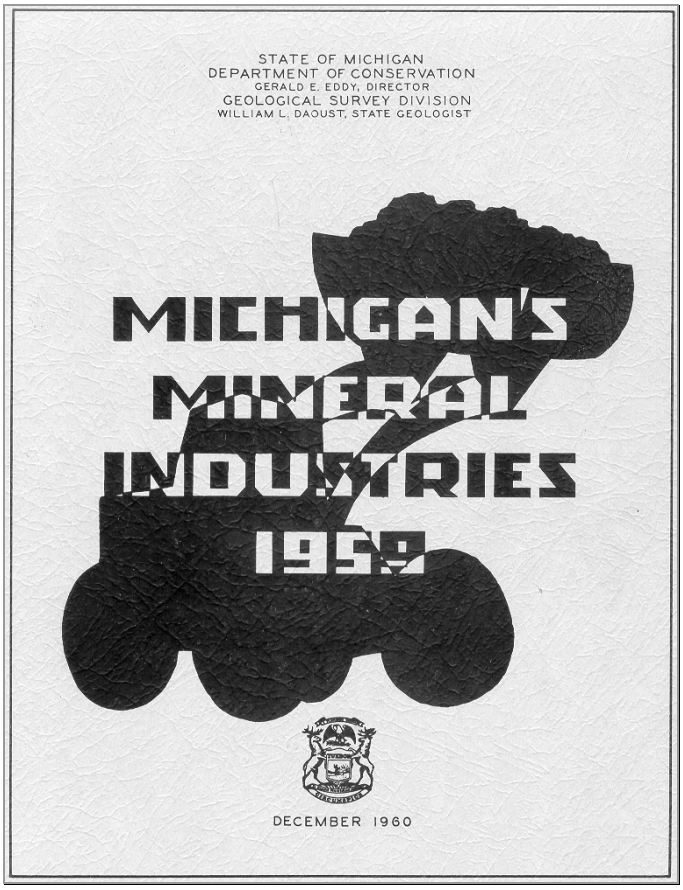

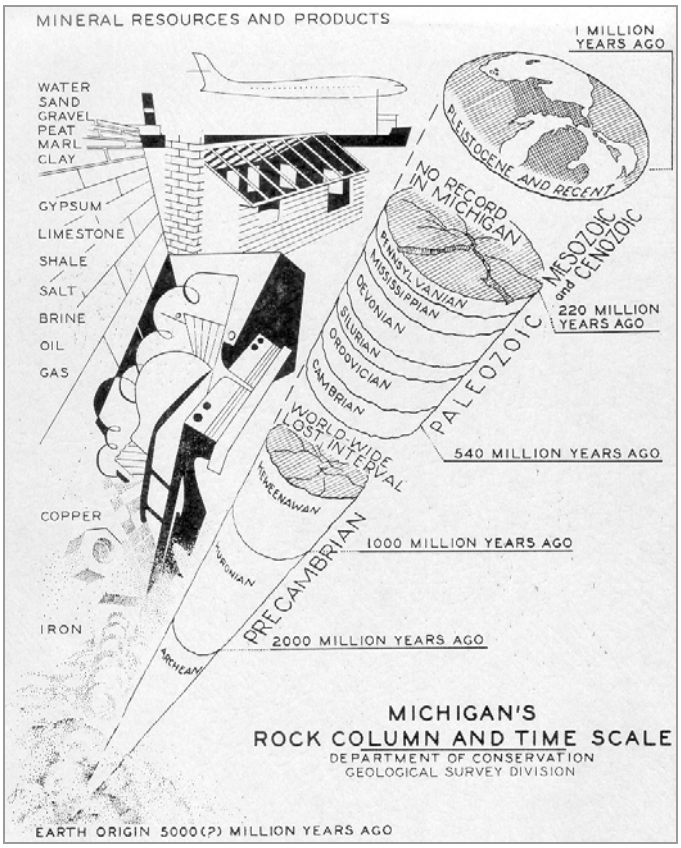

MICHIGAN MINERAL INDUSTRIES 1959

by

Harry O. Sorensen
Emery T. Carlson

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FOREWORD

This report is a record of the Michigan Mineral Industry for the calendar year 1959. Metallic and fuel statistics were compiled by the Michigan Geological Survey. Nonmetallic statistics were compiled in cooperation with the United States Bureau of Mines. The preliminary value of mineral production for 1960 was prepared by the Bureau of Mines.

THE MINERAL INDUSTRY OF MICHIGAN IN 1960* (Preliminary)

Mineral production in Michigan in 1960 was valued at $427 million, according to the Bureau of Mines, United States Department of the Interior. The 12 percent gain over 1959 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 stones 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, sand and gravel, copper, salt, and stone.

*Prepared December 15, 1960 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.

METALS

Metallic minerals accounted for nearly 31 percent of the total value of the State mineral production compared to 27 percent in 1959.

Copper. - Production of copper in terms of recoverable metal was about the same as in 1959, although value increased 5.6 percent. The preliminary average weighted price in 1960 was 32.0¢ per pound compared to 30.7¢ in the previous year. 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. Operating companies included Calumet & Hecla, Inc., Copper Range Company, White Pine Copper Company (a wholly owned subsidiary of Copper Range Company), and Quincy Mining Company.

Iron Ore. - Iron-ore shipments were estimated at 10,750,000 long tons compared to 7,247,449 in 1959. Value of shipments Increased over $31 million. 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 about 10 percent of the State total iron-ore shipments. In September the Humboldt Mining Company (jointly owned by Cleveland-Cliffs Iron Company and Ford Motor Company) opened a plant to produce iron-ore pellets from jaspilite. The plant has an annual capacity of 650,000 tons of pellets and is the second facility in the State that produces pellets from low-grade material.

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.

NONMETALS

Nonmetallic mineral production (except mineral fuels) was fractionally less than in 1959 and was valued at nearly a quarter of a billion dollars. Materials used by the construction industry (cement, clay, gypsum, sand and gravel, stone) accounted for nearly three-fifths of the total value of nonmetallic minerals. Chemicals derived from well brines (bromine, calcium-chloride, magnesium compounds, potassium, salt and lime) comprised the remainder and were used chiefly by the chemical industry.

Mineral Production in Michigan, 1960 (1)
(Estimated)

Mineral	Thousand Short Tons (unless otherwise stated)	Value (thousands)
Cement:		
Portland - thousand 376-pound barrels	19,300	$ 66,600
Masonry - thousand 376-pound barrels	1,200	4,700
Clays	1,800	1,950
Copper (recoverable content of ores, etc.) in short tons	56,000	35,840
Gypsum (crude)	1,517	4,790
Iron ore (usable) thousand long tons	10,750	94,000
Lime	1,170	16,000
Manganiferous ore (5 to 35 percent Mn)	147	(2)
Natural gas - million cubic feet	19,500	4,490
Peat	200	2,450
Petroleum (crude) - thousand 42-gallon barrels	15,386	44,312
Salt (common)	4,150	34,800
Sand and gravel (3)	47,000	40,500
Stone	31,000	32,000
Value of items that cannot be disclosed: Bromine, calcium-chloride and calcium-magnesium chloride, gem stones, magnesium compounds, natural-gas liquids, potassium salts and values indicated by footnote (2)	-	52,171
Total Michigan (4)	-	$427,000

(1) Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
(2) Figure withheld to avoid disclosing individual company confidential data.
(3) Includes friable sandstone.
(4) Total adjusted to eliminate duplicating the value of clays and stone.
(5) Revised figure.

MINERAL FUELS

Mineral fuels accounted for nearly 12 percent of the value of the state mineral production compared to 9 percent in 1958 and 1959. Much of the increase was due to greatly expanded petroleum production which was nearly 50 percept larger than in 1959. Continued development of the Albion-Pulaski-Scipio trend in Calhoun, Hillsdale and Jackson counties resulted in petroleum production of about 8 million barrels from fields in this area compared to 2 million barrels in 1959. Total State production in 1960 was estimated at 15,386,000 barrels compared to 10,439,000 in the

previous year. The output of natural gas liquids and natural gas were respectively 7 percent and 3 percent larger than in 1959. Peat, although classified as a mineral fuel, was used mainly for soil conditioning. Production was 4 percent higher than in 1959.

1960 NEWS ITEMS

ORGANIZATIONAL DEVELOPMENTS:

IRON ORE

The trend to pelletizing taconite, jaspilite and low-grade iron ores for use by the steel Industry was traced by the Wall Street Journal. It predicted that capacity for pellet making will top 14 million tons for 1960, and reach 30 million tons by 1964. Because pelletizing boosts iron yield of low-grade ore above that of good domestic ore. It steps up blast furnace efficiency in steel mills almost 20 percent. Therefore, repercussions are being felt in the mining industry, particularly in the Mesabi range and neighboring ranges in Northern Wisconsin and Michigan. They formerly furnished all but about 20 percent of the country's requirement. Now, up-graded pelletized ore and increased imports of foreign ore (the latter representing 33.7 percent of ore consumption during the first half of the year) are taking business away from the older mines.

Pickands Mather and Company, on the Gogebic Iron Range, has two crushing and screening plants under construction. The project is part of a program aimed at up-grading ore from the Gogebic Range to make it more competitive. The plants are being built at the Newport and Geneva mines near Ironwood.

The Bristol mine, near Crystal Falls, shut down for two weeks during January 1960 for installation of a new hoist to accomodate the recent 250 foot deepening of the shaft to the 1900 foot level. Formerly operated by Oglebay, Norton Company and closed in 1932 because of the depression the mine was taken over by Inland Steel in 1948 and dewatered. The first ore was hoisted a year later. A red hematite ore, not previously worked, is now being produced.

Humboldt Mining Company, owned jointly by the Cleveland Cliffs Iron Company and the Ford Motor Company doubled its concentrate plant capacity to 640.9000 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 a 850 foot heavy duty conveyor system using 1852 feet of belting, the initial beneficiation plant started operation in 1954 producing 320,000 annual tons of flotation concentrate. Concentrate is shipped to Lower Lake steel mills and sintered.

Early in the year the M. A. Hanna Company notified owners of about a dozen homes on mining property near Iron River that their homes would be moved by November 1. The houses were threatened by approaching surface cavings from underground operations of the Company's Hiawatha mine.

M. A. Hanna's new 2,745 foot Homer-Wauseca shaft near Mineral Hills is one of the few U.S. mines having the automatic Koepe hoist. The headframe, with green corrugated plastic windows, is 130 feet high. It has an elevator which carries passengers to the top floor, 110 feet, where the Koepe hoist motors are located. The two 14-ton capacity skips, moving at 1900 feet per minute, can lift 800 tons of ore per hour, far beyond the productive capacity of the mines. One skip will hoist ore from the Homer mine, the other, the Wauseca mine - a unique arrangement made necessary by different fee ownerships which require that the ore from the two mines be kept entirely separate from each other.

Copper Range Company will start a 52 million program to develop a newly found copper deposit on property west of their White Pine Mine in Ontonagon County. An exploration shaft is being sunk as a further check on drilling results. Additional mining and metallurgical testing will follow 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 will establish a mining unit on the site.

PORTLAND CEMENT

Peerless Cement Company has undertaken 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, scheduled for completion in February of 1961 will 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 Company were to have been completed by mid-year. This project will add 7000 bbls. of finish-grind capacity, an increase of more than 15 percent, bringing daily total to 53,000 bbls. The previously announced harbor development project is designed to increase the mill shipping capacity at Alpena.

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.

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.

STONE

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

Inland Lime and Stone Company have in operation a new sinter sand limestone plant at Port inland. Production of sinter sand limestone, of minus one-eighth inch size, will eventually comprise about 10 percent of total plant production. The fluxing limestone is used at the company's Indiana Harbor steel plants where the sinter sand is combined with fuel and finely ground ore and then charged in a sinter machine which produces clinkers which in turn, are charged into blast furnaces.

There is a likelihood that the sandstone industry may be revived in the Copper Country. Loads of white and red banded stone have been reported leaving the Arnheim area for points in lower Michigan and elsewhere. Six projects in Marquette County are scheduled to utilize the sandstone. In early 1880 sandstone quarrying in the Keweenaw Peninsula area was a booming industry and the original operator of the Arnheim quarry was Superior Natural Redstone Quarries.

SAND AND GRAVEL

Twenty companies located in Southern Michigan have organized the Michigan Sand and Gravel Producers Association with headquarters at 1305 Industrial Building, Grand and Washington Blvds., Detroit 26, Michigan. President Lyle J. Walker announced: "We plan to promote greater understanding and cooperation between sand and gravel users and the Industry." The new group will aid in establishing and maintaining standards for aggregate materials used in concrete and bituminous construction, and expects to promote legislation in the best Interest of the public.

The American Aggregates Corporation has added a heavy-media separation unit at the Oxford gravel plants bringing 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 were supplied by Western Machinery Company.

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

SALT

International Salt Company has developed 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 note. After heating, the actual separation takes place by application of a heat sensitive adhesive to a high speed conveyor belt.

GYPSUM

National Gypsum Company's newest and automated gypsum plant at Lorain, Ohio went Into production of wallboard, 16 inch lath, and plaster. The plant features a dust collection system that returns dust to the production process. The company's Tawas City quarry supplies the approximate 3000 tons of raw gypsum required each week.

OTHERS (Lime, periclase)

At the Dow Chemical Company plant in Ludington an Allis Chalmers Lepol-type grate kiln is being 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. ACL kilns have been used by cement producers for several years. The new kiln unit calcinates northern Michigan limestone to chemical grade lime, a basic raw material at the Ludington plant.

Kaiser Refractories and Chemicals completed a new $3 million periclase plant at Midland. Periclase, a crystalline, hard-burned magnesia, is one of the raw materials used in the manufacture of refractory brick mixes. Other products include magnesite and refractory-grade magnesia. The facilities include a 275-foot rotary kiln and associated filtering and handling equipment. The company obtains magnesium hydroxide slurry from Dow Chemical Company. Annual capacity is reported as 45,000 tons of periclase and refractory magnesia.

Wyandotte Chemical Corporation is proceeding with major improvements in its limestone calcining facilities at Wyandotte. Changes in the burning process are expected to improve the quality and increase the available capacity of 1.5 million tons of high-grade lime. The first unit is scheduled to be in operation early in 1961.

PETROLEUM

The year 1960 witnessed a strong upturn in Michigan petroleum activities as oil and gas production registered their best annual total since 1950 and 1948, respectively. Spearheaded by the Albion-Scipio field of Southern Michigan, which yielded nearly one-half of the state's total output, oil production jumped 50 percent above 1959 to an estimated 15,386,000 barrels. By the end of Decembers oil wells were producing at a yearly level of 18,000,000 barrels. Natural gas production rose to almost 19 billion cubic feet, some 20 percent over the year before.

RESEARCH, TECHNOLOGY:

Research in iron ore beneficiation, in blast furnace and direct reduction process and on mining methods will be conducted by the U.S. Bureau of Mines during the fiscal year commencing July 19, 1960. It is hoped that results will improve competitive positions of Lake Superior ores.

U.S. Bureau of Mines long-range fundamental aggregate research continues with a view toward solving problems in the field of explosives, a methods of fragmentation, and the characteristics and damaging effects of blasting vibration on structures, the physics of rock breakage using both standard, and special equipment, and mining and processing methods.

LEGISLATION:

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

PUBLICATIONS:

Publication of the first two volumes of the three-volume Mineral Yearbook for 1959 was announced December 31 by the Bureau of Mines, United States Department of the Interior. Both Volume 1, "Metals and Nonmetals (except fuels)" and Volume 2, "Fuels", can be purchased from the Government Printing Office, Washington, D. C. The third volume titled "Area Reports" will be issued shortly, the Bureau said.

A publication "Iron Ore Resources of the United States including Alaska and Puerto Rico, 1955" by Martha S. Carr and Carl E. Dutton, Geologic Survey Bulletin 1082-C, Geological Survey, U. S. Department of the Interior (1959), is available for 30 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. This pamphlet is a survey of iron ore resources of the United States with selected bibliography and tables of iron ore reserves and potential ore.

A valuable reference work on the gypsum and anhydrite industry in the United States and Puerto Rico has been published as Bulletin 1105 of the U. S. Geological Survey. The authors, Charles F. Withington and Marion C. Jaster, have researched and annotated more than 400 references.

Other valuable reference publications of the Bureau of Mines includes special publication titled "List of Publications issued by the Bureau of Mines from July 1, 1910 to January 1, 1960, with Subject and Author Index", by Hazel J. Straton and Bulletin 585, "Mineral Facts and Problems," 1960 edition by the Bureau of Mines staff. Both are available at a cost of $4.25 (paper bound) and $6.00 (cloth bound), respectively, by writing the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

MICHIGAN MINERAL PRODUCTION 1959 GENERAL REVIEW

The value of Michigan mineral production totaled $385,321,927 in 1959, an increase of 10 percent from the 1958 figure. Record highs were established in the value of shipments of cement, gypsum, lime, peat, sand and gravel, and natural salines. Cement ranked first in value followed by iron ore, natural salines, sand and gravel, salt, copper, petroleum and stone. Metallic mineral value decreased 5 percent and fuel value increased 14 percent while nonmetallic minerals increased 17 percent to a new high.

Commodities in the nonmetals group, mainly construction and chemical materials, represented about two-thirds of the state's output of minerals.

The annual value of iron ore and copper prior to 1900 represented approximately 90% of the total value of all mineral products. The years 1895 to 1900, however, were important years for Michigan's non-metallic industries, as the first successful portland cement plant was begun in 1896. Increasing quantities of marl, clay, limestone, and shale were required. The development of the salt industry at Detroit beginning with the year 1895 resulted in increased production of that product.

The non-metallics grew slowly but steadily in value from 1900 to 1914, but following that year growth was rapid due first to demands for war materials, and subsequently to the great era of industrial expansion which began in 1922, with constantly increasing demands for construction and road building materials. Important new uses and new products were developed which added greatly to the mounting value of non-metallic production. By 1929 this had reached a total of $71,000,000.

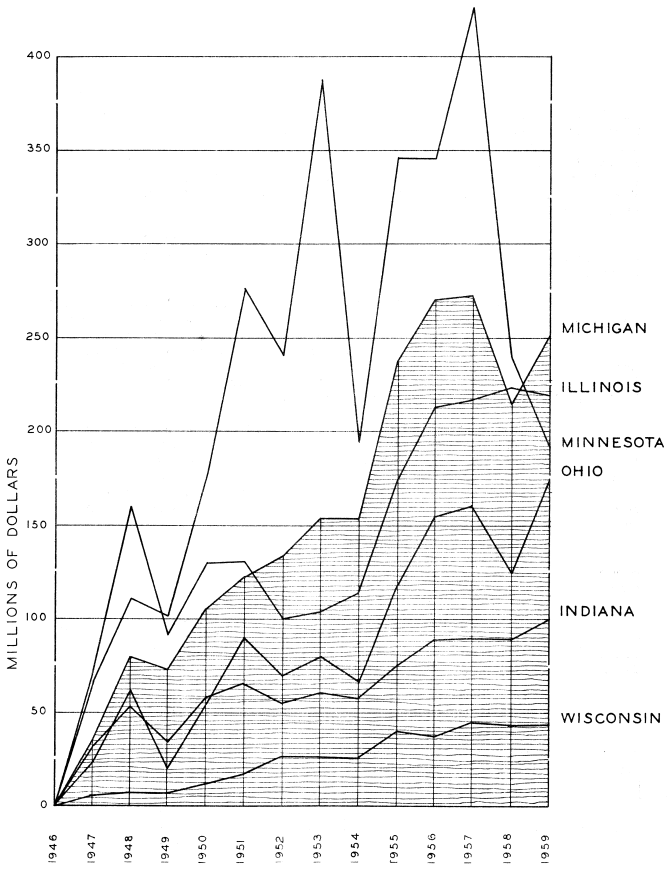
in 1921, 1924, and 1927 the values of non-metallic minerals and mineral products surpassed those of iron ore and copper, and beginning with 1930 the non-metallic definitely assumed the lead.

in volume of mineral production in 1959 in the United States, Michigan ranks: First in salt, peat, gypsum, and magnesium compounds; Second in iron ore, sand and gravel, and bromine; Fourth in cement and marl; Fifth in copper; Sixth in stone.

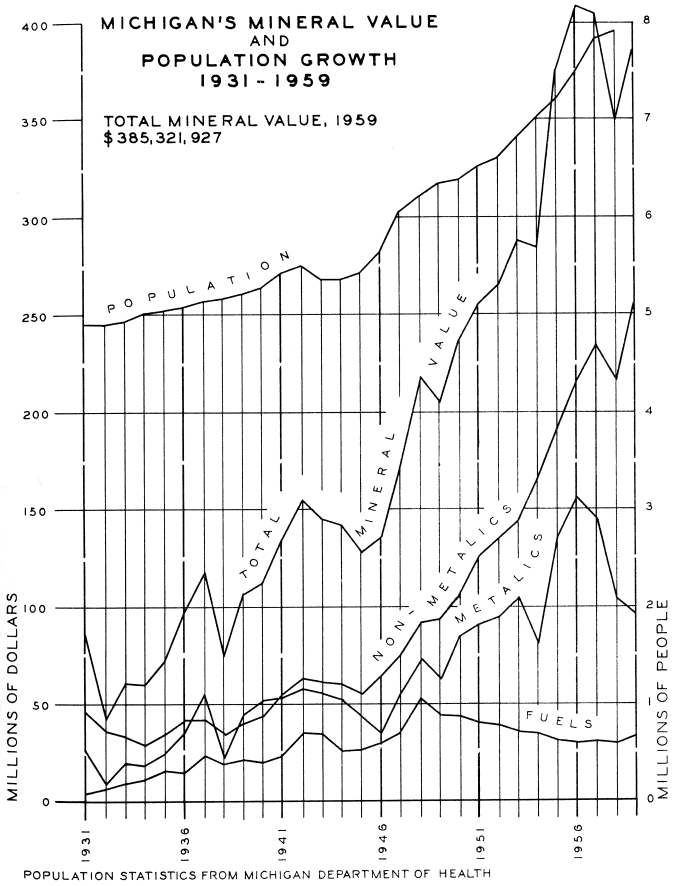
The following table gives the value of Michigan Mineral Production in 1959:

	Value	Per Cent
Nonmetallics	$254,240,437	66.0
Metallics	97,362,759	25.3
Fuels	33,718,731	8.7
	$385,321,927	100.0

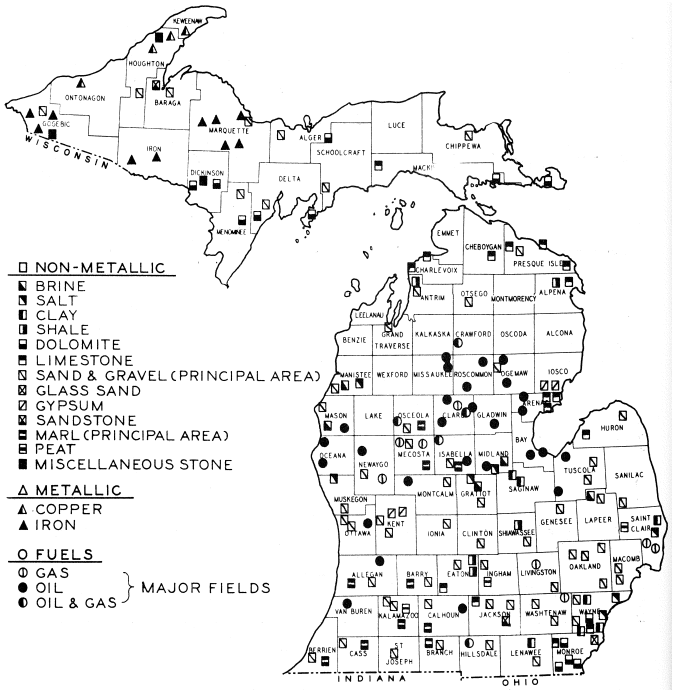
GROWTH IN VALUE OF THE MINERAL INDUSTRIES OF MICHIGAN AND BORDERING STATES 1946 TO 1959



MICHIGAN'S MINERAL VALUE AND POPULATION GROWTH 1931-1959



PRODUCTION MAP, 1960



PROCESSING MAP, 1960

METALLIC MINERALS*

IRON ORE

Geological formation - Huronian. Iron ore is a mineral containing iron in such quantity, grade, and chemical combination as to make extraction commercially profitable. A large number of minerals are iron-bearing, however, only four, magnetite, hematite, limonite, and siderite, are important as a source of the metal. Hematite is the principal mineral utilized in Michigan. The most important iron-bearing rocks are of middle Huronian age. The iron ore is found as isolated masses in a rock called iron formation. Iron formation is a banded sedimentary rock commonly composed of layers of silica alternating with layers of iron minerals. Precambrian banded iron formations are found in a few other places on the earth's surfaces principally Labrador - Quebec, Manchuria, India, Brazil and the Krivoy Rog area of Russia, but until recently such deposits have been little utilized for iron ore production excepting the United States.

The iron and steel industry experienced the longest strike in its history in 1959. Largely as a result of the 116 day shutdown which began July 14 the state's iron ore output was the lowest since 1938. Shipments of iron ore in 1959, from 22 underground mines and 6 open pits comprised 7,258,715 long tons (2,240 lbs.); a decrease of 12 per cent from 1958. Value of shipments dropped to $62,117,507 and iron ore failed to rank first of minerals produced for the first time since 1938. Dates of first and last lake shipments of ore in 1959 from Michigan and Wisconsin ports were: Ashland - C & NW - Soo, April 24 - November 18; Escanaba -C & NW, April 10 - December 8; Marquette - DSS & Ar, April 27 - December 4; Marquette - LS & I, April 24 - December 12; Superior - GN, April 17 -December 20; Superior - NP - Soo, April 27 - November 29o

Underground mines increased working time at the start of 1959. M. A. Hanna Company stepped up its work to 6 days in its 4 iron mines in the Iron River district. Pickands Mather and Company's operations on the Gogebic Range increased to a full 4-day week of 16 shifts after working 12 shifts for some time. North Range Mining Company reopened the Penokee mine at Ironwood idled since March of 1958.

Pickands Mather and Company's Buck mine at Caspian reopened in April after having been closed since July, 1958. Opened on a trial basis, miners worked on a Straight Company account rate as in contract mines and agreed to maintain production at the rate prevailing when the mine closed.

The Republic Steel Corporation, as in the case of Pickands Mather and Company, was shipped from a single mine on the Menominee Range, the Tobin at Crystal Falls. The Tobin was closed October 16, 1957 except for pumping and maintenance through 1958. Repair work was begun on March 9, 1959. Republic leased the adjacent Genesee Mine on May 1959 and planned to mine and hoist through the Tobin shaft after driving a 300 foot drift.

The Bradley open pit mine at Iron Mountain closed upon the death of Edward C. Bradley. The mine, operated by Mr. Bradley and his sons, produced a high silica ore for the Jackson Iron and Steel Company. A total of 313,941 tons of ore was produced the last 11 years of its 20 year existence.

Expansion started early in 1959 on the Cleveland-Cliffs beneficiation plant at Humboldt to bring it up to a production level of 600,000 tons of pellets annually. Facilities include expansion of the crushing, grinding, and flotation section of the plant and construction of an agglomerating section at the concentrator. The company also planned a new pelletizing process for their beneficiation plant at Republic in the hopes of an eventual 2 million tons annual production of high grade pellets there. The Mather "A" mine at Ishpeming began installation of one of the world1s largest slope conveyors. The belt will have a center distance of 3,791 feet and will carry 700 tons per hour of iron ore. The ore will be carried from the 12th to the 9th levels - an elevation of about 800 feet. When all materials have been excavated for the conveyor location in the mine and all succeeding sections of the belt have been added, a total of over 7,500 feet of belting will be operated on this unit.

The M. A. Hanna Company's new 20 foot circular shaft near Iron River was put in operation. This 2,740 foot shaft serves the Homer and Wauseca mines for an expected annual production of 1 million tons of iron ore. Hanna's new Groveland open pit mine and beneficiation plant, near Randville was in production. Estimated reserve on the 3,000 acres is 100,000,000 tons of ore. First shipment of 65% concentrate went to the Granite Steel Company in Illinois. This is the third iron ore beneficiation plant to be established in the Northern Peninsula.

Great Lakes Steel's $100 million construction and expansion program was announced in February. A new 80-inch strip mill will be built on 70 acres adjoining the Detroit Edison Plant on River Rouge. This new installation is ½ mile from the main plant at Ecorse. Completion is scheduled for the middle of 1961 - part of a $300 million expansion program by the parent National Steel Corporation.

The Branch of Ferrous metals and Ferroalloys, U. S. Bureau of Mines, planned to publish the first progress report on the Bureau's integrated study of the iron ores of the Lake Superior District. The study includes investigation of geology, exploration and development on all major iron ranges in the Lake Superior District. Eventually each range will be sampled systematically to determine the mineral combination present and appropriate mineral dressing methods. As part of the study the Bureau is sponsoring research fellowships at the University of Minnesota and Michigan College of Mining and Technology on (1) diamond drilling; (2) the primary iron minerals of Lake Superior District; (3) flotation of iron-magnetic iron minerals present in taconite; and (4) flotation of undeslimed iron ores.

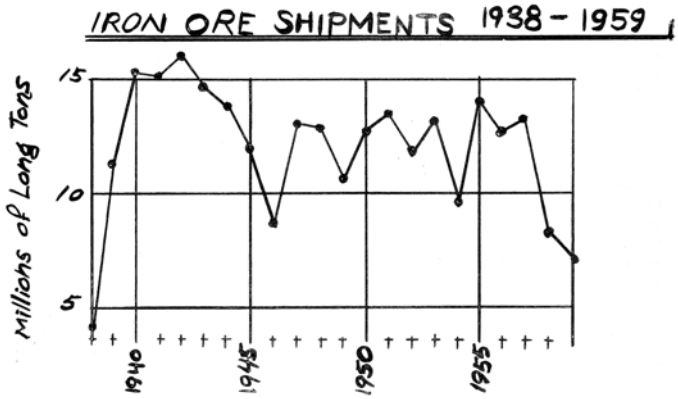
*Metallic statistics compiled by Michigan Geological Survey.

Iron Ore Shipments by Ranges, 1959

Range	Number of Mines Underground	Number of Mines Open Pit	Iron Ore Shipments (Long Tons) Direct Shipments	Siliceous	Total
Marquette	9	4	3,252,552	277,397	3,529,949
Menominee	8	2	2,471,376	6,604	2,477,980
Gogebic	5	-	1,250,786	-	1,250,786
	22	6	6,974,714	284,001	7,258,715

Shipments and Value of Iron Ore, 1955 - 1959

Year	Shipments (Long Tons)	Value
1955	14,148,123	$ 107,890,161
1956	12,536,302	105,688,087
1957	13,126,746	110,605,689
1958	8,210,906	70,704,419
1959	7,258,715	62,117,507



COPPER

Geological formation - Keweenawan. Copper is present in many horizons throughout the Keweenawan series which extends from the tip of the Keweenaw Peninsula south and westward into Wisconsin. The copper mines of Houghton and Keweenaw counties produce native copper from the lava flows and interbedded conglomerates, but the White Pine Mine, in Ontonagon County, produces mostly copper sulphide (chalcocite) from the Nonesuch Shale. Some copper is also produced in Houghton County by reclamation of stamp sand tailings of earlier mill operations.

Michigan produced 113,081,533 pounds of copper during 1959, a decrease of 7 per cent in production. The value of copper, however, increased 12 per cent to $35,245,252 due to a higher average price. Average price used for calculating the value of copper was 31.2 cents per pound in 1959 and 25.7 cents in 1958. At the beginning of 1959 the price of copper stood at 29 cents a pound unchanged since October 24, 1958. In early February, however, it advanced to 30 cents and on March 9 to 3 it cents. By July 15 the price dropped to 30 cents and remained there until early September. Thereafter, prices ranged from 30 to 33 cents until November 12, when a 33 cent price was established.

No silver was recovered from Michigan copper during 1959 as virtually all output was fire refined and marketed as "Lake Copper" at a slight price premium because of the silver content.

Copper Production by Counties, 1959

County	Mines	Reclamations	Copper Production (pounds)		
			Mines	Reclamation	Total
Houghton	3	2	11,832,002	8,857,231	20,689,233
Keweenaw	5	0	22,321,176	409,189	22,730,365
Ontonagon	1	0	69,661,935	-	69,661,935
TOTAL	9	2	103,815,113	9,266,420	113,081,533

The White Pine Copper Company shut-down its mine, mill, and smelter in November because of a strike. Copper Range Company shipped ore from the Champion mine and tailings from Redridge to their Freda mill throughout the year. Concentrates from the Freda mill were processed at the White Pine Company's smelter.

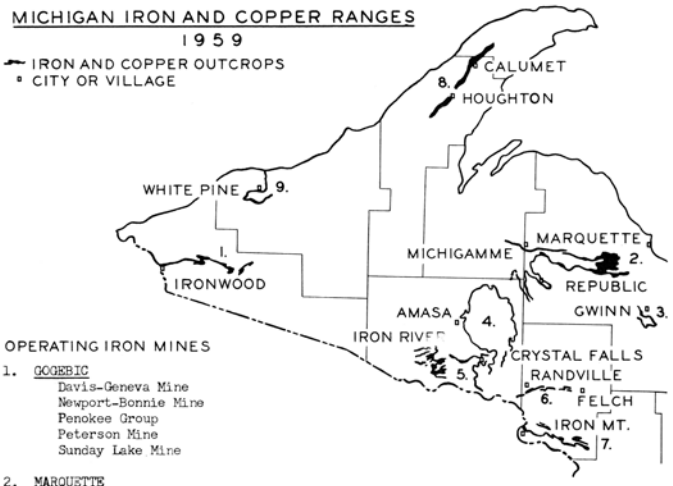
Calumet and Hecla, Inc. operated several of its mines and the Ahmeek mill, the Tamarack reclamation plant, and the Hubbell smelter throughout the yea to

Quincy Mining Company operated their tailings reclamation plant. Concentrates were smelted at the Calumet and Hecla, Inc. smelter until March when Quincy Mining Company's Hancock smelter was put into operation. Reconditioning of Quincy Mining Company's No. 5 copper smelting at Ripley was completed in June and commenced handling concentrates on hand. On October 28th the Hancock smelter was shut-down for repairs and to build up stocks of concentrates. Operations were resumed in the latter part of November.

COPPER PRODUCTION 1955 - 1959

Year	Quantity (pounds)	Value
1955	99,996,160	37,489,560
1956	123,280,235	51,531,138
1957	113,647,143	33,629,326
1958	122,059,023	31,414,330
1959	113,081,533	35,245,252

[Map: Michigan Iron and Copper Ranges]



OPERATING IRON MINES

1. GOGEBIC
   - Davis-Geneva Mine
   - Newport-Bonnie Mine
   - Penokee Group
   - Peterson Mine
   - Sunday Lake Mine

2. MARQUETTE
   - Bunker Hill Mine
   - Champion Open Pit
   - Cliffs Shaft Mine
   - Greenwood Mine
   - Humboldt Open Pit
   - Maas Race Course Mine
   - Mather "A" Mine
   - Mather "B" Mine
   - Morris Mine
   - Ohio-Webster Open Pit
   - Republic Open Pit
   - Tilden Open Pit
   - Tracy Mine
   - Volunteer-Maitland Open Pit

3. GWINN
   - (not active)

4. AMASA OVAL
   - (not active)

5. IRON RIVER - CRYSTAL FALLS
   - Baltic Group
   - Book Mine
   - Bristol-Youngstown Mine
   - Cannon Mine
   - Hiawatha Mine
   - Homer-Cardiff-Minckler Mine
   - Sherwood Mine
   - Tobin Mine
   - Wauseca-Aronson Mine

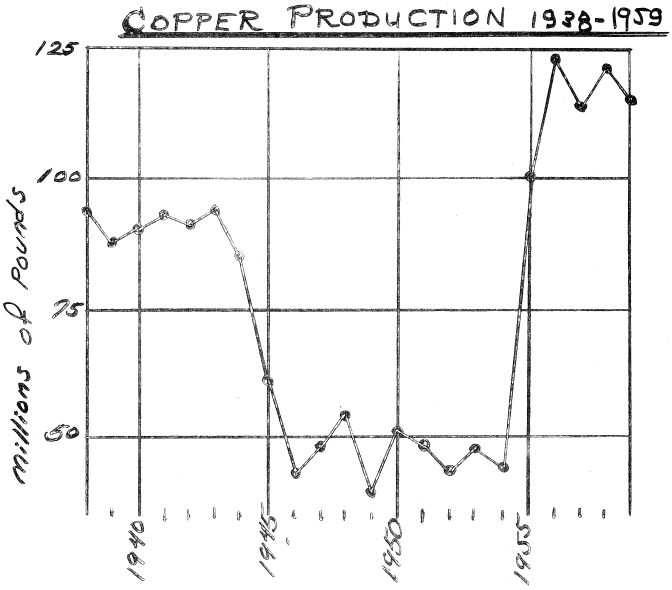
6. FELCH
   - Groveland Open Pit

7. EAST MENOMINEE
   - (not active)

OPERATING COPPER MINES AND RECLAMATION PLANTS

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

9. COPPER SULFIDE
   - White Pine Mine



FUELS*

PETROLEUM

Petroleum production increased in 1959 reversing a declining trend which began more than a decade ago. During the year 10,438,608 barrels valued at $30,518,107 were produced. At the end of 1959, 4,327 producing wells were in 41 counties. Approximately 58 per cent of the total output was from Hillsdale, Isabella, Montcalm, Bay, Osceola, Arenac, Ogemaw, and Gladwin counties; more than half a million barrels were produced in each of these counties a

During the year 598 wells were completed (256 oil producers, 48 gas producers, 294 dry holes). Of these completions 187 were wildcats (11 oil producers, 6 gas producers, and 170 dry holes). The remaining 411 completions were field wells (245 oil producers, 42 gas producers, and 124 dry holes).

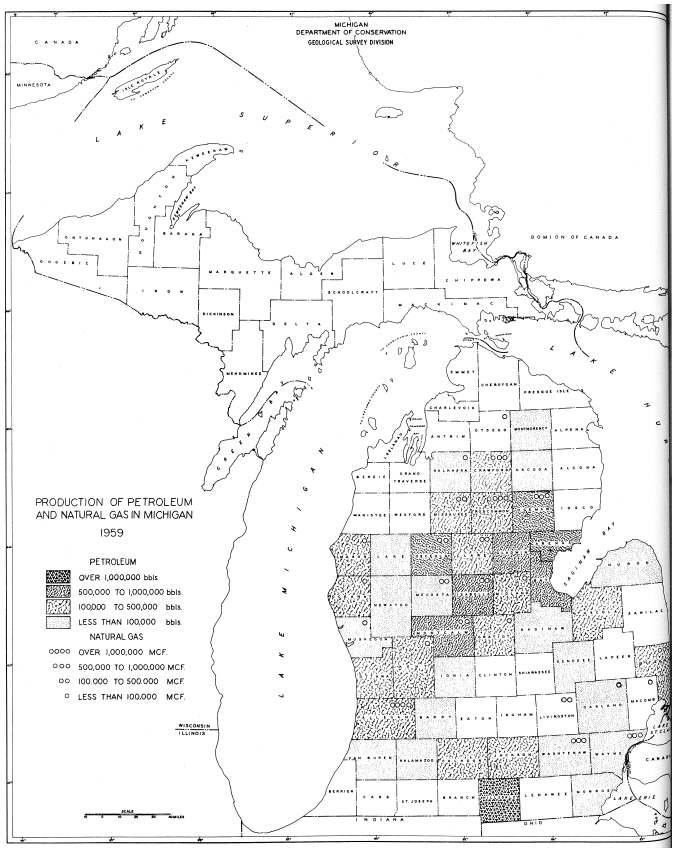
Thirteen refineries & in nine counties 9 processed more than 99 per cent of the crude oil produced in Michigan during 1959. The combined normal daily capacity of all Michigan refineries is approximately 183,200 barrels.

The Northern Peninsula Oil Refining Inc. of Rapid River announced, in June, plans for construction of an oil refinery. The refinery will be on U. S. 41 in Rapid River and will refine crude oil from the Trans-Canada pipe line traversing the area. The plant will market straight run gasoline, kerosene, range oil, diesel fuel, gas and residential fuels within a 100 mile radius of Rapid River.

Detailed information for oil and gas operations is recorded in the "1959 Summary of Operations, Oil and Gas Fields", available from the Michigan Geological Survey.

*Fuel statistics compiled by Michigan Geological Survey.

[Map: Production of Petroleum and Natural Gas]

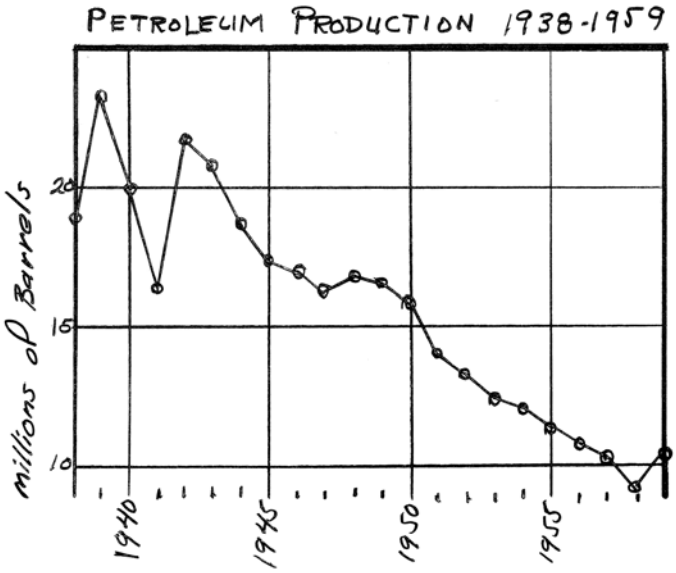


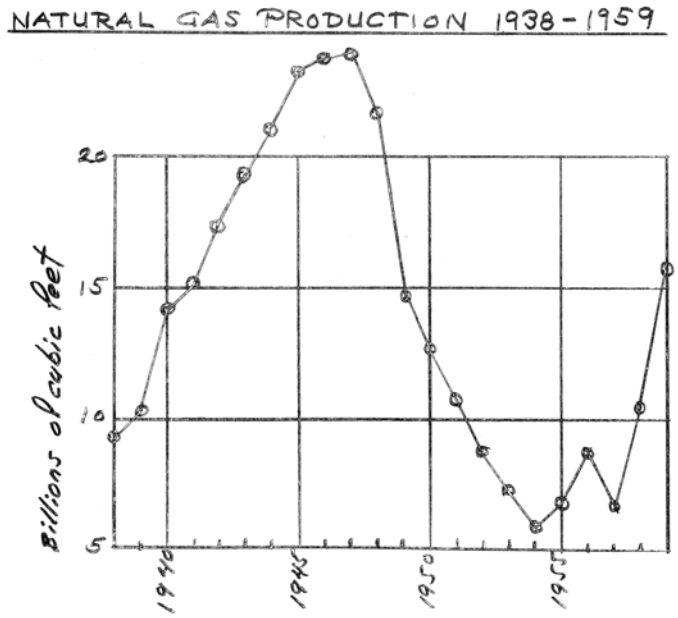
PETROLEUM PRODUCTION AND ACCUMULATED OIL BY FORMATION, 1959

Formation	Production		Accumulated	
	Bbls.	Per Cent	Bbls.	Per Cent
Marshall	1,430	.01	63,985	.02
Berea	20,702	.20	2,136,720	.50
Traverse	1,511,950	14.48	86,218,828	20.25
Dundee	4,155,217	39.81	302,282,706	70.99
Det. River	2,238,621	21.45	30,640,186	7.20
Sal-Niag.	392,527	3.76	611,176	.14
Trenton	2,118,161	20.29	3,832,073	.90
TOTAL	10,438,608	100.00	425,785,674	100.00

PETROLEUM AND NATURAL GAS PRODUCTION, 1955 - 1959

Year	Petroleum		Natural Gas	
	Barrels	Value	M. Cu. Ft.	Value
1955	11,265,832	32,074,018	6,787,697	1,187,846
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





NATURAL GAS

Over 61 per cent of the natural gas produced in Michigan has been from the Michigan Stray - Marshall formations. Natural gas production increased 4,661,849,000 cubic feet in 1959 to a total of 15,626,227,000 cubic feet the largest production since 1948. Of this amount over 4 billion cubic feet was oil well gas. Natural gas was produced from 167 wells in 24 counties. Allegan County with 53 per cent of the state's total was the leading producer followed by Roscommon, Livingston, Ogemaw, and Crawford counties.

GAS PRODUCTION AND ACCUMULATED GAS PRODUCTION BY FORMATIONS - 1959

Formations	Production		Accumulated	
	M. Cu. Ft.	Per Cent	M. Cu. Ft.	Per Cent
Drift			8,020	.00
Stray-Marshall	674,191	4.31	209,355,971	61.49
Berea	8,032	.05	9,783,654	2.88
Antrim	14,912	.10	164,807	.05
Traverse	135,217	.87	7,383,894	2.17
Dundee-Reed City	343,265	2.20	47,790,893	14.03
Detroit River	3,649,466	23.35	20,330,272	5.97
Salina-Niagaran	9,720,047	62.20	39,050,109	11.47
Trenton-Black River	1,081,097	6.92	6,620,118	1.94
TOTAL	15,626,227	100.00	340,487,738	100.00

NATURAL GASOLINE

Michigan in 1959 produced from oil well gas a total of 2,761,551 gallons of natural gasoline and allied products valued at $154,648. Crawford County, with 71 per cent of the state total, ranked first among the six producing counties.

NATURAL GASOLINE PRODUCTION, 1955 - 1959

Year	Quantity (gallons)	Value
1955	3,612,912	361,291
1956	3,740,916	374,092
1957	3,495,703	349,570
1958	3,511,671	351,167
1959	2,761,551	154,648

NONMETALLIC MINERALS

PORTLAND CEMENT

Portland cement is an artificial chemical combination of lime, silica, alumina, iron oxide, and small amounts of other ingredients to which gypsum is added to regulate the set. Chief raw materials used in cement manufacturing in Michigan are limestone, and shale or clay. These raw materials are obtained from Paleozoic limestone and shales and from Pleistocene clays.

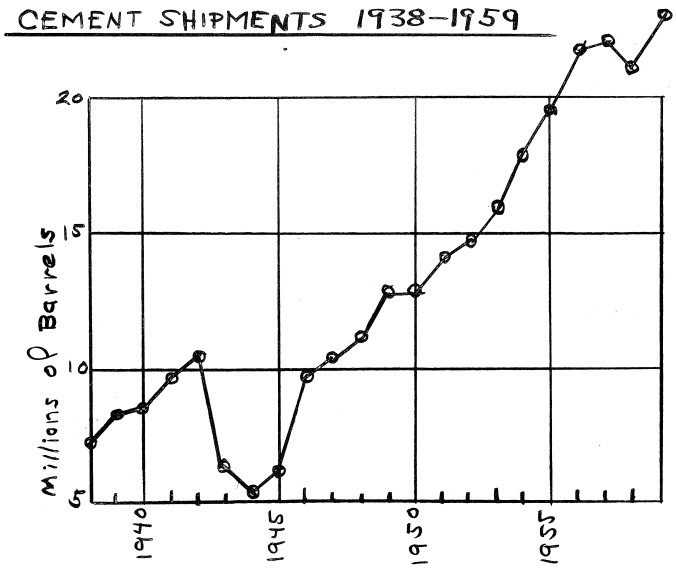
Portland cement was produced by nine cement plants in the state. Antrim shale from Alpena County and Ellsworth shale from Antrim County were used by the northern plants. All southern plants use local glacial or lake clays. The greater part of the limestone used was from the Traverse and Dundee formations.

RAW MATERIAL USED IN THE MANUFACTURE OF PORTLAND CEMENT, 1959

Raw Material	Short Tons
Limestone	5,395,084
Clay and shale	1,620,242
Gypsum	146,598

PORTLAND CEMENT SHIPMENTS, 1955 - 1959

Year	Shipments (barrels)	Value	Rank in U.S.	Number of plants
1955	19,738,400	58,048,378	4	7
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



Cement ranked first in value in 1959 followed by iron ore. Cement shipments increased 2,113,938 barrels and the value Increased $6,781,473 over 1958 to the highest point in history. Alpena County continued to be the leading producer; Wayne County ranked second. Portland cement was produced also in Bay, Emmet, Lenawee, Monroe, and St. Clair counties.

Construction continued on the new cement plant at Dundee. The 30 million dollar plant, with its newly developed quarry in the Dundee formation is one of the largest and most efficient on the North American continent. The plant Is located about 40 miles southwest of Detroit.

General Portland Cement Company and Consolidated Cement Company merged April 30 and the re-elected directors of both companies became members of the board of the combined company. The firm has an annual capacity of 25,000,000 barrels making It the fifth largest in the United States. Consolidated formerly operated three plants located at Cement City, Michigan; Paulding, Ohio; and Fredonia, Kansas.

A new cement distributing plant at St. Joseph was completed by the Huron Cement Company. This facility, the company's 13th distributing plant, has ten silos with a combined storage capacity of 150,000 barrels.

National Gypsum Company of Buffalo, New York, exchanged more than 1 million shares of stock, valued at $67 million, to acquire Huron Portland Cement Company. Huron continued with its own sales force, production units, accounting, and research facilities.

SALT

Geological Formations - Marshall, Detroit River, Dundee, Salina. Almost the entire Southern Peninsula of Michigan is underlain by great thicknesses of rock salt - one of the largest basins of salt depositions in the world.

Successful manufacture of salt began at Saginaw in 1860. Prior to that time the State had set aside lands on which salt springs were located, and appropriated funds for borings upon these lands. Owing, however, to lack of specific knowledge of the geology of the State, the borings obtained brines too weak for salt manufacture, and the State abandoned attempts to manufacture this product. However, to stimulate private enterprise in the development of the salt resources of the state, the legislature of 1859 passed an act exempting all properties engaged in the manufacture of salt from taxation, and furthermore, provided for the payment of a bounty of ten cents per bushel for all salt obtained from wells within the State. This legislation was soon Amended and eventually repealed, but by that time the industry was established on a firm basis, and growth was rapid. As early as 1880 Michigan led all states in salt production.

Artificial brines produced by dissolving salt from the Salina formation are 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.

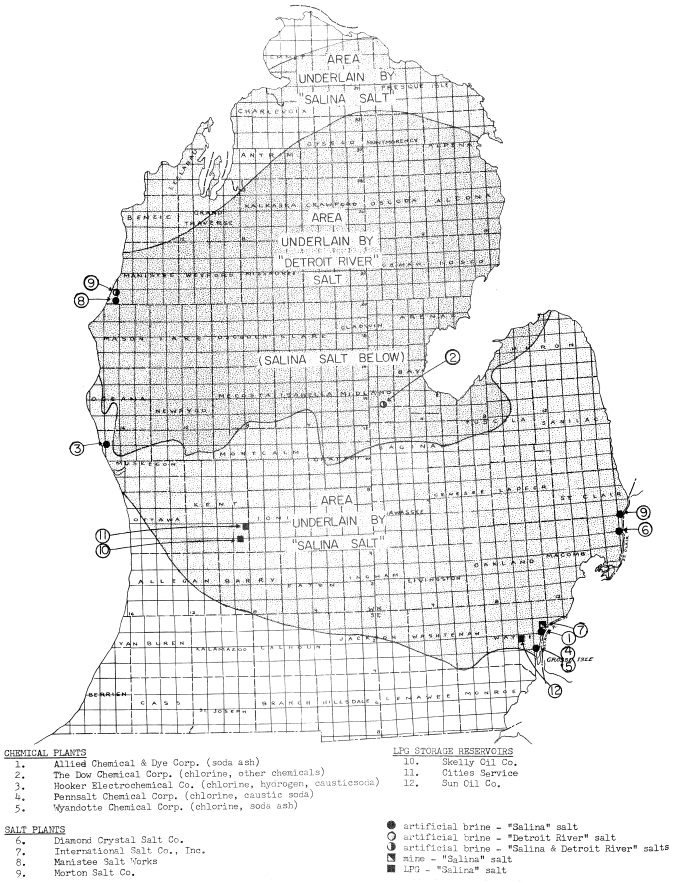
Approximately 57 Per cent of the salt was used by chemical plants in Wayne, Midland and Muskegon counties. Over 2.5 million tons of salt were used in the manufacture of soda ash, chlorine, and other chemicals. Approximately 19 per cent of the total production was dried and evaporated salt.

During 1959, 4,485,145 short tons of salt valued at $35,724,796 were produced. This was an Increase of 5 per cent in production and 8 per cent in value over 1958. Wayne ranked first of the six counties producing salt - followed by St. Clair, Manistee, Midland, Muskegon, and Gratiot.

USES OF SALT, 1959

Uses	Quantity (short tons)	Per Cent
Chemical	2,567,922	57
Highway, Dust & Ice Control	851,607	19
Textile, Hides and Packers	170,811	4
Livestock	175,908	4
Food Processing	128,047	3
Table and Other Household	75,965	2
Water Treatment	51,823	1
Other	112,867	2
Undistributed	350,195	8
TOTAL	4,485,145	100

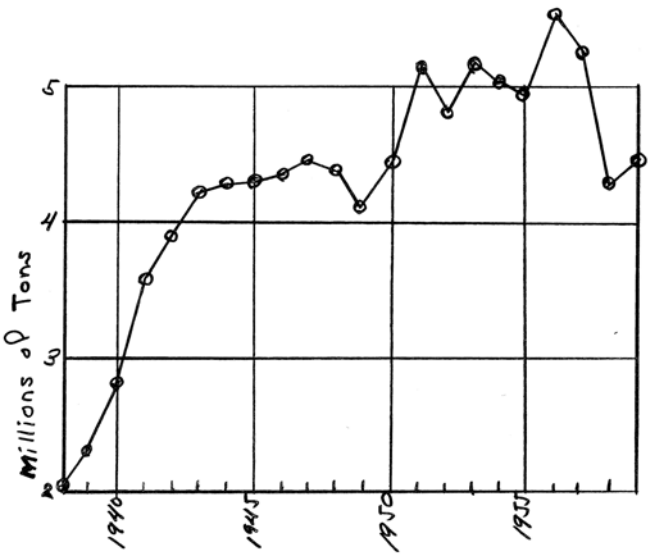
MICHIGAN SALT ROCK DEVELOPMENT 1959



SALT PRODUCTION, 1955 - 1959

Year	Quantity Short Tons	Value	Per Cent U.S. Total	Rank in U.S.
1955	4,975,442	$31,668,351	21.9	1
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	-	1

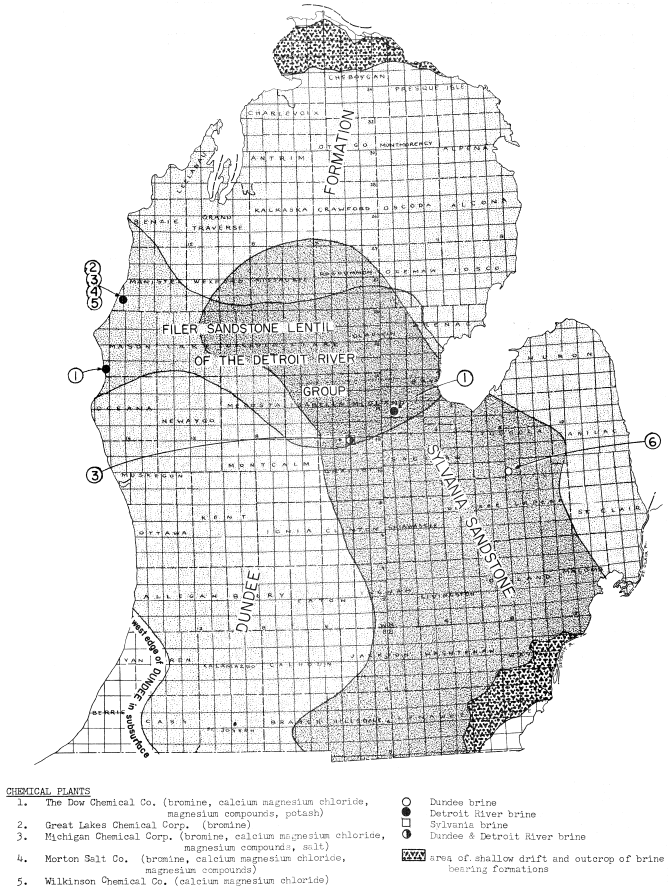
SALT PRODUCTION 1938-1959



NATURAL SALINES

Geological Formation - Sylvania, Detroit River. Natural brine recovered from the Sylvania formation is used by chemical companies in Midland and Gratiot counties. Brine from the Filer sandstone of the Detroit River formation Is produced in Mason and Manistee counties. These natural brines are source material for many chemicals and chemical compounds.

MICHIGAN NATURAL BRINE DEVELOPMENT 1959



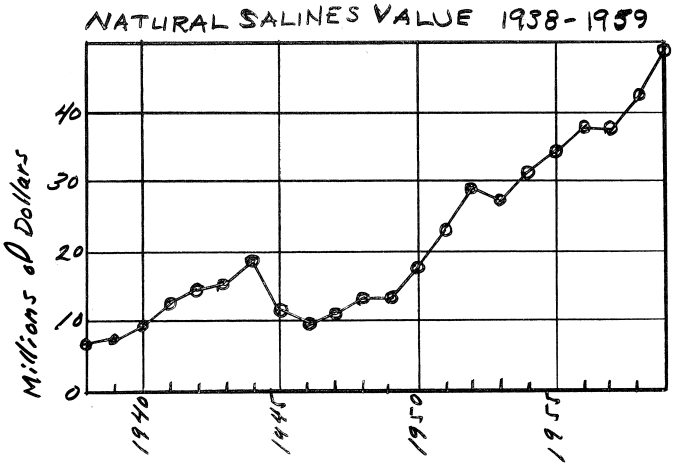
Bromine was produced in 1958 by four companies in six plants in Gratiot, Manistee, Mason, and Midland counties. Magnesium compounds were produced by four companies in Gratiot, Manistee, Mason and Midland counties. Calcium-chloride and calcium-magnesium chloride were produced by three companies in Gratiot, 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 1959 increased 16 per cent over the 1958 value. The highest value was recorded for bromine, followed by magnesium compounds, calcium magnesium chloride and potash.

Field studies in Michigan showed 25 per cent more clear space on icy pavements after 1 hour treatment with 1:3 calcium chloride salt mixture. When calcium chloride dissolves, it releases the heat that salt requires to dissolver which explained the greater effectiveness of the mixture in melting ice. It has demonstrated that premixed calcium chloride and salt could be stockpiled if dry and protected from rain. Underneath the protecting crust that formed the saline mixture remained free flowing.

VALUE OF NATURAL SALINES*, 1955 - 1959

Year	Value
1955	$ 34,282,204
1956	37,873,042
1957	37,664,914
1958	42,360,677
1959	49,286,176



*Includes: bromine, calcium chloride and calcium-magnesium chloride, magnesium compounds, and potash.

SAND AND GRAVEL

Sand and gravel are 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 is 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 increased in 1959 to 48,051,816 short tons valued at $41,192,632 the highest recorded to date. Seventy per cent of the total sand and gravel output was used in road construction and 19 per cent for structural purposes.

Production of sand and gravel was reported from 79 of Michigan's 83 counties. Approximately 45 Per cent of the total production was from 10 counties; in order of rank - Oakland, Livingston, Wayne, Kent, Washtenaw, Ottawa, Macomb, Calhoun, Ingham, and Tuscola. Thirteen per cent of the state total was produced in Oakland County. Each of the other counties produced more than 1,000,000 tons. About 72 per cent of the state's total was reported by commercial producers and the remaining 28 per cent was noncommercial production by county road commissions and other governmental agencies.

USES OF SAND AND GRAVEL, 1959

Uses	Quantity (short tons)	Value	Per Cent of Total
Paving and Road Sand	7,097,683	$ 5,226,574	14.8
Structural Sand	4,829,462	3,753,893	10.1
Molding Sand	1,918,507	2,849,091	4.0
Fill Sand	1,865,559	666,438	3.7
Other Sand*	768,226	1,721,413	1.6
Paving and Road Gravel	26,433,228	21,245,735	55.1
Structural Gravel	4,303,926	5,107,463	9.0
Fill Gravel	525,977	286,106	1.1
Other Gravel**	309,248	335,919	.6
TOTAL	48,051,816	$ 41,192,632	100.0

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

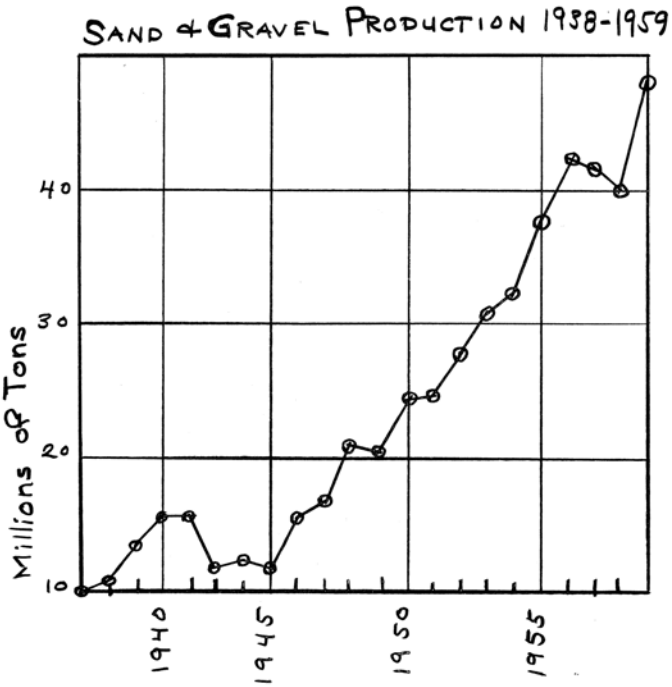
** Includes - Railroad ballast, miscellaneous, and other gravel.

The elastic fractionation process developed in 1957 was used on a commercial scale by a Michigan operation. The particles were bounced off a steel plate so that poor quality gravel with little elasticity dropped in the first compartment while the highest quality material rebounded to the third compartment.

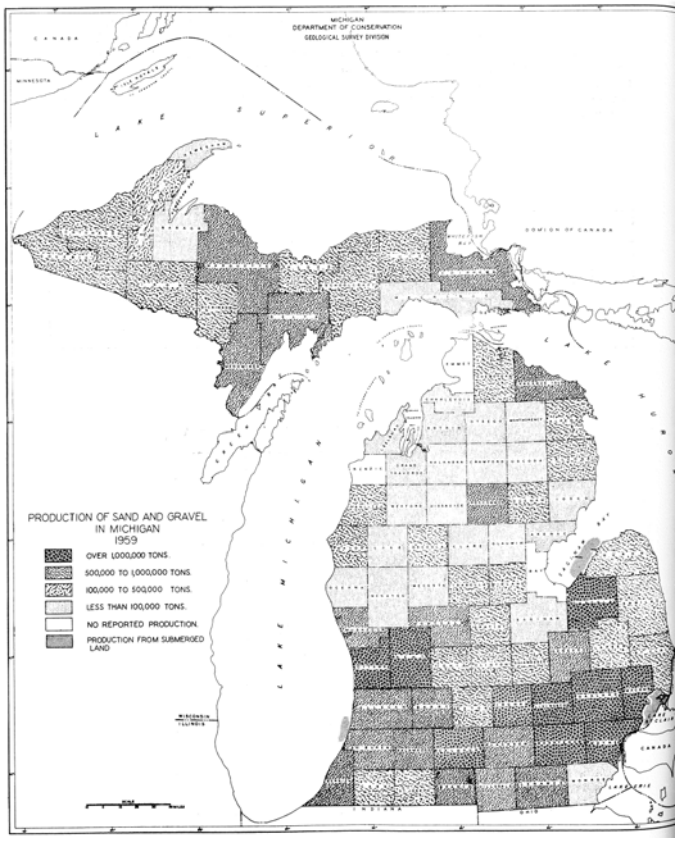
Assets and equipment of the Postma Gravel Company and Postma Equipment Company, Grandville, were acquired by the Grand Rapids Gravel Company. H. F. Postma, the former owner, who had been in the gravel business for 30 years and in the ready-mix concrete business for 12 years, retained title to company land and buildings which were leased to Grand Rapids Gravel. The Postma Equipment Company's sale included a fleet of 80 trucks and concrete mixers.

SAND AND GRAVEL PRODUCTION 1955 - 1959

Year	Quantity (short tons)	Value	Rank in U. S.
1955	37,269,709	$ 29,565,730	2
1956	42,149,946	35,145,953	2
1957	41,837,894	35,144,352	2
1958	39,871,202	34,615,648	2
1959	48,051,816	41,192,632	2
		17,5,164	



[Map: Production of Sand and Gravel]



STONE

Geological formations - Bayport, Marshall, Traverse, Dundee-Rogers City, Detroit River, Bass Island, Engadine, Burnt Bluff, Trenton, Keweenawan, Huronian.

Approximately 61 per cent of the limestone and dolomite produced in Michigan in 1959 was quarried from the Rogers City - Dundee, Detroit River, and Traverse limestone formations in Presque Isle, Charlevoix, Cheboygan, Emmet, Alpena, and Wayne counties. The remaining 30 per cent was from Mackinac, Chippewa, Huron, Eaton, Jackson, Arenac, Monroe, Delta, Dickinson, and Houghton counties. Dimensional limestone was produced in Charlevoix, Eaton, Huron, and Presque Isle counties.

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

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

Stone production and value increased to 20,526,253 tons and $22,708,587 in 1959*.

STONE PRODUCTION, 1959

Commodity	Quantity (short tons)	Value
Limestone and dolomite-		
crushed	20,411,933*	$ 22,432,225
dimensional	6,503	58,120
Sandstone - dimensional	21,779	154,510
Basalt - crushed	86,038	63,732
TOTAL	20,526,253	$ 22,708,587

USES OF CRUSHED LIMESTONE AND DOLOMITE, 1959

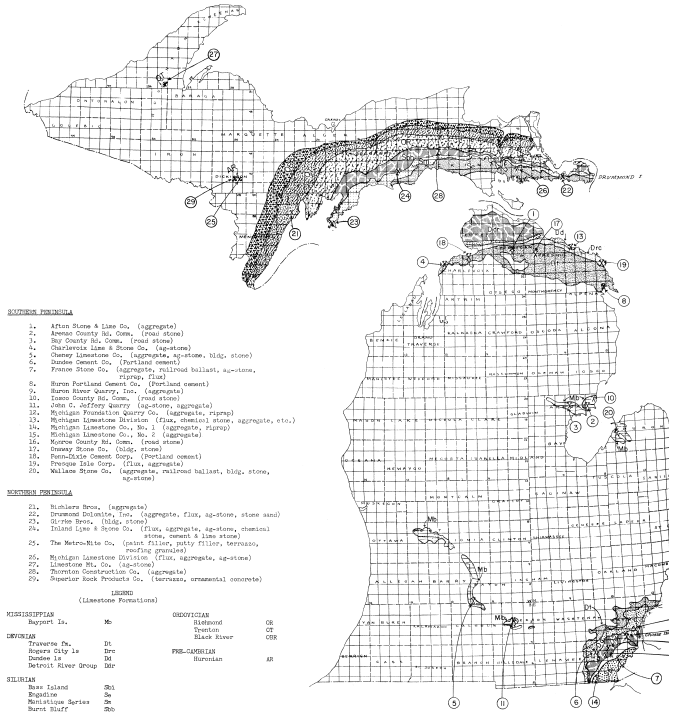
Uses	Per Cent of Total	Quantity (short tons)	Value
Flux	52.9	10,805,705	$ 11,478,863
Concrete & road metal	26.1	5,311,121	6,248,660
Chemical**	18.3	3,729,465	3,697,773
Agricultural	2.1	434,116	749,590
Other***	.6	131,526	257,339
TOTAL	100.0	20,411,933	$ 22,432,225

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

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

*** Includes: Print filler, asphalt, dust for coal mines, mineral food, R. R. ballast, stone sand, and others.

Michigan Limestone Developments 1959

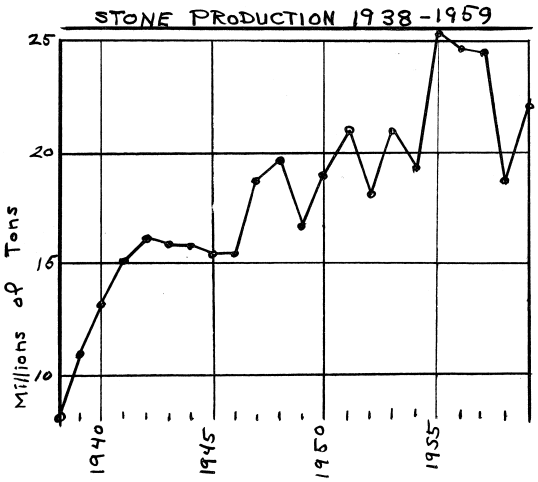


Drummond Dolomite, Inc. continued to develop reserves on Drummond Island, much of this under state lease. Intensive exploration on 2,700 acres since 1956 resulted in proving up some 150,000,000 tons of high quality dolomite extending from the northern tip of Huron Bay westward to Warner's Cove and Canoe Bay, Drummond Dolomite now processes ten sizes of crushed stone for the metallurgical, chemical, and construction industries at the rate of 2,500,000 tons a year. The plant was removed to Drummond Island from Sturgeon Bay, Wisconsin, in 1944.

The United States Bureau of Mines published Information Circular 7917, "Mining and Milling Methods, Inland Lime and Stone Company, Port Inland, Michigan". Written by L. G. Marshall, mine examination and exploration engineer for the Bureau at Minneapolis, this publication covers details of a limestone quarry which produces flux for the steel industry and crushed stone for manufacturing concrete.

STONE PRODUCTION, 1955 - 1959*

Year	Quantity (short tons)	Value	Rank in U. S.
1955	25,312,294	$ 23,361,852	3
1956	24,702,487	24,135,997	2
1957	24,586,940	26,974,290	4
1958	18,584,890	19,997,244	6
1959	20,526,253	22,708,587	6



* Does not include limestone used in the manufacture of cement and lime.

CLAY AND SHALE

Geological formations - Glacial Drift, Saginaw, Ellsworth, Antrim* 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 1959, 2,050,760 short tons of clay and shale, valued at $2,311,917 were produced. Wayne County led in production and value with 33 per cent of the state's total output, followed by Alpena, Saginaw, and St. Clair counties. Approximately 79 per cent of all raw clay and shale produced was used by the cement industry. The remaining 21 per cent was used for the manufacture of a small quantity of prepared clays and for clay products -brick, tile, pottery, and lightweight aggregate.

About 66 per cent of the raw material for the manufacture of clay products was from glacial clay and the balance was from shale deposits.

PRODUCTION OF CLAY AND SHALE, AND CLAY PRODUCTS, 1955 - 1959

Year	Raw clay and shale quantity (short tons)	Value	Clay Products
1955	1,937,593	$ 2,091,077	7,292,477
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

GYPSUM

Geological formation - Michigan.

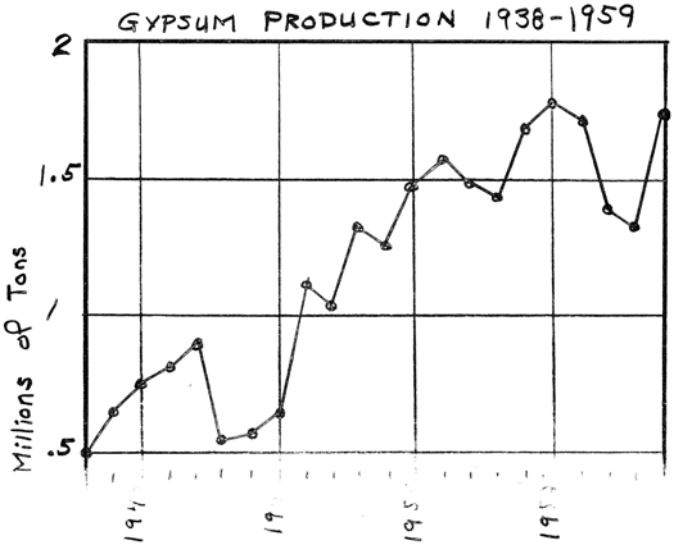
Gypsum is quarried at Alabaster and near Tawas City, Iosco County, and is mined in two underground mines at Grand Rapids, Kent County. The raw material Is processed in gypsum mills at National City, Grand Rapids., River Rouge, East Chicago, Indiana, and Waukegon, Illinois. Principal uses for gypsum are in the manufacture of plaster, wallboard, and allied building materials .and as a Portland cement retarder.

During 1959 Michigan gypsum production increased 390,564 tons to a total of 1,721,453 tons valued at $6,595,256. This is the highest value recorded for crude gypsum although a slightly greater tonnage was produced in 1955.

Shipments of raw gypsum from National Gypsum Company's new quarry near Tawas City were made from their new dock south of Tawas City. Shipments were to the company's plant at Waukegon, Illinois. Later shipments are to be made to the Lorain, Ohio plant which was under construction for processing into wallboard, lath, plaster and other gypsum building products.

PRODUCTION OF GYPSUM, 1955 - 1959

Year	Quantity (short tons)	Value	Per Cent of U. S.	Rank in U. S.
1955	1,762,105	$ 5,660,587	17	1
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	-	1



LIME

Geological formations - Dundee, Burnt Bluff, Engadine.

Raw stone for the manufacture of lime was obtained from the high calcium Dundee limestone in Presque Isle County, the Burnt Bluff limestone in Mackinac County, and the Engadine dolomite in Chippewa County.

Six companies produced quick and hydrated lime in the state. Production of lime reported during 1959 Increased greatly over 1958, however, this was primarily due to the addition of two producers. Forty per cent of the lime sold and used was quick lime. Wayne County ranked first in production.

Until about 1900, when the chemical industries began to grow rapidly, lime was used almost entirely in construction and agriculture. Since then, progressively larger amounts have been employed in chemical and processing industries. All lime produced in the state Is now sold or used for chemical and industrial use.

PEAT

Geological formation - Pleistocene. Peat is partly decomposed and more or less disintegrated vegetable matter that has accumulated in places where ordinary decay or chemical decomposition of the material has been retarded by immersion in water. A peat deposit Is an accumulation of many generations of plants from one or several groups of vegetation. Thus, an individual bog may contain several different types of peat. Peat deposits of Michigan are largely in muskegs and grass-sedge marshes in basins of glacial origin. Although the most extensive deposits are in the Northern Peninsula, the bogs near centers of population in the Southern Peninsula are more Important commercially. It has been estimated that the reserves of peat in Michigan total 1 billion tons.

Production increased in 1959 to 191,661 tons valued at $2,356,656. Michigan, with nearly half of the total, led all states in production followed by California and Florida.

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, 1955 - 1959

Year	Quantity (short tons)	Value	Per Cent of U. S.	Rank in U. S.
1955	30,000	$ 465,000	11.0	3
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

MARL

Geological formation - Pleistocene.

Marl is a loosely consolidated earthy material composed largely of calcium carbonate. It is essentially a form of limestone which has undergone partial induration and is often quite variable in composition. The wide distribution and accessibility of marl throughout the state affords a potential source of almost unlimited supply of agricultural lime. Marl deposits are not continuous over large areas. but are restricted to isolated bodies situated in. small basins, depressions and drainage channels. The material occurs not only in present existing water bodies, but Is often found burled under muck and peat in swamps and decadent lakes and also along old river channels. In places it forms the upper terraces of lakes and streams and may there be exposed to the surface. Many of the large and some of the smaller lake beds of the state contain marl layers of varying thickness. In some lakes the marl is a narrow rim or shelf around the margin which in places has developed considerable thickness. The deposits of marl are limited in extent and thickness by the depressions which confines them. Deposits range in area from merely a fraction of an acre to several square miles and may be from 10 to 15 feet thick. More than 30 feet of marl is of rare occurrence.

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. Commercial marl production was reported in 18 counties during 1959. Kalamazoo County ranked first, followed by Isabella, Branch, Barry, and Calhoun counties. These counties produced approximately 65 per cent of the state's output.

MARL PRODUCTION, 1955 - 1959

Year	Quantity (short tons)	Value	Rank in U. S.
1955	119,313	$ 57,176	1
1956	157,246	94,821	1
1957	137,020	70,635	1
1958	230,105	130,231	4
1959	201,387	118,240	4

VALUE OF MICHIGAN'S MINERALS AND MINERAL PRODUCTION 1944 - 1959

Year	Dollars	Year	Dollars
1944	$ 140,493,319	1952	$ 267,089,423
1945	128,046,408	1953	287,693,135
1946	133,682,135	1954	286,549,922
1947	170,269,272	1955	371,356,604
1948	214,115,771	1956	406,563,233
1949	207,607,694	1957	406,809,600
1950	238,474,008	1958	349,522,638
1951	257,529,882	1959	385,321,927

TABLE I. 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 Ton	7,258,715	62,117,507	2
Natural Salines (3)			49,286,176	1
Sand and Gravel	Short Ton	48,051,816	41,192,632	2
Salt	Short Ton	4,485,145	35,724,796	1
Copper	Pounds	113,081,533	35,245,252	5
Petroleum	Barrels	10,438,608	30,518,107	17
Stone (4)	Short Ton	20,526,253	22,708,587	6
Clay Products			6,745,027	-
Gypsum	Short Ton	1,721,453	6,595,256	1
Natural Gas	M. Cu. Ft.	15,626,227	3,045,976	20
Peat	Short Ton	191,661	2,356,656	1
Clay and Shale (5)	Short Ton	2,049,110		9
Natural Gasoline	Gallons	2,761,551	154,648	15
Marl	Short Ton	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 upon 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.

TABLE II. MINERAL PRODUCTS OF MICHIGAN, 1958[1]

PRODUCT	UNIT	QUANTITY	VALUE	RANK IN U.S. (2)
Iron Ore	Long Ton	8,210,906	$ 70,704,419	2
Cement	Barrels	20,911,990	70,432,501	4
Natural Salines (3)			42,360,677	1
Sand and Gravel	Short Ton	39,871,202	34,615,648	2
Salt	Short Ton	4,266,688	33,018,368	1
Copper	Pounds	122,059,023	31,414,330	5
Petroleum	Barrels	9,308,018	27,924,954	17
Stone (4)	Short Ton	18,584,890	19,997,224	6
Clay Products			6,786,247	-
Gypsum	Short Ton	1,330,889	4,824,431	2
Clay and Shale (5)	Short Ton	1,946,794		9
Peat	Short Ton	107,342	1,683,980	1
Natural Gas	M. Cu. Ft.	10,964,378	1,424,852	20
Natural Gasoline	Gallons	3,511,671	351,167	15
Marl	Short Ton	230,105	130,231	4
Miscellaneous (6)			3,853,609	-
TOTAL			$ 349,522,638	

(1) Metallic and fuel statistics compiled by Michigan Geological Survey.

(2) Based upon quantity.

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

(4) Does not include 8,208,577 short tons of limestone valued at $6,421,508.

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

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

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