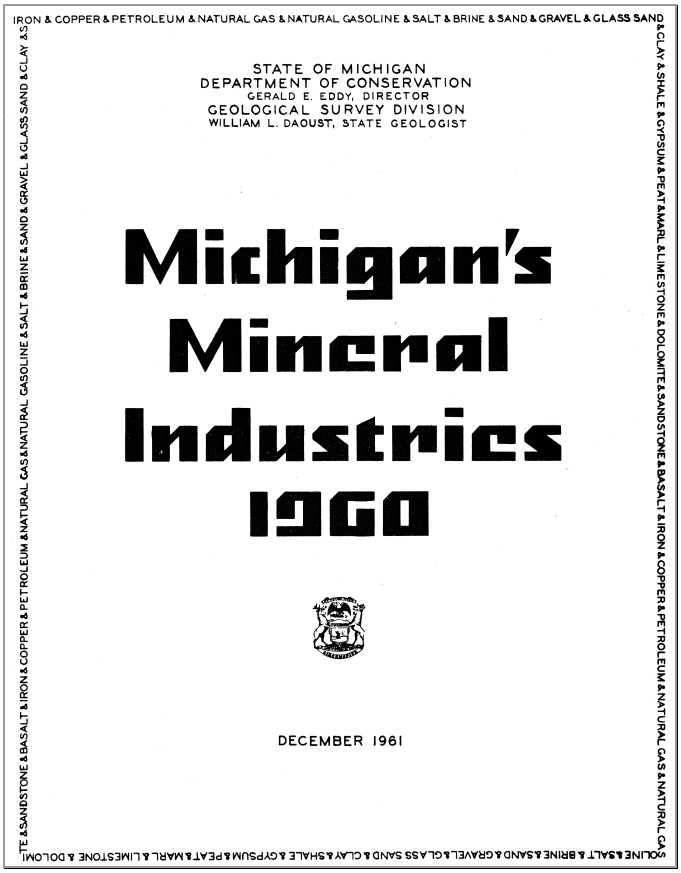

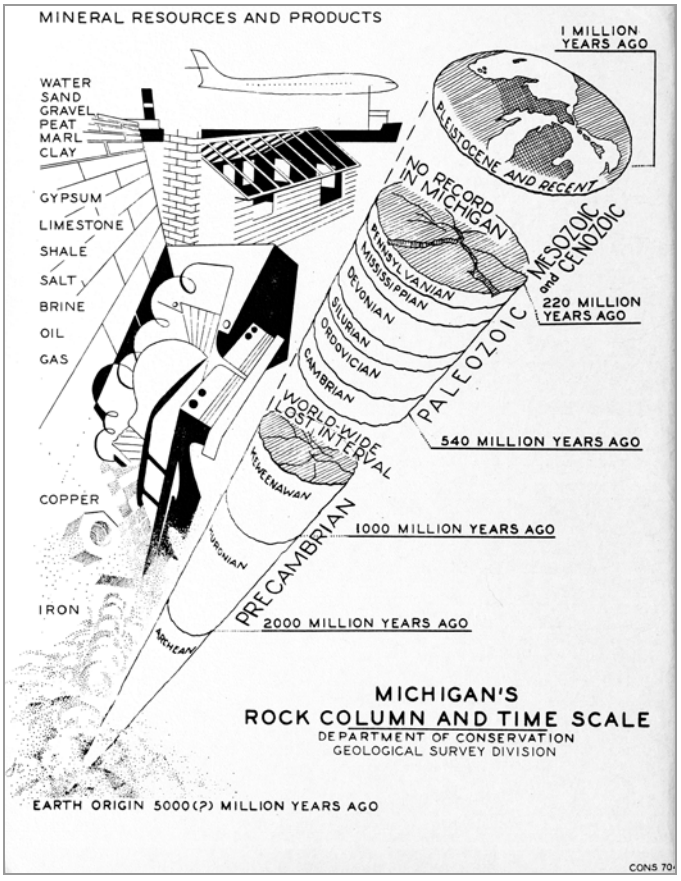

MICHIGAN MINERAL INDUSTRIES 1960

by

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CONTENTS

FOREWORD

This report on the mineral industries of Michigan is a compilation of mineral production for the year 1960. It consists of five sections: preliminary estimate of the Michigan's mineral production for 1961, news items of 1961 happening, a summary of each of the mineral industries, a breakdown of mineral production by counties, and a directory of mineral producers.

Added features in this issue includes a picture presentation of mineral producers and a three-page graph on Michigan's mineral production since 1870. We regret, however, that full coverage of the various mineral industries for the picture presentation was not possible, due to picture shortage within the files of this Department.

Items on 1961 happening in the various mineral fields was drawn heavily from various information sources that includes "Pit and Quarry", "Rock Products", "Mining World", "Steel", "World Oil", and other trade journals, magazines, and publications.

The Michigan Geological Survey expresses appreciation to all the mineral and mineral products producers for the production information they have submitted. Without their cooperation, this report would have been impossible.

THE MINERAL INDUSTRY OF MICHIGAN IN 1961* (Preliminary)

Mineral production in Michigan in 1961 was valued at nearly $435 million, according to the Bureau of Mines, United States Department of the Interior. The mineral output of the State exceeded the 1960 level ($429 million), primarily because of increased output of copper and petroleum which countered smaller shipments of iron ore, construction materials, and salt. Iron ore was first in value, followed by cement, petroleum, and copper.

METALS

Metallic minerals accounted for 29 per cent of the total value of mineral production, compared to 31 per cent in 1960.

Copper: Production of copper in terms of recoverable metal was 25 per cent larger than in 1960, although value increased only 16 per cent. The preliminary average weighted price in 1961 was 30.0¢ per pound compared with 32.1¢ in the previous year. Copper producers operated throughout the year with the exception of Copper Range Co., which shut down the Champion mine at the end of January and reopened in May. Operating companies included Calumet & Hecla, Inc., Copper Range Coal White Pine Copper Co. (a wholly owned subsidiary of Copper Range Co.), and Quincy Mining Co.

Iron Ore: Iron-ore shipments were estimated at 9,285,000 long tons, compared to 10,791,532 in 1960. Value of shipments decreased $12 million.

Lack of demand from the steel industry kept production levels below the previous year. A notable exception were producers of iron-ore concentrates who operated near capacity. In 1961, it was estimated that about 21 per cent of iron-ore shipments were in the form, of concentrates from jaspilite, compared to 11.6 per cent in 1960. During the year, the Hanna Mining Co. announced plans to increase annual capacity of its Groveland iron-ore concentrating plant from 700,000 tons to 15,500,000 tons and will install facilities to produce 1,250,000 tons of high-grade, partially fluxed iron-ore pellets a year. The pellets will contain more than 60 per cent iron. Cleveland-Cliffs Iron Co. began an expansion program as its Republic mine. Crushing, grinding, and flotation facilities will be enlarged and a palletizing plant will be built. Annual capacity will be 2,400,000 tons of high-grade iron ore concentrate and 1,600,000 tons of pellets. The excess 800,000 tons of concentrate will be pelletized at the company's Eagle Mills plant. The Empire Mining Co., operated by Cleveland-Cliffs Iron Co., will develop a low-grade magnetic iron ore deposit near Negaunee and construct a concentrator and a 1-million-ton-per-year pelletizing plant.

The lake shipping season for Michigan ores opened at Escanaba and Marquette on April 24 and closed at Marquette on December 4.

NONMETALS

Of the materials used in building and road construction, only cement, and sand and gravel exceeded 1960 shipments. Production of clay, gypsum, lime, and crushed stone was smaller than in 1960. Increased demand for materials for base course construction in the State Highway program resulted in a larger sand and gravel output. Crushed stone production declined because of smaller shipments of fluxstone and stone for lime manufacture. Chemicals derived from brines (bromine, calcium-chloride, magnesium compounds, and potash) were produced at about the same rate as in 1960. Salt production was about 5 per cent less than in the previous year.

MINERAL FUELS

The value of mineral fuels produced was about 15 per cent of the State's total, compared to 12 per cent in 1960. All types (natural gas and natural-gas products, peat, and petroleum) were produced in greater quantity. The southern Michigan oil fields continued to supply the major part of the State's production of petroleum.

Mineral Production in Michigan, 1961 (1)
(Estimated)

Mineral	Thousand Short Tons (unless otherwise stated)	Value (thousands)
Cement:		
Portland - thousand 376-pound barrels	21,700	$ 74,900
Masonry (2)thousand 280-pound barrels	1,500	4,400
Clays	1,700	1,900
Copper (recoverable content of ores, etc.) in short tons	70,060	42,036
Gypsum (crude)	1,383	4,727
Iron Ore (usable) thousand long tons, gross weight	9,285	83,600
Lime	1,131	15,059
Natural Gas - million cubic feet	23,100	6,000
Peat	235,000	3,055
Petroleum (crude) - thousand 42-gallon barrels	19,146	55,715
Salt (common)	3,900	32,332
Sand and gravel (3)	50,000	42,500
Stone	28,720	29,870
Value of items that cannot be disclosed: Bromine, calcium-chloride and calcium-magnesium chloride, gem stones, magnesium compounds, natural-gas liquids, and potassium salts	-	46,723
Total Michigan (5)		$434,908

(1) Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
(2) Previously reported in 376-pound barrels.
(3) Includes friable sandstone.
(4) Total adjusted to eliminate duplicating value of clays and stone.

*Prepared December 15, 1961 by Donald F. Klyce, Commodity-industry Analyst, under the supervision of Samuel A. Gustavson, Supervising-Commodity-industry Analyst, Minneapolis Office of Mineral Resources, Region V, Minneapolis, Minn.

NEWS ITEMS AND DEVELOPMENTS IN 1961

IRON ORE

It is quite evident that growing competition in the mineral markets, iron ore particularly, much from foreign sources, is demanding closer control of costs, particularly the development of time-saving techniques to offset labor costs. Equally important are the concepts of developing new products and finding new customers.

On Thursday, June 22, 1961, the first session of the hearing on problems of the upper Great Lakes iron ore industry was held before the subcommittee on minerals, materials and fuels of the committee on interior and insular affairs, United States Senate, Washington, D.C. The purpose of the hearing was to learn, through testimonial statements of expert witnesses, what the problems are affecting Great Lakes iron ore industry. Witnesses included: Congressman John A. Blalnik of Minnesota and Senator Jack Miller of Iowa; Representative John B. Bennett of Michigan and Vernon W. Thomson of Wisconsin, Marling J. Ankeny, Director, Bureau of Mines, Department of the Interior and M. E. Volin, Director, Institute of Mineral Research, Michigan College of Mining and Technology; Professor T. D. Tieman and Professor L. D. Clark, Department of Mining and Metallurgy, University of Wisconsin and Professor Henry H. Wade, School of Mines, University of Minnesota; Peter J. Bensoni, representative of the United Steelworkers of America and Hugo E. Johnson of the American Iron Ore Association.

On Wednesday, October 25, 1961, the Annual Conference of the Michigan Natural Resources Council was held in Lansing. This year's conference dealt with the many problems concerning development of Michigan iron ore and copper - both current and for the future. Speakers of the forenoon session were Elmer W. Pehrson, Mining Engineer and Lecturer of Mineral Economics, Columbia University speaking on "Some Worldwide Aspects of Copper and Iron Ore"; Dr. James Boyd, President of Copper Range Company who spoke on "The Economic Environment of Michigan Copper Industry"; and Dr. Stanley W. Sundeen, Manager of Research and Development for Cleveland Cliffs Iron Company who spoke on "The Economic Role of Michigan Iron Ore". The afternoon session consisted of two panel discussions "The Role of Government in Mineral Resource Development" and "Multiple Use and Conflicting Interests in Mineral Resource Development".

The Humboldt Mining Company (jointly owned by Cleveland-Cliffs Iron Company and Ford Motor Company) opened a new plant in September to produce iron-ore pellets from jaspilite. The plant has an annual capacity of 650,000 tons of pellets. Work was started to increase flotation mill capacity by 50 tons per hour at the Humboldt mill. A new ball mill and related equipment will be installed for operation by 1962. With the expansion, the Humboldt mill will be able to treat 5,000 tons per day of crude ore to produce approximately 2,250 tons per day of high grade iron-ore concentrate as feed to the pelletizing plant.

Cleveland-Cliffs also has plans for the construction of a third jasper concentration plant to be located just outside of Ishpeming and to be completed by 1963. The plant will have a capacity of one million tons per year. The property will be known as the Empire Iron Mining Company and will be an open pit. When the new plant is in operation, the three plants will have a combined capacity of about 3.5 million tons per year.

On January 21, the 189 employees of Inland Steel Company's Morris mine at Ishpeming were notified that the mine would be gradually and permanently closed during the next five months. Ray D. Satterley, General Manager of ore mines for Inland said the company had tried for two years to upgrade the Morris ore, but it did not meet today's grade requirements of furnaces.

On January 239 Pickands Mather and Company laid off about 500 men at its 5 Gogebic Range underground mines. The mines affected were the Sunday Lake at Wakefield, the Peterson at Bessemer, the Newport and Geneva at Ironwood, and the Cary, near Hurley, Wisconsin. The 900 employees remaining after the lay-off were put on 16 day-month. Early in June, however, the company completed a $150,000 iron ore drying plant at the Geneva mine. The product from the new drying plant is railed to Escanaba for loading into vessels bound for lower lake docks.

Later in the years Pickands Mather and Company announced the sale of the Sunday Lake Iron Company

underground mine at Wakefield for an undisclosed price to four Gogebic Range area men. About 300 men were employed at the mine before it was closed, because the ore could not be marketed. Most of the miners have been out of work since the closing. It was reported the new owners planned to operate the mine on a profit-sharing basis with the employees.

The Tobin mine of Republic Steel Corporation at Crystal Falls was again closed, although a crushing and screening plant recently had been installed in the shaft headframe at a cost of about $100,000. No assurance as to the mine's reopening was given.

The M. A. Hanna Company installed a long scraper trough, a grizzly, and a 75-horsepower automatically controlled trigger on the 12th level of the Homer-Wauseca mine near Iron River. The installation is expected to result in more efficient development and mining on the 12th level. In operation, the ore will be trammed to the trough and dumped. It will then be scraped onto the grizzly from where it will pass into a strip pocket at the shaft and be hoisted to the surface. The trough will allow continuous production in the event of delays underground.

Approval of a major expansion program was announced by Hanna for its Groveland open pit jasper mine near Iron Mountain on the Menominee Range. The program is to be completed in 1963. New facilities to be installed will permit the first partially fluxed ore pellets for sale in the United States ore markets. The pelletizing capacity of the plant will be increased from 700,000 tons to 1-1/4 million tons per year. The pellets will contain more than 60% iron. The expanded plant will raise the required work force from 180 to 250 by 1963, with a payroll increase of $500,000 a year.

North Range Mining Company announced that it will terminate its lease and close its underground Penokee iron mine late this year. The present sale contracts will be filled from current operations, but all development work has been stopped. The mine owner, Ironwood Mines Corporation, will continue its deep underground diamond drilling program seeking additional ore bodies at depth.

Early this year, the Chicago and North Western Railway completed a $250,000 infra-red iron ore thawing plant near its ore dock at Escanaba. This modern all-electric plant, which is 276 feet long and 24 feet wide, is equipped with 1700 quartz lamps that can thaw iron ore, ten 70 ton railroad cars at a time during the freezing weather of early spring and late fall. At present the Escanaba dock is the only iron ore loading facility on Lake Michigan and in the Lake Superior region serving as many as three ranges.

Positive action in the form of substantial rate reductions for movement of iron ore from the Gogebic Range to docks at both Escanaba and Ashland was one of the contributions made by the Chicago and North Western Railway Company in its attempt to help improve the competitive position of Michigan's iron ore.

COPPER

No startling new developments or ore discoveries are reported by the copper mining industries of Michigan for 1961.

Total mine production of copper comes from three companies. In order of production they are: (1) White Pine Copper Company, a wholly owned subsidiary of Copper Range Company, operating in Ontonagon County; (2) Calumet Division of Calumet and Hecla, Inc., operating in Keweenaw and Houghton counties, and (3) Copper Range Company - Champion Mine, Houghton County.

Very limited exploration for copper has been conducted during 1961. The United States Metals Refining Company, a wholly owned subsidiary of American Metal Climax, Inc., has done some drilling in Ontonagon County during the summer, but this activity was to be terminated with the coming of winter.

Copper Range Company is continuing to sink a development shaft on the new "Southwest ore body" situated on the western downthrown side of the "White Pine fault which cut off the ore of the White Pine ore body. The fault moved the southwest portion of the ore downward so that the new discovery lies just over 2,000 feet below the surface. This portion of the ore body will have to be mined through vertical shaft. The present development shaft is expected to intersect the ore body late in November. The ore at White Pine is essentially sulphide of copper occurring in the Nonesuch Shale.

At White Pine Copper Company, a newly designed underground ore carrier is being tested and studied. This carrier has greater capacity than the shuttle cars presently in use. It is hoped that maintenance and operating costs can be considerably reduced. In addition, several encouraging metallurgical advances are being studied and tested as a possibility for increasing mill recovery.

The Calumet Division of Calumet and Hecla, Inc. is testing ammonium nitrate as a blasting agent and is also testing integral steel bits which appear to last 300% longer than detachable threaded steel bits. The use of a new type mucker, if successful, should make shaft sinking quicker and cheaper. In addition, they are now using the new coromant cut in many drift rounds and raises, thus obtaining faster advance.

LIMESTONE

Drummond Dolomite opened a new quarry about five miles east of their present operation on the south shore of Drummond Island. Production from the new pit is to be gradually increased and will eventually supplant the old quarry completely.

Presque Isle Corporation is continuing development work aimed at opening a new pit to the west of their present quarry, but no production has yet come from this new area.

Michigan Limestone Division, U. S. Steel Corporation, has retired one of its self-unloader vessels, the Calcite, and its replacement by conversion of the William G. Clyde to a self-loader vessel re-christened the Calcite II.

CEMENT

The month of February marked the completion of a half-million dollar expansion program by Peerless Cement Company in Grand Rapids and Schoolcraft. Peerless recently installed new bulk cement storage silos and a distribution system. The expansion program was designed with consideration for nearness to markets and accessibility of both rail and trucking routes. The Schoolcraft silos will serve the southwestern part of Michigan and northern Indiana. The Grand Rapids expansion program was carried out with the intention of giving more expedient service to the Grand Rapids, Holland, and Muskegon markets, served by Peerless since 1900.

It was reported in August that the Huron Portland Cement Company plant at Alpena, presently the largest single plant in the United States, capacity of 12,000,000 barrels per year, will be enlarged. Present construction will increase capacity to 14,000,000 barrels and it is anticipated that the present capacity will be doubled within the next 14 years. Huron has also reported a 13th cement distributing plant is to be built at Waukegan, Illinois. This facility, which will have capacity of 150,000 barrels, is expected to be completed this year.

SAND AND GRAVEL

The 90th anniversary of the Koenig Coal and Supply Company's founding was celebrated in Detroit in October. Diversification of the original business0 a retail coal concern, began in 1921, when a sand and gravel plant was opened at Oxford. The present capacity of the gravel plant is 6,000 tons per day of beneficiated aggregate.

SALT

The only recent significant technological development in the salt producing industry is the adoption of a unique heat-sensitive method for removing impurities and discolored salt from the mined rock salt in the solid state. The process was developed in part, and initially installed by the International Salt Company at Detroit.

CLAY

A producer of natural aggregate has done some exploring and testing of glacial clays as the basic raw material for light-weight aggregate production. Though the resultant product looks good, the presence of small grains and pebbles of carbonate rock produced soft spots in the material. Since this product was not a decided improvement over light-weight aggregate materials now on the market, this program has been tentatively set aside.

GYPSUM

Sargent Sand Company reported that it has recently opened a gypsum quarry just east of Turner, Arenac County. Production during the year has largely gone to cement plants for use in the manufacture of cement.

PETROLEUM

Although there has been no outstanding crude oil discoveries in 1961, the near completion of the scipio-Albion pool development in Southern Michigan along with limited discoveries in St. Clair and elsewhere counties have helped maintain a healthy glow in the State petroleum picture. Reserves of petroleum are holding near the 77 million barrel level attained last year, during which at most 16 million barrels of crude oil were produced in Michigan. Of the State's current production, 61% comes from Trenton dolomite of Ordovician age in the Scipio-Albion pool.

During the year, an application for exploratory drilling on a leased parcel of land in a dedicated State Recreation Area was turned down by the Conservation Commission. The decision, although applying to this specific parcel of land only, was of concern to the State's petroleum industry.

The October 16, 1961 Oil and Gas Journal reported underground LPG storage facilities developed by dissolving caverns in salt beds for Michigan as follows:

	Capacity in barrels	Product
Aurora Gasoline Co.		
Wayne County	150,000	propane
Wayne County	150,000	butane
City Service Oil Co.		
Kent County (4 caverns)	640,000	propane
Dow Chemical Co.		
Midland County	(Capacity not reported)	ethylene
" "		propylene
Skelly Oil Co.		
Kent County	190,000	propane
Sun Oil Co.		
Wayne County (3 caverns)	266,000	propane
Wayne County (2 caverns)	188,000	butane

RESEARCH, TECHNOLOGY:

Cleveland-Cliffs Iron Company is carrying on extensive research work to produce better and cheaper concentrates from low grade iron ores. At Ishpeming, a staff of 50 employees in the research laboratory is continuing to improve the quality of the pellets produced at Cliff's Republic and Humboldt open pit jasper mines

already operating, and the Empire which is scheduled for production in 1963. Five years of intensive research has already gone into the development of the pellets.

At the Institute of Minerals Research, Michigan College of Mining and Technology, at Houghton, investigation continues in the theory and practice of the reduction of hematite to magnetite and magnetite to iron. The fundamentals of froth action are being studied as they apply to mineral flotation. In another project, the distribution of stresses around mine openings are being simulated and analyzed by means of photo-elastic models. Geophysical research includes a study of induced polarisation as a means of exploration for native copper deposits.

At the University of Michigan, work on three new geochemical laboratories, acquired through NSF and University matching funds, is nearing completion. One of these labs will be devoted to high pressure-high temperature phase studies, another to graduate student instruction, and the third to graduate student research. With funds administered by the Great Lakes Institute, flame photometric, x-ray fluorescence, and other equipment for rapid silicate analysis is being installed o In the laboratory of Subsurface Geology, the nature and distribution of the State's gypsum deposits and relative evaporites are being investigated. In this program, which is being supported by the Institute of Science, the applicability of computer techniques to such problems will be evaluated. A comparative study of the salt deposits of Michigan, Ontario, Ohio, and New York will be carried out in cooperation with the University of Kansas and supported by the National Science Foundation. Studies will continue on the petrography and origin of Michigan salt deposits.

LEGISLATION:

LEGISLATION WHICH BECAME LAW

Act No. 21. Iron Ore. Amends Sec. 4 of Act 77 of 1951. Provides for distribution of taxes on low grade ore to local school districts and governmental units.

Act No. 131. Oil and Gas Wells. Amends secs. 6., 13, and 23 of the oil conservation Act 61 of 1939. Provides for regulation of wells for the storage of dry natural gas and liquified petroleum gas. Correct language relating to uniform spacing of oil and gas well.

LEGISLATION WHICH WAS INTRODUCED BUT FAILED

House Bill 161. Equalization. Requires tax equalization to be made on basis of classes of property with iron mining property stated separately. Defeated in House.

House Bill 277. Mining. Permits suits for damage in moving houses on company property for strip mining. Died in House Committee on Judiciary.

House Bill 632. Iron Ore. Provides for condemnation to operate low grade iron ore benefication operations. Died in House Committee on Conservation.

House Bill 638. Mining. Redefines duties of county mine inspectors; creates safety code advisory boards penalties. Died in House Committee on Labor.

House Bill 676. Iron Ore. Provides for taxation of underground beneficiated iron ore; specifies duties of State Geologist and tax officials. Died in House Committee on General Taxation.

INTERIM STUDY COMMITTEES

House Resolution 39. Investigate deep-shaft mining industry of the Upper Peninsula.

House Resolution 90. Study metallic mining industry.

Senate Resolution 26. Study method of developing Porcupine Mountains State Park.

TOPOGRAPHIC MAPPING: (U. S. Geological Survey)

STANDARD SERIES, 15-MINUTE QUADRANGLES

New Issues: Baldwin, Clare, Custer, East Tawas, Evart, Glennie, Harrisville, Hart, Howard City, Lake, Ludington, Montaque, Reed City, Tawas City, White Cloud.

Reprints: Carp River, Kalamazoo, Marenisco, Shepherd, Thomaston.

STANDARD SERIES, 7½-MINUTE QUADRANGLES

New Issues: Allen, Camden, Fayette, Frontier, Hillsdale, Morenci, North Adams, Reading.

RECENT PUBLICATIONS OF INTEREST TO THE MINERAL'S INDUSTRY:

"Geologic Features of parts of Houghton, Keweenaw, Baraga, and Ontonagon counties, Michigan", by K. Spiroff and A. E. Slaughter. Available from: Librarian, Michigan Basin Geological Society, c/o Michigan Department of Conservation, Lansing 26, Michigan. $4.25.

"Summary of Operations, Oil and Gas Fields, 1960", by L. W. Price, et al. Geological Survey Division, Michigan Department of Conservation, Lansing 26, Michigan. Free.

"Bibliography of Michigan Geology, 1956-1960", by E. A. Kirkby. Supplement to Pub. 50, "An Index of the Geology of Michigan, 1823,-1955". Geological Survey Division, Michigan Department of Conservation, Lansing 26, Michigan. Free.

"Geology of the Michigan Basin with Reference to Sub-Surface Disposal of Radioactive Wastes", by Wallace deWitt, Jr., U. S. Geological Surveys Trace Elements. Investigation Report 771 prepared on behalf of the U. S. Atomic Energy Commission. Open file report - not a publication. Copy available for examination in the office of Geological Survey Division, Michigan Department of Conservations Lansing 26, Michigan.

"Geology of Central Dickinson County, Michigan", Geological Survey Professional Paper 310, prepared by the U. S. Geological Survey in cooperation with the Geological Survey Division, Michigan Department of Conservation. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. $5.75.

"Portland Cement Plant Map, 1961", shows all existing producing and distribution plants in the United States, Canada, Mexico, and Puerto Rico, plus all plants under construction and expected to be completed by the end of 1962. Data on plant capacity, type of plant (wet or dry), brand name, etc., are included. Available by writing Pit and Quarry Publications, 431 S. Dearborn St., Chicago 5, Illinois. $1.00.

1961 Transactions of Michigan Natural Resource Council "Iron and Copper in Michigan Economy". To be distributed through Secretary of Michigan Natural Resource Council, c/o Lands Division, Michigan Department of Conservation, Lansing 26, Michigan. Free.

The graph that follows, showing tonnages of Michigan's minerals produced since 1870, was prepared for display at the 7th Annual Conference of the Michigan Natural Resources Council, held October 25, 1961 in Lansing.

Through the reproduction of the graph from its original size (30" x 60"), in color, to this size in black and white, several notations following dates became indistinctly shown. These are:

1878 First iron ore shipment from Menominee Range.

1884 First iron ore shipment from Gogebic Range.

1887 Michigan 40 years copper production leadership terminated by Montana.

1892 Michigan gypsum used in many temporary structures of the World's Fair in Chicago.

1897 Saginaw Valley coal mines.

1901 First iron ore shipment from Mesabi Range. Michigan leadership terminated by Minnesota.

1905 Michigan copper production surpassed by Arizona.

1906 First concrete road in Detroit and in Calumet.

1928 First commercial use of natural gas (casinghead), Muskegon Oil Field.

1928 Mount Pleasant Oil Field discovery.

1951 Production of beneficiated iron ore commenced.

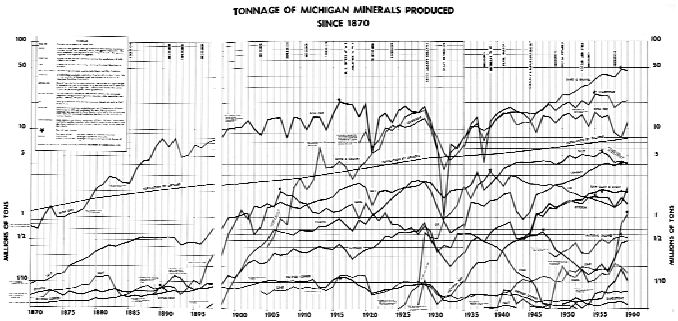
1955 Production of sulphide ore commenced at White Pine.

1959 Michigan 36-year salt leadership terminated by Louisiana and Texas.

Peak Production Years:

1890 Sandstone
1907 Coal
1916 Iron ore and refined copper
1939 Oil
1947 Natural Gas
1955 Limestone and gypsum
1956 Salt, raw clay and shale
1959 Cement, natural salines
1960 Lime

[Graph: Tonnages of Michigan's Minerals Produced Since 1870]



MICHIGAN MINERAL PRODUCTION 1960 GENERAL REVIEW

Mineral production in Michigan in 1960 was valued at $435,129,790, the highest value in history. The 13 per cent gain over 1960 resulted largely from increased output of iron ore and petroleum. A lag in building construction resulted in a decrease in shipments of cement and gypsum. Output of the other major mineral commodities - sand and gravel, crushed stone, and chemicals derived from well brines - did not vary much from the previous year. Iron ore regained first place in value, displacing cement which was followed by petroleum, natural salines, sand and gravel, copper, salt, and stone. Fuel value increased 50 per cent and metallic value 38 per cent. Nonmetallic value decreased 1 per cent.

In volume of mineral production in the United States, Michigan ranks: First in natural salines, gypsum and peat; Second in iron ore and sand and gravel; Third in salt; Fourth in cement, lime and marl; Fifth in copper; Sixth in stone.

The following table gives the value of Michigan mineral production of 1960:

	VALUE	PER CENT
Nonmetallics	$250,402,059	57.5
Metallics	134,098,442	30.8
Fuels	50,629,289	11.7
	$435,129,790	100.0

Value of Michigan's Minerals and Mineral Products 1951-1960

Year	Nonmetallics	Metallic	Fuels	Total
1951	$127,052,493	$ 90,278,695	$ 40,278,695	$257,529,882
1952	134,233,799	94,762,577	38,093,047	267,089,423
1953	145,124,894	105,235,715	37,332,526	287,693,135
1954	168,374,589	82,525,411	35,666,979	286,549,922
1955	192,353,728	145,379,721	33,623,155	371,356,604
1956	216,806,204	157,219,225	32,537,804	406,563,233
1957	230,789,635	144,235,015	31,784,950	406,809,600
1958	217,702,916	102,118,749	29,700,973	349,522,638
1959	254,240,437	97,362,759	33,718,731	385,321,927
1960	250,402,059	134,098,442	50,629,289	435,129,790

TABLE I
MINERAL PRODUCTION OF MICHIGAN, 1960 (1)

PRODUCT	UNIT	QUANTITY	VALUE	RANK IN U.S. (2)
Iron Ore	Long Tons	10,955,866	$ 97,072,686	2
Cement	Barrels	22,361,498	77,694,087	4
Petroleum	Barrels	15,899,206	46,105,421	18
Natural Salines (3)			44,034,486	1
Sand and Gravel	Short Tons	46,910,195	39,304,400	2
Copper	Pounds	115,438,537	37,025,756	5
Salt	Short Tons	4,087,760	33,759,466	3
Stone (4)	Short Tons	21,393,405	24,316,219	6
Lime	Short Tons	1,177,431	15,730,384	4
Clay Products			6,587,345	
Gypsum	Short Tons	1,462,781	5,608,519	1
Clay and Shale (5)	Short Tons	1,989,149		9
Natural Gas	M. Cu. Ft.	19,240,168	3,839,709	17
Peat	Short Tons	214,402	2,755,245	1
Natural Gas Liquids	Gallons	12,217,120	684,159	17
Marl	Short Tons	159,345	91,173	4
Miscellaneous (6)			520,735	
TOTAL			$435,129,790	

(1) Metallic and fuel statistics compiled by Michigan Geological Survey. Nonmetallic statistics compiled in cooperation with the United States Bureau of Mines.

(2) Based on quantity - 1959 data.

(3) Includes bromine, magnesium compounds, calcium-magnesium chloride and potash.

(4) Does not include 9,582,765 short tons of limestone valued at $7,775,410 used in the manufacture of cement and lime.

(5) Used in the manufacture of cement and clay products.

(6) Includes mineral pigments, sulfur, clay, and gem stones.

TABLE II
MINERAL PRODUCTION OF MICHIGAN, 1959 (1)

PRODUCT	UNIT	QUANTITY	VALUE	RANK IN U.S. (2)
Cement	Barrels	23,025,928	$ 77,323,974	4
Iron Ore	Long Tons	7,258,715	62,117,507	2
Natural Salines (3)			49,286,176	1
Sand and Gravel	Short Tons	48,051,816	41,192,632	2
Salt	Short Tons	4,485,145	35,724,796	3
Copper	Pounds	113,081,533	35,245,252	5
Petroleum	Barrels	10,438,608	30,518,107	18
Stone (4)	Short Tons	20,526,253	22,708,587	6
Clay Products			6,745,027	
Gypsum	Short Tons	1,721,453	6,595,256	1
Natural Gas	M. Cu. Ft.	15,626,227	3,045,976	17
Peat	Short Tons	191,661	2,356,656	1
Clay and Shale (5)	Short Tons	2,049,110		9
Natural Gasoline	Gallons	2,761,551	154,648	17
Marl	Short Tons	201,387	118,240	4
Miscellaneous (6)			12,189,093	
TOTAL			$385,321,927	

(1) Metallic and fuel statistics compiled by Michigan Geological Survey. Nonmetallic statistics compiled in cooperation with the United States Bureau of Mines.

(2) Based on quantity.

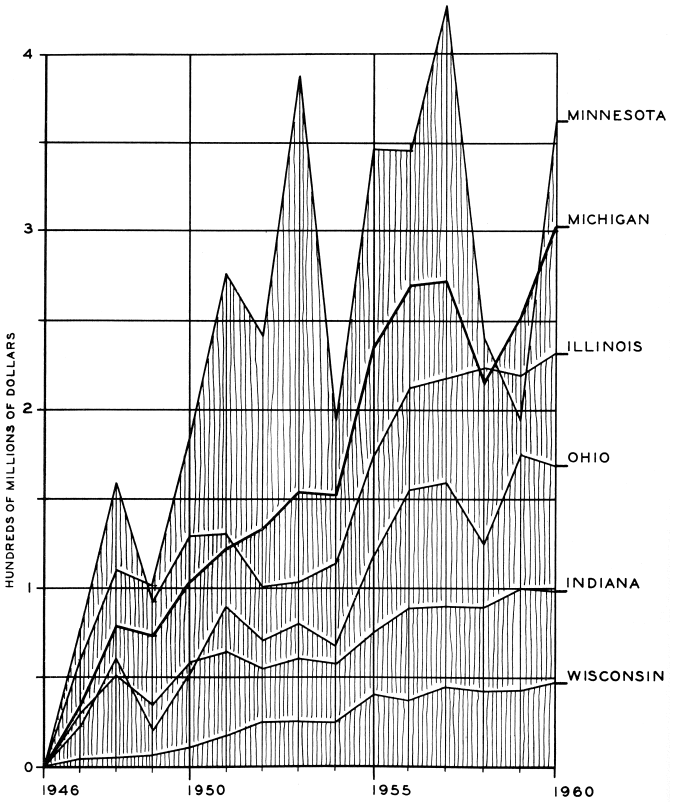
(3) Includes bromine, magnesium compounds, calcium-magnesium chloride and potash.

(4) Does not include 8,828,049 short tons of limestone valued at $7,001,784 used in the manufacture of cement and lime.

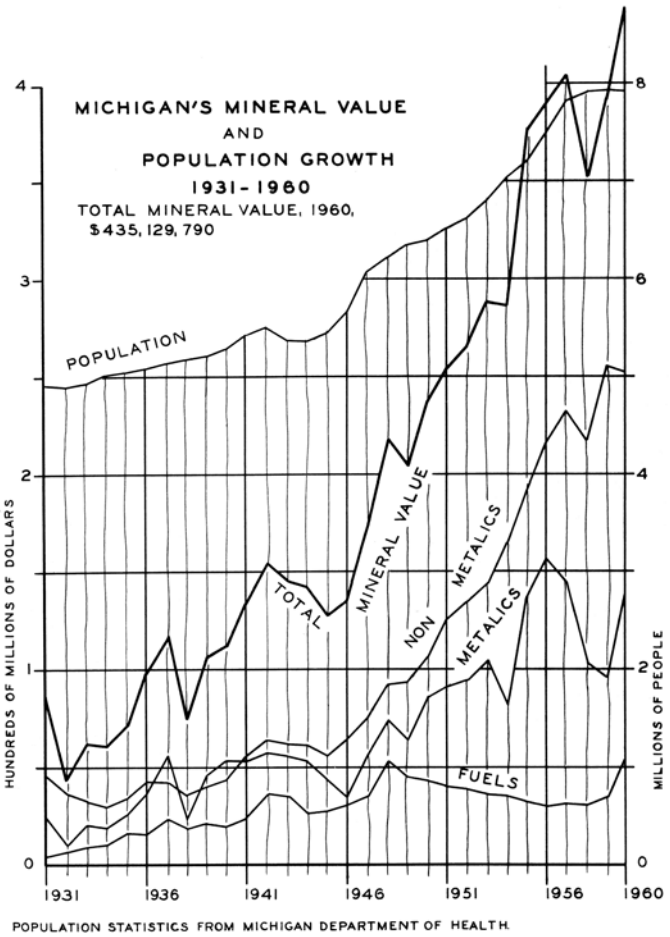
(5) Used in the manufacture of cement and clay products.

(6) Includes lime, sulfur, mineral pigments, clay, and gem stones.

GROWTH IN VALUE OF THE MINERAL INDUSTRIES OF MICHIGAN AND BORDERING STATES, 1948 TO 1960

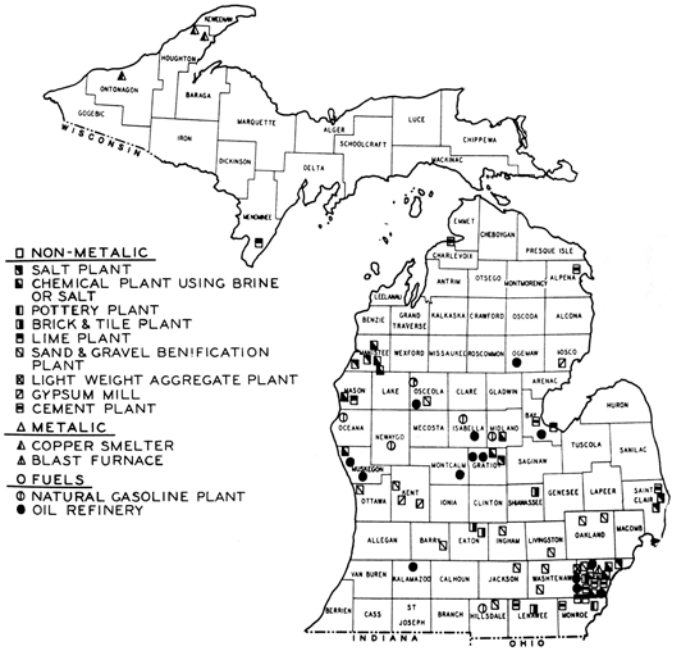


[Graph: Michigan's Mineral Value 1931-1960]

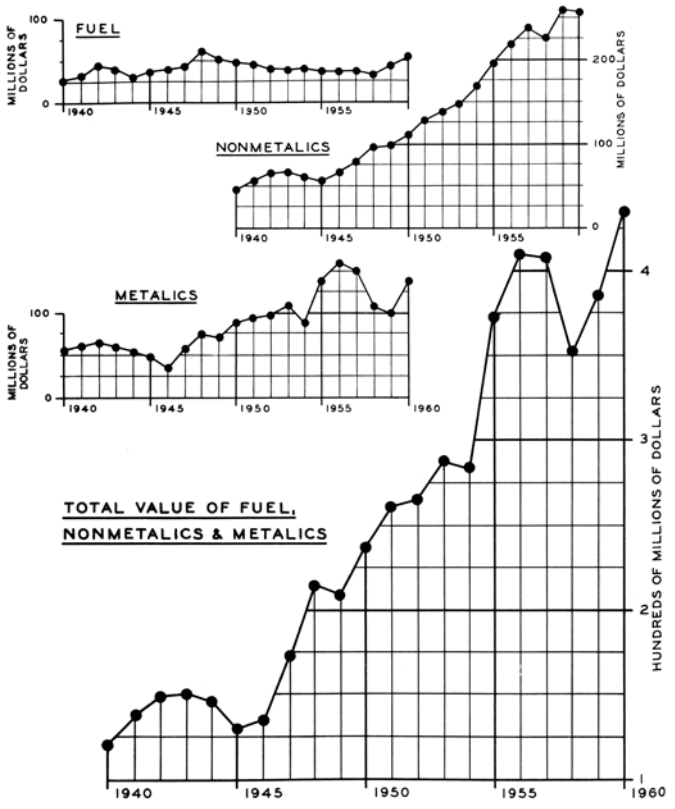


POPULATION STATISTICS FROM MICHIGAN DEPARTMENT OF HEALTH

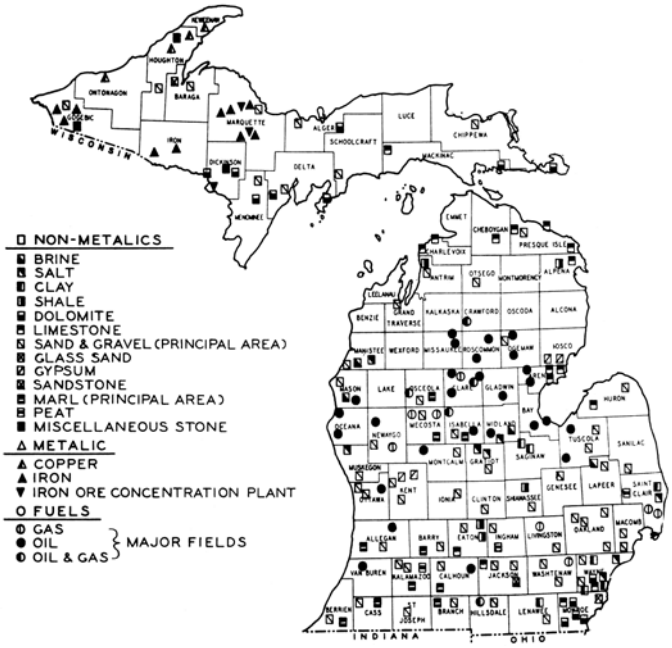
MINERAL PROCESSING MAP, 1961



[Graph: Total Value of Fuel, Nonmetallics, and Metallics]



MINERAL PRODUCTION MAP, 1961



METALLIC MINERALS*

IRON ORE

Iron ore shipments totaled 10,955,866 long tons in 1960 compared to 7,258,715 in 1959 and the value of shipments was $34,955,179 greater than 1959. Production increased in the first part of the year in anticipation of increased business due to the 1959 steel strike. As industrial activity failed to keep pace with expectations and the steel production rate dropped, iron ore shipments were curtailed after mid-year. Shipments of concentrates from jaspilite, a low-grade nonmagnetic ore, continued to increase, and in 1960 represented 11.6 per cent of the State's total iron ore shipments compared to 8.5 per cent in 1959. Dates of first and last lake shipments of iron 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.

IRON ORE SHIPMENTS BY RANGES, 1960

RANGE	Number of Mines		IRON ORE SHIPMENTS (LONG TONS)		
	Underground	Open Pit	Direct Shipments	Siliceous	Total
Marquette	9	5	4,708,487	236,228	4,944,715
Menominee	8	1	4,121,165		4,121,165
Gogebic	5	0	1,889,986		1,889,986
	22	6	10,719,638	236,228	10,955,866

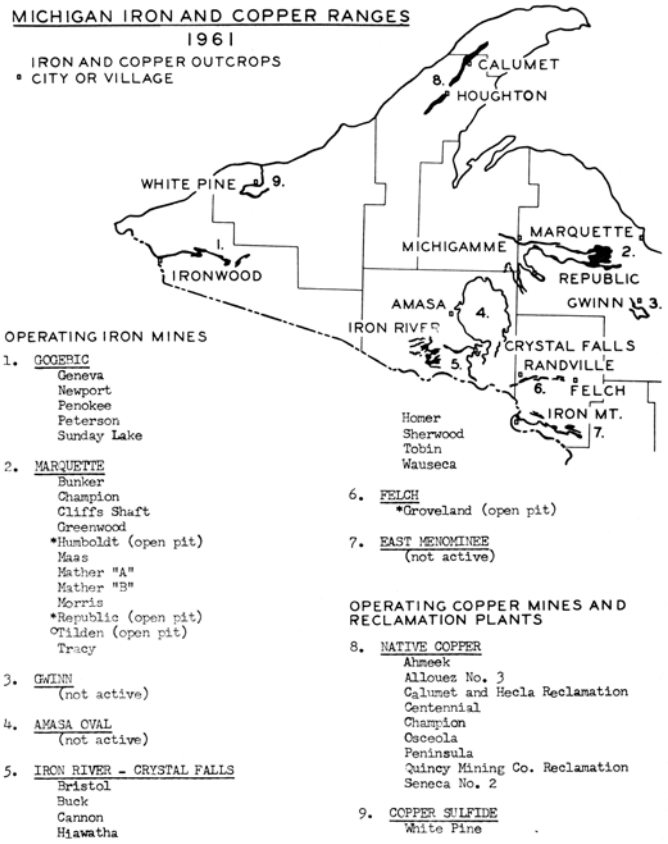
Humboldt Mining Company doubled its concentrate plant capacity to 640,000 tons of flotation concentrate per year. Official dedication of the new plant was on September 16. Two parallel lines of Allis Chalmers grate kiln systems were installed along with 850 foot heavy duty conveyor system using 1,852 feet of belting.

Pickands Mather and Company, on the Gogebic Iron Ranges, had two crushing; and screening plants under construction. The project was part of a program aimed at upgrading ore from the Gogebic Range to make it more competitive. The plants were being built at the Newport and Geneva mines near Ironwood.

Following a study of the mining industries of Northern Michigan by a special committee of the Michigan Legislatures two statutes were enacted. House Bill No. 586 authorized the use of water for the low-grade iron ore concentration plants. House Bill No. 268 clarified the law relating to the taxation of low-grade iron ore properties.

*Metallic statistics compiled by Michigan Geological Survey.

[Map: Michigan Iron and Copper Ranges]

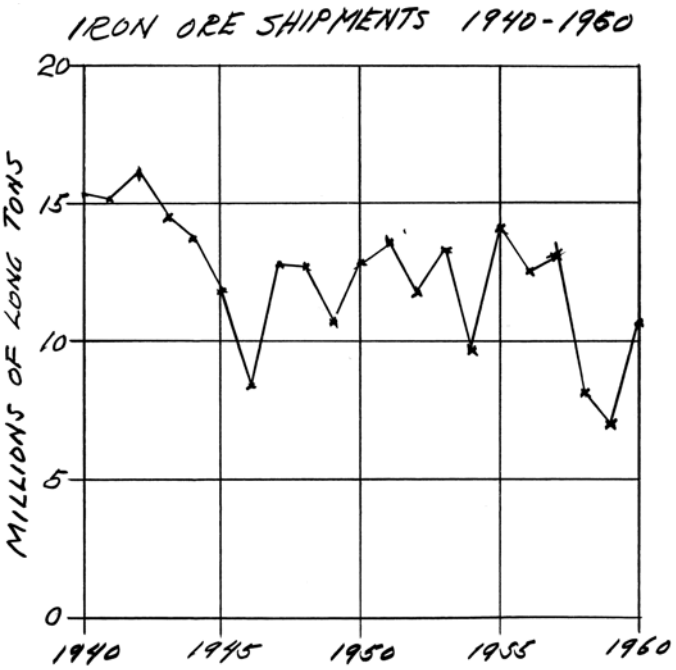


* Low Grade Iron Ore Developments, open pit.
o Siliceous Iron Ore, open pit.

IRON ORE SHIPMENTS BY RANGES

1956-1960 (Long Tons)

Year	Marquette	Menominee	Gogebic	Total Quantity	Total Value
1956	5,689,013	3,899,213	2,958,076	12,536,302	$105,688,087
1957	5,992,772	4,296,567	2,837,407	13,126,746	110,605,689
1958	3,722,139	3,095,239	1,393,528	8,210,906	70,704,419
1959	3,529,949	2,477,980	1,250,786	7,258,715	62,117,507
1960	4,944,715	4,121,165	1,889,986	10,955,866	97,072,686



COPPER

Michigan produced 115,438,537 pounds of copper during 1960, an increase of 2 per cent in production. The value of copper, however, increased 5 per cent to $37,025,756. A labor strike at the White Pine Mine that started October 28, 1959 was settled February 22, 1960. All other copper producers operated throughout the year. Average price used for calculating the value of copper was 32.1 cents per pound in 1960 and 31.2 cents in 1959.

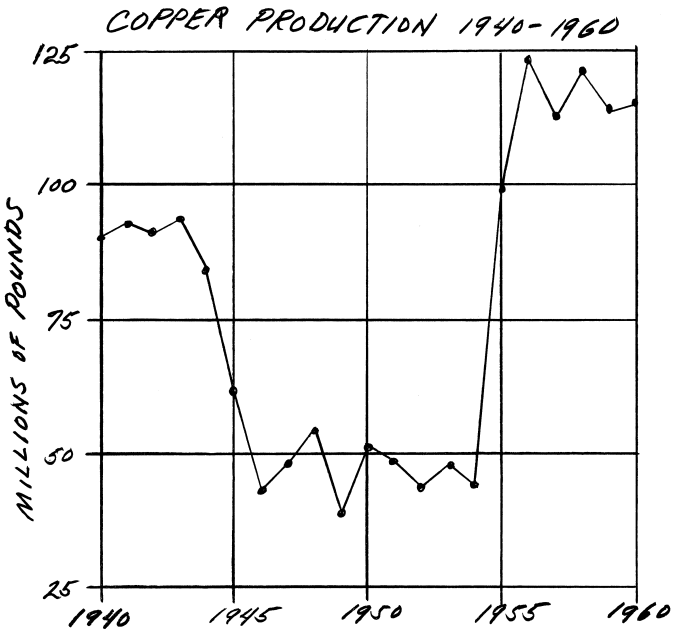
Copper Production by Counties, 1960

County	Mines	Reclamations	Copper Production (pounds) Mines	Reclamation	Total
Houghton	4	3	13,526,601	8,177,675	21,704,276
Keweenaw	4	-	18,029,476	562,739	18,592,215
Ontonagon	1	-	75,142,046	-	75,142,046
TOTAL	9	3	106,698,123	8,740,414	115,438,537

Copper Range Company started a $2 million program to develop a newly found copper deposit on property west of their White Pine Mine in Ontonagon County. An exploration shaft was being sunk as a further check on drilling results. Additional mining and metallurgical testing was planned following completion of the shaft, scheduled for the fall of 1961. If these tests show the ore and mining conditions comparable to the White Pine Mine, Copper Range planned to establish a mining unit on the site.

COPPER PRODUCTION, 1956-1960

Year	Native Copper Mines (Pounds)	Sands Reclamation (Pounds)	Sulphide Ore (Pounds)	Total Quantity (Pounds)	Total Value
1956	38,556,211	9,024,928	75,699,096	123,280,235	$51,531,138
1957	36,147,820	8,937,304	68,562,019	113,647,143	33,629,326
1958	35,301,708	5,100,407	81,656,908	122,059,023	31,414,330
1959	34,167,881	9,266,420	69,647,232	113,081,533	35,245,252
1960	31,577,880	8,740,414	75,120,243	115,438,537	37,025,756



FUELS*

PETROLEUM

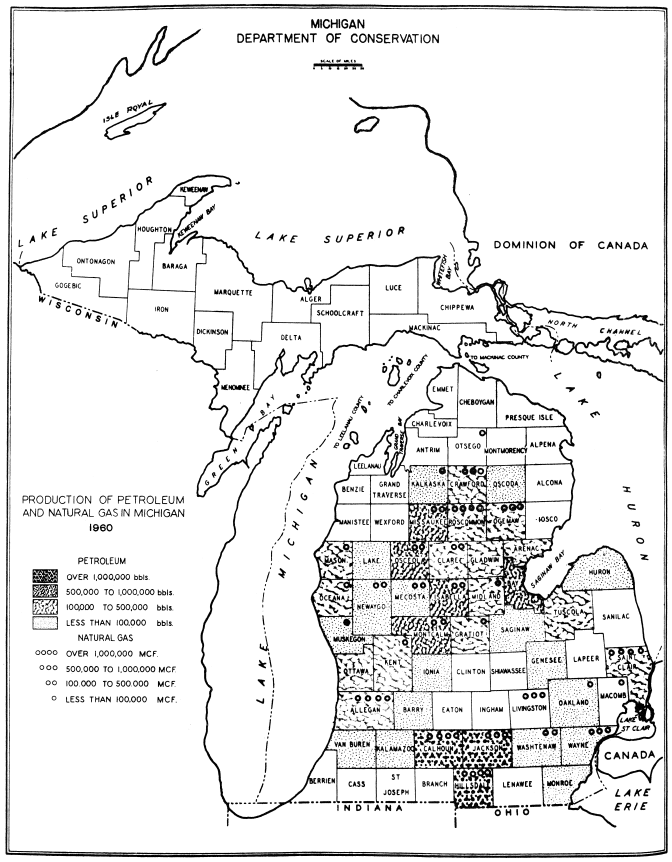
Fuels accounted for 11.7 per cent of the value of the state mineral production compared to 8.7 per cent in 1959. Petroleum production was 52.3 per cent greater than 1959 as development continued in the Albion-Pulaski-Scipio Trend During the year 15,899,206 barrels valued at $46,105,421 were produced. At the end of 1960, 4,555 producing wells were in 40 counties. Approximately 50 per cent of the total output was from Hillsdale, Calhoun and Jackson counties. By the end of December, oil wells were producing at a yearly level of 18,000,000 barrels.

During the year, 832 wells were completed (372 oil producers, 19 gas producers, 441 dry holes). Of these completions 268 were wildcats (11 oil producers, 4 gas producers, and 253 dry holes). The remaining 564 completions were field wells (361 oil producers, 15 gas producers, and 188 dry holes). Fourteen refineries, in nine counties, processed crude oil in Michigan during 1960. The combined normal daily capacity of all Michigan refineries is approximately 186,365 barrels.

Detailed information for oil and gas operations is recorded in “1960 Summary of Operations, Oil and Gas Fields”, available from Michigan Geological Survey.

*Fuel statistics compiled by Michigan Geological Survey.

[Map: Production of Petroleum and Natural Gas]

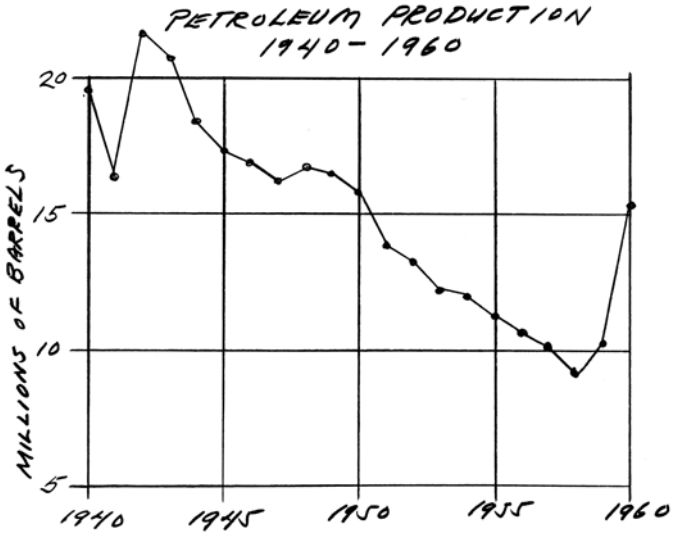


PETROLEUM PRODUCTION AND ACCUMULATED OIL BY FORMATION, 1960

Formation	Production Bbls.	Production Per Cent	Accumulated Bbls.	Accumulated Per Cent
Marshall	1,270	.01	65,255	.01
Berea	19,149	.12	2,155,869	.49
Traverse	1,501,307	9.44	87,720,135	19.86
Dundee	3,987,425	25.08	306,270,131	69.34
Det. River	2,005,871	12.62	32,646,057	7.39
Sal-Niag.	379,806	2.39	990,982	.23
Trenton	8,004,378	50.34	11,836,451	2.68
TOTAL	15,899,206	100.00	441,684,880	100.00

PETROLEUM AND NATURAL GAS PRODUCTION, 1956-1960

Year	Petroleum Barrels	Petroleum Value	Natural Gas M. Cu. Ft.	Natural Gas Value
1956	10,739,697	30,607,137	8,840,933	1,556,575
1957	10,168,602	30,505,806	6,639,813	929,574
1958	9,308,018	27,924,954	10,964,378	1,424,852
1959	10,548,608	30,518,107	15,626,227	3,045,976
1960	15,899,205	46,105,421	19,240,168	3,839,709

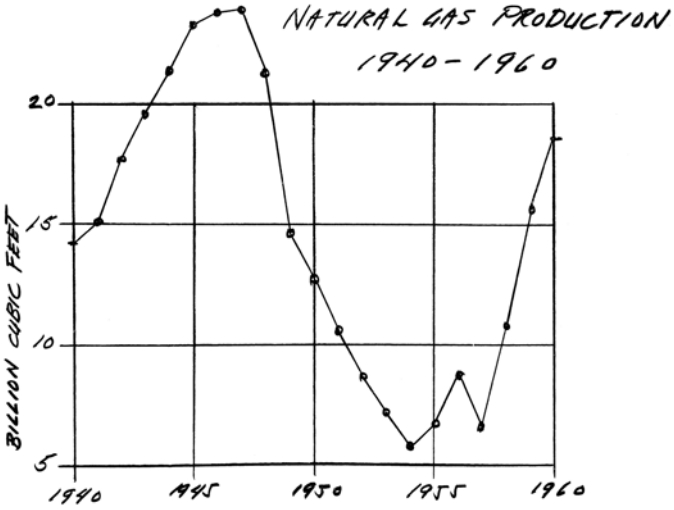


NATURAL GAS

Fifty-one per cent of the natural gas produced in 1960 was from the Salina-Niagaran formation. Natural gas production increased 23 per cent to a total of 19,240,168 Mo cu. ft., the largest production since 1948. Of this amount over 8 billion cubic feet was oil well gas. Allegan County with 41 per cent of the state's total was the leading producer followed by Hillsdale, Roscommon, St. Clair, and Calhoun counties all of which produced over 1,000,000 M. cu. ft.

GAS PRODUCTION AND ACCUMULATED GAS PRODUCTION BY FORMATIONS - 1960

Formations	Production M. Cu. Ft.	Production Per Cent	Accumulated M. Cu. Ft.	Accumulated Per Cent
Drift			8,020	.002
Stray-Marshall	855,169	4.44	210,211,140	58.43
Berea	8,800	.05	9,792,454	2.72
Antrim	37,258	.19	202,065	.06
Traverse	164,509	.85	7,548,403	2.10
Dundee-Reed City	504,474	2.62	48,295,367	13.43
Detroit River	3,979,849	20.69	24,310,121	6.76
Salina-Niagaran	9,877,820	51.35	48,927,929	13.60
Trenton-Black River	3,812,289	19.81	10,432,407	2.90
TOTAL	19,240,168	100.00	359,727,906	100.00



NATURAL GAS LIQUIDS - 1960

Michigan in 1960 produced from oil well gas a total of 12,217,120 gallons of natural gas liquids valued at $684,159. Hillsdale County, with 69.7 per cent of the state total, ranked first among the eight producing counties. The large increase in production over 1959 was due primarily to production from the Albion-Scipio Field.

Year	Quantity (gallons)	Value
1956	3,740,916	374,092
1957	3,495,703	349,570
1958	3,511,671	351,167
1959	2,761,551	154,648
1960	12,217,120	684,159

NONMETALLICS

CEMENT

Portland cement was produced by nine cement plants in the state during 1960. Antrim shale from Alpena County and Ellsworth shale from Antrim County were used by the northern plants. All southern plants used local glacial or lake clays. The greater part of the limestone used was from the Traverse and Dundee formations.

RAW MATERIAL USED IN THE MANUFACTURE OF PORTLAND CEMENT - 1960

Raw Material	Short Tons
Limestone	5,265,094
Clay and Shale	1,566,773
Gypsum	150,009
Other	71,883

Cement ranked second in value following iron ore in 1960. A lag in building construction resulted in a decrease in shipments of cement to 22,361,498 barrels valued at $77,694,087. Alpena continued to be the leading producer; Wayne County ranked second. Cement was produced also in Bay, Emmet, Lenawee, Monroe, and St. Clair counties.

The $25 million plant of Dundee Cement Company, located at Dundee, commenced production March 1st with an initial rate of about 5,000,000 barrels per year. The kilns, 16 feet 6 inches in diameter, 460 feet long, and holding about 200 tons of clinkers, are reported to be the largest in the nation.

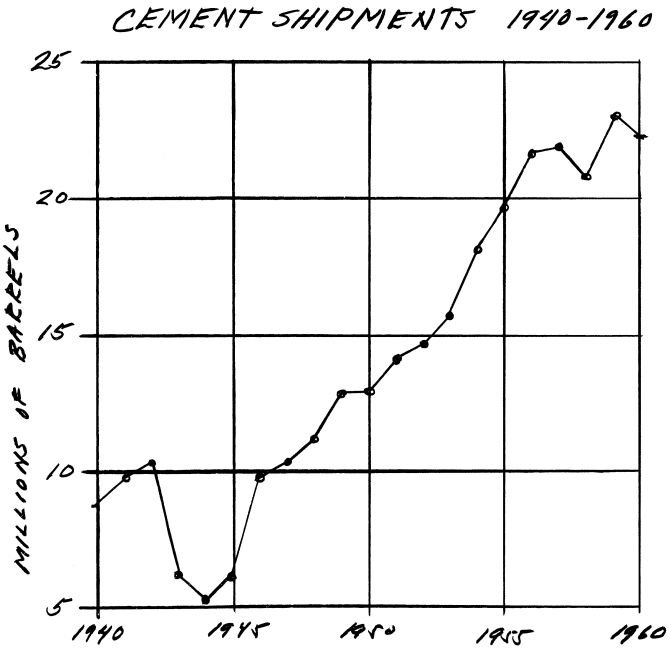
Peerless Cement Company undertook a half-million dollar expansion program calling for construction of new bulk cement storage facility at Grand Rapids and a distribution silo at Schoolcraft near Kalamazoo. The new installations were scheduled for completion in February of 1961 to serve the important commercial areas of western Michigan and northern Indiana.

Facilities to increase the finish-grind capacity of the Alpena mill of Huron Portland cement were under construction. This project adds 7,000 barrels of finish-grind capacity, an increase of more than 15 per cent, bringing the daily total to 53,000 barrels.

The steamer Amoco of American Oil Company was bought by Huron bringing the number of boats in the fleet to seven. The steamer was renamed the H. R. Schemm, in honor of Huron's president.

CEMENT SHIPMENTS, 1956-1960

Year	Shipments (barrels)	Value	Rank in U. S.	Number of Plants
1956	21,880,222	67,798,262	4	8
1957	22,045,034	71,605,137	4	8
1958	20,911,990	70,542,501	4	8
1959	23,025,928	77,323,974	4	8
1960	22,361,498	77,694,087	4	9



NATURAL SALINES

Bromine was produced in 1960 by four companies in six plants in Gratiot, Manistee, Mason, and Midland counties. Magnesium compounds were produced by four companies in Gratiot, Manistee, Mason and Midland counties. Calcium-chloride and calcium-magnesium chloride were produced by three companies in Gratiot, Lapeer, Mason, and Midland counties. The Dow Chemical Company at Midland reported production of potassium salts from natural brines.

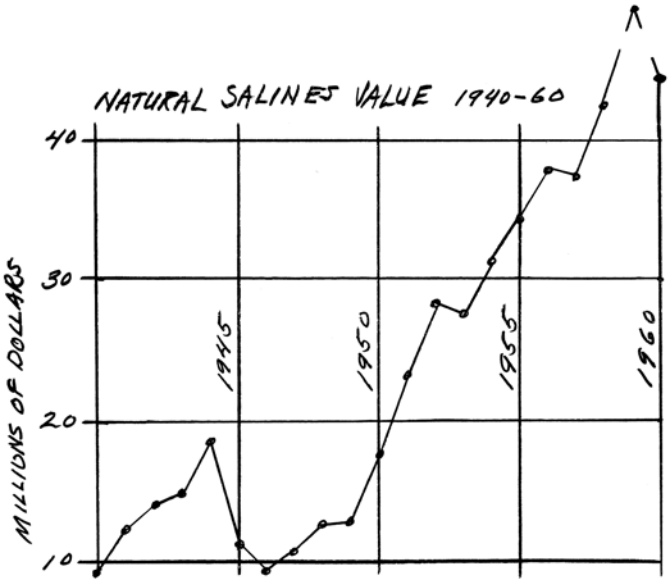
The value of the natural salines recovered by the chemical plants from natural brines in 1960 was $44,034,486. The highest value was recorded for bromine, followed by magnesium compounds, calcium magnesium chloride and potash.

Kaiser Refractories and Chemicals completed a new $3 million periclase plant at Midland. The facilities included a 275 foot rotary kiln and associated filtering and handling equipment. The company obtained magnesium hydroxide slurry from the Dow Chemical Company. Annual capacity was 45,000 tons of periclase and refractory magnesia.

VALUE OF NATURAL SALINES*, 1956 - 1960

Year	Value
1956	$ 37,873,042
1957	37,664,914
1958	42,360,677
1959	49,286,176
1960	44,034,486

* Includes: Bromine, Calcium Chloride and Calcium-Magnesium Chloride, Magnesium Compounds, and Potash.



SAND AND GRAVEL

Sand and gravel were obtained from glacial deposits - kames, eskers, outwash plains, deltas of glacial streams, beach ridges, glacial drainage channels, beds of former glacial lakes and in less concentrated deposits in the glacial drift; from present-day beaches, river channels, and lakes; and from sand dunes. Sand was also obtained from the Lower Devonian Sylvania sandstones, a very pure quartz sandstone with grains of uniform fineness very loosely cemented.

Production and value of sand and gravel decreased in 1960 to 46,910,195 short tons valued at $39,304,400. Sixty-eight per cent of the total sand and gravel output was used in road construction and 18 per cent for structual purposes.

USES OF SAND AND GRAVEL, 1960

Uses	Quantity (short tons)	Value	Per Cent of Total
Paving and Road Sand	5,630,096	$ 4,501,001	12.0
Structural Sand	4,095,429	3,179,242	8.7
Molding Sand	1,699,124	2,718,827	3.6
Fill Sand	3,151,744	1,134,366	6.7
Other Sand*	675,067	1,631,896	1.4
Paving and Road Gravel	25,980,118	20,180,684	55.5
Structural Gravel	4,547,346	5,332,847	9.7
Fill Gravel	904,162	399,215	1.9
Other Gravel**	227,109	226,322	0.5
TOTAL	46,910,195	$ 39,304,400	100.0

* Includes - grinding and polishing, glass, railroad ballast, engine, and blast sand.

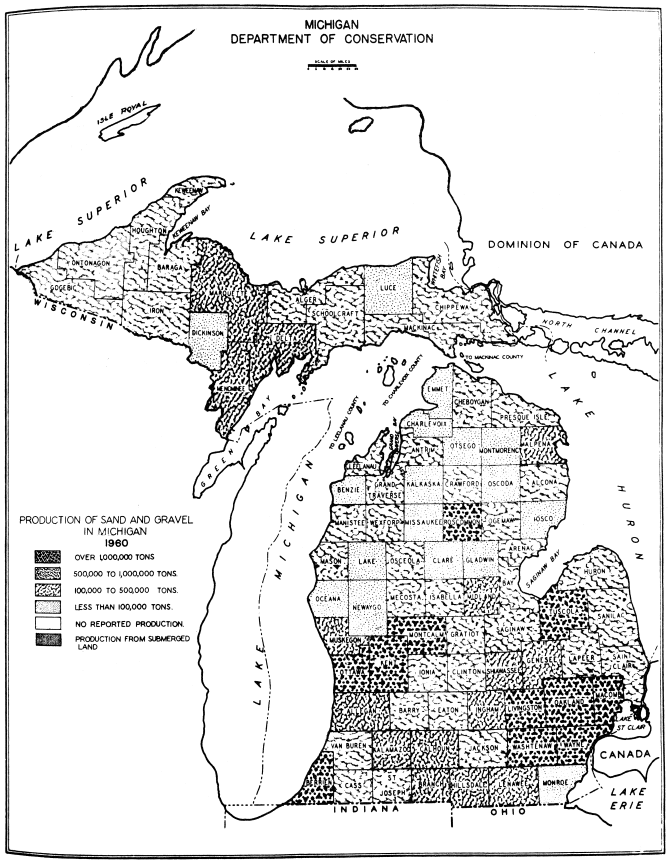
** Includes - railroad ballast, miscellaneous, and other gravel.

Production of sand and gravel was reported from all of Michigan's 83 counties. Approximately 47 per cent of the total production was from 10 counties; in order of rank - Oakland, Livingston, Kent, Ottawa, Wayne, Washtenaw, Tuscola, Macomb, Berrien, and Roscommon. Twelve per cent of the state total was produced in Oakland County. Each of the other counties produced more than 1,000,000 tons. About 73 per cent of the State's total was reported by commercial producers and the remaining 27 per cent was non-commercial production by county road commissions and other governmental agencies.

The American Aggregates Corporation added a heavy-media separation unit at the Oxford gravel plant, bringing the total beneficiation capacity of their Michigan operations, at Oxford and Green Oaks, to 600 tons per hour. The equipment, consisting of a drum, drainage and washing gear, magnetic separator, densifier, demagnetizer, pumps and controls was supplied by Western Machinery Company.

Fourteen gravel beneficiation plants (12 employing heavy-media separators, one a jig and one an elastic fractionation process) were in operation in Michigan to produce the high quality aggregate specified for highway concrete.

[Map: Production of Sand and Gravel]

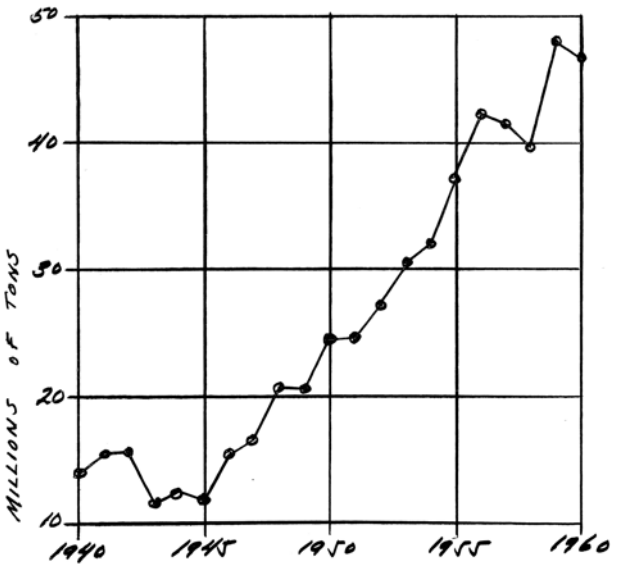


(Short Tons)

Year	Building Use	Paving and Road Use	Molding Sand	Others*	Total Quantity	Total Value
1956	11,374,625	27,254,840	1,753,195	1,767,286	42,149,946	35,145,953
1957	8,252,239	28,245,358	2,237,004	3,103,293	41,837,894	35,144,352
1958	7,960,834	27,653,570	1,792,447	2,464,351	39,871,202	34,615,648
1959	9,133,388	33,530,911	1,918,507	3,469,010	48,051,816	41,192,632
1960	8,642,775	31,610,214	1,699,124	4,958,082	46,910,195	39,304,400

* Includes: grinding and polishing sand, glass sand, railroad ballast, engine sand, blast sand, and fill sand and gravel.

SAND AND GRAVEL PRODUCTION
1940 - 1960



SALT

Artificial brines produced by dissolving salt from the Salina formation were recovered by eight plants in Manistee, Midland, Muskegon, St. Clair and Wayne counties. The brine is used for production of evaporated salt and for use in chemical plants. Salina rock salt mined at Detroit is reached by a shaft approximately 1,100 feet in depth. Evaporated salt is produced from natural brines drawn from the Marshall and Dundee formations at St. Louis, Gratiot County, and from artificial brines from the Detroit River formation at Manistee, Manistee County. Artificial brines from the Detroit River and Salina formations are used at the chemical plant in Midland, Midland County.

During 1960, 4,087,760 short tons of salt valued at $33,759,466 were produced. This was a decrease of 9 per cent in production and 6 per cent in value below 1959. Wayne ranked first of the six counties producing salt - followed by Midland, St. Clair, Manistee, Muskegon, and Gratiot.

Approximately 59 per cent of the salt was used by chemical plants in Wayne, Midland, and Muskegon counties. Over 2.4 million tons of salt were used in the manufacture of soda ash, chlorine, and other chemicals. Approximately 20 per cent of the total production was dried and evaporated salt.

USES OF SALT, 1960

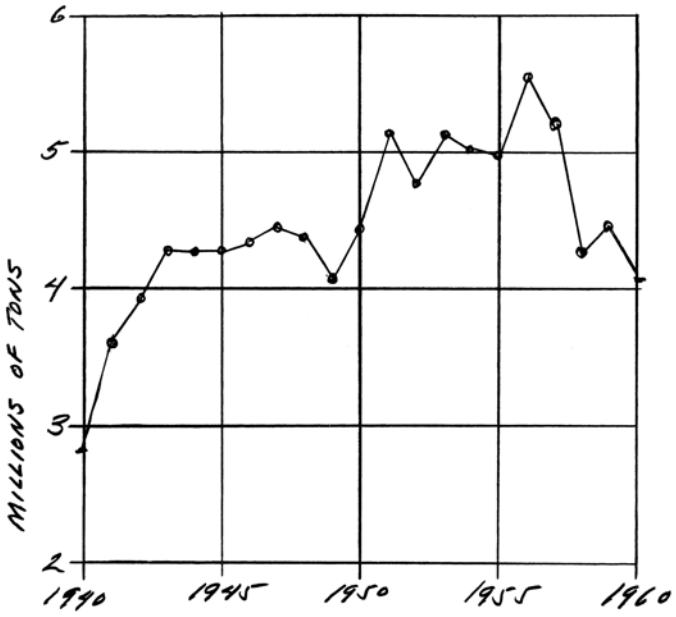
Uses	Quantity (short tons)	Per Cent
Chemical	2,411,440	58
Highway, dust and ice control	718,831	18
Livestock	158,980	4
Textile, hides, and packers	156,191	4
Food Processing	119,709	3
Table and other household	72,647	2
Water treatment	53,906	1
Other	100,916	3
Undistributed	295,140	7
TOTAL	4,087,760	100

International Salt Company installed a process for separating salt from impurities by selectively heating the impure materials with a battery of infra-red heat waves. The separation is possible because the sodium chloride crystals are transparent to the heat waves, whereas the impurities are not. After heating, the actual separation takes place by application of a heat sensitive adhesive to a high speed conveyor belt.

SALT PRODUCTION, 1956 - 1960

Year	Quantity Short Tons	Value	Per Cent U.S. Total	Rank in U.S.
1956	5,548,178	$ 35,643,860	22.9	1
1957	5,225,425	41,072,497	21.9	1
1958	4,266,688	33,018,368	19.5	1
1959	4,485,145	35,724,796	17.8	3
1960	4,087,760	33,759,466	-	3

SALT PRODUCTION - 1940-1960



STONE

Approximately 90 per cent of the limestone and dolomite produced in Michigan in 1960 was quarried in Presque Isle, Mackinac, and Chippewa counties. Dimensional limestone was produced in Charlevoix, Eaton, Huron, and Presque Isle counties.

Sandstone for rough construction, rubble, and flagging stone was quarried from the Marshall sandstone of Mississippian age in Jackson and Hillsdale counties.

Basalt from Precambrian rocks was crushed and used for road construction in Houghton County.

Stone production and value increased to 21,393,405 tons and $24,316,219 in 1960*.

STONE PRODUCTION, 1960*

Commodity	Quantity (Short Tons)	Value
Limestone and dolomite- crushed	21,325,012	$24,104,405
dimensional	6,801	58,889
Sandstone-dimensional	11,615	97,395
Basalt-crushed	49,977	55,530
TOTAL	21,393,405	$24,316,219

* Does not include 9,582,765 short tons of limestone valued at $7,775,410 used in the manufacture of cement and lime.

An additional grinding mill, screens, and storage and material handling equipment were installed at the Rogers City and Cedarville operations of Michigan Limestone Division, U. S. Steel. The new equipment increased production of fluxing fines being used in connection with self fluxing sintered iron ore concentrates.

Inland Lime and Stone Company put in operations a new sinter sand limestone plant at Port Inland.

USES OF CRUSHED LIMESTONE AND DOLOMITE, 1960

Uses	Per Cent of Total	Quantity (Short Tons)	Value
Flux	57.6	12,292,426	$13,164,695
Concrete + Road Stone	24.9	5,306,573	6,156,081
Chemical*	13.9	2,971,051	3,534,096
Agricultural	2.7	572,921	931,486
Other**	.9	182,041	318,047
TOTAL	100.0	21,325,012	$24,104,405

* Includes: alkali, calcium-carbide, sugar, glass, and paper

** Includes: filler, asphalt, dust for coal mines, mineral food rail-road ballast, stone sand, and others.

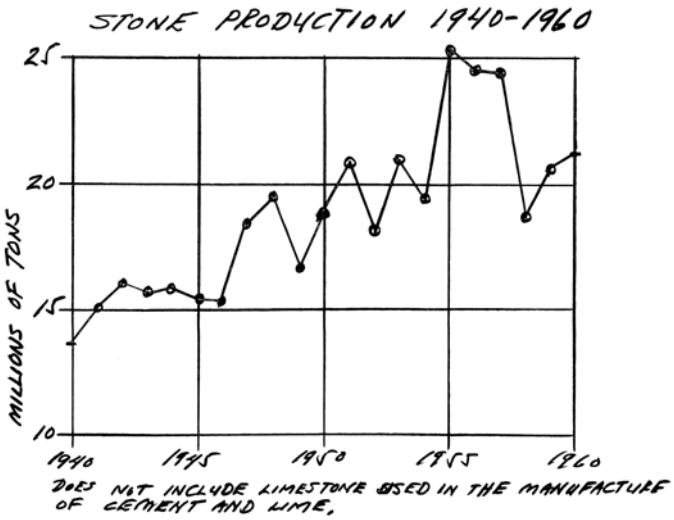
USES OF CRUSHED LIMESTONE AND DOLOMITE

1956-1960 (short tons)

	1956	1957	1958	1959	1960
Flux	14,039,485	14,624,595	8,821,169	10,805,705	12,292,426
Concrete & Rod Metal	5,442,797	4,954,171	6,063,671	5,311,121	5,306,573
Chemical*	4,206,961	3,574,323	2,985,530	3,729,465	2,971,051
Agriculture	538,439	586,558	486,653	434,116	572,921
Others**	359,258	921,765	165,049	131,526	182,041
Quantity	24,586,940	24,661,412	18,522,072	20,411,933	21,325,012
Value	$23,832,728	$26,974,290	$19,754,092	$22,432,225	$24,104,405

* Includes: alkali, calcium-carbide, sugar, glass, and paper.

** Includes: filler, asphalt, dust for coal mines, mineral foods, railroad ballast, stone sand, reprop and riprap, and others.



LIME

Seven companies produced quick and hydrated lime in the state. Production of lime increased 37 per cent to 1,177,431 tons during 1960. Wayne County ranked first in production.

At Dow Chemical Company plant in Ludington an Allis Chalmers Lepol-type grate kiln was used for the first time in the United States for lime production. The 11½' x 160' kiln has a capacity of 600 tons of lime per day.

Wyandotte Chemical Corporation proceeded with major improvements in its limestone calcining facilities at Wyandotte. Changes in the burning process were to improve the quality and increase the available capacity of 1.5 million tons of high-grade lime.

PRODUCTION OF LIME 1959-1960

Year	Production	Value	Rank
1959	861,808	$11,747,657	4
1960	1,177,431	15,730,384	4

CLAY AND SHALE

Clay and shale are produced at widespread localities throughout the state. Antrim shale from Alpena County and Ellsworth shale from Antrim County quarries are used in the manufacture of Portland cement, Saginaw shale is used by three plants for manufacture of tile in Eaton and Shiawassee counties. All other tile, brick, pottery, lightweight aggregate and cement plants operating in the state use clay from local surface deposits. Clay produced in Saginaw County is sold for oil well drilling mud, for molding sand bond and for fertilizer.

During 1960, 1,989,149 short tons of clay and shale, valued at $2,250,950, were produced. Alpena County led in production and value with 32 per cent of the State's total output, followed by Wayne, Saginaw, and Monroe counties. Approximately 78 per cent of all raw clay and shale produced was used by the cement industry. The remaining 22 per cent was used for the manufacture of a small quantity of prepared clays and for clay products - brick, tile, pottery, and lightweight aggregate.

PRODUCTION OF CLAY AND SHALE AND CLAY PRODUCTS, 1956-1960

Year	Raw Clay and Shale Quantity (short tons)	Value	Value Clay Products
1956	2,110,030	$2,401,051	$6,951,866
1957	2,031,890	2,266,599	6,851,113
1958	1,948,444	2,191,909	6,786,247
1959	2,050,760	2,311,917	6,745,027
1960	1,989,149	2,250,950	6,587,345

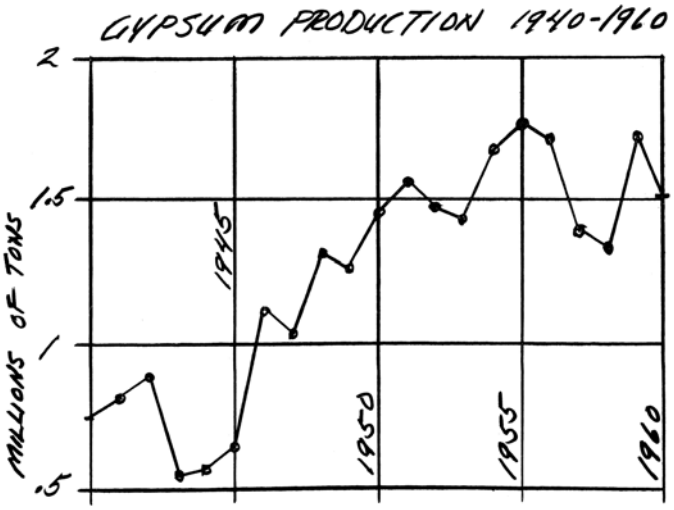
GYPSUM

Gypsum is quarried at Alabaster and near Tawas City, Iosco County, and is mined in two underground mines at Grand Rapids, Kent County. The raw material is processed in gypsum mills at National City, Grand Rapids, River Rouge, East Chicago, Indiana, Waukegan, Illinois, and Lorain, Ohio. Principal uses for gypsum are in the manufacture of plasters wallboard, and allied building materials and as a Portland cement retarder. In 1960, production of gypsum decreased to 1,462,781 short tons valued at $5,608,519 due to the lag in building construction.

National Gypsum Company's automated gypsum plant at Lorain, Ohio went into production of wallboard, 16 inch lath, and plaster. The plant has a dust collection system that returns dust to the production process. The company's Tawas City quarry supplied approximately 3,000 tons of raw gypsum required each week.

GYPSUM PRODUCTION, 1956-1960

Year	Quantity (short tons)	Value	Per Cent of U. S.	Rank in U. S.
1956	1,715,832	$ 5,861,152	17	1
1957	1,385,952	4,822,810	15	1
1958	1,330,889	4,924,431	14	2
1959	1,721,453	6,595,256	16	1
1960	1,462,781	5,608,519	--	1



PEAT

Production increased in 1960 to 214,402 tons valued at $2,755,245. Michigan, with nearly half of the total, led all states in production followed by Florida and California.

Most of the peat produced was used for general soil improvement purposes. Small amounts were used in pottery, in mixed fertilizers, for packing flowers for shipments, and for several miscellaneous uses.

PRODUCTION OF PEAT, 1956-1960

Year	Quantity (short tons)	Value	Per Cent of U.S.	Rank in U. S.
1956	31,111	$ 474,899	10.7	3
1957	80,271	1,406,195	25.4	1
1958	107,342	1,683,980	32.7	1
1959	191,661	2,356,656	45.7	1
1960	214,402	2,755,245	45.5	1

MARL

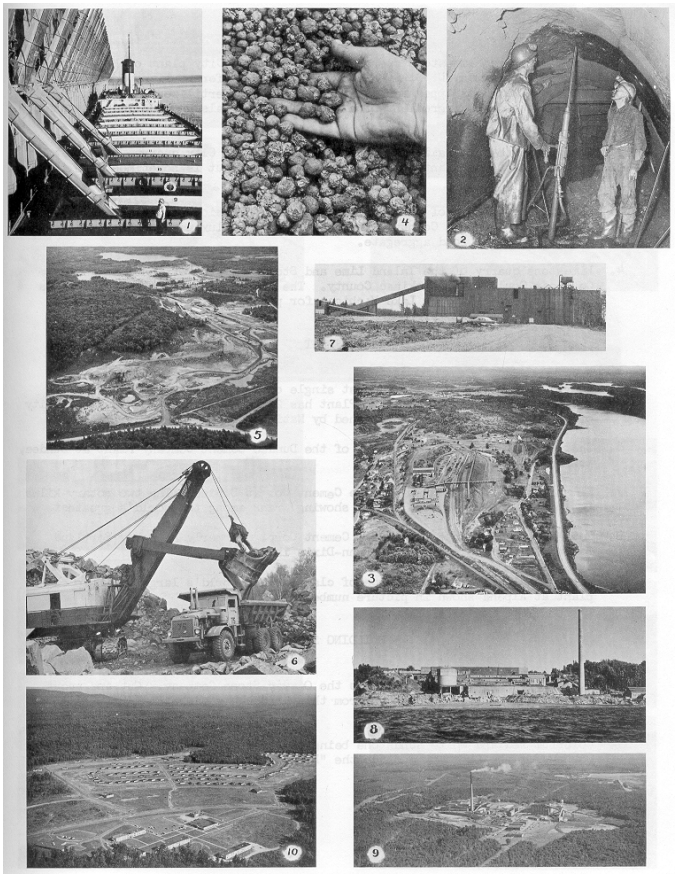
All marl produced in the state is used for agricultural purposes. This material when added to the soils plays the same important role as does commercial lime and may be employed in much the same manner. Commercial marl production was reported in 17 counties during 1960. Kalamazoo County ranked first, followed by Calhoun, Allegan, St. Joseph, and Barry counties. These counties produced approximately 73 per cent of the state output.

MARL PRODUCTION, 1956-1960

Year	Quantity (short tons)	Value	Rank in U.S.
1956	157,246	$ 94,821	1
1957	137,020	70,635	1
1958	230,105	130,231	4
1959	201,387	118,240	4
1960	159,345	91,173	4

[Picture Presentation of Mineral Producers]

IRON ORE



1. Chutes transferring iron ore from dock to ore boat at Marquette.
2. Drilling for blasting in sublevel drift of soft iron ore mine.
3. Aerial view of the surface plant of Cleveland-Cliffs Iron Company, Mather "B" Mine at Negaunee. Right center is Cambria-Jackson Mine now abandoned.
4. Concentrate pellets containing more than 60 per cent iron.
5. Aerial view of Humboldt Mine and Concentration Plant, Humboldt.
6. Loading crude ore at pit of Republic Concentration Plant Republic.
7. Iron ore pelletizing plant, Eagle Mills.

COPPER

8. Copper concentrate mill of Copper Range Co., Freda.
9. Aerial view of Surface plant of White Pine Copper Mine, White Pine.
10. Aerial view of White Pine townsite, White Pine. Porcupine Mountains appear in left background.

LIMESTONE

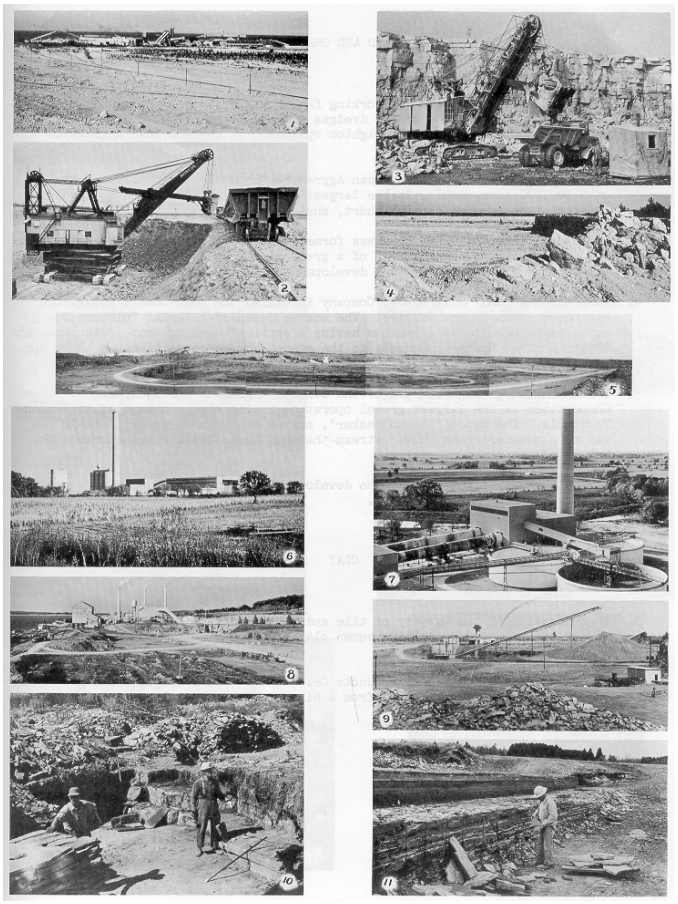
1. World's largest limestone operation. The Rogers City plant of Michigan Limestone Division, U. S. Steel Corp. Some 45 different sizes and chemical combinations are shipped for blast furnace flux, fertilizers, aggregate, cement, the basic ingredient of a number of chemicals and hundreds of other chores.
2. Loading stone into railroad gondolas in the Rogers City quarry. The trip to the processing plant averages about 3½ miles, but is sometimes more than 6 miles.
3. Dolomite operation of the Michigan Limestone Division, located near Cedarville, Chippewa County. The stone goes for flux use in the manufacture of steel and for road aggregate.
4. Limestone quarry of the Inland Lime and Stone Division of the Inland Steel Co. near Gould City, Mackinac County. The quarried stone is railed 7 miles south to Port Inland on Lake Michigan for processing and shipment.

CEMENT

5. Quarry view of the world's largest single cement operation, located on the shore of Lake Huron at Alpena. Plant has 26 kilns, having an annual capacity of 12,000,000 barrels, and is owned by National Gypsum Company.
6. The 350 foot stack is a landmark of the Dundee Cement Company Plant at Dundee, Monroe County.
7. Kilns and slurry basins of Dundee Cement Co. at Dundee. The two rotary kilns (only half their 460 foot length showing) rank among the world's greatest.
8. Petoskey plant of the Penn-Dixie Cement Corp. Formerly Petoskey Portland Cement Co. before purchase by Penn-Dixie in 1954.
9. Paxton shale quarry, the source of clay for the world's largest single cement plant at Alpena shown in picture number 5.

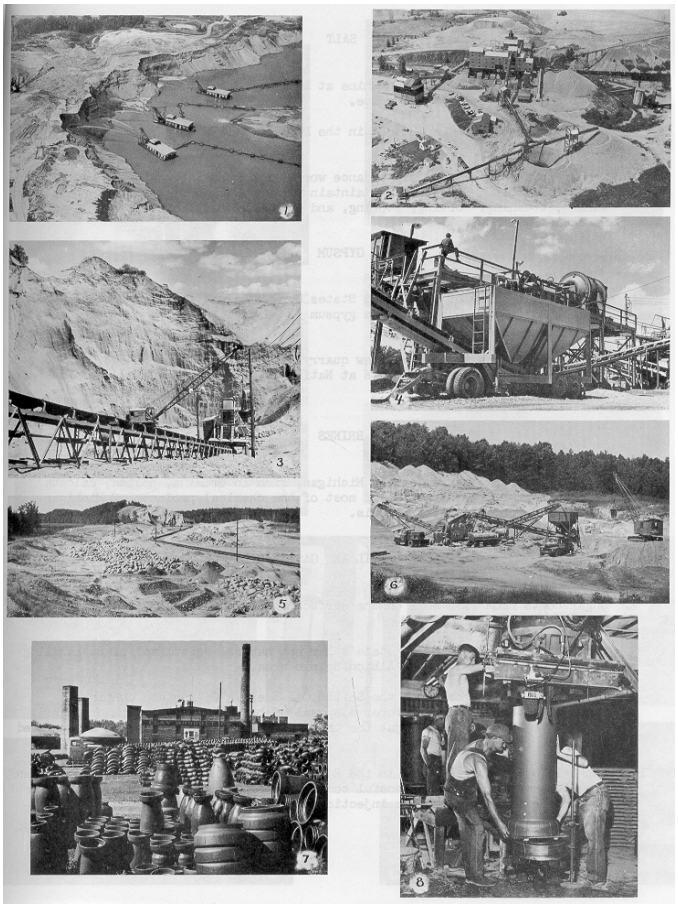
BUILDING STONE

10. At Onaway, Presque Isle County is the Onaway Stone Company. Cut and uncut slabs of thin bedded limestone from this concern is marketed as far south as Lansing.
11. Colorful red and white sandstone being quarried again near Arnheim, Baraga County, for the first time since the "Redstone Era" many decades ago.



SAND AND GRAVEL

1. A soft angle of repose at the working face is maintained by hydraulic jetting. Powerful pumps on the dredges suck up the material and move it to the processing plant. Brighton operation of the American Aggregates Corporation.
2. The Brighton Plant of the American Aggregate Corp. has an annual capacity of 3,500,000 tons, making it the largest single gravel operation in Michigan. Beneficiation removes harmful chert, shale, clay, etc.
3. Bundy Hill in Hillsdale County was formed thousands of years ago by meltwater streams tumbling over the front of a great glacier. Installation of beneficiation equipment insured the development of a significant 100 acre tract.
4. In 1955, the Bundy Hill Gravel Company installed the heavy-media separation equipment shown in the picture. The coarse desanded material (picture No. 3) is mixed with a flotation medium having a critical density that is intermediate to the desired heavy components in the gravel and the objectionable light components.
5. The Millersburg "Big Cut" pit of the Straits Aggregate and Equipment Corporation is the largest gravel operation in the northern part of the Lower Peninsula. The deposit is an “esker”, sorted sands and gravels, left in the bed of a meandering meltwater stream that had tunnelled a course through the bottom of the glacier.
6. Portable gravel plants permit the development of many local deposits - needed for roads and construction work.



CLAY

7. An indication of the variety of tile and vitrified were being manufactured at one of Michigan's remaining seven clay products plants. Grand Ledge Clay Products Co., Grand Ledge.
8. A scene at Grand Ledge Clay Products Co. plant at Grand Ledge, showing a fresh, soft, moist tile being removed from a big steam-operated clay extrusion machine.

SALT

1. The International Salt Company mine at Detroit. This 50 foot haulageway is about 1100 feet below the surface.
2. Electrically operated machinery in the Detroit salt mine precludes fouling the air.
3. Underground assembly and maintenance workshop of the International Salt Co. mine of Detroit. Roadscrapers maintain the many miles of road connecting mining, crushing, sorting, storing, and hoisting operations.

GYPSUM

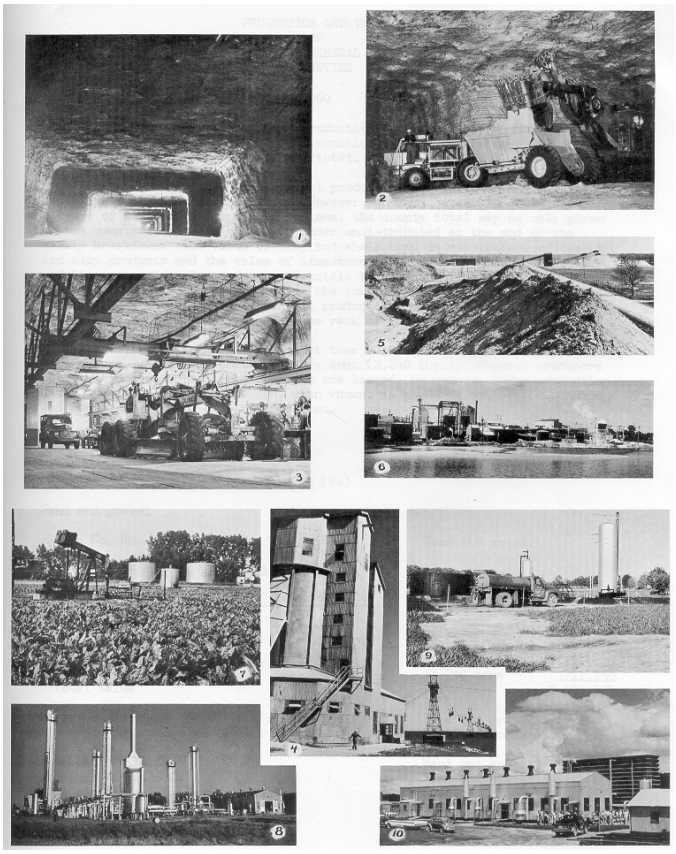
4. The aerial tramway of the United States Gypsum Co. at Alabaster stretches for 1¼ miles into Lake Huron. Crude gypsum is shipped to the company's plants at Detroit and Chicago.
5. The National Gypsum Company's new quarry near National City, Iosco County. Raw material supplies company plants at National City, Lorain (Ohio), and Waukegan (Illinois).

BRINES

6. Scores of brine wells in Central Michigan, rich in bromine, sodium, calcium and magnesium, are the source of most of the chemical products of Michigan Chemical Corporation at St. Louis.

OIL AND GAS

7. Sugar beets from rich soil on the surface - oil from rocks 3,500 feet below. Kawkawlin Oil Field.
8. Processing equipment in the state's largest natural "gasoline" plant handling natural gas produced in the Albion-Scipio area.
9. Tank truck loading brine in the Scipio Oil Field. Oilmen are continually faced with the problem of proper disposal of brines produced with crude oil. Michigan statutes require that the unwanted brine be injected into an approved deep rock formation.
10. Sun Oil Co. recycling plant in the East Norwich Field in Missaukee County - an excellent example of a successful conservation program. The life of this field is being extended by the gas injection method of secondary recovery.



GENERALIZED COLUMNAR SECTION OF MICHIGAN

MICHIGAN GEOLOGICAL SURVEY DIVISION

SYSTEM, SERIES	FORMATION, GROUP	LITHOLOGY	THICKNESS	ECONOMIC PRODUCTS
RECENT				
PLEISTOCENE	GLACIAL DRIFT	SAND, GRAVEL, CLAY, boulders, marl	0-1000	SAND, GRAVEL, PEAT, MARL, FRESH WATER
"PERMO-CARBONIFEROUS"	"RED-BEDS"	SHALE, CLAY, SANDY SHALE, gypsum		
PENNSYLVANIAN	GRAND RIVER	SANDSTONE, sandy shale	80-95	BUILDING STONE, FRESH WATER
	SAGINAW	SHALE, SANDSTONE, limestone, coal	20-535	SHALE, COAL, FRESH WATER, BRINE, GAS
MISSISSIPPIAN	BAY PORT	LIMESTONE, SANDY OR CHERTY LIMESTONE, SANDSTONE	2-100	LIMESTONE, FRESH WATER
	MICHIGAN	SHALE, gypsum, anhydrite, sandstone	0-500	GYPSUM
	"MICHIGAN STRAY"	SANDSTONE	0-80	GAS
	MARSHALL	SANDSTONE, sandy shale	100-400	FRESH WATER, BRINE BUILDING STONE
	COLDWATER	SHALE, sandstone, limestone	500-1100	SHALE, FRESH WATER
	SUNBURY	SHALE	0-140	
	BEREA-BEDFORD	SANDSTONE, SHALE	0-325	GAS, OIL
	ELLSWORTH-ANTRIM	SHALE, limestone	100-950	SHALE, GAS
DEVONIAN	TRAVERSE	LIMESTONE, SHALE	100-800	LIMESTONE, OIL, GAS, FRESH WATER
	BELL	SHALE, Limestone	0-80	SHALE
	ROGERS CITY-DUNDEE	LIMESTONE	0-475	LIMESTONE, OIL, GAS, FRESH WATER
	DETROIT RIVER	DOLOMITE, limestone, salt anhydrite	150-1400	LIMESTONE, DOLOMITE, OIL, GAS, SALT, BRINE, FRESH WATER
	SYLVANIA	SANDSTONE, SANDY DOLOMITE	0-550	GLASS SAND, FRESH WATER
	BOIS BLANC	DOLOMITE, CHERTY DOLOMITE	0-1000	
SILURIAN	BASS ISLAND	DOLOMITE	50-570	DOLOMITE, FRESH WATER
	SALINA	SALT, DOLOMITE, Shale, anhydrite	50-4000	SALT, GAS, OIL
	NIAGARAN (Guelph-Lockport-Engadine) (Manistique-Burnt Bluff) (Cataract)	DOLOMITE, Limestone, shale	150-800	LIMESTONE, DOLOMITE, OIL, GAS, FRESH WATER
ORDOVICIAN	CINCINNATIAN (Richmond) (Maysville-Eden)	SHALE, LIMESTONE	250-800	
	TRENTON-BLACK RIVER	LIMESTONE, DOLOMITE	200-1000	OIL, GAS, LIMESTONE, FRESH WATER
	ST PETER	SANDSTONE	0-150	FRESH WATER
OZARKIAN OR CANADIAN	PRAIRIE DU CHIEN	DOLOMITE, Shale	0-410	
	HERMANSVILLE	DOLOMITE, SANDY DOLOMITE, sandstone	15-500	
CAMBRIAN	LAKE SUPERIOR (Munising) (Jacobsville)	SANDSTONE	500-2000	BUILDING STONE FRESH WATER
ALGONKIAN	KEWEENAW (Copper formations)	LAVA FLOWS, conglomerate, shale, sandstone	9800-35000	COPPER, SILVER, ROAD METAL, SEMI-PRECIOUS GEM STONES
	KILLARNEY GRANITE	GRANITE, GNEISS, diorite, syenite		
	HURONIAN (Iron formations)	SLATES, HEMATITE, SCHIST, QUARTZITE, GRANITE, marble, dolomite	2000+	IRON ORE, ROOFING SLATE, ROAD METAL, GRAPHITE MARBLE
ARCHEAN	LAURENTIAN	SCHIST, GNEISS, GRANITE		ROAD METAL, BUILDING STONE, VERDE ANTIQUE, TALC, GOLD
	KEEWATIN	SCHIST, GREENSTONE, SLATE		ROAD METAL