	(1)	112,200	$2,229,058	$19.87
Interior, rough	170,578	$424,114	$2.49	(1)	(1)	(1)
Interior, sawed, dressed	126,993	1,080,077	8.51	70,326	705,249	10.03
Other uses [2]	262,769	2,191,795	8.34	231,449	462,893	2.00
Total	560,340	3,695,986	6.60	413,975	3,397,200	8.21

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other uses."
[2] Includes exterior sawed and rough interior building stone; dressed and sawed monumental stone; and uses indicated by footnote 1.

for rough architectural, sawed, and dressed building stone and for flagging. Leading producers were Tennessee Stone Co., Inc., and Crab Orchard Stone Co., Inc. Production decreased 1 percent and was 31 percent below the record of 1955.

Vermiculite.—Zonolite Co. exfoliated vermiculite from other States at its Nashville plant.

MINERAL FUELS

Coal.—Bituminous coal was mined at 415 mines in 17 counties, compared with 480 mines in 17 counties in 1959. Leading counties were Anderson, Marion, and Campbell. Leading producers were Clinchfield Coal Co. (Meadow Creek mine), Pocahontas Fuel Co. (Morco mine), and Windrock Coal & Coke Co. (Dean mine). Production was about the same as in 1959 and was 33 percent below the 1956 record. Average production per mine increased from 12,300 to 14,300 tons.

In the northern part of the State (District 8), 267 mines in 9 counties produced 4,235,000 tons of coal, compared with 3,491,000 tons produced by 292 mines in 9 counties in 1959. Average production per mine increased from 12,000 to 15,900 tons. Underground mines produced 63 percent of the total; strip mines, 33 percent; and auger mines, 4 percent. Shipments were 61 percent by rail or water and 39 percent by truck. Captive tonnage was 3 percent of the total.

Equipment used at 196 underground mines included 114 cutting machines that cut 85 percent of the total, 156 power drills that drilled 84 percent, 81 locomotives, 39 shuttle cars, 9 rope hoists, 9 mother conveyors, 22 mobile loading machines that loaded 54 percent, 2 continuous-mining machines that loaded 14 percent, and 38 face conveyors that loaded 6 percent. Equipment used at 60 strip mines included 82 power shovels, 2 draglines, 63 bulldozers, 24 power drills, and 186 trucks. Equipment used at 11 auger mines included 11 coal-recovery augers, 2 bulldozers, 2 power drills, and 14 trucks. Nineteen percent of the coal was crushed.

In the southern part of the State (District 13), 148 mines in 8 counties produced 1,695,000 tons, compared with 2,422,000 tons produced by 188 mines in 8 counties in 1959. Average production per mine decreased from 12,900 to 11,500 tons. Underground and auger mines produced 79 percent of the total, and strip mines produced 21 percent. Shipments were 67 percent by rail or water and 33 percent by truck. The coal was sold in open market, mainly to TVA. Production in District 13 decreased partly owing to closing of the Coal Valley mine in Marion County by Tennessee Consolidated Coal Co.

Equipment used at 136 underground mines included 91 cutting machines, that cut 81 percent of the total, 146 power drills that drilled 86 percent, 30 locomotives, 9 shuttle cars, 1 rope hoist, 12 mother conveyors, 15 mobile loading machines that loaded 15 percent, and 14 conveyors that loaded 18 percent. Equipment used at 11 strip mines

TABLE 11.—Coal production, by counties

County	1959		1960	
	Short tons	Value	Short tons	Value
Anderson	1,067,197	$4,582,788	1,613,244	$5,999,046
Bledsoe	40,649	142,271	23,268	75,317
Campbell	470,309	1,631,833	643,181	2,190,859
Claiborne	158,494	691,637	246,083	887,181
Cumberland	107,007	367,789	84,400	326,430
Fentress	122,644	381,340	104,384	299,777
Grundy	173,837	695,651	167,859	723,948
Hamilton	46,765	156,292	37,062	116,745
Marion	1,607,002	7,120,618	816,768	2,640,668
Morgan	551,248	2,242,035	479,764	1,772,250
Overton	92,089	276,267	118,278	238,665
Putnam	409,956	1,721,553	391,986	1,723,342
Rhea	127,147	298,795	80,278	188,653
Scott	511,882	1,954,209	554,076	2,024,331
Sequatchie	345,370	1,070,673	505,528	1,750,286
Van Buren	70,623	223,261	62,491	192,470
White	10,505	23,636	1,800	4,050
Total	5,912,724	23,580,648	5,930,450	21,154,018
Earliest record to date	388,498,000	(1)	394,428,000	(1)

[1] Data not available.

included 16 power shovels, 2 draglines, 14 bulldozers, 7 power drills, and 22 trucks. Equipment used at 1 auger mine included 1 coal-recovery auger and 5 trucks. Of the total tonnage, 13 percent was crushed.

Coke.—Tennessee Products & Chemical Corp. produced metallurgical coke at byproduct coke ovens in Chattanooga. Peabody-Wright Corp. planned to build a chemical coke plant at Columbia, Tenn. Most of the products were to be used by existing chemical companies in Columbia. The plant was to be adjacent to the Hooker Chemical Co. operations, and Hooker would be one of the purchasers of the chemical coke, for use in producing elemental phosphorus. Coal tar and other byproducts may be shipped to other parts of the United States. The plant was scheduled for operation in early 1961.

Natural Gas.—Marketed production of natural gas increased 21 percent. At the end of the year there were 30 producing gas wells. Cumulative production of natural gas since 1916 was 3,289 million cubic feet.

Petroleum.—Production of crude petroleum was the same as in 1959. At yearend there were 27 producing oil wells. Cumulative production since 1916 was 615,000 barrels valued at $1,029,000.

METALS

Copper.—Tennessee Copper Co. recovered copper concentrate from sulfide ore mined in Polk County. Production of recoverable copper increased 11 percent above the 1959 record. The company continued sinking the Cherokee shaft, which will connect with a haulage drift from the Central shaft on the 10th level.

Ferroalloys.—Shipments of ferromanganese, silicomanganese, ferrosilicon, ferrochromium, ferrochromic silicon, and ferrophosphorus totaled 83,000 tons valued at $10,861,000, compared with 135,700 tons valued at $23,519,000 in 1959.

Gold.—Tennessee Copper Co. recovered gold as a byproduct from smelting copper and zinc concentrates. Production increased 24 percent but was 82 percent below the record of 1930.

Iron Ore.—Rucker Mining Co. and Big Flag Springs Mining Co. mined brown iron ore in McMinn and Blount Counties. Walt Mining Co. mined red iron ore in Union County. Production of iron ore increased 61 percent but was 96 percent below the record of 1902.

Manganese Ore.—Virginia Iron, Coal & Coke Co. mined a small quantity of metallurgical-grade manganese ore in Carter County. Turner mines produced a small quantity of manganiferous ore in Unicoi County.

Pig Iron.—Tennessee Products & Chemical Corp. produced foundry, basic, low-phosphorous, malleable, and chrome-bearing pig iron in Rockwood and Wrigley. Shipments declined 17 percent. Imported iron ore, from Chile, amounted to 3 percent of the total iron ore consumed.

Silver.—Tennessee Copper Co. recovered silver as a byproduct from smelting copper and zinc concentrates. Production increased 8 percent but was 42 percent below the record of 1920.

Zinc.—Tennessee again led as a zinc-producing State. Production of recoverable zinc increased 2 percent over the 1959 record.

TABLE 12.—Mine production of recoverable gold, silver, copper, lead, and zinc

Year	Gold		Silver		Copper	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Short tons	Value (thousands)
1951-55 (average)	216	$8	55,768	$50	8,303	$4,872
1956	189	7	64,878	59	10,499	8,882
1957	172	6	54,407	49	9,790	5,893
1958	124	4	44,592	41	9,109	4,791
1959	99	3	59,739	54	11,490	7,055
1960	123	4	64,560	58	12,723	8,168
1831-1960	23,872	578	3,775,015	2,778	506,808	178,304

Year	Lead		Zinc		Total
	Short tons	Value (thousands)	Short tons	Value (thousands)	Value (thousands)
1951-55 (average)	9	$3	37,132	$10,395	$15,328
1956	5	1	46,023	12,610	21,559
1957			58,063	13,471	19,419
1958			59,130	12,063	16,899
1959			89,932	20,684	27,796
1960			91,394	23,580	31,810
1831-1960	27,092	3,176	1,443,732	287,126	471,962

TABLE 13.—Mine production of gold and silver, 1831–1960

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1831-80	8,118	$167,793			8,118	$167,793
1881	85	1,750			85	1,750
1882	12	250			12	250
1883	36	750			36	750
1884	15	300			15	300
1885	15	300			15	300
1886	24	500			24	500
1887	24	500			24	500
1888	53	1,100			53	1,100
1889	36	750			36	750
1890	48	1,001			48	1,001
1891	25	519			25	519
1892	49	1,006			49	1,006
1893	12	250			12	250
1894	16	329			16	329
1895	16	329			16	329
1896	15	300			15	300
1897	5	100			5	100
1898	43	900			43	900
1899	24	500			24	500
1900	5	100			5	100
1901	12	250	5	$6	17	256
1902	7	145	12,300	15,903	12,307	16,048
1903	38	800	13,000	16,808	13,038	17,608
1904	208	4,300	59,200	34,336	59,408	38,636
1905	160	3,300	95,500	58,255	95,660	61,555
1906	39	800	25,600	17,328	25,639	18,128
1907	184	3,800	58,300	38,500	58,484	42,300
1908	179	3,700	60,900	32,600	61,079	36,300
1909	208	4,300	65,300	33,900	65,508	38,200
1910	135	2,800	69,800	37,700	69,935	40,500
1911	562	11,621	106,660	56,530	107,222	68,151
1912	400	8,265	89,893	55,284	90,293	63,549
1913	367	7,595	108,105	65,295	108,472	72,890
1914	300	6,194	97,402	53,864	97,702	60,058
1915	332	6,862	100,543	50,975	100,875	57,837
1916	278	5,739	94,701	62,213	94,979	67,952

TABLE 13.—Mine production of gold and silver, 1831–1960—Continued

Year	Gold		Silver		Total	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1917	258	$5,326	99,053	$81,619	99,311	$86,945
1918	235	4,866	93,620	93,620	93,855	98,486
1919	274	5,662	98,288	110,083	98,562	115,745
1920	282	5,830	110,719	120,684	111,001	126,514
1921	238	4,920	98,762	98,762	99,000	103,682
1922	209	4,320	78,341	78,341	78,550	82,661
1923	320	6,615	105,712	86,684	106,032	93,299
1924	329	6,800	94,779	63,502	95,108	70,302
1925	359	7,421	102,949	71,446	103,308	78,867
1926	417	8,622	104,000	64,896	104,417	73,518
1927	426	8,816	81,460	46,188	81,886	55,004
1928	538	11,117	75,558	44,201	76,096	55,318
1929	565	11,680	81,281	43,323	81,846	55,003
1930	696	14,388	83,640	32,201	84,336	46,589
1931	403	8,325	41,000	11,890	41,403	20,215
1932	160	3,315	19,300	5,443	19,460	8,758
1933	223	5,712	39,869	13,954	40,092	19,666
1934	455	15,902	61,148	39,530	61,603	55,432
1935	423	14,805	47,151	33,890	47,574	48,695
1936	410	14,350	50,330	38,980	50,740	53,330
1937	263	9,205	49,057	37,946	49,320	47,151
1938	236	8,260	38,333	24,781	38,569	33,041
1939	163	5,705	31,994	21,717	32,157	27,422
1940	173	6,055	38,610	27,456	38,783	33,511
1941	227	7,945	39,161	27,848	39,388	35,793
1942	159	5,565	34,671	24,655	34,830	30,220
1943	303	10,605	52,058	37,019	52,361	47,624
1944	222	7,770	45,907	32,645	46,129	40,415
1945	148	5,180	35,391	25,167	35,539	30,347
1946	95	3,325	18,016	14,557	18,111	17,882
1947	303	10,605	79,147	71,628	79,450	82,233
1948	156	5,460	39,692	35,923	39,848	41,383
1949	171	5,985	41,833	37,861	42,004	43,846
1950	160	5,600	39,958	36,164	40,118	41,764
1951	108	3,780	24,960	22,590	25,068	26,370
1952	241	8,435	57,569	52,103	57,810	60,538
1953	293	10,255	68,935	62,390	69,228	72,645
1954	218	7,630	60,759	54,990	60,977	62,620
1955	221	7,735	66,619	60,294	66,840	68,029
1956	189	6,615	64,878	58,718	65,067	65,333
1957	172	6,020	54,407	49,241	54,579	55,261
1958	124	4,340	44,592	40,358	44,716	44,698
1959	99	3,465	59,739	54,306	59,838	57,771
1960	123	4,305	64,560	58,430	64,683	62,735
Total	23,872	578,435	3,775,015	2,777,521	3,798,887	3,355,956

American Zinc Co. of Tenn. operated the North Friends Station, Young, Coy, and Grasselli mines in Jefferson County, and the Mascot No. 2 mine in Knox County. New Jersey Zinc Co. operated the Jefferson City mine in Jefferson County and the Flat Gap mine in Hancock County. Tennessee Coal & Iron Division of United States Steel Corp. operated the Zinc Mine Works in Jefferson County. Tennessee Copper Co. recovered zinc concentrate from copper-zinc ores mined in Polk County. Total crude ore milled was 4,007,000 tons.

American Zinc Co. of Tenn. announced that its ore reserve in the East Tennessee Zinc District amounted to more than 5 million tons of 60-percent zinc concentrates. The company entered into an agreement with Tri-State Zinc, Inc., to develop a zinc property southwest of New Market, Tenn. The joint operation was to be known as New Market Zinc Co.

New Jersey Zinc Co. closed the Flat Gap mine at the end of the year for an indefinite period.

Exploration and development at zinc and copper-zinc mines included: Diamond drilling, 137,400 feet; percussion drilling, 41,263 feet; drifting, 36,625 feet; long-hole drilling, 22,247 feet; raising, 6,266 feet; churn drilling, 2,550 feet; sinking, 2,356 feet; crosscutting, 896 feet; and winzing, 36 feet.

REVIEW BY COUNTIES

Mineral production was reported from 77 counties in the State, the same as in 1959; the leading counties were Jefferson, Knox, Polk, Maury, and Davidson. In addition to the commodities listed in table 14, small quantities of oil and gas were produced, county origin of which was undetermined.

Anderson.—The Moore mine (Pocahontas Fuel Co.) and the Dean and Windrock No. 2 mines (Windrock Coal & Coke Co.) were the leading producers of the 56 active coal mines. Ralph Rogers & Co. (Oak Ridge quarry) and Anderson County Highway Department (Taylor's Quarry No. 1) crushed limestone for concrete, roads, and stone sand. Lalite Corp. mined miscellaneous clay for lightweight aggregate.

Bedford.—Shelbyville Limestone Co. and Bedford County Highway Department (Delton Baker quarry) crushed limestone for concrete, roads, and railroad ballast.

Benton.—Seven mines produced sand and gravel for structural, paving, molding, glass, and grinding and polishing uses. The leading producers were Hardy Sand Co. (Silica and Camden mines) and Camden Gravel Co.

Bledsoe.—Eight coal mines were active; leading producers were the No. 1 mine (Hugh Allison Coal Co.), the No. 1 mine (Hankins Coal Co.), and the No. 3 mine (Dillard Coal Co.).

TABLE 14.—Value of mineral production in Tennessee, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value[2]
Anderson	(3)	(3)	Coal, limestone, miscellaneous clay.
Bedford	(3)	(3)	Limestone.
Benton	$1,284,016	$1,132,952	Sand and gravel.
Bledsoe	142,271	75,317	Coal.
Blount	(3)	(3)	Marble, limestone, iron ore.
Bradley	(3)	(3)	Limestone.
Campbell	2,183,716	2,624,577	Coal, limestone, sandstone.
Cannon	30,000	(3)	Limestone.
Carroll		(3)	Sand and gravel.
Carter	(3)	(3)	Limestone, sandstone, granite, manganese ore.
Claiborne	691,637	978,119	Coal, limestone.
Cocke	48,480	82,128	Limestone, barite.
Coffee	(3)	(3)	Limestone.
Cumberland	(3)	(3)	Sandstone, limestone, coal, sand and gravel.
Davidson	8,162,786	10,249,335	Cement, limestone, phosphate rock, sand and gravel, lime, miscellaneous clay.
Decatur	(3)	(3)	Limestone, sand and gravel.
De Kalb	45,348	57,123	Limestone.
Dickson	(3)	(3)	Do.
Fayette	161,600	68,600	Sand and gravel.
Fentress	(3)	456,937	Coal, limestone, sandstone.
Franklin	(3)	4,368,947	Cement, limestone, sand and gravel, miscellaneous clay.
Giles	(3)	(3)	Phosphate rock, limestone, sand and gravel.
Greene	(3)	(3)	Limestone, scrap mica, sand and gravel.
Grundy	723,651	754,853	Coal, limestone
Hamblen	330,559	498,127	Limestone.

See footnotes at end of table.

TABLE 14.—Value of mineral production in Tennessee, by counties[1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value[2]
Hamilton	$7,122,063	$6,684,360	Cement, limestone, sand and gravel, coal, miscellaneous clay.
Hancock	(3)	(3)	Zinc ore.
Hardeman	14,660	16,490	Sand and gravel.
Hawkins	53,550	19,022	Limestone, gemstones.
Haywood	65,000	80,142	Sand and gravel.
Henderson	(3)	(3)	Do.
Henry	(3)	(3)	Ball clay, fuller's earth.
Hickman	(3)	(3)	Phosphate rock.
Humphreys	(3)	(3)	Limestone, sand and gravel.
Jefferson	(3)	(3)	Zinc ore, limestone.
Johnson	(3)	(3)	Limestone.
Knox	16,972,602	16,607,235	Cement, zinc ore, limestone, marble, lime, sand and gravel, miscellaneous clay.
Lauderdale	44,350	75,379	Sand and gravel.
Lincoln	(3)	92,074	Limestone.
Loudon	41,870	116,374	Miscellaneous clay, barite, limestone, sand and gravel.
Macon	108,717	166,492	Limestone.
Marion	(3)	(3)	Coal, cement, limestone.
Marshall	(3)	(3)	Limestone.
Maury	9,728,406	10,701,807	Phosphate rock, limestone.
McMinn	(3)	(3)	Limestone, barite, iron ore.
McNairy	(3)	(3)	Sand and gravel.
Meigs	(3)	(3)	Limestone.
Monroe	(3)	(3)	Limestone, sand and gravel, barite.
Montgomery	(3)	(3)	Limestone.
Morgan	2,242,035	1,772,250	Coal.
Obion	103,600	92,000	Sand and gravel.
Overton	276,267	238,665	Coal.
Perry	25,770	----------	
Polk	(3)	(3)	Copper, pyrite, zinc ore, silver, gold.
Putnam	2,162,753	(3)	Coal, limestone, sand and gravel.
Rhea	(3)	(3)	Limestone, coal, miscellaneous clay.
Roane	(3)	(3)	Limestone.
Robertson	(3)	(3)	Do.
Rutherford	(3)	(3)	Do.
Scott	1,954,209	2,024,331	Coal.
Sequatchie	(3)	(3)	Coal, limestone.
Sevier	179,491	439,594	Limestone.
Shelby	1,773,982	1,560,284	Sand and gravel, miscellaneous clay.
Smith	(3)	(3)	Limestone.
Stewart	(3)	(3)	Sand and gravel.
Sullivan	(3)	(3)	Cement, limestone, miscellaneous clay.
Sumner	(3)	(3)	Limestone, sand and gravel.
Tipton	(3)	(3)	Sand and gravel.
Unicoi	(3)	426,104	Sand and gravel, limestone, manganese ore.
Union	(3)	(3)	Marble, iron ore, limestone.
Van Buren	223,261	192,470	Coal.
Warren	(3)	(3)	Limestone, sand and gravel.
Washington	(3)	(3)	Limestone, miscellaneous clay.
Wayne	(3)	(3)	Sand and gravel, limestone.
Weakley	(3)	1,910,144	Ball clay.
White	(3)	(3)	Limestone, coal.
Williamson	(3)	(3)	Phosphate rock, limestone.
Wilson	541,994	547,497	Limestone.
Undistributed[4]	83,299,356	78,329,271	
Total	140,738,000	143,439,000	

[1] The following counties are not listed because no production was reported: Cheatham, Chester, Clay, Crockett, Dyer, Gibson, Grainger, Hardin, Houston, Jackson, Lake, Lawrence, Lewis, Madison, Moore, Pickett, Trousdale.

[2] Petroleum and natural gas not listed by counties as data are not available; value included with "Undistributed."

[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[4] Includes value of petroleum and natural gas and values indicated by footnote 3.

Blount.—John J. Craig Co. (Crisp, Hamil, Marmor, and Lee quarries), Gray Knox Marble Co. (Brown and French Pink quarries), and Tennessee 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. crushed lime-

stone for concrete, roads, and agstone at the Maryville quarry. Big Flag Spring Mining Co. mined brown iron ore at the Wilson mine.

Bradley.—Bradley Limestone Co., Inc., crushed limestone for concrete, roads, and railroad ballast at the Welch quarry.

Campbell.—Sixty-nine coal mines were active; leading producers were the No. 1 Strip mine (Dixie Pine Coal Co.), the Red Ash Strip mine (Price Coal Co.), and the No. 2 Strip mine (Howard Coal Co.). Key Limestone (LaFollette quarry) and Jellico Stone Co., Inc. (Jellico quarry), produced limestone for riprap, concrete, roads, and agstone. One producer crushed sandstone for concrete and roads.

Cannon.—Woodbury Stone Co. crushed limestone for concrete, roads, and agstone at the Norvell quarry.

Carroll.—Hardy Sand Co. mined structural and grinding and polishing sand at the Bruceton mine.

Carter.—Watauga Stone Co. crushed limestone for concrete, roads, railroad ballast, and stone sand. Major Sand Co., Inc., crushed sandstone for concrete and roads. Blue Ridge Stone Co. crushed granite for concrete and roads at the Greer quarry. Virginia Iron, Coal & Coke Co. (Stoney Creek mine) mined metallurgical grade manganese ore.

Claiborne.—Nineteen coal mines were active; leading producers were the No. 1 Strip mine (Rich Gap Coal Co.), the No. 1 mine (Harris Branch Coal Co.), and the No. 1 Auger mine (J & G Coal Co.). Lambert Bros. crushed limestone for concrete and roads.

Cocke.—Wolf Creek Mining Co., Inc. (Meyer mine), mined barite for chemicals. Cocke County Highway Department crushed limestone for concrete and roads at the Smith quarry.

Coffee.—Ralph Rogers & Co., Inc. (Coffee quarry), and Coffee County Highway Department crushed limestone for concrete, roads, and agstone.

Cumberland.—Ten companies quarried dimension sandstone for rough architectural, sawed and dressed building stone, and flagging. The leading producers were Tennessee Stone Co., Inc. (McGuire quarry) Crab Orchard Stone Co., Inc. (Peck quarry), and Turner Bros. Stone Co., Inc. Southern States Lime Mfg. Co. (Crab Orchard mine) and Cumberland County Highway Department (County quarry) crushed limestone for fluxing stone, concrete, roads, railroad ballast, agstone, glass, paper, rock dust for coal mines, filter beds, mineral food, and other uses. Thirteen coal mines were active; leading producers were the No. 2 Strip mine (Waters Coal Co.), the No. 7 Strip mine (Allen Bros. Coal Co.) and the No. 1 Strip mine (George Ed Lewis). Potter Sand & Gravel Co. mined structural, paving, and other sand and gravel.

Davidson.—Davidson County ranked fifth in total value of mineral production. Marquette Cement Mfg. Co. produced masonry and portland cements at the Nashville mill throughout the year. Seven quarries produced limestone for riprap, concrete, roads, agstone, asphalt filler, and fertilizer filler; the leading producers were Lambert Bros. (Danley, Hermitage, and Old Hickory quarries) and Menifee Crushed Stone Co. (Nashville quarry).

Monsanto Chemical Co. and Harsh Phosphate Co. mined marketable phosphate rock. Cumberland River Sand & Gravel Co. mined

structural and paving sand and gravel. Victor Chemical Works produced lime for industrial uses. W. G. Bush & Co., Inc., mined miscellaneous clay for heavy clay products. Tennessee Products & Chemical Corp. (Nashville plant) expanded crude perlite from Western States. Zonolite Co. exfoliated crude vermiculite from South Carolina and Montana at the Nashville mill.

Decatur.—Western Materials, Inc. (Parsons quarry), crushed limestone for concrete, roads, and agstone. Tinker Sand & Gravel Co. mined structural and paving sand and gravel at the Perryville mine.

De Kalb.—De Kalb County Highway Department crushed limestone for concrete and roads at the Chapman Hollow quarry.

Dickson.—Duke Lime & Stone Co. crushed limestone for concrete, roads, agstone, and stone sand at the Duke mine.

Fayette.—Fayette County Highway Department mined paving gravel at the County mine.

Fentress.—Twenty coal mines were active; leading producers were the Highland mine (Murphy Coal Co.), the Wilder mine (Wilder Coal Co.), and the new No. 3 mine (Hollis Miller Coal Co.). Frogge & Williams, Inc. (Wright quarry), crushed limestone for concrete, roads, and agstone. Kentucky-Tennessee Stone Co. quarried dimension sandstone for dressed building stone and flagging at the Jamestown quarry.

Franklin.—Marquette Cement Mfg. Co. produced masonry and portland cements at the Cowan mill throughout the year. Marquette Cement Mfg. Co. (Cowan quarry), Cowan Stone Co. (Cowan quarry and Anderson mine), and Franklin County Highway Department (Bostick quarry) crushed limestone for cement, concrete, roads, railroad ballast, agstone, glass, and other uses. Estill Springs Sand-Gravel Co. mined structural sand and gravel. Marquette Cement Mfg. Co. mined miscellaneous clay for use in cement.

Giles.—Monsanto Chemical Co. and International Minerals & Chemical Corp. (Wales mine) mined marketable phosphate rock for use in agriculture, pig-iron blast furnaces, and elemental phosphorus. Cedar Grove Lime Co. crushed limestone for concrete, roads, and agstone. Giles County Highway Department mined paving and fill gravel.

Greene.—Malone Bros. Co., Agricultural Lime Co., Inc. (Greenville quarry), and Greene County Highway Department (Ratcliffe quarry) crushed limestone for concrete, roads, and agstone. International Minerals & Chemical Corp. recovered scrap mica from silt deposits in Davy Crockett Lake. Nolichuckey Sand Co. (Bewley mine) and Buster Sand Co. mined structural sand and gravel.

Grundy.—Eight coal mines were active; leading producers were the No. 1 Strip mine (Ramsey Coal Co.), the Commando Strip mine (Phipps Coal Co.), and the Church Strip mine (Church Coal Co.). Viola White Lime Co. crushed limestone for concrete, roads, and agstone at the Old State quarry.

Hamblen.—White Pine Stone Co. crushed limestone for concrete and roads at the Hamblen quarry.

Hamilton.—Signal Mountain Portland Cement Division of General Portland Cement Co. produced masonry and portland cements at the Signal Mountain mill throughout the year. Chattanooga Rock

Products, Division of Vulcan Materials Co., crushed limestone for concrete, roads, railroad ballast, and agstone at the Chattanooga quarry. Dixie Sand & Gravel Co. (Dixie mine) mined structural sand and gravel. Twelve coal mines were active; leading producers were the Dill mine (Dill Coal Co.), the No. 1 mine (Dave Frizzell Coal Co.), and the No. 6 mine (Walter Frizzell). Hood Ceramic Corp. mined miscellaneous clay for floor and wall tile.

Hancock.—New Jersey Zinc Co. recovered zinc from zinc ores mined at the Flat Gap mine.

Hardeman.—Tri-State Sand Co. mined structural sand at the Saulsbury mine.

Hawkins.—Lambert Bros., crushed limestone for concrete and roads at the McCloud quarry. Willard Pratt collected a small quantity of gem stones (barite crystals).

Haywood.—Haywood County Highway Department mined paving gravel.

Henderson.—Ayers Mineral Co. mined molding sand at the Zane mine.

Henry.—Kentucky-Tennessee Clay Co. (Tennessee mine), H. C. Spinks Clay Co. (Henry mine), and Dixie Brick & Tile Co. (Puryear mine) mined ball clay for whiteware, floor and wall tile, firebrick and block, saggers, pins, stilts, and wads, heavy clay products, and for export. Southern Clay Co. Inc. (Porters Creek mine), and Tennessee Absorbent Clay Co. (Paris mine) mined fuller's earth for absorbent uses.

Hickman.—M. C. Boyle Phosphate Co. mined marketable phosphate rock at the Bratton mine for agricultural uses.

Humphreys.—Lambert Bros. crushed limestone for concrete, roads, railroad ballast, and agstone at the Rock Hill quarry. Sangravl Co., Inc., mined structural sand and gravel.

Jefferson.—Jefferson County led in total value of mineral production. American Zinc Co. of Tennessee (Young, Coy, Grasselli, and North Friend's Station mines), New Jersey Zinc Co. (Jefferson City mine), and Tennessee Coal & Iron Division of United States Steel Corp. (Zinc mine works) recovered zinc from zinc ores. Limestone was produced as a byproduct from zinc mines; this material was used for concrete, roads, railroad ballast, agstone, and stone sand.

Johnson.—Maymead Lime Co. crushed limestone for concrete, roads, and agstone.

Knox.—Knox County ranked second in total value of mineral production. Volunteer Portland Cement Co. produced masonry and portland 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. Gray Knox Marble Co. (Gray Knox quarry), Tennessee Marble Co. (Eagle quarry), and Appalachian Marble Co. (Appalachian and Bond quarries) produced dimension marble for rough and dressed building stone and for cut, dressed monumental stone. Appalachian Marble Co. and Knoxville Crushed Stone Co. crushed marble for terrazzo and other uses.

Nine quarries and one mine produced crushed limestone for concrete, roads, lime, railroad ballast, agstone, and cement. Leading producers were Volunteer Portland Cement Co. (Knoxville quarry)

and Lambert Bros. (City, Biagotti, Neuberts, and Kennedy quarries). Standard Lime & Stone Co., Division of American-Marietta Co., and Williams Lime Mfg. Co. produced lime for building, chemical, and industrial uses. Knoxville Sand & Gravel Co., Oliver King Sand-Lime Co., and Cameron Sand & Gravel Co. mined structural, paving, grinding and polishing, and engine sands, and structural and paving gravel. Four mines produced miscellaneous clay for cement, lightweight aggregate, and heavy clay products; Shalite Corp. was the leading producer.

Lauderdale.—Lauderdale County Highway Department mined paving gravel.

Lincoln.—Lincoln County Highway Department crushed limestone for concrete and roads.

Loudon.—Old Hickory Brick Co. (Greenback mine) mined miscellaneous clay for heavy clay products. B. C. Wood (Cedar Fork mine) and Smith Mines, Inc., mined barite. Cherokee Stone Co. crushed limestone for concrete and roads. Brooks Sand & Gravel Division of Vulcan Materials Co. mined structural sand.

Macon.—Dixon & Stubblefield crushed limestone for concrete, roads, and cement at the Langford quarry.

Marion.—Sixty-seven coal mines were active; leading producers were the Reels Cove mine (Tennessee Products & Chemical Corp.), the RC 51 mine (Thomas Coal Co.), and the Whitco Strip mine (Whitwell Coal Corp.). Penn-Dixie Cement Corp. produced portland cement at the Richard City mill. Signal Mountain Portland Cement Division (Bennetts Lake quarry), Penn-Dixie Cement Corp., and Marion Stone Co. (Ketchall quarry) crushed limestone for cement, concrete, roads, and agstone.

Marshall.—Lewisburg Limestone Co. crushed limestone for concrete, roads, and agstone.

Maury.—Maury County ranked fourth in total value of mineral production. Six mines produced marketable phosphate rock; leading producers were Monsanto Chemical Co. and Victor Chemical Works. Columbia Rock Products Corp. crushed limestone for concrete, roads, and agstone at the Theta Pike mine.

McMinn.—Floyd D. Webb Stone Co. (Webb quarry) and McMinn County Highway Department (Athens quarry) crushed limestone for concrete, roads, and agstone. National Lead Co. (Ballard mine) and McMinn Barium Corp. (Athens mine) mined barite. Rucker Mining Co. mined brown iron ore at the Nonaburg mine.

McNairy.—Worsham Bros. mined structural, paving, railroad ballast, and other sand and gravel.

Meigs.—Ten Mile Stone Co. and Meigs Stone Co. produced limestone for riprap, concrete, roads, and agstone.

Monroe.—Creighead Limestone Co. and Monroe County Highway Department (Howells quarry) crushed limestone for concrete and roads. Vonore Sand Co. mined structural sand. National Lead Co. mined barite at the Roy mine.

Montgomery.—Simpson Stone Co. (Simpson quarry) and Clarksville Stone Co. (Clarksville mine) crushed limestone for concrete, roads, and railroad ballast.

Morgan.—Forty-two coal mines were active; leading producers were the No. 7 and No. 10 mines (Brushy Mountain Coal Mines), and the No. 6 Strip mine (Allen Bros. Coal Co.).

Obion.—Obion County Highway Department mined paving gravel at the County mine.

Overton.—Fourteen coal mines were active; leading producers were the Branch Strip mine (Jarab, Inc.), the Pine Ridge mine (Pine Ridge Coal Co.), and the Love Joy Strip mine (Dixie Mining Co.).

Polk.—Polk County ranked third in total value of mineral production. Tennessee Copper Co. produced mixed sulfide ore at the Boyd, Calloway, Eureka, and Mary mines. The ore, concentrated in one flotation mill, yielded copper, iron (pyrite), and zinc concentrates; gold and silver were recovered as byproducts from smelting the copper and zinc concentrates; the iron concentrate was roasted, yielding sulfur dioxide, for use mainly in manufacturing sulfuric acid, and iron oxide, which was sintered for use by iron and steel plants. The company continued development work at the Cherokee shaft.

Putnam.—The Meadow Creek mine (Clinchfield Coal Co.) was the only active coal mine. Algood Limestone Co. (Poteet quarry) and Putnam County Highway Department crushed limestone for concrete, roads, and agstone. Sand, Inc., mined structural and paving sand at the Monterey mine.

Rhea.—Rhea County Limestone Co. crushed limestone for concrete, roads, and agstone at the Dayton quarry. Seven coal mines were active; leading producers were the No. 1 mine (Kirkwood Fuel Co.), the No. 2 mine (Piney Knob Coal Co.), and the Bumbee mine (Norris Coal Co.). W. S. Dickey Clay Mfg. Co. mined miscellaneous clay for heavy clay products at the Graysville Clay mine.

Roane.—A. B. Long Quarries, Inc. (Swan Pond quarry), and Lambert Bros. (Rockwood quarry) produced limestone for riprap, concrete, roads, railroad ballast, agstone, and stone sand.

Robertson.—Porter Brown Limestone Co., crushed limestone for concrete, roads, and agstone.

Rutherford.—A&R Stone Co., Inc., crushed limestone for concrete, roads, agstone, and stone sand.

Scott.—Thirty-three coal mines were active; leading producers were the Straight Fork mine (Straight Fork Coal Co., Inc.), the Dean No. 2 Strip mine (Dean Coal Co., Inc.), and the Lassie No. 1 mine (Laddie Coal & Mining Co.).

Sequatchie.—Thirty-six coal mines were active; leading producers were the No. 1 Strip mine (Tennessee Steam Coal Co.), the 7-204 mine (Oak Coal Co.), and the Colton Strip mine (Walden Ridge Coal Co.). Dunlap Stone Co. crushed limestone for concrete, roads, and agstone at the Sequatchie quarry.

Sevier.—Lambert Bros. (Sevier quarry) and Sevier County Highway Department crushed limestone for concrete and roads.

Shelby.—Eight mines produced structural, paving, and fill sand and gravel. Leading producers were Cordova Sand & Gravel Co., Memphis Stone & Gravel Co. (York and East Plant mines), and W. S. Jordan Gravel Co. Moss Lightweight Aggregate Co. (Clay mine) and John A. Denie's Sons Co. (Memphis mine) mined miscellaneous clay for lightweight aggregate and heavy clay products.

Smith.—Oldham Limestone Co. produced limestone for riprap, concrete, roads, and agstone at the Rome quarry.

Stewart.—Sangravl Co., Inc., mined structural and paving sand and gravel at the Dover mine.

Sullivan.—Penn-Dixie Cement Corp. produced masonry and portland cements at the Kingsport mill throughout the year. Lambert Bros. crushed limestone for concrete, roads, and agstone. General Shale Products Co. and Penn-Dixie Cement Corp. mined miscellaneous clay for cement and heavy clay products.

Sumner.—Pilot Knob Limestone Co. and Ralph Rogers & Co., Inc., crushed limestone for concrete, roads, agstone, and stone sand. Sumner County Highway Department mined paving gravel.

Tipton.—Clyde Owen Sand & Gravel Co. and Tipton County Highway Department mined structural and paving sand and gravel.

Unicoi.—Brooks Sand & Gravel Division mined structural and paving sand, and structural, paving, and railroad ballast gravel. Turner Mines and James Rucker mined manganiferous ore at the Bumpass Cove mine. Unicoi County Highway Department crushed limestone for concrete and roads.

Union.—Tennessee Marble Co. quarried dimension marble for rough and dressed building stone at the Luttrell quarry. Walt Mining Co. mined red iron ore at the Riddle mine. Union County Highway Department crushed limestone for concrete and roads.

Van Buren.—Nine coal mines were active; leading producers were the D & H Strip mine (D & H Coal Co.), the No. 1 mine (I. E. Brown Coal Co.), and the No. 4 mine (Johnnie Hankins Coal Co.).

Warren.—Warren Limestone Co. (McMinnville mine) crushed limestone for concrete, roads, and railroad ballast. Cumberland Mountain Sand Co. mined structural sand.

Washington.—Washington County Highway Department crushed limestone for concrete and roads. General Shale Products Corp. mined miscellaneous clay for heavy clay products.

Wayne.—Hassell & Dowdy Sand & Gravel Co. (Baker mine) mined structural sand and gravel. Universal Limestone Co. crushed limestone for concrete, roads, and railroad ballast.

Weakley.—United Clay Mines Corp. (No. 6 mine), Bell Clay Co. (Collins mine), and H. C. Spinks Clay Co. (Gleason mine) mined ball clay for whiteware, art pottery, high-grade tile, rubber filler, pastes, and enameling.

White.—Sparta Limestone Co. and White County Highway Department crushed limestone for concrete, roads, and agstone. The No. 3 mine (Lester Broom Coal Co.) was the only active coal mine.

Williamson.—Monsanto Chemical Co. mined marketable phosphate rock for elemental phosphorus. Lambert Bros. (Franklin quarry) and Williamson County Highway Department (Globe quarry) crushed limestone for concrete, roads, and agstone.

Wilson.—Marquette Cement Mfg. Co. (Martha quarry), Wilson County Rock Products, Inc., and Lebanon Limestone Co. crushed limestone for cement, concrete, roads, and agstone.

The Mineral Industry of Texas

This chapter was prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and The University of Texas, Bureau of Economic Geology.

By F. F. Netzeband,[1] Thomas R. Early,[2] and Roselle M. Girard[3]

MINERAL PRODUCTION in Texas remained below the record 1957 level of $4.5 billion for the third consecutive year. The 1960 total mineral value of $4.1 billion, 2 percent less than in 1959, generally reflected weaknesses exhibited by the Nation's economy after the first half of 1960. Only 10 of the 27 minerals and mineral fuels produced in Texas recorded increases from their 1959 levels.

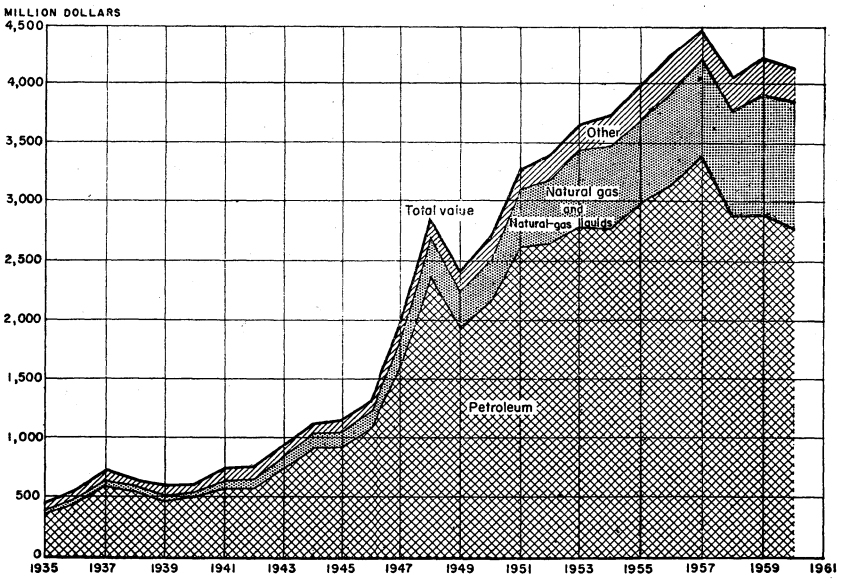

FIGURE 1.—Value of petroleum, natural gas, and natural gas liquids, and total value of mineral production in Texas, 1935–60.

[1] Commodity-industry analyst, Bureau of Mines, Bartlesville, Okla.
[2] Commodity-industry economist, Bureau of Mines, Bartlesville, Okla.
[3] Geologist, Bureau of Economic Geology, The University of Texas, Austin, Tex.

TABLE 1.—Mineral production in Texas[1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand 376-pound barrels	27,991	$88,067	23,365	$76,577
Clays[2]—thousand short tons	3,870	5,703	3,302	5,058
Gem stones	(3)	100	(3)	100
Gypsum—thousand short tons	1,351	4,770	1,131	3,960
Helium—thousand cubic feet	238,113	3,918	120,921	2,044
Lime—thousand short tons	809	8,530	821	9,087
Natural gas—million cubic feet	5,718,993	617,651	5,892,704	665,876
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	2,790,155	209,238	2,880,906	207,583
LP gases—do	4,353,368	181,148	4,476,142	200,478
Petroleum (crude)—thousand 42-gallon barrels	971,978	2,893,146	[4] 933,632	[4] 2,766,972
Salt—thousand short tons	4,519	17,498	4,756	18,222
Sand and gravel—do	35,295	34,726	29,844	30,754
Stone—do	42,172	47,787	39,029	45,088
Sulfur (Frasch-process)—thousand long tons	2,970	68,998	2,747	62,855
Talc and soapstone—short tons	60,945	283	67,031	336
Value of items that cannot be disclosed: Abrasive stones (1959), asphalt (native), bromine, clay (fuller's earth), coal (lignite), feldspar, graphite, iron ore (usable), magnesium chloride (for metal), magnesium compounds (except for metal), mercury, pumice (1959), sodium sulfate, and uranium ore	----------	48,544	----------	49,666
Total Texas[5]	----------	[6] 4,219,757	----------	4,134,901

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain clays; value included with "Value of items that cannot be disclosed."
[3] Weight not recorded.
[4] Preliminary figures.
[5] Total has been adjusted to eliminate duplicating the value of clays and stone.
[6] Revised figure.

Mineral fuels, which form the dominant component of the mineral industry of Texas, supplied 93 percent of the total mineral value, about the same percentage they have contributed for the past several years. In 1957, the peak year for value of mineral production, crude petroleum accounted for 74 percent; natural gas, 11 percent; and natural gas liquids, 8 percent of the total, compared with distribution in 1960 as follows: Crude petroleum, 67 percent; natural gas, 16 percent; and natural gas liquids, 10 percent. Thus, increasing internal competition among the mineral fuels, in addition to reduced crude petroleum production in 1960, was, to a large degree, responsible for stemming the decade of almost continuous growth of the mineral industry in Texas.

Reduced output was reported in 1960 for most of the nonmetals produced in significant quantities except lime and salt. The construction minerals recorded an average 8-percent decline from 1959 values as a result of a 6-percent drop in new construction. Increasing foreign and domestic competition was primarily responsible for an 8-percent decrease in sulfur production.

The State's metal mining and metallurgical industry retained its importance in the State and the National economy. Brazoria County was again the Nation's major source of magnesium metal. The brown iron ores of Cass, Cherokee, and Morris Counties supplied a large part of the pig iron used by Texas metal manufacturers and fabricators. Uranium "yellow cake" was produced in the State's first uranium mill from uranium ores mined within the State. Texas' 18

metallurgical plants contributed significantly to U.S. supplies of aluminum, antimony, copper, lead, tin, and zinc.

Employment data are reported in table 2. Employment in mining and related industries reflected the slight downward movement characteristic of the mineral industry in 1960. However, the chemical industry continued its rapid expansion with a 4-percent increase in employment.

The Port Arthur refinery of Texaco, Inc., established a world's safety record for refineries with 7,647,716 man-hours without a lost-time injury.

TABLE 2.—Employment data in mining and related industries

Industry	Employment		Weekly hours worked		Weekly earnings	
	1959 [1]	1960	1959	1960	1959	1960
Manufacturing	488,800	490,000	41.6	41.1	$89.02	$89.19
Primary metals	24,000	24,700	40.9	38.9	101.84	100.75
Chemicals	42,800	44,700	41.3	41.1	119.36	121.66
Petroleum and coal products	43,100	41,600	40.4	40.2	119.99	121.00
Machinery (oil field)	39,200	39,700	44.0	40.2	106.92	100.10
Transportation equipment	60,100	53,200	39.9	40.4	99.75	114.33
Nonmanufacturing	2,024,000	2,051,500				
Mining	129,500	123,200	43.1	42.1	109.04	106.93
Crude petroleum	122,200	116,400	43.0	42.0	110.51	108.78
Sulfur	7,300	6,800	40.1	40.0	112.28	114.80
Construction	164,000	161,100				

[1] Revised figures.

Source: Texas Employment Commission, in cooperation with U.S. Bureau of Labor Statistics.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Oversupply of crude petroleum and certain refinery products resulted in severe proration of crude oil production, general weakening of crude prices, gasoline price wars, curtailment of exploratory and development drilling, lower employment and employee income, and lower financial returns to State and county governments. Crude oil producers and refiners were also faced with mounting competition for markets from both natural gas and imported crude oil. Natural gas and natural gas liquids were able to increase their output and, except for natural gasoline, their value as well.

Prorated oil production in Texas was limited to a record low of 104 days in 1960 with 8-day allowables for the period May through November, 19 days less than allowed in 1959. The oil and gas industry drilled 14,901 wells, a decrease of 15 percent from the 17,564 wells drilled during 1959. Exploratory drilling resulted in completion of 606 oil wells, 480 gas wells, and 2,922 dry holes; a success ratio of 27 percent, the same as in 1959. Of 10,893 development wells drilled, 7,255 produced oil, 1,203 produced gas, and 2,435 were dry holes.

Total crude stocks were reduced 7 percent to 85.4 million barrels; stocks of refined products rose 3 percent to a grand total of 86 billion barrels; gasoline stocks rose 15 percent to 36.3 billion barrels.

Natural gas sales gained 3 percent to 5,407 billion cubic feet; 55

percent or 2,976 billion cubic feet was shipped from the State. The number of producing gas wells increased 10 percent to 25,809 wells at yearend.

The world's first sextuple gas-well completion was made by Sunray Mid-Continent Oil Co. in North LaWard field in Jackson County. The well flowed 248 million cubic feet of gas a day through various chokes from 6 producing zones ranging from 4,600 to 6,650 feet. The world's largest natural gasoline and cycling plant, the 950-million-cubic-foot-per-day King Ranch plant of Humble Oil & Refining Co., began operating in September.

Asphalt, Native.—Uvalde County supplied all the native asphalt produced. Production was 18 percent lower than that of 1959, reflecting curtailed highway construction and maintenance operations as a result of inclement weather in the first quarter of the year.

Carbon Black.—The carbon black industry recovered 1,085 million pounds valued at $84 million—6 percent more than in 1959 and 53 percent of the entire domestic carbon black production. The industry consumed 124 billion cubic feet of natural gas for an average yield of 3.75 pounds of material per 1,000 cubic feet of gas, and 180 million gallons of gas liquids for an average yield of 4.32 pounds of material per 1,000 gallons of natural gas liquids. There were 24 producing carbon black plants, compared with 22 plants in 1959. Plants in the Panhandle counties—Carson, Gray, Hutchinson, Moore, and Wheeler—supplied 52 percent of the State output.

Helium.—Helium production from two plants, at Amarillo and Exell, declined 10 percent in 1960. The apparent production loss was due to production from the plant at Keyes, Okla., being shipped directly to markets since no helium storage facilities were available at the Oklahoma site. Helium recovered in excess of shipments in Texas was stored.

Lignite.—Lignite, used as fuel to generate electric power and as raw material for manufacturing activated carbon, was mined at open pits in Milam and Harrison Counties.

Natural Gas.—Marketed production of natural gas was a record 5,893 billion cubic feet, 3 percent more than the 1959 production. Gas wells produced 75 percent of the marketed gas; oil wells accounted for the remaining 25 percent. According to the Railroad Commission of Texas, an average of 25,809 gas wells were producing, compared with 23,381 gas wells in 1959. Of 14,901 wells completed during 1960, 1,683 were gas wells. Natural gas was produced in 180 counties.

Estimated natural gas reserve at yearend totaled 119,489,393 million cubic feet or 45 percent of the National reserve, according to American Gas Association statistics.

TABLE 3.—Marketed production of natural gas[1]

Year	Million cubic feet	Value (thousands)	Year	Million cubic feet	Value (thousands)
1951-55 (average)	4,318,826	$311,957	1958	5,178,073	517,807
1956	4,999,889	434,990	1959	5,718,993	617,651
1957	5,156,215	500,153	1960	5,892,704	665,876

[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.—The 1960 output of 7,357 million gallons of natural gas liquids, valued at $408 million, established a new record, and was 3 percent greater than the 1959 record output. As in 1959, LP gases accounted for nearly 61 percent of the recovered liquid. Principal industrial consumers were the expanding petrochemical and synthetic rubber industries. Natural gas liquids were produced in 100 counties.

There were 226 gasoline plants, 16 pressure maintenance plants, and 26 cycling plants recovering natural gas liquids at yearend. Eleven new gasoline plants were built during the year. They were the Alto Loma plant of Margaret Hunt Trust Estate in Galveston County; the Lake Houston plant of Natural Gas Engineering Co., Inc., in Harris County; the Bethel plant of Texaco, Inc., and the Cayuga plant of Tidewater Oil Co., in Anderson County; the Dyes plant of Valera Oil Co. in Taylor County; the Davis plant of Mesquite Gas Products, Inc., in Upton County; the H. J. Strawn plant of Midland Petrochemical Co., Inc., in Tom Green County; the Block No. 31 plant of Atlantic Refining Co. in Crane County; the Salt Creek plant of General Crude Oil Co. in Kent County; the Lamesa plant of Texaco-Seaboard, Inc., in Dawson County; and the Pampa plant of Amarillo Oil Co. in Gray County. Four gasoline plants were shut down during the year.

TABLE 4.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1951–55 (average)	2,715,193	$197,204	2,742,271	$95,207	5,457,464	$292,411
1956	2,964,609	216,378	3,731,047	144,745	6,695,656	361,123
1957	2,944,381	201,423	3,831,664	147,618	6,776,045	349,041
1958	2,871,589	204,501	3,786,575	151,896	6,658,164	356,397
1959	2,790,155	209,238	4,353,368	181,148	7,143,523	390,386
1960	2,880,906	207,583	4,476,142	200,478	7,357,048	408,061

According to the American Gas Association, the proved recoverable reserve of natural gas liquids increased to 3.6 billion barrels and amounted to 53 percent of the Nation's total reserve.

Petroleum.—Despite curtailed production, Texas retained leadership in crude petroleum reserve, facilities, and activities. 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 growing petrochemical industry, operated more drilling rigs and exploratory development projects, and invested more capital in improvement of its oil reserve than any other state.

Because of excessive stocks of crude oil and certain refined products, and continued weakness in demand for domestic crudes which prevailed through most of 1960, crude oil production declined 4 percent to 933.6 million barrels. Stocks of gasoline and distillate fuels remained substantially above normal requirements, resulting in general weaken-

ing of wholesole prices and gasoline price wars at the retail level. The imbalance of supply-demand resulted in strict proration of Texas crude oil production.

TABLE 5.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951-55 (average)	1,015,829	$2,757,674	1958	940,166	$2,872,389
1956	1,107,808	3,131,225	1959	971,978	2,893,146
1957	1,073,867	3,338,119	1960 [1]	933,632	2,766,972

[1] Preliminary figures.

TABLE 6.—Crude petroleum production, indicated demand, and stocks in 1960, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks originating in Texas	Month	Production	Indicated demand	Stocks originating in Texas
January	84,147	87,520	107,759	September	75,029	75,086	96,358
February	79,488	78,224	109,023	October	75,333	75,891	95,800
March	83,412	79,082	113,353	November	75,797	73,869	97,728
April	77,905	78,747	112,511	December	80,039	77,154	100,613
May	75,936	80,892	107,555				
June	75,063	78,381	104,237	Total:			
July	75,396	80,721	98,912	1960	933,632	944,151	----------
August	76,087	78,584	96,415	1959	971,978	989,898	----------

Crude oil output came from 197 counties—26 counties produced over 10 million barrels and 117 counties produced more than 1 million barrels. The five leading counties in order of value of output were Ector, Andrews, Crane, Scurry, and Gregg.

Texas had 192,627 producing oil wells at yearend, an increase of 3,693 or 2 percent over 1959. Average daily production amounted to 13.2 barrels per well, compared with 14.2 barrels per well in 1959.

The proved recoverable reserve of crude oil declined 101 million barrels to 14,758 million barrels as of January 1, 1961, according to the American Petroleum Institute. Exploratory drilling added 91 million barrels to the proved reserve; development drilling in the form of extensions and revisions added 704 million barrels. Texas had 47 percent of the total U.S. oil reserve and 48 percent of the total liquid-fuel reserve, including gas liquids.

Average indicated daily demand for crude oil amounted to 2,488,800 barrels, 8 percent less than in 1959.

TABLE 7.—Production of crude petroleum, by districts and fields

(Thousand barrels)

District and field [1]	1959	1960 [2]
Gulf Coast:		
Amelia	(3)	(3)
Anahuac	4,096	3,491
Barbers Hill	1,385	1,339
Beaumont-West	(3)	(3)
Bloomington	853	767
Boling	1,341	1,237
Chocolate Bayou	3,953	4,057
Conroe	6,958	6,001
Damon Mound	(3)	(3)
Dickinson-Gillock	2,967	3,077
Dyersdale	(3)	(3)
Esperson	976	909
Fairbanks	700	526
Falls City	(3)	(3)
Fannette	1,578	1,731
Francitas	815	641
Friendswood-Webster	6,865	5,801
Gohlke, Helen	1,246	1,041
Goose Creek	2,541	2,468
Greta	1,905	1,471
Hankamer	1,064	1,203
Hastings	9,318	7,741
Heyser	(3)	1,300
High Island	3,958	4,600
Houston-North-South	950	(3)
Hull	3,222	2,632
Humble	1,151	1,184
Liberty, South	4,565	3,560
Livingston	(3)	(3)
Lolita	1,703	1,505
Lovells Lake	751	416
McFadden	477	459
Manvel	1,099	1,055
Markham	1,701	1,356
O'Connor, Tom	7,049	7,697
Old Ocean	4,471	3,709
Oyster Bayou	2,148	1,822
Pierce Junction	3,846	2,962
Placedo	910	791
Port Neches	881	937
Raccoon Bend	1,348	1,293
Refugio-Fox	1,824	1,595
Saratoga	1,119	937
Silsbee	2,047	1,460
Sour Lake	1,151	1,039
Stowell	615	507
Sugarland	616	518
Sugar Valley	695	637
Thompson	5,979	5,186
Tomball	1,619	1,523
Village Mills	2,137	1,578
West Columbia	2,934	2,942
West Ranch	4,713	4,137
Withers-Magnet	2,230	1,629
Other Gulf Coast	66,530	63,810
Total Gulf Coast	183,000	168,277
East Texas:		
East Texas Proper	53,691	49,029
Cayuga	937	899
Ham Gossett	462	419
Hawkins	10,796	9,174
Long Lake	681	524
New Hope	1,933	1,533
Pewitt Ranch	661	581
Pickton	808	603
Quitman	2,478	2,909
Talco	4,280	4,109
Van	5,700	4,885
Waskom	902	709
Woodlawn	384	(3)
Other East Texas	22,690	26,497
Total East Texas	106,403	101,871
Central Texas:		
Big Foot	1,686	1,435
Charlotte	1,474	1,255
Darst Creek	3,331	3,674
Luling	1,832	1,568
Other Central Texas	7,062	9,338
Total Central Texas	15,385	17,270
South Texas:		
Aqua Dulce	1,038	947
Flour Bluff	(3)	(3)
Fulton Beach	2,051	2,265
Garcia	(3)	(3)
Hoffman	1,384	1,240
Kelsey	2,568	2,295
London	(3)	(3)
Midway	(3)	(3)
Mirando	3,335	4,763
Mustang Island	2,207	1,515
Plymouth	6,157	6,385
Portilla	(3)	(3)
Saxet-Saxet Frio	790	685
Seeligson	7,838	8,050
Stratton	1,746	1,143
Sun	1,644	1,941
Taft	899	1,929
White Point	2,275	2,109
Willamar, West	1,512	1,346
Other South Texas	35,615	32,533
Total South Texas	71,059	69,146
North Texas	120,307	117,302
Panhandle	36,750	38,570
West Texas:		
Abell	1,366	1,251
Adair	1,915	1,886
Andector	2,815	3,254
Anton Irish-Anton	2,068	1,789
Benedum	1,520	1,282
Big Lake	(3)	(3)
Block 31	5,786	5,787
Bronte	1,252	1,060
Cedar Lake	1,088	1,152
Cogdell	6,188	5,281
Cowden	10,460	10,480
Cree-Sykes	807	710
Diamond M	5,903	6,123
Dollarhide	3,218	3,018
Elkhorn	(3)	(3)
Embar	1,702	1,290
Emma	3,033	2,749
Fort Chadborne	3,369	2,745
Fort Stockton	1,084	994
Foster	3,049	2,874
Fuhrman	3,969	3,743
Fullerton	6,087	5,834
Garza	2,040	1,766
Goldsmith	23,890	22,253
Good	1,381	1,549
Harper	1,927	1,497
Headlee	3,002	4,830
Hendrick	1,625	1,665
Howard-Glasscock	6,310	6,167
Hulldale Penn	1,340	1,255
Iatan-East and North	1,834	1,788
Jameson	2,971	2,560
Jordan	2,934	2,648
Kelly Snyder	21,072	17,557
Kermit	5,231	5,413
Keystone	5,962	4,679
Lea	963	830
Levelland	6,427	5,842
Luther	910	834
McCamey	1,885	1,889
McElroy	9,249	8,882

See footnotes at end of table.

TABLE 7.—Production of crude petroleum, by districts and fields—Continued

(Thousand barrels)

District and field [1]	1959	1960 [2]	District and field [1]	1959	1960 [2]
West Texas—Continued			West Texas—Continued		
McFarland	2,134	1,534	Todd	1,462	1,414
Mabee	1,636	1,533	Triple N	1,626	1,332
Magutex	2,223	2,011	TXL	4,425	3,870
Martin	1,456	1,234	University	3,682	3,602
Means	4,803	4,046	Vealmoor-East	2,072	1,780
Midland Farms	6,746	6,076	Waddell	2,526	2,669
Pegasus	3,984	4,047	Ward-Estes	19,544	21,186
Penwell	2,679	3,018	Wasson	12,830	12,005
Prentice	4,284	3,470	Welch	2,087	1,909
Reinecke	1,014	860	Wellman	[3]	[3]
Robertson	3,033	3,179	Westbrook	1,597	1,418
Russell	5,206	4,903	Wilshire	1,390	1,320
Salt Creek	3,952	3,333	World	1,800	1,702
Sand Hills	5,294	4,788	Yarbrough	1,294	779
Seminole	3,802	3,261	Yates	6,343	5,495
Shafter Lake	2,487	2,132	Other West Texas	126,182	130,551
Sharon Ridge	3,857	3,146	Total West Texas	439,074	421,196
Slaughter	8,712	8,188			
Sprayberry Trend	12,738	10,162	Total Texas	971,978	933,632
Three Bar	858	657			
Tippett	1,684	1,380			

[1] Texas Railroad Commission districts.
[2] Prelmilnary figures.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Other" fields.

TABLE 8.—Prospecting and drilling in 1960, by counties

County	Geophysical prospecting (crew-weeks)					Drilling						Total
						Development			Exploratory			
	Seismic	Gravity	Magnetic	Core drill	Total	Oil	Gas	Dry	Oil	Gas	Dry	
Anderson	34			1	35	47	6	18	7		26	104
Andrews	64				64	352	1	18	9	2	10	392
Angelina	3			25	28			1			1	2
Aransas	12				12	5	2	3	3		5	18
Archer	20				20	308	5	128	11		15	467
Armstrong	1				1							
Atascosa	17				17	17	3	10	2		15	47
Austin	49				49	6	2	3			6	17
Bandera		15			15						2	2
Bastrop	30		24	3	57	1		1	1		11	14
Baylor	16				16	68		52	2		23	145
Bee	79				79	3	25	8	3	12	30	81
Bell											1	1
Bexar						25		14			3	42
Borden	13				13	40		7	2		8	57
Bowie	21				21						2	2
Brazoria	104				104	32	6	28	4	5	21	96
Brazos	13	1			14		1			2	2	5
Brewster	17	30			47						2	2
Briscoe	27				27							
Brooks	47				47	2	6	11	2	6	3	30
Brown						13	2	8	2	2	16	43
Burleson	17				17						1	1
Caldwell						77		7			6	90
Calhoun	49				49	1	30	9	2	14	13	69
Callahan						19		11	4		42	76
Cameron	69				69		2	2		3	9	16
Camp	12				12	1		1			1	3
Carson						74	13	18	1	3	6	115
Cass	120				120	23	3	4	1	2	5	38
Castro	6	10			16						1	1
Chambers	104	3			107	20	8	15	1	3	19	66
Cherokee	12			28	40	4	1	9	1		23	38
Childress	34	1		1	36						2	2
Clay	5				5	95		23	8		3	129
Cochran	4				4	28		1	1		9	39
Coke	5	4	4		13	8		2	4		11	25

TABLE 8.—Prospecting and drilling in 1960, by counties—Continued

County	Geophysical prospecting (crew-weeks)					Drilling						Total
						Development			Exploratory			
	Seismic	Gravity	Magnetic	Core drill	Total	Oil	Gas	Dry	Oil	Gas	Dry	
Coleman	2				2	61	10	19	5	6	34	135
Collin	9	6			15							
Collinsworth	4				4	1	29	8				38
Colorado	79				79	2	20	5		3	17	47
Comanche						1	3	2			8	14
Concho	4				4					1	12	13
Cooke	12				12	135		72	7		59	273
Coryell											1	1
Cottle	2	3		5	10						2	2
Crane	5				5	208	2	17	11	2	18	258
Crockett	32	4			36	94	9	19	1	4	26	153
Crosby	11				11	5		2	1		3	11
Culberson	77	2			79	4	1	3	1	1	8	18
Dallam	2				2		2	5			6	13
Dawson	92				92	27		5	5		8	45
Deaf Smith	1				1							
Delta	10				10					1	4	5
Denton	5				5	3	2	15		2	9	31
De Witt	238	24			262	6	7	14	2	13	15	57
Dickens								1			3	4
Dimmit	16				16	30	3	15	6	3	27	84
Donley	25	3			28							
Duval	55				55	55	18	52	9	24	61	219
Eastland	7				7	8	6	7	2		8	31
Ector	14				14	325		13	10		4	352
Edwards	43	18			61						2	2
Ellis											3	3
Erath							25	1			2	28
Falls	3				3	2		4			1	7
Fannin	2				2						1	1
Fayette	57				57						2	2
Fisher	13	7			20	16	2	8	2	1	9	38
Floyd	1			4	5							
Foard	16	4		26	46	9		4	2		15	30
Fort Bend	11				11	32	2	18	1	1	9	63
Franklin	10				10	2	5	1			4	12
Freestone	7				7	7	13	11		2	13	46
Frio	10				10	14	3	5			1	23
Gaines	107				107	104	5	19	6		11	145
Galveston	79	8			87	51	4	21	1	6	8	91
Garza	37				37	49		10	4		14	77
Glasscock	9				9	6		9	1		11	27
Goliad	35				35	2	16	7	2	12	14	53
Gonzales	40				40			1		1	20	22
Gray	8				8	101	38	15	1		3	158
Grayson	66			7	73	37	3	6	7	2	11	66
Gregg	1				1	19	8	7		1		35
Grimes	19				19					1	1	2
Guadalupe						38		2			9	49
Hale	8				8							
Hall	10	19			29						3	3
Hamilton	28				28						3	3
Hansford						16	29	20	4	5	3	77
Hardeman	25	12		1	38	2			1		8	11
Hardin	37				37	59	2	22	4	3	16	106
Harris	21				21	71	3	41	1	1	8	125
Harrison	5				5	105	10	3	3	2	6	129
Hartley	31				31						2	2
Haskell	9				9	82		38	8		37	165
Hemphill	15				15		1		1	2	3	7
Henderson	59	3		2	64	1	7	13	1		12	34
Hidalgo	128				128	4	41	16	4	24	22	111
Hill						1		4			4	9
Hockley	39	2			41	34		9	1		10	54
Hopkins	36	3			39						10	10
Houston	6	3		16	25		2	9			9	20
Howard	4				4	83		11	4		12	110
Hudspeth	4	8			12							
Hunt	16				16					1	6	7
Hutchinson	2				2	228	30	16	1	2	3	280
Irion	10	6	7		23	16		19	6	1	27	69
Jack	10				10	62	16	37	13		13	141
Jackson	64				64	14	57	29	11	15	49	175
Jasper	17	13			30		1	1	2		7	11
Jeff Davis		5			5						1	1

TABLE 8.—Prospecting and drilling in 1960, by counties—Continued

County	Geophysical prospecting (crew-weeks)					Drilling						Total
						Development			Exploratory			
	Seismic	Gravity	Magnetic	Core drill	Total	Oil	Gas	Dry	Oil	Gas	Dry	
Jefferson	67				67	45	32	20	3	5	27	132
Jim Hogg	28				28	59	10	4	5	2	15	95
Jim Wells	3				3	8	11	9	9	12	29	78
Johnson											1	1
Jones	4				4	68		42	10		57	177
Karnes	126				126	30	2	9	10	2	19	72
Kaufman	5	1			6						7	7
Kenedy	48	5			53			1	1	1	6	9
Kent						4		5	4		14	27
Kerr											1	1
Kimble										1	10	11
King	1				1	2		8			9	19
Kinney	10	30		23	63				1		5	6
Kleberg	28	2			30	11	9	4	9	15	7	55
Knox				6	6	70		40	3		18	131
Lamar	1				1						2	2
Lamb	7				7	6		1			4	11
La Salle	31				31	4	2	8	1	2	19	36
Lavaca	171				171		19	5		5	8	37
Lee	14				14				1			1
Leon	17				17	5	2	2			12	21
Liberty	91				91	57	4	25	4		24	114
Limestone	12				12	8	6	5	1		16	36
Lipscomb						7	11	10	8	8	9	53
Live Oak	200				200	9	5	18	2	13	44	91
Loving	18				18	65		10			10	85
Lubbock	53				53	6		1	1		8	16
Lynn	10				10	7		3	1		11	22
McCulloch							1	1		2	1	5
McLennan						1		1			2	4
McMullen	25				25	26	13	13	4	4	52	112
Madison	4	4			8			1	1			2
Marion	23	1			24	13		5	2		5	25
Martin	76				76	15		1	7		4	27
Matagorda	208				208	36	24	29	11	18	49	167
Maverick	16				16	200	6	19		2	37	264
Medina			10		10	29		1			9	39
Menard						15		3	2		15	35
Midland						38	46	1	2		2	89
Milam	15				15	1			1		7	9
Mills											2	2
Mitchell	6				6	55		4	1		7	67
Montague	16				16	79		29	6		11	125
Montgomery	63				63	1	1			1	7	10
Moore	22				22	8	15	3	2		3	31
Morris	29	1			30						4	4
Motley	18	7		30	55	5					5	10
Nacogdoches	12	4			16	4						4
Navarro	13				13	123		25			28	176
Newton	51	23			74	14	2	12	3	2	8	41
Nolan	45	2			47	25		10	7		13	55
Nueces	16				16	30	7	11	16	9	29	102
Ochiltree	1				1	60	48	21	12	20	4	165
Oldham	1				1						2	2
Orange	9				9	11	2	5	2	1	6	27
Palo Pinto						16	18	13		17	18	82
Panola	1			3	4	32	4	4	1		5	46
Parker						1	16	13		6	7	43
Pecos	433	31			464	99	13	36	12	10	65	235
Polk	25				25	3	1				2	6
Potter	36				36		8	3		3	2	16
Presidio	51	17			68							
Rains	28	3			31						1	1
Randall	11				11						2	2
Reagan	20				20	58			2	2	1	63

TABLE 8.—Prospecting and drilling in 1960, by counties—Continued

County	Geophysical prospecting (crew-weeks)					Drilling						Total
						Development			Exploratory			
	Seismic	Gravity	Magnetic	Core drill	Total	Oil	Gas	Dry	Oil	Gas	Dry	
Real		17			17							
Red River	6				6						13	13
Reeves	362	15			377	38	20	7	2	1	22	90
Refugio	30				30	58	18	17	7	11	11	122
Roberts	9				9		18	1	2	1	6	28
Robertson	16				16		1	1			3	5
Runnels	11			4	15	53	6	41	21	3	62	186
Rusk	15				15	124	10	15	6	4	7	166
San Augustine	2	5			7						5	5
San Jacinto	8				8						4	4
San Patricio	22				22	16	6	12	12	17	24	87
San Saba											1	1
Schleicher	12	2			14	11	4	6	3		16	40
Scurry	44				44	68		11	1		15	95
Shackelford	26				26	76	2	57	7		94	236
Shelby	34	10			44	1			2		9	12
Sherman	3				3		11	8		1	6	26
Smith	12	32			44	58	2	11	5	2	32	110
Somervell											2	2
Starr	107				107	15	20	18	9	27	38	127
Stephens	31				31	33	8	24	9	6	11	91
Sterling	11	10	12		33	11		2	1		15	29
Stonewall	9	2		2	13	41		20	2		28	91
Sutton	6				6		2	1			3	6
Swisher	18				18						2	2
Tarrant	2				2							
Taylor	3	3			6	133		71	26	1	98	329
Terrell	68	15			83		1	1		1	1	4
Terry	9	1			10	7		2			10	19
Throckmorton	22				22	32		22	10		31	95
Titus	17				17	46		9	3		6	64
Tom Green	13	4	4		21	22		13	3		32	70
Travis								6			14	20
Trinity	17	2		3	22			1				1
Tyler	39				39	1		2			4	7
Upshur	6	3			9	30		13	2		12	57
Upton	33				33	130	3	8	4	2	6	153
Uvalde	2	12			14		5	4		2	5	16
Van Zandt	62	13			75	6		2	2		6	16
Victoria	49				49	6	25	11	3	11	13	69
Walker	14				14						3	3
Waller	23				23	1					2	3
Ward	29	4			33	118	2	18	6		11	155
Washington	38	5			43	5	1				2	8
Webb	68				68	11	8	20	7	2	63	111
Wharton	69				69	8	18	19	4	8	18	75
Wheeler	34				34	35	27	11				73
Wichita	2				2	320		93	1		5	419
Wilbarger	34				34	182		73	2		27	284
Willacy	49	2			51			1	3	2	7	13
Williamson						1					7	8
Wilson	11				11	14	1	18		1	33	67
Winkler	20	6			26	162	19	17	6	3	11	218
Wise						91	52	32	8	2	5	190
Wood	29				29	24	6	6	10	4	9	59
Yoakum	40				40	146		6	8		13	173
Young	26	4			30	145	8	78	15		17	263
Zapata	131				131	1	8	6		8	32	55
Zavala	76		37		113	5	2	3	2		49	61
Offshore	85	45			130				1		10	11
Total	6,997	560	98	190	7,845	7,255	1,203	2,435	606	480	2,922	14,901

Source: International Oil Scouts Association, International Oil and Gas Development, vol. 31, 1961.

TABLE 9.—Petroleum daily average production and runs to stills

(Thousand barrels)

Month	1959		1960	
	Crude production	Runs to stills	Crude production	Runs to stills
January	2,913	2,239	2,714	2,238
February	2,884	2,065	2,741	2,193
March	2,885	2,199	2,691	2,150
April	2,837	2,164	2,597	2,168
May	2,868	2,274	2,450	2,181
June	2,706	2,079	2,502	2,271
July	2,488	2,031	2,432	2,282
August	2,481	2,148	2,454	2,195
September	2,517	2,071	2,501	2,146
October	2,528	2,005	2,430	2,140
November	2,560	2,118	2,527	2,156
December	2,692	2,168	2,582	2,168

TABLE 10.—Runs to stills and output of refineries in 1960, by months

(Thousand barrels)

Month	Runs			Output					
	Crude	Products	Rerun	Gasoline	Kerosine	Fuel oil		Jet fuel	Miscellaneous
						Distillate	Residual		
January	69,390	6,270	−1,879	36,752	4,994	16,737	5,624	2,205	7,469
February	63,602	5,642	−3,329	33,685	3,786	14,428	4,725	2,181	7,110
March	66,653	6,058	−2,715	35,727	4,122	14,571	4,827	2,474	8,275
April	65,037	5,876	−2,080	35,300	3,062	14,724	4,857	2,396	8,494
May	67,615	6,239	−4,125	36,145	3,394	14,724	4,550	2,047	8,869
June	68,121	6,168	−2,754	36,914	3,166	15,374	4,923	2,685	8,473
July	70,738	6,587	−2,507	38,453	3,714	16,060	4,780	2,466	9,345
August	68,030	6,825	−1,286	38,395	3,949	15,827	4,840	2,107	8,451
September	64,365	6,708	−410	36,267	4,041	15,043	4,794	2,071	8,447
October	66,355	6,933	−1,780	36,941	4,133	16,037	4,561	2,016	7,820
November	64,668	6,580	−1,498	35,504	4,497	15,095	4,633	2,379	7,642
December	67,201	7,147	950	37,729	4,989	17,281	5,515	2,433	7,351
Total:									
1960	801,775	77,033	−23,413	437,812	47,847	185,901	58,629	27,460	97,746
1959	777,758	76,712	−22,962	419,042	38,203	186,948	65,605	29,305	92,405

Crude oil stocks as of December 31 amounted to 85.4 million barrels, of which 63.4 million barrels was in pipelines and tank farms, 7.3 million barrels in lease tanks, and 14.7 million barrels in storage at refineries.

Texas had nearly 70 oil refineries with a total daily crude capacity of 2.6 million barrels. Nearly 85 percent of the capacity was on the Gulf Coast adjacent to the Beaumont, Corpus Christi, and Houston areas. Refineries charged 801.8 million barrels of crude oil to stills during the year, 24 million barrels more than in 1959. Refinery output increased from 831.5 million barrels in 1959 to 855.4 million barrels. Most of the increase was gasoline, up 18.8 million barrels from 1959.

Industry expansions and new plants built are discussed in the County Review section. However, a few 1960 highlights are reported as follows: American Oil Co. added a 150,000-barrel-per-day crude running unit, a 47,600-barrel-per-day catalytic cracking unit, and a 14,600-barrel-per-day alkylation unit to its Texas City refinery; the

three new units replaced six units previously operating. Three units (a 12,000-barrel Houdry catalytic cracker, a 3,000-barrel thermocracker visbreaker, and a 1,850-barrel alkylation unit) at the Sinclair Refining Co. Corpus Christi refinery were shut down the last quarter of 1960. Phillips Petroleum Co. planned a 22 million-gallon-per-year high-purity benzene unit at its Sweeny refinery near Houston. The Railroad Commission of Texas reported a total of 350 proposed secondary recovery projects in about 70 counties, which were expected to recover an additional 750 million barrels of petroleum. The largest of these projects would be in the Spraberry Trend area in west Texas, with an estimated recovery of 200 million barrels. Mobil Oil Co. operated the State's first major field-wide pressure maintenance project (Parks field, Midland County), using propane injection followed by dry gas. Output of crude oil increased from 325 to 1,700 barrels per day. The project should recover 55 percent of oil in place, compared with 41 percent by conventional waterflood, and should extend the overall life of the 5,900-acre field from 6 to 12 years. A 20,000-barrel-per-day delayed-coker unit which will convert the heavy oil into lighter fractions as gasoline and fuel oil was added to the Beaumont refinery of Mobil Oil Co.

TABLE 11.—Stocks of crude petroleum at refineries, tank farms, and gathering systems in 1960, by months

(Thousand barrels)

Month	Refineries	Tank farms and pipelines	Lease tanks	Total
January	15,486	68,337	7,934	91,757
February	17,416	68,543	8,069	94,028
March	17,191	71,499	8,234	96,924
April	17,351	70,478	8,369	96,198
May	15,889	68,052	8,194	92,135
June	15,924	64,996	7,429	88,349
July	14,983	60,607	7,499	83,089
August	14,002	60,881	7,164	82,047
September	14,708	59,740	7,114	81,562
October	13,633	61,040	7,314	81,987
November	13,961	62,816	7,189	83,966
December	14,646	63,399	7,319	85,364

TABLE 12.—Stocks of refined products by refineries with plants and pipelines in 1960, by months

(Thousand barrels)

Month	Gasoline [1]	Kerosine	Fuel oil		Jet fuel	Natural gas liquids	Miscellaneous products
			Distillate	Residual			
January	34,685	3,074	13,446	7,426	1,687	773	22,045
February	35,783	2,932	12,216	7,207	1,799	801	23,544
March	36,920	2,781	9,718	7,732	1,747	693	24,036
April	35,522	2,978	10,830	6,834	2,132	678	23,534
May	32,189	3,775	11,667	6,890	1,989	831	24,259
June	31,396	3,722	12,501	7,004	2,220	699	24,416
July	31,839	4,338	15,555	7,190	2,185	616	25,222
August	31,472	4,021	16,261	8,306	2,280	590	24,059
September	32,784	4,432	18,564	8,550	1,782	694	22,887
October	32,828	4,400	19,686	8,594	1,534	818	23,247
November	32,967	4,310	16,757	8,098	1,572	706	23,170
December	36,287	3,950	14,600	7,735	1,740	576	21,143

[1] Includes naphtha.

Petrochemicals.—The petrochemical industry of Texas maintained its dominant National position through new products, installations, and expansions. There were 122 operating petrochemical plants most of which were along the Gulf Coast. More than half of the plants produced complex organic products, 6 produced nitrogen-based chemicals, 17 produced butadiene and copolymer products, and more than 40 recovered sulfur or produced carbon black. The aliphatics group of petrochemicals (ethylene, propylene, butylene, and acetylene) represented over half of the productive capacity. Aromatics (benzene, toluene, and xylene) and inorganic chemicals (ammonia, sulfur, and carbon black) supplied the remaining petrochemical productive capacity. Although the State's petrochemical industry was distinctly raw-material-orientated, availability of water transportation, particularly ocean freight from Gulf Coast ports and inland waterways of the Mississippi and Ohio Rivers, contributed significantly to advantages of the petrochemical industry's Gulf Coast locations.

Industries that consume large quantities of petrochemical products were expanding or building new facilities in Texas. For example, four companies were building or planning synthetic rubber plants having a combined capacity of 110,000 tons annually. Phillips Petroleum Co. was constructing a 25,000-ton-per-year butadiene plant at Borger; Firestore Tire & Rubber Co., a 30,000-ton-per-year polybutadiene plant at Orange; and Goodyear Tire & Rubber Co., a 30,000-ton-per-year plant at Beaumont. Goodrich-Gulf Chemical Co. planned a 25,000-ton-per-year polybutadiene plant at either Orange or at Institute, W. Va. Butyl rubber capacity of the Baytown refinery of Humble Oil & Refining Co. will range from 125 million pounds to 170 million pounds annually. The company planned to increase orthoxylene (an alternate to naphthalene) capacity from 44 million to 72 million pounds annually at its Baytown refinery. A $2 million Hydeal unit to produce 50 million gallons of benzene annually was being installed at the Texas City refinery of Plymouth Oil Co. Another $1 million Hydeal unit to produce 7 million gallons of benzene was added to the Corpus Christi refinery of Sun Tide Refining Co.

Pipelines.—Pipelines contributed to effectiveness and economy of major raw mineral fuels and stimulated distant markets by establishing cheaper means of transportation. Major pipeline expansion and construction projects were reported as follows: Construction began in April on the Nation's first LPG pipeline—a $71 million, 1,800-mile line which will move products from Texas and New Mexico to St. Paul, Minn., and Milwaukee, Wis. Capacity will be 50,000 barrels of products daily. A 1,080-mile, 60,000-barrel-per-day LPG pipeline will be built by Trans-Continental Gas Pipeline Corp. from Mont Belvieu, near Houston, to Danville, Va., with transfer terminals in Louisiana, Mississippi, Alabama, Georgia, North and South Carolina, and Virginia.

A $196 million, 1,890-mile pipeline to deliver 300 million cubic feet of gas daily from Western Texas and Oklahoma to the Los Angeles, Calif., area was completed by Trans-Western Pipeline Co. on August 9, with valve turning ceremonies at Needles, Calif. The project required 3 years to complete; pipeline construction, however, required only 9 months. Markets for new products in new areas were opened

to Texas Gulf Refining operations when Texas Eastern Transmission Corp. completed a 90-mile connecting link between its "Little Big Inch" and the transmission system of Buckeye Pipeline Co. Texas refineries with "Little Big Inch" connections are: Humble Oil & Refining Co., Baytown; Phillips Petroleum Co., Sweeny; Gulf Oil Corp., Port Arthur; Texas City Refining Co. and Republic Oil Refining Co., Texas City; Crown Central Petroleum Co. and Shell Oil Co., Houston; and Mobile Oil Co., Texas Gas Corp., and Atlantic Refining Co., Beaumont. Industrial areas served by this combination of facilities are Toledo and Cleveland, Ohio, and Detroit, Mich.

NONMETALS

The 15 nonmetals produced in 1960 were valued at $262 million, 6 percent of the State total mineral production value. The five principal nonmetal commodities, in order of value, were cement, sulfur, stone, sand and gravel, and salt. Production declines were reported for 10 of the 15 nonmetals; 2 of the 5 showing increases were lime and salt, which were consumed in large volumes by the expanding chemical industry.

Virtually all nonmetals except sulfur were produced for local markets because of their bulk weight and low unit price.

Important industry advances were made during the year. A $1 million plant to remove hydrocarbon and other trace impurities from "dark" sulfur and upgrade the product to premium "bright" sulfur was built at the Spindletop terminal of Texas Gulf Sulfur. A special process developed by the company permitted removal of the minor organic inclusions to yield a sulfur product preferred by most of the sulfur-consuming industry. Sulfur mining (Frasch) operations at Clemens Dome in Brazoria County were terminated by Jefferson Lake Sulfur Co. due to depletion of reserves. Talc production increased in the Allamoore district; deposits were developed by five talc producers. Pioneer Talc Co. continued operation of its new grinding mill; several other mining interests acquired mineral leases for exploratory work. A multimillion dollar expansion of the cement plant near Waco was begun by Universal Atlas Cement Division of U. S. Steel Corp. New facilities, which would double capacity to 2 million barrels of finished cement, included a second rotary kiln and accessory equipment, and a new and more efficient dust collection system. Near Van Horn, Continental Minerals Co. built a 100-ton-a-day mill to process barite ore from its Apache Mountain lease. A $500,000 automatic barite processing plant was built in Houston by International Minerals & Chemical Corp. The plant processed barite ores from Missouri, Mexico, Peru, and the Mediterranean area. Kaiser-Gypsum Co. built a $3- to $5-million gypsum products plant on the Houston ship channel, adjacent to the Olin-Mathieson Chemical Corp. plant. A $750,000 expansion program was begun at the Houston sulfur-chemical facility of Penn Salt Chemicals Corp; the new unit will produce a variety of alkyl mercaptans.

A 1-percent increase in barge rates on the Mississippi River system in the Gulf Intercoastal Canal, effective November 1, was proposed by the Waterways Freight Bureau. Specific rate increases included 11 cents a ton on bulk sulfur; 10 cents a ton on paper, pulp

wood, wood chips, limestone, sand and gravel, bauxite, iron ore, chrome, and salt; 6 cents a ton on phosphate rock and super phosphate; and 22 cents a ton on scrap iron.

Barite.—Crude barite from other states and foreign countries was processed in grinding plants in Cameron, Harris, Maverick, and Nueces Counties. Most of the material was processed for use in drilling mud for the oil and gas industry. Output was less than that of 1959, principally because of less drilling activity in the oil and gas industry.

Bromine.—The tonnage and value of bromine was 13 percent under that of 1959, reflecting excessive gasoline stocks and the growth of the compact car market. Ethyl-Dow Chemical Co., the Nation's foremost producer of bromine, operated its Freeport facilities at reduced rates throughout 1960.

Cement.—The cement industry expanded its production, storage, and handling facilities. There were 16 companies operating with total production capacity of 38.9 million barrels of cement, compared with 15 companies and capacity of 37.5 million barrels in 1959. The multimillion dollar, 1.4-million-barrel-per-year Midlothian plant of Texas Industries, Inc., in Ellis County began production late in 1960. Cement plants were in 11 counties compared with 10 in 1959. Operating at about 59 percent of capacity, output of the plants declined 16 percent in quantity and 13 percent in value. Five of the plants, comprising 34 percent of total capacity, were along the Gulf Coast and used over 2 million tons of shell in producing cement; the 11 remaining plants, in 8 inland counties, used over 4 million tons of limestone. Four of the cement plants used a dry process and accounted for 19 percent of installed capacity. The wet process was used by 12 plants with 81 percent of the capacity. Intrastate markets consumed 87 percent of the cement shipped in 1960.

TABLE 13.—Destination of shipments of portland cement to Texas from mills

Year	Texas (thousand barrels)	Change, percent	
		In Texas	In United States
1951–55 (average)	17,982		
1956	20,954	+1	+6
1957	18,891	−10	−6
1958	22,323	+18	+6
1959	23,884	+7	+9
1960	20,195	−15	−7

TABLE 14.—Portland cement produced and shipped

(Thousand barrels and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1951–55 (average)	20,633	20,520	$52,137
1956	25,655	25,234	73,070
1957	21,845	21,547	66,201
1958	25,465	25,209	77,186
1959	27,111	27,215	85,022
1960	23,190	22,721	73,964

Clays.—Although the clay industry was an important segment of the State's economy and extensive deposits of common clay or shale are widely distributed, only deposits close to large metropolitan or industrial centers were exploited. Clay production decreased 15 percent in quantity and 11 percent in value, compared with 1959.

Miscellaneous clay provided 75 percent of the production, 34 percent of which was used in manufacture of cement. Other important uses included the manufacture of building brick, heavy clay products, and lightweight aggregate. Fire clay accounted for 22 percent of total clay produced. Most fire clay was used in heavy clay products, with smaller quantities being consumed in refractories, pottery, and stoneware. Bentonitic clays, including fuller's earth, were used principally as a filtering medium for mineral and vegetable oils, as a component of drilling muds, and as an absorbent or carrier for insecticides and fungicides.

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
1951–55 (average)	76	$846	364	$1,200	1,908	$2,223	2,348	$4,269
1956	161	1,183	483	1,007	2,502	2,575	3,146	4,765
1957	127	963	454	1,057	2,411	2,913	2,992	4,933
1958	121	889	501	1,135	3,097	3,400	3,719	5,424
1959	133	947	722	1,596	3,015	3,160	3,870	5,703
1960	116	873	715	1,668	2,471	2,517	3,302	5,058

[1] Incomplete total, excludes fuller's earth.

Clay production was reported from 44 counties by 69 producers; 33 of the counties reported miscellaneous clay, 10 reported fire clay, 4 reported bentonite, and 2 reported fuller's earth production. The five principal clay-producing counties, in order of output, were: Harris, Eastland, Rusk, Dallas, and Bastrop. The five principal producing companies were: Ideal Cement Co., Henderson Clay Products, Texas Lightweight Aggregate, General Portland Cement Co., and American Aggregate Co.

Feldspar.—A small amount of feldspar was stockpiled in Llano County to be ground and processed as roofing material.

Fluorspar.—Fluorspar, principally from foreign countries, was processed at mills in Brewster, Cameron, Fayette, and Harris Counties for use in chemical and metallurgical industries. Much of the fluorspar was used in manufacturing cryolite for consumption in aluminum reduction plants in Alabama, Arkansas, Oregon, and Washington.

Gem Stones.—Collection, preparation, and sale of gem stones by amateurs and dealers continued. The principal gem-type minerals found in Texas were agate, jasper, amethyst, apatite, chrysocolla, cinnabar, fluorspar, garnet, obsidian, opal, and agatized wood. Search for the stones centered in Brewster, Culberson, Hudspeth, Jeff Davis, Mason, Webb, and Zapata Counties.

Graphite.—Flake graphite was mined from open pits and processed in the mill of Southwestern Graphite Co. in Burnet County.

Gypsum.—Gypsum production declined 16 percent in volume and 17 percent in value from that of 1959, due largely to excess capacity for making gypsum-wallboard and building products and to a 6-percent drop in construction in the State. Production by seven producers, all from open-pit mines, was reported from five counties—Fisher, Hardeman, Hudspeth, Nolan, and Ward. Most of the crude gypsum was used in manufacturing lath and wallboard; the remainder was used principally in building plaster.

TABLE 16.—Crude gypsum mined

Year	Short tons	Value	Year	Short tons	Value
1951–55 (average)	1,158,664	$3,304,685	1958	1,240,050	$4,120,311
1956	1,156,956	3,623,005	1959	1,351,060	4,770,228
1957	1,043,236	3,343,217	1960	1,131,034	3,960,361

Lime.—Moderate expansion of the lime industry continued as demand by chemical and industrial users remained high. Consumption by chemical and industrial users amounted to 78 percent of total output; the remainder was used in construction. As in 1959, lime production was reported from 8 counties by 10 producers; the 3 leading counties in order of output were Nueces, Comal, and Travis Counties. About equal quantities of limestone and shell were used as basic raw material for lime production.

Most of the lime output, 94 percent, was consumed within the State; the major part was captive. Out-of-State shipments were sent mostly to adjoining states.

TABLE 17.—Lime sold by producers

Year	Quicklime (short tons)	Hydrated lime (short tons)	Total	
			Short tons	Value (thousands)
1951–55 (average)	258,489	175,395	433,884	$4,101
1956	349,693	242,443	592,136	6,938
1957	559,426	236,968	796,394	7,489
1958	414,302	276,359	690,661	7,146
1959	414,052	394,725	808,777	8,530
1960	433,405	388,037	821,442	9,057

The industry utilized 23 shaft kilns and 16 rotary kilns (total annual rated capacity, 1,287,000 tons), operating at about 64 percent of capacity. Principal chemical and industrial uses were in the manufacture of alkalies, paper and petrochemicals, and as metallurgical lime in open hearth and electric furnaces. A large quantity was used for purifying and softening water.

Lithium.—Lithium hydroxide was processed from lepidolite ores from Southern Rhodesia at the San Antonio plant of American Lithium Chemicals, Inc. During the year, this firm completed its contract to supply the Atomic Energy Commission with lithium hydroxide.

Magnesium Compounds.—Magnesium compounds were produced at the Freeport plant of Dow Chemical Co. A significant quantity of the magnesium oxide produced was processed to periclase, a basic refractory material, at the new 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. Improved demand for salt cake resulted in increased production and the company was planning expansions at its Brownfield and Monahans facilities.

Perlite (Expanded).—Although no crude perlite had been produced in Texas since 1956, crude materials from New Mexico and Colorado were expanded at six plants in four counties. The expanded material was used as lightweight aggregate in concrete, as an aggregate in building plaster, and as loose-fill insulation. All plants were close to metropolitan and industrial markets.

Phosphate Rock.—Crude phosphate rock, shipped from Tennessee and Florida, was used as a component of mixed fertilizers. Substantial quantities of processed superphosphate and triple superphosphate were shipped from other states for use in fertilizer preparation.

Salt.—Salt recovered from vast salt domes of the Gulf Coast and salt beds of the coastal plains was a vital component of the growing chemical industry. Production increased 5 percent in quantity and 4 percent in value compared with 1959. Over 90 percent of the output was from brine wells drilled to salt domes in seven counties and to salt beds in four counties. Principal producing counties were Brazoria, Chambers, and Duval. Most of the brine was used in manufacturing chlorine, soda ash, and other chemicals. Other uses included paper and pulp manufacture, feed mixing, water softening, and meat preparation. Nearly all the salt was consumed by industries within the State.

TABLE 18.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	2,867	$7,118	1958	3,843	$15,115
1956	3,963	14,370	1959	4,519	17,498
1957	4,612	17,104	1960	4,756	18,222

Sand and Gravel.—The tonnage and value of sand and gravel declined 15 and 11 percent, respectively, compared with 1959, because of curtailed highway and building construction due to inclement weather during the first quarter and an overall 6-percent decline in construction contracts. Deposits of sand and gravel, usually near the larger streams, are extensive and widespread.

Production was reported from 97 counties. Commercial production supplied 90 percent of total output, and Government-and-contractor production accounted for the remaining 10 percent. Building and paving consumed 91 percent of the output. Other uses were glass manufacture, railroad ballast, engine and molding sand, sandblasting, filtering, and grinding. Over 90 percent of all sand and gravel produced was washed or otherwise prepared. Trucks handled 79 per-

cent; railroads, 19 percent; and waterways, 2 percent of the total shipments.

The average value of commercial sand and gravel in 1960 was $1.11 a ton; prepared material averaged $1.16 a ton. Most 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
1951–55 (average)	18,126	$18,800	3,891	$1,019	22,017	$19,819
1956	23,311	25,512	6,025	1,701	29,336	27,213
1957	19,155	21,979	4,530	1,448	23,685	23,427
1958	27,015	28,703	5,856	2,105	32,871	30,808
1959	29,520	32,098	5,775	2,628	35,295	34,726
1960	26,918	29,857	2,926	897	29,844	30,754

Stone.—The output of stone, including limestone and shell used in manufacture of cement and lime, declined 7 percent from 1959. The five leading stone producing (shell excluded) counties in order of production value were Bexar, Wise, Dallas, Comal, and Travis. The three leading counties producing shell were Chambers, Galveston, and Matagorda.

Of the total output, stone supplied 74 percent and shell, 26 percent. Limestone comprised 93 percent of the stone produced and sandstone, 6 percent; the remaining 1 percent was distributed among basalt, granite, caliche, marble, and miscellaneous stone. Crushed stone—mostly limestone—represented over 99 percent of total stone production. Principal uses for crushed stone were roadstone, concrete, aggregate, railroad ballast, cement, and lime. Shell dredged from shallow bays along the Gulf Coast totaled 10 million tons, about equal to the 1959 output; value of the shell was 8 percent above that of 1959.

TABLE 20.—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
1956	18,706	$18,357	1,286	$1,244	12,018	$15,483	700	$636	32,773	$36,350
1957	19,423	20,509	1,810	1,587	9,650	12,640	(2)	(2)	31,249	36,154
1958	25,470	24,794	997	851	9,035	12,684	404	803	36,076	40,912
1959	29,141	30,064	2,406	1,189	10,310	14,419	177	257	42,172	47,787
1960	26,620	26,208	1,816	1,036	10,304	15,798	159	212	39,029	45,088

[1] Includes other stone and stone indicated by footnote 2.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Total."

Principal uses were in cement and lime manufacture, concrete aggregate, and chemicals.

Dimension stone furnished only a small part of total stone tonnage, but its value contributed substantially to total value of stone production. Rough architectural stone accounted for 17 percent of dimension stone used, dressed building stone for 48 percent, and paving blocks for 35 percent. All stone was produced by quarry or open-pit methods. Trucks moved 27 percent of stone shipments; railroads, 9 percent; waterways, 19 percent; and unspecified, 45 percent.

Sulfur.—Output of native sulfur by the Frasch process was reported from six Gulf Coast counties by five producers. Production of byproduct sulfur from purification of natural gas and refinery gases was reported from 12 inland counties by 18 producers and from 2 Gulf Coast counties by 5 producers. Native sulfur (about 92 percent of total sulfur produced in 1960) decreased 8 percent in tonnage and 9 percent in value, compared with 1959. Increasing competition for both domestic and foreign markets was a major contributing factor for the decline. Major competition for domestic producers came from Mexican Frasch sulfur imports. However, recovered-sulfur producers made inroads in some small local markets. Canadian, Mexican, and French sulfur producers offered growing competition to U.S. export markets, particularly in Canada, Europe, and South America. All Frasch producers and several byproduct sulfur producers offered bulk sulfur to consumers. Special facilities were required to transport sulfur in bulk. Principal sulfuric acid uses were for fertilizers, chemicals, organic pigments, petroleum refining, and iron and steel production. Principal nonacid uses of sulfur were for paper-manufacturing, carbon disulfide, dyes, and other chemicals.

TABLE 21.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments		Year	Production	Shipments	
		Quantity	Value			Quantity	Value
1951–55 (average)	3,686	3,677	$91,266	1958	2,588	2,616	$61,621
1956	3,994	3,437	91,026	1959	2,519	2,970	68,998
1957	3,366	2,880	70,225	1960	2,679	2,747	62,855

Talc and Soapstone.—Talc and soapstone were produced in Gillespie and Hudspeth Counties by seven producers. Output was 10 percent greater in volume and 19 percent greater in value than in 1959. Most of the production came from the expanding Allamoore district in Hudspeth County. Pioneer Talc Co. operated its grinding mill at Allamoore; custom grinding gained during the year. Demand for talc in ceramic products increased materially. Other important uses included carrier for insecticides and fungicides, roofing materials, rubber, and paint. A considerable quantity was exported to Mexico.

Vermiculite (Exfoliated).—Vermiculite obtained from other states was expanded at four plants in three counties. Both tonnage and value decreased compared with 1959. Principal uses were as a lightweight aggregate for plaster and concrete and as loose-fill insulation.

Water.—Water requirements grew rapidly due to population growth and industrial expansion. Petroleum refining and petrochemical industries, important components of industrial expansion, generally require much more water per unit of product than other industries. Intensive study of the State water problem was made by Federal, State, and municipal agencies, and trade groups.

The Nation's first saline water conversion plant, capable of producing 1 million gallons of fresh water daily, was being built at Freeport. Construction of the $1.5 million plant began on August 30. The plant will utilize the long tube, vertical, multiple-effect distillation process. Dow Chemical Co. was authorized to develop an ion exchange process to minimize scale formation in the distillation units.

METALS

Three metals (iron, mercury, and uranium) were mined, and one metal (magnesium) was recovered from sea water; their combined value was only a small fraction of mineral output value. However, Texas had 18 primary metallurgical plants which processed ores and other materials shipped in from other states and foreign countries. These plants recovered a variety of metals including aluminum, antimony, cadmium, copper, gold, silver, iron, lead, magnesium, mercury, manganese, tin, tungsten, and zinc. About a dozen secondary smelters processed scrap and residues of aluminum, copper, lead, tin, and zinc.

Important industry highlights include the following: The 86th Congress enacted a law allowing mining industry tax write-offs for total exploration costs up to $400,000, limited to $100,000 per year. A multimillion dollar expansion was planned at the Houston mill of Sheffield Division of Armco Steel Corp. New facilities were to include a combination slab and 160-inch plate mill which will produce plates 4 inches thick and 144 inches wide. Sheffield also contracted for 100 million cubic feet of oxygen a month to be delivered by pipeline from the new plant of Linde Co., Division of Union Carbide Corp. The steel company planned to increase the use of oxygen in its open-hearth and electric furnaces to increase productive capacity without additional capital investment. Sovereign Steel of Texas planned a $30 million direct reduction plant in the Palestine area that would produce sponge-iron or semisteel from marginal east Texas iron ores. Nichols Copper Refinery of Phelps-Dodge Corp., El Paso, resumed operations early in February after a prolonged labor strike.

TABLE 22.—Smelters, refineries, and reduction plants in 1960

Product, company, and plant	Location, county	Material treated	Source of material
Aluminum:			
Aluminum Company of America:			
Point Comfort (alumina)	Calhoun	Bauxite	Foreign.
Point Comfort (reduction)	do	Alumina	
Rockdale (reduction)	Milam	do	
Reynolds Metals Co.:			
Sherwin (alumina)	San Patricio	Bauxite	Foreign.
San Patricio (reduction)	do	Alumina	
Antimony: National Lead Co.: Laredo smelter	Webb	Ore	Foreign.
Cadmium: American Smelting and Refining Company; electrolytic.	Nueces	Flue dust	Do.
Copper:			
American Smelting and Refining Company: El Paso smelter.	El Paso	Ore and concentrates.	Foreign and domestic.
Phelps Dodge Refining Corp.: Nichols refinery	do	Blister and anode	Domestic.
Iron:			
Lone Star Steel Co.: Daingerfield plant	Morris	Ore and scrap	Foreign and domestic.
Sheffield Division of Armco Steel Corp.: Houston plant.	Harris	do	Do.
Lead:			
American Smelting and Refining Company: El Paso smelter.	El Paso	Ore and concentrates.	Foreign and domestic.
Magnesium: The Dow Chemical Co.: Freeport plant.	Brazoria	Seawater	
Manganese: Tenn-Tex Alloy & Chemical Co	Harris	Ore	Foreign.
Mercury: Terlingua Mercury Corp	Presidio	do	Domestic.
Tin-Tungsten: Wah Chang Corp.: Texas City smelter.	Galveston	do	Foreign.
Zinc:			
American Smelting and Refining Company:			
Amarillo retort smelter	Potter	Ore and concentrates.	Domestic and foreign.
Corpus Christi electrolytic	Nueces	do	Foreign.
El Paso fuming plant	El Paso	Dusts and residues	
American Zinc Co. of Illinois: Machovec smelter	Moore	Concentrates and fumes.	Foreign and domestic.

The Federal Bureau of Mines conducted experiments on injection of solid-fuel fines directly into the smelting zone of a blast furnace to replace part of the coke burden. Results indicated that 20 to 24 percent of the coke requirements could be replaced by utilizing this method.[4]

Laboratory mineral-dressing tests were conducted on several limonite and siderite iron ores from the North Basin of the east Texas iron ore district by the Bureau of Mines. The most effective process proved to be magnetic separation of roasted ore.[5]

Aluminum and Bauxite.—Aluminum productive capacity advanced from 57,000 tons a year in 1950 to 385,000 tons a year in 1960, making Texas the second largest aluminum producing State. The multimillion dollar expansion program at the Point Comfort alumina works of Aluminum Company of America was essentially completed in 1960; most facilities of the second 375,000-tons-per-year unit were installed. The company was considering several alternate plans for a channel through Lavaca Bay to allow deep sea ore boats to reach their unloading dock. All Texas alumina refineries and aluminum reduction plants operated at reduced capacities during 1960.

[4] Ostrowski, E. J., Royer, M. B., and Ropelewski, L. S., Injecting Solid Fuels into Smelting Zone of an Experimental Blast Furnace: Bureau of Mines Rept. of Investigations 5648, 1960, 14 pp.

[5] Powell, H. E., and Dressel, W. M., Laboratory Beneficiation of East Texas Limonite-Siderite Iron Ores: Bureau of Mines Rept. of Investigations 5647, 1960, 14 pp.

Antimony.—National Lead Co. recovered antimony from ores and concentrates imported from Mexico and Bolivia. Some of the antimony produced was for the account of the Commodity Credit Corp.

Cadmium.—The Corpus Christi electrolytic zinc plant of American Smelting & Refining Co. recovered cadmium from flue dust received from other zinc smelters.

Cesium and Rubidium.—Cesium and rubidium were recovered in Alkarb, a mixed potassium, rubidium, cesium carbonate, by San Antonio Chemicals, Inc.

Copper.—Blister copper was produced from ores and concentrates of other states and foreign countries at the El Paso copper smelter of American Smelting & Refining Co. Electrolytic-grade copper and fire-refined copper were produced at the Nichols refinery of Phelps-Dodge Refining Corp. Both the smelter and the refinery resumed operations in February after a prolonged labor dispute that began in August 1959.

Ferroalloys.—Manganese ores, mostly of foreign origin, were processed into ferroalloys at the Houston plant of Tenn-Tex Alloy & Chemical Co.

Iron Ore and Pig Iron.—The output of iron ore from open pits in Cass, Cherokee, and Morris Counties declined 3 percent in quantity and 9 percent in value, compared with 1959. Ore from Mexico and South America supplemented domestic ore for blast furnace feed. Pig iron production amounted to less than 70 percent of capacity.

Lone Star Steel Co. expanded the annual capacity of its rod mill to 36,000 tons of reinforcing bars and made further progress in the use of natural gas in the blast furnace. Use of natural gas resulted in a 15-percent increase in pig iron production capacity and a 15-percent decrease in coke consumption. Expansion projects at the Houston works of Sheffield Steel Division of Armco Steel Corp. included a new plate heat-treating line and new material handling facilities consisting of deep water dock unloading equipment.

Lead.—Lead ores and concentrates from Western States and Mexico were processed into base bullion at the El Paso lead smelter of American Smelting & Refining Co. Seven secondary lead smelters treated scrap material.

Magnesium.—Magnesium—the lightest of structural metals—was produced from sea water by Dow Chemical Co. Sea water averages 0.13 percent magnesium. Production was reported from the Freeport plant; the Velasco unit was idle throughout the year. Magnesium was increasingly used as an alloying constituent with aluminum and as a reducing agent to produce titanium.

Mercury.—Exploration in the Terlingua district furnished ore from which a minor quantity of mercury was recovered.

Tin and Tungsten.—Tin and tungsten were recovered from foreign ores and concentrates at the Texas City smelter of Wah Chang Corp. The tin smelter remained the only source of primary refined tin in the Western Hemisphere.

Uranium.—Uranium "yellow cake" was recovered at the $2 million, 300-ton-a-day uranium mill of Susquehanna-Western, Inc., at Falls City. The mill treated stockpiled ore from open pits in Karnes County.

Zinc.—A considerable part of the Nation's primary and secondary zinc-smelting capacity was in Texas. Three primary plants (two horizontal retort and one electrolytic) processed foreign and Western States ores and concentrates; secondary smelters in the Fort Worth-Dallas and Houston-Beaumont areas treated scrap material. Zinc metal prices were depressed throughout the year, principally because of excessive stocks of refined zinc.

REVIEW BY COUNTIES

Anderson.—Mineral fuels output increased 11 percent in value to $17.9 million. Geophysical prospecting for oil and gas declined 50 percent to 35 crew-weeks; exploratory and development drilling declined 8 percent to 104 wells totaling 479,571 feet and resulted in 54 oil completions. Five new oilfields and three new oil pays were discovered. Natural gas liquids were recovered at seven gasoline plants.

TABLE 23.—Value of mineral production in Texas, by counties [1]

County	1959 [2]	1960	Minerals produced in 1960 in order of value
Anderson	$16,081,752	$17,892,900	Petroleum, natural gas, natural gas liquids.
Andrews	220,520,907	212,522,900	Petroleum, natural gas liquids, natural gas.
Angelina	850,557	669,805	Clays,, natural gas, petroleum.
Aransas	11,894,032	11,239,700	Petroleum, natural gas, natural gas liquids, shell.
Archer	28,539,047	28,632,796	Petroleum, natural gas liquids, natural gas, stone.
Atascosa	18,450,998	16,522,486	Petroleum, natural gas, natural gas liquids, sand and gravel.
Austin	5,326,111	5,414,276	Petroleum, natural gas, sand and gravel.
Bastrop	767,434	799,133	Clays, petroleum, natural gas.
Baylor	9,126,621	9,203,400	Petroleum, natural gas.
Bee	23,145,703	14,100,865	Natural gas, petroleum, natural gas liquids, stone.
Bell	906,284	355,528	Sand and gravel, stone.
Bexar	19,851,918	16,932,301	Cement, stone, sand and gravel, petroleum, clays.
Blanco	23,896	148,901	Stone, sand and gravel.
Borden	39,054,219	31,652,700	Petroleum, natural gas liquids, natural gas.
Bosque	76,775	----------	
Bowie	(3)	(3)	Sand and gravel, petroleum, natural gas.
Brazoria	151,548,222	147,692,411	Petroleum, natural gas, natural gas liquids, bromine, magnesium chloride, salt, sulfur, magnesium compounds, lime, sand and gravel.
Brazos	46,180	323,700	Stone, natural gas.
Brewster	63,124	15,285	Clays, mercury, gem stones.
Briscoe	(3)	(3)	Clays.
Brooks	20,647,861	14,579,500	Petroleum, natural gas.
Brown	1,912,980	2,022,971	Petroleum, natural gas, stone, sand and gravel, clays.
Burleson	14,538	5,500	Petroleum.
Burnet	2,364,644	2,106,467	Stone, graphite.
Caldwell	9,613,258	9,181,600	Petroleum.
Calhoun	18,160,822	16,102,366	Natural gas, petroleum, shell, lime, natural gas liquids, sand and gravel.
Callahan	7,281,925	6,483,600	Petroleum, natural gas.
Cameron	31,449	78,000	Natural gas, petroleum.
Camp	851,810	803,800	Petroleum, natural gas.
Carson	37,639,458	30,360,910	Petroleum, natural gas, natural gas liquids, sand and gravel.
Cass	8,179,541	8,217,825	Petroleum, natural gas, natural gas liquids, iron ore.
Chambers	65,043,368	49,528,112	Petroleum, natural gas, shell, salt, natural gas liquids.
Cherokee	7,663,901	6,530,560	Petroleum, iron ore, natural gas, natural gas liquids, clays.
Childress	74,318	----------	
Clay	16,389,086	15,446,600	Petroleum, natural gas liquids, natural gas.
Cochran	26,008,108	21,985,600	Do.
Coke	35,158,548	24,911,607	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Coleman	11,455,018	11,994,588	Petroleum, natural gas, sand and gravel, natural gas liquids, clays, stone.
Collin	49,501	77,500	Stone.
Collingsworth	1,364	25,400	Stone, petroleum.
Colorado	21,643,309	20,359,334	Natural gas, natural gas liquids, sand and gravel, petroleum.
Comal	3,222,126	3,363,010	Stone, lime, sand and gravel.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1959 [2]	1960	Minerals produced in 1960 in order of value
Comanche	$460,068	$240,000	Petroleum, natural gas, clays.
Concho	87,812	72,800	Petroleum, natural gas.
Cooke	31,304,333	32,102,366	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Coryell	106,271	78,485	Stone.
Cottle	76,919	215,100	Stone, sand and gravel, petroleum.
Crane	104,213,689	121,858,900	Petroleum, natural gas liquids, natural gas.
Crockett	24,790,090	26,205,300	Petroleum, natural gas, natural gas liquids.
Crosby	1,303,349	1,297,780	Sand and gravel, petroleum.
Culberson	2,137,779	3,598,400	Petroleum, natural gas.
Dallam	327,452	185,300	Natural gas.
Dallas	24,178,975	18,637,491	Cement, sand and gravel, stone, clays.
Dawson	15,084,051	15,304,800	Petroleum, natural gas liquids, stone, natural gas.
Deaf Smith	----------	103,210	Sand and gravel.
Denton	367,043	490,994	Petroleum, clays, natural gas, sand and gravel, stone.
De Witt	8,923,775	8,925,173	Petroleum, natural gas, sand and gravel, stone.
Dickens	291,526	233,656	Petroleum, stone, sand and gravel, natural gas.
Dimmit	1,350,114	1,552,200	Petroleum, natural gas.
Donley	117,120	107,000	Stone.
Duval	44,160,706	44,055,013	Petroleum, natural gas, natural gas liquids, salt.
Eastland	4,717,086	5,588,089	Petroleum, natural gas liquids, natural gas, clays.
Ector	209,393,045	252,449,612	Pertoleum, natural gas, liquids, natural gas, cement, stone.
Edwards	3,907	838	Stone, petroleum.
Ellis	290,230	844,640	Cement, stone, clays, sand and gravel.
El Paso	6,895,307	5,086,928	Cement, stone, sand and gravel.
Erath	393,471	443,838	Natural gas, petroleum, stone.
Falls	16,520	31,400	Petroleum.
Fannin	[3]	123,468	Stone, sand and gravel.
Fayette	1,270,627	1,172,075	Petroleum, sand and gravel, clays, stone, natural gas, gem stones.
Fisher	17,225,854	14,153,724	Petroleum, gypsum, natural gas, natural gas liquids, sand and gravel.
Floyd	15,951	11,700	Petroleum, natural gas.
Foard	2,641,135	2,827,400	Petroleum, stone, natural gas.
Fort Bend	35,977,482	32,783,724	Petroleum, Frasch sulfur, natural gas, salt, clays, sand and gravel.
Franklin	12,313,236	23,782,700	Petroleum, natural gas liquids, natural gas.
Freestone	2,023,394	4,240,708	Natural gas, petroleum, clays, stone.
Frio	6,039,335	5,137,942	Petroleum, natural gas, natural gas liquids, sand and gravel.
Gaines	73,912,265	71,411,200	Petroleum, natural gas, natural gas liquids, stone.
Galveston	31,784,688	33,755,157	Petroleum, natural gas, shell, natural gas liquids, Frasch sulfur, sand and gravel.
Garza	21,293,838	18,232,548	Petroleum, sand and gravel, natural gas.
Gillespie	87,907	116,655	Sand and gravel, stone, talc.
Glasscock	5,084,707	7,896,500	Petroleum, natural gas, stone.
Goliad	11,344,371	10,654,100	Natural gas, petroleum, natural gas liquids.
Gonzales	302,881	168,077	Clays, sand and gravel.
Gray	63,040,686	61,538,000	Petroleum, natural gas liquids, natural gas.
Grayson	21,899,932	19,099,200	Petroleum, stone, natural gas, natural gas liquids, sand and gravel.
Gregg	114,653,129	101,756,700	Petroleum, natural gas liquids, natural gas.
Grimes	29,297	544,800	Natural gas, petroleum.
Guadalupe	11,831,460	12,250,961	Petroleum, sand and gravel, clays, natural gas.
Hale	5,577,938	4,903,500	Petroleum, natural gas.
Hall	----------	170,000	Stone.
Hamilton	243,751	194,100	Natural gas, sand and gravel.
Hansford	23,993,405	18,924,800	Petroleum, natural gas, natural gas liquids.
Hardeman	[3]	1,140,867	Gypsum, petroleum, stone.
Hardin	28,795,653	25,201,300	Petroleum, natural gas, natural gas liquids.
Harris	100,108,198	92,639,232	Petroleum, cement, natural gas, natural gas liquids, salt, sand and gravel, lime, shell, clays.
Harrison	24,857,778	21,345,277	Petroleum, natural gas liquids, natural gas, coal, clays.
Hartley	3,286,080	2,389,600	Natural gas, petroleum.
Haskell	10,340,472	12,396,150	Petroleum, stone, natural gas.
Hays	120,432	[3]	Sand and gravel, stone.
Hemphill	367,329	379,610	Petroleum, natural gas, sand and gravel.
Henderson	7,138,764	7,030,576	Natural gas, natural gas liquids, petroleum, sand and gravel, clays.
Hidalgo	30,024,398	26,271,206	Natural gas, natural gas liquids, petroleum, sand and gravel, stone, clays.
Hill	155,670	53,684	Stone, sand and gravel, petroleum.
Hockley	38,881,853	35,072,000	Petroleum, natural gas, natural gas liquids.
Hopkins	5,935,025	5,867,453	Petroleum, natural gas, natural gas liquids, clays.
Houston	1,945,318	1,107,800	Natural gas, petroleum.
Howard	40,549,667	38,471,879	Petroleum, natural gas liquids, natural gas, sand and gravel.
Hudspeth	494,453	527,793	Talc, stone, gypsum.
Hunt	32,072	22,600	Petroleum.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1959 [2]	1960	Minerals produced in 1960 in order of value
Hutchinson	$62,512,578	$64,856,345	Petroleum, natural gas liquids, natural gas, sand and gravel, salt.
Irion	2,126,878	2,106,400	Petroleum, natural gas liquids, natural gas.
Jack	13,522,595	15,609,600	Petroleum, natural gas, natural gas liquids, stone.
Jackson	42,598,227	44,292,514	Petroleum, natural gas, natural gas liquids, sand and gravel.
Jasper	2,668,543	2,943,400	Petroleum, natural gas.
Jeff Davis	8,250		
Jefferson	53,390,506	62,803,715	Petroleum, Frasch sulfur, natural gas, natural gas liquids, salt, sand and gravel, clays.
Jim Hogg	5,482,332	9,403,700	Petroleum, natural gas.
Jim Wells	69,766,842	59,632,900	Petroleum, natural gas, natural gas liquids.
Johnson	1,273,001	1,083,124	Lime, stone, sand and gravel.
Jones	18,824,990	18,833,323	Petroleum, natural gas liquids, sand and gravel, natural gas, stone.
Karnes	9,260,244	13,392,800	Petroleum, natural gas liquids, natural gas, uranium.
Kaufman	2,651,411	2,185,298	Petroleum, stone.
Kendall	18,472	68,710	Stone, sand and gravel.
Kenedy	2,891,107	3,061,300	Natural gas, natural gas liquids, petroleum.
Kent	17,036,571	16,616,500	Petroleum, natural gas, sand and gravel.
Kerr	(3)	63,115	Sand and gravel.
Kimble	50,935	37,947	Sand and gravel, natural gas, petroleum.
King	3,439,155	2,352,400	Petroleum, natural gas.
Kinney		6,014	Stone, petroleum.
Kleberg	20,783,844	54,018,171	Natural gas liquids, petroleum, natural gas, salt.
Knox	7,686,461	8,785,300	Petroleum, natural gas.
Lamb	1,779,074	2,250,800	Do.
Lampasas	77,046	20,828	Sand and gravel.
La Salle	1,264,254	1,443,900	Petroleum, natural gas.
Lavaca	9,318,737	10,843,402	Natural gas liquids, natural gas, petroleum, stone.
Lee	13,541	33,980	Petroleum, gem stones, natural gas.
Leon	3,246,697	2,647,700	Natural gas, petroleum.
Liberty	49,942,240	44,556,210	Petroleum, sulfur, natural gas, sand and gravel, natural gas liquids.
Limestone	1,802,632	1,188,705	Petroleum, clays, natural gas.
Lipscomb	724,947	1,386,900	Petroleum, natural gas.
Live Oak	13,915,817	11,661,200	Natural gas, petroleum.
Llano	951,454	921,912	Stone, feldspar.
Loving	6,337,509	9,272,000	Petroleum, natural gas.
Lubbock	2,431,675	1,428,511	Petroleum, sand and gravel, natural gas.
Lynn	1,425,692	1,383,000	Petroleum, natural gas.
Madison	1,114,231	567,600	Natural gas, petroleum, natural gas liquids.
Marion	9,322,484	5,981,800	Petroleum, natural gas, natural gas liquids.
Martin	2,967,479	5,287,100	Petroleum, natural gas.
Mason	33,159	6,501	Sand and gravel.
Matagorda	31,262,672	38,204,988	Petroleum, natural gas, shell, natural gas liquids, clays, sand and gravel, stone.
Maverick	225,821	67,300	Petroleum, natural gas.
McCulloch	328,213	(3)	Sand and gravel, petroleum.
McLennan	4,732,511	4,159,751	Cement, sand and gravel, stone, clays, petroleum.
McMullen	8,841,254	7,108,042	Natural gas, petroleum, natural gas liquids, sand and gravel.
Medina	683,265	730,561	Petroleum, sand and gravel, clays.
Menard	86,242	6,000	Natural gas, petroleum.
Midland	46,992,585	44,239,950	Petroleum, natural gas, natural gas liquids, stone.
Milam	(3)	(3)	Coal, petroleum, sand and gravel.
Mitchell	7,978,633	7,559,439	Petroleum, sand and gravel, natural gas.
Montague	19,031,620	18,597,604	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Montgomery	29,585,374	27,542,281	Petroleum, natural gas, natural gas liquids, sand and gravel.
Moore	48,428,455	45,854,822	Natural gas, natural gas liquids, petroleum, helium.
Morris	(3)	(3)	Iron ore.
Motley	888,912	1,220,822	Petroleum, sand and gravel.
Nacogdoches	3,142,602	2,909,229	Natural gas, clays, stone.
Navarro	6,309,507	6,048,114	Petroleum, sand and gravel, natural gas, clays.
Newton	4,123,250	4,653,100	Petroleum, natural gas.
Nolan	40,427,353	27,485,876	Petroleum, cement, natural gas liquids, gypsum, natural gas, stone, sand and gravel, clays.
Nueces	85,105,514	78,007,822	Natural gas, petroleum, natural gas liquids, cement, lime, shell, sand and gravel, clays.
Ochiltree	15,872,667	17,115,600	Petroleum, natural gas, natural gas liquids.
Oldham	(3)	(3)	Sand and gravel, petroleum.
Orange	14,175,526	12,300,477	Petroleum, natural gas, cement, natural gas liquids, clays.
Palo Pinto	2,191,838	2,277,012	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Panola	61,460,982	53,683,300	Natural gas, natural gas liquids, petroleum.
Parker	2,421,068	2,508,939	Natural gas liquids, natural gas, stone, petroleum, clays.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1959 [2]	1960	Minerals produced in 1960 in order of value
Pecos	$59,687,052	$55,154,800	Petroleum, natural gas, natural gas liquids.
Polk	5,722,157	4,799,360	Petroleum, natural gas, sand and gravel, stone.
Potter	13,631,649	10,359,659	Natural gas, sand and gravel, helium, natural gas liquids.
Presidio	4,500		
Randall		103,210	Sand and gravel.
Reagan	35,138,625	36,386,800	Petroleum, natural gas liquids, natural gas, stone.
Red River	82,350	110,900	Petroleum.
Reeves	6,102,778	8,823,573	Petroleum, natural gas liquids, natural gas, sand and gravel, gem stones.
Refugio	67,726,604	60,009,100	Petroleum, natural gas, natural gas liquids.
Roberts	5,382,360	4,868,700	Petroleum, natural gas.
Robertson	423,503	[3]	Sand and gravel, petroleum, natural gas.
Runnels	13,923,667	24,920,845	Petroleum, natural gas, natural gas liquids, sand and gravel.
Rusk	67,423,563	58,899,760	Petroleum, natural gas liquids, natural gas, clays.
San Augustine	12,134	25,978	Stone.
San Jacinto	1,586,768	1,580,125	Petroleum, natural gas, sand and gravel.
San Patricio	48,308,921	49,506,637	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Schleicher	10,629,881	9,752,000	Petroleum, natural gas liquids, natural gas.
Scurry	142,971,257	122,706,025	Petroleum, natural gas liquids, natural gas, clays.
Shackelford	10,036,569	11,090,719	Petroleum, natural gas, natural gas liquids, stone.
Shelby	1,540,905	1,164,800	Natural gas, petroleum.
Sherman	8,558,798	18,007,200	Do.
Smith	11,593,865	13,437,998	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Starr	23,091,911	26,056,743	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays.
Stephens	10,284,927	9,949,738	Petroleum, natural gas, natural gas liquids, sand and gravel.
Sterling	1,926,402	2,337,500	Petroleum, natural gas.
Stonewall	23,820,498	21,234,253	Petroleum, natural gas liquids, natural gas, sand and gravel.
Sutton	1,334,987	847,200	Natural gas, petroleum.
Tarrant	12,681,049	9,768,900	Cement, sand and gravel, stone.
Taylor	14,135,417	15,731,580	Petroleum, sand and gravel, stone, clays, natural gas.
Terrell	74,836	170,400	Natural gas.
Terry	19,830,869	19,534,300	Petroleum, natural gas liquids, sodium sulfate, sand and gravel, natural gas.
Throckmorton	11,556,300	9,841,700	Petroleum, natural gas.
Titus	10,029,082	4,287,700	Do.
Tom Green	5,313,739	5,253,235	Petroleum, natural gas liquids, sand and gravel, natural gas.
Travis	3,123,279	3,510,713	Stone, lime, sand and gravel, petroleum.
Trinity	49,997	10,567	Stone.
Tyler	4,671,625	3,127,100	Petroleum, natural gas.
Upshur	6,278,641	5,205,088	Petroleum, natural gas, sand and gravel.
Upton	57,454,034	67,081,100	Petroleum, natural gas, natural gas liquids.
Uvalde	3,295,150	[3]	Asphalt, sand and gravel, basalt.
Val Verde	798,907	611,400	Natural gas, petroleum.
Van Zandt	23,102,948	20,813,618	Petroleum, salt, natural gas liquids, natural gas.
Victoria	23,417,332	24,913,070	Natural gas, petroleum, sand and gravel, stone.
Walker	194,450	125,716	Clays, petroleum.
Waller	41,318,513	36,658,077	Natural gas, natural gas liquids, petroleum, sand and gravel.
Ward	67,301,652	75,665,849	Petroleum, natural gas, natural gas liquids, sodium sulfate, sand and gravel, salt, gypsum.
Washington	559,961	607,700	Petroleum, natural gas.
Webb	5,353,154	6,233,740	Petroleum, natural gas, sand and gravel, clays.
Wharton	62,634,329	46,862,235	Frasch sulfur, petroleum, natural gas, natural gas liquids.
Wheeler	10,010,499	9,311,500	Petroleum, natural gas, natural gas liquids.
Wichita	32,533,957	34,549,358	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Wilbarger	18,021,061	17,876,695	Petroleum, natural gas, stone.
Willacy	5,926,386	5,359,500	Petroleum, natural gas.
Williamson	2,561,148	2,688,855	Stone, lime, petroleum.
Wilson	1,907,559	1,734,496	Petroleum, clays, sand and gravel, natural gas.
Winkler	79,224,250	95,040,600	Petroleum, natural gas, natural gas liquids.
Wise	28,470,189	27,207,833	Natural gas, petroleum, natural gas liquids, stone, clays.
Wood	52,101,403	48,357,575	Petroleum, natural gas liquids, natural gas.
Yoakum	50,364,708	60,592,717	Petroleum, natural gas liquids, natural gas, salt.
Young	20,073,682	18,182,400	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Zapata	2,405,647	2,397,000	Petroleum, natural gas, natural gas liquids.

See footnotes at end of table.

TABLE 23.—Value of mineral production in Texas, by counties [1]—Continued

County	1959 [2]	1960	Minerals produced in 1960 in order of value
Zavala	$806,774	$865,600	Petroleum, natural gas.
Undistributed	17,978,586	3,513,658	
Total	4,219,757,000	4,134,901,000	

[1] The following counties are not listed because no production was reported: Armstrong, Bailey, Bandera, Castro, Delta, Hood, Lamar, Mills, Parmer, Rains, Real, Rockwall, Sabine, San Saba, Somervell, and Swisher.
[2] Revised figures.
[3] Figure withheld to avoid disclosing individual company data; included with "Undistributed."

A $30 million steel mill to produce 1,000 tons per day of finished steel using the Strategic-Udy direct reduction process and electric smelting was planned for the Palestine area by Sovereign Steel of Texas. The company planned to exploit the low-grade brown ores of east Texas.

Andrews.—Andrews County ranked second in crude oil production and in total mineral value. Natural gas liquids were recovered at five gasoline plants. Underground storage for LP gases amounted to 525,000 barrels. Geophysical prospecting decreased 6 percent to 64 crew-weeks; exploratory and development drilling dropped nearly 50 percent to 392 wells totaling 3,063,876 feet. One new oilfield and six new oil pays were discovered. Sulfur was recovered from sour natural gas at the Andrews plant of Parker & Andrews Co. and at the Midland Farms plant of Pan American Petroleum Corp.

Angelina.—The value of minerals produced decreased 21 percent to $669,805 compared with 1959. Declines were reported for crude oil, natural gas, and clay. Geophysical prospecting increased to 28 crew-weeks.

Aransas.—Mineral value declined 6 percent compared with 1959. A gain in natural gas production did not offset combined losses in crude oil and shell. Geophysical prospecting declined about 60 percent to a total of 12 crew-weeks. Exploratory drilling resulted in discovery of one new oilfield. Natural gas liquids were recovered at the K. G. Pearce gasoline plant of Bay Petroleum Corp. Carbon black was produced from natural gas and liquid hydrocarbon in channel and furnace-type plants of United Carbon Co. Shell was dredged from shallow bays along the coast.

Archer.—The value of minerals produced approximated that of 1959. Exploratory and development drilling increased about 150 percent to 467 wells totaling 1,112,154 feet, resulting in 319 oil wells and 5 gas wells. Eight new oilfields and five new oil pays were discovered. Geophysical prospecting declined about 50 percent to a total of 20 crew-weeks. Natural gas liquids were recovered at the Holiday gasoline plant of Warren Petroleum Corp. Sandstone was quarried and crushed for paving gravel and roadstone for District 3 of Texas Highway Department.

Atascosa.—Value of mineral production declined 10 percent to $16.5 million compared with 1959. The loss resulted from a substantial decrease in crude oil and natural gas production. Geophysical prospecting and drilling activities declined over 20 percent. Exploratory drilling resulted in discovery of two new oilfields. Natural gas

liquids were recovered at the Jourdanton gasoline plant of Humble Oil & Refining Co. and the Pleasanton cycle plant of Loni Star Producing Co. National Sulphur Co. recovered sulfur from sour gas at its Karnes City plant. Glass sand and other industrial sands were produced by Espey Silica Sand Co.; building and paving sand and gravel were produced by West-Land Silica Co. District 15 of Texas Highway Department contracted for paving sand and gravel.

Austin.—The value of minerals was 2 percent greater than in 1959 due to increased production of natural gas and sand and gravel. Geophysical prospecting gained over 100 percent to 49 crew-weeks; exploratory and development drilling increased 42 percent and proved 6 oil wells and 2 gas wells. Building and paving sand and gravel were produced on contract for District 12 of Texas Highway Department and by Brazos River Sand and Gravel.

Bastrop.—The total value of mineral production increased 4 percent over 1959. Crude oil and natural gas accounted for nearly half of the county's mineral value. Geophysical prospecting increased over 50 percent to 57 crew-weeks; exploratory and development drilling declined about 21 percent to 14 starts, proving 2 oil wells. One new oil pay was discovered. Fire clay, used in building brick and heavy clay products, was mined from open pits by Elgin-Butler Brick Co., Elgin Standard Brick Manufacturing Co., and Payne Brick Co.

Baylor.—Mineral value approximated that of 1959. Exploratory and development drilling expanded over 300 percent with 145 wells totaling 285,098 feet. Drilling activity proved 70 oil wells but no gas wells; 2 new oil pays were discovered. Geophysical prospecting increased 60 percent to 16 crew-weeks.

Bee.—Minerals produced by the petroleum, natural gas, and crushed stone industries were valued at 39 percent less than in 1959 as crude oil and natural gas production declined. Exploratory and development drilling, totaling 81 wells and 381,464 feet, was 14 percent less than in 1959; three new oilfields were discovered. Geophysical prospecting increased 14 percent to 79 crew-weeks. Natural gas liquids were recovered at a cycling plant of Gasoline Production Corp. and at Burnell & North Pettus plants of Pan American Petroleum Corp. Crushed limestone, used for concrete aggregate and roadstone, was produced near Beeville by Heldenfels Bros.

Bexar.—Value of mineral production declined 15 percent due to less output of crude oil, cement, and stone. Exploratory and development drilling proved 25 oil wells. Dehydration equipment to recover liquid hydrocarbon from lean gas streams was installed at the San Antonio plant of Lone Star Producing Co. Crude oil was processed at the San Antonio refineries of Flint Chemical Co. and Howell Refining Co.

The 5-year contract to supply lithium hydroxide to the Atomic Energy Commission from the San Antonio plant of American Lithium Chemicals, Inc., was completed. The company was considering producing other lithium chemicals for use in aluminum reduction cells. Portland and masonry cements were produced at San Antonio plants of Longhorn Portland Cement Co. and San Antonio Portland Cement Co. Both companies quarried limestone and clay from open pits for use in making cement. Five producers quarried and crushed limestone for use as concrete aggregate, roadstone, riprap, and railroad

ballast; contractors produced crushed limestone for District 13 of the Texas Highway Department. Sand and gravel, used mostly for paving purposes, was processed at six plants by eight producers. District 15 of the Texas Highway Department contracted for paving sand and gravel. Fire clay and miscellaneous clay for brick, heavy clay products, and lightweight aggregate were mined from open pits by Alamo Clay Products Co., Southern Co., and Barrett Industries.

Borden.—Mineral fuels produced were 19 percent less in total value than in 1959 as crude oil and gas liquid outputs were reduced. Natural gas liquids were recovered at the Big Spring gasoline plant of Reef Corp. Geophysical prospecting decreased over 70 percent in 1960; exploratory and development drilling dropped more than 50 percent. Drilling activities proved 42 oil wells.

Brazoria.—Brazoria County ranked first in natural gas production and third in total mineral value. Total mineral value declined 3 percent due to production losses in crude oil, bromine, and sulfur, notwithstanding increases for natural gas, natural gas liquids, salt, and magnesium compounds. Geophysical prospecting dropped about 25 percent; exploratory and development drilling remained at the 1959 pace with 96 starts totaling 569,806 feet, proving 36 oil wells and 11 gas wells. One new oilfield and five new oil pays were discovered. Natural gas liquids were recovered at four gasoline plants during the year. Carbon black was produced from natural gas at Sweeny No. 204 channel plant of Columbia Carbon Co. Phillips Petroleum Co. processed crude oil at its Sweeny refinery.

Annual styrene capacity of Dow Chemical Co.'s Freeport plant was to be expanded to more than 8 million tons; styrene is used in manufacture of synethic rubber, polystyrene plastics, and other plastics. The company also expanded its polyethylene capacity by more than 67 percent. New facilities at the Sweeny plant of Phillips Chemical Co. increased annual ethylene capacity to nearly 600 million pounds. Pan American Petroleum Corp. completed new facilities at its Old Ocean gasoline plant; daily input capacity was increased to 570 million cubic feet of natural gas.

Native sulfur was recovered by the Frasch process from Hoskins Mound Dome of Freeport Sulphur Co. and Clemens Dome of Jefferson Lake Sulphur Co. Bromine, used in manufacture of ethylene dibromide, was recovered from sea water by Ethyl-Dow Chemical Co. Magnesium chloride, used to produce magnesium metal, and other magnesium compounds were recovered from sea water at the Freeport plant of Dow Chemical Co.; lime produced from shell was used in the process. The company also recovered salt as brine from wells for use in manufacture of organic and inorganic chemicals. Paving gravel and crushed sandstone were prepared on contract for District 17 of Texas Highway Department.

Brooks.—Value of minerals produced was 29 percent less than in 1959 due to drastic curtailment of crude oil production. Geophysical prospecting increased 124 percent to 47 crew-weeks. Exploratory and development drilling declined 44 percent to 30 wells totaling 141,252 feet; 5 new oil pays were discovered. United Carbon Co., Inc., produced carbon black from natural gas at its Dixie channel plant.

Brown.—Mineral value increased 6 percent compared with 1959, due to increased production of natural gas and stone. Exploratory and development drilling totaling 164,529 feet proved 15 oil wells and 4 gas wells; 1 new oilfield was discovered. Miscellaneous clay, used in the manufacture of brick and heavy clay products, was produced from open pits by Texas Brick Co. Limestone was quarried and crushed for concrete aggregate and riprap by G. C. McBride, Inc.

Burnet.—Mineral output was valued at $2.1 million, 11 percent under the 1959 value. Southwestern Graphite Co. mined flake graphite from open pits and processed the ore at its mill near Burnet. Crude vermiculite was expanded at the Burnet plant of Texas Vermiculite Co. Crushed granite for riprap and dimension granite for dressed architectural stone and paving blocks were quarried and prepared by Texas Crushed Stone Co. and Texas Granite Corp. Crushed limestone was produced for riprap, flux, railroad ballast, agricultural purposes, concrete aggregate, paint filler, asphalt filler, and glass manufacturing by Pure Stone Co. and Texas Construction Material Co.

Caldwell.—Mineral value was 4 percent less than in 1959. Exploratory and development drilling, totaling 90 wells and 221,165 feet, proved 77 oil wells. Crude oil output, amounting to 3 million barrels, accounted for all mineral production from the county.

Calhoun.—Value of minerals produced was nearly 11 percent less than in 1959. Geophysical prospecting declined 50 percent. Exploratory and development drilling, totaling 564,228 feet, proved 3 oil wells and 44 gas wells; 3 new oil pays were discovered. Natural gas liquids were recovered at the Hyser gasoline plant of Humble Oil & Refining Co. and the Point Comfort plant of Aluminum Company of America. Polyethylene capacity of the Seadrift and Texas City plants of Union Carbide Chemicals Co. was expanded by 170 million pounds annually.

Aluminum Company of America completed the sixth pot line at its Point Comfort reduction works, increasing annual capacity to 140,000 tons of metal. The third and fourth units of the new alumina plant were essentially completed during 1960; the two units completed in 1959 operated throughout the year. Total annual capacity of the plant will be 750,000 to 1 million tons per year, depending on type of ore processed. Also completed was a 200-ton-per-day cryolite recovery unit. Lime was manufactured from shell at the company's new alumina plant. Shell was dredged from shallow bays by Bauer Dredging Co., and Smith Brothers Dredging Co., Inc. Paving sand was produced on contract for District 13 of Texas Highway Department.

Callahan.—There was an 11-percent decrease in the value of mineral production due to curtailed production of both crude oil and natural gas. Exploratory and development drilling totaled 459,117 feet and proved 23 oil wells; one new oilfield was discovered.

Cameron.—Mineral production was 148 percent greater in value than in 1959. Geophysical prospecting increased 140 percent to a total of 69 crew-weeks; exploratory and development drilling gained 60 percent. Facilities costing $2.5 million were added to the Brownsville petrochemical plant of Union Carbide Co.; acetic acid, acetic anhydride, and methyl and ethyl ketone were to be produced. Oxides were

produced from foreign ores at the new Brownsville plant of National Paint & Manganese Co. for use in the ceramic industry.

Carson.—There was a 19-percent decline in the value of minerals produced compared with 1959. Exploratory and development well drilling totaled 390,726 feet, 30 percent less than in 1959. Natural gas liquids were recovered at three gasoline plants. Cabot Carbon Co. produced carbon black from natural gas at its Schoeber channel plant. Building and paving sand and gravel were produced by various operators during the year.

Cass.—The value of minerals produced was essentially the same as in 1959. Geophysical prospecting increased 43 percent to 120 crew-weeks; exploratory and development drilling declined 42 percent. One new pay was discovered. Iron ore was mined from open pits by S. E. Evans Mining Co., Inc.

Chambers.—There was a 24-percent decline in value of minerals produced, compared with 1959, due to production drops in crude oil, natural gas liquids, and shell. Geophysical prospecting continued at about the same pace as in 1959; exploratory and development drilling declined 36 percent to a total of 66 wells. The projects proved 21 oil wells and 11 gas wells; 2 new oilfields and 6 new oil pays were discovered. Natural gas liquids were recovered at the Anahuac gasoline plant of Humble Oil & Refining Co. Crude oil was refined at the Winnie refinery of Texas Gas Corp. Over 5 million tons of shell was dredged from bays of Chambers County by W. D. Haden Co. and Parker Brothers & Co., Inc., for use as aggregate in concrete, in manufacture of paper and magnesium metal, as poultry grit, and as filler. Diamond Alkali Co. obtained salt in brine from domes near Barbers Hill for use in manufacture of industrial chemicals.

Cherokee.—Mineral value declined 15 percent compared with 1959, because of considerably lower crude oil output. Geophysical prospecting totaled 40 crew-weeks; exploratory and development drilling, totaling 162,586 feet, proved 5 oil wells and 1 gas well. Natural gas liquids were recovered at the Neches gasoline plant of Humble Oil & Refining Co. Brown iron ore was strip-mined near Jacksonville by L. D. Haberle Mining Corp. for use by the cement industry; Sheffield Steel Corp. mined the ore from pits near Rusk for its blast furnace at Houston. Fire clay, used in manufacturing fire brick, was mined from open pits by General Refractories Co.

Clay.—Mineral production declined 6 percent in value due to declines in crude oil and natural gas liquid outputs. Natural gas liquids were recovered at the gasoline plant of Otha H. Grimes. Exploratory and development drilling increased 40 percent to 129 wells, proving 103 oil wells; 1 new oilfield and 3 new oil pays were discovered. Geophysical prospecting amounted to 5 crew-weeks.

Cochran.—Mineral output, valued at $22 million, was 15 percent less than in 1959. Production losses in crude oil and natural gas liquids were greater than a gain in natural gas output. Natural gas liquids were recovered at the Lehman gasoline plant of Cities Service Oil Co. Exploratory and development drilling, totaling 39 wells, was 56 percent less than in 1959.

Coke.—Production loss in crude oil was greater than combined gains in natural gas and natural gas liquid outputs and resulted in a 29-

percent reduction in total mineral value, compared with 1959. Exploratory drilling resulted in discovery of two new oilfields and four new pays. Natural gas liquids were recovered at the Jameson plant of Sun Oil Co. and the Perkins plant of Union Texas Natural Gas Corp. Montgomery Sand & Gravel Co. recovered building and paving sand and gravel; District 7 of Texas Highway Department contracted for crushed limestone for use as concrete aggregate and roadstone.

Coleman.—The value of mineral production was 5 percent greater than in 1959 as most mineral outputs registered modest gains. Natural gas liquids were recovered at four gasoline plants. Exploratory and development drilling, totaling 135 wells and 420,281 feet, proved 66 oil wells and 16 gas wells. Molding sand and glass sand were produced by Santa Anna Silica Sand Co., Inc., at its plant near Santa Anna. Miscellaneous clay, used in making heavy clay products, was mined from open pits near Coleman by Martin Brick Co. Crushed limestone was quarried and prepared for use as concrete aggregate and roadstone by T. E. Sanderford.

Colorado.—Mineral production, valued at $20.4 million, was 6 percent less than in 1959 due to reduced output of crude oil, natural gas, and sand and gravel. Natural gas liquids were recovered at the Sheridan cycling plant of Shell Oil Co. and the Chesterville plant of Tennessee Gas Transmission Co. Geophysical prospecting totaled 79 crew-weeks; exploratory and development drilling, totaling 370,805 feet, proved 2 oil wells and 23 gas wells. Building and paving sand and gravel were mined from pits near Columbus, Eagle Lake, Alleyton, Altair, and Glidden by four producers at eight operations; District 13 of Texas Highway Department contracted for 131,826 tons of paving sand and gravel.

Comal.—Mineral production increased 4 percent in value compared with 1959 and included stone, lime and sand and gravel. Limestone from open pits near New Braunfels was used in manufacturing lime by United States Gypsum Co. Servtex Materials Co. quarried limestone from pits near Ogden for use as railroad ballast, riprap, concrete aggregate, and agricultural limestone. Building and paving sand and gravel were obtained from open pits by one commercial producer and by construction crews of District 15 of Texas Highway Department.

Comanche.—Production losses in crude oil, natural gas, and miscellaneous clay resulted in a 48-percent decline in total value of mineral production. Exploratory and development drilling, totaling 14 wells and 40,827 feet, proved 1 oil well and 3 gas wells. Miscellaneous clay was mined from open pits by De Leon Brick Co.

Cooke.—Mineral output valued at $32.1 million included crude oil, natural gas liquids, natural gas, stone, and sand and gravel. Geophysical prospecting totaled 12 crew-weeks. Exploratory and development drilling, totaling 716,835 feet, resulted in 142 oil wells; 1 new oilfield and 2 new oil pays were discovered. Natural gas liquids were recovered at the Walnut Bend gasoline plant of Union Texas Natural Gasoline Corp. and the Sivells Bend gasoline plant of Standard Oil Co. of Texas. Crude oil was processed at the Gainesville refinery of Tydal Co. Paving sand and gravel was produced by Texhoma Mate-

rials Co.; limestone was quarried and crushed for concrete aggregate and roadstone by contractors for District 3 of Texas Highway Department.

Crane.—Crane County ranked third in crude oil production and fifth in total mineral value. Mineral fuels, valued at $121.9 million, gained 17 percent over 1959. Natural gas liquids were recovered from five gasoline plants. Exploratory drilling resulted in discovery of three new oilfields and eight new oil pays. Sulfur was recovered from sour gas at the Crane gasoline plant of Phillips Petroleum Co. and the Waddell plant of Warren Petroleum Corp.

Crockett.—Production of mineral fuels, valued at $26.2 million, was 6 percent greater than in 1959 due to increases in natural gas and natural gas liquid output. Natural gas liquids were recovered at the Todd Ranch gasoline plant of Continental Oil Co. Exploratory drilling accounted for one new oil pay. Geophysical prospecting amounted to 36 crew-weeks.

Culberson.—Production of crude oil and natural gas, valued at $3.6 million, was 68 percent more than that of 1959. Geophysical prospecting declined 50 percent to 79 crew-weeks; exploratory and development drilling declined 77 percent. Continental Minerals Co. was building an 80- to 100-ton-per-day barite processing mill to produce material for use in heavy drilling muds.

Dallas.—Mineral production was valued at $18.6 million, 23 percent less than in 1959, and included cement, sand and gravel, and clay. The value of production of most construction materials declined. Portland and masonry cements were produced from limestone quarried at Cement City by Lone Star Cement Co. and at Eagle Ford 1 and 2 by Trinity Portland Cement Division of General Portland Cement Co. About 4 million tons of sand and gravel was prepared at 17 plants by 13 producers. District 18 of Texas Highway Department contracted for paving sand and gravel. Crude perlite, mined in other Western States, was expanded at the Irving plant of Texas Lightweight Products Co. and the Dallas plant of Texas Vermiculite Co. for use as lightweight aggregate in concrete, building plaster, and loose-fill insulation. Both plants also exfoliated crude vermiculite for use as lightweight aggregate and loose-fill insulation. Miscellaneous clay, used in manufacturing building brick, heavy clay products, and lightweight aggregate, was mined from open pits at the Mesquite plant of Ferris Brick Co. and the Dallas plant of Dallas Lightweight Aggregate Co. Both cement companies recovered surface clays for use in manufacturing cement.

Dawson.—Mineral value approximated that of 1959. Natural gas liquids were recovered at the Lamesa gasoline plant of Texaco Seaboard, Inc. Limestone was quarried and crushed at an open pit near O'Donnell for concrete aggregate and roadstone by Lone Star Materials, Inc. Exploratory and development wells, totaling 381,731 feet, proved 32 oil wells; 4 new oilfields were discovered. Geophysical prospecting amounted to 92 crew-weeks, 33 percent more than in 1959.

Denton.—There was a 34-percent increase in mineral value compared with 1959, due to gains in natural gas, clay, and sand and gravel production. Exploratory and development drilling proved three oil wells and four gas wells; this was the first gas discovery in the county.

The new zone is the Cordell sand of Pennsylvania age; additional production also was indicated in the Caddo formation. Paving sand and gravel was produced by commercial operators and by contractors for District 18 of Texas Highway Department. Limestone was quarried and prepared by contractors for District 18 of Texas Highway Department. Acme Brick Co. mined fire clay from pits near Denton.

De Witt.—Production of crude oil, natural gas, sand and gravel, and stone was valued at $8.9 million, approximating the 1959 value. Geophysical prospecting increased 86 percent to 262 crew-weeks. Exploratory and development drilling, totaling 495,675 feet, proved 8 oil wells and 20 gas wells; 1 new oilfield and 2 new oil pays were discovered. Limestone was quarried and crushed for concrete aggregate and roadstone by various producers and by contractors for District 13 of Texas Highway Department. Paving sand and gravel was produced by several operators.

Dickens.—Value of minerals produced was 20 percent less than in 1959 due to declines in output of crude oil and sand and gravel. Exploratory and development drilling, totaling 33,742 feet, resulted in 4 dry holes. Contractors quarried and crushed limestone for concrete aggregate and roadstone for District 25 of Texas Highway Department. R. W. Mize mined pit-run gravel for fill.

Dimmit.—Mineral fuel production was 15 percent greater than in 1959, due primarily to increased crude oil output. Exploratory drilling accounted for two new oilfields and five new oil pays. Crude oil was processed at the Carrizo Springs refinery of Texstar Petroleum Co.

Duval.—Mineral production, which included crude oil, natural gas, natural gas liquids, and salt, was valued at $44.1 million, about the same as in 1959. Exploratory drilling resulted in discovery of two new oilfields and four new oil pays. Natural gas liquids were recovered at the Hagist gasoline plant of Goliad Corp. Columbia Southern Chemical Corp. recovered salt in brine from wells near San Diego for use in manufacturing industrial chemicals.

Eastland.—Output of crude oil, natural gas liquids, natural gas, and clay was valued at $5.6 million—18 percent greater than in 1959. All mineral fuels registered modest gains in output. Natural gas liquids were recovered at four gasoline plants. Exploratory and development drilling, totaling 31 wells and 89,472 feet, resulted in 10 oil wells and 6 gas wells. Geophysical prospecting amounted to 7 crew-weeks compared with 3 in 1959. Fire clay and miscellaneous clay used in manufacturing lightweight aggregate, floor and wall tile, brick, and pottery were mined from open pits near Ranger by American Aggregate Co.; near Eastland, by Texas Lightweight Aggregate Co.; and near Cisco, by Texeramics Co. and N. D. Gallagher Clay Products Corp.

Ector.—Ector County ranked first in both crude oil production and total mineral value. Exploratory and development drilling declined 52 percent to 352 wells totaling 2,031,243 feet; 2 new fields and 8 new pays were discovered.

Ellis.—Value of minerals produced was 191 percent greater than in 1959 due largely to added cement production. The multimillion dollar, 1.4-million-barrel-a-year Midlothian cement plant of Texas Industries, Inc., began production late in the year. Limestone was

quarried and crushed for use in manufacturing cement at the Midlothian plant. 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 at the Taylor pit by Taylor Gravel Co.

El Paso.—Mineral production declined 26 percent compared with 1959. Southwestern Portland Cement Co. quarried limestone and shale from open pits for use in manufacturing portland and masonry cements at its El Paso works. El Paso refineries of Standard Oil Co. of Texas 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 Co. Structural and paving sand and gravel were prepared on contract for the U.S. Army Corps of Engineers.

Erath.—Value of mineral output was 13 percent greater than in 1959. Limestone was quarried and crushed for District 2 of Texas Highway Department. Crude oil and natural gas production was reported during the year.

Fannin.—Building and paving sand and gravel were produced by one operator; sandstone was quarried and crushed for use as concrete aggregate and roadstone by contractors for District 2 of Texas Highway Department.

Fayette.—Mineral production was valued at $1.2 million, 8 percent less than in 1959. Building and paving sand and gravel were recovered from pits near LaGrange by Thorstenberg Materials Co.; District 13 of Texas Highway Department contracted for crushed limestone and building and paving sand and gravel. Bentonitic clay, used principally in preparing heavy drilling mud, and fuller's earth were recovered from open pits near Flatonia by Milwhite Co., Inc., and Flatonia Fuller's Earth Co.

Fisher.—Mineral value declined 18 percent to $14.2 million, compared with 1959, because of significantly reduced petroleum activity. One new oilfield was discovered through exploratory drilling; geophysical prospecting amounted to 20 crew-weeks. Natural gas liquids were recovered at the Claytonville and "F" gasoline plants of Claytonville Gasoline Co. and the Velta plant of Texas Pacific Coal & Oil Co. Crude gypsum, used in manufacture of wallboard, plaster, and other building products, was mined from open pits near Hamlin by Celotex Corp. and from pits near Rotan by National Gypsum Co. Building and paving sand was prepared by one producer.

Foard.—Mineral production was valued at $2.8 million, 7 percent greater than in 1959. Geophysical prospecting amounted to 46 crew-weeks, compared with 38 in 1959. Exploratory and development wells, totaling 253,638 feet of drilling, proved 11 oil wells; no new oilfields or oil pays were discovered. Limestone was quarried and crushed by contractors for District 25 of Texas Highway Department.

Fort Bend.—Declines in the value of crude oil, clay, sand and gravel, and sulfur production were not offset by increases in natural gas and salt, resulting in a 9-percent drop in the value of mineral output. Geophysical prospecting amounted to 11 crew-weeks, compared with 39 crew-weeks in 1959. Exploratory and development drilling

amounted to 63 wells and 296,734 feet of hole, resulting in 33 oil wells and 3 gas wells; 1 new oil pay was discovered. Native sulfur was recovered by the Frasch method from Orchard Dome by Duval Sulphur & Potash Co. 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 manufacturing lightweight aggregate. Salt-in-brine and evaporated salt were prepared at Blue Ridge Works 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 93 percent greater than in 1959 due to increased production of petroleum and natural gas liquids. Geophysical prospecting totaled 10 crew-weeks. Exploratory and development wells, totaling 108,098 feet, resulted in 2 oil wells and 5 gas wells. 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 110-percent increase in value of mineral production, compared with 1959, was due to production increases in crude oil and natural gas. Exploratory and development drilling, totaling 240,523 feet, proved 7 oil wells and 15 gas wells during the year. Miscellaneous clay, used in manufacturing brick and heavy clay products, was mined from open pits near Teague by Teague Brick & Tile Co. Limestone was quarried and crushed for concrete aggregate and roadstone by East Texas Stone Co.

Frio.—Crude oil, natural gas, and natural gas liquids accounted for most of the $5.1 million mineral value. Paving gravel was produced by crews of District 15 of Texas Highway Department.

Gaines.—Mineral value of Gaines County declined 3 percent, to $71.4 million, as losses in petroleum output were greater than gains in natural gas production. Geophysical prospecting amounted to 107 crew-weeks; drilling of 145 exploratory and development wells proved 110 oil wells and 5 gas wells. Natural gas liquids were recovered at the Seminole plant of Phillips Petroleum Co. and the West Seminole plant of Cities Service Oil Co. Sulfur and carbon black were recovered from sour natural gas at the Seminole No. 67 plant of Columbian Carbon Co. Limestone was quarried and crushed for concrete aggregate and roadstone by one producer.

Galveston.—The value of mineral production in Galveston County was 6 percent greater than that of 1959 as production gains were reported for both natural gas and crude oil. Geophysical prospecting declined 40 percent, compared with 1959, to 87 crew-weeks. Exploratory and development drilling declined 6 percent to 91 wells and proved 52 oil wells and 10 gas wells; 1 new oilfield and 1 new oil pay were discovered. Crude oil was processed at three refineries having a combined daily capacity of 240,000 barrels. At its Texas City refinery, American Oil Co. began construction of a two-stage pipe-still with a fractionation system capable of handling 150,000 barrels per day, a 47,600-barrel-per-day catalytic cracking unit, and a 14,600-barrel-per-day alkylation unit. Sulfur was recovered at the new multimillion dollar Frasch sulfur mine of U.S. Sulphur Corp. at High Island Dome near Galveston. Natural gas liquids were recov-

ered at the Alta Loma gasoline plant of the Margaret Hunt Trust Estate. Shell was dredged from shallow bays at Galveston by Horton & Horton for use principally as roadstone and in manufacturing cement. Paving sand was prepared by construction crews of the City of Galveston.

Garza.—Value of minerals produced in Garza County declined 14 percent as crude oil production was severely curtailed. Geophysical prospecting declined 33 percent to 37 crew-weeks; exploratory and development drilling declined 59 percent to 77 wells totaling 333,105 feet. Building sand and gravel was produced by one operator.

Gillespie.—Mineral value increased 33 percent to $116,655 compared with 1959. Talc was strip mined on contract for Southwestern Talc Corp. Five operators produced a total of 66,760 tons of building and paving sand and gravel. Bear Mountain Quarries mined and prepared rough monumental granite. Crushed limestone was produced on contract for concrete aggregate and roadstone for District 14 of Texas Highway Department.

Glasscock.—There was a 55-percent gain in mineral value in 1960 due to increased production of crude oil and natural gas. Geophysical prospecting during the year declined 36 percent to 9 crew-weeks; exploratory and development drilling increased 35 percent to 27 wells and resulted in 7 oil wells. Limestone was quarried and crushed by contractors for concrete aggregate and roadstone for District 7 of Texas Highway Department.

Goliad.—Declines in both oil and gas production resulted in a 6-percent loss in total mineral value. Geophysical prospecting increased 13 percent to 35 crew-weeks. Exploratory and development drilling dropped 23 percent to 53 wells and proved 4 oil wells and 28 gas wells; 1 new oil pay was discovered. Natural gas liquids were recovered at the Burnell-North Pettus cycling plant of Pan American Petroleum Corp. in Bee County.

Gonzales.—Mineral value declined 45 percent to $168,077. Building and paving sand and gravel were produced by Gonzales Gravel Co.; District 13 of Texas Highway Department contracted for paving gravel. Bentonitic clays were mined from open pits by Baroid Division of National Lead Co. and Southern Clay Products Co. Geophysical prospecting declined over 80 percent to 40 crew-weeks.

Gray.—Reductions in oil and gas production were offset by increased natural gas liquid output so that total mineral value approximated that of 1959. Geophysical prospecting was limited to 8 crew-weeks; exploratory and development drilling, totaling 158 wells and 437,384 feet, resulted in 102 oil wells and 38 gas wells. Natural gas liquids were recovered at eight gasoline plants; carbon black was recovered at three channel plants and one furnace plant.

Grayson.—There was a 13-percent decline in total value of mineral production compared with 1959. Losses in crude oil and natural gas liquid output exceeded increased natural gas production. Natural gas liquids were recovered at eight plants operated by five companies. Geophysical prospecting dropped 15 percent to 73 crew-weeks. Exploratory and development drilling increased 50 percent to 66 wells and proved 44 oil wells and 5 gas wells; 1 new oilfield and 6 new oil pays were discovered. Two producers quarried and prepared lime-

stone for concrete aggregate, riprap, and roadstone. Southwest Sand Co. produced building sand.

Gregg.—Gregg County was the State's fifth largest crude oil producer. Significant production curtailment of crude oil and natural gas liquids resulted in an 11-percent reduction in total mineral value. Natural gas liquids were recovered at five gasoline plants. The 35 exploratory and development wells, totaling 210,768 feet, constituted a 26-percent decrease from 1959. Crude oil was processed at the Longview refineries of Premier Oil & Refining Co. and Skelly Oil Co., and at the Gladewater refinery of Gladewater Refining Co.

Grimes.—A gain in natural gas output increased the value of mineral production to $544,200. Geophysical prospecting declined 27 percent to 19 crew-weeks; 2 exploratory wells proved 1 gas discovery.

Guadalupe.—Mineral production, valued at $12.3 million, was 4 percent greater than in 1959 due to moderate increases in crude oil and sand and gravel output. Exploratory and development drilling declined 25 percent to 49 wells and 141,056 feet, resulting in 38 oil wells. Building and paving sand and gravel were produced by two operators; paving gravel was produced on contract for District 15 of Texas Highway Department. Fraser Brick & Tile Co. mined miscellaneous clay for brick and heavy clay products from open pits near McQueeney.

Hamilton.—Value of natural gas and sand and gravel production was 20 percent less than in 1959. Paving sand and gravel was produced by one operator. Geophysical prospecting totaled 28 crew-weeks.

Hansford.—The 21-percent decline in value of mineral fuel production was due largely to a reduction in natural gas output. Natural gas liquids were recovered at the Hansford and Sherman gasoline plants of Phillips Petroleum Co.

Hardeman.—Geophysical prospecting declined 62 percent to 38 crew-weeks. Exploratory and development drilling increased 22 percent to 11 wells and resulted in 3 oil wells; 1 new oil pay was discovered. Bestwall Gypsum Co. mined gypsum from open pits near Acme for manufacturing 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, valued at $25.2 million, was 12 percent less than in 1959. The loss was due to moderate declines in both crude oil and natural gas liquid output. Geophysical prospecting increased 19 percent to 37 crew-weeks. Exploratory and development drilling dropped 3 percent to 106 wells totaling 457,205 feet; 1 new oilfield and 1 new oil pay were discovered. Natural gas liquids were recovered at the Nos. 25 and 26 cycling plants of Sinclair Oil & Gas Co.

Harris.—Value of mineral production declined 7 percent compared with that of 1959. Natural gas liquids were recovered at four gasoline plants and two cycling plants. Carbon black was produced from liquid hydrocarbons at the Eldon furnace plant of J. M. Huber Corp. Crude oil was processed at seven refineries having a combined daily throughput of 715,000 barrels. Geophysical prospecting declined 52 percent to 21 crew-weeks and drilling, 25 percent to 125 wells; 2 new oil pays were discovered. Sulfur was recovered from refinery gases at the Baytown plant of Stauffer Chemical Co., the Deer Park plant of

Shell Chemical Corp., and the Houston plant of Sinclair Refining Co. A multimillion dollar expansion was made at the Houston mill of Sheffield Division of Armco Steel Corp. New facilities included a slab mill and a 160-inch plate mill which produces plates 4 inches thick and 144 inches wide. This equipment permits rolling all grades of carbon and alloy plates in a wide variety of lengths, widths, and thicknesses. The capacities of the open hearth and electric furnaces were increased through the addition of pure oxygen without additional capital expenditures. Lone Star Steel continued improvement of its practice of introducing natural gas into the blast furnace as a fuel and reductant, thus reducing coke burden and increasing pig iron capacity.

Sheffield Steel requested permission of the U.S. Army Corps of Engineers to build a 10,000-ton raw material handling and storage dock on the Houston ship channel. A $1 million detinning plant to produce high-yield steel scrap and refined electrolytic tin was planned for the Houston area by Vulcan Detinning Division of Vulcan Materials Co.

Portland and masonry cements were manufactured from shell by Lone Star Cement Corp., Ideal Cement Co., and Trinity Division of General Portland Cement Corp. The three cement producers also recovered clay from open pits for manufacturing their cement.

Miscellaneous clay was mined from open pits near Houston and used in manufacture of brick and heavy clay products by Acme Brick Co., J.M. Cordell & Sons, Inc., and Houston Brick & Tile Co. Crude perlite and vermiculite from other states was expanded at the Houston plants of Perlite of Houston, Inc., Vermiculite Products, Inc., and Tri-Lite Corp. for use as lightweight aggregate in concrete and plaster and as loose-fill insulation.

Salt was mined underground and prepared as rock salt and block salt at the Hockley plan of United Salt Co. and was obtained in brine from wells near Houston by Texas Brine Co.

Lime was manufactured from oystershell at the Pasadena plant of Champion Paper & Fiber Co. for use in paper and fiberboard manufacture, at the Houston plant of Nyotex Chemical Co. for use in manufacture of industrial chemicals, and at the Houston plant of Sheffield Division of Armco Steel as a metallurgical flux. Barite from foreign countries and from other states was crushed and ground for use in drilling muds at the Houston plants of Barite Division, National Lead Co., and Milwhite Co., Inc.

Building and paving sand and gravel were produced by five companies; District 12 of Texas Highway Department contracted for paving sand and gravel.

Many additions and plant expansions occurred in the petroleum refining and petrochemical industries in Harris County. A 70-million-pound-per-year styrene monomer plant using a "styrene-from-gasoline" process was planned for the Houston area by Sinclair-Koppers Chemical Co. The plant will recover pure ethylbenzene from a mixed xylene stream. A pilot plant to product 30 million pounds per year of maleic anhydride was built by Petro-Tex Chemical Corp. The Carwin Co. built a 1-million-pound-per-year isocyanates plant. A new research and development center which will include a laboratory with adjacent polymer development facilities was planned for the

Houston area by United Carbon Co. The company also increased the capacity of its copolymer plant from 150 to 200 million pounds per year to meet new demand for a series of new black master batch compounds for improved truck tire rubber. A plant to produce an additional 600 tons per day of oxygen and 100 tons per day of nitrogen was built by Linde Co., Division of Union Carbide, on the Houston ship channel. Pipelines from the new and existing facilities will deliver 140 tons per day of oxygen to the Sheffield Steel plant and 320 tons per day of oxygen and 150 tons per day of nitrogen to the Houston plant of Diamond Alkali Co. Oxygen to other customers will be supplied in cylinders. Phillips Petroleum Co. contracted for two refrigerated propane-ammonia barges. Each barge will carry 1,700 tons of anhydrous ammonia refrigerated to minus 28° F. A $1 million, highly automated rubber plant to produce mixtures of carbon black with polyethylene and polypropylene to be used for cable insulating material and plastic pipe was built at Houston by Columbian Carbon Co. J. M. Huber Corp. increased the carbon black capacity of its Baytown plant from 110 to 193 tons per day at a cost of $2.5 million. Low pressure polyolefin capacity of the Houston plant of Celanese Chemical Co. was increased from 40 million pounds to 50 million pounds per year. The company also expanded its high-density linear polyethylene capacity to 50 million pounds per year. Acetylene capacity of the Deer Park plant of Diamond Alkali Co., was increased by 40 million pounds per year, and new facilities to increase present polymer capacity (polyvinyl chlorides) were also being added.

Sulfuric acid facilities were being added to the La Porte plant of Du Pont. Pennsalt Chemicals Corp. added alkyl mercaptan facilities to its Houston plant. Humble Oil & Refining Co. increased the butyl-x rubber capacity of its Baytown plant to more than 170 million pounds per year. The company also completed a $30 million, 40-million-pound-per-year polypropylene plant. Half the production was to be made to specifications of Spencer Chemical Co. Vacuum capacity of the company's Baytown refinery was increased from 157,000 barrels to 179,000 barrels; catalytic hydrogen treatment capacity was raised from 65,000 barrels to 82,300 barrels daily. A 17-million-gallon underground storage cavity in a salt dome near Houston was developed by Tuloma Gas Products Co. Capacity of the "Little Big Inch" pipeline of Texas Eastern Transmission Co., a 4,468-mile system from Houston, Tex., to Moundsville, W. Va., was increased to nearly 16 million barrels. The company Mt. Belvieu underground LPG storage cavity was enlarged from 320,000 barrels to 550,000 barrels.

Harrison.—The 14-percent decline in mineral value was due to reduction in natural gas and natural gas liquid outputs. Exploratory and development drilling declined 18 percent to 129 wells totaling 504,684 feet. Natural gas liquids were recovered at six gasoline plants. Brick, heavy clay products, stoneware, and pottery were manufactured from miscellaneous clay and fire clay mined from open pits near Waskom by Acme Brick Co. and from pits near Marshall by Marshall Brick Co. and Marshall Pottery Co. Lignite mined from open pits was used in manufacturing several grades of activated

carbon by the D'Arco Division of Atlas Powder Co. Crude oil was refined at the Waskom refinery of Natural Gas Corp.

Hartley.—Value of crude oil and natural gas was 27 percent less than in 1959. Geophysical prospecting increased 180 percent to 31 crew-weeks; only 2 exploratory wells were drilled during the year, both of which were dry holes.

Haskell.—Crude oil, natural gas, and stone production was valued at $12.4 million, 20 percent more than in 1959. The increase was due to greater crude oil and stone production. Of 165 exploratory and development wells drilled, 90 were oil wells; geophysical prospecting totaled 9 crew-weeks. Limestone was quarried and crushed for concrete aggregate and roadstone by contractors for District 2 of Texas Highway Department.

Hemphill.—The 3-percent increase in mineral value was caused by limited improvement in natural gas and sand and gravel outputs. Geophysical prospecting increased 25 percent to 15 crew-weeks; exploratory and development drilling declined 22 percent compared with 1959. Building and paving sand and gravel were produced by several operators.

Henderson.—Mineral value declined 2 percent to $7 million because of modest losses in crude oil and natural gas liquid production. Geophysical prospecting increased 300 percent to 64 crew-weeks; exploratory and development drilling gained 100 percent to 34 wells totaling 124,672 feet. Natural gas liquids were recovered at the Trinidad gasoline plant of Lone Star Gas Co. Brick, heavy clay products, fire brick, and refractory shapes were manufactured from fire and miscellaneous clays mined from open pits near Athens by Athens Brick Co., Inc., Harbison-Walker Refractories Co., Texas Clay Products Co., and Athens Tile & Pottery Co.

Hidalgo.—There was a 13-percent decline in total value of minerals produced in Hidalgo County as crude oil and natural gas outputs were curtailed. Natural gas liquids were recovered at the gasoline plant of Delhi-Taylor-Mayfair Oil Corp. and the Tabasco plant of Anchor Gasoline Corp. Crude oil was processed at the La Blanca refinery of Cactus Petroleum, Inc., and the McAllen refinery of Caddo Refining Co.

Hockley.—The 10-percent decline in mineral value was due to a major reduction in output of crude oil. Geophysical prospecting declined 23 percent, and exploratory and development drilling declined 6 percent compared with 1959. Natural gas liquids were recovered at three gasoline plants. Sulfur was recovered at the Slaughter gasoline plant of Pan American Corp.

Hopkins.—Declines in the output of crude oil and natural gas liquids resulted in a 1 percent decrease in the value of mineral production. Humble Oil & Refining Co. recovered natural gas liquids at its Pickton gasoline plant. A. P. Green Fire Brick Co. of Texas manufactured fire brick and refractory shapes from strip-mined fire clay.

Houston.—Mineral value declined 43 percent because of a significant decline in crude oil production and a smaller decline in natural gas. Geophysical prospecting increased over 50 percent to 25 crew-weeks; drilling activity gained 5 percent to 143,542 feet of hole and proved 2 gas extensions.

Howard.—A 5-percent decline in mineral value was due entirely to curtailed crude oil production. Cosden Petroleum Corp. processed crude oil at its Big Spring refinery. Carbon black was recovered from hydrocarbon liquids at the Dixon furnace plant of Cabot Carbon Co. West Texas Sand & Gravel Co. prepared building and paving sand and gravel. Cosden Petroleum Corp expanded styrene capacity of its Big Spring chemical plant to 60 million pounds per year, orthoxylene capacity to 80 million pounds per year, and metaxylene capacity to 3 million pounds per year due to increased demand for phthalic anhydride and isophthalic acid. A new 50-million-pound-per-year carbon black plant using United Carbon Co. processes was planned for the Big Spring area by Sid Richardson Carbon Co.

Hudspeth.—Increased talc production resulted in a 7-percent increase in total mineral value. Talc used in ceramics, insecticides, paint, roofing, rubber, and joint cement was recovered from open pits near Allamoore by five 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 Penwell.

Hutchinson.—Production increases in both natural gas and natural gas liquids more than compensated for crude oil production losses and the value of mineral production increased 4-percent to $64.9 million. Drilling activity by the oil and gas industry declined 15 percent. Carbon black was recovered at four furnace plants and one channel plant. Natural gas liquids were recovered at eight gasoline plants. A 25,000-ton-per-year cis-4 polybutadiene plant was built by Phillips Chemical Co. adjacent to its Borger butadiene plant. Tri-City Sand & Gravel Co. and Borger Readi-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.

Irion.—Increases in natural gas and natural gas liquids production failed to compensate for losses in crude oil production, with the result that total mineral value declined 1 percent to $2.1 million, compared with 1959. Geophysical prospecting increased over 100 percent to 23 crew-weeks; exploratory and development drilling gained 21 percent to 69 wells totaling 152,513 feet and proved 22 oil wells and 1 gas well. Mertzon Corp. recovered natural gas liquids at its Mertzon gasoline plant.

Jack.—Mineral value increased 15 percent as the petroleum and natural gas industries reported improved production. Geophysical prospecting increased 67 percent to a modest 10 crew-weeks; exploratory and development drilling declined over 43 percent to 141 wells totaling 480,507 feet. Bryson Pipeline & Refining Co. processed crude oil at its Bryson refinery. Natural gas liquids were recovered at the Black Hawk gasoline plant of Black Hawk Gasoline Corp., the Brazos plant of Brazos River Gas Co., and the Jupiter plant of Welstream Equipment Corp.

Jackson.—Gains in natural gas production were greater than crude oil losses, resulting in a 4-percent increase in total mineral value. Geophysical prospecting rose 12 percent to 64 crew-weeks; and ex-

ploratory and development drilling rose 20 percent to 175 wells totaling 908,546 feet and proved 25 oil wells and 72 gas wells. Cycling plants of Francitas Gas Co. and Sunray Mid-Continent Oil Co. and the Vanderbilt Gasoline plant of 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. The world's first sextuple well completion was recorded by Sunray Mid-Continent Oil Co. with production from 6 gas zones at depths from 4,683 to 6,634 feet. A $400,000 expansion of the Carancahua Bay gasoline plant of Sunray Mid-Continent Oil Co. doubled its capacity to 60 million cubic feet of gas per day; natural gas liquids recovery was increased by 30 million gallons per day.

Jasper.—Moderate increases in crude oil production resulted in a 10-percent increase in total mineral value compared with 1959. Natural gas output approximated that of 1959. Exploratory and development drilling decreased 52 percent to 11 wells totaling 124,515 feet and proved 2 oil wells and 1 gas well.

Jefferson.—Crude oil, natural gas, and sulfur accounted for over 90 percent of the county total mineral value. Production of all three commodities rose, resulting in an 18-percent increase in total mineral value to $62.8 million compared with 1959. Although geophysical prospecting declined 57 percent to 67 crew-weeks, exploratory and development drilling rose 17 percent to 132 wells totaling 1,012,086 feet.

A $1 million filtration plant to upgrade sulfur by removing organic and other trace impurities was built at the Spindletop operations of Texas Gulf Sulphur Co. Texaco, Inc., added a 30-million-gallon-per-year benzene facility to its Port Arthur refinery; new equipment included a unifier-catalytic reforming unit, a Udex extraction unit, and other treating and fractionating facilities. The company's Port Arthur refinery set a world's safety record for the refining industry by operating 7.6 billion man-hours without a lost-time injury. Mobil Chemical Co. was building the world's largest high-purity ethylene plant adjacent to its Beaumont refinery. Capacity will be 380 million pounds per year, with initial production scheduled for the first quarter of 1961. Mobil Oil Co. added a 20,000-barrel-per-day delayed-coking unit to its Beaumont refinery. The synthetic rubber copolymer capacity of the Port Neches plant of Texas-U.S. Chemical Co. was increased 10 percent. Koppers Co., Inc., increased high-pressure polyethylene capacity of its Port Arthur facilities to 46 million pounds per year. Facilities to produce 50 million pounds per year of caprolactan from cyclohexane were added to the Beaumont plant of E. I. du Pont de Nemours & Co., Inc. A synthetic rubber plant based on isoprene and butadiene was built by Goodyear Tire & Rubber Co. The first commercial Hydrar unit to produce high-purity cyclohexane from benzene was put on stream at the Port Arthur refinery of Gulf Oil Corp. Six refineries, with a total daily throughput capacity of 986,000 barrels, processed crude oil in the county. Natural gas liquids were recovered at the Texas Gasoline plant of Texas Gas Corp. Native sulfur was recovered by the Frasch process from Spindletop Dome and Fannett Dome by Texas Gulf Sulphur Co. and from refinery gases of the Port Arthur refinery of Gulf Oil Corp. by Olin-Mathieson Chemical Corp. Texas Brine

Corp. recovered salt in brine from wells near Gladys City. Brick and heavy clay products were made from miscellaneous clay mined from open pits by Beaumont Brick Co., Inc. C. A. McKinley Sons, Inc., produced building sand and gravel.

Jim Hogg.—Value of mineral production rose 72 percent to $9.4 million because of a sizable increase in crude oil and natural gas production. Exploratory and development drilling increased 28 percent to 95 wells totaling 393,175 cubic feet and proved 64 oil wells and 12 gas wells.

Jim Wells.—Crude oil and natural gas production both contributed to the 15-percent decline in mineral value. The industry drilled 78 wells totaling 452,535 feet and proved 17 oil wells and 23 gas wells. Natural gas liquids were recovered at the La Gloria cycle plant of La Gloria Oil & Gas Co. and the Seeligson gasoline plant of Mobil Oil Co., Inc.

Johnson.—Reductions in lime and stone production resulted in a 15-percent decline in total mineral value. Lime for chemical and industrial uses and for construction 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 18 of Texas Highway Department. Building and paving sand and gravel were produced by Aggregates Producers, Inc.

Jones.—Total mineral value approximated the 1959 value as increases in natural gas production almost offset losses in crude oil and natural gas liquid output. Exploratory and development drilling decreased 30 percent to 177 wells totaling 642,659 feet and proved 78 oil wells. Petroleum Products Co. processed crude oil at its Lueders refinery. Natural gas liquids were recovered at the Wimberly No. 1 gasoline plant of Texas Natural Gasoline Corp. West Texas Stone Co. quarried and prepared rough architectural and dressed building stone. Limestone quarried in Shackelford County was prepared for rough architectural and dressed building stone by Lueders Limestone Co. Building and paving sand and gravel were produced by one operator.

Karnes.—Production of the State's first uranium oxide (U_3O_8) and increased production of crude oil, natural gas, and natural gas liquids accounted for the 45-percent increase in mineral value. The uranium mill, which cost about $2.4 million and had a rated capacity of 300 tons of ore per day, was put in operation by Susquehanna-Western, Inc. Uranium ores recovered from open pits in the Falls City area will be treated at the mill. Natural gas liquids were recovered at the Capeza Creek and Karnes City gasoline plants of United Gas Pipeline Co. Exploratory and development drilling increased nearly 100 percent to 72 wells totaling 702,975 feet and proved 40 oil wells and 4 gas wells. Sulfur was recovered from sour gas at the Fashing plant of Warren Petroleum Corp.

Kaufman.—Curtailment of crude oil production resulted in an 18-percent decline in total mineral value, compared with 1959. Limestone was quarried and crushed for concrete aggregate and roadstone by various producers for Districts 1 and 18 of Texas Highway Department.

Kenedy.—The increase in natural gas production was greater than decreases for crude oil and natural gas liquid production so that total mineral value was 6 percent greater than in 1959. Natural gas liquids were recovered at the Julian Pasture cycle plant of Humble Oil & Refining Co. Exploratory and development drilling totaling 81,117 feet proved 1 oil and 1 gas well.

Kent.—The 2-percent reduction in total mineral value was due entirely to curtailed crude oil output which was responsible for nearly 90 percent of the county mineral value. The Senn Gravel Co. prepared building sand and gravel.

Kimble.—Total mineral value declined 25 percent compared with 1959; all commodities—petroleum, natural gas, and sand and gravel—had lower output. Weirich Bros., Inc., prepared building and paving sand and gravel.

King.—Sizable curtailment of crude oil production was responsible for the 32-percent decline in total mineral value to $2.4 million. A moderate increase in natural gas production was reported. Exploratory and development drilling reduced by 39 percent to a total of 104,551 feet, proved 2 oil wells.

Kleberg.—Total mineral value advanced 160 percent to $54 million as production of crude oil, natural gas, and natural gas liquids rose. Geophysical prospecting declined 40 percent to 30 crew-weeks; exploratory and development drilling advanced 8 percent to 55 wells totaling 415,464 feet and proved 20 oil wells and 24 gas wells. Humble Oil & Refining Co. completed the world's largest cycling plant, the King Ranch plant 15 miles south of Kingsville, with a daily capacity of 950 million cubic feet to recover 1.2 million gallons of natural gas liquids daily. Natural gas liquids also were recovered at the May gasoline plant of Cities Service Oil Corp. Evaporated salt was prepared from brine by the Trace Elements Corp., Division of United Salt Co.

Knox.—The value of mineral production was 14 percent greater than in 1959 due to greater crude oil production, which accounted for over 90 percent of the total value. There were 73 oil wells proven in the county, although exploratory and development drilling declined nearly 40 percent to 373,340 feet.

Lamb.—Increases in crude oil production resulted in a 27-percent increase in total mineral value to $2.3 million compared with 1959. Seven development wells and 4 exploratory wells totaling 47,718 feet proved 6 oil wells. Crude oil production amounted to 2.3 million barrels.

La Salle.—Moderate increases in crude oil and natural gas production resulted in a 14-percent increase in the county total mineral value compared with 1959. Geophysical prospecting increased 40 percent to 31 crew-weeks; exploratory and development drilling dropped 27 percent to 36 wells totaling 241,576 feet and proved 5 oil wells and 4 gas wells.

Lavaca.—Increases in natural gas liquids recovery offset production losses in crude oil and natural gas and the value of mineral production rose 16 percent above that of 1959. New facilities at the Provident City gasoline plant of Shell Oil Co. increased propane recovery from 21,000 to 33,000 gallons per day and natural gasoline recovery

from 50,000 to 55,000 gallons per day. The oil and gas industry doubled geophysical prospecting to 171 crew-weeks and increased exploratory and development drilling nearly 32 percent to 37 wells totaling 169,410 feet, to prove 24 gas wells. Natural gas liquids were recovered at the Wilcox gasoline plant of Goliad Corp. and the Provident City plant of Shell Oil Co. Sandstone was quarried and prepared as concrete aggregate and roadstone by contractors for District 13 of Texas Highway Department.

Leon.—A moderate reduction in crude oil and natural gas production resulted in an 18-percent decline in total mineral value to $2.6 million compared with 1959. The industry spent 17 crew-weeks in geophysical prospecting and drilled 21 exploratory and development wells totaling 155,850 feet, and proved 5 oil and 2 gas wells.

Liberty.—The 11-percent decline in mineral production value, to $44.6 million, was due to moderate reductions in crude oil and natural gas output. Fuels accounted for over 80 percent of the county mineral value. The Hull gasoline plant of Southwest Industries, Inc., recovered natural gas liquids. The 114 wells drilled by the industry proved 61 oil wells and 4 gas wells. Texas Gulf Sulphur Co. mined native sulfur by the Frasch process at Moss Bluff Dome. Underground storage of 3.3 million gallons of LP gas and ethane was maintained by Socony Mobil Oil Co. Natural gas and LPG were used in producing acetone, formaldehyde, acetic acid, acetaldehyde, and hexylene at the Bishop Chemical plant of Celanese Corp. of America. Building and paving sand and gravel were prepared by Texas Construction Materials Co., as well as industrial sand used for blast, engine, and hydrofrac. Paving sand and gravel was prepared by contractors for Texas Highway Department.

Limestone.—The value of mineral production declined 34 percent, to $1.2 million, due to moderate losses in petroleum and natural gas production, which accounted for about 90 percent of the total mineral value, and to a reduction in stone quarrying. The oil and gas industry reduced geophysical prospecting 70 percent to 12 crew-weeks; exploratory and development drilling increased 90 percent to 36 wells totaling 165,900 feet, and proved 9 oil wells and 6 gas wells. Miscellaneous clay, used in manufacturing building brick and heavy clay products, was mined from open pits by Barron Brick Co.

Lipscomb.—Major increases in crude oil and natural gas production resulted in a 91-percent increase in total mineral value as compared with 1959. Drilling of 53 wells, totaling 375,536 feet, proved 15 oil wells and 19 gas wells.

Live Oak.—Significant reductions in crude oil, natural gas, and sand and gravel production lowered mineral value 16 percent to $11.7 million. The oil and gas industry increased geophysical prospecting 100 percent to 200 crew-weeks but curtailed exploratory and development drilling over 40 percent to 91 wells totaling 531,623 feet to prove 11 oil wells and 18 gas wells.

Llano.—Production losses in stone and feldspar lowered total mineral value 3 percent compared with 1959. Feldspar was mined from open pits by the Moss Estate. Marble was quarried and prepared as roofing material and paint filler by Dezendorf Marble Co. Monumental granite was quarried and prepared by Premier Granite Quar-

ries. A graphitic schist was quarried and prepared as a filter medium by Graphilter Corp.

Loving.—Increases in crude oil and natural gas production resulted in a 46-percent increase in total mineral value to $9.3 million compared with 1959. Although exploratory and development drilling declined 50 percent to 85 wells and 388,092 feet, there were 65 proven oil wells.

Lubbock.—Singular reductions in output of crude oil and sand and gravel resulted in a 41-percent decline in total mineral value to $1.4 million compared with 1959. Seven oil wells were proved through drilling 16 exploratory and development wells totaling 90,931 feet; 53 crew-weeks were spent in geophysical prospecting. Building and paving sand and gravel were prepared from open pits by Caprock Sand & Gravel Co.

Lynn.—Curtailed crude oil production resulted in a 3-percent decline in total mineral value to $1.4 million compared with 1959. Of 22 exploratory and development wells drilled, totaling 104,770 feet, 8 proved to be oil wells.

Marion.—The value of mineral output amounted to $6 million, 36 percent less than in 1959. Geophysical prospecting by the oil and gas industry increased 100 percent to 24 crew-weeks; of 25 wells drilled during the year totaling 122,154 feet, 15 proved to be oil wells. Natural gas liquids were recovered at the Jefferson gasoline plant of Arkansas-Louisiana Chemical Co.

Martin.—The 78-percent increase in mineral value was due primarily to increased crude oil production. Geophysical prospecting increased 145 percent to 76 crew-weeks. Exploratory and development drilling amounted to 27 wells, totaling 263,126 feet, and resulted in 22 oil wells; 3 new fields and 2 new oil pays were discovered. Anchor Petroleum Co. maintained a 440,000 barrel underground storage of LPG.

Matagorda.—The value of mineral production rose 22 percent to $38.2 million due to increased oil, natural gas, sand and gravel, and shell production; moderate declines were reported for natural gas liquids and clay production. Geophysical prospecting amounted to 208 crew-weeks. There was a 56-percent increase in exploratory and development drilling to 167 wells totaling 1,387,259 feet, proving 47 oil wells and 42 gas wells of which 6 were new oilfields and 20 new oil pays. Natural gas liquids were recovered at one cycle plant and two gasoline plants. Pal-Port Clay Products Corp. mined miscellaneous clay from open pits for manufacturing 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. Limestone was quarried and crushed for concrete aggregate and roadstone by one producer.

Maverick.—A significant decline was reported in the value of mineral production. Of 264 wells drilled, totaling 471,300 feet, 200 proved oil wells and 8 proved gas wells. Barite from foreign sources was ground for use as heavy drilling mud by Tejas Barite Co., Ltd. Humble Pipeline Co. built a 63-mile 8-inch crude line and gathering system from Sacatosa field to Humble's main pipeline system at Pearsall. Previous noneconomic oil production in Sacatosa field became a profitable multipay operation following Continental Oil

Co.'s experimental fracturing project. A new gas processing plant with a daily capacity of 55 million cubic feet was built near Palacios by Tennessee Oil & Refining Co.; the plant will recover about 58,000 gallons of gas liquids per day.

McLennan.—Mineral value decreased 12 percent to $4.2 million due to losses in cement, clays, sand and gravel, and stone production. Universal Atlas Cement Co. mined limestone and clay from open pits near its Waco plant for manufacturing portland and masonry cements. The company began a $2 million expansion program to double the cement capacity of its Waco operations to 2 million barrels. New facilities included a second rotary kiln and grinding and accessory equipment. Limestone was quarried and crushed for concrete aggregate and roadstone by various contractors for Texas Highway Department. Building limestone was quarried and dressed by Tonk Quarry. Building and paving sand and gravel were prepared by four producers.

McMullen.—Mineral value declined 20 percent to $7.1 million, compared with 1959. Of 112 wells drilled, totaling 504,507 feet, 30 proved oil wells and 17 proved gas wells. Trans-Jeff Chemical Corp. built a sulfur recovery plant near Tilden. Paving sand and gravel was prepared for Texas Highway Department by various producers.

Medina.—Mineral value, 90 percent of which was due to oil production, was 7 percent greater than in 1959. D'Hanis Brick & Tile Co. mined miscellaneous clay from open pits to use in manufacturing building brick and heavy clay products. Various contractors produced paving sand and gravel for Texas Highway Department.

Midland.—Value of minerals produced declined 6 percent to $44.2 million, compared with 1959. Exploratory and development drilling declined 23 percent to 89 wells totaling 822,091 feet, of which 40 were oil wells and 46 were gas wells. Natural gas liquids were recovered at four gasoline plants. Underground LPG storage by Cities Service Production Co. and El Paso Natural Gas Co. amounted to 300,000 barrels. 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 by one operator for concrete aggregate and roadstone. A 20-million-cubic-foot-per-day gas processing plant was built in the Azalea Strawn and Devonian gas distillate area by Odessa Natural Gasoline Co. and Warren Petroleum Corp.

Milam.—Mineral output increased 22 percent in value, compared with 1959. Lignite, used as a fuel in generating electric power for the Rockdale reduction works of Aluminum Company of America, was mined from open pits by Industrial Generating Co. The Rockdale plant of Alcoa operated five of its six potlines. Alumina from the company's new Point Comfort refinery was used in the operation. Building sand and gravel was produced by one operator.

Mitchell.—Mineral production declined 5 percent to $7.6 million, compared with 1959, due primarily to losses in oil production. Exploratory and development drilling of 67 wells totaling 171,119 feet proved 56 oil wells. Building and paving sand and gravel were prepared by one producer. Crude oil was processed at the Colorado City refinery of Cosden Oil Co.

Montague.—A 2-percent decline of mineral value was due to reduced output of crude oil and natural gas liquids. Natural gas production increased. The 37-percent increase in exploratory and development drilling to 125 wells totaling 259,815 feet resulted in 85 oil wells. Natural gas liquids were recovered at the Bowie gasoline plant of Bowie Gasoline Co. 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.—Mineral value declined 7 percent to $27.5 million, compared with 1959. The oil and gas industry spent 63 crew-weeks in geophysical prospecting and drilled 10 wells totaling 103,588 feet, a decline of 38 percent. The decline in mineral value was due to the drop in oil production; natural gas, natural gas liquids, and sand and gravel output increased. Natural gas liquids were recovered at one cycling plant and two gasoline plants during the year. Jeff Chemical Co. consumed propane in producing acetaldehyde, methanol, and sodium formate at its Conroe petrochemical plant. Carbon black was recovered from hydrocarbon liquid at Monroe No. 63 furnace plant of Columbian Carbon Co. Contractors produced paving sand and gravel for District 12 of Texas Highway Department.

Moore.—Mineral production declined 5 percent in value to $45.9 million, compared with 1959. Significant production losses were reported for oil, natural gas liquids, and helium; only natural gas output increased substantially. Underground LPG storage by Shamrock Oil & Gas Corp. amounted to 1.3 million barrels; the company also operated a 30-ton-per-day sulfur recovery plant at its McKee gasoline plant. Phillips Chemical Co. used natural gas in producing ammonia, nitric acid, and nitrogen solutions. The Machovec zinc retort smelter of American Zinc Co. of Illinois, operating at reduced capacity, treated ores and concentrates from other states and from foreign countries. Natural gas liquids were recovered at six gasoline plants; crude oil was processed at the McKee plant of Shamrock Oil & Gas Corp. Carbon black was produced from hydrocarbon liquids at the Continental furnace plant of Continental Carbon Co.

Morris.—The 19-percent decline in mineral value was due largely to lower production of sand and gravel and brown iron ores. The oil and gas industry increased geophysical prospecting 36 percent to 30 crew-weeks; 4 exploratory and development wells were drilled, all of which were dry holes. Brown ores were mined from open pits by Lone Star Steel Co. and upgraded at its ore mill at Lone Star for blast furnace feed. Lone Star installed a new spiral-weld pipe mill, enlarged a stretch reducing mill, and installed a rod mill that would use both skelp-trim and pig iron.

Motley.—Mineral value increased 37 percent compared with 1959, due to increases in production of petroleum and sand and gravel. Geophysical prospecting by the oil and gas industry increased 130 percent to 55 crew-weeks; exploratory and development drilling declined to 10 wells totaling 53,484 feet, with 5 oil wells proved. Building and paving sand and gravel were prepared by four producers.

Nacogdoches.—Mineral value decreased 7 percent to $2.9 million, compared with 1959, due primarily to reduced natural gas production.

Geophysical prospecting increased 100 percent to a total of 16 crew-weeks; 4 development wells proved 4 oil wells. Miscellaneous clay used in manufacturing brick and heavy clay products was mined from open pits by Acme Brick Co.

Navarro.—There was a 4-percent decline in mineral value to $6 million, compared with 1959, due to declines in output of major mineral products—oil, natural gas, clay, and sand and gravel. Miscellaneous clay, used in manufacturing building brick and heavy clay products, was mined from open pits by Whiteselle Brick-Lumber Co. Exploratory and development drilling by the oil and gas industry declined 30 percent to 176 wells, totaling 181,447 feet, and proved 123 oil wells. Building and paving sand and gravel were prepared by two producers.

Nolan.—Mineral output was valued at $27.5 million, a 32-percent decrease from 1959. Reduced production of petroleum, natural gas, and natural gas liquids was chiefly responsible for the decrease. Natural gas liquids were recovered at five plants. Lone Star Cement Corp. quarried and prepared limestone and mined miscellaneous clay from pits for manufacturing portland and masonry cements at its Maryneal plant. U.S. Gypsum Co. and the Flintkote Co. mined gypsum from open pits near Sweetwater for use as portland cement retarder, agricultural uses, and in 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 decreased 8 percent to $78 million compared with 1959. Nueces was the second largest gas producing county. The mineral output value declined principally because of reduced petroleum allowable. A styrene unit to cost over $1 million was being constructed by Sunray Mid-Continent Oil Co., subsidiary of Suntide Refinery Co., at its Corpus Christi refinery. Completion was scheduled for 1961. All the output from this refinery, a proposed 60 million pounds per year, was sold under long-term contract. Benzene, to be used as raw material for styrene, was produced in a Udex unit and a new Hydeal unit adjacent to the new styrene unit. This addition will bring the company benzene production to about 1,350 barrels per day. Delhi-Taylor Oil Co. continued its petrochemical expansion with construction of a plant at Corpus Christi with capacity to produce about 70 million pounds per year of high-purity orthoxylene. Orthoxylene is used in producing phthalic anhydride for polyester plastics and plasticizers and alkyd resins. Robstown Clay Products Co. used local clay in manufacturing brick and heavy clay products. Natural gas liquids were recovered at seven gasoline and four cycling plants. Columbian Carbon Co. recovered carbon black at its Corpus Christi No. 56 channel plant. Building and paving sand and gravel were prepared by Heldenfels Bros. and M. P. Wright, Jr. Shell, used for concrete aggregate and the manufacture of lime and cement, was dredged from shallow bays surrounding the county by Corpus Christi Shell Co., Heldenfels Bros., General Dredging Co., and Matagorda Shell Co. Portland and masonry cements were manufactured from shell and local clays at the Corpus Christi plant of Halliburton Portland Cement Co. Lime for in-

dustrial, chemical, and building purposes was manufactured from shell by Columbia-Southern Chemical Corp.

Ochiltree.—The value of mineral production was $17.1 million, an increase of 8 percent over 1959. This increase reflected the continued development of petroleum and natural gas fields. Three new oilfields and eight new oil pays were discovered. Natural gas liquids were recovered at the Spearman gasoline plant of Northern Natural Gas Co. and Skelly Oil Co. Capacity of the Northern Natural Gas Co. plant was being doubled to 200 million cubic feet daily, which will result in a 16,000-gallon-per-day increase in recovered liquids.

Oldham.—The value of sand and gravel and crude oil was 37 percent less than in 1959. Building sand and gravel was prepared by Western Aggregates, Inc., and Western Sand & Gravel Co., Inc.

Orange.—The value of mineral production decreased 13 percent from 1959, resulting in a total value of $12.3 million. The county produced approximately 28 billion cubic feet of natural gas and over 2 million barrels of crude oil. Natural Gas Liquids Corp. was constructing a new processing plant on the Sabine River to process natural gas condensate, distillate, and natural gasoline and to produce 98-octane gasoline; capacity of the plant will be approximately 20,000 barrels per day. Allied Chemical Corp. completed a new high-density polyethylene plant. Firestone Tire & Rubber Co. was increasing its butadiene capacity from 40,000 to 70,000 tons per year, and completed a 30,000-ton polyisoprene plant late in 1960. Natural gas liquids were recovered at the Phoenix Lake plant of Ohio Oil Co. Portland cement was manufactured from shell and clay at the Orange cement plant of Texas Portland Cement Co.

Palo Pinto.—Total mineral production value was $2.3 million, a 4-percent gain over 1959; petroleum, natural gas, and natural gas liquids accounted for the major part of mineral value. Lone Star Gas Co. recovered natural gas liquids at its Gordon gasoline plant. Miscellaneous clay, used in manufacturing brick, tile, and heavy clay products, was mined from open pits near Mineral Wells by Texeramics, Inc., Texas Vitrified Pipe Co., Reliance Clay Products Co., and Bill Williams Materials Corp. Mineral Wells Sand & Gravel Co. recovered building and paving sand and gravel from pits near Mineral Wells.

Panola.—Value of mineral production declined from $61.5 million in 1959 to $53.7 million, a 13-percent decrease. Development drilling proved 32 oil and 4 gas wells and exploratory drilling proved 1 oil well. Panola County ceased to be the largest natural gas producer in the State, ranking third with production of 254.7 billion cubic feet.

Parker.—Mineral production increased slightly over 1959, attaining a total value of $2.5 million. The production of natural gas liquids recovered at the Springtown gasoline plant of Lone Star Gas Co. provided most of the value. Miscellaneous clay, used in manufacturing brick and heavy clay products, was mined from open pits near Bennett by Acme Brick Co. and Mineral Wells Clay Products Co.

Pecos.—A decline of 8 percent in value of mineral production was chiefly the result of reduced oil production; total value amounted to $55.2 million. Socony Oil Co., Inc., completed a major gas discovery well in the Delaware Basin, in northwest Pecos County, with a cal-

culated open flow of 102 million cubic feet of gas, plus 1,500 barrels of distillate per day. Flow pressure was reported at more than 10,000 pounds, reportedly the highest in the West Texas-New Mexico region. Spurred on by this new discovery, geophysical prospecting increased 72 percent. Natural gas liquids were recovered at the Puckett gasoline plant of Phillips Petroleum Co. and the Santa Rosa plant of Pecos County.

Polk.—The value of mineral production declined 16 percent compared with that of 1959. The total amounted to $4.8 million. Special industrial sands were recovered from pits near Corrigan and prepared by Texas Construction Material Co. In addition, crushed sandstone was produced for concrete aggregate and roadstone; however, the greatest contributors to the value of mineral output were petroleum and natural gas.

Potter.—Reduced output was recorded for all minerals and the value of mineral production declined 24 percent from 1959. Reduced production of natural gas and closing of the Texas Sand & Gravel Co. Kritser limestone plant were major factors in the decline. 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. Both geophysical prospecting, as reflected by the number of crew-weeks, and drilling increased over 1959.

Reagan.—Total value of mineral production increased 4 percent to $36.4 million. Mineral fuels accounted for most of the total. The Big Lake plant of Barnhart Hydrocarbon Co. utilized the modified Claus process to recover sulfur from sour gas.

Reeves.—Increased production of natural gas and natural gas liquids was responsible for a 45-percent increase in value of mineral production. Phillips Petroleum Co. owned and operated the Tunstill gasoline plant near Orla. The plant processed natural gas from Tunstill, Mason, and North Mason fields. Natural gas liquids were also processed at Ramsey No. 16 gasoline plant of Continental Oil Co. F. M. Reeves & Sons, Inc., prepared building and paving sand and gravel.

Refugio.—Total value of mineral production amounted to $60 million, an 11-percent decrease over 1959. The 13.5 million barrels of crude oil produced was somewhat less than 1959 production. The decrease contributed to the overall decline in mineral value. Drilling activity remained remarkably stable during the year, totaling 122 new wells drilled, of which only 28 were dry holes. Eight oil pays were discovered. Humble Oil & Refining Co. recovered natural gas liquids at its A.G.S.C.O. and Tom O'Connor gasoline plant.

Runnels.—Runnels County continued its outstanding increase in production of petroleum and natural gas with a 79-percent increase in value over 1959. Production of 7.1 million barrels of crude oil more than doubled the 1959 output; a similar increase was recorded in production of natural gas. Drilling of both development and exploratory wells continued, with a total of 186 wells being drilled. Of the 186

wells, 103 dry holes were recorded, and 21 new oilfields and 3 gasfields were discovered.

Rusk.—Natural gas liquids were recovered at the East Texas plant of Humble Oil & Refining Co., the Giles plant of Parade Co., and Plants 19 and 21 of Sinclair Oil & Gas Co. A dehydration plant with capacity of 46 million cubic feet per day was built by Lone Star Gas Co. Miscellaneous and fire clays used in brick and heavy clay products were mined from open pits near Henderson by J. M. Cordell & Sons, Inc., and Henderson Clay Products, Inc. These activities in addition to production of 16.6 million barrels of petroleum, accounted for the total mineral value of $58.9 million, a 13-percent decrease from that of 1959.

San Patricio.—Production of over 12.2 million barrels of crude oil and 74 billion cubic feet of natural gas accounted for over 90 percent of the $49.5 million mineral value. Development and exploratory drilling for oil and gas declined 43 percent, with only 87 wells being drilled. During the year 12 oilfields and 17 gasfields were discovered. Natural gas liquids were recovered at the Redfish Bay gasoline plant of Sunray Mid-Continent Oil Co., Plant No. 20 of Sinclair Oil & Gas Co., the Portilla gasoline plant of Superior Oil Co., and the Plymouth cycling plant of Plymouth Oil Co. Fordyce Gravel Co. and Heldenfels Bros. quarried and prepared crushed limestone for concrete aggregate and roadstone. Building and paving sand and gravel were prepared by Fordyce Gravel Co. The Sherwin alumina plant and the San Patricio aluminum reduction works of Reynolds Metals Co. operated at about the same rate as in 1959.

Schleicher.—Production of petroleum, natural gas, and natural gas liquids was responsible for the $9.8 million total mineral value, an 8-percent decline from the 1959 value. Three oilfields and new oil pays were discovered during the year. Sinclair Oil & Gas Co. recovered natural gas liquids at its No. 23 gasoline plant.

Scurry.—Scurry County ranked fourth in crude oil production and fourth in total mineral value. Production of 33.7 million barrels of oil, in addition to considerable quantities of natural gas and natural gas liquids, was valued at $122.7 million, 14 percent lower than in 1959. Drilling declined 55 percent. Miscellaneous clay was mined from open pits for brick and heavy clay products by Southwestern Brick & Tile Co.

Shackelford.—Mineral fuels output totaled $11.1 million, an 11-percent increase over 1959. Three new oilfields and two new oil pays were discovered through exploratory drilling. Oil from a secondary recovery operation in the Bluff Creek reservoir increased petroleum production. Natural gas liquids were recovered at the No. 1 gasoline plant of Marshall R. Young and the Graridge No. 1 plant of Graridge Corp. Building stone was quarried and prepared by Luedders Limestone Co.

Sherman.—The rapid increase of the natural gas industry in Sherman County resulted in a 110-percent increase in mineral value, totaling $18 million. Drilling produced 12 new gas wells.

Smith.—A 16-percent increase in mineral production value to $13.4 million was reported. Over 3 million barrels of crude oil and 19.4

billion cubic feet of natural gas were produced. Of 39 exploratory wells drilled, 5 produced oil and 2 produced gas. Natural gas liquids were recovered by the Chapel Hill gasoline plant of Etexas Producers Gas Co. and the Chapel Hill cycling plant of Lone Star Producing Co. Crude oils were processed at the Tyler refinery of LaGloria Oil & Gas Co. Miscellaneous clay, used to manufacture 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 valued at $26.1 million, 13 percent greater than 1959, reflected a major increase in production of natural gas and a slight increase in production of petroleum and sand and gravel. Increased interest in oil and gas properties was evidenced by 107 crew-weeks spent on geophysical prospecting. In addition, exploratory drilling discovered 27 gas and 9 oil wells. Two plants of Sun Oil Co. and the Rincon gasoline plant of Continental Oil Co. recovered natural gas liquids. Crushed limestone was quarried and prepared for concrete aggregate and roadstone by Fordyce Gravel Co. Valley Brick & Tile Co. mined miscellaneous clay from open pits for manufacture of brick and heavy clay products.

Stephens.—A value of $9.9 million was reported for mineral output. In addition to the 2.2 million barrels of crude oil and the 14.9 billion cubic feet of natural gas produced, building sand and gravel was obtained from open pits by Taylor Brothers. Exploratory drilling resulted in discovery of seven oilfields and six oil pays.

Stonewall.—Production of petroleum dominated the mineral industry in the county and reduced petroleum production was responsible for an 11-percent decline in the total value of minerals produced. The Stonewall plant of Cities Service Co. processed gases from various fields in the area and recovered natural gas liquids. Building and paving sand and gravel were recovered from open pits by Hamlin Sand & Gravel Co., Inc.

Tarrant.—Mineral output was valued at $9.8 million and was based on production of cement, sand and gravel, and stone. Trinity Division of General Portland Cement Co. quarried and prepared crushed limestone for manufacturing portland and masonry cements. Carruthers Cutstone Co. processed limestone for building purposes. Contractors produced limestone for District 2 of Texas Highway Department. Building and paving sand and gravel were prepared by 12 producers. Mica was ground and prepared by Western Mica Co.

Taylor.—Petroleum accounted for over 95 percent of the total mineral value of $15.7 million. A total of 329 development and exploratory wells were drilled. Clay, used in manufacturing 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 Atlas Sand & Gravel Co. and Caton Sand & Gravel Co. Debco Corp. processed crude oil at its Abilene refinery.

Terry.—The $19.5 million mineral production value was approximately the same as that in 1959. The Adair gasoline plant of Amerada Petroleum Corp. and the Wellman plant of Chillgas Corp. recovered natural gas liquids. Carbon black was recovered from natural

gas and natural gas liquids at the Seagraves No. 64 furnace plant of Columbia 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.

Throckmorton.—As a result of decreased oil production, total mineral value dropped 15 percent; 525.1 million cubic feet of natural gas and 3.2 million barrels of crude oil were produced.

Titus.—Output of petroleum declined sharply. The total $4.3 million mineral production value was 57 percent below that of 1959. American Petrofina Co. of Texas processed crude oil at its Mt. Pleasant refinery.

Tom Green.—A total mineral production value of $5.3 million was reported, essentially the same as in 1959. Montgomery Sand & Gravel Co. and other producers prepared building and paving sand and gravel.

Travis.—Value of mineral production increased 12 percent over that of 1959, principally because of increased production of stone, sand and gravel, and lime. Austin White Lime Co. quarried and prepared limestone for manufacturing lime, which was used by building, agricultural, and chemical industries. From limestone quarried in Williamson County, Texas Quarries, Inc., prepared dressed building stone. In addition, limestone was quarried and crushed for riprap, metallurgic flux, railroad ballast, 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.

Upshur.—Mineral production, valued at $5.2 million, was 17 percent less than in 1959. Thirty development wells were completed during the year. Big Sandy Sand & Gravel Co. prepared building and industrial sand.

Upton.—Continued development of petroleum, natural gas, and natural gas liquid resources increased total value of mineral production to $67.1 million, a 17-percent increase over 1959.

Uvalde.—Native asphalt was quarried and prepared for road surfacing material, from pits near Dabney by White's Uvalde Mines and near Blewett by Uvalde Rock Asphalt Co. Basalt for riprap, concrete aggregate, roadstone, and railroad ballast was quarried and prepared by Southwest Stone Co. The D & D Gravel Co. prepared building and paving sand and gravel.

Van Zandt.—The value of mineral fuels and salt produced was $20.8 million, 10 percent less than the 1959 value. The oil and gas industry produced 3.8 billion cubic feet of natural gas and 5 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.

Victoria.—A 6-percent increase in value of mineral production to $24.9 million was reported. The oil and gas industry spent 49 crew-weeks in geophysical prospecting and completing 6 oil and 25 gas development wells. In addition, exploratory drilling proved 3 oil wells and 11 gas wells. Building and paving sand and gravel were

prepared from pits by Fordyce Gravel Co., Gulf Materials Co., and Heldenfels Bros. Limestone for concrete aggregate and roadstone was quarried and crushed by Fordyce Gravel Co.

Waller.—Production of natural gas and natural gas liquids accounted for over 90 percent of total value of mineral production. Output was valued at $36.7 million, 11 percent below that of 1959. Katy cycling plant of Humble Oil & Refining Co. recovered natural gas liquids. Paving and construction sand and gravel were prepared for District 12 of Texas Highway Department and Waller County Road and Bridge Department.

Ward.—Ward County ranked 10th in value of minerals produced with a total of $75.7 million, an increase of 12 percent over 1959. This was principally effected by increased petroleum production. Approximately 22.6 million barrels of crude oil and 28.3 billion cubic feet of natural gas were produced. Cabot Carbon Co. increased the capacity of its Estes plant to 25 million cubic feet daily and the liquid recovery to 37,500 gallons per day. 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 the Johnson pit near Pyote.

Webb.—A 16-percent increase in value of mineral production resulted from increased crude oil production. Antimony ores from Mexico and Bolivia were processed at the Laredo Smelter of National Lead Co. Miscellaneous clay used in brick and heavy clay products was mined from open pits by Richard Chavana and E. C. Delachica Clay Co. Building sand and gravel was prepared by Aldape Sand & Gravel Co.

Wharton.—Reduced demand for petroleum and sulfur resulted in a 25-percent decrease in total mineral value compared with 1959. The reduction of petroleum production also affected recovery of casinghead gas, and it too declined sightly. Sulfur, the county's principal revenue-producing mineral, declined sharply in value from 1959. Texas Gulf Sulfur Co. continued mining sulfur by the Frasch process at Boling Dome.

Wheeler.—Mineral fuel production, valued at $9.3 million, was 7 percent less than in 1959. The 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 Norrick furnace plant of United Carbon Co.

Wichita.—Production of petroleum was responsible for over 90 percent of the $34.5 million mineral production value. Wichita Falls refineries of American Petrofina, Inc., and Continental Oil Co. refined crude oil. Natural gas liquids were recovered at four 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. prepared building and paving sand and gravel.

Wilbarger.—A decline of 1 percent in total mineral value to $17.9 million was due to a slight decrease in crude oil production. Districts 2 and 3 of Texas Highway Department received crushed limestone from county contractors.

Williamson.—Williamson County, one of the State's leading stone and lime producers, increased its value of mineral production 5 percent. Limestone was quarried and prepared for use in lime by Round Rock White Lime Co. 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 use as concrete aggregate, roadstone, fertilizer, filler, and other industrial uses.

Wilson.—Mineral production, valued at $1.7 million, was 9 percent less than in 1959. Fire clay, used in heavy clay products, was mined from open pits near Saspamco by W. F. Dickey Clay Manufacturing Co.

Winkler.—The county ranked seventh in total value of mineral production with $95 million, a 20-percent increase over 1959. Increased production of crude oil and natural gas was primarily responsible for the increase. Development and exploratory drilling proved 168 oil and 22 gas wells; 6 new oilfields and 3 new gas pays were discovered. Cabot Carbon Co. recovered carbon black from natural gas at its Kermit furnace plant. Sulfur was recovered at the Keystone plant of Sid Richardson Gasoline Co.

Wise.—Mineral production value was $27.2 million, a 4-percent drop from 1959. Petroleum, natural gas, natural gas liquids, and limestone were the major mineral products. Acme Brick Co. mined miscellaneous clay from pits near Bridgeport for use in manufacturing heavy clay products. Limestone was quarried and prepared for concrete aggregate and roadstone by Bridgeport Stone Co., Gifford-Hill & Co., Inc., Southwest Stone Co., and Wesco Stone Corp.

Wood.—Petroleum, natural gas, and natural gas liquids were the only mineral commodities produced. Mineral production totaled $48.4 million, a decline of 7 percent from 1959. The Kaska gasoline plant of Kaska Corp. and the Hawkins gasoline plant of Natural Gasoline Corp. recovered natural gas liquids.

Yoakum.—A 20-percent increase in mineral production resulted from increased petroleum production. The Wasson gasoline plant of Shell Oil Co., and the Prentice plant of Honolulu Oil Corp. recovered natural gas liquids. Frontier Chemical Co. recovered salt in brine from wells near Denver City.

Young.—Total mineral value of $18.2 million was 9 percent under the 1959 value. The oil and gas industry discovered 15 new oilfields and oil pays during the year. Over 5 million barrels of crude oil were recovered. Crude oil was processed at the Graham refinery of Graytex Corp. 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.

615629—61——65

The Mineral Industry of Utah

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineralogical Survey.

By William H. Kerns,[1] F. J. Kelly,[1] and D. H. Mullen [1]

THE TOTAL VALUE of Utah's mineral output in 1960 was $431 million, a gain of $58 million over 1959. Most of this advance resulted from a $51 million increase in the value of copper production. Of the total value, metals accounted for 57 percent; fuels, 37 percent; and nonmetals, 6 percent.

The value of metals was up 30 percent from 1959, primarily because of the aforementioned rise in production of copper and in associate byproducts gold, silver, and molybdenum. This major increase in copper production resulted from a nearly full-year's operation at the State's largest copper mine, which was active during only part of 1959. The labor strike, which idled the mine in August 1959, was settled by February 1960; and full production was reached in March. The value of iron-ore shipments from Utah deposits was $4 million greater than that of 1959 because of a 12-month operation in 1960 compared with a 7-month activity in 1959. A nationwide steelworkers' strike had idled the mines from July until November of 1959. Lead and zinc each gained $1 million in value of output. In contrast, uranium ore and vanadium (recovered as a byproduct of uranium ore) dropped nearly $10 million from 1959.

Production of fuels, with a total value of $159.8 million, increased $536,000, compared with that of 1959. An $11 million decrease in value of petroleum (crude) output was nearly balanced by substantial increases in the value of coal, natural gas, natural gas liquids, and gilsonite produced.

Total value of products from the nonmetal segment of the industry was $28 million, a $1 million increase over the 1959 total. This advance resulted from increased value of output for lime, phosphate rock, potassium salts, and salt that more than offset decreases in cement, sand and gravel, and stone.

Numerous construction, exploration, and development programs affecting the mineral industry of Utah were begun or completed during the year. In the metals field, Utah Copper Division, Kennecott Copper Corp., completed a major addition to the powerplant and started a modification of the Garfield smelter. Kennecott also began a spiral-haulage excavation in its open-pit mine. Utah Construction & Mining Co. began construction of a new beneficiation plant to

[1] Commodity-industry analyst, Bureau of Mines, Denver, Colo.

TABLE 1.—Mineral production in Utah [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asphalt and related bitumens, native: Gilsonite short tons	379,362	$9,385	383,037	$10,020
Carbon dioxide, natural thousand cubic feet	69,625	5	60,425	4
Clays [2] thousand short tons	185	484	143	416
Coal do	4,545	27,982	4,955	31,458
Copper (recoverable content of ores, etc.) short tons	144,715	88,855	218,049	139,987
Fluorspar do	[3]	[3]	1,912	51
Gem stones	[4]	134	[4]	72
Gold (recoverable content of ores, etc.) troy ounces	239,517	8,383	368,255	12,889
Iron ore (usable) thousand long tons, gross weight	2,842	19,979	3,334	23,862
Lead (recoverable content of ores, etc.) short tons	36,630	8,425	39,398	9,219
Lime thousand short tons	90	1,773	127	2,672
Manganese ore and concentrate (35 percent or more Mn) short tons, gross weight	1,511	124	----------	----------
Natural gas million cubic feet	38,921	5,527	51,040	9,187
Petroleum (crude) thousand 42-gallon barrels	39,959	114,283	[5] 37,599	[5] 103,021
Pumice thousand short tons	39	81	60	134
Salt do	209	2,453	231	3,092
Sand and gravel do	8,843	6,436	6,848	6,182
Silver (recoverable content of ores, etc.) thousand troy ounces	3,734	3,380	4,783	4,329
Stone thousand short tons	3,338	4,048	1,837	3,087
Uranium ore short tons	1,210,654	37,310	1,089,757	27,843
Vanadium do	536	[3]	462	[3]
Zinc (recoverable content of ores, etc.) do	35,223	8,101	35,476	9,153
Value of items that cannot be disclosed: Barite, cement, clays (kaolin), gypsum, molybdenum, natural gas liquids, perlite, phosphate rock, potassium salts, pyrites, and values indicated by footnote 3	----------	27,396	----------	36,047
Total Utah [6]	----------	[7] 373,515	----------	431,396

[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] Figure withheld to avoid disclosing individual company confidential data.
[4] Weight not recorded.
[5] Preliminary figure.
[6] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.
[7] Revised figure.

treat iron ore from its mine in Iron County. Bear Creek Mining Co. and its parent company, Kennecott Copper Corp., continued an extensive exploration and development program for lead and zinc on lease holdings in the East Tintic mining district. Other companies, including The Anaconda Company, Cerro Corp., United Park City Mines Co., New Park Mining Co., and Keystone Mining Co., conducted exploration and development for lead and zinc on Utah mineral deposits. Several companies were exploring newly discovered beryllium mineralization in the Topaz-Spor Mountain area and conducting metallurgical tests on samples collected. Minerals Engineering Co. purchased the Howe Sound Co. cobalt refinery near Salt Lake City and planned to convert the plant to produce vanadium pentoxide from out-of-State material.

In the coal industry, Columbia-Geneva Steel Division, United States Steel Corp., installed a new-type coal dryer at its coal-cleaning plant at Wellington. A major contribution to the petroleum industry of Utah was the development of the Northwest Lisbon field, the first to yield petroleum from the Devonian formation in the Paradox basin.

A significant nonmetal development was the completion of additional cement-storage facilities at the Ideal Cement Co. Devil's Slide cement plant. Portland Cement Co. of Utah continued construction

to double the capacity of its Salt Lake City plant. The Utah Lime and Stone Co. began operating a new hydrated-lime plant at Dolomite. San Francisco Chemical Co. began constructing a phosphate plant near Vernal. Texas Gulf Sulphur Co. and Delhi-Taylor Oil Corp. signed an agreement for development of a potash deposit in the Cane Creek area near Moab.

Employment and Injuries.—Preliminary employment and injuries data (excluding the petroleum industry) compiled by the Federal Bureau of Mines are shown in table 2. The nonferrous mining, milling, smelting, and refining industry (excluding uranium mining and processing) accounted for two-thirds of the man-hours worked and 5 of the 14 fatal injuries in Utah's mineral industry. Cumulatively, the coal, asphalt and related bitumens, and coke industry was second to the nonferrous industry in employment and fatal injuries; the uranium industry was third.

Legislation and Government Programs.—Four Office of Mineral Exploration (OME) contracts executed in 1960 for exploration at four mines in Utah are shown in table 3. During the year, New Park Mining Co. continued work on an exploration contract executed in 1958 under the Defense Minerals Exploration Administration (DMEA), now administered by the OME, for lead-zinc-copper exploration at the Mayflower-Galena mine in Wasatch County.

TABLE 2.—Employment and injuries in the mineral industries[1] in 1960[2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Nonfatal	
Nonferrous (excluding uranium)	128	7,777	21,835,752	5	206	9.7
Uranium	191	1,321	2,296,980	4	62	28.7
Ferrous	7	511	973,992	----	4	4.1
Sand and gravel	107	440	751,629	----	12	16.0
Stone	29	424	904,096	----	5	5.5
Nonmetal (other than sand and gravel and stone)	37	587	1,085,880	----	59	54.3
Coal, asphalt and related bitumens, and coke	55	3,103	5,227,622	5	136	27.0
Total	554	14,163	33,075,951	14	484	15.1

[1] Excludes petroleum industry.
[2] Preliminary figures.

TABLE 3.—OME contracts executed in 1960

County and contractor	Property	Commodity	Contract	
			Date 1960	Total amount[1]
Juab:				
Brennan Hannifin	Bullion Beck mine	Lead-zinc-copper	May 3	$47,550
Vitro Minerals Corp	Whitlock claims	Beryllium	Aug. 22	75,440
Salt Lake, Summit, and Wasatch:				
United Park City Mines Co	Daly West Unit	Lead-zinc	May 5	165,930
Summit:				
Keystone Mining Co	Keystone mine	do	June 16	111,710
Total				400,630

[1] Government participation: 50 percent.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—Beryllium exploration in the United States in 1960 was highlighted by intensive prospecting in the Topaz-Spor Mountain area of western Utah (near Delta). Reports of the discovery of major beryllium deposits in this region interested a number of companies. Vitro Minerals Corp. and Beryllium Resources, Inc., the major claim holders, were actively engaged in exploration and metallurgical testing to determine the economics of ore-processing techniques. The ore mineral, tentatively identified as bertrandite, is disseminated in a volcanic tuff underlying a bed of rhyolite.

In August, Vitro Minerals Corp. executed a contract with OME for beryllium exploration in the Topaz Mountain area. Under the contract, OME would participate to the extent of 50 percent of approved costs up to $75,000. Other companies prospecting or exploring in the area included E. I. du Pont de Nemours & Co., Inc., United States Steel Corp., Combined Metals Reduction Co., Food Machinery & Chemical Corp., International Minerals & Chemical Corp. (IMC), and Minerva Oil Co.-The New Jersey Zinc Co.

Cobalt.—Minerals Engineering Co. and Susquehanna-Western, Inc., purchased the Howe Sound Co. cobalt refinery 20 miles west of Salt Lake City. The plant was to be converted to produce vanadium pentoxide for uses in nuclear energy, alloy steels, and vehicle smog-control devices. To assure a source of raw material, the companies signed a 5-year contract with Mineral Products Division of Food Machinery & Chemical Corp. in May for vanadium-bearing slag resulting from treatment of phosphatic ores in Idaho and Montana. Previous plans of Minerals Engineering for new refining facilities adjacent to its Salt Lake City tungsten plant were set aside.

Copper.—Utah continued to rank second only to Arizona in copper output. The value of copper production accounted for 33 percent of the total value of minerals produced in the State. Copper production increased 51 percent in quantity and 58 percent in value compared with 1959. Production of copper advanced from 990 tons in January to 16,400 tons in February, 20,100 tons in March, and 21,200 tons in April. Copper production averaged 19,900 tons per month for the remaining 8 months with monthly figures either above or below the April output.

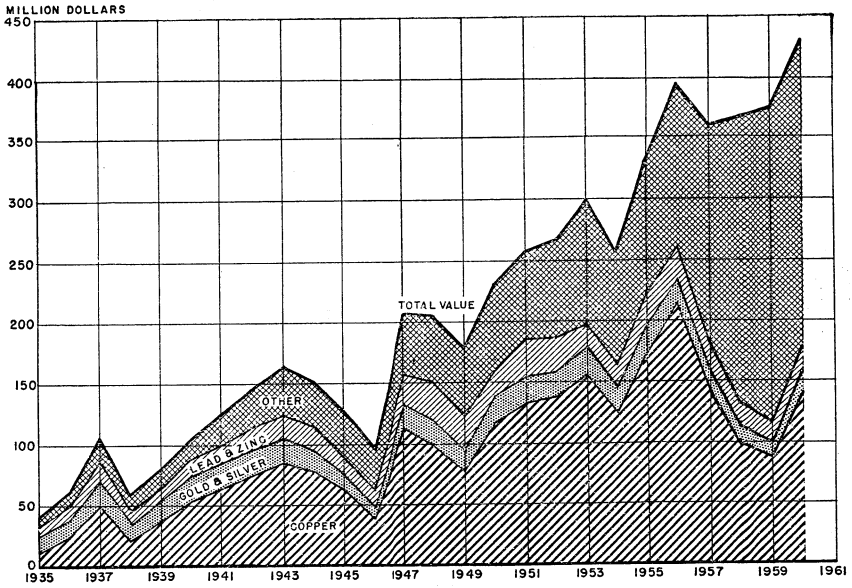

FIGURE 1.—Value of gold, silver, copper, lead, and zinc, and total value of all minerals in Utah, 1935–60.

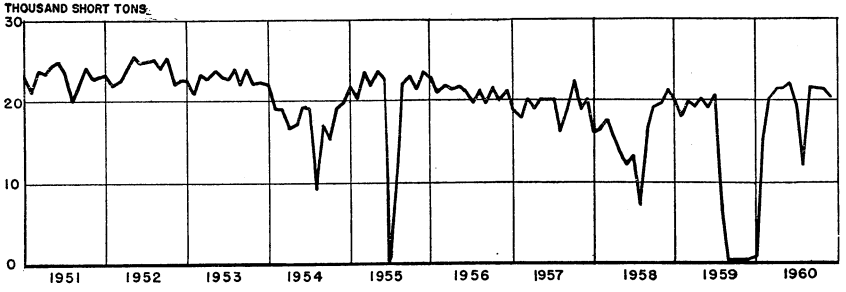

FIGURE 2.—Mine production of copper in Utah, 1951–60, by months, in terms of recoverable metals.

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)
1951–55 (average)	63	--	29,672	439,152	$15,370	6,732	$6,093
1956	91	--	33,232	416,031	14,561	6,572	5,948
1957	76	1	31,722	378,438	13,245	6,198	5,610
1958	61	2	24,871	307,824	10,774	5,278	4,777
1959	30	--	20,221	239,517	8,383	3,734	3,380
1960	37	--	28,832	368,255	12,889	4,783	4,329
1864–1960	--	--	[3] 966,815	16,110,496	464,093	809,032	605,414

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–55 (average)	253,652	$144,316	47,521	$14,372	34,807	$9,642	$189,793
1956	250,604	213,013	49,555	15,560	42,374	11,611	260,693
1957	237,857	143,190	44,471	12,719	40,846	9,476	184,240
1958	189,184	99,511	40,355	9,443	44,982	9,176	133,681
1959	144,715	88,855	36,630	8,425	35,223	8,101	117,144
1960	218,049	139,987	39,398	9,219	35,476	9,153	175,577
1864–1960	8,178,525	3,182,616	5,070,529	679,680	1,513,458	274,384	5,206,187

[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.

TABLE 5.—Mine production of gold, silver, copper, lead, and zinc in 1960, by counties, in terms of recoverable metals

County	Mines producing (lode) [1]	Lode material sold or treated [2] (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
Beaver	[3]	[3]	[3]	[3]	[3]	[3]
Juab	4	6,422	150	$5,250	10,024	$9,072
Millard	2	25	2	70	23	21
Morgan	1	40			102	92
Piute	2	376	62	2,170	3,871	3,503
Salt Lake	9	28,544,305	360,839	12,629,365	3,796,827	3,436,320
San Juan	[3] 3	[3] 3,385	[3] 70	[3] 2,450	[3] 8,647	[3] 7,826
Summit	3	180,070	2,254	78,890	751,330	679,992
Tooele	8	2,101	10	350	5,496	4,974
Utah	2	42,374	1,439	50,365	44,850	40,592
Wasatch	1	52,623	3,429	120,015	161,776	146,415
Washington	1	579			5	5
Wayne	1	6			9	8
Total:						
1960	37	28,832,306	368,255	12,888,925	4,782,960	4,328,820
1959	30	20,220,922	239,517	8,383,095	3,734,297	3,379,727

	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Beaver	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Juab	6	$3,756	242	$56,616	108	$27,851	$102,545
Millard	[4]	96	[4]	59	4	1,045	1,291
Morgan			4	901	[4]	78	1,071
Piute	4	2,825	8	1,755	33	8,604	18,857
Salt Lake	217,180	139,429,335	28,976	6,780,314	23,618	6,093,341	168,368,675
San Juan	[3] 390	[3] 249,963	[3] 24	[3] 5,534	[3] 114	[3] 29,334	[3] 295,107
Summit	200	128,432	5,717	1,337,685	7,583	1,956,388	4,181,387
Tooele	7	4,783	67	15,818	88	22,730	48,655
Utah	34	21,539	5	1,310	1	258	114,064
Wasatch	156	100,409	4,355	1,019,105	3,925	1,012,663	2,398,607
Washington	72	46,160	[4]	23	2	516	46,704
Wayne	[4]	160	[4]	12			180
Total:							
1960	218,049	139,987,458	39,398	9,219,132	35,476	9,152,808	175 577,143
1959	144,715	88,855,010	36,630	8,424,900	35,223	8,101,290	117,144,022

[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] Beaver and San Juan Counties combined to avoid disclosing individual company confidential data.
[4] Less than 1 ton.

TABLE 6.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	1	([2])	1				
Dry gold-silver	6	157,603	2,125	74,701	1,519,400	925,500	458,100
Dry silver	2	70,728	726	172,978	140,600	2,500	1,600
Total	9	228,331	2,852	247,679	1,660,000	928,000	459,700
Copper and uranium [3]	[4] 5	[5] 28,061,672	352,051	2,641,203	411,161,300	27,600	33,200
Copper-lead-zinc and copper-zinc [1]	2	3,042	42	2,697	35,700	4,300	172,700
Lead	9	301	16	2,736	1,600	69,100	12,400
Lead-zinc	13	482,796	12,942	1,861,496	3,079,600	76,673,000	64,167,600
Zinc	2	383	60	3,768	8,800	14,800	74,500
Total	30	28,548,194	365,111	4,511,900	414,287,000	76,788,800	64,460,400
Other "lode" material:							
Gold-silver tailings	([6])	3,030	247	8,267	28,600	42,600	
Copper precipitates	2	12,783			20,028,400		
Copper-lead mill cleanings	([6])	12	1	198	900	2,400	500
Lead cleanings	([6])	49	22	754	1,000	26,600	1,700
Lead-zinc mill and smelter cleanings	([6])	102	5	606	500	12,500	14,200
Zinc slag	([6])	52,588	17	13,556	91,600	995,100	6,015,500
Total	2	68,564	292	23,381	20,151,000	1,079,200	6,031,900
Total "lode" material	37	28,845,089	368,255	4,782,960	436,098,000	78,796,000	70,952,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] Less than 1 ton.
[3] Combined to avoid disclosing individual company confidential data.
[4] Copper mines only; excludes the mine count of uranium mines from which copper was recovered as a byproduct.
[5] Excludes uranium-ore tonnage.
[6] From properties not classed as mines.

TABLE 7.—Mine production of gold, silver, copper, lead, and zinc in 1960, 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	1				
Concentration, and smelting of concentrates:					
Ore [1]	364,988	4,461,029	414,017,700	76,227,000	63,897,100
Cleanings	1	388	100	8,100	11,500
Total	364,989	4,461,417	414,017,800	76,235,100	63,908,600
Direct-smelting:					
Ore	2,974	298,550	1,929,300	1,489,800	1,023,000
Cleanings	27	1,170	2,300	33,400	4,900
Copper precipitates			20,028,400		
Old slag	17	13,556	91,600	995,100	6,015,500
Tailings	247	8,267	28,600	42,600	
Total	3,265	321,543	22,080,200	2,560,900	7,043,400
Grand total	368,255	4,782,960	436,098,000	78,796,000	70,952,000

[1] Includes uranium-ore concentrate.

The increase in copper production reflected an 11-month operation in 1960 by the leading copper producer, Utah Copper, compared with only a 7½-month operation in 1959. The labor strike, which idled the mine, mill, smelter, and refinery in mid-August 1959, was settled by the beginning of February; but the operation did not reach full production until March. In its annual report, Kennecott Copper stated that 28.1 million tons of ore was mined and milled from the Utah Copper open-pit mine, compared with 19.7 million tons in 1959. Copper recovered from all sources at this mine was 215,125 tons in 1960, compared with 142,352 tons in 1959. Copper content of the ore mined was 16.2 pounds per ton—0.1 pound below the 1959 average. In October, the company placed in operation a $16 million, 75,000-kw. addition to the 100,000-kw. powerplant. A $10 million improvement and modification program at the Garfield smelter, acquired from the American Smelting and Refining Co. (Asarco), was begun during the year, to adapt the custom smelter to Kennecott's needs. In August, an excavation project scheduled for completion in 9 months was begun in the Utah Copper open-pit mine. The project involved a spiral approach to the 5,490-foot tunnel, 150 feet below the existing working level of the pit. When the spiral is connected with the new tunnel, the ore from the pit will be hauled downhill and out the new tunnel rather than uphill to the 5,840-foot-level tunnel presently in use.

The U.S. and Lark mine of the United States Smelting Refining and Mining Co., second-ranking Utah copper producer, operated throughout the year with 2 shifts on an alternate 5- and 6-day-per-week basis. Late in the year, the deepening of an internal inclined shaft in the Lark section of the mine was started to prepare lower levels for mining. The ore from the U.S. and Lark mine was treated in the company Midvale flotation mill, which operated throughout the year on an alternate 5- and 6-day-per-week basis. Demolition of the company smelter buildings at Midvale, continuing under contract, was nearly completed by yearend. Of the total copper produced, 94 percent was recovered from copper ore and 5 percent from copper precipitates (produced by leaching copper dump material). The remaining 1 percent came from miscellaneous classes of ore and material, including some copper recovered as a byproduct of uranium ores.

Majestic Oil and Mining Co. made commitments for opening of the Bawana copper deposit near Milford. This action was made possible through an agreement between the company and Bogdanich Development Co., lessees of the property from Cerro Verde Mining Co. Plans were made to develop the property as an open-pit mine and to renovate a 350-ton-per-day mill near Milford to treat the ore.

Gold.—Gold output increased 54 percent ($4.5 million), over that of 1959. This advance directly reflected the increased copper production inasmuch as 96 percent of the gold was recovered as a byproduct of copper.

Kennecott's Utah Copper Bingham open-pit copper mine accounted for most of the State's gold output, followed by the U.S. and Lark, Mayflower-Galena, and United Park City mines, in descending order of output.

Iron Ore.—Production of iron ore shipped increased 500,000 long tons in quantity and $3.9 million in value over 1959. The output came from seven mines operated by four companies in Iron County. The Columbia Iron Mining Co., a subsidiary of United States Steel Corp., which is the State's largest iron-ore producer, shipped ore from the Desert Mound and Iron Mountain mines to Columbia-Geneva Steel Division plants at Geneva and Ironton. The Colorado Fuel and Iron Corp. (CF&I) shipped ore (mined under contract by Utah Construction & Mining Co. from the Blowout, Comstock, and Duncan mines) to its pig iron and steel plant at Pueblo, Colo. Utah Construction shipped ore from its Excelsior (Iron Springs) mine to consumers in Utah, primarily to Columbia-Geneva Steel. Utah Construction, in its annual report, stated that a total of 683,515 tons of ore was mined and shipped during the year, compared with 598,128 tons in 1959 and that a $1.3 million beneficiation plant was being installed to improve product quality and to allow more efficient use of ore reserves. Lambeth Bros., lessees from Helene E. Beatty, marketed ore from the Alberts Iron Nos. 1, 2, and 3 claims.

TABLE 8.—Usable iron ore shipments

(Thousand long tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	4,027	$19,126	1959	2,842	$19,979
1956	4,002	27,508	1960	3,334	23,862
1957	4,156	30,383			
1958	3,514	25,202	1906–60	60,498	256,775

Lead.—Lead production was 8 percent greater than in 1959. The annual weighted average price for lead was 11.7 cents in 1960, compared with 11.5 cents in 1959. Most of the lead came from lead-zinc ore produced at the U.S. and Lark mine at Bingham in Salt Lake County, operated by the United States Smelting Refining and Mining Co. The lead-zinc ore was treated in the company flotation mill at Midvale.

Other major producers of lead from lead-zinc ores included the United Park City and Mayflower-Galena mines. These mines plus the U.S. and Lark accounted for 95 percent of the State's total lead production.

In 1960, OME contracts for a total of $325,190 were executed for lead-zinc exploration programs at three Utah mines. The contractors and the Federal Government were to participate equally in the total amount of the contracts. Data concerning the contracts are shown in table 3.

Significant exploration and development programs were reported at lead-zinc mines. Bear Creek Mining Co. had been exploring lease holdings of approximately 11,000 acres in the East Tintic mining district, Tooele County, since September 1956. The property was owned by Tintic Standard Mining Co. and its subsidiaries and Chief Consolidated Mining Co. Bear Creek completed 9,700 feet of surface rotary and diamond drilling. In May, Bear Creek assigned its lease to the parent company, Kennecott. Bear Creek continued in charge

of surface drilling. Beginning in May, Kennecott operated the Burgin shaft and the underground workings and completed 1,600 feet of underground development and 8,500 feet of diamond drilling. A 440-foot, 25-degree incline winze from the 1,050-foot level (1,000 feet west of the Burgin shaft) was being sunk to determine the lower limit and continuity of the ore.

The Anaconda Company obtained an option from McFarland & Hullinger, mine contractors, on 21 claims comprising the Scranton lead-zinc mine 8 miles north of Eureka and planned extensive geological mapping and sampling on the property. Cerro Corp., in a joint venture with Chief Consolidated Mining Co. and Armet Co., completed a preliminary exploration program for silver-bearing lead ore at the Holt mine near Enterprise in Iron County; however, the company made no announcement of future plans regarding the sinking of a new shaft and unwatering the mine. Marvel Mining Co. discovered high grade lead-silver oxide ore on claims in the Clifton mining district in western Tooele County and made shipments of this ore to the Tooele smelter of International Smelting and Refining Co. Index-Daley Mines Co. announced that it would drive a 1,300-foot exploration tunnel at the Creole mine near Minersville. Heinecke Bros. was to continue to mine silver-bearing lead-zinc ore from the upper levels of the mine and operate the 100-ton-per-day mill on the property. United Park City Mines Co. completed a 400-foot incline winze to develop a silver-bearing lead-zinc ore body in the Humbug formation in the Park City mining district. Keystone Mining Co., through an agreement with United Park City Mines Co., began an exploration project financed equally by Keystone and OME to explore for silver-bearing lead-zinc ore at the Keystone mine adjoining United Park City properties. Under this agreement Keystone was allowed the use of United Park City facilities and equipment. New Park Mining Co. continued its reported $750,000 exploration and development program for silver-bearing lead-zinc ore at its Park City properties. Company officials reported that ore with a greater value was developed and that the ore reserve was increased beyond the rate of withdrawal during the year.

Molybdenum.—The entire production of molybdenum was recovered as a byproduct of copper ore from the Utah Copper mine of Utah Copper. The molybdenum was recovered as a molybdenite concentrate by flotation of the copper concentrate produced at the company Arthur and Magna mills.

Silver.—Silver production increased 28 percent (1 million troy ounces), principally because of major advance in output from the State's leading gold, silver, and copper producer, Utah Copper. The U.S. and Lark and United Park City mines also were important contributors to the total. The three mines accounted for 90 percent of the silver production. Fifty-five percent was recovered from copper ore, 39 percent from lead-zinc ore, and the remainder from other classes of ore and materials.

Tungsten.—Minerals Engineering Co. produced high-purity ammonium paratungstate at its refinery in Salt Lake City from concentrate recovered from ore mined from the company's Calvert Creek property near Dillon, Mont.

TABLE 9.—Mine production of uranium ore by counties [1]

County	1959				1960			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Beaver	2	(3)	(3)	(3)	3	5,497	20,025	$71,126
Emery	47	67,667	321,705	$1,316,497	47	94,355	463,632	1,913,850
Garfield	41	1,789	27,998	130,740	37	1,641	30,240	142,183
Grand	51	41,197	219,522	913,702	45	43,752	224,454	934,077
Iron	1	(3)	(3)	(3)				
Juab	1	15,519	72,463	292,533	1	19,781	76,735	285,638
Piute	4	(3)	(3)	(3)	4	(3)	(3)	(3)
San Juan	167	1,068,787	7,901,726	34,452,053	170	905,845	5,675,076	24,198,450
Sevier	1	(3)	(3)	(3)	2	(3)	(3)	(3)
Wayne	3	(3)	(3)	(3)	3	(3)	(3)	(3)
Undistributed		15,695	56,902	204,927		18,886	77,682	297,330
Total	318	1,210,654	8,600,316	37,310,452	312	1,089,757	6,567,844	27,843,154

[1] Based on data supplied to the Bureau of Mines by the AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowance.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Uranium.—Uranium ore production, from 312 operations in 9 counties, was 10 percent below that of 1959 in quantity and 25 percent less in value. The grade of the ore declined from 0.36 percent U_3O_8 (7.2 pounds per ton) in 1959 to 0.30 percent (6.0 pounds per ton). The major drop was in San Juan County although the county continued to lead the State, followed by Emery and Grand Counties.

Processing plants at Mexican Hat, Moab, and Salt Lake City operated throughout the year. Contracts for the purchase of uranium oxide concentrate by the Atomic Energy Commission (AEC) from Vitro Chemical Co. at Salt Lake City, which were to expire on March 31, 1962, and Texas-Zinc Minerals Corp., which were to expire December 31, 1966, were being reviewed to adjust production rates to meet anticipated requirements of AEC through 1966. The upgrading plant at Green River was operated by Union Carbide Nuclear Co. Ore treated at the plant was shipped to a processing plant at Rifle, Colo.

The AEC invited bids for the purchase and removal of equipment from the Government-owned buying station and sampling plant at Moab. The station, opened early in 1955, had been placed on standby November 1, 1956, when the Uranium Reduction Co. mill began operating and provided a market for ores in the area. The proposed sale of the Government-owned processing plant at Monticello to operators of uranium mills, probably in process units, also was announced. The plant, with a daily capacity of 350 tons of crude ore, closed December 31, 1959. Although not unsafe, the equipment was classified as radioactive, a classification that would preclude bidding by anyone not possessing a uranium oxide purchase contract.

Vanadium.—Uranium ores containing significant quantities of vanadium oxide were processed at mills in southwestern Colorado and northwestern New Mexico where the vanadium was recovered. The vanadium recovered from such ores produced in Emery, Garfield,

Grand, San Juan, and Wayne Counties was credited to Utah. The quantity recovered in 1960 was 14 percent less than that of 1959.

Zinc.—Zinc output slightly exceeded that of 1959, and the value increased 13 percent ($1.1 million) because of the advance in the annual weighted average price from 11.5 cents per pound in 1959 to 12.9 cents in 1960. The leading zinc producers—U.S. and Lark, United Park City, and Mayflower-Galena—together supplied 88 percent of the zinc output.

MINERAL FUELS

Asphalt and Related Bitumens.—Gilsonite (uintahite) production from six mines in Uintah and Duchesne Counties increased 1 percent in quantity and 7 percent in value over that of 1959. American Gilsonite Co., operating the Bonanza mines in Uintah County, continued to develop and improve hydraulic mining methods.

Carbon Dioxide.—Carbon dioxide production came from the Navajo and Coconino formations in the Farnham Dome field in Carbon County. The gas, transported to Wellington by pipeline, was converted to dry ice and liquid carbon dioxide.

Coal.—Bituminous coal production, from 45 underground mines in 7 counties, increased 9 percent above that of 1959. Nearly half (49 percent) of the output was used in manufacturing coke for use in steel plants in Utah and California. Two counties, Carbon and Emery, accounted for 98 percent of the coal produced. Carbon County led with 75 percent. Independent Coal & Coke Co. completed its 1-mile tunnel connecting the Kenilworth and Castle Gate mines. Columbia-Geneva Steel completed a coal-drying plant, the first of its kind west of the Mississippi River, at its cleaning plant at Wellington.

TABLE 10.—Coal production, by counties

(Excludes mines producing less than 1,000 short tons)

County	1959		1960	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Carbon	3,446,396	$6.30	3,697,694	$6.50
Emery	988,809	5.76	1,136,786	5.96
Garfield			1,035	5.50
Iron	42,393	4.91	[2] 49,786	[2] 5.04
Kane	1,300	4.91	[2]	[2]
Sevier	47,250	6.00	49,310	5.91
Summit	18,409	4.44	20,082	4.42
Total	4,544,557	6.16	4,954,693	6.35

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes a 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).

[2] Production of Kane County combined with Iron County to avoid disclosing individual company confidential data.

Natural Gas.—The quantity of marketed natural gas from fields in six counties and residual gas from natural gas plants in three counties was 40 percent above that of 1959. A full year's operation of the El

Paso plant at Aneth, completed late in 1959, accounted for much of the increase. Oil-well gas processed at plants was 71 percent of the usable gas produced. Nine new gas fields were discovered, four each in Grand and Uintah Counties, and one in Carbon. Fourteen successful development wells (10 in Uintah County and 4 in Grand) also were completed. An additional outlet for natural gas from the Westwater area in Grand County was provided when the 6-inch, 9-million-cubic-foot-per-day pipeline was completed by Grand Valley Transmission Co. in November. The line connected with those of the Pacific Northwest Pipeline system of El Paso Natural Gas Co.

Natural Gas Liquids.—Natural gasoline, butane, and propane were recovered from plants in the Clay Basin field in Daggett County, the Red Wash field in Uintah County, and the Aneth field in San Juan County. The quantity recovered was nearly twice that of 1959, and the increase was entirely from the 100-million-cubic-foot-per-day El Paso Natural Gas Co. plant in the Aneth field. Natural gasoline, representing 20 percent of the natural gas liquids recovered, was largely from plants in the Clay Basin and Red Wash fields. The liquids recovered at the Aneth plant were separated at the El Paso Natural Gas Co. Wingate fractionation plant at Wingate, N. Mex. Standard Oil Co. of California began construction of a 40-million-cubic-foot-per-day gasoline plant at Red Wash field in Uintah County.

Petroleum.—Petroleum production, from 796 wells in 5 counties, fell 6 percent below the 1959 figure. Gains were recorded in Grand and Uintah Counties; a substantial decline was noted in San Juan County. Much of the drop was in the Greater Aneth area, particularly the Aneth, White Mesa, and Ratherford fields. Other fields in the area, Cahone Mesa, Ismay, and McElmo Creek, accounted for substantial gains. The designation of the Northwest Lisbon field as the "discovery of the year" in 1959 was fully justified. The producing area was extended to the southeast and to the north. The field, discovered late in 1959, was the first in the Paradox basin to yield petroleum from Devonian formations.

Drilling declined, with completion of 96 exploratory and 147 development wells compared with 101 exploratory and 217 development wells in 1959. The decline in development drilling was largely the result of the official establishment of 80-acre spacing in the Aneth area. Drilling in the fields had been on 80-acre spacing and few additional wells were required. Other development drilling was in Uintah County, particularly in the Red Wash-Walker Hollow area. Exploratory drilling in San Juan, Uintah, Grand, and Duchesne Counties represented 83 percent of all exploratory drilling in the State. Six discoveries were made, five in San Juan County and one in Duchesne County. The success ratio for exploratory drilling was 16 percent, that for development drilling was 85 percent, and that for all drilling was 58 percent.

Four refineries in the Salt Lake City area operated the entire year. Throughput was 31.2 million barrels of crude oil, an increase of 3 percent over that of 1959.

TABLE 11.—Crude petroleum production, by counties[1]

(Thousand barrels)

County	1959	1960[2]	Principal fields in 1960 in order of production
Duchesne	22	19	Duchesne, Starr Flat.
Grand	9	14	Big Flat, Seiber Nose.
San Juan	35,065	31,934	McElmo Creek, Aneth, Ratherford, White Mesa.
Uintah	4,859	5,630	Red Wash, Ashley Valley, Roosevelt, Brennan Bottom.
Washington	4	2	Virgin.
Total	39,959	37,599	

[1] Based on Utah Oil & Gas Conservation Commission county data, adjusted to Bureau of Mines total.
[2] Preliminary figures.

TABLE 12.—Wildcat- and development-well completions in 1960, by counties

County	Crude	Gas	Dry	Total	Footage
Wildcat:					
Box Elder			1	1	800
Carbon		1		1	4,500
Duchesne	1		8	9	58,800
Emery			4	4	18,000
Garfield			2	2	8,500
Grand		4	12	16	80,900
Juab			1	1	7,500
Kane			2	2	17,700
San Juan	5		27	32	196,000
Sanpete			1	1	4,600
Summit			2	2	4,100
Uintah		4	14	18	113,900
Washington			1	1	3,000
Wayne			5	5	21,900
Weber			1	1	600
Total	6	9	81	96	540,800
Development:					
Grand		4	3	7	35,600
San Juan	86		[1] 16	102	582,800
Uintah	25	10	2	37	222,900
Washington			1	1	700
Total	111	14	[1] 22	147	842,000
Total all drilling	117	23	[1] 103	243	1,382,800

[1] Includes development service-well completion.

Source: Oil and Gas Journal.

NONMETALS

Barite.—One firm continued to be the only local outlet for barite. Ore mined by Heinecke Bros. (Beaver County), D. J. Garrick (Juab County), and Lyle Tiller (Tooele County) was shipped to a Salt Lake City grinding plant operated by Custom Milling Co. All the ground barite was sold to the oil-well drilling industry.

Cement.—Production and shipments of portland and masonry cements decreased 6 and 8 percent, respectively, compared with 1959. The decline was attributed, at least in part, to a reduced volume of building and highway construction. Ideal Cement Co., with a 2-kiln plant at Devil's Slide, Morgan County, was the major producer. At its plant, the company completed a $2 million project which consisted

primarily of nine new 36- by 140-foot-high silos and four bins having a total storage capacity of 200,400 barrels.[2]

Portland Cement Co. of Utah operated its Salt Lake City cement plant throughout 1960 and continued its $2.5 million construction program designed to double plant capacity. This project was to be completed early in 1961.

Clays.—Because of a general decline in the demand for building brick and other heavy clay products, output of fire and miscellaneous clay or shale dropped 23 percent in 1960. Also, production of bentonite decreased slightly but the output of halloysite (kaolin-type clay) increased; mine shipments of fuller's earth remained about the same. The Filtrol Corp. Dragon halloysite mine in Juab County was the major producer of clay in 1960. Brick and other clay-products plants were operated by Interstate Brick Co., Utah Fire Clay Co., United Brick Co., and Harrisville Brick Co., which processed nearly all the fire clay and miscellaneous clay. Western Clay & Metals Co., Sevier County; American Mud & Chemical Corp., Garfield County; and Macco Corp., Morgan County, mined all the fuller's earth and bentonite.

Fluorspar.—The resumption of mining operations at the Fluorine Queen (Chesley & Black) and Bell Hill mines (Larsen Industries, Inc.), plus the continued operation of the Lost Sheep mine by Willden Bros., boosted fluorspar sales in 1960 to 1,900 tons, valued at $51,000. Mine production was 2,366 tons, from which 2,228 tons of upgraded concentrate was produced. Shipments were to steel and cement manufacturers.

Gem Stones.—The value of gem and ornamental stones collected was estimated at $72,000—a 46-percent drop from 1959. Data obtained from individuals, societies, and dealers indicated a substantial decline in the value of petrified wood collected in Garfield County and geodes gathered in Juab County. The following areas within selected counties were the centers of activity in 1960: Box Elder (Lucin); Garfield (Escalante and Circle Cliff); Juab (Levan and Jericho); Millard (Black Rock, Delta, and Milford); Tooele (Cedar Mountain, Dugway, and Antelope Springs); and Wayne (Hanksville and Thousand Lake Mountain Range).

Gypsum.—The output of crude gypsum mined by Bestwall Gypsum Co. and United States Gypsum Co. decreased 10 percent in quantity from 1959. Both companies continued to operate wallboard plants near Sigurd.

Lime.—A 37,000-ton gain in the output of quicklime and hydrated lime increased total production of all types of lime to 127,000 tons, 41 percent greater than the 1959 total. The copper and iron industries consumed the bulk of the output. Lime-burning capacity in existence in 1960 was 236,050 tons. Thirteen shaft and 4 rotary kilns, and 1 batch and 4 continuous hydrators were operated by Kennecott Copper Corp., The Utah Lime and Stone Co., Utah Marblehead Lime Co., and Lakeside Lime & Stone Co. Although Utah provided the principal market for lime, shipments were made to Alaska, California,

[2] Intermountain Industry & Engineering, Ideal Initiates New Bulk Storage Facilities: Vol. 62, No. 10, October 1960, pp. 20–23.

Colorado, Idaho, Montana, Nevada, Oregon, Washington, Wyoming, and Canada.

Utah Marblehead Lime Co. produced dead-burned dolomite at its Delle operation. The Utah Lime and Stone Co. began operating its new lime plant at Dolomite during 1960. The new plant had five Ellernan kilns, a hydrator, and a pulverizing and milling unit.[3]

Perlite.—Production of crude and expanded perlite and the industry structure were the same as in 1959. Acme Lite-Wate Products, Inc., mined crude material in Beaver County and expanded it at a plant in Salt Lake City. Bestwall Gypsum Co. continued to expand perlite at Sigurd.

Phosphate Rock.—In April, San Francisco Chemical Co. began constructing a phosphate plant near Vernal. Unit No. 1 of the concentrating plant was scheduled for operation early in 1961. The facility was planned for a 250-ton-per-hour (6,000-ton-per-day) crushing plant, and grinding, desliming, flotation, filtration, and drying equipment with a concentrate capacity of 200,000 tons per year. From the Vernal plant, the concentrate will be shipped to Garfield where Western Phosphates, Inc., will convert it to phosphoric acid, triple superphosphate, and ammonium phosphate.

San Francisco Chemical Co. also operated the Bradley phosphate rock mine in Rich County. Output from the Bradley mine was shipped to Sage, Wyo., for milling, and the upgraded product was shipped to Western Phosphates at Garfield for manufacturing elemental phosporus. Because of a copper strike in 1959, which resulted in a low output of byproduct sulfuric acid at the Garfield copper smelter, Western Phosphates did not secure enough sulfuric acid to operate at capacity. With settlement of the strike early in 1960, an adequate supply of acid again became available and the Bradley mine and Western Phosphates resumed full-scale production.

Potash.—An 8-percent increase was recorded in the production of manure salts and muriate of potash from the Wendover facilities of Bonneville, Ltd. In its annual report covering the year ending June 30, 1960, the company stated that because of reduced precipitation in the area, Great Salt Lake had receded to its lowest level in recorded history and much less brine than usual was collected in the Bonneville ditches. The installation of large booster pumps to recover brine from outlying areas was begun. In addition, a long-range brine-supply research program was established in cooperation with the University of Utah. The company also reported that five draglines were used to dig and clean ditches, instead of the usual two. This activity, the report stated, was considered imperative to maintain production in the event of another dry season.

The extensive potash reserves in the Cane Creek area near Moab received national attention during 1960 through the signing of an agreement between Delhi-Taylor Oil Corp. and Texas Gulf Sulphur Co. covering the development of the deposits. By the end of the year, Texas Gulf's Board of Directors approved a $25 million project which included a 2,700- to 2,800-foot mine shaft and refinery. Also under

[3] Intermountain Industry & Engineering, Utah Lime Opens New Plant: Vol. 62, No. 6, June 1960, p. 32.

way were negotiations for construction of an 18-mile road from Moab to the plant site and 36 miles of connecting rail line.

Pumice.—Greater production of pumice (scoria) by Christensen Construction Co. and Central Utah Block Co. in Millard County, and the addition of Melvin Bradshaw in Beaver County and Ralph Memmott in Millard County to the list of producers boosted output to 60,000 tons, a 54 percent gain over 1959. All the scoria mined was used in manufacturing building block and other structural products.

Pyrites.—With the settlement of a labor strike at the Garfield copper smelter early in 1960, adequate quantities of byproduct sulfur dioxide gas became available to the Garfield Chemical and Manufacturing Corp. sulfuric acid plant. As a consequence, the pyrites shipments to Garfield by United States Smelting Refining and Mining Co. were 51 percent below 1959 shipments. United States Smelting recovered pyrites as a byproduct at the company's Midvale lead-zinc concentrator.

Salt.—Increased harvests from the four major salt operations resulted in an 11-percent gain in sales of salt. Morton Salt Co. was the leading producer, followed by Utah Salt Co., Leslie Salt Co., and Solar Salt Co. The latter three firms maintained facilities in Tooele County, and Morton operated in Salt Lake County. Royal Crystal Salt Co. (Sanpete County) and Poulson Bros. Salt Co. (Sevier County), with mines near Redmond, were the only rock-salt operators. Lake Crystal Salt Co. reported a reduction in output from its Box Elder County solar-evaporation facility. Utah Salt Co. and Van Waters and Rogers, Inc., formed Wendover Specialties, Inc., to produce and distribute salt products. A plant to make salt blocks for animal feed was built and placed in operation.

Sand and Gravel.—Cutbacks in highway construction in Iron, Juab, Weber, Sevier, Salt Lake, and other counties were largely responsible for the 23-percent decline in the quantity of sand and gravel used in 1960. There were 62 commercial and 40 Government-and-contractor operations actively engaged in mining sand and gravel, an increase of 3 operations over 1959. Salt Lake County continued to be the largest producer with production of 2.2 million tons of aggregate by 13 commercial and 2 highway-contractor operators. A report [4] showed that from July 1, 1956, to December 31, 1960, Utah completed 40.1 miles of road to full and acceptable interstate standards and improved 29.2 miles to standards adequate for present traffic, for a total of 69.3 miles open to traffic. On the basis of this mileage, the State ranked 38th in the United States. However, in terms of work in progress on the Interstate System, Utah ranked 31st, with 183.5 miles in construction, engineering, or right-of-way status. Utah had completed to full or acceptable interstate standards only 4 percent of the 934 miles of highway allocated to the State.

Stone.—The cessation of stone quarrying in 1960 in Box Elder County (valued at $2 million in 1959) was only partially offset by gains in the output of stone produced in Cache, Tooele, and Utah Counties. The net result was a 1.5-million-ton or 45-percent reduction in the tonnage of all types of stone quarried. The completion of con-

[4] Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960. Press release BPR 61–6, Feb. 22, 1961.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	778	$761	794	$791
Paving	412	389	318	252
Fill	146	62	14	7
Other	43	63	24	21
Industrial sand:				
Molding	(1)	(1)	23	39
Engine	(1)	(1)	1	3
Other	21	27	----	----
Total sand	1,400	1,302	1,174	1,113
Construction gravel:				
Building	895	820	959	981
Paving	2,319	1,875	2,625	1,919
Railroad ballast	(1)	(1)	24	6
Fill	1,321	668	56	25
Other	80	97	42	79
Miscellaneous gravel	3	7	15	13
Total gravel	4,618	3,467	3,721	3,023
Total sand and gravel	6,018	4,769	4,895	4,136
Government-and-contractor operations:				
Sand:				
Building	5	17	83	167
Paving	15	9	53	43
Fill	9	4	----	----
Total sand	29	30	136	210
Gravel:				
Building	216	147	343	684
Paving	2,580	1,490	1,474	1,152
Total gravel	2,796	1,637	1,817	1,836
Total sand and gravel	2,825	1,667	1,953	2,046
All operations:				
Sand	1,429	1,332	1,310	1,323
Gravel	7,414	5,104	5,538	4,859
Grand total	8,843	6,436	6,848	6,182

[1]Figure withheld to avoid disclosing individual company confidential data; included with "Other."

struction work on the Southern Pacific Co. Great Salt Lake railroad causeway resulted in the closing of Box Elder County quarries which were the source of $2 million worth of crushed limestone and sandstone produced in 1959. More road construction in Cache County, and increased use of limestone as a flux and for lime manufacture in Tooele and Utah Counties were responsible for increased stone production in these counties. Resumption of full-scale production at the major copper operations stimulated the demand for additional quantities of limestone.

Sulfuric Acid.—The Garfield sulfuric acid plant of Garfield Chemical and Manufacturing Corp. operated throughout the year, and output increased considerably over the 1959 total. This plant, jointly owned by Kennecott Copper Corp. and Asarco, ranked second in the Nation in the production of byproduct sulfuric acid. In 1960, the plant was equipped with a new scrubber system designed to recover

sulfur dioxide previously lost. According to Kennecott's annual report, the new equipment will increase acid production by 50 tons per day. Acid plants also were operated by Texas-Zinc Minerals Corp. at Mexican Hat and by U.S. Steel at Provo.

TABLE 14.—Stone production in 1960, by counties

County	Short tons	Value	County	Short tons	Value
Cache	113,899	$227,345	Summit	1,107	$7,929
Daggett	7,800	13,442	Tooele	350,187	789,372
Emery	34,500	31,050	Uintah	63,850	120,200
Iron	(1)	(1)	Utah	(1)	(1)
Juab	(1)	(1)	Wasatch	12,178	22,132
Morgan	(1)	(1)	Washington	(1)	(1)
Salt Lake	(1)	(1)	Other counties	1,239,644	1,855,930
San Juan	11,414	11,414			
Sevier	2,300	8,050	Total	1,836,879	3,086,864

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other counties."

TABLE 15.—Stone sold or used by producers, by kinds

Year	Granite		Limestone		Sandstone	
	Short tons	Value	Short tons	Value	Short tons	Value
1956			1,694,217	$2,563,741	321,588	$430,101
1957			1,723,300	2,359,600	123,175	155,150
1958	77,300	$146,100	2,958,000	3,648,900	10,090,877	10,153,414
1959	1,500	1,500	1,547,600	2,196,400	1,786,186	1,834,808
1960	1,200	1,200	1,702,021	2,921,737	76,158	118,615

Year	Other stone		Total	
	Short tons	Value	Short tons	Value
1956	305,831	$304,164	2,321,636	$3,298,006
1957	6,007,400	6,025,300	7,853,875	8,540,050
1958	200	200	13,126,377	13,948,614
1959	2,600	15,700	3,337,886	4,048,408
1960	57,500	45,312	1,836,879	3,086,864

TABLE 16.—Stone sold or used by producers, by uses

Use	1959		1960	
	Short tons	Value	Short tons	Value
Dimension stone: [1]	1,186	$29,808	1,924	$37,429
Crushed and broken stone:				
Riprap	2,500	2,500	63,532	121,000
Metallurgical	411,500	669,500	679,492	1,101,192
Concrete and roadstone	10,000	13,700	135,162	113,665
Chemical	49,800	169,100	58,136	200,684
Miscellaneous	[2] 2,862,900	3,163,800	[3] 898,633	1,512,894
Total	3,336,700	4,018,600	1,834,955	3,049,435
Grand total	3,337,886	4,048,408	1,836,879	3,086,864

[1] Includes rough construction, dressed, and sawed stones.
[2] Includes stone used in coal dust, cement, lime, trestle fill, landscaping, roofing granules, feed supplement, and soil conditioner.
[3] Includes stone used in railroad ballast, asphalt filler, coal dust, poultry grit, cement, lime, landscaping, and roofing granules.

Talc.—The Ogden mill of Tri-State Minerals Co. nearly doubled its shipments of ground talc. Crude talc mined in California and Montana was shipped to Ogden for grinding. The finished product was consumed by ceramic, insecticide, paint, and toilet-preparations manufacturers.

Vermiculite.—Mines in Montana continued to supply crude vermiculite to the Salt Lake City exfoliating plant of Vermiculite-Intermountain, Inc. Sales of the finished product remained about the same as in 1959. Most of the material sold was used as insulation.

REVIEW BY COUNTIES

Beaver.—Uranium ore shipped from the Desert View, Mystery Sniffer, and Mercury Sec. 14 mines to plants in Salt Lake City and Lakeview, Oreg., for processing represented 46 percent of the total value of mineral production in the county. Output of gold, silver, copper, lead, and zinc from three active mines and cleanup material at one mill accounted for one-third of the total value, and nonmetals—primarily pumice, perlite, and sand and gravel—comprised the remainder.

Box Elder.—Cessation of stone quarrying by Morrison-Knudsen Co., Inc., substantially lowered the total value of mineral production. Completion of the railroad causeway across Great Salt Lake in 1959 eliminated the demand for fill material, and stone production dropped to zero. Heinecke Bros. recovered a small quantity of barite from the Silver Horn mine near Milford. The ore was shipped to Salt Lake City for grinding.

Carbon.—Bituminous coal from 25 mines represented 93 percent of the total value of mineral production in the county. Six companies produced more than 100,000 tons each and accounted for 90 percent of all coal produced. They were Columbia-Geneva Steel at the Columbia and Geneva mines; Kaiser Steel Corp. at the Sunnyside Nos. 1, 2, and 3, and the "B" Canyon mines; Independent Coal & Coke Co. at the Castle Gate Nos. 2 and 4, Clear Creek No. 3, Kenilworth, and O'Connor No. 1 mines; Carbon Fuel Co. at the Carbon Fuel mine; Lion Coal Corp. at the Wattis mine; and Knight Ideal Coal Co. at the Knight Ideal Nos. 2 and 3 mines. Completion of the 1-mile tunnel from the Kenilworth mine to the Castle Gate mine by Independent Coal & Coke Co. substantially reduced production costs. All surface operations at the Kenilworth mine were closed.

Columbia-Geneva Steel completed a coal-drying plant as a complement to the coal-cleaning plant at Wellington completed in 1959. The coal fed to the dryer is maintained in a fluidized condition by upward-moving hot gases under pressure. The drying is accomplished as the coal floats in the stream of hot pressurized air over a refractory brick constriction plate. The dryer was the first of its kind to be built west of the Mississippi River.

Pacific States Steel Corp. of Niles, Calif., announced its intention to exercise an option to purchase, from the Heiner Coal Co., a reserve of 35 million tons of coking coal in three separate seams on 5,720 acres in Carbon County. The property consisted of 640 acres of leased State land, 4,920 acres of leased Federal land, and 160 acres of pri-

TABLE 17.—Value of mineral production in Utah, by counties

County	1959	1960 [1]	Minerals produced in 1960 in order of value
Beaver	$121,648	$156,164	Uranium ore, zinc, pumice, copper, perlite, sand and gravel, lead, silver, gold, gem stones, barite.
Box Elder	2,352,060	607,470	Sand and gravel, salt, gem stones.
Cache	429,300	512,545	Sand and gravel, stone.
Carbon	23,698,854	25,903,362	Coal, natural gas, sand and gravel, carbon dioxide, gem stones.
Daggett	505,500	1,129,242	Sand and gravel, natural gas, stone, natural gasoline.
Davis	268,900	293,000	Sand and gravel.
Duchesne	[2] 480,420	442,881	Gilsonite, petroleum, sand and gravel.
Emery [3]	7,113,583	8,784,173	Coal, uranium ore, sand and gravel, stone, natural gas, gem stones.
Garfield [3]	183,580	175,650	Uranium ore, gem stones, clays, coal, sand and gravel.
Grand [3]	1,236,500	1,176,689	Uranium ore, natural gas, petroleum, sand and gravel, gem stones.
Iron	20,404,143	24,141,028	Iron ore, coal, stone, sand and gravel.
Juab	1,645,382	1,545,568	Clays, uranium ore, lead, fluorspar, zinc, stone, gem stones, barite, sand and gravel, silver, gold, copper.
Kane	6,583	8,082	Coal, gem stones.
Millard	113,192	149,779	Pumice, sand and gravel, gem stones, zinc, copper, gold, lead, silver.
Morgan	7,522,963	7,117,922	Cement, stone, sand and gravel, clays, lead, silver, zinc.
Piute	172,468	313,144	Uranium ore, zinc, silver, copper, gold, lead, gem stones.
Rich	1,100,277	2,235,102	Phosphate rock, sand and gravel.
Salt Lake	127,593,024	188,507,913	Copper, molybdenum, gold, lead, zinc, silver, salt, sand and gravel, cement, lime, stone, pyrites, gem stones, uranium ore.
San Juan [3]	[2] 139,400,805	121,937,967	Petroleum, uranium ore, LP gases, natural gas, natural gasoline, copper, sand and gravel, stone, silver, zinc, gold, lead.
Sanpete	169,683	138,482	Sand and gravel, salt, natural gas, clays.
Sevier	1,366,001	1,333,843	Gypsum, coal, clays, sand and gravel, salt, stone, uranium ore, gem stones.
Summit	3,585,336	4,756,976	Zinc, lead, silver, sand and gravel, copper, coal, gold, clays, stone, gem stones.
Tooele	4,045,749	6,095,561	Lime, potassium salts, salt, stone, clays, sand and gravel, zinc, lead, gem stones, silver, copper, gold, barite.
Uintah	[2] 23,882,371	26,879,151	Petroleum, gilsonite, natural gas, natural gasoline, stone, sand and gravel.
Utah	1,530,751	1,928,367	Stone, sand and gravel, lime, clays, gold, silver, copper, gem stones, lead, zinc.
Wasatch	1,887,102	2,439,739	Lead, zinc, silver, gold, copper, stone, sand and gravel.
Washington	62,846	92,854	Copper, stone, sand and gravel, petroleum, gem stones, zinc, lead, silver.
Wayne	28,924	[3] 5,593	Gem stones, uranium ore, copper, lead, silver.
Weber	569,162	586,008	Sand and gravel, clays.
Undistributed [4]	3,067,748	3,329,978	
Total [5]	[2] 373,515,000	431,396,000	

[1] Value of petroleum is preliminary.
[2] Revised figure. [3] Excludes vanadium. [4] Includes vanadium and some sand and gravel and gem stones. [5] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement and lime.

vately owned surface land. The corporation needed coking coal for its integrated steel plant being built at Niles, Calif. The privately owned surface lands acquired will be available for mine improvement, tipple, storage, trackage, and coke ovens if the corporation decides to conduct such operations in Utah.

Minerals Development Co., a subsidiary of Heiner Coal Co., acquired control of 2,400 acres of leased coal lands, one-half from Book Cliffs Coal Co. and one-half from Malcom McKinnon.

Natural gas from that portion of the Clear Creek field lying in Carbon County was marketed through pipelines. Carbon dioxide from the Farnham Dome field was transported by pipeline to a process-

ing plant at Wellington for conversion into dry ice and liquid carbon dioxide. A new gasfield, Stone Cabin, was discovered in August. The discovery well flowed 1.5 million cubic feet of gas a day from the Wasatch formation at depths of 3,949 to 3,967 and 4,260 to 4,274 feet.

Daggett.—Natural gas from 10 wells in the Clay Basin field was processed at the Mountain Fuel Supply Co. gasoline plant; the natural gasoline recovered was used as blending stock at refineries in Salt Lake City. Residual gas was marketed through company pipelines.

Duchesne.—Petroleum production from four fields was 14 percent below that of 1959. The principal producing field was the Duchesne. The Rock Creek and Starr Flat fields had been abandoned at yearend. One new unnamed field was discovered in January. The discovery well pumped 19 barrels of oil a day from an open hole in the Green River formation at a depth of 2,330 to 2,746 feet. Gilsonite was produced by Standard Gilsonite Co. at the Parriette mine.

Emery.—Emery County ranked second in the production of bituminous coal and uranium ore, the combined value representing 99 percent of the value of mineral production in the county. Forty-one percent of the output of bituminous coal was used at Utah steel plants for the manufacture of coke. Leading producers were Columbia-Geneva Steel at the Geneva mine in Carbon and Emery Counties, and United States Fuel Co. at the King mine, also in Carbon and Emery Counties. Minerals Development Co. acquired the Book Cliffs Coal Co. in November. The purchased property consisted of mine equipment, coal contracts, and 320 acres of coal lands adjoining those of U.S. Steel.

Natural gas produced from three wells in the Flat Canyon field and a portion of the Clear Creek field was marketed through pipelines.

Uranium ore, produced at 47 operations, was 39 percent above that of 1959. Major producers were Four Corners Oil & Minerals Co., Union Carbide Nuclear Co., Shattuck Denn Mining Corp., and Welch United Corp. The ore was shipped to processing plants in Utah and Colorado. Uranium ores in the Temple Mountain district contained a significant quantity of vanadium which was recovered from those ores processed at mills in Colorado.

Garfield.—Uranium ore, produced at 37 operations, accounted for 81 percent of the total value of mineral production in the county. The major producer in terms of value was Harold C. Ekker, with 11 operations in the Henry Mountains and Little Rockies districts. The ore was processed in Colorado where vanadium oxide contained in some of the ores also was recovered. Coal was produced by Twitchell-Munson Coal Co. at the Alvey mine.

Mine production of bentonite dropped to 850 tons in 1960 because of reduced activity at the American Mud & Chemical Corp. mine and plant near Cannonville. The county continued to rank second in the collection of gem and ornamental stones even though the total value dropped from $33,000 in 1959 to $14,000 in 1960; in both years petrified wood and agate were the principal stones in terms of value.

Grand.—Petroleum production from four fields was 56 percent above that of 1959. Major output was from the Big Flat field. Natural gas was produced at six wells in the Bar X field. Three new gasfields and a new producing horizon were discovered. The discovery well at the

Jim Creek field, completed in July, flowed 612,000 cubic feet of gas a day from the Morrison formation at a depth of 5,184 feet. At the Diamond Ridge field, discovered in February, the discovery well flowed 1 million cubic feet of gas a day from the Dakota sandstone at a depth of 7,254 to 7,284 feet. The Bryson Canyon field was discovered in October, and the discovery well flowed 6.1 million cubic feet of gas a day from the Dakota sandstone at a depth of 4,264 to 4,392 feet and 7.2 million cubic feet of gas a day from the Morrison formation at a depth of 4,403 to 4,476 feet. In the Stateline field, a well completed in April flowed 1.3 million cubic feet of gas a day from the Dakota sandstone at a depth of 3,859 to 3,896 feet and 2.5 million cubic feet of gas a day from the Cedar Mountain formation at a depth of 3,956 to 3,978 feet.

Uranium ore from 45 operations represented 79 percent of the total value of all mineral production in the county. Major production was by Union Carbide Nuclear Co. in the Polar Mesa district; Thornburg Mining Co. in the Seven Mile Canyon district; and Climax Uranium Co. in the Yellow Cat, Cane Canyon, and Polar Mesa districts. Nearly all the output was processed at plants in Colorado where a significant quantity of vanadium contained in the ore was recovered. Uranium Reduction Co. operated its 1,500-ton-a-day processing plant at Moab throughout the year. Some crude ore came from mines in the county; however, the greatest part was from mines in San Juan County.

Iron.—Shipments of iron ore from seven mines west of Cedar City in Iron County constituted the entire output of iron ore from Utah in 1960. The leading producer, Columbia Iron Mining Co., shipped ore from the Desert Mound and Iron Mountain mines. Utah Construction & Mining Co. mined and shipped iron ore from the Blowout, Comstock, and Duncan mines for CF&I. In addition, Utah Construction produced iron ore from its Excelsior (Iron Springs) mine. Utah Construction began construction of a $1.3 million iron ore treatment plant, the first in this area, to improve the quality of the ore and extend the ore reserves. Iron ore was shipped from the Alberts Nos. 1, 2, and 3 claims by Lambeth Bros., lessees for Helene E. Beatty. Iron ore shipments from Iron County increased 17 percent in quantity and 20 percent in value.

Coal production from three mines was 14 percent above that of 1959. Koal Kreek Coal Co. operated the Jones-Bulloch mine; Tucker Coal Co., the Tucker mine; and Webster Coal Co., the Webster mine.

Juab.—Nonmetals again contributed 75 percent of the value of mineral production. Halloysite from the Dragon mine of Filtrol Corp. headed the list of minerals. The ore produced from this property was shipped to the company's Salt Lake City plant for processing. The region around Delta supplied all of the metallurgical-grade fluorspar produced in Utah, and the county ranked first in the value of gem and ornamental stones collected. D. J. Garrick mined the bulk of the State output of barite from a property near Trout Creek.

Uranium ore from the Yellow Chief mine, operated by Topaz Uranium Co., was 27 percent greater than in 1959 and represented 18 percent of the total value of mineral production in the county. The entire output was processed at Salt Lake City.

Lead, zinc, gold, silver, and copper were recovered from lead-zinc ore produced from three mines. In addition, significant quantities of these metals were recovered from material shipped from the Godiva dump by the Godiva Mining and Milling Co.

Kane.—Most of the value of mineral production came from coal mined at the Smirl-Alton coal mine by W. J. Smirl. Recovery and sale of gem stones accounted for the remainder.

Millard.—Except for small quantities of zinc, lead, copper, silver, and gold, the $150,000 value of mineral output was supplied by nonmetals. In terms of value, pumice (scoria), from mines near Fillmore and Flowell by Christensen Construction Co., Central Utah Block Co., and Ralph Memmott, was the most important commodity. The construction of highways in the county stimulated an increase in the quarrying of sand and gravel. Obsidian, agate, and petrified wood gathered were valued at $4,800.

Morgan.—Principally because of a decline in cement shipments from the Devil's Slide plant of Ideal Cement Co., the value of mineral production decreased 5 percent from 1959. Declines in output were also recorded for limestone used in the manufacture of cement, clay used in the manufacture of brick and other heavy clay products, and sand and gravel used in highway construction.

Small quantities of lead, zinc, and silver were recovered from ore produced at the Morgan Argentine mine by Continental Exploration Co.

Piute.—Uranium ore from four mines operated by Vanadium Corp. of America represented 94 percent of the total value of mineral production in the county. The entire output was processed at Salt Lake City. Small quantities of gold, silver, copper, lead, and zinc were recovered from gold-silver and zinc ore produced from the Bully Boy and Deer Trail mines, respectively.

Rich.—Increased shipments of phosphate rock from the Bradley mine of San Francisco Chemical Co. doubled the value of mineral production in Rich County. Crude material from this property was transported to the company's Sage, Wyo., mill for upgrading. More intensive highway construction for the Utah State Road Commission resulted in increased output of sand and gravel.

Salt Lake.—Mineral production from Salt Lake County represented 44 percent of the total value of mineral output from the State. Copper production alone accounted for three-quarters ($139.4 million) of the $188.5 million value of mineral production in the county. A large part of the gold and silver and all of the molybdenum were recovered as byproducts of the treatment of copper ore. Copper production increased 51 percent in quantity and 58 percent in value, compared with 1959, mainly because from mid-August 1959 until late February 1960, a labor strike had idled the Utah Copper mining, milling, smelting, and refining complex, the county and State's leading copper producer. In 1960 the company completed a major addition to the powerplant at the Garfield smelter, began to modify the smelter operation, and began a spiral-haulage excavation in the company's open-pit mine.

The U.S. and Lark mine, second-largest copper, gold, and silver

producer and the largest lead and zinc producer in Utah, operated throughout the year. Lead-zinc ore from the mine was treated in the company Midvale mill. Lead concentrate was shipped to the International Smelting and Refining Co. Tooele plant and the Asarco East Helena (Mont.) plant; zinc concentrate went to the Anaconda (Mont.) plant. In addition, gold-silver ore from the mine was shipped directly to the International Smelting Tooele plant. United States Smelting Refining and Mining Co. also shipped zinc slag from the Midvale smelter dump to the Tooele plant and treated custom ore purchased by the company and by International Smelting at the Midvale mill. In its Tooele plant, International Smelting treated zinc slag produced from the Murray smelter dump. Some lead-zinc ore produced from the Wasatch Drainage Tunnel by Cardiff Industries, Inc., was treated in the Midvale mill and some was shipped directly to the Tooele smelter.

Nonmetals continued to supply products necessary for construction and the production and processing of metals. The county was the major source of sand and gravel for residential and industrial construction. Cement produced by Portland Cement Co. of Utah was a significant factor in the construction activity of the mineral industry. A substantial quantity of limestone was quarried and used in manufacturing of cement and lime. The need for large amounts of lime stemmed from the use of lime in the processing of copper ores. Great Salt Lake was the principal source of salt in Utah, and solar-evaporation facilities made Salt Lake County the leading producer. A small quantity of byproduct pyrite was shipped to Garfield for the manufacture of sulfuric acid.

Oil refineries in the Salt Lake City area operated the entire year. Throughput was 31.2 million barrels of crude oil, an increase of 3 percent over that of 1959. A fire and explosion in the catalytic cracking unit of the Utah Oil Refining Co. 35,700-barrel-a-day refinery at Salt Lake City caused damage to the unit estimated at $250,000. Two workmen were killed and two injured. The removal of a valve that released hot oil onto pipes carrying crude oil heated to 900 degrees started the fire and resulting explosion that took seven Salt Lake City fire companies 4 hours to extinguish.

The 600-ton-a-day uranium processing plant of Vitro Chemical Co. at Salt Lake City operated the entire year. In October the operating rate was reduced to 500 tons of ore a day to establish a more economical operating rate until March 31, 1962, when the contract for the purchase of uranium oxide concentrate by AEC was to expire. Negotiations with AEC continued for a purchase contract for 1962–66.

San Juan.—San Juan County led in the production of petroleum, natural gas, natural gas liquids, uranium ore, and vanadium. Production of petroleum from 618 wells in 17 fields was 9 percent below that of 1959. The decline was almost entirely in the Aneth, Ratherford, and White Mesa fields in the Greater Aneth area. Notable gains were recorded in the McElmo, Cahone Mesa, and Recapture Creek fields. The need for secondary recovery operations in the Aneth area had been studied for a considerable period. Primary methods will recover an estimated 16 to 18 percent of the original oil reserve; water flooding

and repressuring with gas over a period of 11 to 15 years would increase the recovery to about 30 percent at a cost of $12 to $14 million. One secondary-recovery unit in the McElmo Creek field was formed by Humble Oil and Refining Co. estimated to cost from $3 to $4 million. Other units were to be formed and plans were considered for 4 units consisting of 500 wells and 50,000 producing acres.

The No. 1 Northwest Lisbon well, completed on January 4, was aptly described by some as the "well of the year." The discovery well flowed 587 barrels of oil a day at a depth of 8,251 to 8,348 feet from the McCracken (Devonian) formation, and the first in the State from Devonian. A second well, completed in June, flowed 272 barrels of oil a day and 686,000 cubic feet of gas a day from Mississippian formations at a depth of 8,767 to 8,830 feet. This well established the importance of Mississippian formation in the field and was followed by other completions, one of which flowed 1,288 barrels of oil and 2.8 million cubic feet of gas a day. Other discoveries included a well southwest of the Ismay field that pumped 14 barrels of oil a day, one in the Gothic Mesa area that flowed 98 barrels of oil a day from the Paradox formation, and a third to the west that pumped 14 barrels of oil a day from the Hermosa formation. At yearend a well at Anido Creek, 7 miles south of the White Mesa-Aneth area and 8 miles northeast of the Boundary Butte field in Arizona, was nearing completion. Details of the rate of recovery were not available, but a substantial flow was reported.

Development drilling was done in and around the Greater Aneth area fields. In the White Mesa-Southern McElmo Creek area, 33 successful wells were completed; to the north in the Aneth-McElmo Creek-Recapture Creek area, 26 were completed; and in the Ismay field, the most easterly in the Utah portion of the Paradox basin, 13 were completed. These completions made the effective length of the field nearly 5 miles.

Oil-well gas from the Greater Aneth area was processed at the El Paso Natural Gas Co. 100-million-cubic-foot-a-day gas plant at Aneth. Natural gas liquids were separated at the company Wingate fractionation plant in New Mexico. Residual gas was marketed through pipelines to consumers in California.

Uranium ore from 170 operations was 15 percent below that of 1959. The average grade of ore shipped declined from 0.37 percent U_3O_8 (7.4 pounds per ton) to 0.31 percent (6.2 pounds per ton) in 1960. Major producers included The Hidden Splendor Mining Co., Standard Metals, Homestake Mining Co., Utex Exploration Co., Inc., Texas-Zinc Minerals Corp., and Hecla Mining Co. The ore was processed in mills at Mexican Hat, Moab, Salt Lake City, and in southwestern Colorado. Ores containing significant quantities of vanadium were processed at mills in southwestern Colorado where the vanadium was recovered. Texas-Zinc Minerals Corp. operated its 1,000-ton-a-day uranium ore processing plant at Mexican Hat and recovered concentrate containing gold, silver, copper, lead, and zinc as a byproduct of some San Juan County uranium ores.

Sanpete.—Clays, salt, and sand and gravel accounted for 86 percent of the total value of Sanpete County mineral production. Cox Bros.;

Hales Sand & Gravel; and De Mar W. Brimhall Construction, contractors for the State highway department; and construction crews of Ephrain City Corp. mined 181,500 tons of building and paving gravel. A salt deposit near Redmond was worked by Morton Salt Co. (formerly Royal Crystal Salt Co.). From a deposit near Sterling, Azome Utah Mining Co. recovered clay for use as a soil conditioner and for poultry feed.

Dry natural gas produced at Joe's Valley field by Three States Natural Gas Co. was 59 percent below that of 1959. The gas was marketed through pipelines.

Sevier.—Seventy-eight percent of the value of mineral output in Sevier County resulted from the production and sale of nonmetals. The extraction and calcining of gypsum near Sigurd accounted for most of the value. United States Gypsum Co. and Bestwall Gypsum Co., the mine producers, operated wallboard plants in conjunction with their mines. Fuller's earth and bentonite were mined and processed by Western Clay & Metals Co. Poulson Bros. Salt. Co. produced rock salt. Coal production from the Southern Utah Fuel Co. No. 1 mine was 4 percent more than that of 1959. Uranium ore from the Helms mine was shipped to plants at Salt Lake City and Moab for processing.

Summit.—The value of gold, silver, copper, lead, and zinc output represented $4.2 million (88 percent) of the $4.8 million combined value of all minerals produced in the county. The United Park City mines operated by United Park City Mines Co. and block leasers was the leading producer. To reduce the cost of operation, the company eliminated overtime pay by switching its employees from a 48-hour week to a 40-hour week and issued small block leases in fringe areas that could not be economically worked by the company's using normal operating procedures. United Park City and Keystone Mining Co. conducted a joint exploration and development program at the Keystone mine, and lead-zinc ore recovered as a result of this work was treated at the United States Smelting Midvale mill. McFarland & Hullinger, lessees, shipped fluxing material from the Daly mine dump, owned by United Park City Mines Co., to the Utah Copper Garfield copper smelter.

Coal production, all from the Chappel Coal Co., was 9 percent above that of 1959.

Tooele.—The mineral industry of Tooele County continued to set records in 1960. Production of nonmetal mineral products accounted for 99 percent of the $6.1 million value of mineral output. The county ranked first in shipments of lime, second in salt production, third in quarrying of clays, and was the only source of potash in the State. Limekilns were in use at The Utah Lime and Stone Co. and Utah Marblehead Lime Co. operations. The latter plant produced the only dead-burned dolomite in the Rocky Mountain region. Salt for industrial and human consumption was harvested at solar-evaporation facilities of Leslie Salt Co. and Solar Salt Co. Utah Salt Co. recovered byproduct solar-evaporation salt from the brine ponds of the Bonneville, Ltd., potash operation. Large quantities of limestone and

dolomite were mined for use in manufacturing lime, and United States Smelting Refining and Mining Co. recovered oolitic limesand at Stansbury Island.

International Smelting and Refining Co. reclaimed cold slag from the Tooele lead smelter dump and treated it in its zinc-fuming plant primarily to recover zinc; however, some silver, copper, and lead also were recovered. International Smelting treated State and out-of-State custom ores, concentrates, and materials in its lead smelter and zinc-fuming plant at Tooele. McFarland & Hullinger conducted development work at the Ophir Unit mine, owned by United States Smelting Refining and Mining Co., and shipped lead-zinc ore produced to the United States Smelting Midvale mill for treatment. Shipments of small lots of gold, lead, and lead-zinc ores, each less than 100 tons, were made from seven other mines.

Uintah.—Petroleum production from 172 wells in 5 fields was 16 percent above that of 1959. Notable increases were recorded at the Ashley Valley and Red Wash fields. Five new gasfields were discovered. The discovery well at the White River field, completed in November, flowed 1.25 million cubic feet of gas a day from the Wasatch formation at a depth of 6,422 to 6,432 feet. The Coyote Wash field was discovered in January. The discovery well flowed 325,000 cubic feet of gas a day from the Wasatch formation at a depth of 4,888 to 5,004 feet. A well, 5.5 miles southwest of the discovery well in the Uintah Unit, discovered in 1959, was completed in May and flowed 2.2 million cubic feet of gas a day from the Wasatch formation at a depth of 5,061 to 5,606 feet. The Rock House field, 5.5 miles south of the Southman Canyon field, was discovered in October. The discovery well flowed 12.5 million cubic feet of gas a day from the Wasatch formation at a depth of 4,144 to 5,008 feet, and 900,000 cubic feet of gas a day from the Mesaverde at a depth of 5,362 to 5,382 feet. The Fence Canyon field, 10 miles northwest of the Westwater field in Grand County, was discovered in April. Initial flow of the discovery well was 5.2 million cubic feet of gas a day from the Dakota sandstone at a depth of 8,544 to 8,580 feet.

Development drilling was confined largely to the Red Wash-Walker Hollow area where 25 oil wells and 1 gas well were completed. In the Chapita Wells field, six gas wells were drilled. Two gas wells were drilled in the Ute Trail field and one in the Ashley Valley field.

California Oil Co. operated its natural-gas plant in the Red Wash field and recovered natural gasoline that was used as a blending stock at refineries in the Salt Lake City area. Residual gas was marketed through pipelines. Standard Oil Co. of California began the construction of a 40-million-cubic-foot-a-day natural-gas plant in the Red Wash field. The natural gas liquids recovered were to be used at the Standard Oil Co. refinery at Salt Lake City and the residual gas were to be sold to pipeline companies for distribution to consumers.

Gilsonite mined at the Bonanza mine by American Gilsonite Co. and at the Little Bonanza, Little Emma, and Warner-Quinlan mines by G. S. Ziegler & Co. and contractors was slightly above that of 1959. American Gilsonite Co., the major producer, further improved its mining method using high-pressure hydraulic nozzles suspended

through vertical drill holes from the surface to a drift at the bottom of the 1,600-foot shaft. Water, delivered at a pressure of 2,500 pounds per square inch to the nozzles suspended through the drill holes, removes the gilsonite as the nozzles are slowly rotated. The broken gilsonite falls to the floor of the drift where it is transported to the shaft by a stream of low-pressure water; after crushing it is pumped to the surface. The method eliminates the necessity of men working along the underground faces and requires no timber. The crushed and sized gilsonite was pumped to the surface and transported through a 72-mile pipeline to the refinery near Fruita, Colo., where it was processed to recover gasoline, diesel fuel, and metallurgical coke.

Utah.—Clay mining operations were reduced from seven to six in 1960; clay output declined 51 percent. Clay mines operating at a substantially lower rate of production were the North and Northeast pits of Loyd R. Stubbs, Fawn mine of Western Fire Clay Co., Powell mine of Interstate Brick Co., No. 24 pit of United Brick Co., and the Clinton property of Utah Fire Clay Co. The Keigley quarry of U.S. Steel and the Lakeside pit of Lakeside Lime & Stone Co. produced 48 percent more limestone. Stone from the Keigley mine was used almost entirely as a flux at the U.S. Steel iron smelter, and the Lakeside stone was calcined to produce quicklime and hydrated lime.

The entire output of gold, silver, copper, lead, and zinc came from gold-silver ore produced at two operations. G. Wm. Wortley, lessee, recovered material from the Eureka Standard dump, owned by Eureka Standard Consolidated Mining Co., and shipped it to the Utah Copper Garfield copper smelter. A small quantity of ore was produced and marketed from Tintic Standard Mining Co. Iron Blossom mine by Glen Larsen, lessee.

Wasatch.—Except for small quantities of sand and gravel and stone, the entire mineral production in the county comprised gold, silver, copper, lead, and zinc recovered from copper and lead-zinc ores at the Mayflower-Galena and United Park City mines. All of the ore from the Mayflower-Galena mine (owned by New Park Mining Co.) was produced by the Mayflower Lease consisting of an average of 94 professional miners working as independent contractors. New Park continued an exploration and development program begun at this mine in 1958 with financial assistance under DMEA, administered by OME. The program provided for 6,000 feet of drifting west of the shaft, 2,600 feet of crosscutting, 11,000 feet of diamond drilling, and 20,000 feet of long-hole drilling. The contract provided for participation by the Federal Government to the extent of 50 percent of the $564,880 estimated cost.

Part of the United Park City Mines Co. operation at the United Park City mines (described under Summit County) is in Wasatch County. Ore produced from the section of the mine in Wasatch County was credited to Wasatch County.

Washington.—Emerald L. Cox shipped crude copper ore containing small quantities of silver, lead, and zinc from the Apex mine to the Asarco El Paso (Tex.) copper smelter. Other mineral products from the county included sand and gravel and crushed sandstone (for use

in highway construction), gem stones (gathered by collectors and dealers), and petroleum (all from the Virgin field).

Wayne.—Uranium ore produced from the Big Jim and Congress mines was shipped to mills in Colorado for processing. The ore contained a significant quantity of vanadium, which was recovered. Gem stones were collected by "rock hounds" and dealers. A small shipment of copper ore containing small quantities of silver, lead, and zinc was made from the Osborn mine to the International Smelting Tooele plant.

Weber.—Most of the value of mineral output came from sand and gravel produced for building and highway construction. Miscellaneous clay production, all from the Harrisville Brick Co. operation at Harrisville, was comparable with that of 1959.

615629—61——67

The Mineral Industry of Vermont

By James R. Kerr [1]

THE VALUE of Vermont's mineral output in 1960 decreased 2 percent because of the cessation of crushed-slate production. Greatly increased output of other stone, particularly crushed limestone for the construction of the new U.S. Route 2 from Montpelier to Burlington, did not offset the loss of the higher unit-priced slate. Sand and gravel production decreased 22 percent; that of other commodities remained relatively stable.

Rutland County, with its valuable marble and slate deposits, led in value of mineral production. Washington and Orleans Counties followed, with granite and asbestos, their leading minerals, respectively.

TABLE 1.—Mineral production in Vermont [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	(2)	$1	(2)	$1
Sand and gravel short tons	2,320,327	1,590	1,809,152	1,218
Stone do	944,298	17,372	2,114,377	17,444
Value of items that cannot be disclosed: Asbestos, clays, lime, talc		4,420		4,240
Total Vermont [3]		23,359		22,879

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Total adjusted to eliminate duplicating value of stone.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Production of chrysotile asbestos continued at virtually the same rate as during the previous year. Shipments were of 25 grades with selling prices ranging from $30 to $440 per ton and averaging $90.91 per ton compared with $95.66 per ton in 1959.

Clays.—Production of miscellaneous clay, chiefly for building brick, remained at the same rate as in 1959. Mine development and mill

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.

construction for a new clay operation continued at Monkton in Addison County.

Gem Stones.—Collectors and gem dealers obtained specimens of jasper, graphite, talc, and garnet at scattered locations throughout the State.

Lime.—Production of quicklime and hydrate lime, chiefly for chemical and other industrial uses, continued at virtually the same rate as in 1959.

Mica, Reconstituted.—Specially delaminated mica scrap was used by the Samica Corp. (subsidiary of Minnesota Mining & Manufacturing Co.) to produce reconstituted mica at Rutland.

Sand and Gravel.—Commercial production of sand and gravel decreased 15 percent chiefly due to a 34-percent decrease in production of gravel for paving uses. Paving sand output decreased at a much smaller rate, indicating the substitution of crushed stone for gravel in some paving applications and pointing to the completion of the road-base segment of many projects. Building sand and gravel output increased 31 percent. The average value of sand and gravel increased $0.11 to $1.05 per ton. The percentage of commercial output washed, screened, or otherwise prepared increased 16 percent to comprise 79 percent of total output substantiating the significant increase in price per ton.

Production of Government-and-contractor sand and gravel as reported by the Vermont State Highway Department decreased 28 percent in 1960. Production was reported from all 14 counties but in most cases on a smaller scale than 1959, indicating the completion of some projects. Chittenden, Grand Isle, and Washington Coun-

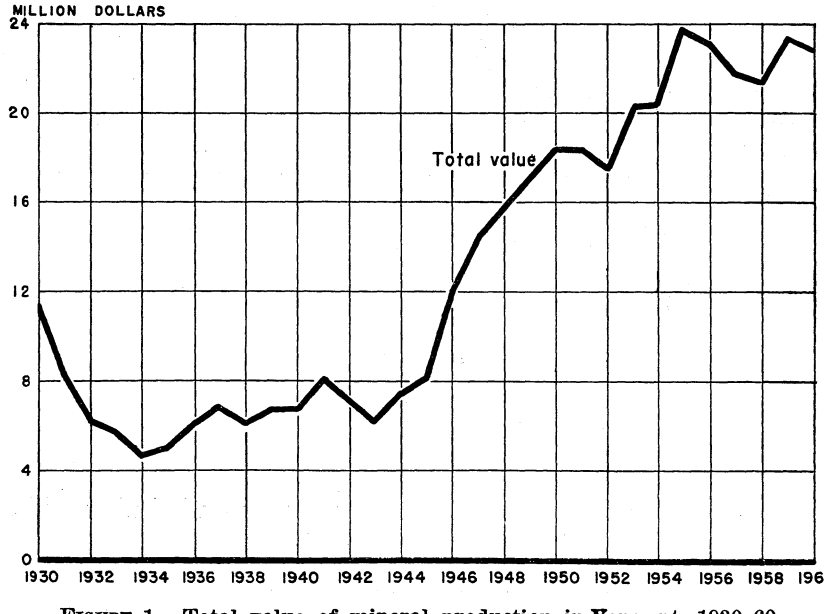

FIGURE 1.—Total value of mineral production in Vermont, 1930–60.

ties reversed the Statewide trend. Greatest activity by far was in Chittenden County where construction of the new U.S. Route 2 was in progress. Government-and-contractor operations are not summarized in the individual county reviews but are listed in table 2.

TABLE 2.—Sand and gravel production by Government-and-contractor operations, by counties

(Short tons)

County	1959	1960	County	1959	1960
Addison	88,945	76,222	Orange	61,211	5,800
Bennington	163,971	38,574	Orleans	115,676	2,900
Caledonia	13,880	12,406	Rutland	250,688	64,765
Chittenden	----------	229,194	Washington	95,732	145,096
Essex	122,186	37,519	Windham	86,730	57,763
Franklin	14,700	11,284	Windsor	143,938	76,017
Grand Isle	----------	63,497	Unspecified	----------	79,911
Lamoille	98,845	7,250	Total	1,256,502	908,198

Stone.—The closing of all slate operations by Central Commercial Co. on December 31, 1959, and the subsequent dismantling of plants resulted in a loss of more than $1 million in the mineral income of the State. Tripled output of crushed limestone for roadbuilding purposes, because of its low unit value, did not offset this loss. Output of dimension granite increased because of a 4-times-greater output of rough architectural building stone. Production of rough monumental stone, comprising 90 percent of total granite output, decreased 7 percent. Output of dimension marble and slate remained relatively stable. Output of crushed sandstone and miscellaneous stone (serpentine) was reported by the State highway department for highway construction.

Talc.—Output of talc declined slightly following a 2-year rise. The No. 2 Waterbury mine of Eastern Magnesia Talc Co., Inc. ceased operations on December 27. The Ward Hill mine of this company reported only drilling and exploration work. Talc was ground and consumed chiefly in roofing, rubber, and paper.

REVIEW BY COUNTIES

Addison.—Vermont Associated Lime Industry quarried limestone for concrete aggregate and lime manufacture at New Haven. Lime was sold for chemical, industrial, and building uses. Vermont Kaolin Corp. did not commence operations at Monkton as expected but spent the year in mill construction and mine development.

Bennington.—William E. Daily produced building and paving sand and gravel, and Burgess Bros. produced fill sand and gravel at a portable crusher near Bennington.

Caledonia.—Paving sand and gravel was produced by the Caledonia Sand & Gravel Co., Inc. at a portable plant at St. Johnsbury. The Vermont State Highway Department produced serpentine for roadstone uses.

Chittenden.—Sand and gravel used mostly for building and paving was produced at five operations, the leading of which were Cass

Warner at Essex Junction and W. C. Kirby at Burlington. Vermont Associated Lime Industries, Inc. quarried limestone just outside the city limits of Winooski for agricultural limestone and for lime manufacture. The company was installing a continuous hydrator at Winooski to replace an outdated facility at New Haven where the Winooski lime output had been sent for hydration. Other construction planned by the company included an additional fine crusher to augment the pulverizing facilities for agstone and an additional primary crusher in the quarry which will greatly boost capacity. The Vermont State Highway Department produced over 500,000 tons of crushed limestone for construction of the new U.S. Route 2 Thruway. In addition, Rowe Contracting Co. and L. A. Demers Crushed Rock Co. produced crushed limestone chiefly for this highway project. The Drury Brick Co., Inc. mined miscellaneous clay from an open pit near Essex Junction for manufacturing building brick.

TABLE 3.—Value of mineral production in Vermont, by counties

County	1959	1960	Minerals produced in 1960 in order of value
Addison	$168,220	(1)	Stone, lime, sand and gravel.
Bennington	(1)	(1)	Sand and gravel.
Caledonia	(1)	(1)	Sand and gravel, stone.
Chittenden	394,524	$1,372,177	Stone, sand and gravel, lime, clay.
Essex	(1)	51,471	Sand and gravel.
Franklin	(1)	(1)	Stone, sand and gravel.
Grand Isle	(1)	(1)	Do.
Lamoille	(1)	(1)	Talc, sand and gravel.
Orange	907,515	(1)	Stone, sand and gravel.
Orleans	(1)	(1)	Asbestos, sand and gravel, stone.
Rutland	11,203,619	9,746,755	Stone, sand and gravel, clay.
Washington	(1)	(1)	Stone, sand and gravel, talc.
Windham	491,842	264,608	Do.
Windsor	321,141	392,942	Do.
Undistributed	9,872,425	[2] 11,026,918	
Total	23,359,000	22,879,000	

[1] Figure withheld to avoid disclosing individual company confidential data; included with undistributed.
[2] Includes gem stones and some sand and gravel that cannot be assigned to specific counties, and values indicated by footnote 1.

Essex.—A. Booska produced sand and gravel for paving.

Franklin.—The Swanton Lime Works, Inc., quarried limestone at Swanton and produced crushed stone, chiefly for roadstone, agstone, papermills, and mineral food. S. H. Evanson produced sand at a stationary plant near Swanton, chiefly for building, but also for grinding and engine sand. Ray Dubois produced a small tonnage of sand for use on icy roads.

Grand Isle.—The Vermont Marble Co. quarried marble at the La Motte quarry at Isle La Motte on an island in Lake Champlain.

Lamoille.—Eastern Magnesia Talc Co., Inc., mined crude talc near Johnson for grinding at the company mill. Ground output was sold for roofing, paper, and paint. A small quantity of crude talc was shipped to a foundry in Ohio. Albert Nadeau produced paving sand and gravel at a portable plant near Johnson, and Kenneth Farr produced sand and gravel for a variety of uses at Elmore.

Orange.—Dimension granite for rough monumental stone was quarried by the Rock of Ages Corp., Pirie Division, near Williamstown. Willard Martin produced paving gravel at a portable plant near Bethel, and Levi Lemieux produced miscellaneous sand and gravel at a stationary plant near Barre Town.

Orleans.—Vermont Asbestos Mines, Div. of the Ruberoid Co., mined and processed chrysotile asbestos at the Lowell quarry and mill. Twenty-five grades of asbestos were sold at varying prices, dependent on length and quality of fibre or other controlling feature. Paving sand and gravel was produced at a stationary plant near Danville by H. G. Calkins. Harry Jipner produced paving gravel.

Rutland.—Dimension marble was quarried at five locations and processed at four mills in the county by Vermont Marble Co. The Green Mountain Marble Co., Division of Georgia Marble Co., operated an underground quarry and mill at West Rutland. Central Commercial Co., the leading slate producer in the State in 1959, ceased operations at the end of 1959 and was dismantling its plants in 1960. No crushed slate was produced. Dimension slate was produced at 18 operations of Vermont Structural Slate, Hilltop Slate Co., Taran Brothers Inc., John Hadeka, and Culvert Slate Co., Inc., in decreasing order of value of production. Structural and sanitary uses and flagging were chief uses of slate. White Pigment Corp. produced crushed limestone at the Florence quarry for whiting and miscellaneous uses such as flooring, plastics, wire drawing, and fabrics. Vermarco Lime Co. produced crushed limestone, chiefly for roadstone and agstone, at the Loveland quarry at Florence. Sand and gravel was produced at four plants, principally for building and paving uses. Vermont Marble used its sand production in sawing marble. Rutland Fire Clay Co. continued to use material from its miscellaneous clay stockpile to produce fire-clay mortar.

Washington.—The Rock of Ages Corp. produced rough monumental granite at the Graniteville quarry (Graniteville), the Wetmore and Morse quarries (Barre), and E. L. Smith quarry (Barre). Charles A. Pellette (Barre) and Wells Lamson Quarry Co., Inc. (Websterville) also produced rough monumental granite. The latter company also produced crushed granite for roadstone. Eastern Magnesia Talc Co. completed operations at the Waterbury mine in December 1960. The exploration work at the company's Ward Hill mine at Waterbury did not prove profitable and was stopped. Sand and gravel, chiefly for building and paving, was produced at five plants, the largest of which was Kings Pit near Barre.

Windham.—Vermont Talc Co. produced talc near Windham for grinding at its mill at Chester, Windsor County. Output was used chiefly in insecticides, roofing, and paper. Brattleboro Sand & Gravel Co., Brattleboro, and West River Sand & Gravel Co., West Townshend, produced paving sand and gravel.

Windsor.—Vermont Marble Co. produced dimension and crushed marble at the Rochester quarry. Barre Building Granite Corp. produced dimension marble for rough architectural building uses plus a small tonnage for riprap. Eastern Magnesia Talc Co. mined talc near Reading for grinding at its mill at Chester. The ground talc

was used for roofing. The company reported no operation at the Gassets mill and Hammondsville mine during 1960. Vermont Concrete Pipe produced building and paving sand and gravel at a stationary plant near Windsor, and Colonial Sand & Gravel produced paving sand and gravel near Sharon.

The Mineral Industry of Virginia

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources.

By Robert W. Metcalf,[1] James L. Calver,[2] and Stanley A. Feitler [1]

ALTHOUGH the value of Virginia's mineral output declined 8 percent to $204 million, it was the fourth highest year on record, surpassed only by 1959, 1957, and 1956. Most commodities declined in both quantity and value, but tonnage of clays and stone both established records. Increased activity in the stone industry was chiefly due to the continued road improvement and highway construction in many parts of the State. Production of iron oxide

TABLE 1.—Mineral production in Virginia [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----thousand short tons--	1,346	$1,397	1,348	$1,395
Coal----do----	29,769	139,224	27,838	122,723
Gem stones----	(2)	4	(2)	5
Lead (recoverable content of ores, etc.)----short tons--	2,770	637	2,152	504
Lime----thousand short tons--	765	8,168	711	8,028
Manganese ore (35 percent or more Mn) short tons, gross weight--	6,232	499	----	----
Mica, sheet----pounds--	108	1	103	1
Natural gas----million cubic feet--	2,280	597	2,227	604
Petroleum (crude)----thousand 42-gallon barrels--	6	(3)	[4] 6	(3)
Sand and gravel----thousand short tons--	8,452	12,369	7,666	11,432
Silver (recoverable content of ores, etc.)---troy ounces--	866	1	----	----
Stone----thousand short tons--	17,787	31,447	[5] 19,358	[5] 33,019
Zinc (recoverable content of ores, etc.) [6]---short tons--	20,334	4,662	19,885	5,142
Value of items that cannot be disclosed: Aplite, portland cement, masonry cement, feldspar, gypsum, iron ore (pigment material), kyanite, manganese ore, ferruginous (10 to 35 percent Mn, 1959), pyrites, salt, soapstone, titanium concentrate (ilmenite and rutile), and values indicated by footnote 3----	----	[7] 28,848	----	25,958
Total Virginia [8]----	----	[7] 222,501	----	203,819

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Weight not recorded.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.
[5] Final figure; supersedes figure given in commodity chapter.
[6] 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.
[7] Revised figure.
[8] Total adjusted to eliminate duplicating value of clays and stone.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] State geologist, Virginia Division of Mineral Resources, Charlottesville, Va.

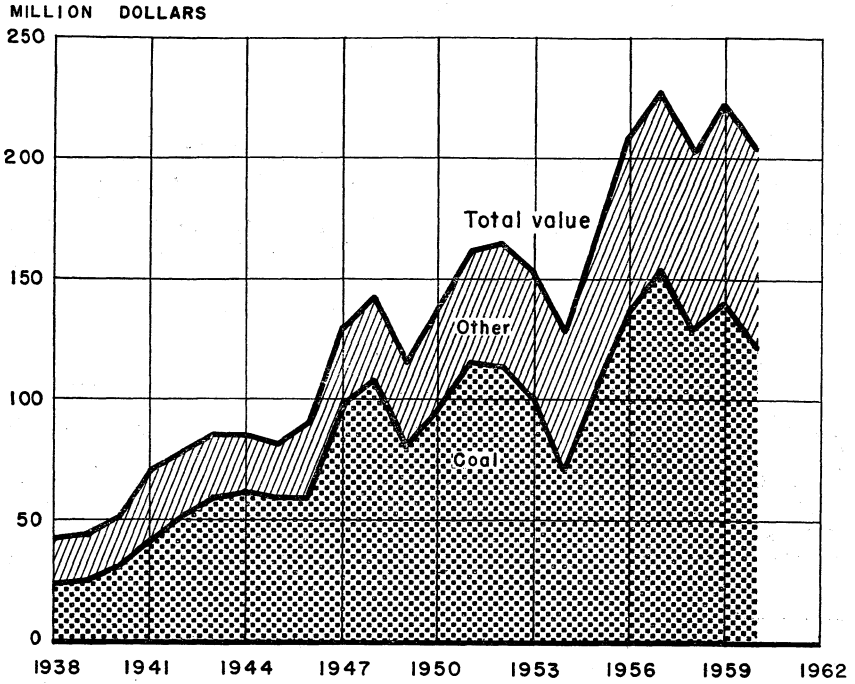

FIGURE 1.—Value of coal and total value of mineral production in Virginia, 1938–60.

pigments and soapstone also were higher than in 1959. All other minerals, including metals and nonmetals, decreased from 2 percent to more than 30 percent. Bituminous coal, the leading commodity in terms of both quantity and value, declined 6 percent in tonnage and 12 percent in value. Output of lead was 22 percent less than in 1959, chiefly due to a 4-month strike. Production of zinc decreased only 2 percent. Of the commodities used extensively by the construction industries, sand and gravel decreased 9 percent, portland cement 15 percent, and gypsum 16 percent.

The chief minerals, in order of value of production, were coal, stone, cement, sand and gravel, and lime. The value of fuels comprised 60 percent of the total value of mineral production in the State (63 percent in 1959). The value of nonmetals accounted for 37 percent of the total, and the value of metals, 3 percent.

Employment and Injuries.—Injury frequency in selected metal and nonmetal industries (excluding coal) was less than in 1959. No fatalities were reported in the metal and nonmetal classifications, compared with two in 1959. Nonfatal injuries declined markedly except for clay mines. Of the 24 coal mine fatalities reported in 1960, 22 were underground and 2 were at associated surface facilities. One of the surface fatalities was a haulage accident, and the second was by a miscellaneous cause. Fourteen of the underground fatalities were due to falls of roof, and two to falls of face, rib, or pillar; three

were underground haulage accidents, two were caused by electricity, and one was caused by machinery. These data reemphasize the danger of falls of rock and point to the need for increased safety programs.

TABLE 2.—Employment and injuries for selected mineral industries

Industry	Average number of men working	Total man-hours	Total number of lost time injuries		Number of injuries per million man-hours	
			Fatal	Nonfatal	Fatal	Nonfatal
1959:						
Coal mines	14,139	22,386,900	22	1,022	.98	45.65
Metals [1]	471	838,338	----	32	----	38.17
Clay mines [2]	71	123,312	----	----	----	----
Nonmetal mines [3]	282	584,342	1	5	1.71	8.56
Quarries and mills [4]	3,288	7,151,755	2	222	.28	31.04
Sand and gravel [5]	622	1,390,167	----	31	----	22.30
1960: [6]						
Coal mines	(7)	(7)	24	(7)	(7)	(7)
Metals [1]	416	689,222	----	25	----	36.27
Clay mines [2]	68	127,908	----	2	----	15.64
Nonmetal mines [3]	211	420,365	----	4	----	9.52
Quarries and mills [4]	3,628	7,511,422	----	172	----	22.90
Sand and gravel [5]	535	1,100,823	----	15	----	13.63

[1] Includes mine and mill data and officeworkers.
[2] Excludes mill data and officeworkers.
[3] Excludes clay mines, also nonmetal mill and officeworkers.
[4] Includes cement and lime plants having no quarry operations; excludes officeworkers.
[5] Excludes officeworkers.
[6] Preliminary data.
[7] Data not available.

Trends and Developments.—Continued active interest in raw materials for road construction was particularly evident in Virginia because of the new and improved highway-building program. A new publication on highway construction materials described deposits and producing areas of stone and sand and gravel according to the geological provinces in which they occur.[3] A brief account of the geology and physical test data is given to enable prospective producers to determine the suitability of a particular material for construction purposes. Additional evidence of the interest in Virginia mineral and water resources was shown in a study of the structural history of the rocks in the Lexington area[4] and a description and detailed tabulation of well-log data in Albermarle County.[5]

The increased demand for sand and gravel and stone for aggregate resulted in new and enlarged raw materials plants, particularly plants for quarrying and processing stone for use in road and highway construction. The Lower Chesapeake Bay Bridge-Tunnel near Norfolk will bring about a large consumption of aggregate and riprap in that area.

Legislation and Government Programs.—Small amounts of mica were purchased from miners in Amelia County for the national stockpile.

[3] Gooch, Edwin C., Wood, Robert S., and Parrott, William T., Sources of Aggregate Used in Virginia Highway Construction: Virginia Division of Miner. Res., Min. Res. Rept. 1, Charlottesville, Va., 1960, 65 pp.
[4] Bick, K. F., Geology of the Lexington Quadrangle, Virginia: Virginia Division of Miner. Res. Rept. of Investigation 1, Charlottesville, Va., 1960, 40 pp.
[5] Cross II, Whitman, Water-Well Data, Western Part of Albemarle County: Virginia Division of Miner. Res. Inf. Circ. 2, Charlottesville, Va., 1960, 18 pp.

The mica was purchased by the Government through the General Services Administration (GSA), Spruce Pine (N.C.) and Franklin (N.H.) Materials Purchase Depots. Government buying of metallurgical manganese ore of 35 percent or more manganese content under the Defense Production Act carlot purchase program was discontinued in August 1959. Small shipments only were made after that date to complete contracts in effect.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal.—Virginia ranked sixth among coal-producing States. Coal mined in Virginia totaled 27.8 million short tons, 6 percent less than in the 1959, peak year. Value of coal production also declined (12 percent) from 1959 resulting in a 6-percent drop in average value per ton. The value of coal production represented 60 percent of the total mineral valuation of the State. A wide variety of coals were mined and prepared for domestic and industrial use, low- and high-volatile coals as well as a small quantity of semianthracite consumed in domestic heating. Eight counties contributed to the coal output, although four of these—Buchanan, Dickenson, Wise, and Russell—accounted for 91 percent of the total tonnage. Output of strip and auger coal was 8 and 9 percent less, respectively, than in the preceding year. Production from underground mines was nearly 1.5 million tons less than in 1959. The total number of mines was 1,268, only 10 mines less than in 1959. Of these, 1,201 were deep mines, 35 were strip operations, and 32 were auger mines. Slightly more than half the total underground output was loaded mechanically, and 88 percent of the mechanically loaded tonnage was loaded by 160 mobile loading machines, 10 more machines than in 1959. Most of the remainder was cut and loaded by 17 continuous mining machines. In addition a small tonnage was hand-loaded on face or room conveyors. Equipment used at the underground mines included 955 cutting machines, 1,343 handheld and postmounted coal drills, 20 mobile drills, and 117 roof and rock drills. Deep-mine haulage consisted of 489 animals, 657 trolley locomotives, 367 battery locomotives, and 38 other locomotives. Intermediate haulage was by 238 cable-reel and 3 battery shuttle cars and by 57 portable and 7 stationary rope hoists. There also were 54 mother conveyors averaging 1,935 feet in length.

Mechanical methods cleaned 48 percent of the total production. Most of the coal was cleaned by wet-washing methods other than jigs. Twenty-eight cleaning plants were active. Tonnage crushed comprised 31 percent of the total, compared with only 17 percent in 1959. Dust-allaying and anti-freezing preparations, mostly oil and combinations of calcium chloride and oil, treated 12 percent of the tonnage, compared with 9 percent in 1959.

Equipment used at stripping operations included 66 power shovels (mostly less than 3-cubic-yard capacity), 4 carryall scrapers, 40 bulldozers, 13 horizontal and 6 vertical overburden drills, and 67 trucks of 10-ton average capacity. Equipment at auger mines included 31

augers, 27 bulldozers, and 26 trucks of average 11-ton capacity. The average haul to a tipple was 6 miles, compared with 8 miles in 1959.

Total man-hours worked at bituminous coal mines in 1959 was 22,386,900 according to final data. The average number of men worked daily totaled 14,139. These men worked an average of 199 active days at 1,357 operations. Injuries included 22 fatal accidents and 1,022 nonfatal accidents. Injury severity rate per million hours was 46.63.

TABLE 3.—Bituminous coal production and value, by counties

(Thousand short tons and thousand dollars)

County	1959		1960	
	Quantity	Value [1]	Quantity	Value [1]
Buchanan	10,320	$44,997	10,568	$44,216
Dickenson	7,569	35,401	7,120	29,665
Lee	451	1,680	616	2,261
Montgomery	16	46	9	33
Russell	2,564	13,081	2,284	11,104
Scott	14	62	16	70
Tazewell	2,500	15,107	1,751	10,688
Wise	6,335	28,850	5,474	24,686
Total	29,769	139,224	27,838	122,723

[1] Value received or charged for coal f.o.b. mine, including selling cost. (Includes value for coal not sold but used by producer, such as mine fuel, and coal coked as estimated by producer at average prices that might have been received if such coal had been sold commercially.)

Coke.—Coke was produced only in Wise County at more than 600 ovens operated by five companies. Most of these ovens were beehive ovens although one company operated a battery of Mitchell or rectangular type ovens. The rectangular ovens, about 30 feet long and 5 feet high, were first manufactured at Braddock, Pa., in 1907 and have been used intermittently since that date. After burning, the coke is pushed out one end of the kiln. No byproducts are recovered. About one-fifth of the coke ovens are hand drawn, and the balance are machine drawn. The annual coke capacity of these ovens is about 350,000 net tons.

Fuel Briquets and Packaged Fuel.—Production of packaged fuel totaled 982 short tons. No production of fuel briquets was reported. Two plants were active. The consumption of these materials had declined radically chiefly due to the increased use of fuel oil and natural gas in domestic heating. Reports from producers showing destination of briquets indicated that 36,729 short tons were sold or used in Virginia in 1960, an increase of 14 percent over 1959. This was contrary to the national trend, as the quantities shipped to most of the larger consuming States were less than in 1959.

Petroleum and Natural Gas.—Approximately the same quantities of petroleum and natural gas were produced as in 1959. No new oil wells were completed, and no new discoveries of oil were made. Discovery of a small quantity of natural gas was reported. Crude oil was produced only in the Rose Hill field, Lee County. Production of natural gas was chiefly from wells in Dickenson and Buchanan Counties. Four new natural gas wells were completed—three in Buchanan County and one in Wise County; one other well in Buchanan County was dry. A well drilled in Dickenson County was tempo-

rarily abandoned when the rig burned. Natural gas was obtained from the Big Lime, Berea Sand, and Devonian shale formations. According to the American Gas Association, reserves of natural gas as of December 31 totaled 33,290 million cubic feet, a decrease of 14 percent from yearend 1959. All reserves were nonassociated, that is, represented free gas not in contact with crude oil in the reservoir.

The natural gas produced, other than that used in drilling operations, was distributed through three pipeline companies—Hope Natural Gas Co., Kentucky-West Virginia Gas Co., and United Fuel Gas Company. Firms active in drilling for natural gas included United Producing Co., United Fuel Gas Co., Cabot Corp., and Clinchfield Coal Co. A wildcat well was reported being drilled in King William County in the Atlantic Coastal Plain area.

The only petroleum refinery operated in Virginia was that of American Oil Co. at Goodwin Neck near Yorktown, York County. This company's facilities included skimming, cracking, and coking. Crude oil capacity was 34,000 barrels per day, and cracked- and reformed-gasoline capacity totaled 17,300 barrels per day. A research laboratory at this plant was concerned chiefly with special problems relating to manufacturing lead-free gasoline.

Another petroleum research laboratory, that of Texaco Experiment, Inc., Richmond, Henrico County, was conducting fundamental research on combustion processes and the development of propulsion systems for missiles and space vehicles. Most of the research was under contract with U.S. defense agencies.

NONMETALS

Aplite.—Three firms operated mines and plants near Piney River in Amherst and Nelson Counties. Aplite, formerly used almost entirely for glass making and other ceramic uses, was being used increasingly for roofing granules, as an aggregate in concrete and roadstone, and as a component of brick and block. Production of aplite for all purposes was slightly higher than in 1959.

A fourth company, near Montpelier, Hanover County, converted its operations from exclusive production of ilmenite and rutile and began to produce chiefly aplite, with byproducts including mica, sphene, and ilmenite and rutile. By the end of the year, only small quantities of material for experimental and testing purposes had been shipped.

Cement.—Shipments of portland and masonry cements declined 15 and 14 percent, respectively, compared with 1959. One firm, operating two plants, produced portland cement in Botetourt and Norfolk Counties. One of these plants used the dry process and the other the wet process. Another firm operated a dry process plant in Augusta County and a fourth firm, in Warren County, produced masonry cement only. Two of the three plants manufacturing portland cement also produced masonry cement. Captive limestone, shale, calcareous marl, and sand were mined by the cement companies. General-use and moderate-heat portland cement was the principal type marketed. Moderate quantities of high-early-strength cement also were produced. All portland cement, except a small quantity shipped by water, was

shipped by railroad. Most was shipped in bulk and the remainder in paper bags.

The distribution of portland cement by types of consumer was 55 percent to ready-mixed concrete companies, 25 percent to concrete-product manufacturers, 7 percent to highway contractors, and the balance to other contractors, Federal, State, and local government agencies, and miscellaneous customers. Most of the portland cement shipments were to Virginia and the neighboring States of North Carolina and West Virginia. The distribution of masonry cement was largely to Virginia, North Carolina, West Virginia, and the District of Columbia. Smaller shipments were made to Pennsylvania, certain New England States, and other destinations.

Clays.—Production of clay increased slightly over 1959 and rose to a new high. Output was miscellaneous clay or shale, used chiefly in making building brick and other heavy clay products. Other markets included lightweight aggregate and portland cement manufacture. Seventeen firms mined and processed clay in 17 counties from 22 mines. The chief producing counties in order of value of output were: Botetourt, Prince William, Nansemond, Chesterfield, and Buckingham. According to preliminary data, 68 men worked 127,908 man-hours and experienced only two lost-time nonfatal accidents.

TABLE 4.—Clays sold or used by producers

Year	Short tons	Value	Year	Short tons	Value
1951–55 (average)	861,758	$869,132	1958	1,152,850	$1,143,160
1956	1,000,019	1,032,665	1959	1,346,014	1,396,433
1957	893,255	986,302	1960	1,347,766	1,394,665

Feldspar.—Tonnage and value of ground and crude feldspar were substantially less than in 1959. Potash and mixed potash-soda feldspar were produced from four mines and ground in a mill at Bedford. Chief uses for the ground feldspar were pottery and enamel. Small quantities were consumed in abrasives, welding-rod coating, and brick facing.

Gem Stones.—Mineral collectors and hobbyists reported finding gems and mineral specimens in Amelia, Madison, and Nelson Counties. Gems collected included amazonite (Amelia County), unakite and epidote (Madison County), and rutile (Nelson County). Coverage of the collection of gem materials was not complete and possibly many additional specimens were collected. Gems and mineral specimens were obtained in past years from Amelia (albite, cleavelandite, garnet), Page (epidote, onyx), Prince Edward (amazonite, amethyst, kyanite), and Rockbridge (unakite) Counties.

Gypsum.—United States Gypsum Co. mined and processed crude gypsum at Plasterco in Washington County. Output was less than in 1959. Products included calcined gypsum and plasterboard. Both domestic and imported gypsum were calcined by the same firm at a plant in Norfolk. Imported gypsum from Nova Scotia was sold by a number of fertilizer firms in the Norfolk area, largely for use as an agricultural land dressing.

Kyanite.—Crude ore mined and sales of refined kyanite remained about the same as in 1959. Kyanite Mining Corp. operated two mines and flotation plants, one in Buckingham County and one in Prince Edward County. Part of the flotation concentrate was pulverized for special uses at the company Pamplin (Appomattox County) processing plant.

Lime.—Output of lime decreased 7 percent, compared with 1959. A large part was captive production. As in 1959 chemical and industrial uses comprised 95 percent of the total output which was mainly quicklime (92 percent). Both agricultural and chemical lime decreased but building lime showed a small increase. Shell was used by two companies in lime manufacture in the Norfolk area. The chief lime-producing counties were Giles, Smyth, and Shenandoah. Smaller tonnages were burned in Frederick, Tazewell, Isle of Wight, and Norfolk Counties.

Among the chemical applications for which quicklime was used were the manufacture of calcium carbide, the making of paper and whiting, and the manufacture of alkalies; quicklime was also used as a flux in steelmaking. Uses for hydrated lime included water purification, leather tanning, and sewerage- and trade-waste treatment. Lime for building use was largely hydrated, and both quicklime and hydrated lime were used for agricultural purposes.

TABLE 5.—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
1951–55 (average)	20,059	$238,938	9,566	$111,549	432,847	$4,370,981	462,472	$4,721,468
1956	25,125	322,644	3,572	41,914	483,649	5,561,357	512,346	5,925,915
1957	[1] 17,897	354,287	[1] 4,190	51,995	[1] 35,250	5,622,860	510,216	6,029,142
1958	[2]	[2]	[2]	[2]	438,449	5,119,929	471,313	5,532,833
1959	29,519	351,955	5,345	73,628	730,376	7,742,829	765,240	8,168,412
1960	27,011	319,829	5,541	82,753	678,487	7,625,404	711,039	8,027,986

[1] Excludes production of quicklime to avoid disclosing individual company confidential data; included in total.
[2] Figure withheld to avoid disclosing individual company confidential data; included in total.

Mica.—A small quantity of hand-cobbed and full-trim mica, mined in Amelia County, was sold through the GSA Spruce Pine (N.C.) and Franklin (N.H.) Purchase Depots. Richmond Mica Corp., Newport News, wet ground domestic and foreign scrap mica for use in paint, rubber, wallpaper, plastics, and other applications.

Nitrogen Compounds.—Nitrogen compounds were manufactured at Hopewell (Prince George County) by Allied Chemical Corp., Nitrogen Division. Products, which included ammonia, urea solution, ammonium sulfate, and other nitrogen compounds, were used chiefly as fertilizer ingredients.

Perlite.—Perlite shipped from Colorado was expanded at Hopewell (Prince George County) chiefly for use as building plaster.

Pyrites.—The Gossan mine in Carroll County yielded pyrites (pyrrhotite) which was used in the manufacture of sulfuric acid at Pulaski

by General Chemical Division, Allied Chemical Corp. Production declined sharply compared with 1959.

Salt.—Production of salt brine declined 6 percent compared with 1959. The salt was used principally in the manufacture of chlorine and soda ash, and other chemicals. Output was obtained from underground salt beds at Saltville, Smyth County, in the southwestern part of the State.

Sand and Gravel.—Production of sand and gravel declined 9 percent in quantity and 8 percent in value to 7.7 million short tons valued at $11.4 million. Output for building purposes decreased 31 percent, and production for paving increased 39 percent over 1959. Building and paving uses comprised 93 percent of commercial production. Of the total output, building and paving uses comprised 43 and 53 percent, respectively, compared with 52 percent for building and 37 percent for paving in 1959. Other types of sand and gravel produced included glass, molding, grinding, polishing, engine, filtration, railroad ballast, fill, and miscellaneous sand (including sand for ice control and other purposes). Sand comprised slightly less than half the total output. The average value per ton increased to $1.49 from $1.46 in 1959. Production was reported from 29 counties, compared with 32 in 1959. Output by commercial operators comprised 97 percent of the total production; the balance was reported by State, Federal, and local government agencies. There were 39 commercial producers operating 43 sand and/or gravel pits in 24 counties. The principal counties in order of size of production were Henrico, Fairfax, Chesterfield, Prince George, and Princess Anne.

Soapstone.—Both output of crude and sales of ground soapstone were greater than in 1959. Two firms—one each in Franklin and Nelson Counties—mined, crushed or ground soapstone for consumption in roofing, rubber, foundry facings, and insecticides. Soapstone used as dimension stone is included with miscellaneous stone in the stone section of this chapter.

Stone.—Continued active building and highway construction resulted in a 9-percent increase in output of stone over 1959. Production rose to 19.4 million short tons, a new record. Stone continued to rank second in tonnage and value among minerals produced in the State. Concrete and highway construction accounted for 67 percent of the stone produced, and stone used for cement and lime comprised 11 and 7 percent of total output, respectively. Types of stone produced were limestone, granite, basalt, sandstone, marble, miscellaneous stone (including soapstone, greenstone, and crushed and broken aplite), calcareous marl, slate, and shell. Shell was recovered as a byproduct of the oyster and mollusk fishing industries. The chief uses for this material were for agstone and lime manufacture. Limestone comprised 64 percent of total stone, and granite and basalt combined totaled 32 percent. Crushed and broken stone comprised the bulk of output, but a small amount of dimension sandstone and miscellaneous stone was produced. The principal stone-producing counties in order of output were Loudon, Washington, Fairfax, Botetourt, and Campbell. Commercial stone was produced in 50 counties by 83 producers, and 7 State or municipal agencies in 11 counties produced Government-and-contractor store. Four companies in three

615629—61——68

TABLE 6.—Sand and gravel sold or used by producers, by classes of operations and uses

Class of operation and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Building	2,060,716	$2,643,117	1,379,428	$1,734,400
Paving	1,064,636	1,218,769	1,834,581	2,478,685
Engine	(1)	(1)	33,862	49,827
Filtration	18,781	27,749	(1)	(1)
Fill	543,541	510,789	138,294	80,345
Other [2]	363,568	818,722	337,595	794,033
Total	4,051,242	5,219,146	3,723,670	5,137,290
Gravel:				
Building	2,326,390	4,392,856	1,665,493	2,504,531
Paving	1,727,505	2,423,395	2,051,559	3,668,291
Other [3]	42,150	22,660	9,430	9,415
Total	4,096,045	6,838,911	3,726,482	6,182,237
Total, sand and gravel	8,147,287	12,058,057	7,450,242	11,319,527
Government-and-contractor operations:				
Sand:				
Paving	90,079	42,105	67,647	25,015
Other			25,468	10,187
Total	90,079	42,105	93,115	35,202
Gravel:				
Building			43,814	3,245
Paving	214,177	268,847	79,229	73,835
Total	214,177	268,847	123,043	77,080
Total, sand and gravel	304,256	310,952	216,158	112,282
Grand total	8,451,543	12,369,009	7,666,400	11,431,809

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes glass sand, molding sand, grinding and polishing sand, railroad ballast, ground sand, engine sand (1959), and filtration sand (1960).
[3] Includes fill, and other sand (1960).

counties produced and marketed shell. Commercial stone producers were as follows: Limestone, 54 companies (62 quarries); granite, 14 companies (17 quarries); basalt, 8 companies (8 quarries); sandstone, 9 companies (9 quarries); marble, 1 company (1 quarry); miscellaneous stone, 4 companies (4 quarries); calcareous marl, 3 companies (3 quarries); and slate, 3 companies (3 quarries). According to preliminary data, 3,628 men (excluding officeworkers) worked 7,511,422 man-hours in the stone industries. Lost-time injuries totaled 172, resulting in an injury frequency rate of 22.90 injuries per million man-hours of exposure.

Crushed and sized slate was produced for roofing granules by Blue Ridge Slate Corp. near New Canton, Buckingham County. Roofing granules also were prepared from aplite by two companies in Nelson County.

Sulfur.—American Oil Co. recovered hydrogen sulfide from fuel gas for conversion to elemental sulfur at its Yorktown refinery, York County. Shipments of sulfur were 17 percent higher than in 1959.

TABLE 7.—Stone sold or used by producers, by kinds and uses

Kind and use	1959		1960	
	Short tons	Value	Short tons	Value
Dimension stone:				
Sandstone, all uses	(1)	(1)	401	$5,210
Crushed and broken stone:				
Granite: Concrete and roadstone [2]	2,779,833	$4,273,567	3,787,947	5,363,546
Basalt: Concrete and roadstone	[2] 2,231,859	[2] 3,761,551	[3] 2,370,067	[3] 3,622,657
Limestone:				
Riprap	5,389	7,398	(4)	(4)
Fluxing stone	621,255	1,051,566	622,558	1,071,472
Concrete and roadstone	6,065,427	8,453,678	6,650,119	8,872,155
Railroad ballast	217,598	273,229	[4] 215,578	[4] 260,393
Agricultural	818,035	1,580,293	761,163	1,601,295
Miscellaneous	4,277,843	6,728,281	4,106,392	6,576,757
Sandstone: All uses	314,585	572,258	368,646	673,051
Shell: Miscellaneous uses	20,386	(1)	13,999	78,890
Slate: Dimension and crushed and broken	51,877	1,069,591	(1)	(1)
Undistributed [5]	382,595	3,675,640	461,352	4,893,092
Total	17,786,682	31,447,052	19,358,222	33,018,518

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[2] Includes riprap and railroad ballast.
[3] Includes railroad ballast.
[4] Riprap included with railroad ballast.
[5] Includes dimension and crushed and broken miscellaneous stone, crushed and broken calcareous mar and marble, and data indicated by footnote 1.

METALS

Ferroalloys.—E. J. Lavino & Co. produced ferromanganese in two blast furnances at Reusens, a suburb of Lynchburg.

Iron and Steel.—Newport News Shipbuilding & Drydock Co. (Newport News) operated three electric furnaces producing ingot and casting steel. Roanoke Electric Steel Corp. produced ingot and casting steel at its electric furnace in Roanoke.

Iron Ore (Pigment Material).—One company produced crude natural iron oxide pigments near Hiwassee. Pigments included sienna, umber, ocher, and other natural red and yellow iron oxides. The same company produced finished iron oxide pigments at two plants, one near Hiwassee and the other at Pulaski. Both natural and manufactured iron oxide pigments were marketed. A second company produced a wide range of finished natural and manufactured iron oxide pigments at its plant in Franklin County near Henry.

Lead and Zinc Ores.—Output of recoverable zinc decreased 2 percent in quantity. The average value per ton rose slightly. Production of lead, however, declined more than one-fifth, owing to a 113-day strike at the Ivanhoe and Austinville Mines in Wythe County. Ore mined at the Ivanhoe and Austinville plants was treated at the Austinville mill. Zinc-lead ores were mined in Wythe County, and zinc ore was produced at Timberville in Rockingham County. The Timberville plant operated the entire year. Zinc concentrate was shipped for treatment to Josephtown and Palmerton, Pa., and to East Chicago, Ind. Lead concentrate was shipped to Palmerton, Pa., Omaha, Nebr., and Carteret, N.J. Lead concentrate also was exported to Japan.

TABLE 8.—Mine production of recoverable silver, lead, and zinc

Year	Silver		Lead		Zinc	
	Troy ounces	Value	Short tons	Value	Short tons	Value [1]
1951–55 (average)	[2] 1,597	[2] $1,446	3,081	$910,007	14,497	$3,816,092
1956	1,874	1,696	3,035	952,990	19,196	5,180,616
1957	1,745	1,579	3,143	898,898	23,080	5,277,476
1958	2,023	1,831	2,934	686,556	18,472	3,807,853
1959	866	784	2,770	637,100	20,334	4,661,792
1960			2,152	503,568	19,885	5,142,275

[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.
[2] Average of 1953, 1954, and 1955; no output reported 1951–52.

Manganese Ore.—Because the Government discontinued purchasing of domestic carlot manganese ore in 1959, no shipments of manganese ore were supplied to the Government's stockpiles during 1960. No output or sales of manganese ore for commercial use or consumption were reported.

TABLE 9.—Manganese ore and manganiferous ore shipped from mines

Year	Short tons	Value	Year	Short tons	Value
1951–55 (average)	12,959	$1,056,843	1958 [2]	8,184	$648,479
1956 [1]	20,231	1,901,983	1959 [1]	6,232	499,315
1957	12,655	1,057,462	1960		

[1] Incomplete total; excludes a small quantity of ferruginous manganese ore.
[2] Includes 56 tons of ferruginous manganese valued at $1,120.

Silver.—No silver was recovered as byproduct of the lead concentrate produced at Austinville owing to the closing of the American Smelting & Refining Co. smelter at Federal, Ill., which formerly processed this material.

Titanium Concentrate.—Output of titanium concentrate consisted mainly of ilmenite plus a small quantity of rutile. Production decreased significantly, compared with 1959. Ilmenite was produced by American Cyanamid Co. at Piney River (Amherst County) for consumption chiefly in manufacturing titanium pigments. Metal and Thermit Corp. produced both ilmenite and rutile.

REVIEW BY COUNTIES

The Virginia Department of Highways produced Government-and-contractor sand and gravel in six counties; some tonnage also was mined in unspecified counties. Most of this output was by State crews, and most was washed and screened, or otherwise prepared. Counties in which Government-and-contractor sand and gravel was produced were Accomack, Hanover, Nelson, Northampton, Northumberland, and Pittsylvania. One county highway department (Henrico) also produced paving sand and gravel with its own crews. All Government-and-contractor sand and gravel produced was used in paving and for maintenance of roads and streets.

Albemarle.—Superior Stone Co., Division of American-Marietta Co. mined granite at its Red Hill quarry, and Charlottesville Stone Co. produced crushed basalt near Charlottesville. The output of both quarries was sold for concrete aggregate and roadstone.

S. L. Williamson Co., Inc., Charlottesville, dredged pit-run sand for use in highway construction.

Soapstone was produced at Alberene, and serpentine was produced near Schuyler by the Alberene Stone Division of the Georgia Marble Co. This company also operated two soapstone quarries in Nelson County.

Alleghany.—Limestone was mined and prepared for concrete aggregate and roadstone by W. G. Mathews, Jr., Inc., at a quarry near Lowmoor.

Amelia.—The Rutherford mineral-collecting area near Amelia Courthouse yielded amazonite and garnet.

Hand-cobbed and full-trimmed mica was produced by W. D. Baltzley, Joe L. Snyder, and J. E. Wilson from the Baltzley No. 5 and No. 6 mines. This mica was sold through the GSA Purchase Depots at Franklin, N.H., and Spruce Pine, N.C.

Amherst.—Aplite was quarried by Riverton Lime & Stone Co., Division of Chadbourn Gotham, Inc. The output was processed in the company's adjacent plant in Nelson County near Piney River. The finished material was sold for the manufacture of glass, as granules for asphalt roofing paper and shingles, and as crushed stone for concrete aggregate.

American Cyanamid Company mined and sold ilmenite at its Piney River operations for consumption at its adjacent titanium-pigment plant. Production was less than in 1959.

Smiley Sand Co. operated a dredge north of Lynchburg to produce washed and screened building sand.

Appomattox.—Limestone was mined and ground for soil conditioning by the Virginia Department of Agriculture & Immigration at a State-owned plant. Kyanite Mining Corp. operated a grinding plant at Pamplin where flotation concentrate from its Dillwyn and Cullen plants were pulverized for special applications.

Augusta.—Lehigh Portland Cement Co. mined limestone and shale for use in portland and masonry cement at its Fordwick plant. General-use and high-early-strength portland cements and masonry cement were produced by the dry process in six kilns for consumption in Virginia, North Carolina, and West Virginia.

Limestone was mined, crushed, and sized for concrete aggregate and roadstone by Valley Stone Co., Belmont Trap Rock Co., Inc., and Augusta Stone Corp., all near Staunton. The Virginia Department of Agriculture & Immigration ground limestone for agstone, and the Virginia Department of Highways mined and crushed limestone for highway construction and maintenance.

Processed and bank-run building sand were produced by Katie L. Weeks from a deposit north of Raphine.

Bath.—Limestone was mined and prepared for highway construction and maintenance by the Virginia Department of Highways at a quarry near Millboro.

Bedford.—Potash and potash-soda feldspar was produced from four mines by Clinchfield Sand & Feldspar Corp. The company mill at Bedford ground the feldspar for use chiefly in making pottery and enamel. Ground feldspar was shipped mostly to Maryland, Ohio, Pennsylvania, and New Jersey.

Blue Ridge Stone Co., Roanoke, quarried limestone in Bedford County for concrete aggregate, roadstone, railroad ballast, stone sand, and agstone.

Bland.—Limestone riprap was produced near White Gate by the Bland Correctional Farm.

Botetourt.—Both tonnage and value of limestone were greater than in 1959, and Botetourt continued to be the leading limestone producing county. Two companies operating three quarries mined and prepared limestone for a wide variety of uses. James River Hydrate & Supply Co., Buchanan, and Liberty Limestone Corp., with two quarries near Buchanan, produced limestone for concrete aggregate, roadstone, filler for fertilizer, agstone, chemical uses, and railroad ballast, in order of decreasing quantity. Minor tonnages were sold for metallurgical flux, asphalt filler, stone sand, cattle food additive, papermaking, and mine dusting. Lone Star Cement Corp. produced limestone for use in manufacturing cement at its Cloverdale plant. The company produced both air-entrained and non-air-entrained general-use and high-early-strength portland cements as well as masonry cement in four 340-foot by 9-foot rotary kilns.

TABLE 10.—Value of mineral production in Virginia, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value[2]
Accomack	$9,436	$9,383	Sand and gravel.
Albemarle	(3)	(3)	Stone, sand and gravel.
Alleghany	(3)	(3)	Stone.
Amelia	(3)	1,116	Mica.
Amherst	(3)	(3)	Titanium concentrate, stone, aplite, sand and gravel.
Appomattox	49,741	61,119	Stone.
Augusta	(3)	(3)	Cement, stone, clays, sand and gravel.
Bath	----------	49,751	Stone.
Bedford	(3)	(3)	Stone, feldspar.
Bland	(3)	7,113	Stone.
Botetourt	(3)	(3)	Cement, stone, clays.
Brunswick	(3)	(3)	Stone, clays.
Buchanan	45,002,934	[4] 44,215,698	Coal, sand and gravel.
Buckingham	(3)	2,099,748	Stone, kyanite, clays.
Campbell	(3)	1,310,033	Stone.
Caroline	(3)	(3)	Sand and gravel.
Carroll	(3)	(3)	Pyrites.
Chesterfield	(3)	(3)	Sand and gravel, clays.
Clarke	(3)	81,550	Stone.
Craig	----------	(3)	Do.
Culpeper	(3)	(3)	Stone, sand and gravel.
Dickenson	35,401,385	29,665,478	Coal.
Dinwiddie	(3)	(3)	Stone, clays.
Fairfax	3,944,186	4,011,194	Sand and gravel, stone.
Fauquier	620,346	449,084	Stone.
Franklin	(3)	(3)	Soapstone.
Frederick	2,147,352	2,095,764	Stone, lime, sand and gravel, clays.
Giles	(3)	(3)	Lime, stone.
Goochland	375,038	(3)	Stone.
Greensville	(3)	(3)	Do.
Hanover	(3)	(3)	Stone, titanium concentrate, sand and gravel.
Henrico	(3)	3,370,294	Sand and gravel, stone, clays.
Henry	(3)	(3)	Stone.
Highland	1,630	25,576	Do.
Isle of Wight	(3)	65,965	Lime, stone.
King William	(3)	(3)	Sand and gravel.
Lee	2,023,649	2,622,997	Coal, stone.

See footnotes at end of table.

TABLE 10.—Value of mineral production in Virginia, by counties [1]—Continued

County	1959	1960	Minerals produced in 1960 in order of value [2]
Loudon	(3)	$2,766,166	Stone.
Louisa		(3)	Do.
Madison	$50	25	Gem stones.
Mecklenberg	(3)	(3)	Stone.
Montgomery	576,647	589,415	Stone, coal, clays, sand and gravels.
Nansemond	(3)	(3)	Stone, clays.
Nelson	(3)	(3)	Stone, aplite, soapstone, sand and gravel, gem stones.
Norfolk	(3)	(3)	Cement, lime, sand and gravel, stone.
Northampton		1,307	Sand and gravel.
Northumberland		11,500	Do.
Nottoway	130,000	195,000	Stone.
Orange	(3)	(3)	Clays.
Page	728		
Patrick	(3)	(3)	Stone.
Pittsylvania	(3)	376,822	Stone, sand and gravel.
Powhatan	(3)	(3)	Stone.
Prince Edward	(3)	(3)	Kyanite.
Prince George	796,821	1,036,174	Sand and gravel.
Prince William	269,057	(3)	Clays, stone.
Princess Anne	470,489	303,401	Sand and gravel.
Pulaski	(3)	(3)	Stone, iron ore (pigment material).
Richmond	19,000		
Roanoke	(3)	(3)	Stone, clays, sand and gravel.
Rockbridge	752,809	744,917	Sand and gravel, stone, clays.
Rockingham	3,351,461	2,455,205	Zinc, stone.
Russell	13,247,124	11,400,587	Coal, stone, clays.
Scott	330,110	314,783	Stone, coal.
Shenandoah	(3)	(3)	Lime, stone.
Smyth	(3)	(3)	Salt, lime, stone, sand and gravel, clays.
Spotsylvania	(3)	(3)	Sand and gravel, stone.
Stafford		(3)	Sand and gravel.
Surry	57,900	(3)	Do.
Tazewell	[5] 15,186,289	[5] 10,758,145	Coal, stone, lime, clays.
Warren	1,261,102	(3)	Cement, stone.
Washington	(3)	(3)	Stone, gypsum.
Westmoreland		(3)	Sand and gravel.
Wise	28,849,921	[6] 24,686,050	Coal, stone.
Wythe	[7] 4,560,902	4,486,937	Zinc, stone, lead, sand and gravel.
Undistributed	[8] 63,064,493	[8] 53,636,752	
Total	[9] 222,501,000	203,819,000	

[1] The following counties did not report production: Arlington, Charles City, Charlotte, Cumberland, Essex, Floyd, Fluvanna, Gloucester, Grayson, Greene, Halifax, James City, King and Queen, King George, Lancaster, Lunenberg, Mathews, Middlesex, New Kent, Rappahannock, Southampton, Sussex, and York.
[2] Value of natural gas and petroleum included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Excludes sand and gravel; included with "Undistributed."
[5] Excludes stone and clays; included with "Undistributed."
[6] Excludes stone; included with "Undistributed."
[7] Excludes manganese ore (10 to 35 percent Mn) and (35 percent or more Mn); included with "Undistributed."
[8] Includes value of natural gas and petroleum; part of value of gem stones, manganese ore (35 percent or more Mn) (1959), stone (1959), and sand and gravel (1960), for which commodities complete distribution by counties was not available; and values indicated by footnote 3.
[9] Revised figure.

Production of clay declined, but the county continued as the chief clay-producing county. Webster Brick Co., Inc. (formerly Roanoke-Webster Brick Co., Inc.), and Virginia Lightweight Aggregate Corp., both with plants at Webster near Roanoke, produced miscellaneous clay and shale for use in heavy clay products and lightweight aggregate, respectively.

Brunswick.—Granite was quarried and prepared for use as concrete aggregate, roadstone, and riprap by Southern Materials Co., Inc., at the Rawlings quarry.

Miscellaneous clay and shale was mined by Brick & Tile Corp. (Lawrenceville) for use in manufacturing building brick. Four men

working a 5-day week produced enough raw material to keep the company's tunnel kiln operating 365 days.

Buchanan.—Bituminous coal production totaled 10.6 million short tons, an increase of 2 percent over 1959. The county was first among Virginia coal-producing counties, with 38 percent of the State total produced from its 800 active mines. Most of the coal came from underground operations. Small quantities were mined at strip and auger mines. Equipment used at underground mines included 881 handheld and postmounted drills and 16 rock drills. Haulage facilities included 269 animals, 646 locomotives, 3,537 mine cars, 58 shuttle cars, and 30 rope hoists; 10 main conveyors and 558 cutting machines were used. Equipment used at auger mines included 8 augers, 1 diesel power shovel, 5 bulldozers, 2 power drills, and 8 trucks.

Leading producers of bituminous coal including Harman Mining Corp., Island Creek Coal Co., Jewel Ridge Coal Corp., Panther Coal Co., and Oakwood Red Ash Coal Corp. Principal seams from which coal was recovered were the Red Ash, Blair, Splashdam, Jewell, and Jewell Ridge seams.

United Producing Co. and United Fuel Gas Co. completed three successful natural gas wells in the Berea sand, the Big Lime, and the Devonian shale formation. One other well was dry, and another was drilled through the Berea sand and was awaiting testing at the end of the year. The gas produced was distributed mostly through the pipelines of Hope Natural Gas Co. although a sizable quantity was delivered to the United Fuel Gas Co. pipelines.

Buckingham.—Slate was quarried, sawed, and split by LeSueur-Richmond Slate Corp. and Arvonia-Buckingham Slate Co., Inc., at quarries near Arvonia. Williams Slate Co. which, as of June 30, 1959, had merged with Arvonia Buckingham Slate Co., Inc., was operated as a part of that firm in 1960. Blue Ridge Slate Corp. produced crushed slate for roofing granules from its Dutch Gap quarry near New Canton.

Miscellaneous clay and shale was mined and processed at Bremo Bluff by Solite Corp. for use in the manufacture of lightweight aggregate. The raw material was trucked about one-half mile from the open-pit mine to a crushing plant and then conveyed to six rotary kilns which converted it to a lightweight product.

Kyanite was produced by Kyanite Mining Corp. at its Willis Mountain mine and Dillwyn mill for use in special refractories and other ceramics products.

Campbell.—Rockydale Stone Service Corp., near Concord, and Blue Ridge Stone Corp., near Lynchburg, mined and crushed large tonnages of limestone for use as concrete aggregate and roadstone. Virginia Greenstone Co., Inc., Lynchburg, produced dressed building stone, bakery-oven hearthstones, rubble, and random broken flagging at its Virginia Greenstone quarry.

Caroline.—Prepared and bank-run sand and gravel for building, fill, and other uses were produced by Dyson Sand & Gravel Co. at its stationary plant near Milford and by Mattaponi Sand and Gravel Co. near Point Eastern.

Carroll.—Lump ore and fine pyrrhotite concentrate were produced from the Gossan mine near Galax, by General Chemical Division,

Allied Chemical Corp. The pyrrhotite was used as a raw material for the manufacture of sulfuric acid at the General Chemical plant in Pulaski.

Chesterfield.—Miscellaneous clay or shale was produced at open-pit mines near Richmond for use in making building brick by Redford Brick Co., Richmond Clay Products Corp., Southside Brick Works, Inc., and Daniels Brick and Tile Co., Inc.

Chesterfield County continued to rank third in output of sand and gravel although less tonnage was produced than in 1959. Southern Materials Co., Inc., operating a dredge at Kingsland Reach on the James River, produced washed and screened sand and gravel for use as concrete aggregate in highway construction and sand for water filtration. More than 70 percent of the county output was shipped by water, and the remainder by railroad.

Clarke.—J. C. Digges & Son, White Post, and Elmer Kenney Lime Co., Berryville, mined, pulverized, and air-dried calcareous marl for agricultural use. Limestone was mined and prepared for concrete aggregate and roadstone by Stuart M. Perry, Inc., at a quarry near Berryville. Virginia Department of Highways mined limestone for use in highway construction and maintenance at the Double Toll Gate quarry.

Craig.—An operation was opened by Castle Sands Co. at New Castle where sandstone was quarried for concrete aggregate, roadstone, and other uses.

Culpeper.—Culpeper Stone Co., Inc., Culpeper, mined sandstone for use as concrete aggregate and roadstone. Culpeper Sand Co. (Culpeper) prepared sand for building and paving at a stationary plant.

Dickenson.—Bituminous coal production dropped 6 percent, but the county maintained its second ranking position among coal producing counties. The number of mines decreased to 100 from 114 in 1959. Ninety-eight percent of the tonnage was obtained from underground mines. Power drills used in underground mining included 93 hand-held and postmounted drills, 20 mobile drills, and 30 rock drills. Haulage included 54 animals, 107 locomotives, 753 mine cars, 60 shuttle cars, and 10 rope hoists. Principal producers included Clinchfield Coal Co., Baker Coal Co., Cassell Coal Co., and Dotson Bros. Coal Co. Coal seams mined included Upper Banner, Lower Banner, Clintwood, Tiller, and Jawbone.

Natural gas was produced by the Clinchfield Coal Co. from the Big Lime and Devonian shale formations. One well was drilled through the Berea sand to a depth of 5,481 feet where the tools were lost. After unsuccessful "fishing" operations and a fire in the rig, the hole was temporarily abandoned. Natural gas produced was distributed through the pinelines of the Kentucky-West Virginia Gas Co.

Dinwiddie.—Southern Materials Co., Inc., mined and crushed granite for roadstone at its Jack quarry near Petersburg. Shale for use in manufacturing heavy clay products at its plant near Richmond was produced under contract near Dinwiddie, Virginia, by Daniels Brick & Tile Co., Inc.

Fairfax.—Sand and gravel operations in Fairfax County accounted for 24 percent of the State total. Seven plants were active; five produced only prepared (washed and screened) material, and two pro-

duced bank-run sand and gravel. Output was used entirely for building and paving. Among the larger producers were L. S. Sorber & Co., Northern Virginia Construction Co. Inc., Virginia Sand & Gravel Co. Inc., Modern Sand & Gravel Corp., and Alexandria Sand & Gravel Corp. All shipments were by truck.

Granite was quarried and prepared for use as concrete aggregate, roadstone, railroad ballast, and riprap by W. E. Graham & Sons, Division of Vulcan Materials Co. at a quarry near Occoquan. Fairfax Quarries, Inc., produced basalt (traprock) for concrete and roadstone at a quarry near Fairfax. Oystershell was used to make poultry grit and lime by Herbert Bryant, Inc., Alexandria.

Fauquier.—Basalt (traprock) was mined and prepared for use as concrete aggregate and roadstone by Riverton Lime & Stone Co., Division of Chadbourn, Gotham, Inc. (Paris) and W. W. Sanders Quarry (Warrenton). Millbrook Quarries, Inc. (Broad Run), mined and crushed limestone conglomerate for concrete aggregate and roadstone. Dimension sandstone was produced for flagging, rough facing stone, and rubble by J. W. Costello, The Plains, and James Edward Corum, Broad Run.

Franklin.—Soapstone was mined by Blue Ridge Talc Co., Inc., at its King-Ramsey mine near Henry. Output was marketed for use in foundry facings and insecticides. This firm also produced a wide variety of manufactured iron oxide pigments at its Henry plant.

Frederick.—Frederick County ranked third in the production of limestone, but output decreased compared with 1959. Three companies, operating four quarries at Clearbrook, Winchester, Middletown, and Stephens City, mined and prepared limestone for a wide variety of uses. Major quantities were sold for metallurgical flux, concrete aggregate, glass, lime, agstone, paper, and cement. M. J. Grove Lime Co., Division of The Flintkote Co. produced quicklime and hydrated lime at its Stephens City plant from captive limestone. Output was sold for mason's lime, agricultural lime, and chemical and other industrial uses. Shipments were principally to Maryland, Virginia, Pennsylvania, North Carolina, and Delaware. The plant was equipped with eight kilns—one of which was an Azbe-type vertical shaft—one batch hydrator, and one continuous hydrator.

Shenandoah Brick & Tile Corp. near Winchester mined shale for manufacturing building brick.

Virginia Glass Sand Corp. (Winchester) recovered and processed sand near Gore for use in the manufacture of glass. A small part of the output was used in building construction.

Giles.—Giles County moved up in rank from third to second in production of limestone, although tonnage and value decreased 3 percent and 9 percent respectively compared with 1959. Standard Lime & Cement Co., Division of American-Marietta Co., and National Gypsum Co., with quarries near Kimballton, and Virginian Limestone Corp. and Ripplemead Lime Co., Inc., with quarries near Ripplemead, mined and prepared limestone principally for lime, concrete aggregate, and roadstone. Smaller quantities were sold for metallurgical flux, stone sand, coal-mine dusting, agstone, and railroad ballast.

Both National Gypsum Co. and Standard Lime & Cement Co., Division of American-Marietta Co., with plants near Kimballton, produced lime in coal-fired rotary kilns. Most of the output was for chemical and other industrial uses but some was used for agriculture and mason's lime. Ripplemead Lime Co., Inc., produced a small quantity of mason's and chemical lime in a coal-fired vertical kiln at its Ripplemead plant.

Goochland.—Royal Stone Corp. mined and crushed quartzite for concrete aggregate and roadstone at its quarry near Hylas. Granite was mined and sized for roadstone by Boscobel Granite Corp. at its Manakin Quarry.

Greensville.—Trego Stone Corp. near Skippers quarried and crushed granite for concrete roadstone, riprap, and railroad ballast. Output was shipped mostly by railroad.

Hanover.—The Verdon granite quarry near Doswell, formerly owned by J. E. Baker Co., was operated by General Crushed Stone Co. Crushed granite produced was used for building, highway construction, and railroad ballast.

Metals and Minerals Division, Metal & Thermit Corp., produced ilmenite and rutile at its Beaverdam plant near Montpelier. In the future, aplite for roofing granules will be the principal product rather than ilmenite and rutile as in the past. Titanite and mica also will be recovered as byproducts.

Henrico.—Henrico County continued to lead in sand and gravel production, accounting for 27 percent of the State total. Southern Materials Co., Inc., recovered sand and gravel with a floating dredge and shipped the output by water. Commonwealth Sand & Gravel Corp., Carter Sand and Gravel Co., Inc., and West Sand & Gravel Co., Inc., processed sand and gravel in stationary plants and shipped the product by truck and railroad. The entire output was used in construction.

Tidewater Crushed Stone Co., Richmond, mined and crushed granite for building and highway construction and riprap.

Henry.—Martinsville Stone Corp. and Snyder Stone Quarry both near Martinsville produced crushed granite for concrete aggregate and roadstone in stationary plants. Output was shipped by truck. The Public Works Department of Martinsville prepared crushed granite for road building and maintenance.

Highland.—Virginia Department of Highways produced roadstone at the Hightown limestone quarry.

Isle of Wight.—Battery Park Fish & Oyster Co. used stockpiled oystershell to manufacture lime in a coal-fired pot kiln. Output was hydrated and sold for soil conditioner. Dudley C. Waltrip discontinued gravel production.

King William.—Fox Co., Aylett, produced sand and gravel for building and paving at a portable plant. Of interest was a wildcat well being drilled 25 miles northeast of Richmond in the Atlantic coastal plain area. This is a new area for oil or gas exploration.

Lee.—Bituminous coal output increased 37 percent over 1959. Sixty-three mines were active, of which 57 were underground mines, 2 were strip mines, and 4 were auger mines. Sixty-one percent of the coal

came from underground operations. Equipment used underground included 51 handheld and postmounted drills and 49 cutting machines. Haulage consisted of 10 animals, 26 locomotives, and 278 mine cars. Strip mine equipment included 1 diesel power shovel, 2 bulldozers, 1 horizontal drill and 4 trucks or tractor trailers. Auger mines used 4 augers, 4 bulldozers, and 1 truck. Chief producing companies included Wisco Coal Corp. (both strip and auger), Darby Fuels, Inc., Betsy Darby Coal Co., B & G Coal Co., and Virginia Lee Coal Co., Inc. The principal coal seams mined were No. 5 and Nos. 11 and 12.

The Rose Hill field continued to be the only crude oil producing area in Virginia. Output was small and was consumed locally.

Limestone was mined and processed for concrete aggregate, roadstone, agriculture, railroad ballast, stone sand, and dusting coal mines by the Kentucky-Virginia Stone Co., Inc., at its Wheeler Quarry near Gibson Station. Woodway Stone Co. (Woodway) produced limestone for concrete aggregate, roadstone, and agriculture.

Loudon.—Chantilly Crushed Stone, Inc., produced crushed basalt at its Arcola quarry for runway construction and approaches at the new international airport near the District of Columbia. Part of the crushed basalt produced by Virginia Trap Rock, Inc., and Arlington Stone & Macite Co., both near Leesburg, also was used in construction of the new airport. The balance was used for building and highway construction. Bull Run Stone Co. near Manassas mined and crushed granite for concrete aggregate and roadstone.

Louisa.—Limestone was mined, crushed, and screened for concrete aggregate and roadstone at a quarry near Gordonsville by Superior Stone Division of American-Marietta Co.

Madison.—Mineral collectors and hobbyists collected unakite and epidote near Syria in the Rose River area.

Mecklenburg.—W. E. Graham & Sons Division of Vulcan Materials Corp., Boydton, mined and crushed granite for concrete aggregate and roadstone. The finished stone was delivered to consumers by truck and railroad.

Montgomery.—Limestone was mined and prepared for concrete aggregate, roadstone, and agricultural use by Montgomery Limestone Corp., Christiansburg. Velvet Sand Co., Inc., near Ironto, mined and crushed sandstone for building and highway construction. One underground mine operated by Jones & Keister Coal Co. produced a small quantity of semianthracite for domestic heating. Old Virginia Brick Co., Inc., mined shale at Elliston for the manufacture of building brick.

Nansemond.—Calcareous marl was mined at Chuckatuck by the Lone Star Cement Corp. to supply its South Norfolk cement plant, Norfolk County. Lone Star also dredged clay from the James River for cement manufacture. Webster Brick Co., Inc., mined miscellaneous clay near Suffolk for building brick.

Nelson.—Dimension and ground soapstone were produced at Alberene Stone Division of the Georgia Marble Co. at its plant near Schuyler. Blocks of soapstone were sawed and prepared for architectural and laboratory applications. Irregular-shaped slabs were sold for flagging. Spalls and trimming waste were ground for roofing,

rubber, filler, and other uses. The company operated two quarries in Nelson County and two in Albemarle County.

Aplite was mined by Consolidated Feldspar Department of International Minerals & Chemical Corp. and Buffalo Mines, Inc., near Piney River. These two companies and Riverton Lime & Stone Co., Division of Chadbourn Gotham, Inc., also had crushing and grinding plants. Riverton Lime & Stone Co. obtained its crude material in a quarry adjacent to its mill, but across the border in Amherst County. Most of the output was reduced to minus 20-mesh and sold for the manufacture of glass. Both Buffalo Mines, Inc., and Riverton Lime & Stone Co., sold part of their output for concrete aggregate, roadstone, roofing granules, and other uses. Aplite for glass was shipped chiefly to New Jersey, Ohio, West Virginia, Illinois, and Virginia.

Rutile and aplite were among the minerals collected by hobbyists in Nelson County.

Norfolk.—Lone Star Cement Corp. used calcareous marl and clay mined in Nansemond County in making cement at its South Norfolk plant. The wet process was used to manufacture general-use portland cement in three 219- by 7.3-foot kilns. The entire output was consumed in Virginia and North Carolina.

Reliance Fertilizer & Lime Corp., Norfolk, manufactured lime in a coal-fired pot kiln from oystershell purchased from J. H. Miles & Co., Inc., and Ballard Fish & Oyster Co., Inc., both of Norfolk. The lime was hydrated and sold for agricultural uses in Virginia and North Carolina.

Interstate Division of Commonwealth Sand and Gravel Corp. operated a dredge near Norfolk to recover sand for use as railroad ballast and for paving and building construction.

Domestic and imported gypsum was calcined by United States Gypsum Co. at a plant at Norfolk for plaster and other products. Crude gypsum imported from Nova Scotia was ground and prepared as a soil dressing by fertilizer plants in or near Norfolk.

Virginia Smelting Co., West Norfolk, produced zinc sulfate, a zinc pigment used in the manufacture of rayon, and for agricultural purposes, paint and varnish processing, in flotation reagents, glue manufacture, and medicinals.

Nottaway.—Granite was quarried and crushed for roadstone and concrete at the stationary plant of the Burkeville Stone Corp., Inc., Burkeville.

Orange.—Webster Brick Co., Inc., mined miscellaneous clay near Orange for use in making building brick.

Patrick.—A. C. Wilson Construction Co. mined and crushed granite for concrete aggregate and roadstone at its Patrick Springs quarry and plant.

Pittsylvania.—Granite was quarried for concrete aggregate and roadstone by Superior Stone Co., Division of American-Marietta Co. near Danville. The Public Works Department of the city of Danville prepared roadstone from granite mined by its own crew.

Sand was washed and screened in portable plants by Marshall Sand & Gravel Co. and Kendall Sand Works (both of Danville) for building, paving, and fill.

Lightweight aggregate was manufactured at a two-kiln plant near Leaksville Junction by Virginia Solite Corp. Raw material came from a miscellaneous clay deposit just over the State line in North Carolina.

Powhatan.—Virginia Stone & Construction Co. quarried and prepared granite for concrete aggregate and roadstone.

Prince Edward.—Kyanite was produced at the Baker Mountain mine and beneficiated at the Cullen flotation plant by the Kyanite Mining Corp. The prepared product was used in high-temperature refractories and special ceramic bodies.

Prince George.—With sand and gravel production higher in both tonnage and value than in 1959, Prince George County continued to rank fourth among sand and gravel producing counties in the State. Friend Sand & Gravel Co., Inc., produced material for building, paving, and filtration at its Whitehill plant. Southern Materials Co., Inc., discontinued operating its Bryan Rock & Sand Co. plant and expanded production of sand and gravel for building and paving at its Puddledock plant (started in 1959). Gravel for highway construction was produced by Hitch Gravel Corp. at its Powell's Creek plant.

Perlite was expanded by Virginia Perlite Corp., Hopewell, from Colorado raw materials. The expanded product was sold mostly for building plaster, although sizable quantities were used as concrete aggregate and as soil conditioner.

Allied Chemical Corp., Nitrogen Division, Hopewell, manufactured nitrogen compounds for use in fertilizer. The products included solid and solution ammonium nitrate, ammonium nitrate-limestone, urea solutions, and other nitrogen compounds.

Princess Anne.—Although output of sand was 35 percent less than in 1959, the county continued to lead in production of sand for industrial uses. Operating at and near Norfolk City were E. V. Williams Co., Inc., Tidewater Sand Co., Inc., and Little Creek Sand & Gravel Corp. These companies produced engine sand, sand for building, paving, fill, foundry uses, and filler for fertilizer. Near Oceana, J. C. Jones Sand Co., Inc., and R. H. Baillio Co., produced building, paving, and fill sand; traction sand for engines; sand for molding, filtration, grinding and polishing; and sand for fertilizer filler.

Prince William.—Gainesville Stone Quarry, Inc., Gainesville, mined and crushed diabase for concrete aggregate, roadstone, and railroad ballast.

Woodbridge Clay Products Co. operated two clay pits and mills near Manassas for building brick.

Pulaski.—Limestone was quarried in Pulaski County by Radford Limestone Co., Inc., Radford, processed at a stationary plant, and marketed as aggregate, roadstone, agstone, railroad ballast, and stone sand for concrete and mason's sand.

Limestone for concrete aggregate and roadstone was produced in portable plants by Montgomery Limestone Corp. at its New River quarry and Salem Stone Corp. at its Newburn quarry. The city of Radford produced crushed limestone for street maintenance.

Crude natural iron ore pigments were produced near Hiwassee by American Pigment Corp. Ocher, sienna, umber, and natural yellow iron oxide were mined and finished at a nearby plant. Manufactured

red and yellow oxide pigments were made by the same company at its Pulaski plant.

Roanoke.—Rockydale Quarries Corp., Rockydale, quarried and prepared limestone for concrete aggregate, roadstone, and agricultural stone. Old Virginia Brick Co., Inc., near Salem mined and processed shale for building brick.

Rockbridge.—Lone Jack Limestone Co., Inc., and Charles W. Barger and Son mined and prepared limestone for railroad ballast, roadstone, and concrete aggregate. W. G. Mathews, Jr., Inc., Natural Bridge Station, produced quartzite for manufacturing ferrosilicon.

Locher Silica Corp., Glasgow, produced sand for glass, building, and traction. Surface (miscellaneous) clay was mined by Locher Brick Co., Inc., near Glasgow for building brick.

Rockingham.—Limestone was mined and prepared for agricultural stone, concrete aggregate, and roadstone by C. S. Mundy Quarries, Inc., Broadway, and Fred K. Betts III, and R. Y. Frazier, Harrisonburg. Marble was crushed for terrazzo by Jamison Black Marble Co., Inc., at its marble quarry near Harrisonburg.

Zinc ore was mined and concentrated at the Bowers-Campbell mine and mill of the Tri-State Zinc, Inc., near Timberville and the flotation concentrate was shipped to the St. Joseph Lead Co. smelter at Josephtown, Pa. The mine and mill were active the entire year. The mine was worked by the room and pillar method from adit opening or haulageway. The mine is 2½ miles northwest of Timberville on State Highway 42.

A detailed discussion of the geology and mineral resources of Rockingham County was published as part of the continuing geological investigations of Virginia resources by the State Division of Mineral Resources.[6]

Russell.—Coal production declined 11 percent from 1959. Thirty-two active mines included three strip and four auger operations. Underground tonnage comprised 93 percent of the output. Equipment used underground included 41 handheld and postmounted drills and 11 rock drills; haulage facilities included 8 animals, 61 locomotives, 691 mine cars, and 22 shuttle cars. Leading coal producers were Clinchfield Coal Co., Stallard-Lawson Coal Co., Smith Coal Co., Hicks Coal Co., and Meadows Coal Co. Principal coal seams mined included the Tiller and the Upper and Lower Banner veins.

Clinch River Quarries, St. Paul, produced limestone which was sold for concrete aggregate and roadstone.

The Virginia Department of Highways mined limestone for highway construction at Camp No. 29.

Clinchfield Coal Corp., in its first year of lightweight aggregate production, expanded sizable quantities of shale obtained from the operation of the Moss No. 3 mine.

Scott.—Foote Mineral Co. produced limestone from its underground mine near Duffield for use as a reagent in the manufacture of lithium products at its refining plant at Sunbright. The lithium ore (spodumene) used in making lithium products was mined and concentrated at the company's Kings Mountain, N.C., quarry. Limestone was pro-

[6] Brent, William B., Geology and Mineral Resources of Rockingham County: Virginia Division of Miner. Res. Bull. 76, Charlottesville, Va., 1960, 174 pp.

duced at Speers Ferry by the Penn-Dixie Cement Corp., and shipped to its cement plant near Kingsport, Tenn. Natural Tunnel Stone Co. quarried and crushed limestone at Glenita for concrete aggregate and roadstone, and Blountville Construction Co. mined limestone at the Tri-State Lime Quarry near Blountville, Tenn., for concrete aggregate, roadstone, agstone, filler in fertilizer, and filter bed material.

Increased production of bituminous coal was reported from three underground mines (two in 1959).

Shenandoah.—Dominion Division of Chemstone Corp. (Strasburg) produced limestone mainly for lime and metallurgical flux, but smaller quantities were used for cement manufacture, asphalt filler, and other uses. The company's nearby lime plant, employing four gas-fired shaft kilns, produced quicklime and hydrated lime principally for chemical uses. These uses included metallurgical flux, paper bleach, sewerage treatment, tanning of leather, and water purification. Out-of-State shipments were principally to Pennsylvania and Ohio. Shenandoah Valley Lime and Stone Corp. mined high-calcium limestone for flux in blast furnaces and open-hearth plants and for cement manufacture. Toms Brook Lime & Stone Co., Inc., Toms Brook, mined and processed limestone for concrete aggregate, roadstone, and agstone at its stationary plant. Roadstone and concrete aggregate were produced at limestone quarries near Mt. Jackson and Timberville, by N. K. Kipps and C. S. Mundy Quarries, Inc., respectively.

Smyth.—Organic Chemical Division of Olin-Mathieson Chemical Corp. produced a large quantity of limestone at the Worthy mine near Saltville for manufacturing lime and for roadstone. The limestone was transported to the nearby plant of the Industrial Chemical Division of Olin-Mathieson Chemical Corp., by aerial tramway to supply the company lime plant which consisted of 3 rotary and 14 vertical coal and coke fired kilns. Brine pumped from salt wells and quicklime produced at the lime plant were used to manufacture chlorine, soda ash, and other chemicals.

Concrete aggregate and roadstone were produced from limestone quarries of E. P. Ellis and Holston River Quarry, Inc., both near Marion. Rockydale Hardrock Co. was inactive during the year. Building sand was produced by C. R. Snider & Sons and Sayers Sand Co., both near Marion.

Spotsylvania.—Railroad ballast, concrete aggregate, and roadstone were produced by Fredericksburg Stone Co. at its granite quarry near Fredericksburg. The entire output was sold to agencies of the State and Federal governments. Massaponax Sand & Gravel Corp. washed and screened building and paving sand and gravel at its stationary plant near Fredericksburg.

Stafford.—Jobe Newton and Diamond Construction Co. with plants near Fredericksburg produced sand and gravel for building, paving, and fill.

Surrey.—Friend Sand & Gravel Co. produced building and paving sand and gravel at a portable plant.

Tazewell.—Production of coal dropped 30 percent, although the number of active mines increased by one. Of total mines, 31 were underground, 2 were strip, and 4 were auger. Over 92 percent of the tonnage came from underground mines. Equipment used under-

ground included 46 handheld and postmounted drills, 25 rock drills, and 37 cutting machines. Haulage facilities included 18 animals, 57 locomotives, 131 mine cars, 53 shuttle cars, 17 rope hoists, and 4 main conveyors. Four diesel powered shovels were used in the strip mines. Auger-mine equipment included 4 augers, 1 diesel power shovel, 5 bulldozers, and 8 trucks. Principal producers were Pocahontas Fuel Co., Southeastern Mining Co., Wildcat Coal Co., Rebecca Coal Co., and Alfredton Coal Co. The chief seams mined were the Upper Seaboard, the Red Ash and the Jawbone.

Pounding Mill Quarry Corp. with operations at Bluefield and Pounding Mill mined, crushed, and prepared limestone principally for concrete aggregate and roadstone. Other uses included railroad ballast, dust for coal mines, and stone sand. About two-thirds of the output was shipped by truck, and one-third, by railroad.

Peery Lime Co., Inc., North Tazewell, and Blue Grass Lime Co., Maxwell, mined limestone to supply their nearby lime plants. Both companies used coal-fired pot kilns and produced hydrated lime for mason's and agricultural lime. Output was used locally and shipped to West Virginia, Tennessee, South Carolina, and North Carolina.

Miscellaneous clay and shale was produced by General Shale Products Corp. near Richland at an open-pit mine for the manufacture of heavy clay products.

Warren.—Riverton Lime & Stone Co., Division of Chadbourn Gotham, Inc., mined shaley limestone to supply its nearby masonry cement plant. The principal consuming areas were Virginia, North Carolina, and the District of Columbia. Limestone mined by Skyline Crushed Stone Co. and Riverton Lime & Stone Co. Quarry No. 5 was sold for concrete aggregate, roadstone, agstone, and stone sand.

Washington.—Lambert Bros., Inc., Division of Vulcan Materials Co., with quarries at Abingdon and Bristol, and Meadowview Lime Co., Meadowview, quarried and prepared limestone for building and highway construction and for agstone.

United States Gypsum Co. produced the only gypsum mined in the State, at Plasterco. This firm also produced and sold plasterboard and other gypsum products.

Westmoreland.—Sand and gravel for building, paving, and fill was produced by Potomac Sand & Gravel Co. in its stationary plant at Kinsale and by Brown Construction Co. near Colonial Beach.

Wise.—Output of bituminous coal dropped 14 percent but the county retained its rank as the third largest coal-producing county. There were 232 active mines, of which 195 were deep mines, 26 were strip mines, and 11 were auger mines. Over three-fourths of the tonnage came from deep mines, and nearly one-fifth came from strip operations. Wise County again ranked first in production of strip mine coal, although output declined to 1 million tons compared with 1.3 million tons in 1959. Underground equipment included 227 handheld and postmounted drills, 35 rock drills, and 168 cutting machines. Haulage facilities included 126 animals, 165 locomotives, 818 mine-cars, 48 shuttle cars, 6 rope hoists, and 40 main conveyors. Strip mine equipment comprised 11 diesel electric power shovels, 49 power shovels, 4 carryall scrapers, 35 bulldozers, 11 horizontal and 6 vertical power drills, and 67 trucks. Auger mine equipment included 9

615629—61——69

augers, 8 bulldozers, 2 power drills, and 7 trucks. The chief producers were Stonega Coke & Coal Co., Coal Processing Corp., Wise Coal & Coke Co., Sunrise Coal Co., Inc., and Mudlick Coal Co. The principal seams mined were the Taggart, the Imboden, the High Splint, the Norton, and the Blair veins.

Beehive coke was produced by five companies—Christie Coal & Coke Co., Hawthorne Coke & Mining Co., Stonega Coke & Coal Co., Norton Coal Co., and Wise Coal & Coke Co. No slot-type ovens were in operation, and no byproducts were recovered.

The Clinchfield Coal Co. completed one natural gas well into the Big Lime formation.

Limestone was mined for concrete aggregate and roadstone by Southwest Quarries, Inc., near Big Stone Gap. Shipments of finished stone were 90 percent by truck, and 10 percent by railroad.

A detailed description of the occurrence and appearance of strontium minerals in the county was reported. Other localities in Virginia where these minerals have been found also were mentioned.[7]

Wythe.—Recoverable lead and zinc were produced at the Austinville mill of the New Jersey Zinc Co., Bertha Minerals Division. This mill handled the output of both the Ivanhoe and Austinville mines. Ore from the Ivanhoe mine was hauled through a 2½-mile tunnel under the New River to the Austinville concentrating mill with 10-ton diesel locomotives and 80-cubic-foot mine cars. The ore was mined by the room and pillar method. Mine openings were vertical shafts. The Austinville mine worked at full capacity for the first 8 months of the year. Operations were then interrupted by a 113-day strike (August 6 through November 30). The labor contracts negotiated expire July 27, 1963, with the right to open discussions, for a wage change only, on March 27, 1962. Concentrate was treated at smelters at Palmerton, Pa., East Chicago, Ind., Omaha, Nebr., and Carteret, N.J. Because of the closing of the American Smelting & Refining Co. smelter at Federal, Ill., where silver had been obtained from smelting lead concentrate, no byproduct silver was reported during 1960. Another byproduct of the lead and zinc ores at Austinville and Ivanhoe was the limestone county rock which was sold chiefly for agricultural purposes, including fertilizer filler.

Limestone for concrete aggregate and roadstone was produced near Austinville and Wytheville by H. D. Crowder & Sons, Virginia Stone & Construction Corp. and Pendleton Construction Corp. The Town of Wytheville also mined and prepared limestone for road building and maintenance. Newman Brothers, Sylvatus, mined and crushed sandstone for concrete aggregate and roadstone. Silica Products Co. produced building sand at its Max Meadows plant.

---

[7] Mitchell, Richard S., and Pharr, Richard F., Strontium Minerals From Wise County, Virginia: Virginia Minerals (published by Virginia Division of Mineral Resources, Charlottesville, Va.), vol. 6, No. 4, October 1960, pp. 1–4.

The Mineral Industry of Washington

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

By Frank B. Fulkerson,[1] William N. Hale,[1] and A. J. Kauffman, Jr.[2]

MINERAL production in Washington totaled $70 million in 1960, a record for the State. This value was 4 percent greater than the previous high of $67.3 million in 1955 and 10 percent greater than the 1959 total of $63.9 million. Half the gain over 1959 was attributed to metal mining and half to nonmetal extraction. In the value of metal output larger yields of gold, silver, uranium, and zinc more than offset lower production of lead. Among the nonmetals, sand and gravel and stone production and cement shipments increased in volume. Higher prices and unit values for some minerals and metals were offset by declines for other commodities, and the increase in total value was due entirely to greater quantities produced. The index of the quantity of production was 110 (1959 = 100), which represented the same 10-percent gain over 1959 as in the value of production. The index was an average of the percentage changes from 1959 to 1960 in the quantities of the commodities produced, weighted by their 1960 values.

Five mines supplied nearly the entire metal production. These were Knob Hill (gold-silver, Ferry County), Gold King (gold-silver, Chelan County), Pend Oreille and Grandview (both lead-zinc, Pend Oreille County), and Midnite (uranium, Stevens County).

Production of primary aluminum increased from 333,615 to 346,126 tons. The 1960 figure was 72 percent of the rated capacity of the Washington primary aluminum industry. The long-term outlook for this industry in the State was good owing to greater availability of power and expected market expansion. Production has been curtailed since 1957.

---

[1] Commodity-industry analyst, Bureau of Mines, Albany, Oreg.
[2] Chief, Albany Office of Mineral Resources, Bureau of Mines, Albany, Oreg.

TABLE 1.—Mineral production in Washington [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	180	$171	169	$163
Coal do	242	1,841	228	1,721
Copper (recoverable content of ores, etc.) short tons	49	30	78	50
Iron ore (usable) thousand long tons	4	5		
Lead (recoverable content of ores, etc.) short tons	10,310	2,371	7,725	1,808
Manganese ore and concentrate (35 percent or more Mn) short tons, gross weight	83	[3]		
Peat short tons	32,884	124	27,770	121
Petroleum (crude) thousand 42-gallon barrels	1	[3]	[4] 1	[3]
Pumice thousand short tons	9	112	[3]	[3]
Sand and gravel do	21,360	18,576	25,297	18,979
Stone do	12,278	13,587	13,897	15,796
Talc and soapstone short tons	4,073	23	2,406	12
Uranium ore do	152,336	[3]	171,255	3,223
Zinc (recoverable content of ores, etc.) do	17,111	3,936	21,317	5,500
Value of items that cannot be disclosed: Abrasive stone (grinding pebbles), barite, carbon dioxide, cement, diatomite, gem stones, gold, gypsum, magnesite, olivine, silver, strontium (1959), and values indicated by footnote 3		25,054		24,552
Total Washington [5]		63,894		70,005

[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] Figure withheld to avoid disclosing individual company confidential data.
[4] Preliminary figure.
[5] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement.

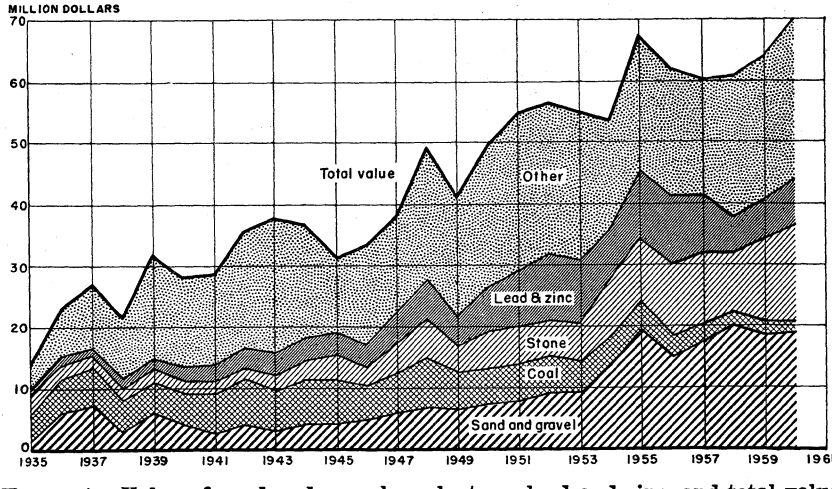

FIGURE 1.—Value of sand and gravel, coal, stone, lead and zinc, and total value of mineral production in Washington, 1935–60.

Trends and Developments.—The Industrial Raw Materials Advisory Committee to the State Department of Commerce and Economic Development recommended a 10-year program of mapping to assist in developing and using the mineral resources of Washington. It was estimated that only 25 percent of the State had been covered by adequate topographic maps, and that less than 10 percent was covered by adequate geologic maps. The committee reported that many raw materials, known to occur in Washington, were being purchased elsewhere.

New power for industrial users became available from the Bonneville Power Administration (BPA) in 1960 because new projects were completed by Federal and non-Federal agencies in the Pacific Northwest. Another favorable power development was the agreement reached by delegations appointed by the Governments of Canada and the United States on basic terms for cooperative development of the water resources of the Columbia River Basin. The agreement, which was to be incorporated into a treaty early in 1961, if implemented by construction would provide 15.5 million acre feet of controlled storage at Arrow Lake, Duncan Lake, and Mica Creek, British Columbia. The storage would be usable for increased hydroelectric power generation downstream as well as in providing substantial benefits for flood control, irrigation, navigation, and pollution abatement.

The Atomic Energy Commission (AEC) was studying the possibility of converting the new plutonium reactor under construction at the Hanford atomic works at Richland to a dual-purpose reactor for producing electricity to aid in the development of the Pacific Northwest. The conversion, estimated to cost $100 million, would require Congressional approval. The reactor, rated at 700,000 kw., would be the largest nuclear powerplant in the world.

A bibliography of Washington mineral resources was published.[3]

Consumption, Trade, and Markets.—Slower business conditions led to slackened production of some commodities by yearend.

Although building activity in the State dropped sharply (building permits decreased 21 percent in value) because of less residential construction, the overall annual trend in the construction industry was about the same as in 1959. Employment and weekly hours of construction workers increased slightly, and cement shipments to and within Washington declined slightly. Value of contracts awarded by the State highway commission increased more than one-third, and value of highway work put in place during the year was the same as in 1959. Heavy-engineering awards declined sharply compared with 1959 because of decreases in several categories including military, electric power, and nuclear energy projects. A number of exceptionally large contract awards had been made in 1959, and as a result heavy-engineering construction in the State increased in 1960.

[3] Reichert, William H., Bibliography and Index of the Geology and Mineral Resources of Washington, 1937–1956: Washington Div. of Mines and Geol., Bull. 46, 1960, 721 pp.

TABLE 2.—Indicators of Washington business activity

		1959	1960 [1]	Change, percent
Personal income:				
Total	million dollars	6,363.0	6,674.0	+5
Per capita	dollars	2,254.0	2,334.0	+4
Construction activity:				
Building permits	million dollars	411.9	325.5	−21
Heavy engineering awards	do.	494.1	221.1	−55
State highway commission:				
Value of contracts awarded	do.	49.7	68.3	+37
Value of contract work performed	do.	54.0	54.7	0
Cement shipments to and within Washington	thousand 376-pound barrels	5,737.0	5,642.0	−2
Average weekly hours of construction workers		36.0	36.5	+1
Cash receipts from farm marketings	million dollars	545.1	546.2	0
Factory payrolls	do.	1,287.0	1,286.9	0
Annual average labor force and employment:				
Total labor force	thousands	1,084.7	1,095.4	+1
Unemployment	do.	61.8	69.1	+12
Employment:				
Construction	do.	45.9	46.3	+1
Aircraft	do.	67.2	57.8	−14
Lumber and wood products	do.	46.9	45.0	−4
Food processing	do.	27.4	27.5	0
All manufacturing	do.	225.9	217.6	−4
All industries	do.	1,020.9	1,026.1	+1

[1] Some of the 1960 figures are preliminary.

Sources: Survey of Current Business, Construction Review, Pacific Builder and Engineer, Washington State Highway Commission, The Farm Income Situation, Washington Labor Market, Employment and Payrolls in Washington State, Labor Force and Employment in Washington State, and Bureau of Mines.

The increase in personal income in Washington in 1960 was equal to the national gain. Annual average unemployment increased 12 percent in 1960 as the result of curtailed employment in the aircraft and lumber and wood products industries. Employment was maintained in food processing, the third largest manufacturing industry. Employment declined 4 percent in all manufacturing industries, but payrolls remained the same as in 1959.

Employment and Injuries.—Average annual employment in the mining industry increased slightly. In most other mineral industries, employment was below 1959, according to the Washington Employment Security Department. As the result of dwindling employment in the last quarter, the number of workers in the primary aluminum industry averaged 5,900 for the year, compared with 6,600 in 1959 and 9,800 in 1956, when peak activity in this industry was reached.

The injury statistics in table 4 were compiled from reports to the Bureau of Mines from the mining companies in the State.

TABLE 3.—Annual employment and total wages in the mineral industries

Industry	1959		1960	
	Employment	Wages (thousands)	Employment	Wages (thousands)
Mining:				
Metal mining	597	$3,673	609	$3,935
Bituminous coal, crude petroleum, and natural gas	292	1,700	258	1,536
Nonmetallic mining and quarrying	859	5,099	909	5,649
Total	1,748	10,472	1,776	11,120
Stone, clay, and glass products:				
Cement, hydraulic	695	4,093	659	4,040
Structural clay products	333	1,797	326	1,802
Concrete, gypsum, and plaster products	3,409	20,272	3,233	19,299
Other	777	4,448	767	4,512
Total	5,214	30,610	4,985	29,653
Smelting, refining, and casting:				
Blast furnaces, steel works, rolling and finishing mills	1,932	12,281	2,025	13,076
Iron and steel foundries	947	5,369	999	5,886
Smelting, refining, and casting of nonferrous metals, except aluminum	681	3,735	1,164	6,634
Smelting, rolling, drawing, and casting of aluminum	6,592	43,912	5,940	40,641
Miscellaneous	70	425	49	323
Total	10,222	65,722	10,177	66,560
Industrial chemicals [1]	9,343	68,749	8,754	68,591
Petroleum refining and related industries	1,531	10,191	1,443	9,556
Grand total	28,058	185,744	27,135	185,480

[1] The Hanford atomic installation is the largest in this classification.

Source: Washington Employment Security Department bulletins on industries covered by Washington State Employment Security Act. Industry groups may vary from those in the Bureau of Mines canvass.

TABLE 4.—Injury experience in the mineral industries [1]

Year and industry	Men working daily	Average active days	Man-hours worked	Fatal injuries	Non-fatal injuries	Injuries per million man-hours
1959:						
Quarries and mills [2]	1,081	226	1,956,924	----------	13	7
Nonmetal mines and mills	195	174	270,951	----------	7	26
Sand and gravel operations	817	206	1,345,339	1	12	10
Metal mines and mills	450	254	914,700	1	39	44
Coal mines	285	199	452,929	----------	29	64
Total	2,828	218	4,940,843	2	100	21
1960: [3]						
Quarries and mills [2]	924	218	1,610,206	1	7	5
Nonmetal mines and mills	293	153	359,625	----------	11	31
Sand and gravel operations	793	196	1,245,329	----------	17	14
Metal mines and mills	517	236	976,343	----------	39	40
Coal mines	202	176	285,174	1	22	81
Total	2,729	205	4,476,677	2	96	22

[1] Includes only commercial operations.
[2] Includes cement- and lime-processing plants.
[3] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Manufacturers Mineral Co., Chewelah, Stevens County, produced grinding pebbles for use at its Seattle plant. Output was less than in 1959.

Barite.—Production of barite more than doubled, compared with 1959. Two companies—D & P Lewis Mining Co. (formerly Chewelah Minerals Co.) and Natural Stone Co.—supplied the output. Work at the Lynx Cats deposit (D & P Lewis) on Eagle Mountain near Chewelah was resumed in September after having been idle since 1958.

Cement.—Combined output of portland and masonry cement was 7 percent lower than in 1959; shipments were 1 percent higher. The industry, comprised of six plants owned by four companies, operated at about 66 percent of capacity (67 percent in 1959); yearend stocks decreased considerably. Within-State-shipment terminations increased to 88 percent, compared with 83 percent in 1959; the remainder went to other Pacific Northwest States and Alaska.

Construction of a cement-distribution terminal at Vancouver by Ideal Cement Co. continued. Three storage silos having a capacity of 100,000 barrels were completed about midyear. Field studies were continued by the company on limestone deposits 30 miles up the Snake River from Clarkston, Asotin County; location of the site and interest in building a cement-producing facility were announced in 1959.

Combined production from nine cement plants in Washington and Oregon was 8,244,300 barrels (376 pounds each); the same plants shipped 8,319,400 barrels during the year. Average value of portland cement shipped by producers in Washington and Oregon was $3.52 per barrel, f.o.b. plant, compared with $3.50 in 1959.

Clays.—Clays sold or used by producers decreased 5 percent, largely because of reduced output of miscellaneous clay for heavy clay products (building brick and draintile); smaller output of fire clay used in making refractory products (firebrick and block) also contributed to the decline.

Fire clay was mined at five operations in Spokane and King Counties; 13 pits in 8 counties yielded miscellaneous clay; and King, Spokane, and Whatcom Counties were the source of clay used in manufacturing cement. A small quantity of bentonite was dug in Yakima County for lining irrigation canals.

Diatomite.—Quantity and value of diatomite production increased 10 percent and 2 percent, respectively, over 1959. Kenite Corp., Quincy, Grant County, mined and prepared diatomite for filler, insulation, and miscellaneous purposes.

Gypsum.—Agro Minerals, Inc., mined gypsite (a mixture of gypsum, quartz, and clay) from its Poison Lake deposit near Tonasket, Okanogan County. Output was marketed for agricultural uses.

In Seattle, Kaiser Gypsum Co., Inc., processed raw material from Baja California, Mexico, for gypsum building products. Gypsum

imported from British Columbia was marketed by a Spokane firm for agricultural purposes.

Magnesian Minerals.—Lessened demand for refractory magnesia by the steel industry resulted in a 25-percent decrease in tonnage and value of crude magnesite mined by Northwest Magnesite Co.

Production of olivine, principally for use as foundry sand, continued to increase and was 42 percent higher than in 1959. Northwest Olivine Co. mined olivine at the Twin Sisters quarry, Skagit County, and processed the material at its Hamilton plant.

Pumice.—Grimes Co. marketed pumicite from its Sunnyside quarry, Yakima County, for use as a pozzolan material. Output increased substantially over that of 1959.

Sand and Gravel.—Production of sand and gravel increased from 21.4 million tons ($18.6 million) in 1959 to 25.3 million tons ($19 million). Demand for use in highway construction and maintenance continued strong.

Sand and gravel was produced in 36 of the 39 counties in the State. The output of each of five counties was valued at over $1 million—Walla Walla, Pierce, Snohomish, King, and Franklin. Distribution by use was road building and maintenance, 30 percent; construction, 26 percent; and miscellaneous, 44 percent. Included under miscellaneous for 1960 was a large quantity of fill material used at dam-construction projects.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	5,366	$5,725	4,765	$4,854
Road material	4,267	4,076	3,584	3,360
Railroad ballast	(1)	(1)	359	214
Other [2]	1,693	1,368	2,039	1,393
Total	11,325	11,170	10,748	9,821
Government-and-contractor operations:				
Building	975	894	1,781	2,251
Road material	5,953	3,973	4,026	3,284
Other [2]	3,106	2,539	8,742	3,623
Total	10,034	7,406	14,549	9,158
All operations:				
Building	6,340	6,619	6,546	7,105
Road material	10,220	8,049	7,610	6,644
Railroad ballast	(1)	(1)	359	214
Other [2]	4,799	3,908	10,780	5,016
Total [3]	21,360	18,576	25,297	18,979

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Mainly fill material used at dam-construction projects; also includes special sands for construction and industrial uses and sand and gravel used for miscellaneous unspecified purposes, including items indicated by footnote 1.
[3] Owing to rounding, individual items may not add to totals shown.

Stone.—The quantity of stone quarried totaled 13.9 million tons valued at $15.8 million, compared with 12.3 million tons valued at $13.6 million in 1959. Consumption by the U.S. Army Corps of Engineers (Walla Walla district) furnished a large part of the increase. Stone was quarried in 34 of the 39 counties. Walla Walla County led in stone output, followed by Klickitat and Douglas Counties; Walla Walla and Klickitat Counties each had production valued at more than $1 million.

R. H. Sussex developed a silica deposit along the Loup Loup Pass highway, 14 miles from Okanogan. Lane Mountain Silica Co. began constructing a 400-ton-a-day silica-processing plant near Valley, Stevens County. The mill was to upgrade silica (weathered quartzite) from a deposit on Lane Mountain, 10 miles distant, to a high-grade sand suitable for use by the glass industry in the Pacific Northwest.

Basalt, greatest in tonnage output, was used for concrete aggregate, roadstone, riprap, and ballast. Walla Walla and Klickitat Counties had the largest output.

Limestone production from Chelan, Pend Oreille, Skagit, Stevens, and Whatcom Counties was used in manufacturing cement. Crushed limestone for agricultural purposes came from Snohomish County, and limestone from Stevens County was used at paper mills and metallurgical plants. Dimension marble and marble crushed for roofing granules and terrazzo chips and for agricultural uses were marketed from Stevens County quarries.

TABLE 6.—Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1959		1960	
	Quantity	Value	Quantity	Value
Dimension stone (building)	(1)	(1)	7	$265
Concrete and roadstone	8,458	$8,600	6,834	6,743
Riprap	2,408	1,930	1,229	2,003
Railroad ballast	(1)	(1)	(1)	(1)
Other [2]	1,412	3,056	5,828	6,786
Total [3]	12,278	13,587	13,897	15,796

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Used at cement, paper, metallurgical, and chemical plants; sugar refineries; and for miscellaneous unspecified purposes, including items indicated by footnote 1.
[3] Owing to rounding, individual items may not add to total shown.

Dimension granite was quarried in Grant, Kitsap, Spokane, Whatcom, and Yakima Counties. Crushed granite quarried in Chelan, Douglas, Ferry, King, Kitsap, Okanogan, and Snohomish Counties was used mainly as roadstone; other uses included roofing rock, riprap, and poultry grit.

Sandstone was quarried for facings and flagging (Ferry and Kittitas Counties), as rough blocks (Pierce County), for use in manufacturing cement (Pend Oreille County), and for making ferroalloys (Spokane County).

Talc and Soapstone.—Tonnage and value of soapstone output were about half the 1959 totals. Soapstone mining was limited to Skagit County where three operators near Marblemount produced the raw material for processing at two grinding plants. Some of the output was shipped to Oregon for grinding. The chief use for the ground soapstone was as a carrier for insecticides; a small quantity was sold for paint filler.

Vermiculite (Exfoliated).—An increased tonnage of Montana vermiculite was expanded at the Spokane plant of Vermiculite Northwest, Inc. The product was marketed principally for use in insulation and lightweight-plaster and concrete aggregate.

METALS

Aluminum.—Primary aluminum output totaled 346,126 short tons valued at $181.1 million, an increase of 4 percent in tonnage and 10 percent in value over 1959. Aluminum output, largely because of slackened markets and increased competition from new plants in the Midwest and East, was 28 percent (136,900 tons) short of the total State primary capacity (483,000 tons).

TABLE 7.—Primary aluminum plant capacity and production data

Year	Rated primary capacity, short tons	Primary production			Average U.S. ingot price per pound, cents
		Short tons	Percent of national total	Value (thousands)	
1951–55 (average)	389,000	368,475	31	$146,757	21.0
1956	481,000	486,204	29	233,632	26.0
1957	483,000	445,709	27	227,383	27.5
1958	483,000	311,417	20	156,376	26.9
1959	483,000	333,615	17	165,423	26.9
1960	483,000	346,126	17	181,138	[1] 26.0

[1] Price of pig now applied to ingot. The use of the term "pig" was discontinued in August 1960.

Higher purity end products and exports of primary metal and semifabricated products to western Europe were becoming more important to State producers. Additional refining cells for producing superpurity aluminum were in operation at the Mead plant of Kaiser Aluminum & Chemical Corp. at Spokane. The Mead plant became one of the leading producers of superpurity aluminum in the world. New products were aluminum shot for deoxidizing steel and impact extrusion slugs for manufacturing seamless cans. The Kaiser company Trentwood rolling mill began producing sheet for food cans, using new equipment that cost $3 million.

Further expansion of facilities to produce higher purity products was considered by some of the aluminum companies. Reynolds Metals Co. planned to expand the Longview aluminum reduction plant to produce extrusion ingot, improved ingot products, and bar stock for making aluminum conductor wire. The estimated $600,000 expansion included a new building, three holding furnaces, a horizontal

casting machine, sawing equipment, and homogenizing furnaces. Aluminum Company of America (Alcoa) decided to increase manufacturing facilities in the ingot-casting department of the Vancouver plant; $250,000 was to be spent to construct a building and install a preheat furnace for extrusion ingot.

Bauxite.—The Washington Division of Mines and Geology mapped bauxite deposits in Cowlitz and Wahkiakum Counties during the year.

Copper.—Copper output was 78 tons, an increase of 59 percent over 1959. Of the total, 53 percent came from lead-zinc ores of Pend Oreille Mines & Metals Co. (Pend Oreille mine) and American Zinc, Lead & Smelting Co. (Grandview and Mineral Rights mines)—all in Pend Oreille County. Operations directed principally to recovering lead and zinc had been the main source of copper since closure of the Holden mine, Chelan County, in 1957.

Kromona Consolidated Mines, Inc., produced 40 percent of the State total from the Kromona mine, Snohomish County, where ore was valued chiefly for its copper content. Small quantities of copper concentrate were shipped to the Tacoma smelter by Paymaster Mines, Inc. (Paymaster mine), Okanogan County; Amco Mining Co. (Wayside mine), Snohomish County; Bonanza Mines, Stevens County; and Machinery Center, Inc. (Holden mine cleanup operations), Chelan County.

Ferroalloys.—Keokuk Electro-Metals Co., Wenatchee, produced silicon metal and ferrosilicon in four electric furnaces (three silicon, one ferrosilicon) until July 1; output was curtailed during the remainder of the year owing to depressed markets.

Pacific Northwest Alloys, Inc., reactivated the second of its four furnaces early in the year at the Mead ferrochromium plant.

Gold.—Gold output increased 9 percent over 1959. Lovitt Mining Co., Chelan County (Gold King mine), and Knob Hill Mines, Inc., Ferry County (Knob Hill and Gold Dollar mines) were the principal producers. Four other companies were active gold producers; Machinery Center, Inc., Salt Lake City, Utah, recovered the metal from cleanup operations at the Holden mine, Chelan County.

Iron Ore.—No iron ore was produced in 1960. Results of a magnetometer and scintillometer survey, made by Hunting Geophysical Services, Inc., in 1959, were published.[4] This report, including 25 maps, covered parts of northeastern Okanogan County and northwestern Ferry County.

Lead.—A lengthy strike at The Bunker Hill Co. lead smelter, Kellogg, Idaho, and a higher price for zinc (companies focused attention on zinc production) contributed to a decline in lead production. Lead output decreased 25 percent from the 10,310 tons produced in 1959; however, total value of lead production dropped 24 percent, indicating a slightly higher 1960 weighted average price for lead ($0.117 a pound compared with $0.115 a pound for 1959).

[4] Hunting Geophysical Services, Inc., Geological Interpretation of Airborne Magnetometer and Scintillometer Survey, Mt. Bonaparte, Bodie Mountain, Curlew, Aeneas, and Republic Quadrangles, Okanogan and Ferry Counties, Wash.: State of Washington Div. of Mines and Geol. Rept. of Investigations No. 20, 1960, 34 pp.

TABLE 8.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1951–55 (average)	26	2	1,536	65,168	$2,281	344	$312
1956	34	1	1,697	70,669	2,473	448	406
1957	19	1	1,495	(3)	(3)	(3)	(3)
1958	14	3	975	(3)	(3)	(3)	(3)
1959	15	1	958	(3)	(3)	(3)	(3)
1960 [4]	17	----------	1,070	(3)	(3)	(3)	(3)
1860–1960	----------	----------	(5)	[6] 2,844,331	[6] 78,307	[6] 16,391	[6] 12,333

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1951–1955 (average)	3,956	$2,267	10,218	$3,051	24,583	$6,584	$14,494
1956	2,926	2,487	11,657	3,660	25,609	7,017	16,044
1957	1,700	1,023	12,734	3,642	24,000	5,568	13,766
1958	52	27	9,020	2,111	18,797	3,835	10,469
1959	49	30	20,310	2,371	17,111	3,936	10,986
1960 [4]	78	50	7,725	1,808	21,317	5,500	12,388
1860–1960	122,000	43,233	208,000	47,912	420,000	94,722	294,216

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, and ore shipped to smelters during calender year indicated. Owing to rounding, individual items may not add to totals shown.
[2] Does not include gravel washed.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] No placer operations in 1960.
[5] 1860–1903—data not available; 1904–60—30,339,091 short tons.
[6] Excludes 1957–60.

TABLE 9.—Mine production of gold, silver, copper, lead, and zinc in 1960, by classes of ore or other source material, in terms of recoverable metals

Source	Number of mines	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	6	108,214	(1)	(1)	8,000	----------	----------
Dry gold-silver and dry silver [2]	3	100	(1)	(1)	2,000	----------	----------
Copper	5	1,933	(1)	(1)	64,000	----------	----------
Lead-zinc	3	959,822	(1)	(1)	82,000	15,450,000	42,634,000
Total	17	1,070,069	(1)	(1)	156,000	15,450,000	42,634,000

[1] Figures withheld to avoid disclosing individual company confidential data.
[2] Combined to avoid disclosing individual company confidential data.

Three mines in Pend Oreille County (American Zinc, Lead & Smelting Co., Grandview and Mineral Right mines; and Pend Oreille Mines & Metals Co., Pend Oreille mine) yielded the entire production.

Manganese.—Sixty-seven manganese deposits in Clallam, Jefferson, Mason, and Grays Harbor Counties were described in a publication.[5]

[5] Magill, E. A., Manganese Deposits of the Olympic Peninsula: Bureau of Mines Rept. of Investigations 5530, 1960, 82 pp.

Nickel.—No nickel was produced in 1960. The Jumbo Mountain nickel deposit, Snohomish County, was the subject of a report.[6]

Silver.—Silver production increased 3 percent over 1959. As in 1959, Knob Hill Mines, Inc. (Knob Hill and Gold Dollar mines, Ferry County), was the leading source of silver. Six gold producers supplied 96 percent of the total silver output. Silver was recovered at the average ratio of 4.7 ounces per ounce of recoverable gold.

Three lead-zinc operations furnished 3 percent of the silver output; silver was recovered at the average ratio of 2.7 ounces per ton of lead produced, compared with a 3.6:1 ratio in 1959.

Two silver and five copper producers supplied about 1 percent of the State total; ore from the silver mines averaged 76.6 ounces a ton, and silver from copper mines was recovered at the average ratio of 24 ounces per ton of recoverable copper.

Steel.—Bethlehem Steel Co., Pacific Coast Division, installed a new Universal platemill, which was capable of rolling plate up to 30 inches wide, 3 inches thick, and 70 feet long.

The company expanded the industrial fastener plant at Seattle; new equipment included a ¾-inch cold boltmaker for production of 6-inch long, ⅝-, ¾-, and ⅞-inch diameter bolts and 1-inch diameter rivets. Also planned was installation of a new Universal cold header for forming ½- and ⅝-inch diameter bolts and ½-, ⅝-, and ¾-inch diameter rivets all up to 6 inches in length.

Uranium.—According to the Newmont Mining Corp. annual report, Dawn Mining Co. (controlling interest—51 percent Newmont Mining Corp. and 49 percent Midnite Mines, Inc.) milled 170,142 tons of uranium ore in 1960, compared with 160,000 tons in 1959. Dawn Mining Co. purchased the Silver Buckle Mining Co. Peters uranium lease for $1 million in June. Isbell Construction Co., Reno, Nev., contractor for open-pit mining operations at the Dawn company Midnite mine, also began mining the Peters lease.

The Dawn company uranium-ore-purchasing contract with the AEC was made effective until December 31, 1966; it provided only for purchase of concentrates produced from uranium ores that were developed before November 24, 1958. Twenty-five Pacific Northwest operators met the September 30, 1959, deadline for submitting ore reserve data to the AEC and became eligible to sell ore to the Dawn company for processing at the Ford mill under the new contract. Twenty-five percent of the Dawn company mill capacity was allocated for handling custom ore.

Zinc.—The rise in zinc output, 25 percent above that in 1959, was attributed to the emphasis placed on zinc recovery as the result of a price increase; the yearly weighted average price of zinc was $0.129 a pound compared with $0.115 a pound in 1959. Increased price and higher production boosted the value of output 40 percent above that of 1959.

---

[6] Mills, J. W., Geology of the Jumbo Mountain Nickel Deposit, Snohomish County, Washington: Min. Eng., vol. 12, No. 3, March 1960, pp. 272–274.

Zinc concentrate, usually shipped to The Bunker Hill Co. electrolytic plant at Kellogg, Idaho, was moved to The Anaconda Company zinc facility (Anaconda, Mont.) during the 7-month strike at Bunker Hill. Three mines in the Metaline district—the Pend Oreille, Grandview, and Mineral Right—yielded lead-zinc ore.

MINERAL FUELS

Carbon Dioxide.—There was a 9-percent increase 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 concern 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.—Nine underground and two strip-mine operations contributed to the 228,000-ton coal output, about 14,000 tons less than 1959. Stoker Coal Mining Co. operated the Tono No. 4 (Thurston County) under lease but was not active at the Stoker Nos. 2 and 3 in Lewis County.

Two announcements by midyear indicated the possibility of a brighter picture for coal mining in the State—Japanese interests reported favorably on coking coal from Pierce County for use by the steel industry in Japan, and the Hanford atomic works contracted for a minimum of 50,000 tons of bituminous coal from Washington producers. Negotiations were reopened during the year between interested parties relative to a coal-fired steamplant for generating electrical energy at Lake Cle Elum in Kittitas County. The county public utility district has had an option to buy the Roslyn operations of Northern Pacific Railway Co. Coal Department.

A mechanical planer, designed by Bureau of Mines engineers at Spokane for use in underground phosphate mines of the Western States, was tested at the Northern Pacific Railway Co. Coal Department No. 9 mine at Roslyn. The planer worked well in a steeply dipping coalbed, yielding a ton of coal per minute of working time from a 35-foot test face. The planer as used in phosphate mining was described in a Bureau of Mines report.[7]

Peat.—Production of peat was 27,800 tons, 5,100 tons less than 1959. King County led in peat production, followed by Snohomish, Kitsap, and Thurston.

Petroleum and Natural Gas.—Recovery of crude oil from Sunshine Mining Co. Medina No. 1, Ocean City, Grays Harbor County, was the same as in 1959.

Sunshine Mining Co. and Cascade Natural Gas Co. jointly drilled the Oscar No. 1 and Oscar No. 1–A, a southeast extension of the Ocean

[7] Service, A. L., and Howard, T. E., Design and Test Operation of a Pneumatic Vibrating-Blade Planer. A Progress Report on Phosphate-Mining Research, 1956–57: Bureau of Mines Rept. of Investigations 5437, 1959, 22 pp.

City discovery, as well as the Rayonier No. 1 and Rayonier No. 1–A, 12 miles north of Ocean City at Aloha. According to the companies, electrical logs of the Rayonier well, which was bottomed at 6,500 feet, indicated the presence of several producing horizons down to a depth of 4,700 feet. The production casing was set to 4,731 feet and a flow rate of 120 barrels a day was reported from a short production test.

TABLE 10.—Test holes drilled for oil and gas in 1960

Company	Well	Total depth	County
Sunshine Mining Co., Cascade Natural Gas Co., and others	Rayonier No. 1	1,220	Grays Harbor.
Do	Rayonier No. 1A	6,500	Do.
Do	Oscar No. 1	5,280	Do.
Do	Oscar No. 1A	4,137	Do.
Development Associates, Inc	Development No. 1	4,682	Lincoln.
Sunshine Mining Co., Cascade Natural Gas Co., and others.	France No. 1	2,625	Grays Harbor.

Source: Washington Division of Mines and Geology.

It was announced that Sunshine, through Summit Pipeline Co., a wholly-owned subsidiary, would pipe natural gas to Ocean City and Copalis Beach from the Sampson-Johns No. 1 near Oyehut.

REVIEW BY COUNTIES

Chelan.—Limestone from the Soda Springs quarry near Leavenworth was shipped to the Grotto plant (King County) of Ideal Cement Co.

Clark.—Miscellaneous clay was used for making heavy clay products by Hidden Brick Co. and Ridgefield Brick & Tile Co.

A $250,000 expansion of the ingot-casting department of the Alcoa Vancouver aluminum plant was expected to be completed by the fall of 1961. The new facilities would permit production of higher quality ingots for use in making extruded shapes.

In August, over 1,500 tons of aluminum ingot produced at the Alcoa Vancouver plant was shipped to western Europe. The shipment, the largest aluminum cargo ever loaded at the Port of Vancouver, consisted of extrusion ingot and smaller ingot shapes to be used as a metallurgical additive and for general foundry purposes at West German steel plants.

Cowlitz.—Reynolds Metals Co. produced aluminum metal at its Longview reduction plant; a $600,000 plant expansion was planned.

Douglas.—Silicon metal and ferrosilicon were produced in electric furnaces at the Keokuk Electro-Metals Co. plant near Wenatchee.

TABLE 11.—Value of mineral production in Washington, by counties[1]
(Thousand dollars)

County	1959	1960	Minerals produced in 1960 in order of value
Adams	$1,239	$396	Stone, sand and gravel.
Asotin	(2)	(2)	Sand and gravel.
Benton	256	125	Sand and gravel, stone.
Chelan	1,749	(2)	Gold, stone, sand and gravel, silver, copper.
Clallam	109	88	Sand and gravel.
Clark	890	608	Sand and gravel, stone, clays.
Cowlitz	420	371	Sand and gravel, stone.
Douglas	685	849	Stone, sand and gravel.
Ferry	(2)	(2)	Gold, silver, sand and gravel, stone.
Franklin	1,131	1,838	Sand and gravel, stone.
Garfield	52	51	Stone.
Grant	1,682	891	Diatomite, sand and gravel, stone.
Grays Harbor	288	350	Sand and gravel, stone, petroleum.
Island	236	220	Sand and gravel, stone.
Jefferson	318	457	Stone, sand and gravel.
King	10,000	7,558	Cement, sand and gravel, stone, coal, clays, peat, silver.
Kitsap	232	282	Sand and gravel, stone, peat.
Kittitas	1,214	1,071	Coal, sand and gravel, stone, gold, silver.
Klickitat	1,692	2,828	Stone, sand and gravel, carbon dioxide.
Lewis	668	654	Sand and gravel, stone, coal, clays.
Lincoln	230	484	Stone, sand and gravel.
Mason	(2)	(2)	Sand and gravel, stone.
Okanogan	506	238	Sand and gravel, gypsum, stone, silver, copper, gold.
Pacific	204	171	Stone, sand and gravel.
Pend Oreille	(2)	10,194	Zinc, cement, lead, stone, sand and gravel, copper silver, uranium.
Pierce	3,012	3,290	Sand and gravel, stone, clays.
San Juan	120	156	Sand and gravel.
Skagit	3,539	3,053	Cement, stone, sand and gravel, olivine, talc and soapstone.
Skamania	703	188	Stone, sand and gravel.
Snohomish	1,828	1,938	Sand and gravel, stone, peat, clays, copper, gold, silver.
Spokane	4,980	3,872	Cement, sand and gravel, stone, clays, uranium.
Stevens	3,391	5,093	Uranium, magnesite, stone, sand and gravel, barite, copper, silver, grinding pebbles, gold.
Thurston	588	267	Coal, sand and gravel, stone, peat.
Walla Walla	1,547	6,486	Sand and gravel, stone.
Whatcom	(2)	(2)	Cement, stone, sand and gravel, clays.
Whitman	496	190	Stone, sand and gravel.
Yakima	964	1,290	Sand and gravel, stone, pumice, clays.
Undistributed[3]	20,861	16,378	
Total[4]	63,894	70,005	

[1] No production reported in Columbia and Wahkiakum Counties.
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes value of some sand and gravel, stone, and gem stones that cannot be assigned to specific counties and values indicated by footnote 2.
[4] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement.

Ferry.—Knob Hill Mines, Inc., the leading producer of gold and silver in the State, operated its Knob Hill gold mine and the adjacent Gold Dollar mine owned by Day Mines, Inc., at Republic.

According to the Day Mines, Inc., annual report to shareholders, the Knob Hill company produced 41,376 tons of gold ore from the Gold Dollar mine on a joint production basis with the Day company. Ore reserves were expanded with development of the 11th level, and two diamond drill holes indicated the persistence of the vein to the 13th level; however, indications were that the grade was lower at depth. A new ore body, 400 feet long, designated as the No. 3–JO vein, was disclosed on the 8th level at the Gold Dollar property.

Adjoining properties were developed in 1960; development included 5,638 feet of drifts and crosscuts and 12,188 feet of diamond drilling.

Thomas Consolidated Mines, Inc., Spokane, trenched and sampled the South Penn open-pit gold mine in the Republic district. The work extended the known mineralized zone 75 feet beyond the open-pit boundaries, which had been carried out over a 200-foot width; metallurgical tests indicated that the ore was amenable to cyaniding.

Franklin.—Sand and gravel production was 1.3 million tons (471,000 tons in 1959); the county ranked fourth in the State. Most of the increase was used by the U.S. Army Corps of Engineers at the Ice Harbor Dam.

King.—The value of nonmetal commodities produced in King County was $2.4 million less than in 1959. This marked the first time King County had been surpassed as a source of these commodities. Substantial decreases in output of cement, sand and gravel, and stone contributed to this decline.

Cement production by Ideal Cement Co. at its Grotto plant was less than in 1959; the quantity of clay mined by the company was almost double the 1959 tonnage. The Seattle plant of Lone Star Cement Corp. was closed for a short while for inventory adjustments.

The Danville and Rogers mines of Palmer Coking Coal Co., Inc., supplied most of the coal production. The company also dug clay at its Bagley pit for making clay products.

Locally mined clays were used by manufacturers of firebrick and block, heavy clay products, and flowerpots. Soapstone mined in Skagit County was ground at the Manufacturers Mineral Co. plant in Seattle.

Bethlehem Steel Co., Pacific Coast Division, Seattle, operated a new platemill at the steel plant and installed new equipment at a nearby fabrication plant to make a greater variety of cold-formed bolt products. A building for 150 office employees, completed in 1960, was the last major project of a 3-year, $25-million expansion program.

Kittitas.—Kittitas County maintained its position as the leading source of coal produced. Northern Pacific Railway Co. Coal Department and Roslyn Cascade Coal Co. each operated a surface and underground mine.

Okanogan.—Gypsite was mined near Tonasket (Poison Lake) by Agro Minerals, Inc. An epsomite deposit owned by the company in the same area was idle.

Paymaster Mines, Inc., Pateros, completed construction of a 50-ton-a-day mill at the site of a gold-silver-copper-tungsten property which included 30 claims along Squaw Creek, northwest of Pateros. An air raise was being driven in the old Hunter tunnel, which was opened between 1892 and 1900. Work at the mine, which started in April, included opening old tunnels on the property, setting up a dam and sawmill, and building a pilot-type ore-reduction plant.

Pend Oreille.—The Metaline Falls plant of Lehigh Portland Cement Co. was the principal nonmetal industry in the county. Cement production by the company decreased 18 percent in contrast to a 30-percent increase in shipments, compared with 1959. Sand and gravel

output increased sharply. The county gained some $600,000 in value of nonmetals over the preceding year.

Pend Oreille Mines & Metals Co., according to the company annual report to stockholders, mined and milled 727,759 tons of ore, a 17-percent increase over 1959. Total costs were reduced from $3.384 a ton in 1959 to $3.254; operating costs were reduced from $3.116 to $3.004 a ton. Underground development expenditures totaled $305,132 ($298,340 in 1959) and consisted of 6,725 feet of drifts and raises, 25,380 cubic feet of station excavation, and 67,215 feet of diamond and long-hole drilling. Management substituted long-hole drilling where feasible to cut exploration and development costs; long-hole drilling costs averaged $0.37 a foot, compared with $2.80 a foot for diamond drilling.

Ore production at the Grandview mine (American Zinc, Lead & Smelting Co.) near Metaline Falls was started on a 650-foot level that was reached by sinking an inclined shaft 3,000 feet from the bottom of the main shaft; ore was mined from three levels.

American Zinc, Lead & Smelting Co. opened up working stopes in the Mineral Right mine on company property near the Grandview mine. According to the annual report to shareholders, the company expected to mine 50 percent of its tonnage from the Mineral Right mine by mid-1961, and by the end of the year only a small tonnage, if any, would come from the Grandview mine property.

A property merger of claims in the Metaline district owned by Metaline Contact Mines, Inc.; Day Mines, Inc.; and The Bunker Hill Co. into one operating unit (Metaline Contact Mines, Inc.) was proposed and accepted by directors of the companies involved. The property acquisition was to be handled by exchange of Bunker Hill and Day Mines holdings for common stock of Metaline Contact. Consolidation of the Metaline area holdings was considered desirable to facilitiate a program of exploration, development, and operation under one operating unit. The agreement was subject to stockholder ratification.

Pend Oreille County Public Utility District No. 1 and Diamond National Corp. granted $5,000 and $2,000, respectively, to two Washington State University geologists to make a geochemical and geophysical mineral resources survey in the Metaline mining district. Geochemical soil samples and geophysical anomalies were correlated with ore deposits indicated by previous diamond drilling.

Skagit.—Value of nonmetal commodities produced was $485,000 less than in 1959. A sharp drop in production of sand and gravel was not offset by gains in cement, stone, and soapstone production. The Lone Star Cement Corp. plant at Concrete was the major nonmetal industry in the county. Olivine was mined at the Twin Sisters quarry. Soapstone was mined at deposits near Marblemount by Herman Smith, William Soren, and Cascade Talc & Silica Co.

Snohomish.—The value of mineral production was $1.9 million. The county ranked second as a peat-producing area. Lowell Brick & Tile Co. used locally mined clay to make building brick.

Bear Creek Mining Co., exploration subsidiary of Kennecott Copper Corp., did geological work at the Index mine, Sultan Basin area,

where three large breccia zones contain copper mineralization. Bear Creek also continued geological, geophysical, and geochemical exploration work on the Glacier Peak Mining & Smelting Co. property south of Plummer Mountain on Miners Ridge. The firm had worked summers on the property since 1953 and had made regular option payments. E. J. Longyear Co. conducted extensive diamond drilling at the Glacier Peak property for Bear Creek during the summer. Glacier Peak Wilderness Area, established September 6 by the Secretary of Agriculture, encompassed this property.

Equipment to separate molybdenite from chalcopyrite was installed at the Kromona property, Sultan Basin district.

Spokane.—Nonmetal mineral production was valued at $3.9 million, compared with $5 million in 1959. This decrease caused the county to drop to fourth place in value of nonmetals. Cement, sand and gravel, and stone production was lower. There was a small advance in clay output. Clay mined locally, limestone from Stevens County, and iron ore from Benewah County, Idaho, were used at the Irvin plant, Ideal Cement Co., the principal nonmetal industry in the county. Fire clay refractories and other clay products were made at Mica by Gladding, McBean & Co. Greenacres Gypsum Co. marketed Canadian gypsum for use as land plaster.

Uranium ore was shipped by Daybreak Uranium Co. (Dahl lease) and Evergreen Uranium Exploration Co. (Morning lease), 48 and 62 miles, respectively, to the Dawn Mining Co. mill at Ford, Stevens County.

Silver Hill Mining Co., Spokane, purchased a 130-acre tungsten property on Moran Prairie from Spokane Tin Mines Co. Silver Hill planned to build a pilot mill on the property.

Stevens.—Magnesite mining at the Red Marble and Keystone quarries of Northwest Magnesite Co. was the main nonmetal mineral industry. Limestone was quarried for use in cement manufacture, as a metallurgical flux, and for various other purposes.

Triton Mining Co. developed the old Schumaker property (Joe Creek mine) near Colville. Development consisted of retimbering a 300-foot adit, diamond drilling, and draining and sampling a winze.

Goldfield Consolidated Mines Co. drove a 1,500-foot drift from the bottom of the 100-foot-deep Anderson open-pit mine; three zinc ore bodies, discovered by diamond drilling, were developed. The 15- by 16-foot drift was driven at a grade of about 10 percent to permit use of diesel-powered trucks to haul ore out of the mine.

Clayloon Uranium Co. moved a 1,000-ton-a-day mill from Spokane to the Stevens County Lead Trust mine. Jigs, ore crushers, hoppers, a 175-horsepower diesel-electric powerplant, and other equipment were taken to the property and set on foundations built early in the year. A building was constructed over the equipment in the fall; late in the year the lead-zinc gravity-type mill was operated on a test basis, treating ore from the company-leased Lead Trust and Lead King mines.

The Dawn Mining Co. Midnite mine was the leading producer of uranium ore in the State. The nearby Peters lease, purchased by Dawn from Silver Buckle Mining Co. in June, yielded a considerable tonnage. Ore was hauled about 20 miles to the Dawn Mining Co. mill at Ford for processing.

Walla Walla.—Value of sand and gravel and stone production, the only mineral commodities produced, rose to $6.5 million from $1.5 million in 1959. Most of the output was used by the U.S. Army Corps of Engineers at its Ice Harbor Dam project.

Whatcom.—Whatcom County ranked first as a source of nonmetal production. Substantial increases in cement and stone output accounted for the advance. The Olympic Portland Cement Co., Ltd., plant at Bellingham was the leading nonmetal industry in the county, and it continued to have the largest cement output in the State. Limestone for use at the cement plant was produced by the company from the Kendall quarry near Maple Falls.

Yakima.—Pumicite mined near Sunnyside was used as a pozzolan material. A small quantity of bentonite was produced for use in sealing irrigation canals by Tietonite Mines, Inc., near Naches. Granger Clay Products Co. made building brick from clay mined locally.

The Mineral Industry of West Virginia

This chapter has been prepared under the cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geologic and Economic Survey.

By James R. Kerr [1] and Jean Pendleton [2]

MINERAL production in West Virginia declined 2 percent in value in 1960 despite increased production of most mineral commodities. The continuing decline in coal output after the steel strike was the contributing factor in the decline. Coal prices dropped $0.17 to $5.02, further decreasing the total dollar realization from this major industry.

Greatly increased crushed stone production was recorded to meet the demand for materials used in constructing Interstate routes 77 from Charleston to Parkersburg and 64 from Huntington to Charleston. Clays, salt, and petroleum output also increased significantly.

Leading in mineral production were the larger coal-producing counties of McDowell, Logan, Wyoming, Marion, Kanawha, and Raleigh.

TABLE 1.—Mineral production in West Virginia [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	596	$2,492	626	$2,639
Coal do	119,692	621,003	118,944	597,222
Natural gas million cubic feet	204,633	53,205	208,757	54,694
Natural gas liquids:				
Natural gasoline thousand gallons	29,242	1,808	23,211	1,513
LP gases do	308,316	15,534	329,874	16,527
Petroleum (crude) thousand 42-gallon barrels	2,184	7,862	[2] 2,318	[2] 9,434
Salt thousand short tons	811	3,305	920	3,673
Sand and gravel do	4,854	10,513	4,506	9,802
Stone [3] do	5,923	10,482	8,001	14,001
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, cement, gem stones, and lime	----------	13,319	----------	13,196
Total West Virginia [4]	----------	[5] 737,616	----------	720,674

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Preliminary figure.
[3] Excludes certain stone, included with "Value of items that cannot be disclosed."
[4] Total adjusted to avoid duplicating value of clays and stone used in manufacturing cement and lime.
[5] Revised figure.

[1] Commodity-industry analyst, Bureau of Mines, Pittsburgh, Pa.
[2] Statistical clerk, Bureau of Mines, Pittsburgh, Pa.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal.—Coal production decreased slightly from 1959. Captive production for the metallurgical market increased 7 percent but did not compensate for a 2-percent decline in commercial output. Although total output decreased, the number of mines increased significantly from 1,464 to 1,700. The increase was chiefly in small underground mines as many miners, who were out of work because of increasing mechanization in the larger mines, opened pits and produced small tonnages for local markets.

Underground-mined tonnage comprised 92 percent of total production; strip, 6 percent; and auger, 2 percent. The average value of coal production dropped from $5.19 to $5.02 per ton, reflecting a continuance of cost-cutting practices and greater competition for markets.

Over 90 percent of underground production was loaded mechanically. Output by continuous mining increased 6 percent to 32 percent of total mechanically loaded output. There were 55 more continuous miners in use, bringing the total to 315. Most of the new machines loaded directly onto conveyors and into shuttle cars rather than onto the bottom for disposition by mobile loaders. The number of mobile loaders, decreased by 123, and the tonnage loaded by these devices dropped 5 percent to comprise 66 percent of mechanically loaded output. Of the 1,060 mobile machines, 88 loaded into mine cars; 169, onto conveyors; and 803, into shuttle cars. The remaining tonnage was mechanically loaded by 326 hand-loaded face conveyors.

Other equipment at underground mines included 1,865 cutting machines, 2,420 handheld and post-mounted drills, 147 mobile drills, and 703 rotary and 483 percussion roof or rock drills.

The following equipment was used at strip mines: 280 power shovels, 13 dragline excavators, 9 carryall scrapers, 247 bulldozers, 86 horizontal and 58 vertical overburden drills, and 570 trucks of an average of 14-ton capacity, hauling an average of 7 miles from pit to tipple. At auger mines, 101 augers, 23 power shovels, 1 carryall scraper, and 78 bulldozers were used. A total of 210 trucks, average capacity of 14 tons, traveled an average of 6 miles from pit to tipple.

The number of active cleaning plants dropped 14 to 170. Almost

86.5 million tons of coal, 73 percent of total output, was cleaned. Jigs cleaned 37 percent, wetwashing other than jigs, 54 percent; and pneumatic methods, 9 percent. Of total output, 31 percent was crushed and 15 percent was treated, chiefly with oil for dust-allaying purposes.

According to preliminary data, the State coal-mining industry recorded 119 fatal and 4,580 nonfatal lost-time injuries during the year, compared with 86 fatal and 4,800 nonfatal injuries in 1959. An alarming increase in fatality rates over the commendable record of 1959 was evident in the rise from 0.73 to 1.00 fatal injury per million tons of coal mined. Nonfatal injury rates were 60.28 per million man-hours and 38.33 per million tons mined, compared with 56.46 and 40.68, respectively, in 1959. Comparative employment data showed that the average number of men active decreased from 54,800 to 48,100. The average number of days worked per man increased to 200.5 from 196.9. Total man-hours decreased to 76 million from 85 million.

A major disaster occurred in a West Virginia mine on March 8 when a mine fire claimed the lives of 18 men. Preliminary data indicated that 91 of the State's remaining 101 fatalities occurred underground. Of these, 64 were caused by falls of roof, 12 by haulage, 4 by machinery, 3 by electricity, 3 by gas or dust explosions, 2 by falls of face, and 3 by other circumstances. The fatalities occurring in surface facilities associated with the underground mines were caused by haulage (3), machinery (1), and other circumstances (4). The one fatality each occurring at strip and auger mines was caused by machinery.

Two West Virginia mines were among the top five bituminous coal mines in the Nation with the lowest injury-severity rates in the 1960 National Safety Competition. They were (ranking 2d), the Montcoal No. 1 mine of Armco Steel Corp., Montcoal, Raleigh County, which worked 362,508 man-hours without a lost-time injury; and (ranking 5th), the No. 6 mine of United States Steel Corp., Gary, McDowell County, which worked 252,169 injury-free man-hours.

Initial planning was announced for constructing a $125 million-plus coal-slurry pipeline from West Virginia to the east coast. The proposed pipeline, 24 inches in diameter, would move coal 350 miles to utility companies in Pennsylvania, New Jersey, and New York. Partners in the venture were Texas Eastern Transmission Corp. and Consolidation Coal Co.[3]

[3] Oil and Gas Journal, vol. 58, No. 45, Nov. 7, 1960, p. 103.

TABLE 2.—Bituminous coal production, by counties

(Thousand short tons and thousand dollars)

County	1959		1960	
	Quantity	Value	Quantity	Value
Barbour	3,097	$13,413	3,280	$14,067
Boone	6,307	29,892	6,152	28,465
Braxton	132	555	235	997
Brooke	371	2,070	541	2,599
Fayette	4,809	25,178	4,642	22,664
Gilmer	422	1,537	957	4,038
Grant	75	244	(1)	(1)
Greenbrier	671	3,036	852	3,581
Hancock			1	6
Harrison	6,539	28,636	6,296	27,719
Kanawha	9,393	45,064	9,378	42,546
Lewis	954	3,239	605	2,023
Lincoln			25	115
Logan	16,681	78,699	16,378	74,410
Marion	9,348	50,431	9,020	49,022
Mason	497	1,606	440	1,540
McDowell	13,522	92,180	13,318	87,923
Mercer	799	4,199	642	3,949
Mineral	49	205	81	294
Mingo	6,556	32,037	5,803	29,504
Monongalia	7,277	37,147	6,901	34,481
Nicholas	4,802	23,852	4,929	24,637
Pocahontas	451	1,842	376	1,592
Preston	2,308	8,223	2,730	9,559
Putnam	66	298	66	299
Raleigh	6,518	39,897	6,631	36,724
Randolph	914	4,738	1,213	6,098
Taylor	75	274	138	521
Tucker	146	415	259	918
Upshur	1,083	4,769	1,093	4,687
Wayne	73	280	49	229
Webster	431	2,476	(1)	(1)
Wyoming	10,886	64,031	10,684	57,430
Undistributed [2]	4,441	20,540	5,229	24,585
Total	119,692	621,003	118,944	597,222

[1] Included with "Undistributed."
[2] Includes data for Clay, Marshall, and Ohio Counties, and Counties indicated by footnote 1.

TABLE 3.—Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Year	Quantity	Value
1951–55 (average)	138,858	$696,733	1958	119,468	$635,201
1956	155,890	824,043	1959	119,692	621,003
1957	156,842	875,587	1960	118,944	597,222

Coke and Coal Chemicals.—Four oven-coke plants with 691 ovens were active, 51 ovens less than in 1959. Oven-coke production was 2,758,002 tons, a decrease of 10 percent from 1959. Average value per ton at the ovens was $17.43, an increase of $0.87 per ton. A total of 4,038,073 tons of coal was carbonized (average yield 68.3 percent). Recovered products at the oven-coke plants included 168,889 tons of coke breeze, almost 47 billion cubic feet of coke-oven gas; 41,483 tons of ammonium sulfate equivalent, 41,252,265 gallons of coke-oven tar, and 12,012,892 gallons of crude light oil from which were derived 7,521,720 gallons benzene, 2,143,073 gallons toluene, 665,239 gallons xylene, and 72,002 gallons of solvent naphtha (crude and refined).

Pennsylvania provided almost three-fourths of the coking coal requirements in West Virginia. However, West Virginia was the

leading coking coal-producing State; Pennsylvania, Ohio, and Indiana, consumed large tonnages.

Wheeling Steel authorized Koppers Co. to rebuild a battery of 51 coke ovens at its East Steubenville plant. The existing No. 3 battery of an original 6-battery plant of 314 ovens was to be replaced.

Petroleum and Natural Gas.—Production of petroleum increased 6 percent, and natural gas production increased 2 percent. Total production of natural gas liquids increased because of a 7 percent increase in output of LP-gases. Natural gasoline production dropped 21 percent.

The number of well completions increased by 78 to 884. Only 11 of these were wildcat completions. Of total completions, 686 were gas, 78 were oil, 94 were dry holes, and 26 were service wells. Total footage drilled was 2,161,149, an average of 2,445 feet per well. Drilling was done chiefly with cable-tool rigs; 880 wells were completed by this method. Lewis County led in total completions with 141, followed by Doddridge, 107; Wayne, 94; Ritchie, 83; and Calhoun, 74.[4]

According to the American Petroleum Institute and the American Gas Association, reserves on December 31, 1960, were 1,831,125 million cubic feet of natural gas; 51,433,000 barrels of petroleum, and 44,734,000 gallons of natural gas liquids.

NONMETALS

Cement.—Production of portland and masonry cements decreased 3 percent. Shipments from the one plant, in Berkeley County, were mostly non-air-entrained, general use, and moderate heat types, principally to Maryland, Virginia, and the District of Columbia. Consumers were chiefly ready-mixed concrete companies. Concrete product manufacturers and building material dealers also consumed significant quantities.

Clays.—Total production of clays increased 5 percent. Production of fire clay for firebrick and block and foundries and steelworks rose to meet the demand of renewed steel production, but fire clay output for building brick dropped. Miscellaneous clay production for heavy clay products (mainly building brick) increased 19 percent, but output for cement manufacture dropped 19 percent.

Fire clay was mined at three underground mines and one open pit in Kanawha and Hancock Counties. Miscellaneous clay was mined at seven open-pit mines in Berkeley, Cabell, Mercer, Lewis, and Taylor Counties.

TABLE 4.—Clays sold or used by producers

Year	Fire clay		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951–55 (average)	545,555	$1,931,719	324,258	$312,173	869,813	$2,243,892
1956	428,033	2,171,942	341,485	277,266	769,518	2,449,208
1957	402,581	2,445,427	304,952	245,182	707,533	2,690,609
1958	264,107	1,732,634	245,699	227,340	509,806	1,959,974
1959	328,792	2,178,974	266,932	312,970	595,724	2,491,944
1960	346,053	2,328,865	279,570	310,341	625,623	2,639,206

[4] Oil and Gas Journal, Review Forecast: Vol. 59, No. 5, Jan. 30, 1961.

Gem Stones.—Quartz crystal and miscellaneous gem materials were collected by hobbyists at scattered locations throughout the State.

Lime.—Lime production increased 3 percent, owing to increased output (12 percent) for chemical and industrial uses. The refractory market was virtually unchanged from 1959. Output of quicklime for agricultural uses was only a fraction of the preceding year's output. Two producers operated in Berkeley County, and one operated in Jefferson County.

Natural Salines.—Elemental bromine, ethylene dibromide, miscellaneous bromide compounds, and calcium-magnesium chloride were produced from well brines at South Charleston. Output of the double salt decreased, but bromide materials increased 15 percent.

Salt.—An improved market for chlorine, the chief end product of brine salt, brought about a 13-percent increase in salt production. Three companies, two in Marshall and one in Kanawha, produced salt in brine for chlorine manufacture. One company in Mason County produced evaporated salt for sales to feed dealers and water-softener manufacturers.

Sand and Gravel.—Production of sand and gravel decreased for the third consecutive year. Output was 7 percent lower than that of 1959, as gravel output dropped sharply. Paving gravel output decreased 35 percent in sharp contrast to paving sand production which increased 39 percent. Building sand and gravel decreased 7 percent and 17 percent, respectively, but building comprising 53 percent of the total remained as the most important use for sand and gravel. Significant tonnages of glass sand and ground sand also were produced.

There were 27 commercial operations active in 18 counties. In addition, the State Road Commissioner of West Virginia reported Government-and-contractor production in six counties. Hancock County led in production, followed by Morgan, Wood, Cabell, and Ohio. Morgan County with its valuable glass sand deposits led in value of production.

TABLE 5.—Sand and gravel sold or used by producers, by classes of operations and by uses

Class of operations and use	1959		1960	
	Short tons	Value	Short tons	Value
Commercial operations:				
Sand:				
Building	1,348,426	$1,639,914	1,254,507	$1,475,835
Paving	273,583	474,545	380,538	574,109
Fire or furnace	44,813	64,104	29,196	33,575
Engine	98,143	278.061	117,827	328,228
Gravel:				
Building	1,339,069	1,506,153	1,116,174	1,287,348
Paving	482,507	945,462	313,690	519,188
Fill			7,104	12,397
Undistributed [1]	1,267,511	5,604,812	1,194,362	5,481,000
Government-and-contractor operations:				
Gravel:				
Fill			1,350	500
Paving			91,400	90,280
Total sand and gravel	4,854,052	10,513,051	4,506,148	9,802,460

[1] Includes blast, glass, molding, ground, and other sands, railroad-ballast gravel, and other gravel.

Stone.—A heavy demand for roadstone caused a 35-percent increase in stone production. Limestone output, which comprised 87 percent of total, increased 28 percent over 1959. Instrumental in this increase was over 500,000 tons of Government-and-contractor output. Leading uses for limestone were concrete aggregate and roadstone, flux, and cement and lime manufacture. Commercial production of crushed sandstone, chiefly for roadbuilding, decreased considerably, but, combined with almost 650,000 tons of Government-and-contractor production for roadbuilding, total production of sandstone more than doubled. A small quantity of dimension sandstone was produced for rough construction.

Leading counties for limestone production were Berkeley, Jefferson, and Greenbrier. Leading sandstone-producing counties were Lewis, Harrison, and Kanawha.

TABLE 6.—Stone sold or used by producers, by uses

Use	1959		1960	
	Short tons	Value	Short tons	Value
Crushed and broken stone:				
Flux	2,091,241	$3,926,152	2,231,617	$4,164,780
Concrete and roadstone	2,327,733	3,951,001	3,711,942	6,003,084
Railroad ballast	115,959	177,315	(1)	(1)
Agriculture	(1)	(1)	87,374	223,742
Other [2]	227,495	493,162	314,777	919,085
Undistributed [3]	1,160,565	1,934,229	1,655,348	2,689,957
Total	5,922,993	10,481,859	8,001,058	14,000,648

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Includes limestone for miscellaneous uses (asphalt filler, masonary mortar (1959) coal dust, and stone sand.
[3] Includes limestone used for cement and lime, riprap, calcareous marl (1960), refractory sandstone (1960) and uses indicated by footnote 1.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. completed its first full year of operation at its four-potline primary aluminum plant at Ravenswood, W. Va. Yearly capacity of the plant, which was completed in 1959, was estimated at 145,000 tons of aluminum per year.

Ferroalloys.—Union Carbide Metals Co. and Vanadium Corporation of America produced a wide variety of ferroalloys at Alloy and Graham, respectively, in electric furnaces.

Iron and Steel.—Weirton Steel Co., Division of National Steel Corp., began operating a new continuous annealing line enlarging its capacity to produce annealed tin, for which there was an increasing demand. A new 650-ton-per-day oxygen plant was to begin operating in 1961, bringing total oxygen supply for the 14 open-hearth furnaces to 1,100 tons of oxygen per day. One of four company blast furnaces was blown out for enlarging and relining after 8 years of continuous operation, a new record for the steel industry.

Zinc.—Matthiessen & Hegeler Zinc Co. operated a vertical-retort zinc smelter at Meadowbrook.

Zirconium.—Carborundum Metals Co., Inc., produced zirconium sponge at its plant in Wood County from Florida zircon.

REVIEW BY COUNTIES

Barbour.—Coal production increased 6 percent as the number of active mines increased by 14 to 66. Underground mining supplied 74 percent of total output; strip mining, 23 percent; and auger mining, 3 percent. Significant new mines were opened by Virgil Harris Coal Co., Marino Coal Co., and Turkey Run Coal Co., Inc. The Glen Cambria mine which had been abandoned by Mountain Fuel Co. in 1959 was taken over by McGraw Coal Co. The Lechiara Coal Co. abandoned its Carol mine at yearend.

Over 80 percent of the underground tonnage was loaded mechanically. Badger Coal Co. added two continuous miners, bringing the county total to five, which furnished one-third of the mechanically loaded total. The remainder was handled by mobile loading machines. Forty-two percent of total production was mechanically cleaned, 70 percent was crushed, and 10 percent was treated. The first-aid teams of the Compass No. 1 mine of Clinchfield Coal Co. won the State and National first-aid contests.

Crushed sandstone was produced at a portable plant near Belington by Feather Construction Corp. for road construction.

TABLE 7.—Value of mineral production in West Virginia, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value[2]
Barbour	$13,665,634	(3)	Coal, stone.
Berkeley	13,033,424	$13,201,040	Cement, stone, lime, clays.
Boone	29,891,948	28,464,570	Coal.
Braxton	555,012	996,489	Do.
Brooke	2,133,681	2,653,998	Coal, sand and gravel.
Cabell	(3)	(3)	Sand and gravel, clays.
Calhoun	70,728	----	
Clay	(3)	(3)	Coal.
Fayette	25,178,142	22,663,682	Do.
Gilmer	1,601,889	4,084,911	Coal, stone.
Grant	257,517	(3)	Do.
Greenbrier	(3)	(3)	Coal, stone, sand and gravel.
Hampshire	(3)	(3)	Stone.
Hancock	(3)	(3)	Clays, sand and gravel, coal.
Hardy	(3)	13,450	Stone.
Harrison	28,635,986	(3)	Coal, stone.
Jackson	----	46,606	Stone:
Jefferson	(3)	(3)	Stone, lime.
Kanawha	46,897,708	44,746,934	Coal, salt, bromine, stone, clays, calcium chloride, sand and gravel.
Lewis	3,432,982	(3)	Coal, stone, clays.
Lincoln	11,573	205,164	Coal, stone, sand and gravel.
Logan	78,698,697	74,418,020	Coal, sand and gravel.
Marion	50,430,723	49,073,971	Coal, stone.
Marshall	(3)	(3)	Coal, salt, stone.
Mason	(3)	(3)	Coal, salt, sand and gravel.
McDowell	92,179,969	87,764,959	Coal.
Mercer	4,199,793	4,052,558	Coal, stone, clays.
Mineral	(3)	(3)	Stone, coal.
Mingo	32,036,918	29,523,832	Coal, sand and gravel.
Monongalia	(3)	35,567,353	Coal, stone, sand and gravel.
Morgan	(3)	(3)	Sand and gravel, gem stones.
Nicholas	23,861,766	24,646,076	Coal, sand and gravel.
Ohio	(3)	(3)	Do.
Pendleton	26,623	94,609	Stone.
Pleasants	----	(3)	Sand and gravel.
Pocahontas	1,842,127	1,595,260	Coal, sand and gravel.
Preston	8,481,813	(3)	Coal, stone.
Putnam	297,599	299,031	Coal.
Raleigh	39,932,401	(3)	Coal, stone, sand and gravel.
Randolph	(3)	(3)	Coal, stone.
Roane	68,888	48,190	Stone.
Taylor	273,985	(3)	Coal, stone, clays.
Tucker	414,671	954,982	Coal, stone.
Tyler	----	(3)	Sand and gravel, stone.
Upshur	4,834,237	4,686,820	Coal.
Wayne	(3)	(3)	Coal, sand and gravel.
Webster	2,475,556	(3)	Coal, stone.
Wetzel	(3)	(3)	Sand and gravel, stone.
Wirt	44,873	22,200	Stone.
Wood	1,190,564	(3)	Sand and gravel.
Wyoming	(3)	(3)	Coal, sand and gravel.
Undistributed	230,958,865	290,849,265	
Total	[4] 737,616,000	720,674,000	

[1] Doddridge and Ritchie Counties not listed, as no production was reported.
[2] Excludes natural gas, natural-gas liquids, petroleum, some gem stones and stone (1960) not assigned to specific counties, included with "Undistributed."
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Revised figure.

Berkeley.—Standard Lime & Cement Co., Martinsburg, was the sole cement producer in the State. Output decreased slightly in 1960. The company operated five kilns; a sixth kiln was down for repairs the entire year. The bulk of the output was shipped to Maryland, Virginia, and the District of Columbia to ready-mixed concrete companies, concrete product manufacturers, building material dealers, and highways contractors.

The county continued to lead in limestone production. Plants of Standard Lime & Cement Co., Blair Limestone Division of Jones & Laughlin Steel Corp., W. S. Frey Co., and J. E. Baker Co. crushed limestone, mainly for cement and lime manufacture and for metallurgical uses. Blair Limestone put two new gas-fired limestone kilns into operation; these new kilns doubled lime capacity and should improve quality. The two kilns, with a yearly capacity of 72,000 tons of burned lime for Jones & Laughlin furnaces in Pittsburgh and Aliquippa. The gas-fired kilns reportedly reduced the sulfur content of the burned lime, thus increasing efficiency of steelmaking furnaces; they replaced 11 coke-fired kilns. Standard Lime & Cement Co. also manufactured lime. County lime production decreased 10 percent.

Standard Lime & Cement Co. mined shale for cement manufacture, and Continental Clay Products Co. and United Clay Products Co. mined miscellaneous clay for building brick. Clay output increased significantly.

Boone.—Although coal production decreased 2 percent, the county increased in rank from 10th to 9th. Underground tonnage from 33 mines comprised almost 90 percent of total output. The only strip mine was operated by Glenn Brooke Coal Co. There were five active auger mines. The Red Parrot mines (underground and auger) of North American Coal Corp. were abandoned in October, and the company Red Cedar mine was closed all year, idling an average of 375 men. The Westmoreland Coal Co. opened the Hampton No. 2 underground and auger mines in November, employing 26 and 12 men, respectively. Ninety-seven percent of the underground tonnage was mechanically loaded. The number of continuous miners rose from 6 to 17 as Eastern Gas & Fuel Associates added 10 and Armco Steel added 1. However, 56 mobile loading machines loaded over three-fourths of the mechanically loaded coal. There were seven active cleaning plants, one less than in 1959 owing to the closing of the North American Red Cedar mine. Eighty-nine percent of the county tonnage was cleaned; 24 percent was crushed; and 5 percent was treated.

Braxton.—Coal production increased 78 percent because of increased production by Guardian Coal Co. at a mine formerly operated by Cedar Creek Coal Co. There were nine mines: seven underground (an increase of two over 1959), one strip, and one auger. Jigs and other wetwashing methods were used at the Guardian Coal Co. cleaning plant. Two mobile loading machines, loading into shuttle cars, and 2 hand-loaded face conveyors, loaded almost nine-tenths of the underground tonnage. Four-fifths of the county output was crushed, and one-third was treated with calcium chloride.

Brooke.—Coal production increased 46 percent and the number of mines rose by 3, to 12. Underground mines furnished 56 percent of the output; strip mines, 41 percent; and auger mines, 3 percent. Captive coal for power generation was mined from the Pittsburgh No. 8 seam by Windsor Power House Co. The Half Moon cleaning plant and the Beech Bottom cleaning plant of Windsor Power House operated jigs and an R. & S. Hydro Separator, respectively. Ninety-four percent of the underground output was mechanically loaded into shuttle cars by six mobile loading machines.

Sand for fire or furnace use and building and fill gravel were produced by the Brilliant Sand Co.

Cabell.—Sand and gravel production, chiefly for building and paving, increased slightly. Producers were Ohio River Dredging Co. and Union Sand & Gravel Co. both of Huntington. Sand comprised about two-thirds of county output; gravel, the remainder.

Miscellaneous clay (red shale) was mined by Barboursville Clay Mfg. Co. for building brick.

Clay.—County coal mines increased by 3, to 11. Elk River Coal & Lumber Co. was the largest of eight underground producers. The company also operated one of the county's two auger mines but abandoned the auger in April. There was one strip mine. Underground tonnage, which comprised nine-tenths of output, was mined from the Kittanning seams. About nine-tenths of the output was cleaned at the Rich Run cleaning plant of Elk River Coal & Lumber Co., which employed dense-medium washers. Ninety-two percent of output was crushed, and 80 percent was treated with oil. Eighteen mobile loaders loaded 90 percent of the underground tonnage into shuttle cars, and four hand-loaded face conveyors handled 3 percent.

Fayette.—Coal production declined 3 percent even though the number of mines increased by 19 to 148. Of the total tonnage, 97 percent came from 139 underground mines. The remainder was from three strip and six auger mines. In June, Eastern Gas & Fuel Associates abandoned its operations in the county when it closed the Beards Fork mine, idling 240 men. The Layland and Minden mines of New River & Pocahontas Consolidation Coal Co. were abandoned during the year. Eel River Mining, Inc., abandoned its Long Branch strip mine in January and opened the Gamoco strip and auger mines in June. Seventy-eight percent of the underground coal was mechanically loaded. Of this quantity, mobile loaders handled 85 percent; continuous miners, 10 percent; and hand-loaded face conveyors, the remainder. Jigs cleaned 26 percent and wetwashing other than jigs cleaned 38 percent of the output. Twenty percent was crushed; 11 percent was treated mostly with oil.

Gilmer.—Among the coal-producing counties, production from Gilmer increased the most (126 percent), because output from Rochester & Pittsburgh Coal Co. was over four times that of 1959. Output from 13 underground mines comprised 82 percent of the county total; the remainder came from 2 strip mines (9 percent) and 2 auger mines (9 percent). Jigs were used at the O'Donnell plant of Rochester & Pittsburgh Coal Co. to clean its underground, strip, and auger output.

615629—61——71

Three-fourths of the county underground coal was mechanically loaded by one continuous miner and four mobile loading machines. Forty-six percent of the county total was crushed.

Sandstone was crushed for use as concrete aggregate by Basil R. Heavner. The State produced sandstone for use in concrete and as roadstone.

Grant.—The number of mines decreased from seven to five, causing a decrease in production. Lindsey Coal Mining Co., the largest producer, operated the only strip mine. The largest of the four underground mines was that of Moomau Coal Co.

Limestone from the two quarries of the Beans Lime & Stone Co., Inc., Moorefield and Petersburg, and of Keplinger & Co., Maysville, was crushed for use in concrete as roadstone and for agricultural purposes.

Greenbrier.—Coal production increased 27 percent, because 27 new mines were active. Although only seven were strip mines, strip tonnage comprised 41 percent of total output. In comparison, 96 underground mines produced 58 percent. The only auger mine was operated by Beech Run Coal Co. The Lafayette Springs Coal Co. strip mine was by far the leading producer. Strip mining utilized 17 shovels, 4 draglines, 18 bulldozers, and 23 trucks with average capacity of 18 tons. Underground mines were small hand-loading operations, except four mines which employed mechanical loading methods. Lafayette Springs Coal Co. and Leckie Smokeless Coal Co. operated cleaning plants where over half the total production was cleaned by wetwashing methods. Seventeen percent of the output was crushed. Anjean Coal Co. took over operation of the Leckie Smokeless Coal Co. preparation plant on November 1 and acquired more than 20 small underground operations during the year.

Limestone produced by H. Frazier Co., Inc., was used for railroad ballast. Output from the Snow Flake quarry of Acme Limestone Co. was used for concrete aggregate, railroad ballast, agricultural purposes, dust for coal mines, and stone sand. The Fort Spring Stone Co. produced dimension sandstone (rough blocks for construction). Gravel for State roads was produced by the State Road Commission.

Hampshire.—Crushed limestone for concrete and roadstone was produed by Terra Alta Limestone Co. and Williams Quarry, Inc., from operations near Forks Capon, and Romney, respectively. Output increased significantly over 1959.

Hancock.—Clay production increased 24 percent, and sand and gravel output decreased 13 percent. Despite the lower production of sand and gravel, the county remained the leader in production of both commodities. Fire clay for refractories was mined by The Globe Brick Co., Newell, and Crescent Brick Co., Inc., and West Virginia Fire Clay Manufacturing Co., both of New Cumberland. The refractory clay industry in the county depended chiefly upon the steel industry. The market was firm as the year began, but slowed as the year progressed.

The number of sand and gravel producers increased to three with the addition of a new stationary plant by Volino Brothers near Newell. The Dravo Corp. Nos. 9 and 16 plants and Arroyo Sand & Gravel Co. continued operations. Sand comprised 55 percent and gravel 45 percent of production. Except for a small quantity for fill, output was used for building purposes.

Coal was mined by the Velegol Coal Co. from the Freeport seam.

Hardy.—The State Soil Conservation Potomac Valley District crushed limestone at its Baker plant for agricultural purposes.

Harrison.—Harrison County ranked eighth in coal production. Output decreased 4 percent. The number of mines remained at 102 (70 underground, 23 strip, and 9 augers). Of the total, underground production comprised 81 percent and strip production, 16 percent. Strip pits used 34 power shovels, 5 draglines, 39 bulldozers, and 116 trucks. About nine-tenths of the underground coal was mechanically loaded, of which 78 percent was loaded by mobile loaders and 22 percent by continuous miners. There were 7 continuous miners and 68 mobile loading machines. Fifty-eight percent of the output was cleaned by wetwashing methods. Galloway Land Co. used pneumatic cleaning for the first time.

Feather Construction Corp., Wolfe Summit, and North View Stone Co. crushed sandstone for concrete aggregate and roadstone. The State Road Commission produced sandstone for paving.

Jackson.—Sandstone was crushed for paving by the State Road Commission.

Jefferson.—Jefferson County was the second largest stone producer. Firms were U.S. Steel Corp., Michigan Limestone Division; Jones & Laughlin Steel Corp., Blair Limestone Division; and American-Marietta Co., Standard Lime & Cement Co. Division. Output was used for metallurgy, the manufacture of dead-burned dolomite, railroad ballast, concrete aggregate and roadstone, and for agricultural purposes. Over four-fifths was shipped by railroad.

Output of calcareous marl by West Virginia Lime Co. decreased considerably. The product was sold in raw sun-dried condition for agricultural purposes.

Kanawha.—Kanawha County ranked fourth in coal production. Virtually the same tonnage was produced as in 1959 although an additional 19 mines were active, bringing the total to 120. Ninety percent was mined by 111 underground mines; the remainder came from 6 auger and 3 strip mines. The Dana No. 1 mine of Amherst Coal Co. was abandoned in March, idling 180 men. Auger No. 6 was opened by Carbon Fuel in June employing an average of 40 men. Imperial Colliery Co. purchased the No. 2 underground mine from Wyatt-Seanor Coal Co. in May. Oglebay Norton Co. closed its No. 11 underground mine and opened the No. 12 underground mine in November. The four leading producers mined over 1 million tons of coal each and furnished over half the underground production. Continuous miners, which increased to 15 with the addition of 1 by Cannelton Coal Co., loaded 13 percent of the underground-mined

615629—61——72

coal. Mobile loading machines (118) handled 78 percent, and the remainder was taken care of by 26 hand-loaded face conveyors and hand loading into mine cars. Sixty-three percent of the coal was cleaned (69 percent by jigs, 20 percent by wetwashing other than jigs, and 11 percent by air methods); 40 percent was crushed, and 11 percent was treated with oil.

Westvaco-Chlor-Alkali Division, Food Machinery & Chemical Corp., increased salt output for manufacturing chlorine. Bromine, bromine compounds, and calcium-magnesium chloride also were produced.

Tony Pacifico opened a stone quarry near Charleston and produced crushed sandstone for use in furnaces and irregular-shaped stone for buildings. Mazzela Quarries, Inc., South Charleston, crushed sandstone for concrete aggregate.

Fire clay was mined near Charleston by West Virginia Brick Co. and Charleston Clay Products Co. An over-heated stove sent flames through part of the West Virginia Brick Co. plant and caused damage estimated at $175,000. A 320-foot-long warehouse, a railroad loading dock, the plant office, two railroad cars, an 1,800-foot-long conveyor belt, and a mine tipple were destroyed.

Engine sand was produced by the St. Albans Sand Co. The company discontinued business on May 3. Building sand was produced by the Charleston Sand Corp. near Big Chimney.

Lewis.—Active coal mines increased by one to nine, but production decreased 36 percent. Three each—strip, auger, and underground mines—supplied 64 percent, 34 percent, and 2 percent of output, respectively. Stripping operations used 16 power shovels, 16 bulldozers and 26 trucks with an average capacity of 13 tons. In the auger mines, five augers were used along with 9 bulldozers and 17 trucks. Jigs cleaned more than one-fourth of the total output.

Sandstone was crushed for use on State roads by Feather Construction Corp. and Weston Stone Co. Miscellaneous clay for building brick and tile and draintile was mined by Weston-Jane Lew Brick & Tile Co. at mines Nos. 1 and 2 near Weston and Jane Lew.

Lincoln.—Coal was dredged from the Guyandot River by Davis & Adkins Coal Co., Dial Coal Co., Rebel Coal Co. and Sand Dredging Operation Co.

The State Road Commission produced crushed sandstone for road paving. Engine sand was produced by Davis & Adkins Sand Co., Ferrellsburg, and sand for industrial use was produced by Hal Dial & Sons Co., Branchland.

Logan.—Although coal production decreased slightly (2 percent), the county maintained first place for the sixth consecutive year. The number of mines decreased by 10 to 70. Sixty-four underground mines furnished 96 percent of the total production. Output from one strip mine, operated by Boone County Coal Corp., and five auger mines composed the remainder. Three-fourths of the underground coal was produced, in order of decreasing output, by the following companies: Island Creek Coal Co.; Amherst Coal Co.; Omar Mining Co.; Princess Coals, Inc.; and Lorado Coal Mining Co. An average of 3,490 men

were employed in the 23 mines operated by these companies. The Amherst Coal Co. Auger No. 2 was abandoned in December. The Lorado Coal Mining Co. opened an underground mine (No. 5) in July. Six percent of the underground tonnage was loaded by 12 continuous miners, 5 more than in 1959; Amherst Coal Co. added 3 and Island Creek Coal Co. and Omar Mining Co. added 1 each. Ninety-three percent of the output was loaded by 179 mobile loading machines. The remainder was hand-loaded into mine cars and onto face conveyors. Twenty-one cleaning plants prepared 92 percent of the coal. One-fifth was crushed, and 14 percent was treated with oil and a combination of oil and calcium chloride.

Gravel for roads was produced by the State Road Commission.

Marion.—Coal production decreased 4 percent, but the county continued to rank fifth. There were 12 mines (10 underground and 2 strip), 3 less than in 1959. Almost all the coal was mined mechanically from the underground mines of Mountaineer Coal Co. (four mines), Bethlehem Minerals (two mines), Eastern Gas & Fuel Associates, Joanne Coal Co., Rochester & Pittsburgh Coal Co., and Corwin Coal Co., Inc. Equipment included 45 mobile loading machines loading 31 percent and 42 continuous miners loading 69 percent. In addition, 32 mobile loaders were used in conjunction with the continuous miners. Two-thirds of the total production was cleaned, of which jigs and wetwashing other than jigs cleaned 47 percent each and pneumatic methods, 6 percent. Forty-six percent of the coal was crushed. In December, Eastern Gas & Fuel Associates began constructing a multimillion dollar coal-cleaning plant. When in full production, the plant was to process 12,500 tons of coal per day with a heavy-medium washer, concentrating tables, and froth flotation.

Sandstone was crushed by the State Road Commission.

Marshall.—Underground coal mines were operated by Hanna Coal Co., Division of Consolidation Coal Co., Valley Camp Coal Co., and West Virginia State Penitentiary. Almost all the coal was mechanically loaded by 2 mobile loaders and 19 continuous miners (an increase of 3 miners). Four-fifths of the coal was cleaned by jigs, chance cones and concentrating tables; almost three-fourths was crushed.

Output of salt increased slightly. Columbia Southern Chemical Corp., New Martinsville, and Solvay Process Division of Allied Chemical Corp. continued to produce salt in brine for use in manufacturing chemicals, chiefly chlorine. Solvay announced plans for new facilities to increase production by 20,000 tons per year. A 40 percent increase in capacity for chlorinated methanes also was planned.

The State Road Commission crushed sandstone for concrete aggregate and roadstone.

Mason.—Coal output dropped 11 percent. Nine underground mines produced 83 percent of the total; one strip and two auger mines produced the remainder. Of the underground output, over nine-tenths was mechanically loaded by 11 mobile loading machines. Seventy-eight percent of the total was crushed.

The Liverpool Salt Co. evaporated salt production was sold to feed dealers and mixers and water-softener manufacturers. Sand and gravel for road paving was produced by Letart Sand & Gravel Co., Inc., New Haven.

McDowell.—McDowell ranked second among the coal-producing counties in tonnage but led in value. Thirty-two additional mines brought the total active to 184, the most in any county. Of this number, 168 were underground mines from which 95 percent of the total production was loaded. The remainder was mined by nine strip and seven auger mines. U. S. Steel Corp. was the leading producer, followed by Island Creek Coal Co., Olga Coal Co., and Eastern Gas & Fuel Associates. Companies and mines closed in 1960 were: U. S. Steel Corp., No. 6 mine in July (210 men idled); New River & Pocahontas Consolidation Coal Co., No. 6 mine in March and No. 9 mine in June (156 idled); Pocahontas Fuel Co., Peerless mine in April and Amnonate mine in August (556 men idled). No large mines were opened. Over nine-tenths of the underground tonnage was loaded mechanically. Of this total, 61 percent was cut and loaded by 74 continuous miners, 14 more than in 1959. Eastern Gas & Fuel Associates, Island Creek Coal Co., Olga Coal Co., and U. S. Steel Corp. installed the additional machines. Thirty-seven percent of the coal was loaded by 82 mobile-loading machines (38 less than in 1959). The remainder was loaded by 4 duckbills and 17 hand-loaded face conveyors. A total of 23 cleaning plants (2 more than in 1959) cleaned 86 percent of the output. Forty-three percent of the coal was crushed, and 50 percent was treated.

Mercer.—Coal mines increased from 16 to 25, but production decreased 20 percent. Ninety percent of the total was mined by 22 underground mines. The remainder was mined at two strip and one auger mines. Nine-tenths of the underground coal was loaded by 15 mobile loading machines and 1 continuous miner. Four cleaning plants cleaned most of the output. The Arista mine of Weyanoke Coal & Coke Co. closed for an indefinite period in August, idling 122 men.

The Oakvale Stone Co., Princeton, crushed limestone for concrete and roadstone. The Virginian Brick & Tile Co. mined miscellaneous clay near Princeton for building brick and heavy clay products.

Mineral.—Production of limestone increased significantly. Aurora Stone Co., near Thomas, and Spencer Lime Co., Keyser, crushed limestone for use in ceramics, concrete, and roadstone plus a small tonnage of agstone.

Although the number of active coal mines dropped from nine to five, production increased significantly owing to output of the new strip operation of Walter H. Duncan, Inc. Output from two hand-loaded underground mines and one auger mine comprised 16 and 18 percent, respectively, of the remaining tonnage.

Mingo.—Because coal production decreased 11 percent, despite the addition of 46 mines, Mingo County dropped from 7th to 10th place among the coal-producing counties. Total active mines increased to 94, but the additional mines were small, and the leading operators

were idle part of the year. The Junior mine of Island Creek Coal Co. was abandoned in April; the Massey Coal Mining Co. No. 1 mine closed temporarily in June; the Ben Creek No. 2 strip mine ceased operation in August; the Alma mine of the Sycamore Coal Co. closed in July; and the S.B. & O. Coal Co. mine was abandoned in January. Of total output, 97 percent was mined at 88 underground mines. Output of five auger and one strip mine comprised the remainder. The largest producers were Island Creek Coal Co., Massey Coal Mining Co., Crystal Block Coal & Coke Co., and Ames Coal Co. Six continuous miners and 50 mobile loading machines loaded 93 percent of the underground coal. Eleven cleaning plants, one less than in 1959, cleaned 91 percent of the coal; 20 percent was crushed.

Engine sand was produced by Guyan Valley Sand Co., Gilbert. Gravel was produced for paving roads by the State Road Commission.

Monongalia.—Coal production decreased 5 percent, but the county continued to rank sixth. Almost the entire output came from 64 underground mines, of which the leading were the Christopher Coal Co. Pursglove No. 15, Osage No. 3, Humphrey No. 7, Booth No. 6, and Arkwright No. 1, which combined employed 1,115 men. The Christopher Coal Co. Booth No. 6 mine was abandoned in August, and the South Union Coal Co. No. 11 and No. 12 mines were abandoned in January and April, respectively. The Maiden No. 1 mine of Valley Camp Coal Co. was sold to Petitte Coals, Inc., in August. The number of cleaning plants, which dropped by two to seven, cleaned 70 percent of the coal. Continuous miners, which increased to 29 with the addition of 2 by Christopher Coal Co., loaded 70 percent of the underground coal. Of the remainder, 18 mobile loading machines loaded 26 percent and 4 percent was hand-loaded. Twenty-two percent of the coal was crushed.

Limestone was crushed, mainly for use as concrete aggregate and roadstone, by Greer Limestone Co. in Greer. Lambert Bros, Inc., was not active. Keeley Construction Co. did not operate its sandstone quarry in 1960. The company reported it was no longer in the stone-quarrying business.

Deckers Creek Sand Co. produced glass and engine sands at a stationary plant near Masontown.

Morgan.—Production of glass sand by the Pennsylvania Glass Sand Co. Berkeley Works increased slightly. Output was used chiefly for glass manufacture and for grinding for abrasives.

Quartz crystals were collected by Raymond W. Grant near Berkeley Springs.

Nicholas.—An additional 20 mines brought the county total to 111 and increased production 3 percent. Ninety-nine underground mines, the largest of which were operated by Maust Coal & Coke Corp., Johnstown Coal & Coke Co., Imperial Smokeless Coal Co., and Sewell Coal Co., mined over nine-tenths of the output. Five strip and seven auger mines produced the remainder. The number of cleaning plants dropped to eight, which prepared slightly over half the total output. Over 80 percent of the underground output was mechanically loaded, of which 71 percent was loaded by 60 mobile loading machines; 16

percent, by 131 hand-loaded face conveyors; and 13 percent, by 7 continuous miners. Nineteen percent of the coal was crushed, and 15 percent was treated. The auger mine of Eel River Mining Co. and the strip mine of Quinwood Mining Co. were abandoned in June and December, respectively. Also, Tasa Coal Co. closed its Peerless strip mine.

Building sand was produced by Nettie Sand Co., Nettie. Gravel for fill was produced by the City Engineer of Wheeling.

Ohio.—Coal production increased 7 percent. The strip mine of the Jesuit Fathers of Wheeling College was closed. Valley Camp Coal Co. (two mines) and Dependable Coal Co. were active. Virtually all the coal was cleaned by tables and jigs and loaded by six mobile loading machines. Two-thirds was treated with oil, and one-third was crushed.

Sand and gravel was produced by Delta Concrete Co., Wheeling; Ohio River Sand & Gravel Corp., Parkersburg; and the City Engineer of Wheeling, for building and paving.

Pendleton.—Because a new quarry was opened by Germany Valley Limestone Co., Riverton, limestone production increased sharply. This company along with Ruddle Lime, Franklin, and North Fork Lime Producers, Riverton, crushed limestone for concrete aggregate and roadstone, agricultural purposes, and rock dust for coal mines.

Pleasants.—Sand and gravel was dredged from the Ohio River by Ohio River Sand & Gravel Corp. Output was used mostly for paving. The remainder was used for building, railroad ballast, and fill.

Pocahontas.—The same number of coal mines operated as in 1959, but production decreased 17 percent. Nine of the eleven mines were underground mines, whose output composed the major part of total output. Maust Coal & Coke Corp. was the leading underground producer. One strip and one auger mine were operated by Cherry River Coal & Coke Co. and Erickson & Bowers Co., respectively. Four mobile loading machines and 19 hand-loaded face conveyors loaded three-fourths of the underground tonnage. All coal was mined from the Sewell seam, which averaged 40 inches in thickness.

A small tonnage of gravel was produced by the State Road Commission.

Preston.—The number of coal mines increased from 91 to 105, and production increased 18 percent. Over two-thirds of the total was mined at 87 underground mines. The remainder was mined by 16 strip and 2 auger mines. Chapel Coal Co., Tri-State Mining Co., and Brookside Mining Co., Inc., were the largest underground producers. The largest strip mine was operated by Kingwood Mining Co. Over half the underground coal was hand-loaded; the remainder was mechanically loaded by 8 mobile loading machines and 21 hand-loaded face conveyors. The No. 4 mine of Floyd Fuel Co. was abandoned in February and the No. 1 mine of Bellfield Coal Co., in May. Both mines employed over 20 men.

Output of limestone increased significantly owing to the new operation of Preston Limestone Co., Inc., Kingwood, and greater production by Terra Alta Limestone Co., Aurora. Most of the crushed output was used for concrete and roadstone. A small tonnage was used for agricultural purposes. Irregular-shaped dimension building sandstone was quarried at Aurora by Consolidated Supply Co.

Putnam.—Virtually the same tonnage of coal was mined as in 1959 from 18 underground mines (an increase of 3). All the mines were small hand-loading operations producing less than 10,000 tons each. Mining was from the Pittsburgh No. 8 seam which average 63 inches in thickness.

Raleigh.—Coal production increased 2 percent, and Raleigh County rose to seventh place despite 17 fewer mines. Ninety-six percent of the output came from 113 underground mines. Six auger mines and five strip mines produced the remainder. Two-thirds of the output was produced by four underground operators: Winding Gulf Coals, Inc. (five mines, two of which were the Eastgulf and Mead No. 4, purchased from C. H. Mead Coal Co. in February), Eastern Gas & Fuel Associates (three mines), Slab Fork Coal Co. (one mine), and Armco Steel Corp. (two mines). Of the underground coal, 70 percent was loaded by 74 mobile loading machines; 13 percent, by 18 continuous miners; 6 percent, by 39 hand-loaded face conveyors. The remainder was hand-loaded into mine cars. Almost two-thirds of the coal was cleaned. Of this amount, 40 percent was cleaned by jigs, 30 percent was wetwashed other than by jigs and 30 percent was cleaned by pneumatic methods. Over 100 men were idled because of mine closings by Raleigh Eagle Coal Co., Sterling Smokeless Coal Co., and Crandon Coal Co. Raleigh Pocahontas Mining Co., a newly organized concern, purchased the Affinity, Killarney, and Lillybrook No. 3 mines, which were closed in 1959 by Lillybrook Coal Co. The new company planned to reactivate the No. 3 mine as soon as possible and install a new preparation plant at the Affinity mine, which would eventually process the coal from all three mines.

Sandstone was crushed for concrete aggregate and roadstone by the Table Rock sand plant, Beaver. Beaver Block Co., Beaver, produced building sand.

Randolph.—Because of increased production by Bethlehem Minerals Co. and Peerless Coals, Inc., the county's largest underground mining companies, coal production increased considerably. A total of 22 underground mines produced 83 percent of the total output; 6 strip mines and 3 auger mines produced the remainder. The addition of 1 continuous miner by Peerless Coals, Inc., and 2 by J. T. Coal Co. increased the total to 10, which loaded almost half the underground tonnage. Over one-fourth was loaded by five mobile loading machines; the rest was hand-loaded onto face conveyors and into mine cars. There was no cleaning, but 40 percent of the coal was crushed, and 8 percent was treated with oil.

Elkins Limestone Co. crushed limestone near Elkins chiefly for concrete aggregate and roadstone, plus a small tonnage for road sand.

Roane.—Sandstone was crushed for concrete aggregate and roadstone by Tri-State Stone Corp. at the Roberts quarry near Spencer and by the State Road Commission.

Taylor.—Underground coal production increased 26 percent as Blue Ridge Coal Co., the leading producer, tripled production. Two auger mines were active; none produced in 1959. One-third of the coal was crushed.

The State Road Commission crushed sandstone for concrete aggregate and roadstone. Miscellaneous clay for building brick was mined near Grafton by the Grafton Brick Co.

Tucker.—The new Kempton strip operation, opened on January 1 by Douglas Coal Co., Inc., increased coal production significantly. Two hand-loaded underground mines produced only a small part of the total tonnage. Seven power shovels and one dragline were used at the four strip operations.

Fairfax Sand & Crushed Stone Co. produced crushed sandstone near Thomas for concrete aggregate and roadstone.

Tyler.—Sand and gravel was dredged from the Ohio River by the Ohio River Sand & Gravel Corp. Paving uses consumed most of the output; railroad ballast and fill, the remainder. Crushed sandstone for State roads was produced by the State Road Commission.

Upshur.—Underground mining increased 8 percent, but owing to decreased strip and auger output, there was little change in overall production. Eighty-five percent of the underground coal was mechanically loaded at 4 of the 27 underground mines. Seven mobile loading machines and two continuous miners were active. Reppert Fairmont Coal Co. and Pecks Run Coal Co. were the leading producers. Four cleaning plants prepared 71 percent of the output. Two-thirds was crushed, and a small tonnage was treated.

Corhart Refractories Co., a subsidiary of Corning Glass Works, announced plans in October for constructing a new refractories plant at Buckhannon that would employ 60 persons.

Wayne.—Decreased output by the four underground mines dropped coal production by one-third. Traction and building sands were dredged from the Big Sandy River near Fort Gay by Laval Sand Co., Inc.

Webster.—Output from nine additional mines increased coal production. Twenty underground mines produced most of the coal output. One auger mine also was in operation. The Sewell seam was mined solely. Johnstown Coal & Coke Co., the leading producer, operated the only cleaning plant in the county. Four mobile loading machines and 4 continuous miners were used. Williams River Coal Co. merged with Johnstown Coal & Coke Co. in July.

Basil R. Heavner operated a portable crusher near Bolair and crushed sandstone for concrete aggregate and roadstone.

Wetzel.—Sand and gravel production was less than half that of 1959 as the Ohio River Sand & Gravel Corp. did not operate in 1960. The Ohio Valley Sand Co. dredged sand and gravel near New Martinsville. Building sand comprised over three-fourths of the output;

the remainder was used for paving. Crushed sandstone and gravel for concrete aggregate and roadstone was produced by the State Road Commission.

Wirt.—Tri-State Stone Corp. continued operations at the Vandall quarry near Elizabeth and crushed sandstone for concrete aggregate and roadstone.

Wood.—Production of sand and gravel by Pfaff & Smith Builders Supply Co., Charleston, and Kanawha Sand Co., and Ohio River Sand & Gravel Corp., Parkersburg, decreased one-third. Output was mainly for building and paving. Railroad ballast and fill uses constituted the remainder.

Wyoming.—Wyoming County continued to rank third as a coal-producing county. Although the number of mines increased by 27 to 93, production decreased 2 percent. Eighty-three underground mines produced over nine-tenths of the tonnage. Of this quantity, nearly two-thirds was mined by Eastern Gas & Fuel Associates, Pocahontas Fuel Co., Semet Solvey Division of Allied Chemical Corp., and Island Creek Coal Co. Six strip mines and four auger mines furnished the remainder. The Glen Rogers mine of Raleigh-Wyoming Mining Co. was closed indefinitely in July, idling 196 men. Over two-thirds of the coal was cleaned at 17 plants; 23 percent was crushed; and 14 percent was treated, mainly with oil. Continuous miners increased by 12 to 36 and loaded over one-fourth of the underground coal. Two-thirds was loaded by 122 mobile loading machines; duckbills and hand loading onto face conveyors and into mine cars supplied the remainder. The 82 mother conveyors, averaging 1,517 feet in length, in use ranked Wyoming County second only to Kanawha County in the number of mother conveyors.

Engine sand was produced by Casto & Lackney Sand Co. near Kimball.

The Mineral Industry of Wisconsin

This chapter has been prepared under a cooperative agreement for collection of mineral data between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Wisconsin.

By Samuel A. Gustavson [1]

MINERAL output of Wisconsin was valued at $77.2 million in 1960, exceeding the 1959 high of $72 million. Nonmetals represented about three-fourths of this total, and sales of these minerals were generally at about the same level as, or slightly less than, in 1959. The increased total mineral value for the State in 1960 can be attributed to increased production of lead, zinc, and iron ore.

Consumption, Trade, and Markets.—Sand and gravel production, especially for highway use, declined slightly from 1959. However, the State Highway Commission indicated that this decrease could be attributed more to the stage of road construction than to decline in activity. Proportionally less fill and subsurface work was done compared with surfacing and finishing. Declining sales of abrasive stones reflected strong competition from foreign grinding pebbles and synthetic grinding stones. Sales of most other nonmetallic minerals were little changed from the previous year. Relatively

TABLE 1.—Mineral production in Wisconsin [1]

Mineral	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasive stones: Pebbles (grinding) and tube-mill liners—short tons	770	$27	397	$12
Clays—thousand short tons	178	192	144	156
Iron ore (usable)—thousand long tons, gross weight	701	(2)	1,502	(2)
Lead (recoverable content of ores, etc.)—short tons	745	171	1,165	273
Peat—do	7,500	(2)	8,500	(2)
Sand and gravel—thousand short tons	41,999	27,535	35,681	25,648
Stone—do	13,522	23,782	16,486	22,302
Zinc (recoverable content of ores, etc.)—short tons	11,635	2,676	18,410	4,750
Value of items that cannot be disclosed: Cement, lime, and values indicated by footnote 2		18,541		25,619
Total Wisconsin [3]		71,959		77,171

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Total adjusted to eliminate duplicating value of clays and stone.

[1] Chief, Minneapolis Field Office, Division of Mineral Resources, Bureau of Mines, Minneapolis, Minn.

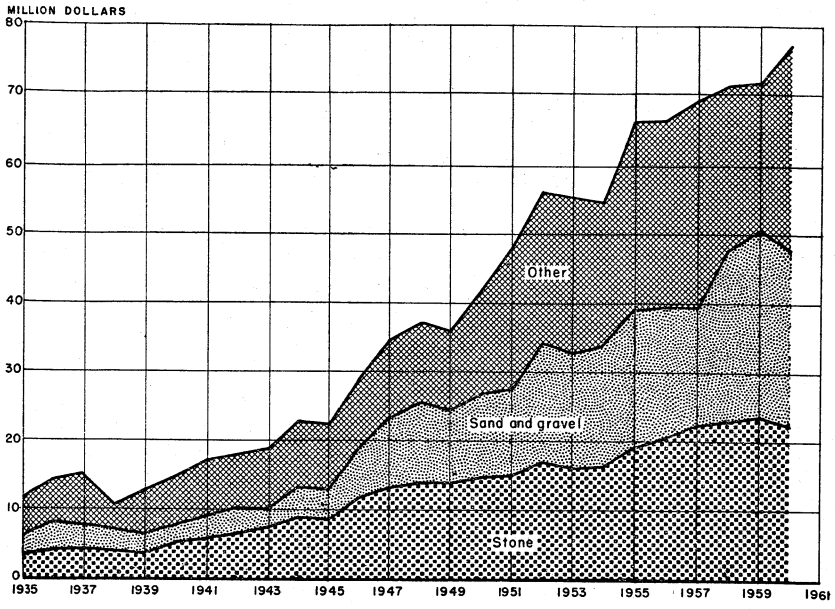

FIGURE 1.—Value of sand and gravel, stone, and total value of all minerals produced in Wisconsin, 1935–60.

stable zinc and lead prices and nearly continuous operation by two major companies in southern Wisconsin resulted in substantially greater output of these two metals in 1960. Demand for iron ore was strong at the beginning of the season as a result of the previous year's extended strike. However, expected demand for steel did not develop, and the shipping season closed early because of high iron-ore stock levels at lower ports. Even with early closing of the season, shipments of iron ore were double those of 1959 and about average for the last 10-year period.

Trends and Developments.—There was no exploratory drilling for iron ore in Ashland, Bayfield, or Iron Counties. Work on lower-grade magnetic iron-ore deposits in the vicinity of Butternut in Ashland County was reportedly abandoned.

Cerro Corp. ceased exploration for copper in Douglas County; however, Bear Creek Mining Co., a subsidiary of Kennecott Copper Corp., continued exploration on property owned by Douglas County.

The New Jersey Zinc Co. was driving an inclined tunnel to a zinc deposit south and east of Platteville. Plans to construct a mill at the site were deferred.

TABLE 2.—Employment and injuries for selected mineral industries [1]

Year and industry	Average number of men working	Total man-hours	Total number of lost-time injuries		Total number days lost or charged	Injury frequency rate [2]	Injury severity rate [3]
			Fatal	Nonfatal			
1959:							
Clays [4]	70	76,932		2	16	26.00	208
Granite	159	310,955		11	(5)	35.37	(5)
Limekiln [6]	124	324,345	1	10	(5)	33.91	(5)
Limestone [7]	1,280	1,996,875	1	98	(5)	49.58	(5)
Marl	8	5,630					
Sand and gravel	2,371	3,760,807		70	1,580	18.61	420
Sandstone	117	209,904		2	(5)	9.53	(5)
1960: [8]							
Clays [4]	59	79,643					
Granite	116	231,817		10	(5)	43.14	(5)
Limekiln [6]	126	327,606		8	(5)	24.42	(5)
Limestone [7]	1,483	2,460,620		78	(5)	31.70	(5)
Marl	6	5,330					
Sand and gravel	2,088	3,464,016	1	38	6,663	11.26	1,923
Sandstone	115	199,433					

[1] Excludes officeworkers.
[2] Total number of injuries per million man-hours.
[3] Total number of days lost or charged per million man-hours.
[4] Excludes pits producing clay used exclusively in manufacturing cement. Includes clay processing plants operated in conjunction with the mine.
[5] Data not available.
[6] Includes limestone quarries producing raw material used in manufacturing lime.
[7] Excludes quarries producing limestone used exclusively in manufacturing cement and lime.
[8] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Production and sales of grinding pebbles and tube-mill liners were less than half those of 1959, as lower-cost pebbles imported from Europe and synthetic materials manufactured in the United States continued to capture an increasing percentage of the market. The Baraboo Quartzite Co. manufactured these items from a hard quartzite deposit near Baraboo in Sauk County. Tubemill liners are cut to specifications furnished by the buyer. Grinding pebbles are usually cut to standard sizes. Grinding pebbles are made by first cutting the quartzite into cubes of the desired size. These cubes are then placed in a grinding mill, where the corners are rounded.

Cement.—Total sales of portland cement produced by plants in Wisconsin were about 5 percent under 1959 sales; however, sales within the State remained about the same. The Manitowoc Portland Cement Co., a subsidiary of Medusa Portland Cement Co., manufactured cement at Manitowoc, using limestone from Michigan and locally obtained clay. The company had four kilns and used a wet process. The Marquette Cement Manufacturing Co. of Chicago, at Milwaukee, produced cement, using limestone from Michigan and shale from Illinois. The company had one large kiln and used a dry process. Cement clinker was shipped in from Michigan by Universal Atlas Cement Co. and ground at a plant in Milwaukee. The Huron Portland Cement Co. maintained storage silos at Milwaukee and Green Bay for cement made at its plant in Michigan.

All cement produced in the State was of types I and II, general use and moderate heat. Some masonry cement was made at the Milwaukee plant. Capacity of the two producing plants had not changed since 1957. The average mill value per 376-pound barrel of portland cement was slightly over $3.30.

Clays.—Production of miscellaneous clay or shale in 1960 was reported by the same eight companies and from the same pits in seven counties as in 1959. All output was consumed by the producers. The Manitowoc Portland Cement Co., at Manitowoc, used clay in the manufacture of cement. Output for this purpose was slightly less than in the previous year. Other producers used clay in the manufacture of building brick or draintile. Consumption for brick and tile manufacture was also slightly less than in 1959.

Lime.—There was virtually no change in the output or value of quicklime and hydrated lime in 1960. Production was from the same six plants. The Western Lime and Cement Co. operated one plant each in Brown, Dodge, and Fond du Lac Counties; the Mayville White Lime Works operated in Dodge County; Cutler-LaLiberte-McDougall Corp. in Douglas County; and Rockwell Lime Co. in Manitowoc County. Lime, in order of decreasing quantities, was used for the following purposes: Paper manufacture, mason's lime in the building industry, water purification, metallurgy, agriculture, insecticides, polishing compounds, paints, sewage disposal, plastics, and tanneries. About 23 percent of all the quicklime was hydrated. Hydrated lime represented about 28 percent of the total weight of quicklime and hydrated lime shipped in Wisconsin in 1960.

Perlite.—Crude perlite from Colorado and New Mexico was expanded in plants of the Western Mineral Products Co. at Milwaukee and the Midwest Perlite Co. at Applington. Expanded perlite was used chiefly in lightweight plaster and concrete. Vermiculite from Montana also was expanded by Western Mineral Products Co. It was used as insulation and as a lightweight aggregate.

Sand and Gravel.—The quantity and value of sand and gravel output declined to 35.7 million tons and $25.6 million, respectively, decreases of 15 and 7 percent from 1959. Most of the decline was explained by the Wisconsin State Highway Commission as a "stage of road construction." During the year much of the highway construction was that of finishing and surfacing. Sand and/or gravel in the past had been produced in every county. In 1960 operators reported production from 63 counties; several operators did not designate the source of their output. Most of the production, 71 percent, was for highway use; 18 percent was for building uses. The quantity and value of sand and gravel sold for building uses was little changed from the previous year, indicating a virtually unchanged level of building construction and continued keen competition for work, unit values did not increase with labor and operating costs.

Demand for industrial sand increased slightly over 1959, approaching $3 million. Uses of industrial sand included foundry, engine, blast, filter, and hydrofractionating. Most of the industrial sands were produced from surface or near-surface deposits in Clark, Portage, Sauk, and Wood Counties. Preparation of industrial sands for

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand: [1]				
Molding	66	$124	83	$178
Building	3,079	2,591	3,071	2,711
Paving	2,363	1,924	2,615	2,099
Railroad ballast	108	86	105	84
Fill	1,320	648	751	413
Other [2]	122	239	205	276
Total	7,058	5,612	6,830	5,761
Gravel:				
Building	3,423	3,028	3,409	3,198
Paving	9,511	7,095	10,306	7,960
Railroad ballast	522	380	503	365
Fill	1,222	637	773	385
Other	261	148	1,053	913
Total	14,939	11,288	16,044	12,821
Total sand and gravel	21,997	16,900	22,874	18,582
Government-and-contractor operations:				
Sand:				
Building	1	[3]	[3]	[3]
Paving	11,844	5,698	5,938	3,007
Fill	161	50	408	151
Total	12,006	5,748	6,346	3,158
Gravel:				
Paving	7,971	4,878	6,307	3,857
Fill	25	9	154	51
Total	7,996	4,887	6,461	3,908
Total sand and gravel	20,002	10,635	12,807	7,066
All operations:				
Sand	19,064	11,360	13,176	8,919
Gravel	22,935	16,175	22,505	16,729
Grand total	41,999	27,535	35,681	25,648

[1] Includes friable sandstone.
[2] Includes sand for foundry use (1959), engine, blast, filter, oil (hydrafrac), and other industrial sand (1959-60).
[3] Less than $1,000.

marketing usually required special equipment for sizing and removing contaminants if the deposit were not free of contaminants.

The 10 leading commercial operators were: Consumers Co., Division of Vulcan Materials Co., Chicago; Courtney & Plummer, Inc., Neenah; Janesville Sand & Gravel Co. and Wm. J. Kennedy & Son, Janesville; Edward Kraemer & Sons, Inc., Plain; C. C. Linck, Inc., Beaver Dam; Arthur Overgaard, Inc., Elroy; Ozaukee Sand & Gravel Co., Milwaukee; H. Turner & Son, Boscobel; and Wissota Sand & Gravel Co., Eau Claire.

Stone.—Limestone deposits are widespread throughout the southern two-thirds of the State. Thinly bedded limestone deposits, chiefly in eastern Wisconsin, yielded dimension stone of good quality for building, construction, and house veneer. Most of the quarries of companies producing dimension limestone were in Waukesha County.

Others produced dimension limestone from quarries in Brown, Door, Fond du Lac, Manitowoc, and Milwaukee Counties in the eastern portion of the State, and one company operated in each of Juneau, La Crosse, and St. Croix Counties in the western part of the State. Commercial and noncommercial producers indicated output of crushed and broken limestone from quarries in 42 counties. Some reporting companies did not designate the locations of their quarries. About 88 percent of the crushed and broken limestone was used for concrete aggregate and roadstone and about 8 percent for agricultural purposes. Uses of the remaining 4 percent, in order of magnitude of tonnages sold, were: riprap, railroad ballast, lime, metallurgical flux and other metallurgical, asphalt filler, filter beds, fertilizer filler, and chemical (paper mills).

There was a declining market for dimension limestone, which had a high unit value. Tonnages of crushed limestone sold for most uses also declined in 1960. Several companies reported that sales of agricultural limestone were as much as 20 percent less than in the previous year. However, sales of crushed limestone for highway and building construction increased about 3 million tons, resulting in a net increase in tonnage of limestone produced, although the total value of limestone sold was about the same as in 1959.

The 10 leading commercial producers of crushed and broken limestone, listed alphabetically, were: Badger Highways Co., Inc., Menasha; Consumers Co., Division of Vulcan Materials Co., Chicago; Courtney & Plummer, Inc., Neenah; Fond du Lac Stone Co., Inc., Fond du Lac; Halquist Lannon Stone Co., Sussex; Edward Kraemer & Sons, Inc., Plain; Arthur Overgaard, Inc., Elroy; Quality Limestone Products, Inc., Sussex; H. Turner & Sons, Boscobel; and Waukesha Lime & Stone, Inc., Waukesha.

TABLE 4.—Limestone sold or used by producers, by uses [1]

Use	1959		1960	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction thousand short tons	12	$81	7	$65
Rubble do	28	105	56	151
Rough architectural thousand cubic feet	3	3	2	1
Dressed (cut and sawed) do	498	1,153	418	1,042
Flagging do	126	116	118	113
Total approximate thousand short tons [2]	90	1,458	106	1,372
Crushed and broken:				
Riprap thousand short tons	40	31	93	132
Concrete aggregate and roadstone do	9,704	9,987	12,918	12,812
Agriculture do	1,292	1,793	1,216	1,719
Lime do	(3)	(3)	89	105
Other [3] do	334	464	168	244
Total do	11,370	12,275	14,484	15,012
Grand total do	11,460	13,733	14,590	16,384

[1] Includes both commercial and Government-and-contractor production.
[2] Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.
[3] Includes limestone for alkali works, lime (1959), flux, railroad ballast, paper mills, asphalt, fertilizer, filter beds, and other uses.

Granite, quarried chiefly for building and monumental uses, was produced in Marathon, Marquette, and Waushara Counties. Some of the material was sold as rough blocks, and some rough blocks were shipped to finishing plants in Minnesota. Most of the granite, however, was cut and polished in plants near the quarries. Trimmings and pieces not suitable for dimension purposes were crushed for local use as concrete aggregate. In Marathon County, decomposed granite from weathered outcroppings was excavated and sold locally as a road-surfacing material.

Deposits of sandstone, quartzite, andesite, argillite, and basalt were also operated in the State. Dimension sandstone was sold chiefly for flagging and rough construction uses. One quartzite deposit was quarried to produce grinding pebbles and tubemill liners. Most of the quartzite produced was ground and sized for use in the manufacture of sandpaper or refractory brick. Andesite and argillite served as a raw material in the manufacture of roofing granules.

METALS

Iron Ore.—Shipments of iron ore were more than double those of 1959, when production was adversely affected by a 116-day strike. Wisconsin production was chiefly from two underground mines on the Gogebic Range in Iron County. They were the Montreal mine, operated by Oglebay, Norton & Co., and the Cary mine, operated by Pickands Mather & Co. Ore from these two mines was of direct-shipping grade. Some iron-ore concentrates were produced and shipped from stockpiles at the Badger and Meress mines in Florence County by Zontelli Brothers Division of Pittsburgh Pacific Co. These stockpiles were reported as depleted by the company in 1960. Ore from the Montreal and Cary mines was shipped to ports at Ashland, Wis., or Escanaba, Mich., for lake transport to consumers. In 1960, because of adjustments in freight rates, more than half of the ore was shipped through Escanaba. Ore from the Badger and Meress mines was shipped through the port at Escanaba.

Base prices per long ton for iron ores were unchanged from those posted January 30, 1957, as follows: High Phosphorus, $11.45; Mesabi Non-Bessemer, $11.45; Mesabi Bessemer and Old Range Non-Bessemer, $11.70; and Old Range Bessemer, $11.85. Prices for iron ore included all shipping costs from the mines to lower Lake ports; these costs do not appear in the total value of iron-ore output of Wisconsin. The base prices were for ores grading 51.50 percent iron (natural)

TABLE 5.—Iron-ore production and shipments

Year	Number of mines	Production (thousand long tons)	Shipments (thousand long tons)	Iron content of shipments natural (percent)
1956	3	1,551	1,488	52.49
1957	3	1,618	1,576	52.32
1958	2	1,152	867	53.72
1959	4	944	701	53.39
1960	4	1,484	1,502	53.50

and for Bessemer ores less than 0.045 percent phosphorus (dry). Ores higher than 0.18 percent phosphorus (dry) were classed as High Phosphorus. Variations in grade from this base and diversities in physical structure from established norms called for premiums or penalties.

Shipments of iron ore from Ashland started April 17 and ended November 6; those from Escanaba started March 28 and ended November 17. The closing dates for iron-ore shipping were unusually early and reflect the lack of demand for steel in the latter half of the year.

Lead and Zinc.—Lead and zinc production increased 56 and 58 percent, respectively, over 1959. Eagle-Picher Co. operated its Shullsburg mine and mill continuously, the Birkett-Bastian-Andrews mine from January through November 4th with the exception of the period October 1–31 during a labor strike and the Kickapoo-Alden Thomson mine and Linden mill from March through September. Vinegar Hill Division, American Zinc, Lead and Smelting Company operated its mill and the Blackstone, Temperly, and Thompson mines continuously and the Hancock mine from August through December. Piquette Mining Co. operated its mine and mill from January to July. A small tonnage of ore was shipped by the Mifflin Mining Co. All mines except the Shullsburg operation of Eagle-Picher Co. had been idle during most of 1959.

A report on shallow lead diggings in Grant and Lafayette Counties based on work done in 1947–49 was published.[2]

Average weighted prices per pound used to calculate the values of lead and zinc in table 1 in 1960 were, respectively, 11.7 and 12.9 cents. The average price used in 1959 was 11.5 cents for both metals. There was little fluctuation in prices in 1960. Lead quotations, per pound New York, opened at 12 cents, remained at that level through December 12, and were 11 cents beginning December 13 to the end of the year. Zinc quotations, per pound East St. Louis, opened at 12.5 cents, rose to 13 cents January 8, declined to 12.5 cents December 13, and to 12 cents December 19.

TABLE 6.—Mine production of lead and zinc, in terms of recoverable metals

Year	Mines producing		Material treated		Lead		Zinc		Total value
	Lode	Tailings	Ore (short tons)	Tailings (short tons)	Short tons	Value	Short tons	Value	
1951–55 (average)	18	6	562,534	37,532	1,739	$519,986	17,406	$4,860,822	$5,380,809
1956	14	5	828,579	139,346	2,582	810,748	23,890	6,545,860	7,356,608
1957	16	3	710,776	17,066	1,900	543,400	21,575	5,005,400	5,548,800
1958	2	----	468,822	----	800	187,200	12,140	2,476,560	2,663,760
1959	6	----	464,390	----	745	171,350	11,635	2,676,050	2,847,400
1960	8	1	686,085	993	1,165	272,610	18,410	4,749,780	5,022,390

[2] Grosh, W. A., Shallow Lead Diggings, Grant and Lafayette Counties, Wis.: Bureau of Mines Rept. of Investigations 5694, 1960, 59 pp.

TABLE 7.—Mine production of lead and zinc in 1960, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc	Month	Lead	Zinc
January	115	1,700	August	100	1,600
February	110	1,440	September	90	1,650
March	110	1,660	October	60	860
April	130	1,650	November	60	1,430
May	125	1,850	December	75	1,500
June	110	1,750			
July	80	1,320	Total	1,165	18,410

REVIEW BY COUNTIES

Sand and gravel or crushed limestone for use in construction and roadbuilding was produced in virtually every county. Reports received for 1960 indicated production of one or both of these mineral commodities for 69 of the 71 counties. Several of the larger road-building contractors, who operated portable plants, did not indicate the county source on their reports. Among the commercial operators, 192 produced sand and gravel and 113 produced crushed limestone. Noncommercial or Government-and-contractor operators included State and county highway departments, cities, towns, and full-time contractors for Federal or State projects. Production of minerals other than sand and gravel or crushed limestone was reported from only 30 counties. These minerals included dimension stone (limestone, granite, sandstone, and quartzite), special sands, marble, andesite, marl, and peat in the nonmetals group and zinc, lead, and iron ores among the metals.

Ashland.—No new work was reported at the low-grade magnetic iron deposit near Butternut, and plans for bringing the property into production were deferred.

Bayfield.—A dolomitic marble deposit was quarried near Grand View by Wisconsin Marble Heights Quarries, Inc. The product was crushed and sold as chips for manufacture of a synthetic stone.

Brown.—Production of sand and gravel and crushed limestone for roadwork was reported by 12 operators. Among the largest producers were Allard & Van Nelson, Daanen & Janssen, Fred Kropp, Schuster Construction Co., W. B. Sheedy, Vic Zeman, Scray Quarries, and Village of Howard Highway Department.

Miscellaneous clay for brick and other heavy clay products was produced by Duck Creek Brick Co. and Hockers Brothers Brick & Tile Co.

Western Lime & Cement Co., Milwaukee, made quicklime and hydrated lime at its plant in Green Bay.

Buffalo.—Crushed limestone for roads and agricultural uses was the only mineral production reported for the county. Herbert Tiffany, Jr., and Neuheisel Lime Works accounted for most of the production.

Calumet.—Sand and gravel was produced by Sell Brothers Stone & Gravel Co., Quality Sand & Gravel Co., and Arnold M. Ortlepp. Sand and gravel and limestone were produced by the Calumet County Highway Department.

615629—61——73

TABLE 8.—Value of mineral production in Wisconsin, by counties[1]

County	1959	1960	Minerals produced in 1960 in order of value
Adams	(2)	(2)	Sand and gravel.
Ashland	(2)		
Barron	(2)	$193,833	Sand and gravel.
Bayfield	(2)	(2)	Stone.
Brown	$1,230,889	1,083,562	Sand and gravel, lime, stone, clays.
Buffalo	(2)	(2)	Stone.
Burnett	171,790	59,055	Sand and gravel.
Calumet	187,505	246,297	Sand and gravel, stone.
Chippewa	19,730	18,170	Sand and gravel.
Clark	129,891	450,605	Sand and gravel, stone.
Columbia	(2)	1,478,915	Stone, sand and gravel.
Crawford	203,268	213,875	Do.
Dane	1,683,855	1,809,914	Sand and gravel, stone.
Dodge	797,975	1,336,528	Sand and gravel, lime, stone.
Door	(2)	358,349	Sand and gravel, stone.
Douglas	(2)	(2)	Lime, sand and gravel.
Dunn	332,212	175,073	Sand and gravel, stone, clays.
Eau Claire	(2)	(2)	Sand and gravel, stone.
Florence	(2)	(2)	Iron ore.
Fond du Lac	1,095,429	1,319,331	Stone, sand and gravel, lime, clays.
Forest	64,549	84,170	Sand and gravel.
Grant	533,900	886,350	Stone, zinc, lead, sand and gravel.
Green	483,623	388,639	Stone, sand and gravel.
Green Lake	259,798	234,564	Sand and gravel, stone.
Iowa	442,018	637,010	Stone, zinc, sand and gravel, lead.
Iron	(2)	(2)	Iron ore, sand and gravel.
Jackson	111,500	(2)	Sand and gravel.
Jefferson	160,247	159,124	Sand and gravel, stone.
Juneau	(2)	(2)	Stone, sand and gravel.
Kenosha	426,650	232,584	Sand and gravel.
Kewaunee	98,226	127,411	Do.
La Crosse	94,509	102,628	Sand and gravel, stone.
Lafayette	(2)	(2)	Zinc, lead, stone.
Langlade	295,895	284,607	Sand and gravel.
Lincoln	(2)	137,940	Sand and gravel, stone.
Manitowoc	(2)	(2)	Cement, sand and gravel, lime, stone, clays.
Marathon	6,691,290	2,854,133	Stone, sand and gravel, clays.
Marinette	(2)	(2)	Stone, sand and gravel.
Marquette	(2)	265,211	Do.
Milwaukee	5,637,496	5,568,869	Cement, stone, sand and gravel.
Monroe	85,729	103,167	Stone.
Oconto	314,934	148,759	Sand and gravel.
Oneida	142,622	150,665	Sand and gravel, stone.
Outagamie	323,900	497,070	Do.
Ozaukee	89,895	195,425	Sand and gravel.
Pepin	(2)	5,303	Stone, sand and gravel.
Pierce	340,279	417,109	Sand and gravel, stone.
Polk	677,199	496,112	Stone, sand and gravel.
Portage	410,472	(2)	Sand and gravel, stone.
Price	1,699	3,154	Sand and gravel.
Racine	1,677,608	1,822,205	Stone, sand and gravel, clays.
Richland	(2)	(2)	Stone, sand and gravel.
Rock	1,325,628	1,533,220	Sand and gravel, stone.
Rusk	80,650	83,022	Sand and gravel.
St. Croix	696,716	677,456	Sand and gravel, stone.
Sauk	1,242,697	1,738,637	Stone, sand and gravel, abrasives.
Sawyer	68,671	63,323	Sand and gravel.
Shawano	474,010	469,224	Sand and gravel, stone.
Sheboygan	363,288	482,799	Do.
Taylor	(2)	189,777	Sand and gravel.
Trempealeau	(2)	(2)	Stone.
Vernon	(2)	(2)	Stone, sand and gravel.
Vilas	56,500	63,135	Sand and gravel.
Walworth	272,109	591,872	Do.
Washburn		71,034	Do.
Washington	1,029,451	1,235,010	Sand and gravel, stone.
Waukesha	6,382,187	5,848,522	Sand and gravel, stone, peat.
Waupaca	(2)	115,365	Stone, sand and gravel, clays.
Waushara	(2)	(2)	Sand and gravel, stone.
Winnebago	1,884,696	2,262,803	Do.
Wood	(2)	(2)	Stone.
Undistributed[3]	33,831,446	38,788,005	
Total[4]	71,959,000	77,171,000	

[1] No production reported for Washburn County (1959).
[2] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by footnote 2.
[4] Total adjusted to eliminate duplicating value of clays and stone.

Clark.—Sand and gravel was produced by three companies. The largest producer was Plautz Brothers Sand & Gravel Co. The Clark County Highway Department also produced sand and gravel. Sandstone produced by Ellis Quarries, Inc., was used for building, construction, and flagging.

Columbia.—Several companies produced sand and gravel, the largest being C. C. Linck, Inc., followed by A. T. Riese Trucking Co. and Columbia Ready Mix Co. The Columbia County Highway Department also was a large producer of sand and gravel.

Crushed limestone and dolomite were produced by Dann & Wendt and Edward Kraemer & Sons, Inc.

Portage-Manley Sand Co., Rockton, Ill., produced high-quality glass and foundry sand from a quarry near Portage. Representative samples of this sandstone contained more than 99.5 percent silica. The quarry face stood vertically and was about 75 feet high. Overburden was up to 50 feet deep. Only moderate blasting was necessary.

Crawford.—Sand and gravel was produced by the Prairie Sand & Gravel, Inc., and Lakeside Sand & Gravel. Limestone and dolomite were produced by Edward Kraemer & Sons, Inc., Loren J. Slaght, and Velmer Monroe.

Dane.—This county was the leading producer of crushed limestone. It also produced sand and gravel.

Leading producers of crushed limestone included Madison Stone Co., Inc., Hammersley Stone Co., Inc., Baumgardt Construction Co., and Melvin Paulson.

The larger sand and gravel producers included C. C. Linck, Inc., Wingra Stone, Capitol Sand & Gravel Co., Madison Sand & Gravel Co., Hartland-Verona Gravel Co., and General Silica Co.

Dodge.—Mayville White Lime Works, Mayville, and Western Lime & Cement Co., Milwaukee, produced limestone for lime, metallurgical use, and roadstone. The former made quicklime at its plant near Mayville; most of the quicklime is used in preparing a barn disinfectant. Western Lime & Cement Co. manufactured quicklime and hydrated lime at its Knowles plant.

Larger operators producing sand and gravel included C. C. Linck, Inc., Linck & Henes, and the Dodge County Highway Department.

Door.—Sand and gravel and crushed limestone were produced. Vernon E. Olsen Excavating Co. and the Door County Highway Department were the larger producers of sand and gravel. The highway department and Adamski-Fisher Quarry produced crushed limestone.

Douglas.—Quicklime and hydrated lime were manufactured at a plant in Superior, Wis. by Cutler-LaLiberte-McDougall Corp., Duluth, Minn. The plant was equipped with two rotary kilns. Limestone was purchased in Michigan.

Some sand and gravel was produced by the Douglas County Highway Department and the Superior City Engineer.

Dunn.—Sand and gravel was produced by Edward Kraemer & Sons, Inc., and the Red Cedar Sand & Gravel Co.

Limestone was produced by the Barron County Agricultural Agent for agricultural uses. The Menomonie Brick Co. made building brick from clay mined near Menomonie.

Eau Claire.—Eau Claire Sand & Gravel Co. mined and prepared industrial sand for blast, engine, filter, and foundry uses at its plant in Eau Claire. The company also produced sand and gravel for building and highway construction. One of the largest producers of sand and gravel for construction and highway use was the Wissota Sand & Gravel Co.

Florence.—Zontelli Brothers Division of Pittsburgh Pacific Co. produced iron ore from stockpiles of the Badger and the Meress open pit mines on the Menominee Range near Florence. The company reported depletion of these stockpiles during 1960.

Fond du Lac.—The larger producers of sand and gravel included Braun Construction Co., M. A. Leiberg, and the Fond du Lac County Highway Department.

Larger producers of crushed limestone were Fond du Lac Stone Co., Hamilton Stone Co., Elmer Dais Stone Co., C. C. Linck, Inc., Nellis Stone Quarry, Inc., Waupun Ready-Mix Concrete Corp., Western Lime & Cement Co., Oakfield Stone Quarry, and Edward Kraemer & Sons, Inc.

The Oakfield Shale Brick & Tile Co., mined clay for the manufacture of heavy clay products, and Western Lime & Cement Co. quarried limestone to make both quicklime and hydrated lime.

Grant.—The Piquette mine and mill, the county's only producer of lead and zinc, after reopening December 7, 1959, operated continuously until the early part of July. The company sold its jig tailings for road use.

A small quantity of sand and gravel was produced by Becker & Tuckwood.

The principal producers of crushed limestone for road use included Becker & Tuckwood, Dell Needham, George Wendtlandt, Bertie & Russell Zenz, and Harry Croft & Sons.

Green.—Crushed limestone and dolomite and sand and gravel were produced. The chief producers of crushed limestone were P. W. Ryan Sons, Inc., and Rees Construction Co.

Sand and gravel was produced by Henry Altman and Green County Sand & Gravel Co.

Green Lake.—Molding sand was produced by Chier St. Marie Sand Co. and Clifford Chier Sand Co. The larger sand and gravel producers for highway use were Paul Polenska & Son, Kopplin & Kinas Co., Inc., and the Green Lake County Highway Commission.

Crushed limestone was produced by Gaastru Brothers.

Iowa.—The Eagle-Picher Co. operated the Kickapoo-Alden Thomson mine and Linden mill from March through September for the production of zinc and lead ores. Mifflin Mining Co. shipped a small quantity of zinc ore from the Bickford-Coker mine.

Crushed limestone for building and highway construction was produced by several companies. The larger included Ivey Construction Co., George Wendtlandt, and the Iowa County Highway Department.

A relatively small quantity of sand and gravel was sold by Davis & Richardson.

Iron.—Most of the iron-ore production from the State came from two underground mines operated in this county—the Montreal mine, operated by Oglebay Norton & Co., and the Cary mine, operated by

Pickands Mather & Co. Output was about the average for the last 10-year period and about double that of 1959, when an abnormally low production was reported as a result of a 116-day strike. Most of the ore from the Cary mine was shipped via Escanaba, Mich., and that from the Montreal mine through the Ashland, Wis., port.

Edward Kraemer & Sons, Inc., produced sand and gravel for highway construction.

Jackson.—Sand and gravel for building and road use was produced by Laurence Murphy and H. T. Smith.

Jefferson.—Sand and gravel and crushed limestone were produced for road use, chiefly by the Jefferson County Highway Commission and Rude Sand & Gravel.

Juneau.—Limestone was quarried for use as flagging by the Lone Rock Stone Quarry.

Arthur Overgaard Co. produced crushed stone for highway use and agricultural purposes. This company had seven portable crushing units. The Juneau County Highway Commission produced sand and gravel.

Kenosha.—Gravel for road construction was produced by Consumers Co., Division of Vulcan Materials, Chicago, and Bloss Sand & Gravel. Limestone was produced by the Kenosha County Highway Department.

Kewaunee.—Schuster Construction Co. produced sand and gravel for highway purposes.

La Crosse.—Dimension limestone was produced by Herbert Hass of La Crosse.

Sand and gravel was produced by Kammel-Smith Sand & Gravel Co., La Crosse Sand & Gravel Co., and the county highway department.

Lafayette.—The Eagle-Picher Co. and Vinegar Hill Division, American Zinc, Lead and Smelting Company were the only lead and zinc mine operators in the county. Eagle-Picher Co., except for a labor strike October 1st to October 31st, operated the Shullsburg mine and mill throughout the year, and the Birkett-Bastian-Andrews mine from January through November 4th. The Birkett-Bastian-Andrews ore was shipped for concentration to the company's Graham mill in Illinois. Vinegar Hill Division, American Zinc, Lead and Smelting Company operated the Blackstone, Hancock, Thomson, and Temperly mines. The Hancock mine was operated from August through December; the other mines were operated continuously throughout the year. The New Jersey Zinc Co. performed considerable churn drilling and started an incline shaft to a new zinc property a few miles south and east of Galena. Plans to start construction of a mill were deferred.

Production of crushed limestone for highway and building use was reported by several operators—the largest was George Wendtlandt.

Langlade.—Sand and gravel was produced chiefly for highway use by Duffek Sand & Gravel, Inc., and the county highway department.

Lincoln.—Sand and gravel and crushed limestone were produced chiefly for road work by the county highway department, Merrill Gravel & Construction Co., and Clifford Gatterman.

Manitowoc.—Portland cement was manufactured by the Manitowoc Portland Cement Co. The plant has four 10-foot-diameter rotary kilns ranging in length from 160 to 340 feet. The company mined its own clay from a nearby pit and used a 6-inch hydraulic line to transport the clay to the plant. Limestone was shipped in from Michigan, as local limestones have too high a magnesium oxide content for the process used.

Quicklime and hydrated lime for building, chemical, and other industrial uses were produced by the Rockwell Lime Co. at its plant near Francis Creek. The company had a rotary kiln and a batch-type hydrator.

Dimension limestone, chiefly for building veneer and flagstone, was produced by Valders Lime & Stone Co.

Sand and gravel and crushed stone were produced by several companies in the area including Manitowoc County Highway Department, Rockwell Lime Co., R. & J. Fricke Co., Schroeder Bros. Sand & Gravel Co., and Fred Radandt Sons.

Marathon.—Minnesota Mining and Manufacturing Co., St. Paul, Minn., produced material for the manufacture of roofing granules from an argillite deposit north of Wausau and quartzite, chiefly for manufacture of sandpaper, from a quarry west of Wausau. Output of argillite was somewhat less than in 1959.

Dimension granite for building and monument purposes was produced by Anderson Bros. & Johnson Co., Cold Spring Granite Co., Cold Spring, Minn., Lake Wausau Granite Co., Prehn Granite Quarries, Inc., and Wisconsin Quarries, Inc. (a subsidiary of Rock of Ages). Most of the rough granite produced was cut and finished in plants near Wausau. However, Cold Spring Granite Co. shipped rough block to its Minnesota plant for finishing.

Clay for the manufacture of building brick was produced by the Marshfield Brick & Tile Co.

Tony Schilling Granite Pit produced road material from weathered outcroppings of granite near Mosinee.

Ellis Quarries, Inc., Stevens Point, quarried and dressed sandstone for building use. Several companies produced sand and gravel for highway use. The larger included Riverside Gravel Co., Lotz Sand & Gravel Co., and Heiser Ready Mix Co.

Marinette.—Andesite was quarried for use in the production of both natural and colored roofing granules by the Central Commercial Co. of Chicago, Ill., at a pit about 10 miles east of Pembine. The stone has been called basalt, greenstone, and traprock. A basalt dike traverses the quarry, but this material is discarded. Some sand and gravel for highway use was also produced.

Marquette.—Montello Granite Co. produced dimension granite for building and monument uses at Montello. Edward Kraemer & Sons, Inc., produced crushed limestone, and the Marquette County Highway Department produced gravel for road use.

Milwaukee.—Marquette Cement Mfg. Co. of Chicago, Ill., manufactured cement, using shale from Illinois and limestone from Michigan.

Dimension limestone was produced by Franklin Stone Products, Inc., and the Wauwatosa Stone Co. Crushed stone, chiefly for highway use, was produced by Consumers Co., Division of Vulcan Materials

Co., Chicago, Ill., and Wauwatosa Stone Co. Several companies produced sand and gravel.

Pierce.—Sand for industrial purposes was produced by Maiden Rock Silica Sand Co., Bay City Sand Co., Inc., and River Falls Sand & Gravel Co. The largest producer of sand and gravel for highway use was the Pierce County Highway Department. Crushed limestone for highway use was produced by Sanders Stone & Lime Co. and Caturia Limestone Co.

Polk.—Basalt was quarried and crushed chiefly for road use by the Dresser Trap Rock Co.

The Polk County Agricultural Agent produced limestone for agricultural use. The county highway department and Ostermann Sand & Gravel, Inc., were the largest producers of sand and gravel for highway use.

Portage.—Ellis Quarries, Inc., at Stevens Point, quarried sandstone for flagging and construction purposes. A small quantity of marl was excavated and sold by Caldwell's Dredging Co. and Bert Somers for agricultural use. The two largest producers of sand and gravel for highway and building purposes were F. F. Mengel Co. and Wimme Sand & Gravel.

Racine.—Large quantities of limestone were quarried by Consumers Company, Division of Vulcan Materials Co., Chicago, Ill.; the product was used for riprap, metallurgical uses, roadstone, and agricultural purposes.

Clay for the manufacture of heavy clay products was produced by the Union Grove Drain Tile Co.

Larger sand and gravel producers in the county included Edward Kraemer & Sons, Inc., J. W. Peters & Sons, and Jeffries Const. Co.

Rock.—Considerable quantities of crushed limestone and sand and gravel were produced chiefly for highway use in the county. Larger producers of sand and gravel included Janesville Sand & Gravel Co., Chicago, Milwaukee, St. Paul & Pacific Railroad Co., and Edgerton Sand & Gravel Co.

Larger producers of crushed limestone included Rock County Highway Department, P. W. Ryan Sons, Inc., Little Limestone Co., and Footville Lime & Rock Co.

St. Croix.—Dimension stone for building and veneer use was quarried by the St. Croix Valley Stone Co., Stillwater, Minn. Construction road materials were produced by several operators; the largest were St. Croix Highway Department, Edward Kraemer & Sons, Inc., Wilson Rock & Limestone Co., and Leary Constr. Co.

Sauk.—Quartzite for the manufacture of grinding pebbles and tubemill liners was quarried by the Baraboo Quartzite Co., Inc. Output in 1960 was considerably less than that of 1959. Competition from foreign imports and synthetic products was severe, and the profit margin reportedly was very small. The plant was built about 17 years ago to provide tubemill liners and grinding pebbles chiefly for war production.

The largest operation in the county was that of Foley Bros., Inc., at a quartzite quarry. The product was chiefly for railroad ballast.

Dimension sandstone, chiefly for building purposes, was produced by Alfred Boyles Flagstone Qy., Walter Dwars, and E. R. Gall Stone Co.

General Refractories Co., Philadelphia, Pa., and Harbison-Walker Refractories Co., Pittsburgh, Pa., produced quartzite chiefly for use in manufacturing refractories. General Refractories Co. shipped its product by rail to Joliet, Ill., where it was crushed, ground, and formed into firebrick. Several companies produced sand and gravel and limestone for highway purposes. The larger operators included Edward Kraemer & Sons, Inc., W. R. Dubois & Son, Inc., Deppe Lumber Co., and Baraboo Concrete Products Co.

Waukesha.—Quarries in Waukesha County supplied much of the dimension limestone produced in the State from ledge-type deposits prominent in the area. Uses were chiefly for veneer. Producers of dimension limestone included Thomas Lee Carlson, Cawley Stone Quarry, Dudovick Lannon Stone Co., Fonda Lannon Stone Co., Halquist Lannon Stone Co., Joecks Brothers Stone Co., Johnson & Sons, Kindler Brothers Stone Co., Frank & Lindquist Lannon Stone Co., Lisbon Lannon Stone Corp., Meadow Hill Quarries, Inc., Midwest Lannon Stone Co., W. G. Perren Quarry., Quality Limestone Products, Inc., Sussex Lannon Stone Corp., Weather Rock Lannon Stone Qy., West Side Stone Co., and White Rock Lannon Stone Co.

Crushed limestone for miscellaneous uses was produced by the Waukesha Lime & Stone, Inc.

Peat produced by Demilco, Inc., was used chiefly in the company's own product, which was sold as a potting mixture.

Sand and gravel also was produced.

Waupaca.—Building brick was manufactured from clay produced near New London by the Hockers Brick Co.

Some marl was produced by Caldwell's Dredging Co. for agricultural use.

A small amount of sand and gravel was produced for construction and highway use.

Waushara.—Granite was quarried by the Lohrville Stone Co. at Redgranite for construction and monumental uses. The company also produced dimension sandstone or quartzite in the same general area.

Other minerals produced included marl for agricultural purposes and gravel for highway use.

Winnebago.—Badger Highways Co., Inc., produced limestone for riprap, roadstone, and agricultural uses. Other large producers of crushed limestone were Consumers Company, Division of Vulcan Materials Co., Chicago, Ill. and Courtney & Plummer, Inc., Neenah, Wis. The latter also produced considerable sand and gravel. Production of over 1 million tons each of limestone and sand and gravel was reported for the county.

Wood.—Dimension sandstone for construction and flagging uses was quarried and dressed by Ellis Quarries, Inc., Klesmith Stone Co., and Tony Schmick.

The Mineral Industry of Wyoming

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Wyoming.

By F. D. Everett [1]

THE WYOMING mineral industry in 1960 continued a trend of increasing annual output uninterrupted since 1949. The value of mineral production was $443 million, a 12-percent gain over 1959. The principal increases were in the value of petroleum, natural gas, and uranium production with significant gains recorded for sand and gravel, sodium carbonate, and natural gas liquids. Small declines were noted in output of iron ore, phosphate rock, and sodium sulfate. Of the 22 mineral commodities produced, petroleum contributed 77 percent of the total value, followed in order by uranium and natural gas.

The second of two 100,000-kw. units of the Dave Johnston powerplant of Pacific Power & Light Co. at Glenrock was placed in operation in November. Coal for both units was strip mined from a 35-foot seam in a pit 17 miles north of the plant. Utah Power & Light Co. completed an earth-fill dam as the first stage in construction of a reported $90 million steam-electric project on Hams Fork River near Kemmerer. Coal was to be supplied from a strip mine adjacent to the plant.

The Intermountain Chemical Co. completed an expansion program at the Westvaco plant 22 miles west of Green River and announced another to be completed by 1962 for production of 700,000 to 750,000 tons of soda ash annually. West End Chemical Co. Division of Stauffer Chemical Co. began construction of surface facilities for producing sodium carbonate (trona) at a site 21 miles northwest of Green River. Sinking of two circular concrete-lined shafts began in November, and a 10-mile rail spur from the main line of the Union Pacific railroad was begun in December. Completion of the project, designed for production of 200,000 to 300,000 tons annually, was scheduled for 1962.

Big Horn Gypsum Co. began a $3 million project for mining and processing gypsum and manufacturing wallboard at Cody. The plant, designed for a capacity of 100 million square feet of gypsum board yearly, was to begin producing early in 1961. The product was to be marketed in several Western States, principally in Wyo-

[1] Mining engineer, Bureau of Mines, Salt Lake City, Utah.

TABLE 1.—Mineral production in Wyoming [1]

Mineral		1959		1960	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate	short tons, gross weight	1	(2)	5	$2
Clays [3]	thousand short tons	764	$9,449	788	9,571
Coal	do	1,977	6,669	2,024	6,992
Gem stones		(4)	76	(4)	68
Gold (recoverable content of ores, etc.)	troy ounces			40	1
Gypsum	thousand short tons	9	31	13	46
Iron ore (usable)	thousand long tons, gross weight	503	2,923	(5)	(5)
Natural gas	million cubic feet	156,978	12,715	181,610	21,793
Natural gas liquids:					
Natural gasoline	thousand gallons	64,586	4,003	72,195	4,535
LP gases	do	90,314	3,951	120,693	5,279
Petroleum (crude)	thousand 42-gallon barrels	126,050	315,125	[6] 135,521	[6] 340,158
Pumice	thousand short tons	94	77	33	30
Sand and gravel	do	4,692	3,982	5,928	5,356
Silver (recoverable content of ores, etc.)	troy ounces			4	(2)
Stone	thousand short tons	1,317	1,791	1,401	2,302
Uranium ore	short tons	864,582	17,610	1,357,225	27,387
Value of items that cannot be disclosed: Cement, fireclay (1959) and miscellaneous clay, phosphate rock, sheet mica, sodium carbonate, sodium sulfate, vanadium (1960), and value indicated by footnote 5			15,970		19,741
Total Wyoming [7]			[8] 393,841		442,738

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than $1,000.
[3] Excludes fire clay (1959) and miscellaneous clay; included with "Value of items that cannot be disclosed."
[4] Weight not recorded.
[5] Figure withheld to avoid disclosing individual company confidential data.
[6] Preliminary figure.
[7] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement.
[8] Revised figure.

ming, Montana, Idaho, South Dakota, North Dakota, Nebraska, Oregon, and Washington.

The Columbia-Geneva Steel Division of United States Steel Corp. began constructing facilities to mine, concentrate, and agglomerate the taconite iron ores of the Atlantic City area. The project, estimated to cost $73 million, was designed to produce 4,000 tons of pellets a day. Completion was scheduled for late in 1962. Reportedly, exploration indicated 300 million tons of taconite ore containing 21 to 35 percent iron.

Globe Mining Co., a unit of Union Carbide Nuclear Co., a division of Union Carbide Corp., started processing uranium ore in its Gas Hills plant in January. Utah Mining Corp., subsidiary of Utah Construction & Mining Co., mined the first commercial uranium in the Shirley basin 50 miles south of Casper. Petrotomics Co. (a corporate combine of Kerr-McGee Oil Industries, Inc., Tidewater Oil Co., Skelly Oil Co., and Getty Oil Co.) was awarded an Atomic Energy Commission (AEC) contract that provided for Government purchase of 1 million pounds of U_3O_8 concentrates before March 31, 1962, and 3.2 million pounds of concentrates between that date and December 31, 1966. Total value of the contract quantity of uranium concentrates approximates $25 million. Petrotomics Co. reportedly will mine the ore by open-pit methods and build a mill at the mine site.

Employment and Injuries.—Preliminary statistics for employment and injuries in the mineral industries, excluding the petroleum in-

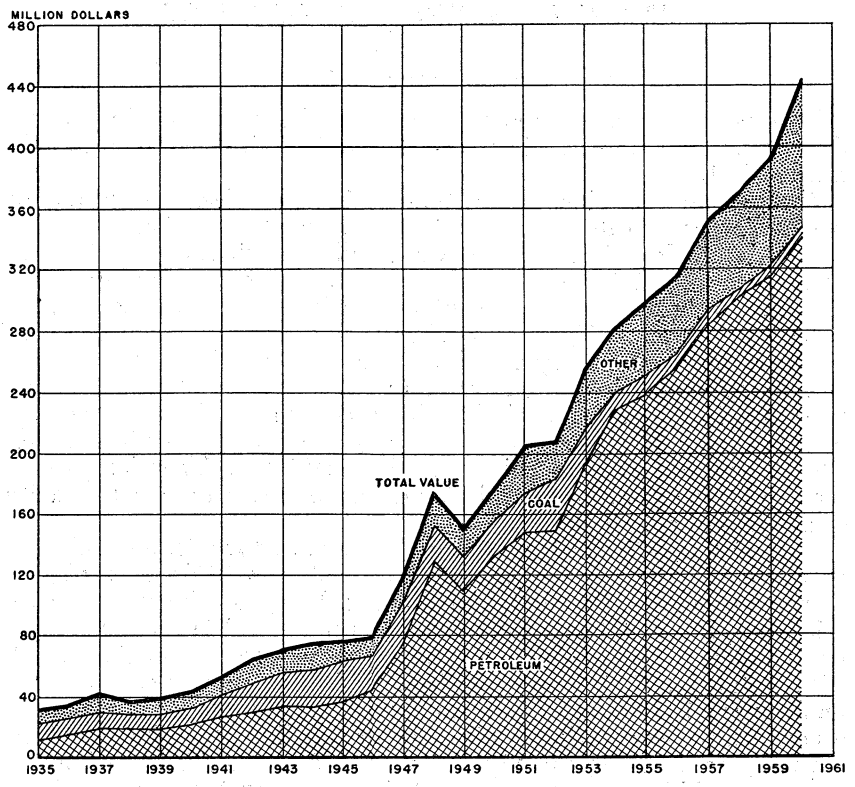

FIGURE 1.—Value of petroleum, coal, and other minerals, and total value of all minerals produced in Wyoming, 1935–60.

dustry, are given in table 2. The uranium industry accounted for 36 percent of the employment. One fatal and 11 nonfatal accidents were reported in coal-mining operations, and 7 fatal and 187 nonfatal accidents in the non-coal-mining industry.

TABLE 2.—Employment and injuries in the mineral industries [1] in 1960 [2]

Industry	Number of operations	Average number of men employed	Total man-hours worked	Injuries		Frequency rate (injuries per million man-hours)
				Fatal	Non-fatal	
Ferrous and nonferrous (excluding uranium)	4	333	462,616	1	19	43.2
Uranium	71	1,499	2,899,152	5	116	41.7
Nonmetal (excluding sand and gravel and stone)	46	990	1,852,864	1	32	17.8
Sand and gravel	68	385	585,400		3	5.1
Stone	21	355	650,471		17	26.1
Coal	25	599	679,569	1	11	17.7
Total	235	4,161	7,130,072	8	198	28.9

[1] Excludes petroleum.
[2] Preliminary figures.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels represented 85 percent of the value of mineral production in the State, an increase from $342 million in 1959 to $379 million in 1960.

Coal.—Coal was mined from 19 mines in 8 counties, and production was 2 percent greater than in 1959. Converse County had the greatest output, followed in order by Campbell, Sheridan, Lincoln, Sweetwater, Carbon, Hot Springs, and Fremont. The strip mine supplying the Dave Johnston powerplant of Pacific Power & Light Co. had the largest production. The second addition to the powerplant was placed in operation in November, and the two units required 3,000 tons of coal a day when operating at rated capacity. A test plant to produce metallurgical coke from subbituminous coal mined from surface operations near Kemmerer was started jointly by the United States Steel Corp. and Food Machinery & Chemical Corp. The plant, scheduled to begin operations in mid-1961, was to have a reported capacity of 250 tons of coke daily.

Natural Gas.—Natural gas production was 24,632 million cubic feet more than in 1959, an increase of 16 percent. Gasfields in Big Horn, Carbon, Converse, Fremont, Hot Springs, Johnson, Lincoln, Natrona, Niobrara, Park, Sublette, Sweetwater, Uinta, and Washakie Counties contributed to the production. Reported [2] reserves as of January 1, 1961, totaled 3,975 billion cubic feet, 128 billion cubic feet more than on January 1, 1960. Colorado Interstate Gas Co. placed in operation a new compressor station 8 miles east of Rawlins which increased the capacity of its Wyoming pipeline from 138 to 188 million cubic feet a minute. This company won conditional approval from the Federal Power Commission for a $151 million project to construct a 155-mile pipeline from Rock Springs to Provo, Utah; the pipeline would con-

TABLE 3.—Coal production, by counties

(Excludes mines producing less than 1,000 short tons annually)

County	1959		1960	
	Short tons	Average value per ton [1]	Short tons	Average value per ton [1]
Campbell	426,609	$1.27	458,644	$1.25
Carbon	98,307	3.18	151,676	3.68
Converse	471,506	3.32	525,998	3.58
Fremont	1,902	6.01	1,329	6.17
Hot Springs	14,789	8.36	11,820	9.47
Lincoln	313,146	3.08	249,605	3.24
Sheridan	385,923	3.36	382,377	3.36
Sweetwater	264,626	7.00	242,747	7.27
Total	1,976,808	3.37	2,024,196	3.45

[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] Oil and Gas Journal, 1960 Was a Good Year for Gas: Vol. 59, No. 5, Jan. 30, 1961, pp. 122–123.

nect with a 395-mile line to be built by El Paso Natural Gas Co. to the California-Nevada border near Las Vegas, Nev.

Natural Gas Liquids.—Production of natural gasoline, butane, and propane was 25 percent greater than in 1959. Fifteen natural gas processing plants in 13 counties recovered 192,888,000 gallons of natural gas liquids. The Big Horn plant of Mobil Oil Co. at Manderson terminated operations in mid-1960.

Petroleum.—Crude-petroleum production was 9.5 million barrels greater than in 1959, an 8-percent increase. Output came from 206 fields in 20 of the State's 23 counties. Forty-seven fields had an output that exceeded 100,000 barrels for the year. Wildcat drilling of 435 wells resulted in 31 oil and 9 gas discoveries for a success ratio of 9 percent. Development drilling of 639 wells yielded 452 oil and 47 gas producers for a success ratio of 78 percent.

An important source of oil, the development highlight of the year, was at the Patrick Draw, Beacon Ridge, and Arch units in Sweetwater County. Areas in Campbell and Crook Counties also were among the most active in petroleum development. In Campbell County, the Rozet field, which entered production in 1959, had developed into one of the most important oil finds in Wyoming in many years.

Counties having an annual output of 10 million or more barrels of crude oil were, in order of production, Park, Hot Springs, Fremont, Natrona, and Big Horn. Wildcat drilling resulted in discoveries in the four major basins—Powder River (16 oil, 1 gas), Green River (6 oil, 7 gas), Wind River (5 oil, 1 gas), and the Big Horn (4 oil). Forty-five percent of the successful development wells were in the Powder River basin (206 oil, 1 gas) followed in order by Green River (142 oil, 45 gas), Big Horn (70 oil), Wind River (33 oil, 1 gas),

TABLE 4.—Crude petroleum production, by counties

(Thousand barrels)

County	1959	1960 [1]	Principal fields in 1960 in order of production
Albany	365	409	Quealy.
Big Horn	12,386	11,471	Garland, Byron, Bonanza.
Campbell	966	1,816	Dead Horse Creek, Rozet, Barber Creek.
Carbon	4,216	3,970	Wertz, Rock River, Big Medicine Bow.
Converse	5,182	4,693	Glenrock, Big Muddy.
Crook	3,058	4,676	Donkey Creek, Robinson Ranch, Coyote Creek.
Fremont	14,372	14,602	Steamboat Butte, Winkleman Dome, Beaver Creek, Big Sand Draw.
Goshen	30	17	Torrington.
Hot Springs	21,219	21,183	Hamilton Dome, Grass Creek, Murphy Dome, Little Buffalo Basin, Gebo.
Johnson	7,729	8,115	Sussex, North Fork, Meadow Creek, Meadow Creek-N.
Laramie	336	311	Horse Creek.
Natrona	12,760	12,273	Salt Creek, Grieve Unit, Salt Creek-E.
Niobrara	1,212	1,251	Lance Creek, Lance Creek-E, Little Buck Creek.
Park	30,007	33,683	Elk Basin, Oregon Basin, Fourbear, Frannie.
Sheridan	875	997	Ash Creek.
Sublette	1,245	1,607	Big Piney, La Barge.
Sweetwater	3,592	6,652	Lost Soldier, Patrick Draw.
Uinta	74	93	Church Buttes.
Washakie	3,601	3,205	Cottonwood Creek, Worland, Slick Creek, Hidden Dome.
Weston	2,825	4,497	Fiddler Creek, Miller Creek, Clareton, Skull Creek.
Total	126,050	135,521	

[1] Preliminary figures.

TABLE 5.—Wildcat- and development-well completions in 1960, by counties

County	Crude	Gas	Dry	Service	Total	Footage
Wildcat:						
Albany			4		4	8,200
Big Horn	4		11		15	49,000
Campbell	5		51		56	416,100
Carbon	[1] 1	3	20		24	142,200
Converse			6		6	41,800
Crook	5	1	57		63	260,000
Fremont	2	1	33		36	147,900
Goshen			2		2	11,400
Hot Springs			6		6	26,300
Johnson	1		12		13	56,400
Lincoln			5		5	44,000
Natrona	[1] 4		33		37	165,400
Niobrara	1		27		28	186,900
Park			6		6	27,200
Platte			2		2	5,800
Sheridan			5		5	35,900
Sublette	2	1	17		20	129,800
Sweetwater	4	3	44		51	292,400
Uinta			1		1	4,300
Washakie			6		6	23,500
Weston	4		46		50	270,900
Total	[2] 33	9	394		436	2,345,400
Development:						
Big Horn	12		4		16	71,600
Campbell	56		15		71	500,000
Carbon	6		3		9	37,000
Converse	8		4		12	59,500
Crook	51	1	20		72	411,500
Fremont	7		8		15	42,000
Hot Springs	22		7		29	103,900
Johnson	30		2		32	162,700
Laramie	1				1	7,400
Lincoln		7			7	50,300
Natrona	26	1	17		44	139,100
Niobrara	4		4		8	7,500
Park	32		4	3	39	194,900
Sublette	26	22	6		54	227,200
Sweetwater	110	16	11		137	679,000
Washakie	4		1	1	6	19,700
Weston	57		26	4	87	350,100
Total	452	47	132	8	639	3,063,400
Total all drilling	[2] 485	56	526	8	1,075	5,408,800

[1] Includes 1 condensate-well completion.
[2] Includes 2 wildcat condensate-well completions.

Source: Oil and Gas Journal.

and Laramie (1 oil) basins. A contract was awarded for drilling 10 wells in the Teapot Dome reserve in Natrona County. This field, controlled by the U.S. Navy, had been idle for many years. Refinery crude-oil throughput was 38.7 million barrels, an increase of 4 percent over that of 1959. Husky Oil Co. completed expansion at the Cody refinery, raising capacity from 7,200 to 9,000 barrels of crude oil a day. The addition of a 2,500-barrel-per-day gas-oil cracking unit and a 700-barrel-per-day sulfuric acid alkylation unit was scheduled for the refinery in 1961. Texaco, Inc., completed installation of a hydrotreating unit with a capacity of 4,000 barrels a day. Standard Oil Co. (Indiana) continued a modernization program at the Casper refinery, and announced replacement of a 37,000-barrel-a-day distillation unit which was to be installed in the spring of 1961. Products Pipeline of El Paso Natural Gas Co. built 32 miles of 6-inch line from the expanding Patrick Draw field to a connection

with Service Pipeline Co. line near Wamsutter. State approval was granted for extending pipeline service northwest of Donkey Creek to Miller Creek and Rozet fields in Campbell and Crook Counties. One of the 10 compressor stations planned by Colorado Interstate Gas Co. was completed 8 miles east of Rawlins on the Green River to Denver (Colo.) transmission lines. Late in 1960 the Federal Power Commission gave its final but conditional approval to the Utah Project of El Paso Natural Gas Co. for a pipeline from Green River to Provo, Utah, and to the California-Nevada border near Las Vegas, Nev. Delivery of 470 million cubic feet of gas per day would be possible through the system.

The Federal Bureau of Mines Laramie Petroleum Center at Laramie continued its studies on petroleum production, petroleum processing and use, and oil shale, with particular emphasis on Rocky Mountain and Alaskan problems. Production and secondary recovery research concerned the variation of the physical characteristics of petroleum-reservoir fluids within geological basins and determinations of the types and amounts of clay minerals in reservoir rocks, their effects and that of permafrost on the behavior and water sensitivity of the petroleum-producing formations. Processing and utilization research included analysis of newly discovered crude oils from the Rocky Mountain States and compositional studies of sulfur and nitrogen compounds found in petroleum.

Research on oil shale and shale oil included studies of the composition and properties of oil shale, analysis of shale oil and its fractions, studies of thermal reactions of shale-oil components, and research on new methods for converting shale organic matter to oil, such as by in situ retorting, irradiation, and the action of micro-organisms. A study was made of the application of depleted uranium catalysts in hydrogenating and reforming shale oil and its fractions.

Reports[3] of the results of petroleum and oil-shale research and pilot-plant processing of oil shale were published.

---

[3] Baptist, Oren C., Oil Recovery and Formation Damage in Permafrost, Umiat Field, Alaska: Bureau of Mines Rept. of Investigations 5642, 1960, 22 pp.

Biggs, Paul, and Espach, Ralph H., Petroleum and Natural Gas Fields in Wyoming: Bureau of Mines Bull. 582, 1960, 538 pp.

Cook, G. L., Meyer, R. A., and Earnshaw, D. G., Dual-Inlet System for a Mass Spectrometer: Bureau of Mines Rept. of Investigations 5663, 1960, 8 pp.

Dannenberg, R. O., and Matzick, A., Bureau of Mines Gas-Combustion Retort for Oil Shale, a Study of the Effects of Process Variables: Bureau of Mines Rept. of Investigations 5545, 1960, 73 pp.

Frost, C. M., Carpenter, H. C., Hopkins, C. B., Tihen, S. S., and Cottingham, P. L., Hydrogenating Shale Oil and Catalytic Cracking of Hydrogenated Stocks: Bureau of Mines Rept. of Investigations 5574, 1960, 17 pp.

Heady, H. H., Adams, L. G., and Dinneen, G. U., Composition of Naphtha from Hydrogenation of Gas-Combustion Shale Oil: Bureau of Mines Rept. of Investigations 5662, 1960, 12 pp.

Jacobson, I. A., Jr., Thermal Decomposition of Organic Nitrogen and Sulfur Compounds: Bureau of Mines Inf. Circ. 7947, 1960, 99 pp.

Matzick, A., Dannenberg, R. O., and Guthrie, B., Experiments in Crushing Green River Oil Shale: Bureau of Mines Rept. of Investigations 5563, 1960, 64 pp.

Robinson, W. E., and Stanfield, K. E., Constitution of Oil-Shale Kerogen: Bibliography and Notes on Bureau of Mines Research: Bureau of Mines Inf. Circ. 7968, 1960, 79 pp.

Stanfield, K. E., Smith, J. W., Smith, H. N., and Robb, W. A., Oil Yields of Sections of Green River Oil Shale in Colorado, 1954–57: Bureau of Mines Rept. of Investigations 5614, 1960, 186 pp.

Wenger, W. J., and Reid, B. W., Properties of Petroleum from the Four Corners Area of Arizona, Colorado, New Mexico, and Utah: Bureau of Mines Rept. of Investigations 5587, 1960, 25 pp.

NONMETALS

Cement.—The quantity of cement manufactured in the only cement plant in the State was approximately the same as in 1959. The cement was marketed chiefly in Wyoming, Colorado, and Nebraska. Shale (natural cement rock), limestone, gypsum, and sandstone were the raw materials used in the processing.

Clays.—Clay production was slightly higher. Bentonite was first in value of the clays mined, and its production was 2 percent greater than in 1959. Deposits in five counties were the principal source of swelling-type bentonite in the United States. Eleven plants were operated by nine companies, and the processed product was used chiefly for foundry, oil-well drilling, and iron-agglomerating industries. A new plant with a designed capacity of 50,000 tons a year was being constructed by the Benton Clay Co. of Casper.

Miscellaneous clay production increased by 39,000 tons over 1959. Building brick and heavy clay pipe continued to be manufactured in plants at Lovell and Sheridan. Great Western Aggregates, Inc., mined bloating shale near Laramie and processed it into a lightweight aggregate marketed chiefly in the Laramie, Cheyenne, and Denver (Colo.) areas. Clay production started from two new pits 15 miles north of Evanston in Uinta County early in 1960. Brick manufacturing companies in Utah used the clay in making high-quality white building brick.

Gem Stones.—Wyoming was a source of several semiprecious or ornamental stones. Such stones, hunted by individuals and commercial collectors, consisted mainly of varieties of Wyoming jade, agate, petrified wood, fossils, and mineral specimens. The reported value of the stones collected was estimated at 11 percent less than for 1959.

Gypsum.—Gypsum was mined in Albany County by Wyoming Construction Co. for use in manufacturing cement. A relatively small quantity was sold by Cody Sulphur Production Corp. as a soil-treating material from stocks of gypsum previously mined in Park County.

A deposit near Cody in Park County was being developed by the Big Horn Gypsum Co. for processing into plasterboard in a plant that was to be completed early in 1961.

Mica.—A small quantity of hand-cobbed sheet mica was produced from pegmatite mines in Goshen and Platte Counties.

Phosphate Rock.—Production of phosphate rock was less than in 1959; San Francisco Chemical Co. was the only producer. Phosphate rock from Wyoming and Utah mines was processed in a plant at Sage in Lincoln County. The processed rock was sold to companies in Utah for manufacturing superphosphate and triple superphosphate fertilizers and phosphoric acid; the company exported phosphate rock to Canada.

Pumice.—Production of scoria from a deposit in Sheridan County was 61,000 tons less than in 1959. The crushed and screened scoria was used for railroad ballast.

Sand and Gravel.—The value of sand and gravel was 35 percent greater in 1960. Paving sand and gravel accounted for the major increase. Production of commercial sand and gravel came from 29

TABLE 6.—Sand and gravel production in 1960, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Albany	325	$180	Platte	31	$102
Big Horn	1	1	Sheridan	230	137
Carbon	187	66	Sublette	218	113
Converse	(1)	(1)	Sweetwater	(1)	(1)
Fremont	794	608	Teton	2	2
Goshen	13	13	Uinta	57	40
Hot Springs	6	10	Washakie	24	23
Johnson	233	129	Weston	4	4
Laramie	332	511	Yellowstone National Park	1	1
Lincoln	5	10	Undistributed	2,680	2,766
Natrona	527	446			
Park	258	194	Total	5,928	5,356

[1]Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

commercial operations in 16 counties and from Government-and-contractor operations in 19 counties. Sand and gravel prepared by washing, screening, or crushing continued to increase and comprised 58 percent of the Government-and-contractor and 92 percent of the commercial output.

The Bureau of Public Roads[4] indicated that from July 1, 1956, to December 31, 1960, 98.9 miles of road was completed and 20.5 miles of road improved to acceptable standards. On the basis of 119.4 miles of road open to traffic from this program, the State ranked 28th in the United States. One hundred sixty-six miles of road was under construction and 59.3 miles was in engineering or right-of-way status. The total designated mileage for the State was 916.8 miles, of which 572.1 miles remains to be completed. Wyoming had completed 38 percent of its interstate road program.

Sodium Carbonate and Sulfate.—Intermountain Chemical Co. increased trona (natural sodium carbonate) production to a new high. The company started and completed mine and plant expansion so that facilities had a capacity of 600,000 tons at the end of 1960. Still another expansion program was announced, to be completed in 1961, when facilities will have a capacity of 700,000 to 750,000 tons a year.

West End Chemical Co. started work during the year on a project for mining trona and processing 200,000 to 300,000 tons of soda ash annually. Completion was scheduled for late 1962. Diamond Alkali Co. had been actively exploring for trona for 2 years. Texota Oil Co., Utah Construction & Mining Co., and Allied Chemical Corp. also were reported to have interests in trona deposits.

Sweetwater Chemical Co. and William E. Pratt continued to harvest sodium sulfate from saline lake deposits in Carbon and Natrona Counties. Most of the product was shipped to the Midwest as an additive to stockraising feed.

Stone.—The value of stone production was 29 percent greater than in 1959. Crushed limestone, constituting the largest production, was used in manufacturing cement and refining sugar beets. Crushed

[4]Bureau of Public Roads, Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1960, press release BPR 61–6, Feb. 22, 1961.

granite and dolomite were prepared for riprap and railroad ballast, and miscellaneous stone was used for riprap and road building. De Wald Stone Works quarried and prepared sandstone near Laramie for use as stone facing blocks in buildings of the University of Wyoming.

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	1959		1960	
	Quantity	Value	Quantity	Value
Commercial operations:				
Construction sand:				
Building	151	$220	150	$211
Paving	225	138	48	69
Railroad ballast			14	14
Fill	(1)	(1)	(2)	(3)
Other	36	27	(2)	(3)
Total sand	412	385	212	294
Construction gravel:				
Building	285	384	153	216
Paving	1,124	774	1,558	1,029
Railroad ballast	189	95	161	81
Fill	(1)	(1)	10	14
Other	46	35		
Miscellaneous gravel			18	21
Total gravel	1,644	1,288	1,900	1,361
Total sand and gravel	2,056	1,673	2,112	1,655
Government-and-contractor operations:				
Sand:				
Building	95	95	51	87
Paving	98	102	45	113
Total sand	193	197	96	200
Gravel:				
Building	394	299	114	230
Paving	2,049	1,813	3,549	3,231
Other			57	40
Total gravel	2,443	2,112	3,720	3,501
Total sand and gravel	2,636	2,309	3,816	3,701
All operations:				
Sand	605	582	308	494
Gravel	4,087	3,400	5,620	4,862
Grand total	4,692	3,982	5,928	5,356

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Other."
[2] Less than 1,000 short tons.
[3] Less than $1,000.

TABLE 8.—Stone production in 1960, by counties

County	Short tons	Value	County	Short tons	Value
Albany	(1)	(1)	Platte	(1)	(1)
Big Horn	11,000	$33,900	Teton	74,024	$86,840
Crook	14,164	29,534	Yellowstone National Park	39,560	123,162
Fremont	49,700	54,670	Undistributed	736,217	1,120,541
Laramie	459,387	834,076			
Lincoln	14,000	16,100	Total	1,401,052	2,301,823
Natrona	3,000	3,000			

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Sulfur.—Output of sulfur processed from hydrogen sulfide-bearing natural gas was 11 percent less than in 1959. Production was in three counties, by Texas Gulf Sulphur Co. (Washakie County), Pan American Petroleum Corp. at Elk Basin (Park) and Cottonwood Creek (Washakie), Texas Seabord, Inc. (Park) and Jefferson Lake Sulphur Co. (Big Horn). According to the Jefferson Lake Sulphur Co. annual report, the Manderson plant, which began producing elemental sulfur from concentrated hydrogen sulfide in March 1955, discontinued operations in August 1960, having produced approximately 90,000 long tons of high-grade sulfur. The Mobil Oil Co. adjacent sour-gas-processing plant, which delivered hydrogen sulfide, discontinued operations because of losses due to greatly reduced volumes of sour natural gas from wells of the Manderson field.

Vermiculite.—Golden Clover Corp. was developing the Platt mine near Encampment for vermiculite.

METALS

Beryllium.—Five tons of beryl valued at $2,407 was produced from three mines. Two operators shipped hand-cobbed beryl to the Government purchase depot at Custer, S. Dak., and one operator sold to Mineral Concentrates & Chemical Co., Inc., of Loveland, Colo., and Gladys Wells of Custer, S. Dak.

Gold and Silver.—A lode and a placer operation in the Atlantic City-South Pass area of Fremont County produced 40 ounces of gold and 4 ounces of silver.

Iron Ore.—Iron-ore production decreased. Reduced operating schedules of the steel plant at Pueblo, Colo., necessitated stoppage of work at the Sunrise mine of The Colorado Fuel and Iron Corp. (CF&I) in Wyoming for two periods, the first from August 21 to September 25 and the second from November 27 to December 31. Iron ore produced by Magnetite Products Corp. from the Cobar No. 1 mine in Albany County was concentrated and shipped to Texas for use as a heavy aggregate in coating underwater pipelines and transmission lines.

The proposed $73 million taconite-iron mining project of Columbia-Geneva Steel passed from the planning into the development stage during the year. Pomeroy-Bechtel Joint Venture was contracted to start the open pit and construct the concentrating plant. Arthur G. McKee and Co. was subcontracted to construct the 4,000-ton-a-day pelletizing plant. A 76-mile railroad spur was started from Winton Junction on the main line of the Union Pacific railroad to the iron deposit near Atlantic City. Initial production was scheduled for late in 1962. Reportedly, exploration indicated 300 million tons of taconite ore containing 21.8 to 35.2 percent iron.

Uranium.—Uranium-ore production increased 57 percent. Production started at several large mines after long periods of development. The 492-ton-per-day mill of Globe Mining Co. started processing ore in January, and all five uranium mills in the State were operating at or above rated capacity most of the year. Fremont County supplied 73 percent of the ore mined, with Natrona, Crook, Converse, Carbon, Campbell, Big Horn, Niobrara, and Johnson Counties supplying the remainder. A total of 106 operations was reported.

TABLE 9.—Mine production of uranium ore, by counties [1]

County	1959				1960			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Big Horn	6	3,529	18,928	$78,250	3	286	1,369	$5,518
Campbell	17	3,366	15,730	61,463	20	8,653	36,027	133,044
Carbon	5	2,405	9,320	36,786	8	27,397	248,134	1,104,925
Converse	19	27,148	113,795	445,887	13	50,810	214,323	857,449
Crook	15	44,957	198,332	788,930	13	83,957	377,043	1,527,396
Fremont	36	732,304	3,858,510	15,894,501	39	990,371	5,231,292	21,651,096
Johnson	4	481	2,376	9,456	1	34	82	196
Natrona	7	50,068	119,525	291,602	8	195,640	631,694	2,106,747
Niobrara					1	77	216	604
Sublette	1	[3]	[3]	[3]				
Sweetwater	1	[3]	[3]	[3]				
Undistributed		324	917	2,671				
Total	111	864,582	4,337,433	17,609,546	106	1,357,225	6,740,180	27,386,975

[1] Based on data supplied to Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowance.
[3] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Utah Mining Corp. mined the first commercial uranium ore from the Shirley basin 50 miles south of Casper near the Natrona-Carbon County line; the ore was processed in the Lucky Mc mill in the Gas Hills. Several companies contributed to the development of multi-million-ton reserves in the Shirley basin. Petrotomics Co. was awarded an AEC contract which provides for the purchase of 1 million pounds of U_3O_8 concentrates before March 31, 1962, and 3.2 million pounds of concentrates between that date and December 31, 1966. Total value of the contract quantity of U_3O_8 approximated $25 million. The Petrotomics Co. had AEC permission to build a mill or to make arrangements with other companies for treating the ore produced at existing mills.

The uranium-concentrate purchase contract between AEC and Susquehanna-Western, Inc., operator of a 500-ton-a-day uranium processing plant at Riverton, was extended to December 31, 1966. Under the extended contract AEC will purchase uranium concentrates valued at approximately $47 million. All five of the uranium processing companies and the Petrotomics Co. had AEC contracts with extending concentrate purchasing through 1966.

Vanadium.—Vanadium oxide was recovered from Wyoming uranium ores processed at the uranium mill of Mines Development, Inc., at Edgemont, S. Dak., where installation of a vanadium-recovery unit was completed in November. The uranium ore containing vanadium came chiefly from mines in Crook, Campbell, and Converse Counties. Recovery of vanadium from Wyoming ores, previously processed at mills in southwestern Colorado, was reported in 1954 and 1956–58.

REVIEW BY COUNTIES

Albany.—Cement manufacture at the Laramie plant of Monolith Portland Midwest Co. accounted for the large value of mineral production in the county. Shale (cement rock) and limestone were mined by the company, and cement was produced in about the same amount as in 1959. Gypsum was mined by Wyoming Construction Co. for use in cement manufacture. A plant adjacent to the cement plant and operated by Great Western Aggregates, Inc., processed shale as lightweight aggregate, chiefly used in building construction in the Laramie, Cheyenne, and Denver (Colo.) areas. Production was 19 percent greater than in 1959. DeWald Stone Works continued to supply sandstone blocks for facing buildings at the University of Wyoming. One Wyoming State Highway Department and three commercial operations produced 56 percent more sand and gravel than in 1959. Magnetite Products Corp. mined iron ore and shipped it to Gulf Coast areas.

Major production of petroleum continued to be from the Quealy field.

Big Horn.—Big Horn County was fifth in production of petroleum, which amounted to 91 percent of the value of the county mineral output. Four new discoveries were made, and 12 successful development wells were completed. Production came from 13 fields, the most active being Garland with 5.2 million barrels, Byron with 2.5 million, and Bonanza with 2.4 million. New discoveries included a new pay zone in the Lamb field, pumping 50 to 60 barrels of oil a day from the Peay formation; a new field on the Cherry anticline, pumping 2.5 barrels a day from the Phosphoria formation; a new field at Lovell, pumping 15 barrels of oil a day from the Phosphoria; and a new field at North Deaver, pumping 120 barrels from the Tensleep formation. Of 16 development wells, 12 resulted in completions. Mobil Oil Co. operated a natural gas plant at Manderson for 6 months of the year, producing an unreported quantity of natural gas liquids. The residual gas was processed in a plant of Jefferson Lake Sulphur Co. for elemental sulfur until the plant was closed because of inadequate supplies of concentrated hydrogen sulfide gas.

The bentonite producers in the county maintained the second largest production in the State, although output was 42,000 tons less than in 1959. Magnet Cove Barium Corp. had the largest operation in the State with mines and a mill north of Greybull. Wyo-Ben Products Co. also produced bentonite from mines and a mill in the same vicinity. Lovell Clay Products Co. maintained its steady operation of mining clay and shale and manufacturing building brick and heavy clay pipe. Production was reported from one Government-and-contractor sand and gravel operation.

Campbell.—Petroleum production accounted for 87 percent of the value of mineral output. Five fields were in operation, with the main activity at Dead Horse Creek with 703,600 barrels of oil, Rozet with 628,400, and Barber Creek with 350,200. Of 56 exploratory wells drilled, 5 resulted in oil discoveries. A well in a new pay zone in the Raven Creek field pumped 440 barrels of oil a day from the

TABLE 10.—Value of mineral production in Wyoming, by counties

County	1959	1960 [1]	Minerals produced in 1960 in order of value
Albany [2]	$5,494,840	$5,968,138	Cement, petroleum, stone, clays, iron ore, sand and gravel, gypsum, gem stones.
Big Horn [3]	[4] 34,123,995	31,369,857	Petroleum, clays, stone, uranium ore, gem stones, sand and gravel.
Campbell	3,017,937	[5] 5,266,030	Petroleum, coal, uranium ore.
Carbon [6]	[4] 10,935,667	11,713,985	Petroleum, uranium ore, coal, sand and gravel, sodium sulfate, gem stones.
Converse [6]	[4] 14,971,705	[5] 14,520,969	Petroleum, coal, uranium ore, gem stones, sand and gravel.
Crook	13,071,810	[5] 18,579,053	Petroleum, clays, uranium ore, stone.
Fremont [6]	[4] 52,311,804	59,005,209	Petroleum, uranium ore, sand and gravel, stone, gem stones, coal, gold, silver.
Goshen	100,643	57,882	Petroleum, sand and gravel, gem stones, beryllium concentrate, mica (sheet).
Hot Springs [7]	[4] 53,193,453	53,291,402	Petroleum, coal, sand and gravel.
Johnson [6]	19,374,206	20,535,973	Petroleum, sand and gravel, clays, uranium ore.
Laramie	1,921,500	2,126,176	Stone, petroleum, sand and gravel.
Lincoln [6]	(8)	(8)	Phosphate rock, coal, stone, sand and gravel, gem stones.
Natrona [6]	[4] 33,039,663	33,635,507	Petroleum, uranium ore, sand and gravel, clays, sodium sulfate, stone, gem stones.
Niobrara [2]	3,030,000	[7] 3,141,698	Petroleum, beryllium concentrate, uranium ore.
Park [3]	[4] 75,139,700	84,738,000	Petroleum, sand and gravel.
Platte	3,375,313	3,046,115	Iron ore, stone, sand and gravel, mica (sheet).
Sheridan	3,722,066	3,954,622	Petroleum, coal, sand and gravel, pumice, clays.
Sublette [7]	(8)	4,147,400	Petroleum, sand and gravel.
Sweetwater [6]	21,655,180	30,488,043	Petroleum, sodium carbonate, coal, sand and gravel, gem stones.
Teton	24,100	88,640	Stone, sand and gravel.
Uinta [6]	227,650	273,400	Petroleum, sand and gravel, clays.
Washakie [3]	9,052,500	8,068,200	Petroleum, sand and gravel.
Weston [2]	8,548,263	12,753,734	Petroleum, clays, sand and gravel.
Yellowstone National Park	(8)	123,762	Stone, sand and gravel.
Undistributed [9]	[4] 28,040,478	36,366,837	
Total [10]	[4] 393,841,000	442,738,000	

[1] Values of petroleum are preliminary.
[2] Excludes natural gas liquids.
[3] Excludes natural gas, natural gas liquids, and sulfur.
[4] Revised figure.
[5] Excludes vanadium.
[6] Excludes natural gas and natural gas liquids.
[7] Excludes natural gas.
[8] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[9] Includes natural gas, natural gas liquids, vanadium (1960), some sand and gravel, stone, gem stones, beryllium concentrate (1960), and values indicated by footnote 8.
[10] Total adjusted to eliminate duplicating value of raw materials used in manufacturing cement.

Minnelusa formation; a discovery in the Rainbow Ranch field pumped 125 barrels of oil a day from the Minnelusa formation; a North Donkey field discovery well pumped 100 barrels of oil a day from the Minnelusa formation; an O'Connor field discovery well pumped 295 barrels of oil from the Muddy formation; and a Pownall Ranch field discovery pumped 90 barrels of oil a day from the Minnelusa formation. Of the 71 development wells, 56 resulted in oil completions.

A new strip coal mine was started on the south side of U.S. Highway 14–16 by Wyodak Resources Development Corp. The company produced 32,000 tons more than in 1959. The coal, mined from a seam averaging 70 feet thick, was used chiefly in thermo-powerplants in eastern Wyoming and western South Dakota.

Uranium production reported from 20 mines had approximately double the value of the 1959 output. Some vanadium was recovered as a byproduct in concentrating uranium ore.

Carbon.—The value of mineral production increased 7 percent because of new uranium production in the Shirley basin. Petroleum output, which provided 85 percent of the total mineral valuation, was 246,000 barrels less than in 1959. Oil production came from 90 wells in 13 fields; the producing oilfields were Wertz with 2.3 million barrels, Rock River with 976,000 barrels, and Big Medicine Bow with 107,000 barrels. Of 24 wildcat wells, 3 natural gas discoveries were made. The Cow Creek discovery flowed 11 million cubic feet of gas from the Frontier and Nugget formations, and the Cole Springs Draw discovery flowed 8.2 million cubic feet of gas from the Sundance formation. Nine development wells resulted in six oil completions. Sinclair Refining Co. operated its 26,000-barrel-a-day refinery throughout the year. Ohio Oil Co. operated a refrigeration-absorption natural gas plant at Rock River and produced 7,600 gallons of natural gas liquids from an average daily throughput of 1.4 million cubic feet of gas.

Uranium production was from the Shirley basin and Baggs area. Utah Mining Corp. shipped ore to the Lucky Mc mill in the Gas Hills, and producers near Baggs shipped to the Trace Elements mill at Maybell, Colo. The underground operation of Utah Mining Corp. was plagued by pumping and high-cost mining because of the large amount of water encountered in the productive zone. Basin Engineering Co. and Trace Elements Corp., a unit of Union Carbide Nuclear Co., division of Union Carbide Corp., were the principal ore producers in the Baggs area.

Coal production increased 54 percent. Monolith Portland Midwest Co., Hanna Basin Construction & Coal Co., and Rosebud Coal Sales Co. operated strip mines; Mike & Harry Thomas worked an underground mine.

The Sweetwater Chemical Co. harvest of sodium sulfate from a saline lake north of Rawlins was slightly less than in 1959. Two Government-and-contractor and one commercial sand and gravel operation had triple the output of 1959.

Converse.—Petroleum, coal, and uranium had the highest value of the minerals produced. Petroleum output decreased 9 percent from 1959, but still accounted for 81 percent of the value of mineral production. Of the seven producing fields, Glenrock and Big Muddy led in output with more than 2.3 and 1.8 million barrels of oil, respectively. No new fields were discovered, but eight crude oil completions were reported. The Cabot Carbon Co. operated its natural gas plant at Glenrock. Throughput averaged 5 million cubic feet, with recovery of 46,000 gallons of natural gas liquids. Coal was produced from two strip mines.

The value of uranium ore mined was almost double the 1959 output, although the number of operations decreased from 19 to 13. Robert W. Adams, B. & H. Mines, and Vernon A. Mrak operated the major producing mines. Some vanadium was recovered as a byproduct of uranium-ore processing.

One commercial sand and gravel operation was reported.

Crook.—Petroleum continued to increase in importance, and production from six fields was 53 percent greater than in 1959. Major fields

and production were Donkey Creek with 2.7 million barrels, Robinson Ranch with 855,000 barrels, and Coyote Creek with 793,000 barrels. Sixty-three wildcat attempts resulted in one natural gas and five oil discoveries. The natural gas discovery, in the Kummerfeld field, flowed 5.2 million cubic feet a day from the Dakota formation. The Coyote Creek well pumped 50 barrels of oil a day from a new pay zone in the Muddy formation; the Grasshopper Butte discovery pumped 6 barrels a day from a new pay zone in the Minnelusa formation; the Kummerfeld discovery flowed 231 barrels a day from the Dakota formation; the Mellott Ranch discovery pumped 38 barrels a day from the Minnelusa formation; and the Prairie Creek discovery pumped 271 barrels a day from the Newcastle formation. Development-well completions totaled 51 oil and 1 gas.

Bentonite production, 14 percent above that of 1959, assumed second place in the county value of mineral products. Mines were operated by American Colloid Co., Archer-Daniels-Midland Co., Black Hills Bentonite Co., International Minerals & Chemical Corp., and Baroid Division of National Lead Co. Mills at Colony were operated by Baroid and Archer-Daniels-Midland Co. The other companies processed bentonite in mills in South Dakota.

Uranium ore produced from 13 operations was shipped to the mill at Edgemont, S. Dak. The Hauber mine of Homestake Mining Co. had the largest production. Vanadium was recovered at the mill from some of the uranium ore mined in Crook County.

Rounds Construction Co. mined and crushed stone for use in road surfacing.

Fremont.—Fremont County was second highest in value of mineral production; petroleum production represented 62 percent of the mineral output. Petroleum was produced from 21 fields, and output was 2 percent above that of 1959. Major fields were Steamboat Butt with 2.9 million barrels of oil, Winkleman Dome with 2.7 million, Beaver Creek with 2.6 million, and Big Sand Draw with 1.8 million. Two discoveries were made at Sage Creek field, with one well pumping 2 barrels of oil a day from a new pay zone in the Red Peak formation and the other pumping 53 barrels a day from the Phosphoria formation. A natural gas discovery at Pavillion Unit flowed 1.9 million cubic feet a day from the Fort Union formation. Natural gas liquids were produced at plants of Northern Utilities Co. and Pan American Petroleum Corp. Pan American Petroleum Corp. processed 19,600 gallons of natural gas liquids from an average daily gas throughput of 26 million cubic feet. Residual gas from both plants was transported to consumers through pipelines of the Rocky Mountain Gas Co.

Uranium-oxide production had the second highest mineral valuation in the county, representing 37 percent of the mineral output. Production was reported from 39 operations in the Gas Hills and Crooks Gap areas. The five uranium-ore processing mills operated steadily; contracts with the AEC were to allow for purchase of specific quantities through 1966. Mills were operated by Utah Construction & Mining Co. (Lucky Mc mill), Western Nuclear, Inc. (Jeffrey City), Susquehanna-Western, Inc. (Riverton), and Federal-Radorock-Gas Hills Partners (Gas Hills).

The Duncan mine, operated by Atlantic Western Mining Co., and Bonanza No. 1 placer, operated by D. H. Branson, had a small output of gold and silver. A highlight of the year was the start of construction of the reported $73 million Atlantic City iron-ore project by Columbia-Geneva Steel.

Sand and gravel was reported from 13 Government-and-contractor and 4 commercial operations. The county gem stone production, largest in the State, was chiefly jade, agate, and petrified wood.

Less than 1,400 tons of coal was produced from one operation.

Goshen.—Petroleum production from the Torrington field, the only producing field in the county, again declined. Two exploratory wells were drilled, but both were dry. Nicola & Harvey produced a small quantity of beryl concentrate from the Spook mine. One Government-and-contractor sand and gravel operation was active.

Hot Springs.—Petroleum accounted for 99.8 percent of the value of mineral output, the second largest in the State. Production came from 17 fields, the major ones being Hamilton Dome with 7.6 million barrels of oil, Grass Creek with 4.4 million, Murphy Dome with 2.9 million, Little Buffalo basin with 2.1 million, and Gebo with 1.2 million. No new discoveries were made; 22 development wells of 29 drilled resulted in oil completions. Empire State Oil Co. increased the throughput to its refinery to 2 million barrels of oil per year.

Two underground coal mines were operated, with approximately the same production as in 1959. The Roncco Coal Co. mined 79 percent of the coal produced.

One commercial sand and gravel operation was reported.

Johnson.—Petroleum output, 5 percent above that of 1959, accounted for nearly all the value of mineral production. Eleven oil fields were active, the largest production coming from Sussex with 3.1 million barrels of oil, North Fork with 1.4 million barrels, and Meadow Creek with 1.3 million barrels. One oil discovery was made at the Cellers Ranch field, where pumping produced 358 barrels of oil a day from the Tensleep formation. Of 32 development wells drilled, 30 resulted in oil completions. Continental Oil Co. processed natural gas at the Linch refrigeration plant; 34,500 gallons of natural gas liquids was recovered from an average throughput of 15.6 million cubic feet a day.

Bentonite production held steady in 1960. The Benton Clay Co. operated a mine near Kaycee and trucked bentonite about 70 miles to its plant in Casper. One commercial and one Government-and-contractor sand and gravel operation were reported.

Uranium production was limited to a small yield from one mine.

Laramie.—Petroleum production, 7 percent less than in 1959, came from four relatively small fields, one of which, Horse Creek, produced 131,600 barrels. One development well was completed. The 21,000-barrel-a-day refinery of Frontier Refining Co. at Cheyenne processed 6 percent less crude oil than in 1959.

The Great Western Sugar Co. continued to mine and crush limestone for its sugar refineries. Production was reported from two commercial and two Government-and-contractor sand and gravel operations.

Lincoln.—The only phosphate-rock mine in the State, at Sage, was operated by the San Francisco Chemical Co.

Coal production from the Elkol strip mine near Kemmerer decreased, but coal production from the underground Brilliant No. 8 mine slightly increased. Both mines were operated by the Kemmerer Coal Co. United States Steel Corp. and Food Machinery & Chemical Corp. began constructing a plant to make metallurgical coke from subbituminous coal near the Elkol mine south of Kemmerer. Coke pellets from the plant were to be used in electric furnaces making elemental phosphorus near Pocatello, Idaho, and in the Columbia-Geneva Steel plant at Provo, Utah.

El Paso Natural Gas Co. recovered 164,700 gallons of natural gas liquids from its gas absorption plant at Opal. The residual gas was marketed through the company pipeline system in the Northwestern States.

Stone was mined and crushed for road construction. One commercial and one Government-and-contractor sand and gravel operation were in production.

Natrona.—Petroleum production, accounting for 92 percent of the value of the mineral output, came from 1,277 wells in 23 fields. Major fields were Salt Creek-L & B with 4.4 million barrels of oil, Grieve Unit with 4.2 million barrels, and Salt Creek-E with 1 million barrels. Three discoveries resulted from 37 exploratory attempts. A Wallace Creek discovery flowed 80 barrels of oil a day and 1.4 million cubic feet of gas a day from the Muddy and Thermopolis formations; a well in the Boone Dome field flowed 325 barrels of condensate a day and 28.5 million cubic feet of gas from a new pay zone in the Frontier formation; and a Twenty-Mile Hill discovery flowed 274 barrels of oil a day from the Frontier formation. Development drilling resulted in 1 gas and 26 oil completions from 44 tries. Oil refineries of Texaco, Inc., Socony Mobil Co., and Standard Oil Co. (Indiana) continued refinery operations at Casper; the combined throughput was 16.6 million barrels of oil, an increase of 4 percent. Pan American Petroleum Corp. operated its natural gas absorption plant at Midwest, producing 99,300 gallons of natural gas liquids from an average daily throughput of 18 million cubic feet of gas. The residual gas was transported through Northern Utilities Co. pipelines.

The value of uranium-oxide production increased sevenfold over that of 1959. This production, from eight operations in the Gas Hills, was centered in the operations of Globe Mining Co. and Federal-Radorock-Gas Hills Partners. The Globe Mining Co. mill began operating in January at its capacity of 492 tons a day and maintained capacity output most of the year.

Benton Clay Co. increased bentonite output 11 percent over that of 1959. William E. Pratt continued to harvest sodium sulfate from a small saline lake 28 miles west of Casper. Three commercial and three Government-and-contractor sand and gravel operations reported production.

Niobrara.—Petroleum accounted for virtually all the mineral production value. Production, which came from 325 wells in 8 fields, was 3 percent more than in 1959. Principal fields were Lance Creek with 754,000 barrels of oil, Lance Creek-E with 233,600 barrels, and

Little Buck Creek with 125,000 barrels. One discovery was made from 28 exploratory wells. The KREJCI discovery well, completed in the Mowry formation, flowed 93.5 barrels of oil a day. Development drilling resulted in four completions from eight attempts. The oil refinery of C & H Refinery Co. operated with 19 percent less throughput. The natural gas absorption plant of Ohio Oil Co. operated throughout the year with recovery of 18,400 gallons of natural gas liquids.

A small beryl operation by Dale McDermond and a uranium operation by Silver Cliff Mining Co. each had production valued at less than $1,100.

Park.—Petroleum production, highest in the State, represented nearly the entire value of mineral output. Twenty-five fields produced; the major fields were Elk Basin-Hvy with 17.8 million barrels of oil, Oregon Basin with 5.2 million barrels, Fourbear with 3.2 million barrels, and Frannie with 2.7 million barrels. No new discoveries were made, but 32 oil completions resulted from 39 development wells. Husky Oil Co. increased the daily capacity of its refinery at Cody from 7,200 to 9,000 barrels of oil but processed 5 percent less petroleum than in 1959. Texaco Seaboard, Inc., and Pan American Petroleum Corp. produced elemental sulfur as byproducts from their natural gas plants. The Pan American Petroleum Corp. plant at Elk Basin processed 80,100 gallons of natural gas liquids from an average daily throughput of 13.2 million cubic feet of gas.

One Government-and-contractor and three commercial sand and gravel operations had production. Big Horn Gypsum Co. was constructing a gypsum-board plant at Cody.

Platte.—Although iron ore produced by CF&I at the Sunrise mine decreased 4 percent, it was the principal mineral commodity. Additional sinking of the main hoisting shaft was one of the company improvements at the Sunrise property.

Dolomitic limestone was produced by Guernsey Stone Co. for use as railroad ballast. One Government-and-contractor sand and gravel operation was reported.

Sheridan.—Petroleum and coal were the chief minerals produced. Oil output increased 14 percent, with 944,600 barrels of oil being produced from the Ash Creek field. No new discoveries were made. Coal production by Big Horn Coal Co. and Welch Coal Co. held steady in 1960.

Sheridan Press Brick & Tile Co. mined less clay in 1960. Tongue River Stone Co. decreased its scoria output to one-third; the scoria was used for railroad ballast. Two commercial and four Government-and-contractor sand and gravel operations were in production.

Sublette.—Petroleum accounted for nearly all the value of mineral production. Output came from seven fields, the largest being Big Piney with 820,300 barrels of oil a day, followed by La Barge with 367,900 barrels. Two oil discoveries and one gas were made from 20 exploratory wells. The discovery well in the Hogsback field pumped 285 barrels of oil a day from the Nugget formation; the Mickelson Creek discovery well flowed 360 barrels of oil a day from the Mesaverde formation; and the McDonald Draw discovery well flowed 11.6

million cubic feet of gas a day from the Wasatch formation. Of 54 development wells, 26 oil and 22 gas wells were completed.

Two Government-and-contractor sand and gravel operators reported production.

Sweetwater.—Petroleum, sodium carbonate, and coal comprised most of the minerals produced. Petroleum accounted for 55 percent of the value of mineral output with production from 82 wells in 13 fields; the output was almost double that of 1959. Principal fields were Lost Soldier with 3.6 million barrels of oil and Patrick Draw with 2.3 million barrels. Four oil and three natural gas discoveries were made from 51 exploratory wells. A discovery in the State Line Unit flowed 450 barrels of oil a day, and another well in the field flowed 6.2 million cubic feet of gas a day, both from the Fort Union formation; an Arch Unit well flowed 607 barrels of oil a day, and two wells in the West Desert Springs area flowed 14 and 200 barrels, all from the Almond producing zone. A Jackknife Springs well flowed 7.2 million cubic feet of gas from the Mesaverde formation; the Sand Butte discovery well flowed 10.6 million cubic feet of gas a day; and an unnamed field discovery well flowed 65,000 cubic feet of gas a day from the Almond producing zone. Of 137 development wells, 110 oil and 16 gas completions resulted, with most activity in the Patrick Draw, West Desert Springs, and Arch Units. The natural gas plant of Sinclair Oil & Gas Co. at Baroil recovered 8,000 gallons of natural gas liquids from a throughput averaging 7 million cubic feet a day.

Coal production decreased 8 percent. The Union Pacific Coal Co. operated the Rock Springs No. 8 and the Superior D. O. Clark mines, Gunn Quealy Coal Co. operated the Rainbow Nos. 6 and 7 mines, and Edwin L. Swanson Bros. operated the Van Dyke mine.

Intermountain Chemical Co. increased soda-ash output 11 percent over that of 1959. In November, the West End Chemical Co. began constructing buildings and sinking a shaft for trona 21 miles west of Green River. One commercial sand and gravel operation was in production.

Teton.—Utah-Idaho Sugar Co. mined and crushed limestone for sugar refining and road material. One Government-and-contractor sand and gravel operator reported production.

Uinta.—Petroleum produced from two fields increased from 74,000 barrels of oil in 1959 to 93,000 barrels. No new discoveries or development completions were made. Mountain Fuel Supply Co. operated a natural gas absorption plant at Lyman and produced 1,200 gallons of natural gas liquids from an average daily throughput of 55 million cubic feet of gas a day. One commercial and one Government-and-contractor sand and gravel operator reported production.

Washakie.—Petroleum represented most of the value of mineral production. Crude-oil production decreased 11 percent. Eleven fields were active, the largest being Cottonwood Creek with 2 million barrels of oil, followed by Worland with 332,000 barrels, Slick Creek with 243,000 barrels, and Hidden Dome with 186,000 barrels. No new discoveries were made, but four oil completions resulted from six development wells. Pan American Petroleum Corp. recovered

elemental sulfur and 5,000 gallons of natural gas liquids from its natural gas plant at Cottonwood field. Pure Oil Co. recovered 72,000 gallons of natural gas liquids from its absorption plant near Worland, and Texas Gulf Sulphur Co. recovered elemental sulfur from the concentrated hydrogen sulfide gas. One commercial and one Government-and-contractor sand and gravel operation was reported.

Weston.—Petroleum and bentonite accounted for almost all mineral production. Petroleum production was up 59 percent. Among 14 producing fields, the following were the most active: Fiddler Creek with 1.2 million barrels of oil, Miller Creek with 1.1 million barrels, Clareton with 589,000 barrels, and Skull Creek with 430,000 barrels. Four new oil discoveries resulted from 50 exploratory wells. A discovery well in the Lovetree Creek field flowed 455 barrels of oil a day from the Dakota formation, and a well in an unnamed field pumped 120 barrels of oil a day from the Muddy formation. Of 87 development wells, 57 new producers were completed. Sioux Oil Co. operated its 6,000-barrel-a-day refinery at Newcastle; throughput was 1 percent above that of 1959. Wyton Oil Co. operated its 5.5-million-cubic-foot-a-day natural gasoline plant at Newcastle.

American Colloid, Archer-Daniels-Midland, and Baroid mined and processed 5 percent more bentonite than in 1959. Two commercial and one Government-and-contractor sand and gravel operation were reported.

○