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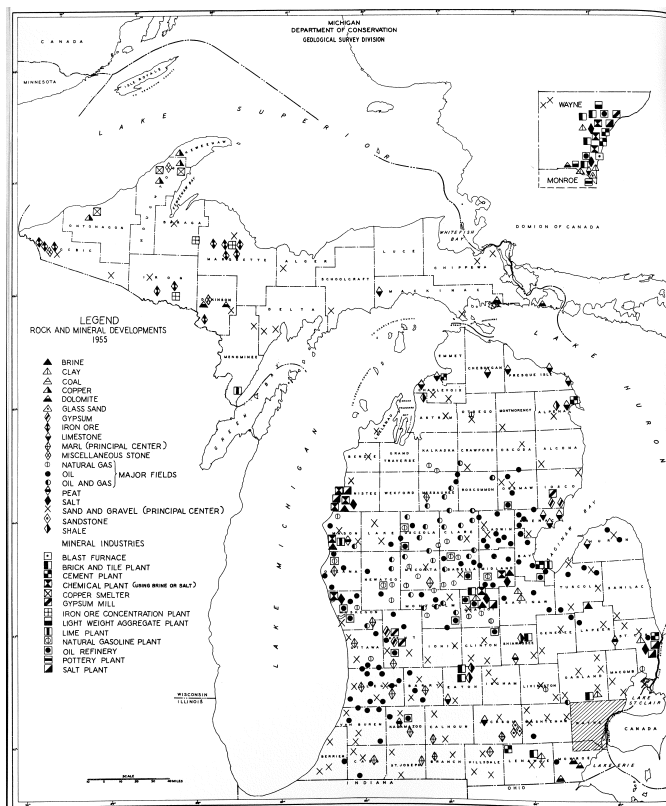
[Map Showing Locations of Rock and Mineral Developments and Mineral Industries]

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MICHIGAN'S MINERAL INDUSTRIES
1954

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FOREWORD

This report is a record of Michigan Mineral Industries for the calendar year 1954. Reports filed by the mineral producers of individual operations throughout the state supplied the information for the study which was made in cooperation with the Bureau of Mines of the United States Department of Interior and Bureau of the Census of the United States Department of Commerce.

The estimated value of mineral production for 1955 was submitted by the United States Bureau of Mines on January 27, 1956. The section on developments in the mineral industries was prepared through office and field conferences with mineral producers and from articles published in Pit and Quarry, Rock Products, Mining Journal and other trade journals.

LATE DEVELOPMENTS IN MICHIGAN'S MINERAL INDUSTRIES

A brief resume of late developments in Michigan mineral industries show that progress will continue in 1956. The Cleveland Cliffs Iron Company is reported to begin operations of The Republic beneficiation plant early in 1956. At this plant, which has an annual capacity rated at 400,000 tons, iron ore concentrate will be recovered by 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 peltitizing plant now 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 now being hoisted 1,000 feet from the new seventh level.

Republic Steel Company announced plans to open the Genesee iron ore body, which lies adjacent to the Tobin mine, Crystal Falls location.

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

Calumet & Hecla, Incorporated completed dewatering and rehabilitation of the No. 13 shaft of the Osceola Mine at Calumet, Houghton County in 1955, and that part of the mine will go into full production in 1956. Meanwhile, dewatering and rehabilitation of No. 6 shaft continues, with completion scheduled for late in the year.

Construction of a new cement plant at Detroit by the Peerless Cement Corporation is now underway. The plant is scheduled to go into production in 1956 and will supply a million barrels of cement annually to the Michigan market. At the company's Port Huron plant, a stack dust collecting system was installed to eliminate air pollution in the nearby residential district.

Facilities to increase production of the Huron Portland Cement Company at Alpena, the world's largest cement plant, are underway and completion is scheduled for April 1956. New raw grinding, clinker burning and finish grinding equipment are being installed. Changes and improvements in the vessel-loading system and equipment for handling, conveying and apportioning raw material have been completed. Company officials announced the purchase of the "E. 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, now owner of the Petoskey Portland Cement Company plant at Petoskey, announced that the new 375-foot long kiln should increase cement production by 50 per cent. Addition of the kiln is part of a \$4,000,000 expansion program which includes installation of a stone crusher and several new tool and work houses.

Wyandotte Chemical Corporation, Wyandotte, Wayne County, has announced the expansion of its cement plant facilities at a cost of approximately \$2,500,000. This expansion will double production to almost 2,500,000 barrels of cement annually. Air pollution control equipment, including an electro-static precipitator, will be installed. Clinker coolers have been installed and linings have been extended to the full length of the plant stacks. Addition of two silos, cement conveying systems, and extension of bulk loading facilities are included in the expansion program. The Company also manufactures chlorine, soda ash, caustic soda, and specialized cleaning compounds.

Shipment of limestone from the new \$15,000,000 quarry and plant of the Presque Isle Corporations, 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 produced for cement and lime. Chemstone Corporation, Cleveland, Ohio (formerly Kelley Island Lime and Transport Company) manages 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 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. When the 1956 quarrying season begins the company will use a new 120-foot tower equipped with two 90 degree radial stacking conveyors, beneath which a new tunnel will be 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. Dolomitic 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", on April 16, 1955. This Northern Peninsula dolomite quarry was opened to supplement the high calcium limestone produced at the company's Rodgers City operation in the Southern Peninsula.

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 is to be installed.

The Holly Sand and Gravel Company, Holly, Oakland County, has opened a new \$300,000 processing plant. Production capacity has been 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 & Sons, Incorporated, the parent company.

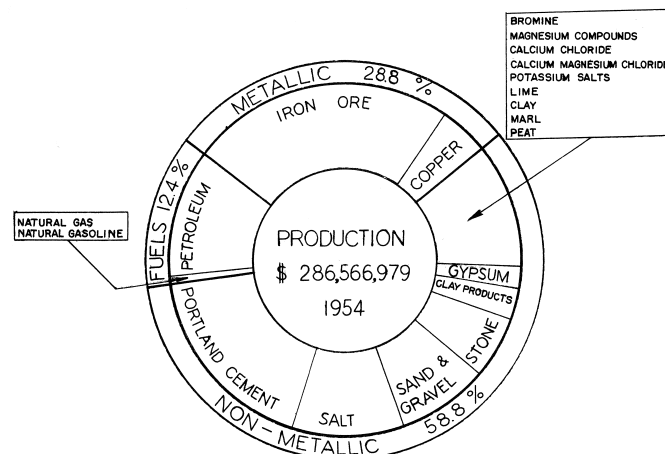
The waste rock piles and stamp sands of the old copper mines are coming into use. Waste piles of the Hancock Mining Company, now owned by the Thornton Construction Company, are used as ballast for railroad crossing and paving between Dollar Bay and Lake Linden, Keweenaw County. The huge deposit of stamp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

Plans for an aerial tramway, sticking more than a mile out into Lake Huron from a point just south of Tawas City, are 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 are included in the program. The 6,000-foot tramway will carry gypsum out to lake freighters.

MICHIGAN MINERAL PRODUCTION 1954

Mineral production in Michigan in 1954 declined only four-tenths of one per cent from the all time high of the previous year of 1953. New production highs were established for bromine, clay, shale, sand, gravel, and cement. Non-metallic mineral production increased 16 per cent, but production of fuels and metallic minerals declined.

Michigan's rank in the United States in volume of mineral production for 1954 is: First in gypsum and salt; Second in iron ore, bromine, magnesium compounds, sand and gravel; Fourth in stone and peat; Fifth in portland cement.



METALLIC MINERALS

IRON ORE: Shipments of iron ore, from 32 underground mines and 9 open pits totaled 9,722,884 long tons (2,240 lbs.) in 1954, a decrease of 27.3 per cent from 1953. This is the lowest total shipment since 1946 when 8,477,425 long tons were shipped and the pre-war year 1938 when 4,092,904 long tons left the Northern Peninsula. The 1954 season was the first full season since 1939 in which iron ore requirements were not affected by the demands of an active war or the prospect of imminent war. The 1954 decrease in shipment resulted from the low rate of operation of the steel industry operated throughout most of the year, and because a very substantial tonnage of ore was in stock at the lower lakes at the start of the 1954 shipping season.

For many years the possibilities of using a flotation process for concentrating Lake Superior ores has been discussed and investigated. The first commercial plant for such a process was put into operation in 1954 and its successful operation marks another milestone for the industry. This flotation plant located at the Humboldt Mine, at Humboldt, Marquette County, is owned jointly by the Ford Motor Company and the Cleveland-Cliffs Iron Company, with Cleveland-Cliffs as operator. The low grade ore (jasper and specular hematite) is mined by the open pit method and hauled to the plant where it is

crushed. The ore is then ground to flotation size, approximately 65 mesh. Through flotation and filtering processes a high grade concentrate containing approximately 64 per cent iron is recovered.

The filtered concentrate is shipped to steel plants where it is mixed with coarser ores before sintering.

Cleveland-Cliffs during the year had a larger mill under construction at the nearby Republic property where similar ore will be concentrated by the process used at the Humboldt plant. The plant will contain a primary crushing and flotation section to treat the low-grade (jasper) hematite.

Production of direct shipping ore ceased at the Book mine, near Alpha, Iron County early in the year. Production was maintained during the shipping season, however, by reclaiming ore from the old lean ore and rock piles of a heavy media plant. Meanwhile, underground development of low grade ore was carried on in the mine. In 1955, low grade ore was to be mined, hoisted to the surface and treated in the heavy media plant to obtain a shipping product.

The Blueberry Mine, located 7 miles west of Ishpeming, on the Marquette Iron Range, was permanently closed December 3, 1954, because of exhaustion of the ore reserves. Underground working had been carried to a depth of 2,000 feet, but there the ore bodies are small and non-commercial. The Blueberry is the third Michigan mine to be labeled "exhausted" in the past 2 years, following the Davidson and James mines at Mineral Hills, Iron County. North Range Mining Company took over the operation of the Blueberry from Ford Motor Company in 1933. From 1926, the year of first shipment, until the mine was closed in 1954, the mine shipped approximately 6 million tons of ore.

Inland Steel Company's Cagia mine near Crystal Falls, Iron County was closed permanently in January, 1954. Sand and water from the overburden filled the mine, and since no safe and economical method of resuming operation could be devised, the mine had to be abandoned. Only a small tonnage of ore had been mined.

The surface plant of the M. A. Hanna Company's Cannon Mine, Stambaugh, Iron County was completed and the shaft sinking neared its objective of 1,700 feet. Plant construction neared completion and underground development progressed at the state's two other new mines, the Peterson at Bessemer, Gogebic County, and the Tracy at Negaunee, Marquette County.

Iron Ore Shipments by Ranges, 1954

Range	Number of mines		Iron Ore Shipped (Long tons)		
	Underground	Open Pit	Direct Shipping	Siliceous	Total
Marquette	13	5	3,514,270	161,159	3,675,429
Menominee	13	3	3,616,467	53,243	3,669,710
Gogebic	6	1	2,377,743	.....	2,377,743
Totals	32	9	9,508,480	214,402	9,722,882

Shipments and Value of Iron Ore, 1950-1954

Year	Shipments (Long tons)	Value
1950	12,926,756	\$73,214,839
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

COPPER. Michigan produced 44,786,803 pounds of copper during 1954. This was 3,212,887 pounds or 3 per cent below the 1953 production. Eleven copper mines in Houghton, Keweenaw, and Ontonagon counties produced approximately 85 per cent of the total copper output. The remaining 15 per cent was recovered by two reclamation plants in Houghton County from waste or tailings rejected by earlier mill operations.

Calumet and Hecla, Inc. continued dewatering operations and rehabilitation of the Osceola mine during 1954 to make available a new supply of copper-bearing rock. The mine originally was open in 1873 but abandoned in 1931 because of low price of copper.

White Pine Copper Company, a subsidiary of Copper Range Company, continued underground development and construction of surface facilities at the White Pine mine, Ontonagon County. By the close of 1954 development in the mine had progressed far enough so that actual mining operations could be started. On October 4, 1954 some 700,000 tons of ore had been stockpiled on the surface. All surface construction, townsite and utility facilities were almost completed by the end of 1954. The mill was started at partial capacity on October 5. The White Pine mine is unique in Michigan because the ore in the Nonsuch shale is mainly copper sulphide (chalcocite, with minor amounts of native copper). The copper mines of Houghton and Keweenaw counties obtain native copper from the Keweenawan lava flows and interbedded rhyolite conglomerates.

Copper Production, 1954

County	Number of		Copper Production (Pounds)		
	Mines	Reclamations	Mines	Reclamation	Total
Houghton	4	2	13,371,884	6,530,840	19,902,724
Keweenaw	6	0	23,805,586	-	23,805,586
Ontonagon	1	0	1,078,493	-	1,078,493
Totals	11	2	38,255,963	6,530,840	44,786,803

Copper Production, 1950-1954

Year	Quantity (Pounds)	Value
1950	51,788,017	\$10,997,185
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

Fuels

[Map: Production of Petroleum and Natural Gas in Michigan, 1954]

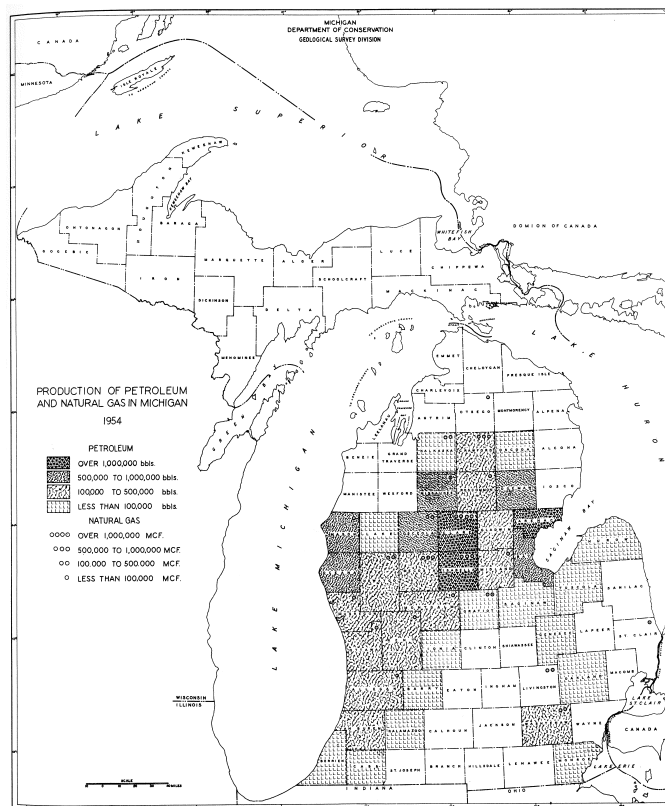
PETROLEUM: Petroleum production in Michigan in 1954 decreased 2 per cent in quantity and approximately 4 per cent in value below 1953. At the end of 1954 there were 4,174 producing wells in 37 counties.

Approximately 36 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 567 wells were completed (219 oil producers, 10 gas producers, and 338 dry holes). Among these completions were 243 wildcats (22 Oil producers, 2 gas producers, and 219 dry holes). The remaining 324 completions were field wells (197 oil producers, 8 gas producers, and 119 dry holes).

Fourteen refineries, in nine counties, processed more than 99 per cent of the crude oil produced in Michigan during 1954. Of the total oil refined in the state, Michigan crude supplied nearly one-third. The combined normal daily capacity of all Michigan refineries is approximately 137,500 barrels.

Detailed information for oil and gas operations is recorded in the pamphlet entitled 1954 Summary of Operations, Oil and Gas Fields, available from Michigan Geological Survey.



Petroleum Production and Accumulated Oil by Formations, 1954

Formation	Production (Barrels)	Per Cent	Accumulated (Barrels)	Per Cent
Marshall	1,875	.02	55,802	.02
Berea	22,217	.18	2,026,082	.54
Traverse	2,450,967	20.38	77,469,490	20.72
Dundee	6,402,152	53.22	276,632,009	73.99
Detroit River	2,967,174	24.67	16,914,711	4.53
Salina-Niagaran	15,692	.13	43,091	.01
Trenton	167,982	1.40	723,732	.19
Total	12,028,059	100.00	373,864,917	100.00

Petroleum and Natural Gas Production, 1950-1954

Year	Petroleum		Natural Gas	
	Barrels	Value	M. cu. ft.	Value
1950	15,826,148	\$43,157,902	12,614,024	\$1,967,788
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

NATURAL GAS: Natural gas production declined 1906 per cent to 5,698,175,000 cubic feet in 1954. Of this amount 1088 billion cubic feet was oil well gas. Natural gas was produced from 301 wells in 21 counties. Clare, Crawford, and Isabella counties led with 55 per cent of the state total.

Gas Production and Accumulated Gas by Formations - 1954

Formations	Production (M. cu. ft.)	Per Cent	Accumulated (M. cu. ft.)	Per Cent
Glacial Drift	...	...	8,020	.00
Michigan Stray)	3,035,260	53.27	200,455,581	68.02
Marshall	...	...	2,381,033	.81
Berea	114,317	2.01	10,108,200	3.43
Antrim	7,528	0.13	108,121	.04
Traverse	64,852	1.14	11,135,498	3.78
Dundee	727,694	12.77	40,697,907	13.81
Detroit River	1,272,651	22.33	535,811	.18
Richfield	...	...	7,255,209	2.46
Salina-Niagaran	465,148	8.16	18,932,585	6.43
Trenton	10,725	.19	10,725	.00
Unassigned	...	...	3,050,143	1.04
Total	5,698,175	100.00	294,678,833	100.00

NATURAL GASOLINE: Michigan, in 1954, produced from oil-well gas a total of 3,898,312 gallons of natural gasoline and allied products valued at \$389,831. Of the six producing counties, Crawford ranked first with 62 per cent of the state total.

Natural Gasoline Production, 1950-1954

Year	Quantity (Gallons)	Value
1950	5,218,794	\$349,660
1951	6,871,119	387,112
1952	5,330,139	533,014
1953	4,414,351	441,438
1954	3,898,312	389,831

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, 1954

Raw Material	Short Tons
Limestone	4,313,093*
Clay and shale	1,425,014
Gypsum	112,497

*Includes lime mud.

Shipments and value of Portland cement increased for the tenth 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.

During 1954 the Huron Portland Cement Company increased its capacity about 25 per cent by the installation of four new 10 by 153-foot Allis Chalmers kilns with corresponding increases in raw and finish grinding capacity. The clinker storage was relocated by the addition of a new 2,000,000 barrel storage. Reclamation is through a 600-foot concrete tunnel under the storage.

In March, 1954, the Bay City Aetna Portland Cement Company completed an expansion program which increased annual capacity by 500,000 barrels to a total of 2,200,000 barrels. Expansion included installation of a new 10 by 175-foot kiln (making a total of four kilns), a waste heat boiler, a grate-type clinker cooler, a 7 by 26-foot raw mill, a 91/2 by 16-foot finish mill, and other equipment. During the summer larger slurry tanks were built and four new 6,000 barrel silos were under construction.

Late in the year Penn-Dixie purchased the Petoskey Transportation Company and the Petoskey Portland Cement Company plant at Petoskey. A modernization and expansion program was announced which included quarry improvement, and the installation of new crusher equipment, kiln, cooler and several new tool and work houses. The Petoskey plant is now operated under the Penn-Dixie name.

Portland Cement Shipments, 1950-1954

Year	Shipments (Barrels)	Value	Rank in U.S.	No. of Plants
1950	12,854,423	\$29,619,766	5	7
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

STONE: Limestone and dolomite made up over 99 per cent of Michigan stone production. Approximately 66 per cent of the stone was quarried from the Rogers City, Dundee, and Traverse limestones in Presque Isle, Cheboygan, Alpena, Wayne and Emmet counties. The remaining 34 per cent was from the Niagaran limestones and dolomites in Mackinac and Chippewa counties, the Bass Island and Detroit River dolomites in Monroe County, and the Bayport limestone in Huron, Eaton, Jackson and Arenac counties.

Dimensional limestone was produced in Eaton, Huron and Presque Isle counties. Sandstone for rough constructions rubble and flagging stone was quarried in Jackson County. Basalt was crushed and used for road constructions in Houghton and Ontonagon counties. Crushed diorite was used for road constructions, in Marquette County.

Stone Production, 1954

Commodity	Quantity (Short tons)	Value
Limestone and dolomite:		
Crushed	19,357,455	\$17,318,514
Dimensional	8,938	68,984
Sandstone:		
Crushed	11,151	6,058
Dimensional	3,574	31,435
Basalt:		
Crushed	80,700	101,752
Total	19,461,818*	\$17,526,743

*Does not include 8.02 million tons of limestone used in the manufacture of Portland cement and lime.

In 1954, stone production dropped approximately 2,000,000 tons below 1953 production, due largely to lesser demands for flux stone by the steel industry. However, more than three million tons of limestone and dolomite were produced from: Chippewa, Mackinac, and Presque Isle counties.

Uses of Crushed Limestone and Dolomite, 1954

Uses	Per cent of Total	Quantity (Short Tons)	Value
Flux	55.9	10,815,128	\$ 9,032,464
Concrete & road metal	21.4	4,151,096	4,445,300
Chemical*	18.3	3,528,324	2,995,047
Agricultural	2.9	534,306	485,252
Railroad ballast	.6	114,916	143,618
Riprap	0	38,134	22,549
Others**	.9	175,551	194,284
Totals	100.0	19,357,455	\$17,318,514

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

** Includes putty filler, asphalt, roof filter, carbon, mineral feeds, stone sand, dust for coal, ornamental concrete, and others.

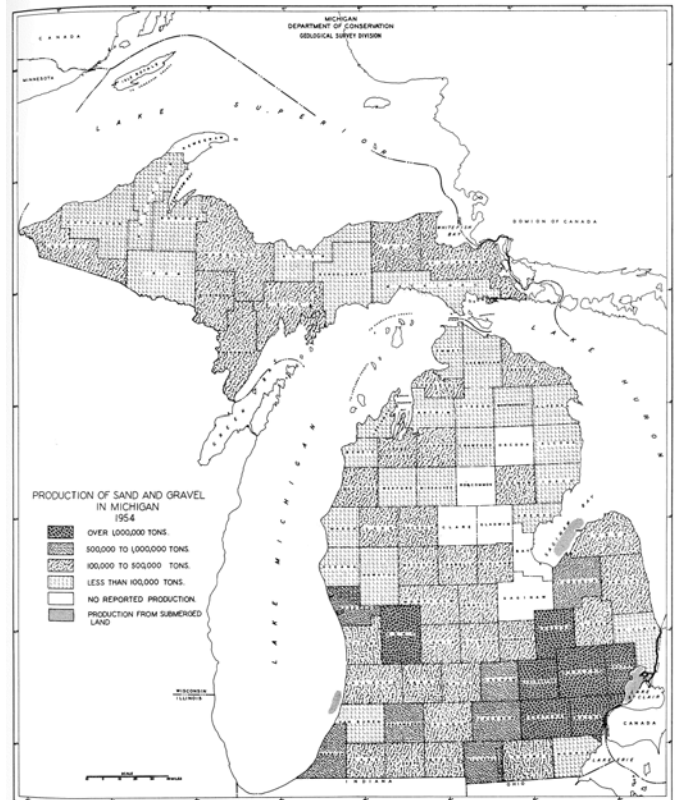
Work on the Michigan Limestone Division, United States Steel Corporation, Cedarville project continued during the year. Five miles of railroad track were laid from the quarry to the harbor "Port Dolomite", a primary crusher was erected on the floor of the quarry, and a processing plant and loading dock were constructed at Port Dolomite.

Information regarding the new Presque Isle Corporation plant which began quarrying in December, may be found in the section on late Developments.

Production of Stone, 1950-1954

Year	Quantity (Short Tons)	Value	Rank in U. S.
1950	19,095,703	\$15,389,684	3
1951	20,935,767	17,082,206	3
1952	18,001,080	15,590,573	4
1953	21,053,866	17,442,250	-
1954	19,461,818	17,526,743	-

[Map: Production of Sand and Gravel in Michigan, 1954]



Production of Sand and Gravel, 1950 - 1954

Year	Quantity (Short tons)	Value	Rank in U. S.
1950	24,559,253	\$16,699,203	2
1951	24,688,264	18,324,872	2
1952	27,126,339	21,050,125	2
1953	30,459,663	23,170,802	-
1954	32,035,729	25,458,503	-

SAND AND GRAVEL: Production and use of sand and gravel continued to a new high. The reported increase of 1,576,066 tons over 1953 production may be owing to the fact - that by the canvass of the U. S. Bureau of the Census, data was obtained from a number of sand and gravel operators who had not reported production in former years. The increased production figure, therefore, may in large measure be due to a more complete canvas of the industry. On the other hand, production of molding sand decreased by 848,070 tons and production of railroad ballast decreased by 221,421 tons.

Approximately three-quarters of the total sand and gravel output was used in road construction. Structural purpose use increased about 29 per cent.

Production of sand and gravel was reported from 77 of the 83 counties of Michigan. Approximately 55 per cent of the total production was from seven counties in order of rank - each producing more than 1,000,000 tons: Oakland (about 19 per cent of state total), Livingston, Washtenaw, Wayne, Kent, Macomb, and Genesee. About 81 per cent of the states' total was reported by 198 commercial producers and the remaining 19 per cent was non commercial production by county road commissions and other governmental agencies.

Uses of Sand and Gravel, 1954

Uses	Quantity (Short tons)	Value	Per Cent of Total
Molding sand	1,117,737	\$ 1,273,601	3.4
Structural sand	4,718,488	3,530,110	14.7
Paving and road sand	3,525,463	2,562,190	11.0
Engine sand	33,324	25,798	.1
Other sand *	1,076,697	1,338,940	3.4
Structural gravel	4,922,085	4,730,736	15.4
Paving and road gravel	15,983,613	11,516,231	49.9
Railroad ballast gravel	284,306	267,750	.9
Other gravel	374,016	213,138	1.2
Totals	32,035,729	25,458,503	100.1

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

SALT: Artificial brines formed by 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 was mined at Detroit by means of a shaft approximately 1,100 feet in depth. Evaporated salt was produced from natural brines drawn from the Marshall and Dundee formations 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 60 per cent of the salt produced was used by chemical plants in Wayne, Midland and Muskegon counties. Some two million tons of salt were used in soda ash plants, and 1.4 million tons were used for the manufacture of chlorine and other chemicals. Approximately 16 per cent of the total production was dried and evaporated salt.

Uses of Salt, 1954

Uses	Quantity (Short tons)
Chemical	3,369,400
Highway, dust and ice control	553,100
Food processing	405,100
Livestock	256,400
Water treatment	104,000
Table and other household	90,100
Metallurgy	67,300
Textile, hides, and leather processing	28,900
Refrigeration	6,500
Agricultural	000
Others	182,305
Total	5,063,600

Production of Clay and Shale, and Clay Products, 1950-1954

Year	Raw Clay and Shale		Clay Products
	Quantity (Short tons)*	Value*	Estimated Value
1950	1,426,659	\$1,137,002	\$5,499,000
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

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

GYPSUM: 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 plasters, 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 1954, Michigan produced 1,693,279 short tons of crude gypsum valued at \$5,035,550.

Salt Production, 1950 - 1954

Year	Quantity (Short tons)	Value	Per cent of U.S. Total	Rank in U. S.
1950	4,446,667	\$19,178,765	26.7	1
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

The Hooker Electro-Chemical Company, of Niagara Falls, New York, opened a new \$12,000,000 plant on the north shore of White Lake, about 2 miles southwest of Montague, Muskegon County. Artificial brines are obtained from Salina salt at a depth of 3,100 feet and are used in the production of caustic soda, hydrogen, and chlorine.

CLAY AND SHALE: Clay and shale are produced at widespread localities throughout the state. Antrim shale from Alpena County and Ellsworth shale from Antrim County quarries are used in the manufacture of Portland cement. 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 11 producing counties. Wayne County lead in production and volume with 30 per cent of the state's total output, followed by Alpena, St. Clair and Saginaw counties. Approximately 75 per cent of all raw clay and shale produced was used by the Portland Cement industry. The remaining 25 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 78 per cent of the raw materials for the manufacture of clay products and shale deposits supply the remaining 22 per cent.

Production of Gypsum, 1950-1954

Year	Quantity (Short Tons)	Value	Per Cent of U. S.	Rank in U. S.
1950	1,474,210	4,090,777	18	1
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

PEAT: 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, 1950-1954

Year	Quantity (Short Tons)	Value	Per Cent of U. S.	Rank in U. S.
1950	13,625	\$186,000	10.4	4
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	-	-

MARL: All marl produced in the state is used for agricultural purposes. Commercial marl production was reported by 23 producers in 14 counties during 1954. Kalamazoo County ranked first, followed by Calhoun, Allegan, and Branch counties. Combined, these counties produced approximately 57 per cent of the state output.

Production of Marl, 1950-1954

Year	Quantity (Short tons)	Value	Rank in U. S.
1950	218,429	\$122,212	1
1951	144,731	125,212	1
1952	130,613	119,705	1
1953	183,685	72,781	1
1954	106,668	37,724	...

LIME: Production of lime in Michigan was approximately the same in 1954 as in 1953. 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 for chemical and industrial use. Mason County continued to rank first in productions, 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. More than 90 per cent of the 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 per cent of the lime was sold or used as quick lime. The remaining 10 per cent is treated with water to form hydrated lime, a fine white powder.

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

Elemental bromine was produced by three companies in five 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-proofing curing of cement. Magnesium compounds have a variety of uses and are particularly important in the manufacture of fertilizers, oxychloride 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 1954 by the chemical plants increased 12 per cent over the 1953 value. The increase was due mainly to increased production of bromine used in preparation of ethylene dibromide for gasoline and anti-knock mixtures.

Production of Bromine and Calcium-Magnesium Chloride, 1949-1954

Year	Bromine		Per Cent of U. S. Total	Rank in U.S.	Magnesium Compounds		Rank in U.S.
	Quantity (Pounds)	Value			Quantity (Tons)	Value	
1949	28,034,765	\$7,023,211	32.0	2	*	*	...
1950	*	*		2	59,036	\$4,998,342	2
1951	*	*		2	*	*	1
1952	*	*		2	*	*	2
1953	*	*		2	43,190	4,591,922	2
1954	*	*		2	39,096	4,628,756	-

*Data concealed

Value of Michigan's Minerals and Mineral Products

1938-1954

Year	Value	Year	Value
1938	\$ 75,897,923	1947	\$170,269,272
1939	109,867,740	1948	214,115,771
1940	117,991,285	1949	207,607,694
1941	135,492,921	1950	238,474,008
1942	152,624,946	1951	257,529,882
1943	147,113,888	1952	267,089,423
1944	140,493,319	1953	287,693,135
1945	128,046,408	1954	286,549,922
1946	133,682,135		

TABLE I
MINERAL PRODUCTS OF
MICHIGAN, 1954⁽¹⁾

TABLE II
MINERAL PRODUCTS OF
MICHIGAN, 1953⁽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	5
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⁾	<u>28,068,821</u>	...
Total			\$286,566,979	

Product	Unit	Quantity	Value	Rank in U. S. (2)
Iron ore	Long tons	13,380,756	\$91,402,764	2
Portland cement	Barrels	15,853,096	41,860,464	...
Petroleum	Barrels	12,284,510	35,644,982	...
Sand and gravel	Short tons	30,459,663	23,170,802	...
Salt	Short tons	5,127,387	22,171,988	1
Stone (3)	Short tons	21,453,866	17,442,250	...
Copper	Pounds	47,999,690	13,832,951	...
Clay products	...	...	6,995,000	...
Magnesium compounds	Short tons	43,190	4,591,922	2
Gypsum	Short tons	1,446,973	4,091,002	1
Clay and shale, raw	Short tons	1,605,804	(4)	...
Natural gas	M. cu. ft.	7,089,985	1,246,106	...
Natural gasoline	Gallons	4,414,371	441,438	...
Peat	Short tons	25,439	257,176	4
Marl	Short tons	183,685	72,781	...
Miscellaneous (5)	...	...	<u>24,471,509</u>	...
Total			\$287,693,135	

- (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.

- (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 INDUSTRIES OF MICHIGAN IN 1955* (Preliminary)

The estimated value of mineral production in Michigan in 1955 was 346.6 million, an increase of nearly 23 per cent over 1954, according to the Bureau of Mines, United States Department of the Interior. Major increases, over 10 per cents were recorded in the production of copper, iron ore, marl, sand and gravel, lime and limestone. Gains of less than 10 per cent were noted in other nonmetallic minerals. Clay output decreased. Output of petroleum and natural gasoline decreased and no coal was produced.

Iron ore continued to rank first in value of the minerals produced with 29 per cent, followed by cement, 15 per cent; copper, 11 per cent; petroleum, 10 per cent; salt, 9 per cent; sand and gravel, 8 per cent; stone, (excepting limestone for cement and lime) 6 per cent and all others 12 per cent. Of the total value of output, nonmetallic minerals accounted for 50 per cent, metals, 40 per cent and fuels, 10 per cent.

*Prepared, January 27, 1956, by Donald H. Mullen, Commodity Industrial Analysts, under the supervision of Samuel A. Gustavson, Chief, Minneapolis Field Office, Division of Mineral Industries, Region V8 2908 Colfax Ave., So. Minneapolis 8, Minnesota.

Metallic Minerals

COPPER: Production of copper in Michigan in 1955, in terms of recoverable metal, was more than double production of 1954. The increase was primarily the result of output from the White Pine mine of the White Pine Copper Co., a subsidiary of Copper Range Co. The mine is in Ontonagon County. The Calumet & Hecla, Inc. operated its group of mines, Ahmeek mill and Tamarack reclamation plant in Houghton and Keweenaw counties. The company experienced a labor strike from May 2 through August 21. During the labor strike at Calumet & Hecla, Inc. mines and plants, unwatering of the company's Osceola mine was reduced to maintaining of the water level attained May 2. Quincy Mining Company's reclamation plant and Copper Range Company's Champion mine were operated throughout the year.

Average weighted prices used for calculating the value of copper were 37 cents per pound in 1955 and 29.5 cents in 1954. Quoted market prices for copper per pound, delivered at Connecticut Valley, opened 1955 at 30 cents, rose to 36 cents by March 31, then 40 cents August 18; reached a maximum of 45.35 cents on September 1 and closed 1955 at 43.275 cents.

IRON & MANGANESE: Good demand for iron ore and a favorable shipping season accounted for the 44 per cent increase in shipments of iron ore and concentrates from Michigan mines in 1955 over 1954. Mines are located in Baraga, Dickinson, Gogebic, Iron and Marquette counties. Dates of first and last lake shipments of ore in

1955 from Michigan and Wisconsin ports were: Ashland - Soo, April 24 - November 28; Ashland - C & NW, April 24 - November 20; Escanaba - E and NW, April 7 - December 8; Marquette - DSS & A, April 22 - November 13; Marquette - LS & I, April 18 - December 31 Superior - GN, April 14 - December 3; Superior - NP - Soo, April 21 - November 26.

No shipment of ore containing over 5 per cent manganese were reported from Michigan mines in 1955. Shipments in 1954, all Ferruginous manganese ore (10-35 per cent Mn) total 13,715 long tons (15,361 short tons), gross weight.

Nonmetallic

Michigan produces numerous nonmetallic minerals. Construction materials, cement, clay, gypsum, lime, sand and gravel and crushed stone, excluding clay and limestone used for manufacture of cement and lime, accounted for about 32 per cent of the value of 1955 mineral output and an increase over 1954 of nearly 10 per cent. Common salt (NaCl) from one underground mine and brine wells and salines from brine wells are the source of raw material in the production of several chemicals. In addition to salt (NaCl) the brines contain substantial quantities of bromine and magnesium. Sales of salt and salines produced, accounted for 18 per cent of the total mineral value of the state in 1955.

Fuels

Fuels produced in Michigan were petroleum, peat, natural gas and natural gas products. In 1955 the production of petroleum decreased by 6 per cent and natural gasoline 47 per cent. Production of natural gas remained about the same. Output of natural gas liquids increased about 3 per cent. Production of peat, all used as a soil conditioner, was estimated to be slightly greater than in 1934.

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