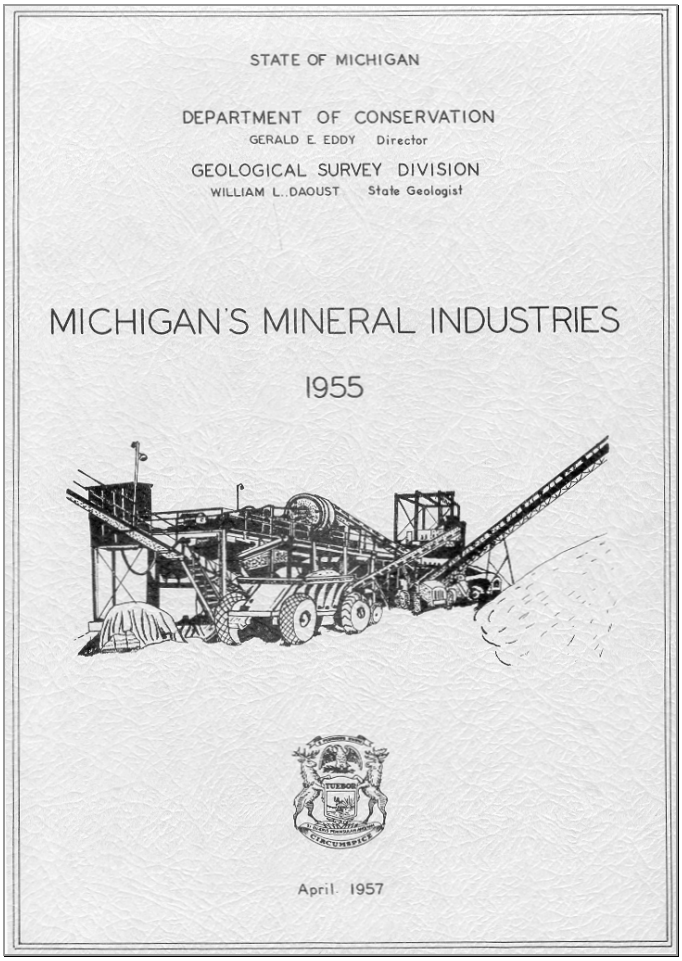

MICHIGAN MINERAL INDUSTRIES 1955

by

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Contents

Forward 1

Late Developments in Michigan's Mineral Industries . 1

Map Showing Locations of Rock and Mineral Developments and Mineral Industries 3

Michigan Mineral Production 3

Graph: Value of Minerals and Mineral Products in Michigan 1945-55 4
Metallic Minerals: 4
Iron Ore 4
Copper 4
Fuels: 4
Petroleum 4
Map: Production of Petroleum & Natural Gas in Michigan 5
Natural Gas 5
Natural Gasoline 5
Nonmetallic Minerals: 5
Portland Cement 5
Stone 6
Sand and Gravel 7
Map: Production of Sand and Gravel in Michigan 1955 7
Salt 8
Clay and Shale 8
Gypsum 8
Peat 9
Marl 9
Lime 9
Bromine, Calcium-Magnesium Chloride, Magnesium Compounds, Potash 9
Water 10

Table I. Mineral Products of Michigan, 1955 11

Table II. Mineral Products of Michigan, 1954 11

The Mineral Industry of Michigan in 1956 12

FOREWORD

This report is a record of Michigan Mineral Industries for the calendar year 1955, compiled from statistical reports and information filed by the mineral producers of the state and in cooperation with the Bureau of Mines.

The estimated value of mineral production for 1956 was submitted by the United States Bureau of Mines on January 15, 1957. The section on developments in the mineral industries was prepared from office and field conferences with mineral producers, and from articles published in Pit and Quarry, Rock Products, Mining Journal, and other trade journals. Since water is the most valuable of our mineral resources (but hitherto little considered) a brief summary on it's useage and importance is included. The sketch on the cover represents one of Michigan's five heavy-media gravel separation plants which are upgrading marginal gravels to meet concrete specifications of the State Highway Department

LATE DEVELOPMENTS IN MICHIGAN'S MINERAL INDUSTRIES

A brief resume of developments in the mineral industries shows that developments reported for 1954 continues. New processes, techniques and methods have been initiated which develop lower grade and fringe minerals 9 thus conservation's wise use of the minerals prolong and expand the industries. According to estimates by Bureau of Mines, U.S. Department of Interior, the value of mineral production in Michigan in 1956 was $389,706,000, an increase of nearly 7 per cent over 1955. Major increases - over ten per cent - were recorded in the production of Portland cement, clay and shale, copper, marl, sand and gravel.

The Republic mine began commercial operation early in 1956. This is the second and larger low grade iron ore

operation utilizing Michigan “Jasper ore”. The mine is owned by the Marquette Iron Mining Company, a union of the Cleveland Cliffs Iron Company (which operates the property), Inland Steel Company, International Harvester Company, Jones and Laughlin Steel Corporation and the Wheeling Steel Corporation. Geared to an output of 550,000 tons per year, the Republic set-up follows the Humboldt mine in the new activity in Northern Michigan iron ranges.

Working three shifts on a five day week, the open pit operation supplies the mill with from 3,500 to 4,000 tons per day of the 30 per cent iron Jasper. Two tons of crude yields one ton of concentrate, 63 per cent iron and 8 per cent silica.

Republic features froth flotation treatment using an oil reagent of the forest-industries. Two units have 59 flotation cells.

The palletizing plant located 27 miles away at Eagle Mills, also features new techniques: four "Flying Saucer” agglomerating discs and an up-drift traveling grate that can turn out 2,000 tons of pellets per day. First shipments, about 4500 tons of pellets, were made by boat on October 3, 1956 to the International Harvester Steel plant at Chicago.

Lake Superior and Ishpeming Railroad Company announced that they will construct an iron ore loading facility on Little Bay de Noc on Lake Michigan in the vicinity of Rapid River. The decision to establish this facility was largely due to the demand for iron ore at Chicago and the development and pelletization of low grade ores. The new dock will be a belt conveyor type to speed loading of boats and to minimize breakage in handling iron ore pellets.

M.A. Hanna Company announced plans to sink a new 26-foot diameter, concrete circular shaft to a depth of 25000 feet on what is known as the Minckler farm property, at Mineral Hill on the Menominee Range. A large surface plant including offices, change house, and shops will also be constructed at the shaft. This will not open a new property but will be a joint plant to serve both the Homer and Wauseca mines.

The Richmond mine, of the M. A. Hanna Company, located near Palmer, was closed permanently April 9, 1956. The Richmond Iron Company was incorporated in 1898 and operated the old Richmond mine until 1927 when a nearby property was opened and operated as the New Richmond until its abandonment.

White Pine Copper Company has authorized the purchase of two long conveyor systems to replace the long underground truck haulage. When the conveyor system has been installed the trucks will carry the ore from the headings to the conveyors which in turn will deliver the ore to the underground crusher and to the surface.

Number 13 shaft of the Calumet & Hecla, Inc., Osceola lode in the Keweenaw Peninsula has been completely unwatered. Mining has started on the lower levels and a substantial rate of production is in progress. Unwatering of the Number 6 shaft was completed late in 1956 and mining of copper ore is expected to begin about mid 1957.

The Huron Portland Cement Company operating the largest plant of its kind in the world, continues to expand its facilities at Alpena to a point where it can produce some 10,000,000 barrels of Portland cement and Masonry cement annually and furnish employment to more than 1,100 men. The company has recently purchased Sportsmen’s Dock at Benton Harbor as the site of a storage and handling plant. The site, on the St. Joseph River, is located near the Chesapeake and Ohio Railroad right-of-way.

The recently completed new Peerless Cement Corporation cement plant in Detroit is now producing at the initial rate of 1,250,000 barrels annually. This output, added to the former 5,000,000 barrels volume of Peerless cement, will give then company nearly 30 per cent of the state‘s total cement production

One of the most important features of the new plant is the 450 foot rotary-kiln, longest in the state. Automation of many processes permits a crew of only 70 workers to handle 3 shifts, 7 days-a-week operation.

Recent expansion projects at the Inland Lime and Stone Company's Port Inland operation will increase the output to an annual capacity expected to total 5,000,000 tons for 8 months1 shipping season. Expansion included the installation of belt conveyors and other equipment which will raise screening capacity 50 per cent.

Work on a multi-million dollar crushing plant is In progress at the Wyandotte Chemical Corporations Alpena quarry site. Wyandotte limestone is used in the-manufacture of Portland cement at the adjacent. Huron Portland Cement Corporation plant and for the production of Alkali at the Company’s Wyandotte, Wayne County plant.

National Gypsum Company., Buffalo, N.Y. is proceeding with development of the Tawas City Gypsum quarry, anticipating production in the spring of 1958. Stripping of the overburden was started in the fall of 1956 and new machinery delivered at the site in January included 40-ton trucks, bulldozers, graders and drills. Construction of the crusher building is in progress.

Gypsum will be extracted by open pit method. A year’s supply of the gypsum rock will be stock-piled at National City, and the remainder shipped to new plants in Ohio and Illinois. The company will dredge a 12,000-ft. channel, 250 feet wide. In Lake Huron, near Tawas City, to permit loading of lake freighters.

Bestwall Gypsum Company, organized during 1956 at Ardmore, Pennsylvania, acquired and now operates the Certain-Teed Products Corp. Grand Rapids plant and mine. The name of the plant was officially changed to Bestwall July 1, 1956.

Construction was begun on a major expansion program designed to double the capacity at the Standard Lime and Cement Company's chemical plant at Manistee. Included in the expansion program is an additional rotary kiln, more thickeners and settling basins, reactors, and accompanying equipment. Loading facilities at the plant will be improved and enlarged. Completion of the enlarged facilities have been scheduled for June, 1957.

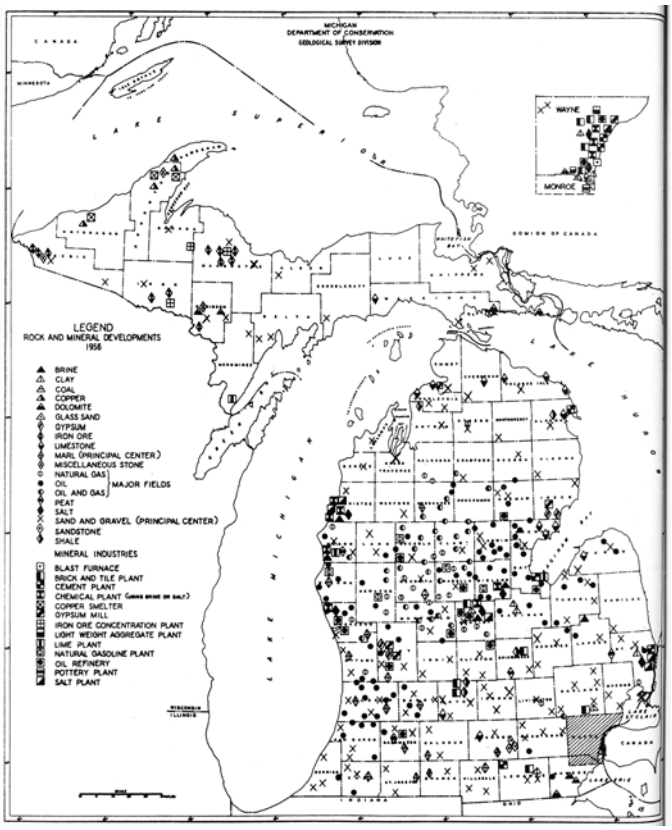
Five commercial sand and gravel plants ranging in capacity from 100 to 300 tons per hour and employing heavy-media separation have not been established in Michigan at pits formerly considered uncapable of producing premium-quality gravel suitable for specified highway concrete. These concerns are: American Aggregate Corp., Green Oaks, Livingston County; Bundy Hill Gravel Company, Somerset Center, Hillsdale County; Harry Pickitt, Northville, Wayne County; Killians Gravel Company, Ann Arbor, Washtenaw County; and Groveland Gravel Company, near Davisburg, Oakland County.

Grand Rapids Gravel Company, Grand Rapids, has completed a new office building, the last step in an expansion program begun in 1954. The program has included establishment of a third and fourth ready-mixed concrete plant, and a sand, gravel, and crushed stone, screening plant.

Michigan Chemical Corporation announced its entry into the rare earth field through the acquisition of the Assets of Saturnium Corporation. In its new activities, the company will continue rare earth research as well as place in operation pilot-plant procedures. The Saturnium research laboratory at California, Kentucky, will be closed, and its facilities moved to St. Louis, Michigan.

Charred wood unearthed during an archaeological expedition to Isle Royale in Lake Superior has been dated by radio-active carbon 14 method in a University of Michigan laboratory. According to Dr. R.W. Drier, professor of Metallurgical Engineering at Michigan College of Mining and Technology, evidence found indicates there were mining pits oil the island as early as 2000 B.C. The ancient miners heated copper-bearing rocks with fire, then poured water on the rocks to split them.

[Map Showing Locations of Rock and Mineral Developments and Mineral Industries]



MICHIGAN MINERAL PRODUCTION 1955

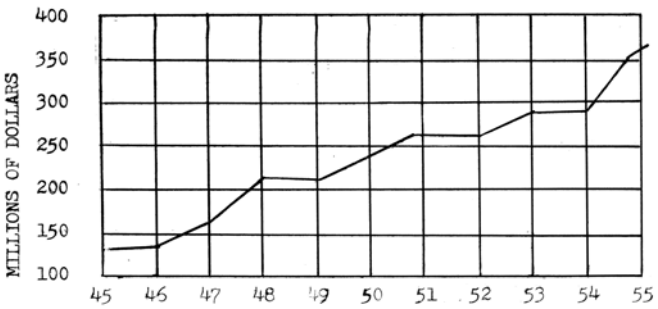
Mineral production in Michigan in 1955 increased 29.6 per cent over 1954 to an all time high. New production highs were established for bromine, clay and shale, sand and gravel, cement, stone, gypsum, magnesium compounds, and calcium-magnesium chloride. Metallic mineral production increased 76% and non-metallic production increased 14%, but the production of fuels declined 6%.

According to estimates by Bureau of Mines, U.S. Department of Interior, the value of mineral production in Michigan in 1956 was $389,706,000, an increase of nearly 7 per cent over 1955. Major increases - over ten per cent -were recorded in the production of Portland cement, clay and shale, copper, marl, sand and gravel.

Michigan's rank in the United States in volume of mineral production for 1955 is: First in gypsum, salt, and marl; Second in iron ore, bromine, magnesium, compounds, sand and gravel; Third in stone and peat; Fourth in Portland cement; Sixth in copper.

	Value	Per Cent
Metallic-minerals (iron and copper)	$ 145,379,721	39.1%
Fuels (petroleum, natural gas, natural gasoline)	33,623,155	9.1
Non-metallic minerals and mineral products (all others)	192,353,728	51.8%
TOTAL	$ 371,356,604	100.0%

[Graph: Value of Minerals and Mineral Products in Michigan 1945-55]



VALUE OF MINERALS AND MINERAL PRODUCTS IN MICHIGAN, 1945-55

METALLIC MINERALS

Iron Ore

Geological formation - Huronian. Shipments of iron ore, from 29 underground mines and 8 open pits total 14,148,123 long tons (2,240 lbs.) in 1955, an increase of 45.5 per cent from 1954. This is the highest total shipment since 1943 when 14,510,357 long tons were shipped. The peak year of iron ore shipments was 1916 when 18,812,972 long tons were shipped. Good demand, for iron ore and a favorable shipping season accounted for the increase. No shipments of ore containing over 5 per cent manganese were reported from Michigan mines in 1955.

Iron Ore Shipments by Ranges, 1955

	Number of Mines		Iron Ore Shipped (Long tons)		
Range	Underground	Open Pit	Direct Shipping	Siliceous	Total
Marquette	11	5	6,313,187	326,779	6,639,966
Menominee	12	3	4,238,508	87,117	4,325,625
Gogebic	6	0	3,182,532	. . .	3,182,532
Total	29	8	13,734,227	413,896	14,148,123

Construction continued on the Marquette Iron Mining Company's Republic beneficiation plant and operation was planned to begin in 1956. Iron ore concentrate will be recovered by the flotation process from low-grade jasper ore. Concentrates will be shipped to Eagle Mills, east of Negaunee, where the fine mill product will be agglomerated in the pelletizing plant under construction.

The surface plant of the M.A. Hanna Company's Cannon Mine, near Stambaugh, Iron County was completed and the first iron ore was hoisted through the new shaft late in March 1955. Shaft sinking of the Cannon property started August 22, 1951. Ore Is being hoisted 1,000 feet from the new seventh level.

Republic Steel Company planned to open the Genesee Iron ore body, which lies adjacent to the Tobian mine, Crystal Falls location.

One of the nation's largest blast furnaces (hearth diameter 30 feet 3 inches) was constructed at Ecorse, Wayne County for Great Lakes Steel Corporation. Operation of this furnace began in 1955.

Shipments and Value of Iron Ore, 1951-1955

Year	Shipments (Long Tons)	Value
1951	13,673,873	$ 78,120,718
1952	11,798,250	83,942,523
1953	13,380,756	91,402,764
1954	9,722,882	69,226,417
1955	14,148,123	107,890,161

Copper

Geological formation - Keweenawan. Michigan produced 99,996,160 pounds of copper during 1955. This was more than double the production of 1954 or an increase of over 123 per cent. Twelve copper mines in Houghton, Keweenaw, and Ontonagon counties produced approximately 93 per cent of the total copper output. The remaining 7 per cent was recovered by two reclamation plants In Houghton County from waste or tailings rejected by earlier mill operations. The increase In production was primarily the result of output from the White Pine Mine, Ontonagon County, of the White Pine Copper Co. The 1955 copper production In Michigan was the largest since 1931 when 118,495,055 pounds were produced. The year of peak production was 1916 when 269,794,531 pounds were produced. Average price used for calculating the value of copper in 1955 was 37.5 cents per pound.

Copper Production, 1955

	Number of		Copper Production (Pounds)		
County	Mines	Reclamations	Mines	Reclamation	Value
Houghton	4	2	11,349,221	6,402,255	$17,751,476
Keweenaw	6	0	17,534,792	. . .	17,534,792
Ontonagon	2	0	64,709,892	. . .	64,709,892
Total	12	2	93,593,905	6,402,255	99,996,160

Copper Production, 1951-1955

Year	Quantity (Pounds)	Value
1951	49,297,864	$12,077,976
1952	43,939,304	10,820,054
1953	47,999,690	13,832,951
1954	44,786,803	13,298,994
1955	99,996,160	37,489,560

FUELS

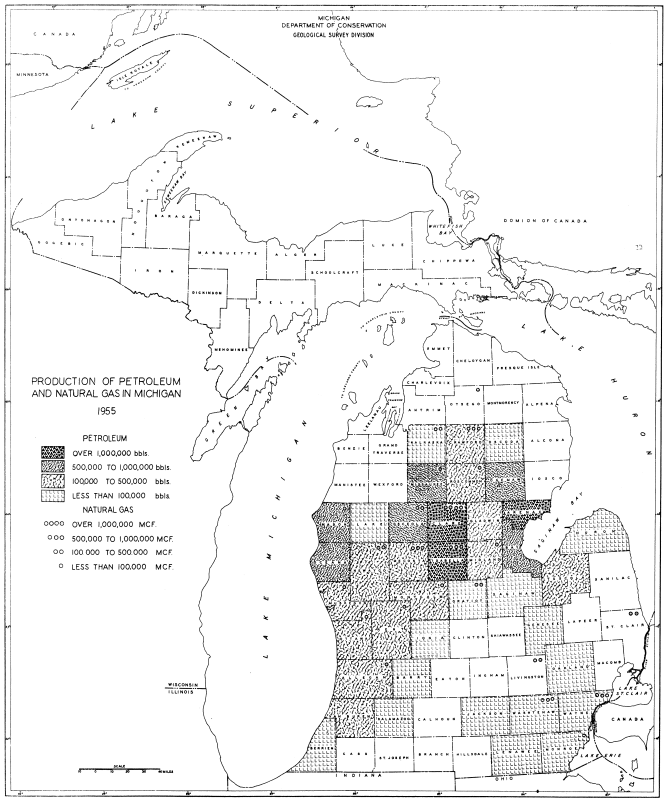
Petroleum

Geological formation - Marshall, Berea, Traverse, Dundee, Detroit River, Salina-Niagaran, Trenton. Petroleum production in Michigan in 1955 decreased 6«per cent in quantity and 6 per cent in value below 1954. At the end of 1955 there were 4,223 producing wells in 30 counties. Approximately 35 per cent of the total output was from Arenac, Isabella, and Clare counties. More than one million barrels were produced in each county.

During the year 510 wells were completed (204 oil producers, 13 gas producers, and 293 dry holes). Of

these completions 203 were wildcats (6 oil producers, 2 gas producers, and 195 dry holes). The remaining 307 completions were field wells (198 oil producers, 11 gas producers, and 98 dry holes).

[Map: Production of Petroleum & Natural Gas in Michigan]



Fifteen refineries, in ten counties, processed more than 99 per cent of the crude oil produced in Michigan during 1955. Michigan crude supplies nearly one-third of the oil refined in the state. The combined normal daily capacity of all Michigan refineries is approximately 150,500 barrels.

Detailed information for oil and gas operations is recorded in the pamphlet entitled "1955 Summary of Operation, Oil and Gas Fields," available from Michigan Geological Survey.

Petroleum Production and Accumulated Oil by Formations, 1955

Formation	Production (Barrels)	Per Cent	Accumulated (Barrels)	Per Cent
Marshall	1,662	.02	57,464	.01
Berea	26,193	.23	2,052,275	.53
Traverse	2,047,230	18.17	79,516,720	20.65
Dundee	5,961,864	52.92	282,593,873	73.38
Detroit River	3,099,621	27.51	20,014,332	5.20
Salina-Niagaran	11,139	.10	54,230	.01
Trenton	118,123	1.05	841,855	.22
Total	11,265,832	100.00	385,130,749	100.00

Petroleum and Natural Gas Production, 1951-1955

Year	Petroleum		Natural Gas	
	Barrels	Value	M. cu. ft.	Value
1951	13,926,518	$ 37,949,762	10,524,495	$ 1,641,821
1952	13,251,387	36,176,306	8,677,737	1,353,727
1953	12,284,510	35,644,982	7,089,985	1,246,106
1954	12,028,059	34,279,968	5,698,175	997,180
1955	11,265,832	32,074,018	6,787,697	1,187,846

Natural Gas

Geological formation - Glacial drift, Michigan Stray-Marshall, Berea, Antrim, Traverse, Dundee, Detroit River, Richfield, Salina-Niagara, Trenton. Natural gas-production increased 19 per cent to 6,787,697,000 cubic feet in 1955. Of this amount 1.96 billion cubic feet was oil well gas. Natural gas was produced from 321 wells in 23 counties. Clare, Washtenaw, Isabella, and Mecosta counties led with 62 per cent of the state total.

Gas Production and Accumulated Gas by Formations - 1955

Formations	Production (M. cu. ft.)	Per Cent	Accumulated (M.cu.ft.)	Per Cent
Glacial Drift	. . .	. . .	8,020	.00
Michigan Stray) Marshall)	2,420,282	35.66	205,256,896	68.08
Berea	71,455	1.05	10,179,655	3.38
Antrim	8,289	.12	116,410	.04
Traverse	31,671	.47	7,044,017	2.34
Dundee	564,591	8.31	38,148,212	12.65
Detroit River	. . .	. . .	535,811	.18
Richfield	1,432,635	21.11	8,687,844	2.88
Salina-Niagaran	1,202,718	17.72	20,135,303	6.68
Trenton	1,056,056	15.56	1,066,781	.35
Unassigned	. . .	. . .	10,287,581	3.41
Total	6,787,697	100.00	301,466,530	100.00

Natural Gasoline

Michigan, in 1955, produced from oil-well gas a total of 3,612,912 gallons of natural gasoline and allied products valued at $361,291. Of the six producing counties, Crawford ranked first with 73 per cent of the state total.

Natural Gasoline Production, 1951-1955

Year	Quantity (Gallons)	Value
1951	6,871,119	$ 387,112
1952	5,330,139	533,014
1953	4,414,351	441,438
1954	3,898,312	389,831
1955	3,612,912	361,291

NON-METALLIC MINERALS

Portland Cement

Portland cement was produced by seven cement plants in the state. Raw materials used in cement manufacturing include clay, shale, limestone and gypsum. 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 in the northern part of the Southern Peninsula. All gypsum was purchased.

Raw Material Used in the Manufacture of Portland Cement, 1955

Raw Material	Short Tons
Limestone	4,592,317
Clay and shale	1,401,222
Gypsum	123,818

Shipments and value of Portland cement increased for the eleventh consecutive year. Nearly all plants operated at or near capacity during the year. Alpena County continued as the leading producer, and Wayne County ranked second. Portland cement was produced also in Bay, Emmet, Lenawee, and St. Clair counties.

A new cement plant was under construction at Detroit by the Peerless Cement Corporation in 1955. At the Company's Port Huron plant, a stack dust collecting system was installed to eliminate air pollution in the nearby residential district.

The Huron Portland Cement Company at Alpena added facilities to increase production of its plant. New raw grinding, climber burning and finish grinding equipment were installed. Changes and improvements in the vessel-loading system and equipment for handling, conveying and apportioning raw material were completed. The company purchased the "C. C. Collins", a 440-foot bulk ore carrier. Addition of the "Collins" and the "Presque Isle", purchased in 1954, make a total of six ships owned by Huron.

Penn-Dixie Cement Company at Petoskey added a new 375-foot long kiln to increase its production by 50 per cent. Addition of the kiln was part of a $4,000,000 expansion program which included a stone crusher and several new tool arid work houses.

Wyandotte Chemical Corporations Wyandotte, Wayne County, expanded its cement plant facilities at a cost of approximately $2,500,000. This Air polution control equipment, including an electro-static precipitator were installed. Clinker coolers were installed and. linings were extended to the full length of the plant stacks. Addition of two silos, cement conveying systems, and extensions of bulk loading facilities were included in the expansion program. The company also manufactures chlorine, soda-ash, caustic soda, and specialized cleaning compounds.

Portland Cement Shipments, 1951-1955

Year	Shipments (Barrels)	Value	Rank in U.S.	No. of Plants
1951	14,112,639	$ 35,121,324	5	7
1952	14,760,783	36,819,041	5	7
1953	15,853,096	41,860,464	5	7
1954	18,106,975	50,460,566	5	7
1955	19,738,400	58,048,378	5	7

Stone

Geological formation - Marshall, Traverse, Dundee-Rogers City, Detroit River, Bass Island, Engadine, Burnt Bluff, Keweenawan, Huronian. Limestone and dolomite made up over 99 per cent pf Michigan stone production. Approximately 59 per cent of the stone was quarried from the Rogers City, Dundee, and Traverse limestone in Presque Isle, Cheboygan, Alpena, and Wayne counties. The regaining 41 per cent was from the Niagaran limestone and dolomites in Mackinac and Chippewa counties, the Bass Island and Detroit River dolomites in Monroe County, and the Bayport limestone from Huron, Eaton, Jackson and Arenac counties.

Dimensional limestone was produced in Eaton, Huron, and Presque Isle counties. Sandstone for rough construction, rubble, and flagging stone was quarried In Jackson County. Basalt was crushed and used for road construction in Houghton and Gogebic counties.

Stone Production, 1955

Commodity	Quantity (Short tons)	Value
Limestone and dolomite:		
Crushed	25,242,052	$ 23,150,838
Dimensional	6,932	73,457
Sandstone:		
Dimensional	8,731	79,410
Basalt:		
Crushed	54,579	58,147
Total	25,312,294*	$ 23,361,852

*Does not include 8.3 million tons of limestone used in the manufacture of Portland cement and lime.

In 1955, stone production increased approximately 6,000,000 tons over the 1954 production, due largely to greater demands by the steel industry for flux stone. More than twenty-two million tons of limestone and dolomite were produced from Chippewa, Mackinac, and Presque Isle counties.

Uses of Crushed Limestone and Dolomite, 1955

Uses	Per cent of Total	Quantity (Short Tons)	Value
Flux	62.0	15,662,554	$ 13,603,476
Concrete & road metal	18.9	4,763,440	5,083,510
Chemical*	14.6	3,678,703	3,294,259
Agricultural	2.5	633,483	612,501
Railroad ballast	.9	231,439	249,506
Riprap	.3	84,758	93,286
Other**	.8	187,675	214,300
Total	100.0	25,242,052	$ 23,150,838

* Includes alkali, calcium-carbide, sugar, glass and paper.
** Includes paint filler, putty filler, asphalt, dust for coal mines, mineral food, store sand, and others.

Shipments of limestone from the new $15,000,000 quarry and plant of the Presque Isle Corporation, owned by five steel companies and located 3 miles north of Bell, Presque Isle County began in April 1955. Five grades of high calcium limestone are produced for open hearth and blast furnace flux stone. Some stone is sold for the manufacture of cement and lime, Chemstone Corporation, Cleveland, Ohio (formerly Kelley Island Lime and Transport Company) ranges and operates the plant on a fee basis. This plant, said to be the second largest flux stone plant In the nation, has a capacity of 2,000 tons of limestone per hour. Stone Is quarried from the 50 to 55 foot thick high calcium Rogers City-Dundee limestone.

The year 1955 closed a decade of operation by the Drummond Dolomite Corporation, Drummond Island, Chippewa County. Starting from scratch, in 1945, this company has grown into one of the world's largest dolomite producers, by providing a high quality raw material for chemical, steel and construction purposes throughout the Great Lakes area. The aggregate for the piers and foundation work of the Mackinac Bridge was supplied from Drummond Island. The company is now using a new 120 foot tower equipped with two 90 degree radial stacking conveyors, beneath which a new tunnel has been extended. Another prominent feature now in use, located on high ground near the mill is a new 7,200 square foot Butler-type office-maintenance storage building.

Huron River Quarry Corporation opened a quarry just west of Flat Rock, Wayne County. Dolomite rock quarried from the Amherstberg member of the Detroit River formation is marketed for parking lot and general building purposes.

The new flux stone operation of the Michigan Limestone Division, United States Steel Corporation, near

Cedarville, Mackinac County, began full scale production in 1955. The first cargo left their new port, "Port Dolomite", April 16, 1955. This Northern Peninsula dolomite quarry was opened- to supplement the high calcium limestone produced at the company's Rogers City operation in the Southern Peninsula.

The wasterock piles and stamp sands of the old copper mines were utilized. Waste piles of the Hancock Mining Company, now owned by the Thornton Construction Company, were used as ballast for railroad crossing and paving between Dollar Bay and Lake Linden, Keweenaw County. The huge deposit of stamp sand at the old Isle Royale mill in Portage Lake, near Houghton, was used as a source of railroad ballast by the D.S.S. and A. Railroad Company. In addition, the Houghton County Road Commission used a considerable quantity of the sand for road repair in Portage and Chassell townships, Houghton County. On September 15, 1955 the company started quarrying dolomite rock from Limestone Mountain at Alston. The stone is crushed and used for agricultural fertilizers.

Production of Stone, 1951-1955

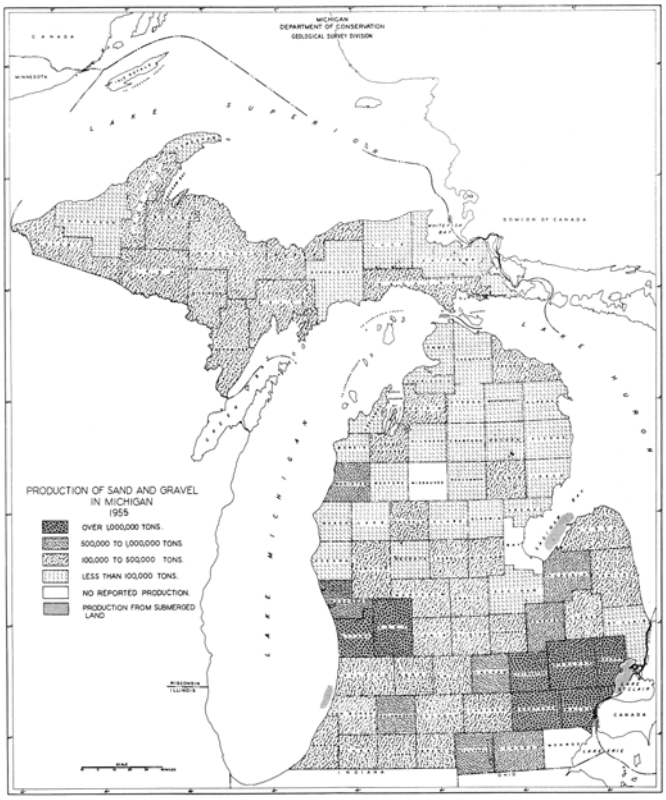
Year	Quantity (Short tons)	Value	Rank in U.S.
1951	20,935,767	$ 17,082,206	3
1952	18,001,080	15,590,573	4
1953	21,053,866	17,442,250	3
1954	19,461,818	17,526,743	3
1955	25,312,294	23,361,852	3

Sand and Gravel

Geological formation - Glacial Drift. Production and use of sand and gravel again reached a new high in 1955. Both quantity and value increased approximately 16 per cent to 37,269,709 tons valued at $29,565,730.

Sixty-three per cent of the total sand and gravel output was used in road construction and 26 per cent for structural purposes.

[Map: Production of Sand and Gravel in Michigan 1955]



Uses of Sand and Gravel, 1955

Uses	Quantity (short tons)	Value	Per cent of total
Structural sand	5,243,086	$ 4,104,182	14.1
Paving and Road sand	5,006,015	3,800,416	13.4
Molding sand	1,895,382	1,795,555	5.1
Grinding & Polishing sand	291,472	102,015	.8
Other sand*	1,117,544	1,427,173	3.0
Paving & road gravel	18,461,929	13,301,294	49.6
Structural gravel	4,459,400	4,430,449	11.9
Railroad ballast gravel	283,761	222,216	.7
Other gravel	511,120	382,430	1.4
Total	37,269,709	$29,565,730	100.0

*Includes glass sand, engine sand, blast sand, railroad ballast sand, and other sand.

Production of sand and gravel was reported from 80 of the 83 counties of Michigan. Approximately 67 per cent of the total production was from seven counties in order of rank - each producing more than 1,000,000 tons: Oakland (about 18 per cent of state total), Livingston, Wayne, Washtenaw, Ma comb, Kent, and Ottawa. About 83 per cent of the state's total was reported by 192 commercial producers and, the remaining 17 per cent was non-commercial production by county road commissions and other governmental agencies.

Production of Sand and Gravel, 1951-1955

Year	Quantity (short tons)	Value	Rank in U.S.
1951	24,668,264	$ 18,324,872	2
1952	27,126,339	21,050,125	2
1953	30,459,663	23,170,802	2
1954	32,035,729	25,458,503	2
1955	37,269,709	29,565,730	2

The first commercial application of "beneficiation" of gravel in Michigan involved the installation of a heavy media separation unit to up-grade materials at a plant

near Northville, Wayne County. This plant is unique, it has been adapted for operation with portable crushing, screening, and washing units. The process removes objectionable chert and shale to meet Michigan State Highway Department and Wayne County material specifications.

Fenner-Crane and Construction Service Company, Muskegon, purchased a 30 acre tract in Cedar Creek Township, Muskegon County, for sand recovery operations. The sand is sold as hardtopping road mix and for construction work by the Great Lakes Dock and Material Corporation.

Michigan Gravel Company, Muskegon, opened a 90-ton-per hour sand and gravel plant in Casnovia Township near Muskegon. The plant produces washed mortar and concrete sand and several sizes of gravel. A gravel jig for removing impurities has been installed.

The Holly Sand and Gravel Company, Holly, Oakland County, opened a new $300,000 processing plant. Production capacity was increased 300 per cent to 400 tons of sand and gravel an hour. This expansion permits increased production of ready-mixed concrete by J.P. Burrough and Sons, Incorporated, the parent company.

Salt

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

Approximately 66 per cent of the salt was used by chemical plants in Wayne, Midland and Muskegon counties. Over 1.8 million tons of salt were used in soda ash plants, and 1.5 million tons were used for the manufacture of chlorine and other chemicals. Approximately 17 per cent of the total production was dried and evaporated salt.

Uses of Salt, 1955

Uses	Quantity (short tons)
Chemical	3,302,700
Highway, dust and ice control	630,100
Livestock	282,800
Textile, hides, and packers	227,500
Food processing	183,500
Table and other household	112,300
Metallurgy	65,700
Water treatment	57,000
Refrigeration	3,333
Other	110,500
Total	4,975,400

Although tonnage of salt declined slightly in 1955, the value reached an all-time high, due largely to the higher value producers placed on the brine used. Of the six counties producing salt, Gratiot, Manistee, Midland, Muskegon and St. Clair, Wayne County ranked first. Four companies in Wayne County reported a combined total of 3,643,166 tons or approximately 73 per cent of the state's total output.

Salt Production, 1951-1955

Year	Quantity (short tons)	Value	Per cent of U.S. total	Rank in U.S.
1951	5,137,639	$ 21,221,330	25.4	1
1952	4,778,347	21,406,382	24.4	1
1953	5,127,387	22,171,988	24.7	1
1954	5,063,633	29,396,812	...	1
1955	4,975,442	31,668,351	...	1

Clay and Shale

Geological formation - 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. In Eaton and Shiawassee counties, Saginaw shale is used by three plants for manufacture of tile. Other tile, brick, pottery, and light-weight aggregate plants and some southern Michigan cement plants use local surface clay deposits. Glacial lake clay, produced in Saginaw County, is sold for oil well drilling mud, for molding sand bond; for fungicide and insecticide base and for cosmetic "beauty packs".

A new record high for raw clay and shale production was set by the 12 producing counties. Wayne County led in production and value with 32 per cent of the state's total output, followed by Alpena, Saginaw and St, Clair counties. Approximately 72 per cent of all raw clay and shale produced was used by the Portland cement industry. The remaining 28 per cent was used for the manufacture of a small quantity of prepared clays and for clay products - brick, tile, pottery, and lightweight aggregates.

Clay deposits furnish about 82 per cent of the raw material for the manufacture of clay products and shale deposits the remaining 18 per cent.

Production of Clay and Shale, and Clay Products, 1951-1955

	Raw Clay and Shale		Clay Products
Year	Quantity (short tons)*	Value **	Estimated Value
1951	1,531,732	$ 1,592,137	$ 5,112,000
1952	1,580,123	1,615,122	4,534,000
1953	1,605,804	1,646,113	6,995,181
1954	1,890,950	1,940,408	7,331,998
1955	1,937,593	2,019,077	7,292,477

*Sold or used. Value of clay used in cement and heavy clay products not included in total value of state.

Gypsum

Geological formation- Michigan. Gypsum is quarried at Alabaster and National 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, and River Rouge, Wayne County. Principal uses for gypsum are in the manufacture of a variety of plaster, wall board, and allied building materials and as a Portland cement retarder.

Since 1945 Michigan, producing about 18 per cent of the national total, has ranked first in the production of crude

gypsum. In 1955, Michigan produced 1,762,105 short tons of crude gypsum valued at $5,660,587.

Production of Gypsum, 1951-1955

Year	Quantity (short tons)	Value	Per Cent of U.S.	Rank in U.S.
1951	1,566,276	$ 4,402,725	18	1
1952	1,487,642	4,200,418	18	1
1953	1,446,973	4,091,002	18	1
1954	1,693,279	5,035,550	-	1
1955	1,762,105	5,660,587	-	1

Plans for dredging a 12,000 foot channel, 250 feet wide In Lake Huron from a point just south of Tawas City, was part of a $90,000,000 expansion program by National Gypsum Company, which operates quarries and a gypsum plant 12 miles southwest of Tawas. New quarries in the area were included in the program. The 6,000 foot tramway will carry gypsum out to lake freighters.

Peat

Geological formation - Pleistocene. Peat is produced in Lapeer, Shiawassee, Kalamazoo, and Mason counties. Michigan peat is used almost exclusively for horticultural purposes, marketed largely as a soil conditioner for lawns, golf courses, gardens, nurseries, and greenhouses. It is estimated by the United States Bureau of Mines that the glacial lakes and bogs of Michigan, Minnesota and Wisconsin contain 75 per cent of the nation's total peat reserves.

Production of Peat, 1951-1955

Year	Quantity (short tons)	Value	Per Cent of U.S.	Rank in U.S.
1951	20,180	$320,100	10.4	5
1952	36,020	430,156	16.6	2
1953	25,439	257,176	12.5	4
1954	27,847	429,116	-	3
1955	30,000	465,000	-	3

Marl

Geological Formation - Pleistocene. All marl produced In the state is used for agricultural purposes. Commercial marl production was reported by 23 producers in 15 counties during 1955. Kalamazoo County ranked first, followed by Calhoun, Allegan, and Branch counties. Combined, these counties produced approximately 59 per cent of the state output.

Production of Marl, 1951-1955

Year	Quantity (short tons)	Value	Rank in U.S.
1951	144,731	$ 125,212	1
1952	130,613	119,705	1
1953	183,685	72,781	1
1954	106,668	37,724	1
1955	119,313	57,176	1

Lime

Geological formation - Dundee, Burnt Bluff. Production of lime in Michigan increased approximately 29 per cent in production and 25 per cent in value over 1954. Raw stone for its manufacture was obtained from the high calcium Dundee limestone In Presque Isle County and from the Burnt Bluff limestone in Mackinac County. All Lime produced was sold or used for chemical and industrial use. Mason County continued to rank first in production, followed by Menominee and Bay counties.

Until the turn of the century, when the chemical industries began to grow rapidly, lime was used almost entirely in building and agriculture. Since then, progressively larger amounts have been employed in chemical tests and processes. All lime produced in the state is now sold or used for chemical purposes. Lime Is used to soften and purify water, to make glass, petrochemicals, bleaches, pharmaceuticals, insecticides, sugar and leather, and as a causticizing agent in paper and pulp manufacturing. It is used as a flux in the purification of steel. It continues to be used widely in mortar, stucco, plastering material and as a fertilizer.

Lime is obtained by calcining or cooking Limestone rock. The rock is crushed, screened, and conveyed to rotary or vertical kilns where it is calcined at 2200°F. Into quick lime (calcium oxide) by removal of carbon dioxide as gas. Ninety-three per cent of the lime was sold or used as quick lime. The remaining 7 per cent is treated with water to form hydrated lime, a fine white powder.

Bromine, Calcium-Magnesium Chloride, Magnesium Compounds, Potash

Geological formation - Marshall, Dundee, Sylvania, Detroit River. Natural brines from the Marshall, Dundee and Sylvania formations were used by chemical companies of Midland and Gratiot counties; and brines from the Filer sandstone of the Detroit River formation were used in Mason and Manistee counties. These natural brines are source material for many chemicals and chemical compounds.

Elemental bromine was produced by four companies In six plants in Gratiot, Manistee, Mason and Midland counties. Bromine compounds were produced by three companies in Gratiot, Manistee, 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. Only one plant (Dow Chemical Co., Midland) reported production of potassium salts from natural brines.

Most of the calcium-magnesium chloride sold was for stabilization of dirt roads and for dust control. Other Important uses for calcium chloride are the "freeze-proofing" of coal, iron ore and other materials shipped in bulk in railroad cars or stockpiled in the open and for the freeze-proof curing of cement. Magnesium compounds have a variety of uses and are particularly important in the manufacture of fertilizers, oxy-chloride cement, rayon and rubber. Magnesium chloride is at present the principal raw material used in the production of metallic magnesium. Magnesium sulfate, carbonate, oxide and hydroxide are used extensively in pharmaceuticals.

The value of the natural salines recovered from natural brines in 1955 by the chemical plants increased 10 per cent over the 1954 value. The greatest increase in value was recorded by calcium-magnesium chloride, followed by magnesium compounds, bromine, and potash.

Production of Magnesium Compounds, 1950-1955

Year	Quantity (tons)	Value	Rank in U.S.
1950	59,036	$ 4,998,342	2
1951	*	*	1
1952	*	*	2
1953	43,190	4,591,922	2
1954	39,096	4,628,756	2
1955	86,264	5,630,978	2

*Data concealed

Water

Water has finally come to be recognized as the most important and valuable of our mineral resources. Each citizen of modern society requires more than 1300 gallons daily to meet direct and indirect needs. Industry uses tremendous quantities for man's direct needs especially when we consider that for every 100 gallons of water a person uses directly, many times that amount is used for him by industry and service facilities. For example, it takes 14,400 gallons of water to produce one ton of pig iron; 65,000 gallons to produce one ton of finished steel; 18 barrels of water to refine a barrel of oil; 15,000 gallons of water to make an automobile; 100 gallons of water to produce one slice of breakfast bacon. Fortunately Michigan is blessed with an abundance of water,

During the retreat of the great continental glacial many thousands of years ago deposits of glacial drift - sand, clay, gravel, boulders - were layed down on the bed rock. Many Michigan cities, villages, and rural areas now obtain fresh water from the sands and gravel beds of the glacial drift. Sands and gravels deposited in the moraines and outwash plains, or from the beaches and delta deposits of ancient glacial lakes and rivers. In other localities where the drift is relatively thin fresh water is recovered from underlying porous bed rock formations. In some places, however, it has been necessary to pipe large volumes of water from the Great Lakes to industrial areas or cities where groundwater resources are inadequate or contain salty or brackish waters.

Because water resources are renewable (from rains and snows) and are transient (much water runs off to rivers, much is transpired to the air by plants) a great deal of information is required to adequately plan their development and uses. Appraisal of water resources is becoming more and more important to insure a lasting supply sufficient to meet needs of expanding industries as well as an ever increasing population. This appraisal includes consideration of climate, surface, and sub-surface land forms, land uses, land forms, stream flow and other seemingly remote bits of information. Hydrological conditions regarding rainfall, runoff, and percolation must be understood in developing a water supply.

Precipitation is the source of all water supply. Only a small part of the rain-snow fall on the land is converted by man to his use. With an average rainfall of 30 to 33 inches per year only about 5 inches become useful groundwaters. The remainder runs off to streams on its way back to the sea. Of the precipitation that enters the ground, plants transpire an enormous amount, and rainfall is not concentrated where water is most needed, in the industrial and irrigation areas.

Underground water is a source of supply of small communities but large cities with a few exceptions, either utilize waters of the Great Lakes or of the rivers on whose shores they were founded.

Best estimates available from the U.S. Department of Commerce indicate that 30,000 water wells are drilled in Michigan each year. Approximately one million water wells are in use for all purposes. One of the most serious shortages on data on groundwater exists in the water well! log files of the Geological Survey. Only by compiling many hundreds of logs of a given area is it possible to unravel the geologic puzzle and thus make an educated guess concerning the underground reservoir capacity.

In the Saturday Evening Post, May 13, 1950, Hugh H. Bennett of the United States Conservation Service warns that cities and areas plagued by water shortages grow in number every year. In 1955, for example, the city of Flushing ran out of water. With adequate hydrological investigations, however, shortage in most communities can be met intelligently or avoided, by making an approximate analysis of the quantity and quality of water needed and by designing the systems on the basis of reliable information on the source of the water to be developed. Water can be provided in adequate quantity and quality in any part of the state if the funds are available to construct the necessary facilities.

What is the monitory value of the mineral water? No data has been compiled on the gallons used for domestic, industrial, agricultural, scenic and recreational purposes and no dollar value has been assessed.

Value of Michigan's Minerals
and
Mineral Products
1940-1955

Year	Value	Year	Value
1940	$ 117,991,285	1948	$ 214,115,771
1941	135,492,921	1949	207,607,694
1942	152,624,946	1950	238,474,008
1943	147,113,888	1951	257,529,882
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

TABLE I
MINERAL PRODUCTS OF MICHIGAN, 1955[1]

Product	Unit	Quantity	Value	Rank in U.S.(2)
Iron ore	Long tons	14,148,123	$107,890,161	2
Portland cement	Barrels	19,738,400	58,048,378	4
Copper	Pounds	99,996,160	37,489,560	6
Petroleum	Barrels	11,265,832	32,074,018	12
Salt	Short tons	4,975,442	31,668,351	1
Sand and Gravel	Short tons	37,269,709	29,565,730	2
Stone (3)	Short tons	25,312,294	23,361,852	3
Clay Products	. . .	. . .	7,292,477	. . .
Gypsum	Short tons	1,762,105	5,660,587	1
Magnesium Compounds	Short tons	86,264	5,630,978	2
Clay and Shale, raw	Short tons	1,886,976	(4)	9
Natural Gas	M. cu. ft.	6,787,697	1,187,846	17
Peat	Short tons	30,000	465,000	3
Natural Gasoline	Gallons	3,612,912	361,291	15
Marl	Short tons	119,313	57,176	1
Miscellaneous (5)	. . .	. . .	30,603,199	. . .
Total			$371,356,604	

(1) Statistics compiled in co-operation with the United States Bureau of Mines.

(2) Based upon quantity.

(3) Limestone used in the manufacture of Portland cement and lime not included.

(4) Value of clay and shale used in clay products and cement industries not included in state total value; value of other clays included under miscellaneous.

(5) Includes bromine, calcium chloride, calcium-magnesium chloride, clay, lime, potassium salts, and gem stones (Agates, Datolite, Petoskey stone, Chlorastrolite, Jasper, and Thomsonite).

TABLE II
MINERAL PRODUCTS OF MICHIGAN, 1954[1]

Product	Unit	Quantity	Value	Rank in U.S.(2)
Iron ore	Long tons	9,722,882	$69,226,417	2
Portland Cement	Barrels	18,106,975	50,460,566	4
Petroleum	Barrels	12,028,059	34,279,968	...
Salt	Short tons	5,063,633	29,396,812	1
Sand and Gravel	Short tons	32,035,729	25,458,503	2
Stone[3]	Short tons	19,461,818	17,526,743	4
Copper	Pounds	44,786,803	13,298,994	...
Clay Products	...	...	7,331,998	...
Gypsum	Short tons	1,693,279	5,035,550	1
Magnesium Compounds	Short tons	39,096	4,628,756	2
Clay and Shale, raw	Short tons	1,886,976	(4)	...
Natural Gas	M. cu. ft.	5,698,175	997,180	...
Natural Gasoline	Gallons	3,898,312	389,831	...
Peat	Short tons	27,847	429,116	2
Marl	Short tons	106,668	37,724	1
Miscellaneous[5]	...	...	28,068,821	...
Total			$286,566,979	

(1) Statistics compiled in co-operation with the United States Bureau of Mines.

(2) Based upon quantity.

(3) Limestone used in the manufacture of Portland cement and lime not included.

(4) Value of clay and shale used in clay products and cement industries not included in state total value; value of other clays included under miscellaneous.

(5) Includes bromine, calcium chloride, calcium-magnesium chloride, clay, lime, and potassium salts.

THE MINERAL INDUSTRY OF MICHIGAN IN 1956* (Preliminary)

Mineral production in Michigan in 1956 had an estimated value of $390 million according to the Bureau of Mines, United States Department of the Interior. Over-all the total value of minerals produced was 7 percent greater than 1955 when output was valued at $364 million. A wide range of change was noted in the various mineral commodities. Copper showed an increase in value of output of 38 percent, sand and gravel 28 percent and Portland cement 22 percent. Iron ore productions reflecting the work stoppage caused by the steel and shipping strikes, decreased about 10 percent in value. The value for petroleum and natural gas was about 5 percent less than in 1955.

Iron ore continued to rank first in value of minerals produced, followed by cement, copper, sand and gravel, salt, petroleum and stone. Of the total value of output, nonmetallic minerals accounted for 54 percent, metals 37 percent and fuels 9 percent. In 1955 the percentage breakdown of values was: nonmetallics 51 percent, metals 39 percent and fuels 10 percent.

*Prepared January 15, 1957 by Donald F. Klyce, Commodity Industry Analyst, under the supervision of Samuel A. Gustavson, Chief, Minneapolis Field Office, Division of Mineral Industries, Region V.

METALS

Copper.-Production of copper in Michigan in 1956, in terms of recoverable metal, was 20 percent greater, while value was up 38 percent over 1955. Production was reported by the White Pine Copper Co. in Ontonagon County, the Calumet and Hecla operations in Houghton and Keewenaw Counties and the Quincy Mining Co. and Copper Range Co, in Houghton County.

Average weighted prices used for calculating the value of copper was 41.9 cents per pound in 1956 and 37.3 cents in 1955. Quoted market prices for copper, per pound, delivered Connecticut Valley, opened 1956 at 43 cents, was increased to 46 cents in the latter part of February, lowered to 40 cents in July and was further lowered to 36 cents in October where it remained beyond the year end.

Iron & Manganese.-Iron ore production fell off 12 percent due chiefly to labor strikes. Increases in the value of the ore held dollar loss to about 10 percent less than 1955 totals. Mines are located in Baraga, Dickinson, Gogebic, Iron and Marquette Counties.

Dates of first and last lake shipments of ore in 1956 from Michigan and Wisconsin ports were: Ashland-Soo, April 23 - Nov. 25; Ashland-C&NW, April 25 - Nov. 28; Escanaba-C&NW, April 7 - Dec, 3; Marquette-DSSA, April 26 -Nov, 11; Marquette-LS&S, April 9 - Dec* 5; Superior-GN, April 5 - Dec. 8; Superior-NP-Soo, April 8 - Nov. 25.

No shipments of ore containing over 5 percent manganese were reported from Michigan mines in 1956. The last shipments for such ore were in 1954.

NONMETALS

Michigan produces a variety of nonmetallic minerals. The most important group are used in the construction industry and include cement, clay, gypsum, lime, sand and gravel and stone. They represent 37 percent of the value of the State's mineral output.

Salines from brine wells are the source of raw materials in the production of several chemicals, notably bromine and magnesium compounds and common salt. The value of salt and salines produced accounted for 17 percent of the 1956 dollar total for mineral production.

MINERAL FUELS

Mineral fuels (peat, petroleum, natural gas and natural gas products) accounted for about 9 percent of the total value of minerals produced in 1956. Over-all production of fuels was slightly less than in 1955. Peat, although classified as a fuel, is sold principally as a soil conditioner. No coal production was reported.

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