MICHIGAN MINERAL INDUSTRIES 1961

by

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Contents

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The STATE GEOLOGICAL SURVEY was one of the very first offices established when Michigan attained statehood in 1837. The First Legislature charged it "...to make an accurate and complete geological survey of this state, which shall be accompanied with proper maps and diagrams, and furnish a full and scientific description of its rocks, soils and minerals...and geologic productions" — work pursued to this very day.

In 1921 the several state agencies exercising independent jurisdiction over natural resources were combined into a single organization. Thus, the Geological Survey, headed by its chief administrative officer, the State Geologist, became one of the divisions of the Department of Conservation.

Assisting the Supervisor of Wells (Director of Conservation) in enforcing regulatory practices prescribed by Michigan's oil and gas conservation laws comprises the greater part of the Division's work. Some assistance is also given the State Public Utilities Commission which regulates the transmission and use of natural gas.

The Survey constitutes a bureau of continuing information and service in the field of earth science. This function is manifested through publications, maps, reference files, and personal consultation — efforts that aid materially in delineating potential areas of economic mineral deposits, and in achieving understanding of the state's geologic history.

Iron and copper mining properties are appraised annually for general property tax purposes. From time to time, appraisals of other mineral properties are made for the State Tax Commission. Evaluations of mineral venture securities being promoted in the state are prepared upon the request of the State Securities Commission.

Mineral statistics are compiled, in cooperation with the U. S. Bureau of Mines, and published annually along with information on the progress and development of the industry. Also, cooperative assistance is provided in the development of public water supplies and in conducting surface and ground water studies.

The Survey's main offices are on the 4th floor of the Mason Building, one block west of the Capitol. A branch office, serving the Upper Peninsula, is maintained at Escanaba. In addition, district offices for oil and gas regulatory work, are maintained in Lansing, Mt. Pleasant, Plainwell, and Cadillac.

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FOREWORD

This report on the mineral industries of Michigan is a compilation of mineral production data for the year 1961. It consists of six sections: preliminary estimate of Michigan's mineral production for 1962, news items and developments in 1962, a summary of each of the mineral industries, a breakdown of mineral production by counties, a directory of mineral producers, and a picture presentation of mineral producers.

Items on 1962 developments in the various mineral fields were 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 producers for the production information they have submitted. Without their cooperation, this report would have been impossible.

THE MINERAL INDUSTRY OF MICHIGAN, 1962* (Preliminary)

Mineral production in Michigan in 1962 was valued at $439 million, according to the Bureau of Mines, United States Department of the Interior. Value of output was lower than in 1961 ($443 million) chiefly because of smaller shipments of iron ore and petroleum. Iron ore remained first in value, followed by cement, petroleum, and copper*

Nonmetallic minerals accounted for 57 percent of the value of mineral production, metallic minerals 29 percent, and mineral fuels 14 percent. There was little change from 1961 when nonmetals represented 56 percent, metals 29 percent, and mineral fuels 15 percent.

Production of copper in terms of recoverable metal was 4 percent larger than in 1961. Value was over 7 percent higher because the preliminary average weighted price in 1962 was 31.0¢ per pound, compared with 30.0¢ in 1961. Copper producers operated throughout the year with only minor interruptions with the exception of the Quincy Mining Co., which was closed down from May 31 to September 3 because of the collapse of a surge bin at their reclamation plant. Development of the White Pine Copper Co.’s Southwest orebody continued. The exploration shaft was completed and large-scale testing of development ore begun. Late in the year Calumet & Hecla, Inc. reported the discovery of an orebody in the Kingston Conglomerate Lode with indications of a grade of ore higher than any mined in the Michigan copper district in recent years. A crosscut from the Allouez No. 3 mine is being driven to intersect the lode.

Iron-ore shipments were estimated at 9,250,000 long tons, compared to 9,384,206 in 1961. Value of shipments decreased about $6 million. Effective April 1, Lake Erie base prices for natural blast furnace iron ores were reduced $.80 per ton. Growing preference for higher quality iron ores for blast-furnace feed had a considerable effect on iron-ore raining in Michigan. Shift in demand from direct-shipping ores to higher quality concentrates resulted in the closing of two underground mines during the year.

Concentrates produced from jaspilite accounted for over a quarter of iron-ore shipments in 1962. Capacity of facilities for producing and processing this material will be doubled when current and planned projects are completed. Construction of the Empire taconite plant, near Palmer, began in May. The plant will consist of crushing, grinding, concentrating, and pelletizing sections. Initial capacity of the plant, scheduled for opening late in 1963, will be 1,200,000 tons of pellets per year from low-grade magnetite. Ultimate capacity will be 3,000,000 tons of pellets a year. Hanna Mining Co. completed expansion of its Groveland operation which increased its concentration plant capacity from 700,000 to 1.5 million tons per year. These additional beneficiating facilities will be capable of producing 1.25 million tons of pellets per year. Cleveland-Cliffs Iron Co. completed the second 800,000 ton per year concentration unit at the Republic open-pit mine. A third 800,000-ton unit is under construction and scheduled for completion by the end of the year. When construction is completed, the Republic operation will have a capacity of 2.4 million tons of concentrate per year.

The Lake shipping season for Michigan ores opened at Escanaba on April 17 and closed at Marquette on December 4.

Nonmetallic minerals used for building and road construction were produced at about the same level as in 1961. Small declines in the output of sand and gravel and stone were balanced by increased shipments of cement, clay, and gypsum. Huron Portland Cement Co. completed construction of a large rotary kiln at its Alpena plant. The largest dry process kiln in the State, with an output of 5,200 barrels per day, will increase the annual capacity of the Alpena plant from 12 million to 14 million barrels.

Salt production increased by 11 percent, while the value of chemicals derived from brines (bromine, calcium-chloride, iodine, magnesium compounds, and potash) was about 6 percent larger than in 1961.

The value of mineral fuels produced was 5 percent lower than in 1961. The decline was due to lower output of petroleum, down 1.7 million barrels from 1961. This is the first decline in petroleum production since 1958 when the development of southern Michigan oil fields reversed a downward trend. Producers of other mineral fuels (natural gas and natural gas products, and peat) reported larger outputs than in 1961.

*Prepared December 21, 1962 by Donald F. Klyce, Mineral Economist, under the supervision of Wesley A. Grosh, Chief, Minneapolis Office of Mineral Resources, Region V, Minneapolis, Minn.

Mineral Production in Michigan, 1962 (1)
(Estimated)

Mineral	Thousand Short Tons (unless otherwise stated)	Value (thousands)
Cement:		
Portland - thousand 376-pound barrels	23,200	$ 76,300
Masonry - thousand 280-pound barrels	1,500	4,400
Clays	1,925	2,100
Copper (recoverable content of ores, etc.) in short tons	73,125	45,338
Gypsum	1,300	4,900
Iron Ore (usable) thousand long tons, gross weight	9,250	81,400
Lime	1,160	15,300
Natural Gas - million cubic feet	29,600	6,500
Peat	225,000	2,335
Petroleum (crude) thousand 42-gallon barrels	17,208	50,247
Salt	4,300	33,000
Sand and Gravel	53,300	46,100
Stone	28,581	29,927
Value of items that cannot be disclosed: Bromine, calcium-chloride and calcium-magnesium chloride, gem stones, magnesium-compounds, natural-gas liquids, and potassium salts	-	49,385
Total Michigan (2)		$439,469

(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.

NEWS ITEMS AND DEVELOPMENTS IN 1962

IRON ORE

Growing preference for high quality iron ore for blast-furnace feed continued to shift demands from shaft ruined direct-shipping ores to the higher quality concentrates of beneficiation plants supplied by surface workings. Four underground mines closed down, and tax valuation appraisals of underground mines dropped $9,817,700 to $68,147,000. Department valuations of mineral properties in the iron mining counties are as follows: Marquette, $31,207,000; Iron, $28,035,000; Gogebic, $8,847,800; and Dickinson, $58,000. The specific tax on beneficiation plants in Marquette and Dickinson counties amounted to $326,858, an increase of $108,030 over 1961.

On the Gogebic Range, North Range Mining Company had closed the Penokee Mine at Ironwood November 30, 1961, but continued to load railroad cars with stockpile iron ore through October 1962. Only two iron mines, the Geneva and Peterson, remain operative on the Gogebic Iron Range.

In the Iron River-Crystal Falls Iron District, the Cannon Mine discontinued operation September 20, 1962. Underground equipment was removed and the mine allowed to fill with water. The Tobin Mine, operated by the Republic Steel Corporation, reopened on April 1, 1962, but closed again August 24th. The Bristol, Hiawatha, Homer and Sherwood mines operated mostly on four-day weeks. The Wauseca Mine continued as a 5-day operation.

On the Marquette Iron Range, the Mather, Bunker Hill and Cliffs Shaft mines of the Cleveland-Cliffs Iron Company reduced operations because of lack of demand for underground ores. Inland Steel Company announced the Greenwood Mine would close in early 1963. The Champion Mine of the North Range Mining Company was on a 4-day schedule.

The Cleveland-Cliffs Iron Company reported the second line of the agglomerating plant at the Republic Mine in full operation. The pelletizing plant and an enlarged mill now have an annual capacity of 2.4 million tons concentrate, of which 1.6 million tons will be agglomerated at the mine with the remainder being agglomerated at the existing Eagle Mills plant.

At the Company's Empire Mine construction proceeded at a rapid pace, completion date of the 1.2 million ton initial unit being November 1, 1963. This new operation near Palmer will consist of crushing, grinding, concentrating and pelletizing sections.

The large expansion program of the Groveland beneficiation plant of the Hanna Mining Company, located near Randville, approached completion. Annual capacity will be 1,500,000 long tons of iron ore concentrate compared to existing capacity of 670,000 long tons. The original plant, completed in 1959, had two mill lines in the concentrator with space for a third. The expansion program includes installation of the equipment for the third line, remodeling the original lines, and expansion of the shop area of the service building, addition of a process water system, and construction of a pelletizing plant.

COPPER

Annual appraisal made for tax purposes by the Geological Survey Division showed that Ontonagon County's only mine, the White Pine Mine, again carries Michigan's top copper mine valuation of $10,010,000. Copper mines in Houghton and Keweenaw counties are appraised at $3,385,000 and $815,000, respectively.

Copper Range Company began experimental processing of copper ore from the new ore body located about two miles from its other mining and processing facilities. The ore body is situated on the western downfaulted side, of the White Pine Fault. The development shaft had been completed at a depth of 2,290 feet in November, 1961. By September, 1962 2,400 feet of development drifting had been completed.

An exchange of mineral rights between Calumet & Hecla, Inc., and Copper Range Company enables both firms to consolidate land holdings and, therefore, undertake more aggressive mineral exploration programs on vast acreages of unexplored lands.

Late in the year Calumet & Hecla, Inc. announced discovery of a promising copper ore body. The deposit, described as a previously unknown ore body in the Kingston Conglomerate Lode (also known as the Kearsarge), was cut by eight drill hiles at an inclined depth of about 500 feet. A development crosscut from

the 6th level of the Allouez No. 3 mine is now being driven toward the lode.

An interested group has proposed that the State take over the old Minnesota Mine area in Ontonagon County as a historical site showing how copper was first mined. Backers said the move would preserve Indian pits where weapons, hammers and other tools were fashioned from copper by prehistoric peoples. The largest mass of copper ever produced in Michigan came from the Minnesota Mine. Reducing it into chunks small enough to get to the surface required 15 months work by 20 men.

SILVER

White Pine Copper Company now recovers about half a million ounces of silver annually. This precious metal is stripped in the early stages of copper ore milling. Silver sells at $1.00 an ounce; copper, at around 31 cents a pound. White Pine's copper ore assays at 34 to 37 ounces of silver per ton. After stripping, it still runs 25 ounces per ton.

PORTLAND CEMENT

The largest dry-process kiln in Michigan started production June 19 at the Huron Portland Cement Company's plant at Alpena. The new horizontal rotary kiln, 460 feet long and from 13 to 15 feet in diameter, turns out some 5200 bbls. of cement per day - an amount said to be greater than that produced by the eight original kilns installed in 1907. Seven concrete piers support the more than 1300-ton kiln and its auxiliary equipment. A 300 h.p. motor turns the kiln. The entire operation can be electronically controlled by one man. Annual capacity of the plant is now 14 million barrels. The new kiln culminates the first step begun two years ago, in a 15-year plant expansion program designed ultimately to increase capacity to 22,000,000 barrels a year by 1975.

In January, the General Portland Cement Company advised its 114 production employees at Cement City to look for other jobs. Only 5 workers were retained on the payroll when the plant closed in December.

Wyandotte Chemical Corporation and Huron Portland Cement Company announced they would dissolve their 60-year cement marketing agreement on January 1, 1963. Huron has been marketing Wyandotte Cement since 1903, and had operated the Wyandotte mill under lease agreement until 1926. Wyandotte will now establish its own cement marketing organization.

Approximately $200,000 was spent at Peerless Cement Company's Port Huron plant in a modernization program involving kilns and stack. A dry dust collector at the barge-loading site cost an additional $35,000.

In December Martin Marietta Corp. announced the purchase of the Aetna Portland Cement Company's 3 million-barrel cement plant at Bay City. The new owner intends disposing of Hetha's three concrete pipe plants located in Saginaw, Grand Rapids and Jackson.

Technical service engineers working out of Detroit, Saginaw, Lansing and Grand Rapids are bringing mobile testing equipment to customers of Huron Portland Cement Company. Laboratory facilities for aggregate analyses, designing of concrete mixtures, and making moisture, impurities, and air tests are installed in their station wagons.

A Michigan contractor, Pierson Contracting Company of Saginaw, claimed a new record for Portland Cement concrete paving. Working 40 hours between August 21 and 249 they paved 4.45 miles of road. In one 12-hour day, the firm paved 8,101 lineal feet of reinforced concrete pavement, 24 feet wide and 9 inches thick.

LIMESTONE

A 3-day civic celebration honoring the 50th anniversary of Michigan Limestone Division and Bradley Transportation Line was held on August 3, 4 and 5 at Rogers City. The Michigan Limestone Division, known as the Michigan Limestone and Chemical Company when first founded in 1910, began operation in 1912. Purchased by Carl D. Bradley and the U. S. Steel Corporation in 1920, the Company came under the sole ownership of U. S. Steel upon Bradley's death in 1928. In 1951 the Company became a Division of the Corporation. Self-unloader vessels of the Division's Bradley Transportation Line carry limestone from here, the world's largest limestone quarry, to industrial ports around the Great Lakes.

SAND AND GRAVEL

J. P. Burroughs & Son, Inc., Holly, producer of sand and gravel, is the surviving company in a merger with the Wallace Stone Company, Bayport, Wallace is said to be the oldest continuous producer of commercial aggregates in the state. It has a limestone quarry at Bayport, a sand and gravel plant at Hersey, and docks at Bay City, Saginaw, and Ludington.

Anderson Sand and Gravel Company of Saginaw built a ready-mix plant in Zilwaukee on the Saginaw River. The overall cost of the plant, including dredging operations for an 1100-foot docks was estimated at about $200,000.

PETROLEUM

As a result of Detroit area gasoline price wars, Leonard Oil Company in July posted cuts ranging from 15 to 25 cents per barrel for Michigan crude. Leonard buys about 40% of Michigan's average 50,000 barrels per day production. In the Albion-Scipio area, largest oil producing region in the state, top crude price of $2.95 per barrel was shaved to $2.80. Most central state area grades were cut 25 cents to $2.70 per barrel. St. Clair County area, producing 2,300 barrels per day, was the

only district escaping cut backs. Its price stayed at $2.80.

The State Conservation Department received a record $310,811 for 253,109 acres of state land offered late in the summer for oil and gas leasing. Most of the land is in the northern Lower Peninsula, with about 90 percent in State forests.

RESEARCH TECHNOLOGY

The Institute of Mineral Research at Michigan College of Mining and Technology received a $3,200 fellowship grant from Olin Mathieson Chemical Corporation for a basic study of flotation. The study will deal with measuring the effect of certain phosphate chemicals on the electrical charges that develop on mineral surfaces, such as quartz and Iron oxide minerals. The long range application could possibly mean improved methods of separating iron oxides and quartz in iron ore by flotation.

LEGISLATION

PASSED

Act. No. 22. Mineral rights. Requires purchase of land for highways to include fair price for mineral rights (will become law March, 1963).

Act. No. 158. Tax lands. Permit conveyance to lessees of mining land reverted to State, Amends Sec. 131a, Act 206, P.A. 1893. (C.L. 211. 131A).

INTRODUCED BUT FAILED

House Bill 324. Mining. Moving of houses on company property.

House Bill 366. Mining Inspection. Duties of county mine inspectors; create safety code advisory board.

House Bill 544. Appropriations. $25,000 to Conservation Department for mineral exploration of Gogebic County.

House Bill 708. Mineral Rights. Separate; require registration and fee.

House Bill 746. Taxation. Equalization to be by class of property; iron mining to be separate class; state equalization valuation to be entered on assessment roll for each item of property.

INTERIM STUDY COMMITTEES

House Resolution 54. A special committee on metallic mining.

House Resolution 120. A special committee on tax laws.

TOPOGRAPHIC MAPPING: (U. S. Geological Survey)

STANDARD SERIES, 15-MINUTE QUADRANGLES

Reprints: Dexter, Dundee, Fowlerville.

STANDARD SERIES, 7½-MINUTE QUADRANGLES

New Issues: Assumption, Bronson N., Bronson S., California, Camden, Coldwater W., Kinderhook, Lyons, Pigeon Pt.

Revisions: Delaware.

1:250,000 SERIES (1° x 2° QUADRANGLES)

New issues: Grand Rapids (military edition), Hancock, Iron River, Marquette, Racine. These issues now afford complete coverage on Michigan.

RECENT PUBLICATIONS OF INTEREST TO THE MINERALS INDUSTRY:

"Summary of Operations, Oil and Gas Fields, 1961," by L. W. Price, et al. Geological Survey Division, Michigan Department of Conservation, Lansing 26, Michigan. Free.

"Rocks and Minerals of Michigan" by O. Floyd Poindexter, Helen M. Martin, and Stanard G. Bergquist. Publication 42, Michigan Geological Survey, Lansing 26, Michigan (fourth edition revised, 1962) $.50

"Summary of Rock Salt Deposits in the United States as Possible Storage Sites for Radioactive Waste Materials" by G. Pierce and E. I. Rich. U. S. Geological Survey Bulletin 1148 (1962) $1.25

"Sand and Gravel Operations and Costs, Construction Aggregates Corp., Ferrysburg, Michigan," by W. A. Beck. U. S. Bureau of Mines, Information Circular 80921 (1962). Free

"Cost Accounting and Control at Calumet Division, Calumet & Hecla, Inc., Calumet, Michigan," by B. C. Peterson, E. R. Helson, and W. A. Beck. U. S. Bureau of Mines, Information Circular 8044 (1962). $.30

"Cake Superior Iron Resources," by D. W. Frommer and P. A. Wasson, U. S. Bureau of Mines, Report of Investigation No. 6104 (1962). Free

"Aeromagnetic Map of the Eagle Harbor Quadrangle, Keweenaw County, Michigan," by J. R. Balsey et al., U. S. Geological Survey, Map GP-314 (1962). $.50. First of a series of overlays to be printed for the geologic maps already available for the Keweenaw area.

"Copper in the U. S.," by H. R. Kinkle, Jr. and N. P. Peterson, et al. U. S. Geological Survey, Mineral Investigations Resource Map MR-21 (1962). $.75

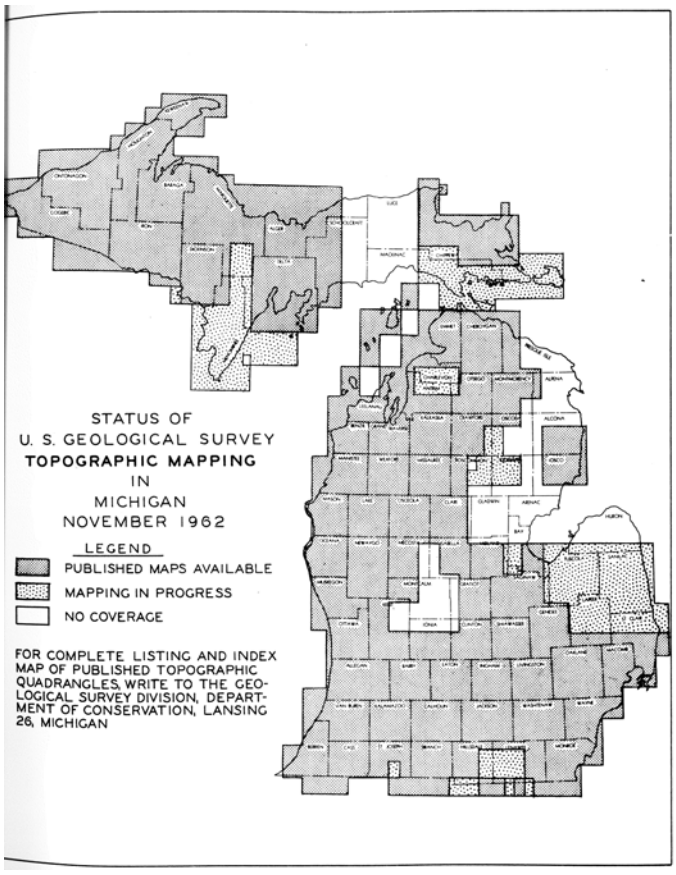
"Electromagnetic Studies of Iron Formations in the Lake Superior Region," by F. C. Frischknecht and E. B. Ekren. Mining Engineering, v. 13, no. 13, p. 1157-62 (1962).

"Silurian Rocks of the Southern Lake Michigan Area," edited by J. H. Fisher. Annual Field Conference of the Michigan Basin Geol. Soc. Available, from Librarian, Michigan Basin Geol. Soc., c/o Michigan Dept. of Conservation, Lansing 26, Michigan. (1962) $5.00

"Structure Associated with the Albion-Scipio Oil Field Trend," by G. D. Ells. Geological Survey Division, Michigan Dept. of Conservation (1962), $1.00

"Gypsum and Anhydrite in the U. S." by C. F. Withington, U. S. Geological Survey, Mineral Investigations Resource Map MR-33 (1962). $.75

[Map: Status of Topographic Mapping in Michigan]



MICHIGAN MINERAL PRODUCTION 1961 GENERAL REVIEW

Mineral production in Michigan in 1961 was valued at $443,263,278. The mineral output of the state exceeded the 1960 level by $8,133,488 primarily because of increased output of fuels. Fuel value increased 23 per cent and nonmetallic value 2 per cent. Metallic value decreased 6 per cent. Iron ore was first in value, followed by cement, petroleum, and sand and gravel.

The following table gives the value of Michigan mineral production 1961.

	Value	Per Cent	Rank U.S.*	Per Cent U.S.Total*
Nonmetallics	255,163,702	57.6	4	6.73
Metallics	125,955,550	28.4	4	6.63
Fuels	62,144,026	14.0	23	0.42
TOTAL	443,263,278	100.0	13	2.40

*Based on 1960 data.

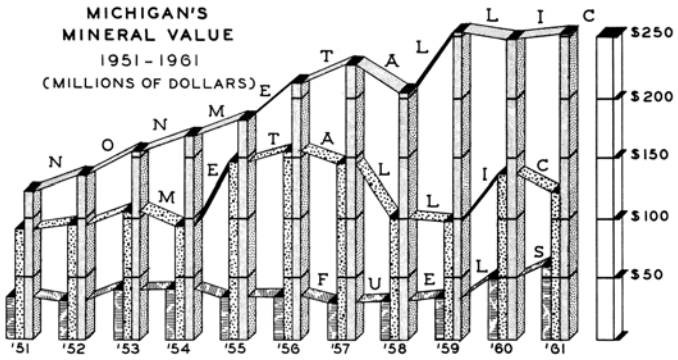


TABLE I
MINERAL PRODUCTION OF MICHIGAN, 1961 (1)

PRODUCT	UNIT	QUANTITY	VALUE	RANK IN U.S. (2)
Iron Ore	Long Tons	9,390,197	$ 83,375,984	2
Cement	Barrels	23,462,554	79,638,973	4
Petroleum	Barrels	18,900,947	55,247,081	17
Sand and Gravel	Short Tons	54,603,338	47,790,111	2
Natural Salines (3)			44,343,198	1
Copper	Pounds	142,268,588	42,579,566	6
Salt	Short Tons	3,885,130	31,283,571	3
Stone (4)	Short Tons	18,815,855	21,991,980	6
Lime	Short Tons	1,169,036	15,526,791	3
Clay Products			6,927,050	
Natural Gas	M. Cu. Ft.	25,044,786	5,209,662	17
Gypsum	Short Tons	1,294,619	5,095,210	2
Peat	Short Tons	209,266	2,002,310	1
Clay and Shale (5)	Short Tons	2,005,361		9
Natural Gas Liquids	Gallons	29,601,462	1,687,283	17
Marl	Short Tons	157,351	99,578	3
Miscellaneous (6)			464,930	
TOTAL			$443,263,278	

(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 - 1960 data.

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

(4) Does not include 9,762,230 short tons of limestone valued at $8,032,098 used in the manufacture of cement and lime.

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

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

TABLE II
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.

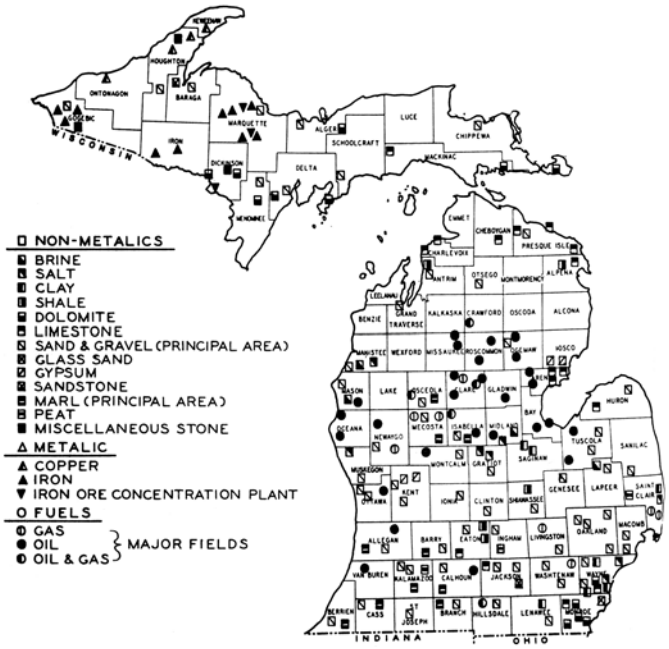
(3) Includes bromine, magnesium compounds, calcium-magnesium chloride, and potash.

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

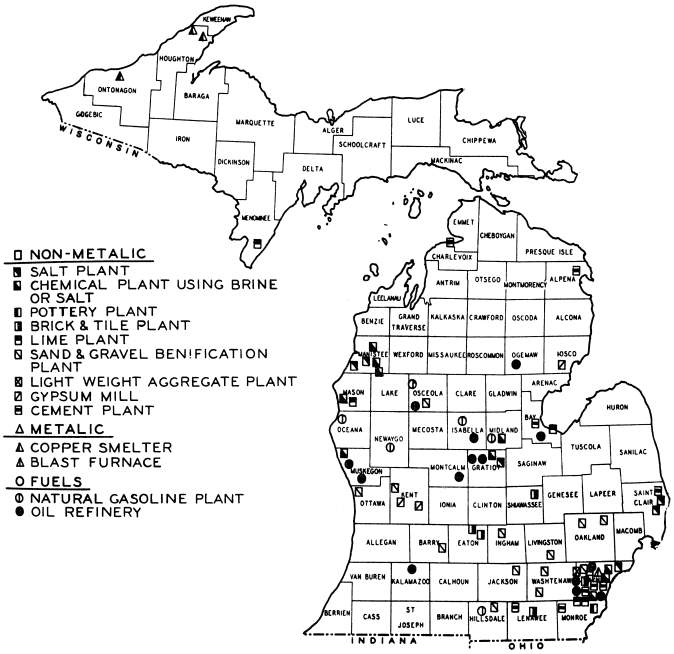
(5) Used in the manufacture of cement and clay products.

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

MINERAL PRODUCTION MAP, 1961



MINERAL PROCESSING MAP, 1961



METALLIC MINERALS*

IRON ORE

Iron ore shipments totaled 9,390,197 long tons, compared to 10,955,866 in 1960. Value of shipments decreased 14 million dollars.

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 about 21 per cent of iron-ore shipments were in the form of concentrates from jaspilite, compared to 11.6 per cent in 1960. The lake shipping season for iron ore opened at Escanaba and Marquette on April 24 and closed at Marquette on December 4th.

IRON ORE SHIPMENTS BY RANGES, 1961

Range	Number of Mines		Iron Ore Shipments (Long Tons)		
	Underground	Open Pit	Direct Shipments	Siliceous	Total
Marquette	9	3	4,060,491	81,949	4,142,440
Menominee	6	1	3,885,902	-	3,885,902
Gogebic	5	-	1,361,855	-	1,361,855
TOTAL	20	4	9,308,248	81,949	9,390,197

The Humboldt Mining 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 was being 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

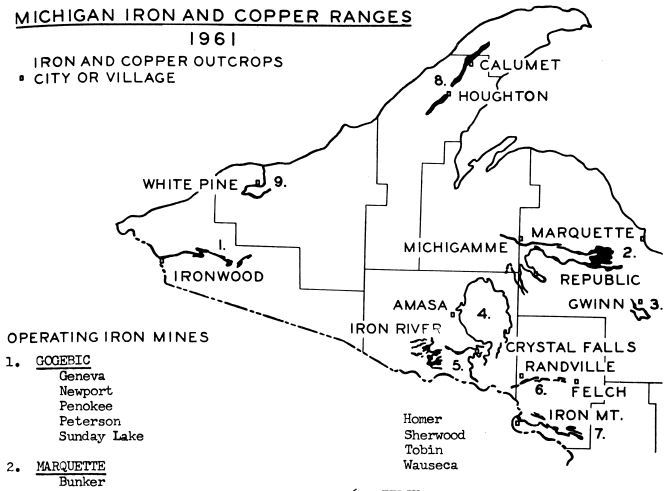
of high grade iron-ore concentrate as feed to the pelletizing plant.

Cleveland-Cliffs planned 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 1 million tons per year. The property will be known as the Empire Iron Mining Company and will be an open pit. The three plants will have a combined capacity of about 3.5 million tons per year.

Early in the year the Chicago and Northwestern Railway completed a $250,000 infra-red iron ore thawing plant near its ore dock at Escanaba. This plant 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.

*Metallic statistics compiled by Michigan Geological Survey.

[Map: Michigan Iron and Copper Ranges]



OPERATING IRON MINES

1. GOGEBIC
   - Geneva
   - Newport
   - Penokee
   - Peterson
   - Sunday Lake
2. MARQUETTE
   - Bunker
   - Champion
   - Cliffs Shaft
   - Greenwood
   - *Humboldt (open pit)
   - Maas
   - Mather "A"
   - Mather "B"
   - Morris
   - *Republic (open pit)
   - °Tilden (open pit)
   - Tracy
3. GWINN
   - (not active)
4. AMASA OVAL
   - (not active)
5. IRON RIVER - CRYSTAL FALLS
   - Bristol
   - Buck
   - Cannon
   - Hiawatha
6. FELCH
   - *Groveland (open pit)
7. EAST MENOMINEE
   - (not active)

OPERATING COPPER MINES AND RECLAMATION PLANTS

8. NATIVE COPPER
   - Ahmeek
   - Allouez No. 3
   - Calumet and Hecla Reclamation
   - Centennial
   - Champion
   - Osceola
   - Peninsula
   - Quincy Mining Co. Reclamation
   - Seneca No. 2
9. COPPER SULFIDE
   - White Pine

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

IRON ORE SHIPMENTS BY RANGES

1957-1961 (Long Tons)

Year	Marquette	Menominee	Gogebic	Total	
				Quantity	Value
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
1961	4,142,440	3,885,902	1,361,855	9,390,197	83,375,984

COPPER

Production of copper was 23 percent larger than in 1960, although value increased only 15 percent. Average price used for calculating the value of copper was 29.9 cents per pound in 1961 and 32.1 cents in 1960. Copper producers operated throughout the year with the exception of Copper Range Company, which shut down the Champion mine at the end of January and reopened in May.

COPPER PRODUCTION BY COUNTIES, 1961

County	Mines	Recla-mations	Copper Production (Pounds)		
			Mines	Reclamation	Total
Houghton	4	3	12,804,849	7,370,561	20,175,410
Keweenaw	4	-	18,337,000	-	18,337,000
Ontonagon	1	-	103,756,178	-	103,756,178
TOTAL	9	3	134,898,027	7,370,561	142,268,588

Copper Range Company continued to sink a development shaft on the southwest ore body situated on the western downthrown side of the White Pine fault which cuts 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 a vertical shaft. The ore at White Pine is essentially sulphide of copper occurring in the Nonesuch shale.

COPPER PRODUCTION, 1957-1961

Year	Native Copper Mines	Sands Reclamation	Sulphide Ore	Total	
				Quantity	Value
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
1961	31,141,849	7,370,561	103,756,178	142,268,588	42,579,566

FUELS*

PETROLEUM

The value of mineral fuels produced was 14 percent of the state's total, compared to 12 percent in 1960. Petroleum production was 19 percent greater than 1960. The southern Michigan oil fields continued to supply the major, part of the state's production of petroleum. During the year 18,900,948 barrels valued at $55,247,081 were produced. At the end of 1961, 4,619 producing wells were in 45 counties. Approximately 59 percent of the total output was from Hillsdale, Calhoun, and Jackson counties.

During the year 740 wells were completed (197 oil producers, 57 gas producers, 486 dry holes). Of these completions 317 were wildcats (15 oil producers, 11 gas producers, and 291 dry holes). The remaining 423 completions were field wells (182 oil producers, 46 gas producers, and 195 dry holes). Fourteen refineries, in nine counties, processed crude oil in Michigan during

1961. The combined nominal daily capacity of all Michigan refineries is approximately 191,815 barrels.

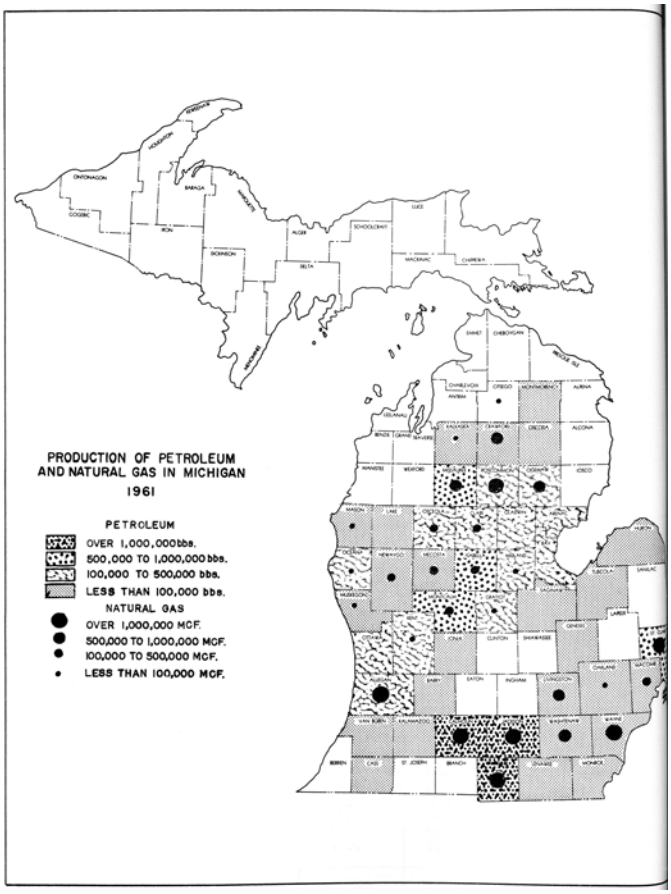
Detailed information for oil and gas operations is recorded in "196l Summary of Operations, Oil and Gas Field," available from Michigan Geological Survey.

Fuel statistics compiled by Michigan Geological Survey

PETROLEUM PRODUCTION AND ACCUMULATED OIL BY FORMATION, 1961

Formation	Production		Accumulated	
	Bbls.	Percent	Bbls.	Percent
Marshall	1,268	.01	66,523	.01
Berea	16,945	.09	2,172,814	.47
Traverse	1,380,081	7.30	89,100,216	19.35
Dundee	3,539,682	18.73	309,809,813	67.26
Det. River	1,748,644	9.25	34,394,701	7.47
Sal.-Niag.	916,157	4.85	1,907,139	0.41
Trenton	11,298,171	59.77	23,134,622	5.03
TOTAL	18,900,948	100.00	460,585,828	100.00

[Map: Production of Petroleum and Natural Gas]



PETROLEUM AND NATURAL GAS PRODUCTION, 1957-1961

Year	Petroleum		Natural Gas	
	Barrels	Value	M. Cu. Ft.	Value
1957*	10,168,602	31,090,708	6,639,813	1,221,163
1958*	9,308,018	27,213,388	10,964,377	2,071,720
1959	10,438,608	30,518,107	15,626,227	3,045,976
1960	15,899,206	46,105,421	19,240,168	3,839,709
1961	18,900,947	55,247,081	25,044,786	5,209,662

*Values revised to conform to Michigan Department of Revenue.

NATURAL GAS

Seventy-nine percent of the natural gas produced in 1961 was from the Salina-Niagaran and Trenton-Black River formations. Natural gas production increased 30 percent to a total of 25,044,786 M. cu. ft., the largest production in history. Of this amount over 14 billion cubic feet was oil well gas. Allegan County with 25 percent of the state's total was the leading producer followed by Hillsdale, Calhoun, Jackson, and St. Clair counties, all of which produced over 2,000,000 M. cu. ft.

GAS PRODUCTION AND ACCUMULATED GAS PRODUCTION BY FORMATIONS - 1961

Formations	Production		Accumulated	
	M. Cu. Ft.	Percent	M. Cu. Ft.	Percent
Drift			8,020	.002
Stray-Marshall	616,710	2.46	210,827,850	54.79
Berea	7,357	.03	9,799,811	2.55
Antrim	25,573	.10	227,638	.06
Traverse	208,967	.83	7,757,370	2.02
Dundee-Reed City	348,084	1.39	48,643,451	12.64
Detroit River	4,054,480	16.19	28,364,601	7.37
Salina-Niagaran	9,955,240	39.75	58,883,169	15.30
Trenton-Black River	9,828,375	39.25	20,260,782	5.27
TOTAL	25,044,786	100.00	384,772,692	100.00

NATURAL GAS LIQUIDS - 1961

Michigan in 1961 produced from oil well gas a total of 29,601,462 gallons of natural gas liquids valued at $1,687,283. Hillsdale County, with 89 percent of the state total, ranked first among the eight producing counties.

Year	Quantity (Gallons)	Value
1957	3,495,703	349,570
1958	3,511,671	351,167
1959	2,761,551	154,648
1960	12,217,120	684,159
1961	29,601,462	1,687,283

NONMETALLICS

CEMENT

Cement ranked second in value following iron ore in 1961. Cement was produced by nine plants in the state during the year and increased to 23,462,554 barrels valued at $79,638,973. Alpena continued to be the leading producer; Wayne County ranked second. Cement was produced also in Bay, Emmet, Lenawee, Monroe, and St. Clair counties.

RAW MATERIAL USED IN THE MANUFACTURE OF PORTLAND CEMENT

1961

Raw Material	Short Tons
Limestone	5,251,697
Clay and Shale	1,631,435
Gypsum	163,411
Other	26,864

February marked the completion of a half-million dollar expansion program by Peerless Cement Company in Grand Rapids and Schoolcraft. Peerless 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 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.

CEMENT SHIPMENTS, 1957-1961

Year	Number of Plants	Shipments (Bbls.)	Value	Rank
1957	8	22,045,034	71,605,137	4
1958	8	20,911,990	70,542,501	4
1959	8	23,025,928	77,323,974	4
1960	9	22,361,498	77,694,087	4
1961	9	23,462,554	79,638,973	4

SAND AND GRAVEL

Increased demand for materials for base course construction in the state highway program resulted in a larger sand and gravel output. Production and value of sand and gravel increased in 1961 to 54,603,338 short tons valued at $47,790,111.

USES OF SAND AND GRAVEL, 1961

Uses	Quantity (Short Tons)	Value	Percent of Total
Paving and road sand	6,800,955	5,576,140	12.4
Structural sand	4,427,062	3,428,149	8.1
Molding sand	1,693,079	2,497,998	3.1
Fill sand	3,388,721	1,263,288	6.3
Other sand*	958,181	2,121,597	1.8
Paving and road gravel	32,015,474	27,129,470	58.4
Structural gravel	4,380,969	5,200,477	8.1
Fill gravel	470,044	288,257	0.9
Other gravel**	468,853	284,735	0.9
TOTAL	54,603,338	47,790,111	100.0

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

**Includes - Railroad ballast, and miscellaneous gravel.

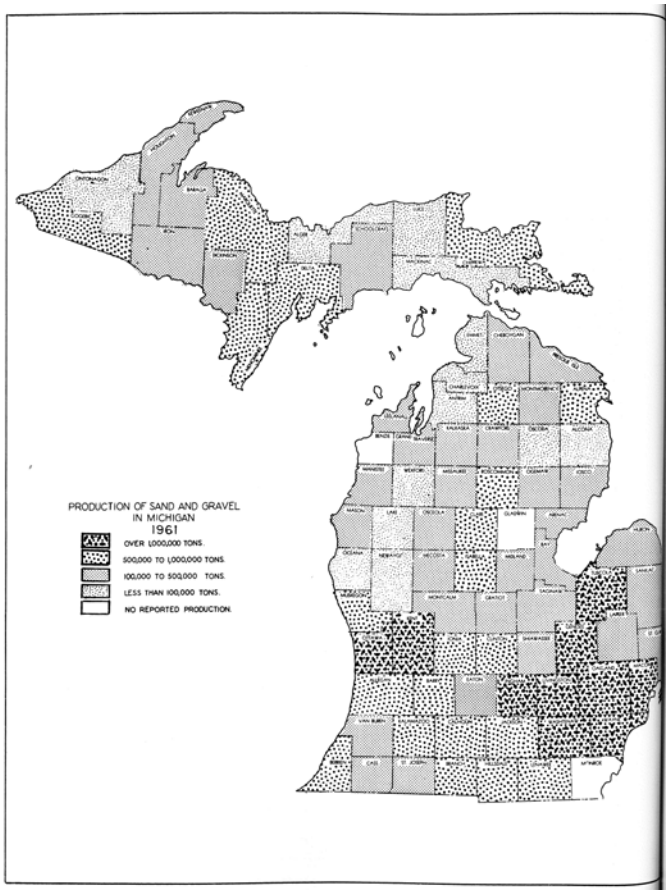
Production of sand and gravel was reported from 80 of Michigan's 83 counties. Approximately forty-six percent of the total production was from 10 counties, in order of rank - Oakland, Washtenaw, Livingston, Kent, Wayne, Tuscola, Ottawa, Macomb, Genesee, and Ingham. Twelve percent of, the state total was produced in Oakland County. Each of the other counties produced more than 1,000,000 tons. About 73 percent of the state's total was reported by commercial producers and the remaining 27 percent was noncommercial production by county road commissions and other governmental agencies. Seventy-one percent of the total sand and gravel output was used in road construction and 16 percent for structural purposes.

SAND AND GRAVEL PRODUCTION, 1957-1961

Year	Building Use	Paving and Road Use	Molding Sand	Others*	Total Quantity	Total Value
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
1961	8,808,031	38,816,429	1,693,079	5,285,799	54,603,338	47,790,111

*Includes - Grinding and polishing sand, glass sand, railroad ballast, engine sand, blast sand, and fill sand and gravel.

[Map: Production of Sand and Gravel]



NATURAL SALINES

Chemicals derived from brines (bromine, calcium-chloride, magnesium compounds, potash, and iodine) were produced at about the same rate as in 1960. The value of the natural salines recovered by the chemical plants from natural brines in 1961 was $44,343,198. The highest value was recorded for bromine, followed by magnesium compounds, calcium magnesium chloride potash and iodine.

VALUE OF NATURAL SALINES, 1957-1961

Year	Value
1957	$37,664,914
1958	42,360,677
1959	49,286,176
1960	44,034,486
1961	44,343,198

SALT

Salt was mined at Detroit, produced from natural brines at St. Louis, Gratiot County, and produced from artificial brines in Manistee, Midland, Muskegon, St. Clair, and Wayne counties.

Daring 1961, 3,885,130 short tons of salt valued at $31,283,571 were produced. This was a decrease of 5 percent in production and 7 percent in value below 1960. Wayne ranked first of the six counties producing salt-followed by Midland, St. Clair, Manistee, Muskegon, and Gratiot.

Approximately 56 percent of the salt was used by chemical plants in Wayne, Midland, and Muskegon counties. Over 2.1 million tons of salt were used in the manufacture of soda ash, chlorine, and other chemicals. Approximately 23 percent of the total production was dried and evaporated 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.

SALT PRODUCTION, 1957-1961

Year	Quantity Short Tons	Value	Percent U.S. Total	Rank in U. S.
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	16.0	3
1961	3,885,130	31,283,571	-	-

STONE

Stone production declined to 18,741,370 tons valued at $21,749,506 because of smaller shipments of fluxstone. and stone for lime manufacture. Approximately 90 percent of the limestone and dolomite produced in Michigan in 1961 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 flaggins stone was quarried in Baraga, Jackson and Hillsdale counties. Basalt was crushed and used for road construction in Baraga and Houghton counties.

STONE PRODUCTION, 1961*

Commodity	Quantity (Short Tons)	Value
Limestone and dolomite		
Crushed	18,741,370	21,799,506
Dimensional	27,516	119,950
Sandstone-Dimensional	19,136	77,577
Basalt-Crushed	27,833	44,947
TOTAL	18,815,855	21,991,980

*Does not include 9,762,230 short tons of limestone valued at $8,032,098 used in the manufacture of cement and lime.

USES OF CRUSHED LIMESTONE AND DOLOMITE, 1961

Uses	Percent of total	Quantity (Short Tons)	Value
Flux	56.3	10,565,419	11,855,938
Concrete & road stone	24.8	4,649,369	5,324,073
Chemical*	15.2	2,839,444	3,387,724
Agricultural	2.8	520,680	872,080
Other**	0.9	166,458	309,691
TOTAL	100.0	18,741,370	21,749,506

*Includes: Alkali, calcium-carbide, sugar and paper.

**Includes: Filler, asphalt, dust for coal mines, mineral food, railroad ballast, stone sand and others.

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 was to be gradually increased to eventually supplant the old quarry completely.

Presque Isle Corporation continued development work aimed at opening a new pit to the west of their present quarry.

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

USES OF CRUSHED LIMESTONE AND DOLOMITE

1957-1961 (Short Tons)

Year	Flux	Concrete + Road metal	Chemical*	Agriculture	Others**	Total Quantity	Total Value
1957	14,624,595	4,954,171	3,574,323	586,558	921,765	24,661,412	26,974,290
1958	8,821,169	6,063,671	2,985,530	486,653	165,049	18,522,072	19,754,092
1959	10,805,705	5,311,121	3,729,465	434,116	131,526	20,411,933	22,432,225
1960	12,292,426	5,306,573	2,971,051	572,921	182,041	21,325,012	24,104,405
1961	10,565,419	4,649,369	2,839,444	520,680	166,458	18,741,370	21,749,506

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

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

LIME

Production of lime decreased 1 percent to 1,169,036 tons valued at $15,526,791 during 1961. All lime was sold or used for chemical and industrial purposes with the manufacture of alkalies the principal use. Wayne County ranked first in production.

PRODUCTION OF LIME 1959-1961

Year	Production	Value	Rank
1959	861,808	11,747,657	4
1960	1,177,431	15,730,384	4
1961	1,169,036	15,526,791	3

CLAY AND SHALE

Clay and shale were used for the manufacture of cement, brick, tile, pottery, and lightweight aggregate. During 1961 2,007,011 short tons of clay and shale, valued at $2,256,061 were produced. Alpena County led in production and value with 26 percent of the state's total output, followed by Wayne, Saginaw, and Monroe counties. Approximately 78 percent of all raw clay and shale produced was used by the cement industry.

A producer of natural aggregate did some exploring and testing of glacial clays as the basic raw material for light-weight aggregate production. Though the resultant product looked 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 was tentatively set aside.

PRODUCTION OF CLAY AND SHALE AND CLAY PRODUCTS, 1957-1961

Year	Raw Clay and Shale Quantity (Short Tons)	Value	Value Clay Products
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
1961	2,007,011	2,256,061	6,927,050

GYPSUM

Production of gypsum decreased to 1,294,619 short tons valued at $5,095,210. Gypsum was quarried in Arenac and Iosco counties and mined in Kent County. The raw material was processed in gyps-urn mills at National City; Grand Rapids, River Rouge; East Chicago, Indiana; Waukegan, Illinois; and Loraine, Ohio. Raw gypsum was also used as a retarder in cement manufacture.

Sargent Sand Comparer opened a gypsum quarry just east of Turner, Arenac County. Production during the year largely went to cement plants for use in the manufacture of cement.

GYPSUM PRODUCTION, 1957-1961

Year	Quantity (Short Tons)	Value	Percent of U.S.	Rank in U.S.
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	15	2
1961	1,294,619	5,095,210	-	-

PEAT

Production of peat decreased in 1961 to 209,266 tons valued at $2,002,310. Michigan, with 29 producing companies, was the chief producing state, having 40 percent of the total production and nearly one-quarter of the active plants.

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, 1957-1961

Year	Quantity (Short Tons)	Value	Percent of U.S.	Rank in U.S.
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
1961	209,266	2,002,310	40.0	1

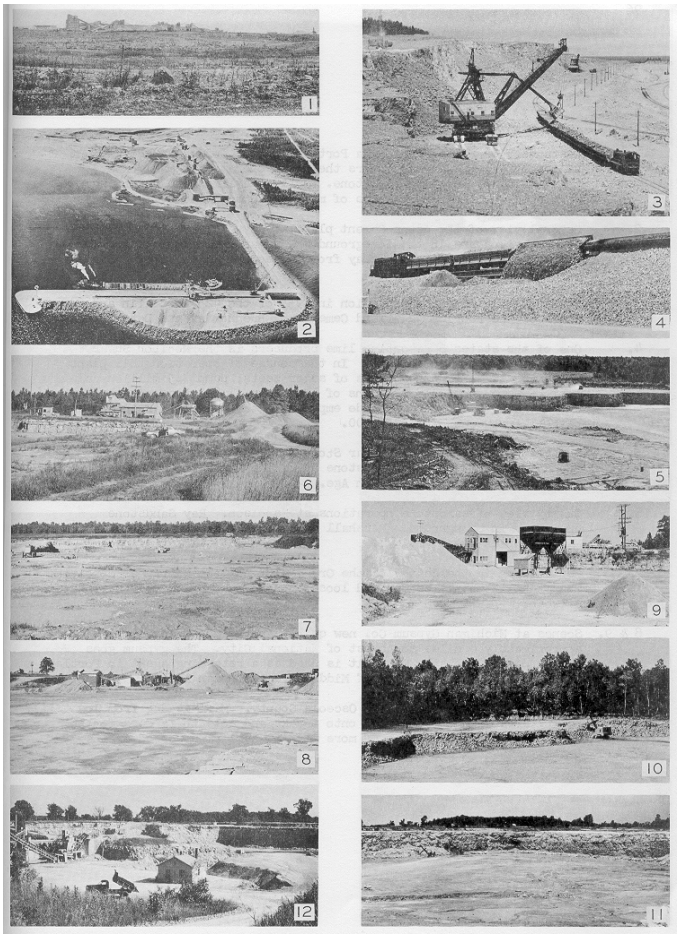
MARL

Marl production decreased to 157,351 tons valued at $99,578 in 1961. Commercial marl production was reported in 16 counties during 1961. Calhoun County ranked first, followed by Kalamazoo, Cass, Allegan, and Barry. These counties produced approximately 80 percent of the state output. All marl produced in the state is used for agricultural purposes. This material when added to the soil plays the same important role as does commercial lime and may be employed in much the same manner.

MARL PRODUCTION, 1957-1961

Year	Quantity (Short Tons)	Value	Rank in U.S.
1957	137,020	70,635	1
1958	230,105	130,231	4
1959	201,387	118,240	4
1960	159,345	91,173	4
1961	157,351	99,578	4

[Picture Presentation of Mineral Producers]



1. Second largest limestone producer on the Great Lakes. The Presque Isle Corp., on Lake Huron, 20 miles north of Alpena. This plant went into operation in 1955 and produces fluxstone for lower Great Lakes steel plants.

2. Air view of Presque Isle operations shown in picture number 1. Picture shows boat loading dock in foregrounds screening and storage facilities in background.

3. Loading stone into railroad gondolas in the world's largest limestone quarry. The Rogers City quarry of the Michigan Limestone Division, U. S. Steel Corporation. The stone is high-calcium lime stone of the Rogers City-Dundee formations of Middle Devonian Age.

4. Unloading crushed Engadine dolomite at Port Dolomite. The Cedarville plant of the Michigan Limestone Divisions U. S. Steel Corporation. The stone will be processed to size before shipment to steel centers of the lower Great Lakes.

5. New quarry of the Drummond Dolomite, Inc. in the Engadine formation on Drummond Island. The stone is marketed both for flux in the making of steel and aggregate for roads and building construction.

6 & 7. Iosco County Road Commission roadstone operation near AuGres. The stone is that of the Bayport Limestone formation of Middle Mississippian Age. Quarry opened in 1953.

8. Arenac County Road Commission roadstone operation near AuGres. The stone is Bayport limestone, stratigraphically equivalent to that quarried by Iosco and Bay County Road Commissions shown in pictures numbered 7 and 10. Quarry opened in 1952.

9 & 10. Bay County Road Commission roadstone operation near Omer. The stone is stratigraphically equivalent to that shown in pictures numbered 7 & 8. County has operated at this site since about 1938.

11. View of the stone quarry operated for the production of aggregate by the Michigan Stone Co. near Ottawa Lake. The dolomitic limestone is that of the Upper Bass Islands Group of Late Silurian Age.

12. Monroe County Road Commission roadstone operation, 6 miles west of Dundee. The dolomite stone is that of the Amherstburg formation of the Detroit River Group of Middle Devonian Age.

1. Distance view of the Peninsula Portland Cement Co. wet-process plant at Cement City. For many years the plant operated on marl or a combination of marl and limestone. In 1951 a limestone quarry was developed in Ohio, and the use of marl was discontinued for this stone.

2. General view of the Aetna Cement plant at Bay City. Four new cement storage silos are in the foreground. Raw material use includes limestone from Rogers City and clay from the company's deposit in Saginaw County.

3. Scene shortly after construction in 1955 of the 425-foot kiln and stack of the Peerless Portland Cement co. Brennon Avenue Detroit plant.

4. One of the states 6 reporting lime producers is the Monitor Sugar Division located at Bay City. In the course of operation this plant will process some 350,000 tons of sugar beets; pump 725 million gallons of water; burn 18,000 tons of limestone; 1,800 tons of coke; 40,000 tons of coal and provide employment that results in an annual payroll in excess of $1,250,000.

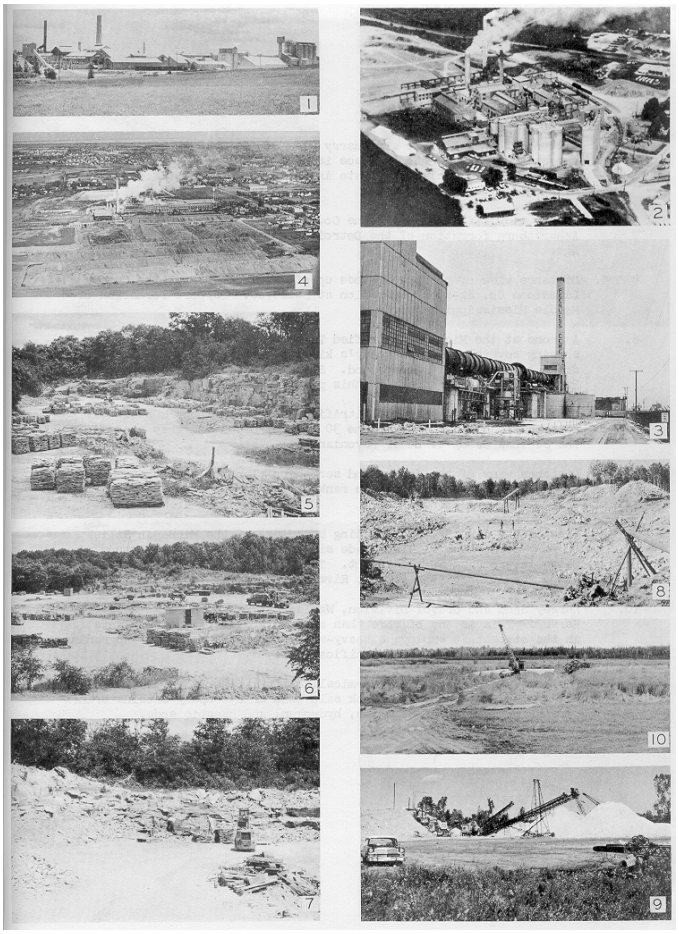
5. Scene at the quarry of the Star Stone Co. one of three sandstone operations at Napoleon. The stone is of the Marshall sandstone formation of Middle Mississippian Age.

6. Quarry view of sandstone operations at Napoleon. Ray Sandstone operation in background. Marshall sandstone formation of Middle Mississippian Age.

7. Men at work in the quarry of the Original Sandstone Quarry at Napoleon. The stone is thinly bedded and loose enough to be pried apart with a crowbar.

8 & 9. Scenes at Michigan Gypsum Co. new quarry and railroad loading area, approximately 4 miles southwest of National City. The gypsum goes to the cement industry where it is used as a retarding agent in Portland cement. Michigan formation of Middle Mississippian Age.

10. C. Stanley Hooker marl pit in Osceola County. Marl is dug from low swampy area like this, loaded onto trucks and sold to farmers for soil conditioning. This is one of more than 50 marl pits worked in the state.



1 & 2. Distance scene of plant and quarry view of the Wallace Stone Co.'s operation near Bayport« Wallace is said to be the oldest continuous producer of commercial aggregate in the state. Bayport formation of Middle Mississippian Age.

3. Quarry view of the Maybee Stone Co. aggregate operation near Maybee. Amherstburg formation of the Detroit River Group of Middle Devonian Age.

4 & 5. Distance view of plant and close up of stone crusher at the Cheney Limestone Co. ag-stone operation at Bellevue, Bayport formation of Middle Mississippian Age.

6. A scene at the Michigan Vitrified Tile Co.'s tile plant at Corunna showing several of the company's kilns in background and stacks of drain tiles in right foreground. Shale of the Saginaw Group of Early Pennsylvanian Age is used at this plant.

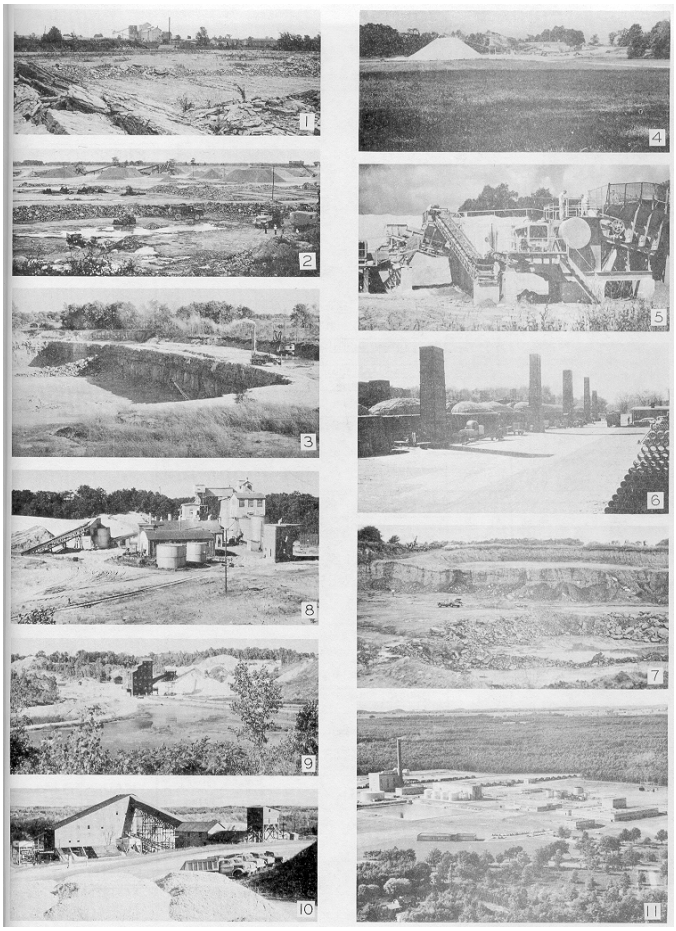
7. Quarry view of the American Vitrified Products Company's shale pit at Grand Ledge. Pit shows some 30 feet of black and gray shales of the Saginaw Group of Lower Devonian Age.

8. Distance view of the drying and screening plant of the Nugent Sand Company at Muskegon. Michigan ranks first in the production of sand for molding and foundry use.

9. View of the crusher and screening buildings of the Michigan Silica Company at Rockwood. High-grade silica sand for the manufacture of glass is produced at this plant. The sand is of the Sylvania Sandstone formation of the Detroit River Group of Middle Devonian Age.

10. Hersey Sand and Gravel Division, Wallace Stone Co.'s plant near Hersey. This is one of more than a dozen gravel producing plants in the state that employs a heavy-media separation unit for upgrading aggregate to meet highway specifications.

11. Plant of the Hooker Electrochemical Company at Montique. With salt wells 3,000 feet deep into rock salt beds this company obtains brines for the production of chlorine, hydrogen, and caustic soda.



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