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## COVER ILLUSTRATIONS

The covers of this directory were created by Mr. Donald E. Raymond of the Geological Survey Division staff. The front cover idealizes the production and value charts plotted over the years for Michigan's Mineral production. The back cover depicts the many years of mineral

production statistics maintained by the Geological Survey Division.

The year 1977 marks 100 years of official collection of mineral statistics in Michigan. Some statistics have been kept unofficially since the early 1840's. The topic, Mineral Statistics, included in this booklet, briefly explains the history involved, and gives condensed mineral production and value data for 1976. More detailed statistical information is available in other publications listed in this directory.

## MICHIGAN MINERAL PRODUCERS 1977

GEOLOGICAL SURVEY DIVISION

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### ANNUAL DIRECTORY 11

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Compiled

By

Milton A. Gere, Jr.

STATE OF MICHIGAN

William G. Milliken, *Governor*

DEPARTMENT OF NATURAL RESOURCES

Howard A. Tanner, *Director*

GEOLOGICAL SURVEY DIVISION

Arthur E. Slaughter, *Chief*  
and *State Geologist*

NATURAL RESOURCES COMMISSION

Dean Pridgeon, *Chairman*, Montgomery, 1974

E. M. Laitala, Hancock, 1961

(Mrs.) Joan L. Wolfe, Belmont, 1973

Hillary F. Snell, Grand Rapids, 1971

Harry H. Whiteley, Rogers City, 1961

Carl T. Johnson, Cadillac, 1963

Charles G. Younglove, Allen Park, 1972

John M. Robertson, *Executive Assistant*

... the State Geological Survey shall make an annual report to the Governor, setting forth in detail the mineral statistics for the year; with the progress and development ... mining and smelting industries.

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On deposit in public libraries, state libraries, and university libraries in Michigan and other selected localities.

## PREFACE

"Michigan Mineral Producers, 1977", is the eleventh annual directory of Metallic and Nonmetallic mineral commodity producers in Michigan. This edition includes the names and addresses of the producers and the locations of their operations as of the end of 1977, and mineral commodity production and values for 1976. Much of the material in this directory is based upon the 1976 annual canvass of the mineral producers by the U.S. Bureau of Mines, and name and location updates supplied to them by the U.S. Mine Safety and Health Administration.

Listings are on a commodity basis by operator as well as a cross reference by county. Numerous location maps and historical production and value charts accompany the various commodity material. Once again, a list of state-owned sand and gravel pit locations is included.

The writer wishes to thank the mineral producers for their cooperation in submitting the U.S.B.M. forms and answering inquiries for information pertaining to their operations. Thanks are given to the Bureau of Mines, U.S. Department of the Interior, both their Federal headquarters and the State Liaison Office - Michigan for canvassing the mineral producers and providing the data collected. The author wishes to give special thanks to the Michigan Liaison Officer, Mr. Edward C. Peterson, and the Liaison Program Assistant, Ms. Esther A. Middlewood for much extra help to complete this directory.

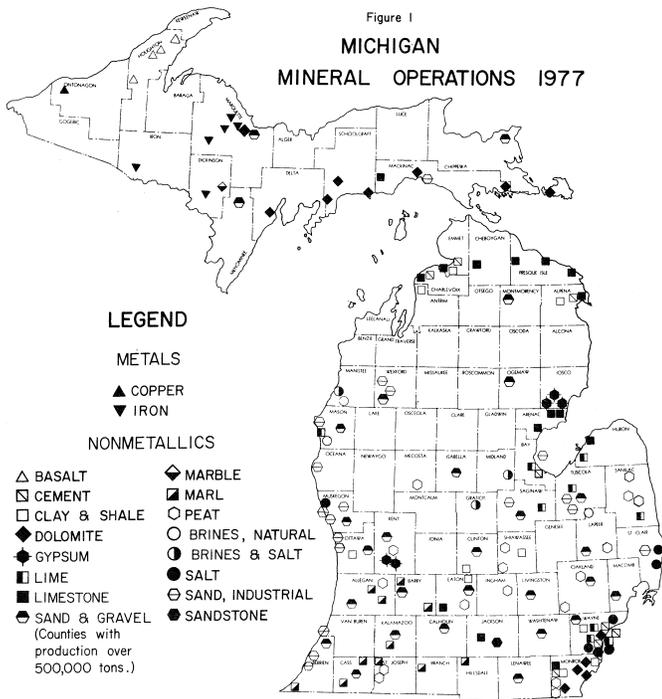
The Lansing and Marquette offices of the Mine Safety and Health Administration of the U.S. Department of Labor are to be thanked for updates on producer name and location changes. These updates throughout the year help keep the material reported herein more accurate.

The writer is also indebted to the following persons from the Geological Survey Division and wishes to express his thanks: 1) Authors of previous editions for ideas and formats passed on; 2) Mr. Donald E. Raymond for designing the covers and updating the various maps and charts; 3) Mr. Harry O. Sorensen, Unit Supervisor and Mr. William A. Maiden, Subunit Supervisor, both of the Mining and Economic Geology Unit, for their helpful suggestions; 4) Mrs. Lois A. Padgett, of the Mining and Economic Geology Unit for typing the manuscript.

It is hoped that this edition, although later than usual, will be useful to those persons interested in Michigan's vast resources of Minerals. Suggestions for additions, deletions, changes, or other improvements for future editions will be gratefully received.

Lansing, Michigan     Milton A. Gere, Jr.  
   Geologist  
December, 1978     Mining and Economic Geology Unit

[Figure 1 - Michigan Mineral Operations - 1977]



## INTRODUCTION

Michigan's mineral industry produces a wide variety of mineral commodities from many locations throughout the state as indicated by the listings in this directory for 1977. As of the end of the year there were 435 producers of 16 categories of metallic and non-metallic commodities with over 698 active operations. There was also active exploration for more mineral deposits in various parts of the state.

The mineral industry is important to the citizens of Michigan as an employer of thousands of people. According to Michigan Employment Security Commission statistics, an average of 12,700 people were employed by the mining industry in Michigan in 1976. This does not include the number of owner-operators also involved in the mineral industry, along with others involved in the production of petroleum and natural gas. These people produced \$1,485,646,237 worth of mineral commodities in Michigan in 1976. This amounts to about two percent of the Gross State Product for this year.

Michigan's nearly 1½ billion dollars of mineral commodity production during 1976 can be placed into three general categories; Metallics, Nonmetallics, and Fuels. The value for Metallics was \$487,171,681; Nonmetallics was \$563,240,353; and \$435,234,203 for Fuels.

The mineral commodities produced in Michigan are used within the state and are also shipped to other states and countries to help fulfill their mineral needs. In return, other mineral commodities are shipped to Michigan for industries which process materials not produced here.

The U.S. Bureau of Mines State Liaison Office estimates that the processing of raw minerals in Michigan results in products valued about ten times the value of the State's extracted minerals themselves. Michigan's availability of bulk shipping via the Great Lakes enhances this important form of interstate and international trade.

Besides being important for the economy, many Michigan minerals are sought after by mineral and rock collectors. These may not be the same mineral commodities used by industry and they may be of little or unknown dollar value, but their natural beauty makes them of interest to a growing number of people.

Anyone interested in Michigan's mineral commodities and various aspects of the geology of the state are invited to contact the Geological Survey Division offices. Many files of maps, well logs, and other materials of public record are available for office use.

## MINERAL PRODUCTION STATISTICS

### Background

Michigan mineral production statistics have been officially kept for 100 years. Act 9 of Public Acts of 1877, as amended, was entitled "An act to authorize the appointment of a commissioner of mineral statistics..." Among the duties listed is the following, known as Sec. 5, "Said commissioner is hereby authorized to demand, and it shall be the duty of all corporations or individuals engaged in mining to make such reports under oath, as to product and other matters as shall be required by him on blanks to be furnished by said commissioner for that purpose".

The Commissioner of Mineral Statistics office was abolished and the duties transferred to the Board of Geological Survey by Act 7 of P. A. 1911, as amended. Then Act 17 of P. A. 1921, as amended, transferred the duties of the Board of Geological Survey to the Department of Conservation wherein the Geological Survey Division was formed. Act 380 of P. A. 1965, as amended, known as the Executive Organization Act, changed the name of the Department of Conservation to the Department of Natural Resources (DNR). Thus, the original "commissioner" duties now lie within the DNR.

For the last number of years the Geological Survey Division, DNR, has had a memorandum of understanding with the U.S. Bureau of Mines in which the U.S.B.M. gives the Geological Survey Division copies of the mineral production data which it gathers during its' annual canvass of the mineral industry. It is now from this canvass that the state receives most of its' mineral production and value data. Copper and iron ore data is collected separately by the Geological Survey Division for tax purposes. Petroleum and natural gas figures are reported directly, and indirectly, to the

Geological Survey Division's Production Proration Unit for proration and statistical purposes.

The publication of Michigan mineral statistics is done in several ways. A very brief summary sheet of production and value data is printed in the Annual Directory, such as this publication, but the data is for the year previous to the Directory listing. Also, in the directory are a number of historical production and value charts for various commodities and all commodities combined.

A detailed booklet containing yearly mineral statistical data, mineral commodity and industry information is entitled "The Mineral Industry of Michigan". This is a preprint from the annual "U.S. Bureau of Mines Minerals Yearbook" and is currently written by the State Liaison Officer and Liaison program assistant of the State Liaison Office of the U.S. Bureau of Mines, located in Lansing. Under a memorandum of understanding between the Geological Survey Division and the U.S. Bureau of Mines, the Geological Survey Division attaches a cover and preface to this "U.S.B.M. Minerals Yearbook" chapter and offers it as the Geological Survey Division's "Annual Statistical Summary" for the minerals industry.

Yearly statistics for Michigan's petroleum and natural gas exploration and production are published as another Geological Survey Division Annual Statistical Summary entitled "Michigan's Oil and Gas Fields". This booklet is compiled by the Petroleum Geology Unit of the Geological Survey Division and is available for \$2.00 per copy.

An additional U.S.B.M. publication which also includes some statistical data is "Minerals in the Economy of Michigan". This annual booklet is written by the State Liaison Office and was first published in 1978.

A yearly release of statistical data for iron is produced by the Geological Survey Division as a three page speciality. The title is "General Statistics Covering Production of Michigan Iron Mines". Historical production of iron through 1974 is reported in the Geological Survey Division's Circular 12, "One Thousand Million Tons", by R. C. Reed, 1975, which is sold for 50 cents per copy.

Geological Survey Division publications are available from the following address: Michigan DNR, Information Services Center, Box 30028, Lansing, MI 48909. The Center is located on the 7th floor of the Stevens T. Mason Building and is open for over-the-counter sales. Sales within Michigan are subject to 4% sales tax.

Information about U.S. Bureau of Mines publications is available from the U.S. Bureau of Mines, State Liaison Office - Michigan, Room 200, Corr Building, 300 E. Michigan Ave., Lansing, MI 48933.

## Current Production Data

As of the end of 1977, there were 435 metallic and nonmetallic mineral commodity producers with at least

698 operations in Michigan. We assume more than the 698 operations existed because numerous sand and gravel operators use portable equipment and operate out of several locations in a year's time. Not all of these locations get reported to us. The list of operations follows in Table 1.

[Table 1 - Number of Producers and Operations by Commodity - 1977]

Commodity Produced	Number of Producers	Number of Operations
Copper	2	2
Iron	3	6
Clay and Shale	8	9
Gypsum	5	9 (quarries + mills)
Marl	10	10
Natural Brines	5	6
Peat	15	17
Salt	8	9
Sand and Gravel		
Construction	317	554+
Industrial	15	18
Stone		
Limestone and Dolomite	26	30
Miscellaneous Stone	2	5
Sandstone	3	4
Cement	8	8
Lime	6	9
Sulfur	2 (refineries)	2
Total	435	698+

The 1976 Production and Value is shown by Table 2. Our figures and those of the U.S. Bureau of Mines may not be the same due to using different categories and criteria.

Historical mineral value information for the years 1910 to 1976 is illustrated by Figure 2. Fuels, Metallic Minerals, Nonmetallic Minerals, and Total values are shown. The 1976 mineral commodity value and rank for each county is included in Table 3. Since the county ranking is based upon dollar values, those counties producing crude oil and natural gas may not have their true production values shown.

The county values for crude oil and natural gas are based upon average values per barrel and thousand cubic feet (M.C.F.), respectively, multiplied by the production figures published in "Michigan's Oil and Gas Fields, 1976". The oil values shown may differ from actual values because crude oil prices depend upon whether the well is classified as "old oil", "new oil", "stripper oil", and "sweet" or "sour" oil. The gas values may differ because the price paid for gas at the wellhead depends upon individual contract agreements and the B.T.U. content of the gas. Thus, counties with large quantities of oil and gas production may in reality have a higher or lower mineral production value and ranking than shown here.

The map in Figure 3 shows 1976 county mineral production value as to category of Fuels, Metallic Minerals, and Nonmetallic Minerals. As mentioned in the Introduction, the 1976 value of Fuels was \$435,234,203, Metallic Minerals \$487,171,681, Nonmetallic Minerals \$563,240,353, and the total value was \$1,485,646,237.

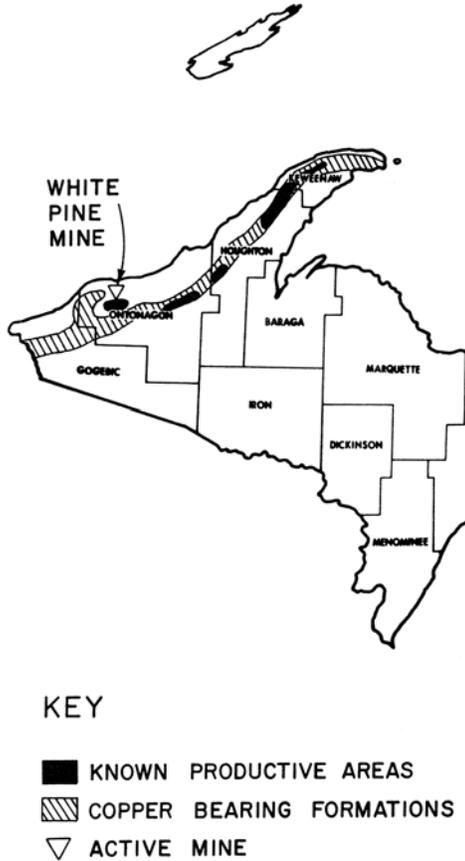




[Figure 5 - Michigan Copper Resources]

Figure 5

## MICHIGAN COPPER RESOURCES



## NONMETALLIC MINERALS

Nonmetallic minerals produced in Michigan during 1976 included the following: Sand and Gravel, Natural Brines, Salt, Stone, Gypsum, Clay and Shale, Peat, Marl and some Sulfur. Two important nonmetallic commodities which are produced by processing raw minerals are also included with the minerals themselves. These are Cement and Lime.

## CEMENT

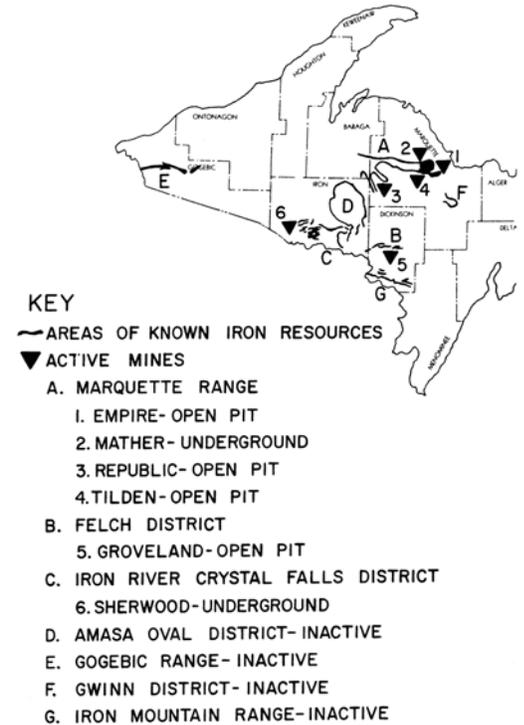
Cement, like lime, is a manufactured mineral product which has been included with nonmetallic mineral production over the years. Simply, Portland cement is made by combining five parts of limestone and one part of shale or clay. The mixture is ground to a powder and passed through a rotary kiln which is fired to a temperature of about 1500°C. In the kiln the materials roll up into gray, ball shaped masses which emerge as hardened clinkers. The clinkers are then ground to a powder and ground gypsum is combined with it to form what we know as Portland cement. Additional ingredients are added to form various other types of cement for specific uses, such as masonry cement, etc.

Michigan's eight cement plants operate in three different ways in respect to their raw materials: Four plants are located at or adjacent to their limestone quarries, two receive all of their raw materials from pits and quarries in other locations, some from Canada; two purchase partially processed material, clinker, from other producers and complete the processing at their facilities.

[Figure 6 - Michigan Iron Resources]

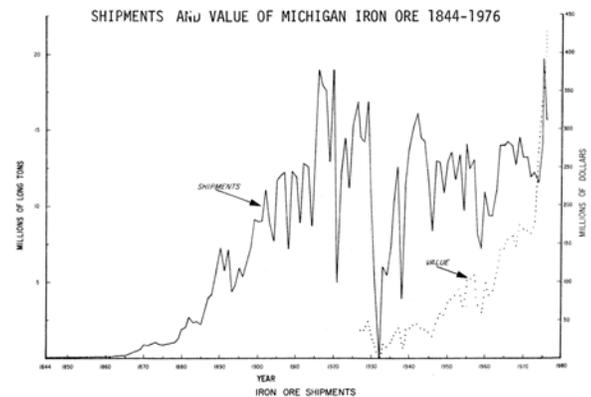
Figure 6

## MICHIGAN IRON RESOURCES



[Figure 7 - Shipments and Value of Michigan Iron Ore 1844-1976]

Figure 7

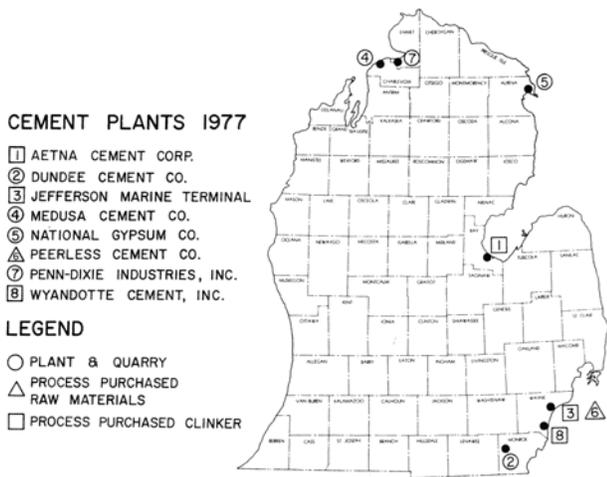


During 1977 there were two changes made by Michigan's Cement producers: 1) Martin Marietta Cement's Northern Division plant at Essexville was sold to the Aetna Cement Corporation, a subsidiary of Lake Ontario Cement Ltd., of Toronto, Ontario, Canada. 2) Jefferson Marine Terminal, a division of the Edward C. Levy Co., Detroit, ceased production of cement near the end of the year.

[Figure 8 - Michigan Cement Plants - 1977]

Figure 8

MICHIGAN CEMENT PLANTS - 1977



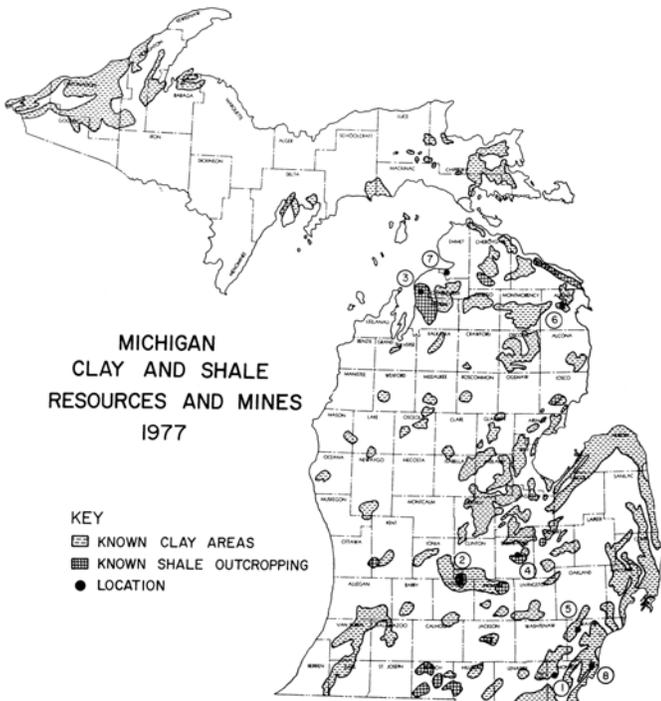
### CLAY AND SHALE

Clay and/or Shale are mined by five companies in Michigan for use as an ingredient in making cement. Three other operators mine clay and/or shale for making drain tile, sewer pipe and flue linings, bricks, and flower pots. Years ago there were many more producers of brick and drain tile, etc.

Michigan has vast resources of clay and shale which could be utilized if new economic uses are discovered for it. The accompanying map shows the known Michigan clay areas, shale outcroppings, and present mine locations.

[Figure 9 - Michigan Clay and Shale Resources and Mines - 1977]

Figure 9 CLAY AND SHALE RESOURCES AND MINES 1977



### GYPSUM

The mineral Gypsum ( $\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$ ), along with some Anhydrite ( $\text{CaSO}_4$ ), occurs in sedimentary rocks. Thick beds of gypsum are mined in both Kent and Iosco Counties. Some of the reported uses of gypsum from Michigan are: 1) manufacturing plaster wall board; 2) an important ingredient in Portland cement; and 3) agricultural uses (soil treatment, etc.).

The majority of the gypsum mined in Michigan is used for the manufacture of construction materials, thus the rate of mining is tied in with the economy of the building industry. Figure 11 illustrates the many fluctuations in the production and value of gypsum produced in Michigan between 1868 and 1976.

Michigan is a leading producer of gypsum. The state has been in first or second place for the value of gypsum produced in the U.S. for most of the years since 1930. The high rank was maintained again in 1976 when 22 states with 68 mines were compared.

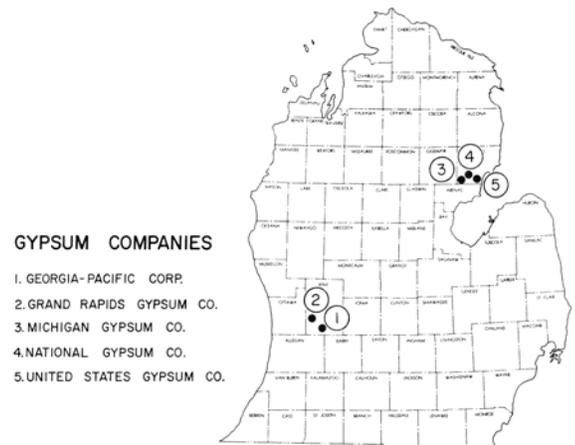
The 1976 U.S. Bureau of Mines list of the nation's ten largest producing gypsum mines included two from Michigan. These two Iosco County mines are operated by the National Gypsum Company and the U.S. Gypsum Company. They were ranked, respectively, as the first and third largest producers in the entire United States.

The map in Figure 10 indicates the approximate locations of the two underground mines in Kent County. The addresses for the gypsum companies and their mine locations and mill locations are listed below.

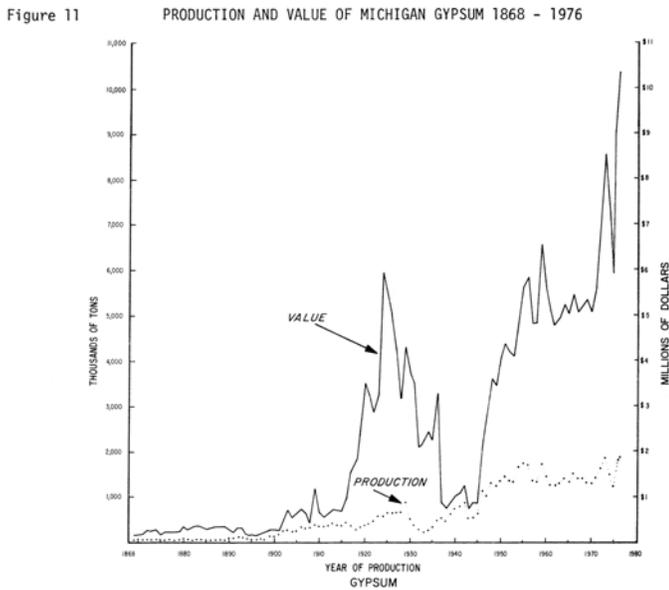
[Figure 10 - Michigan Gypsum Mines - 1977]

Figure 10

MICHIGAN GYPSUM MINES - 1977

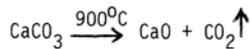


[Figure 11 - Production and Value of Michigan Gypsum 1868-1976]



## LIME

Lime is a mineral product which is produced by heating limestone ( $\text{CaCO}_2$ ) in a kiln to about  $900^\circ\text{C}$  which causes the limestone to form lime ( $\text{CaO}$ ) and the gas carbon dioxide ( $\text{CO}_2$ ). Chemistry books illustrate the process like this:



The producers of lime in Michigan report that their lime is produced for the following uses and products: 1) Alkalies (ammonium, potassium, and sodium compounds); 2) Steel (basic oxygen converters, electric furnaces, open-hearth furnaces); 3) Water purification and softening; 4) Food and food products; 5) Paper and pulp (include bleach and filler used in paper); 6) Sewage and trade-wastes treatment (include neutralization of waste acids); 7) Sugar refining; and 8) Other chemical and industrial uses and products. Some years lime is also produced to be used to remove sulfur from stack gases and in the manufacturing of plastics.

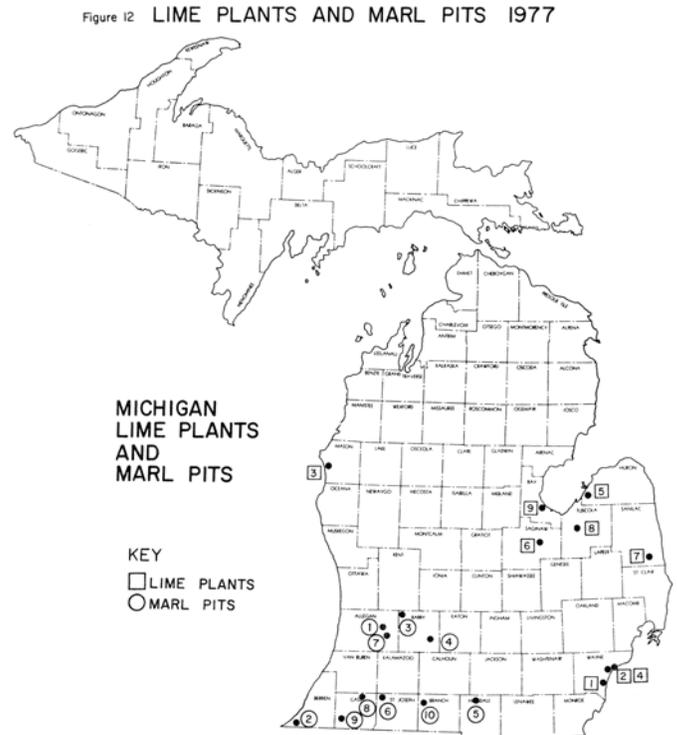
The limekilns operate with limestone which is sometimes transported great distances to them from the location where it is extracted from the ground.

## MARL

Marl is a non-consolidated calcium carbonate rich material which was deposited in a lake or marsh area by plant and/or animal life. Michigan's glacial overburden has a number of present and former lakes which contain large accumulations of marl. There are now eleven companies which produce marl for use as a soil conditioner. Formerly, marl was also produced in Michigan for the manufacture of cement and lime, and to be used as an ingredient in tooth powder, scouring

powder, and in paints. Another name for marl is bog line.

[Figure 12 - Michigan Lime Plants and Marl Pits - 1977]



## NATURAL BRINES

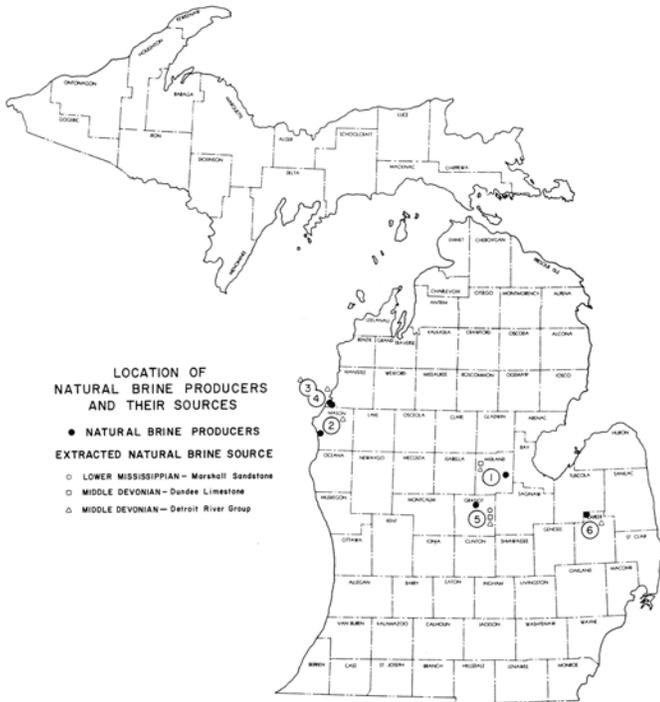
Natural brines, or natural salines are naturally occurring waters within the ground which are rich in chlorides and calcium, magnesium, sodium, and minor amounts of potassium, bromine, and iodine. Several chemical companies operate numerous brine wells and process the brine into various chemical compounds. Michigan is one of two producers of iodine in the U.S. and ranks in first or second place in the production of bromine, magnesium compounds, and calcium-magnesium chlorides.

Natural brines are also used for dust and ice control and stabilization of roads. Several county road commissions operate one or more brine wells for this purpose. Some oil well operators which produce brine as a byproduct also supply brine for road uses, others return the brine to the bedrock formations through brine disposal or injection wells.

Chemical companies produce natural brines from several geological formations in Michigan. These are the Lower Mississippian System Marshall Sandstone, Middle Devonian System Dundee Limestone, and the Filer and Sylvania Sandstones both from the Detroit River Group. The accompanying map shows the locations of these operations.

[Figure 13 - Natural Brine Producers - 1977]

Figure 13 NATURAL BRINE PRODUCERS 1977



## PEAT

Peat is an accumulation of various dead plant materials, particularly mosses, in a bog which forms an organic soil containing less than 30 percent mineral soil. Michigan ranks first in peat production in the U.S. and has 17 peat producers which process various types of peat for use as a soil conditioner. Historically, peat has been used as a fuel and is presently being studied in Minnesota to be used in power plants as it is in some parts of Europe. With other fuel supplies diminishing and the advancement of technology, peat may become the fuel of the future in Michigan.

The accompanying map indicates the location of the current peat operations and the approximate acreages of organic soils in the 83 counties of the state. It should be noted that not all organic soils meet the organic content requirements of peat.

In 1976, William A. Walden, a geologist on the Geological Survey Division staff, prepared an Intradivisional Information Circular entitled "Report on Michigan Peat Reserves." This short unedited report is an updating on Michigan's peat reserves and separates peat from organic soils which have sometimes been classified together as peat in the past. Copies of this report are available for reading in the Survey's Lansing office or arrangements may be made for a loan copy.

## SALT DEPOSITS

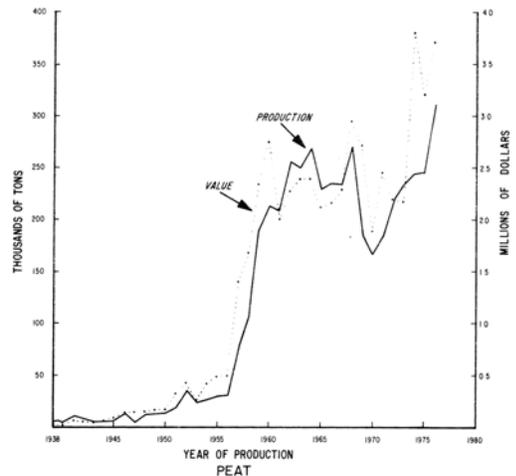
Bedded salt is extracted by two different methods in Michigan: Dry mining and Solution mining.

Dry mining is the conventional type of underground mining which most people think of when the word mining is used. The International Salt Co., Inc. uses this method to produce rock salt in Michigan. Their Detroit Mine underlies about 900 acres of Detroit and Melvindale at a depth of approximately 1100 feet. Since 1910 about 36 million tons of salt have been produced from this mine.

[Figure 14 - Production and Value of Michigan Peat 1938-1976]

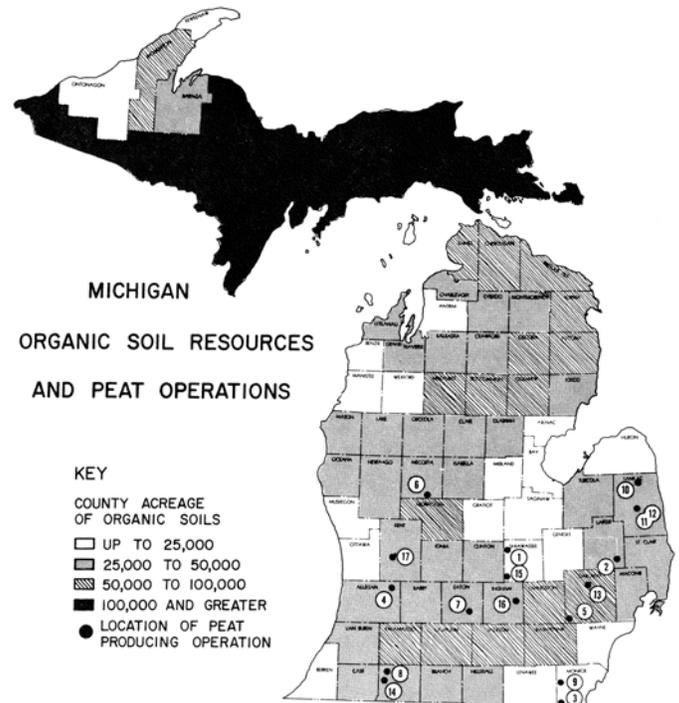
Figure 14

PRODUCTION AND VALUE OF MICHIGAN PEAT 1938-1976



[Figure 15 - Michigan Organic Soil Resources and Operations]

Figure 15 ORGANIC SOIL RESOURCES AND OPERATIONS 1977

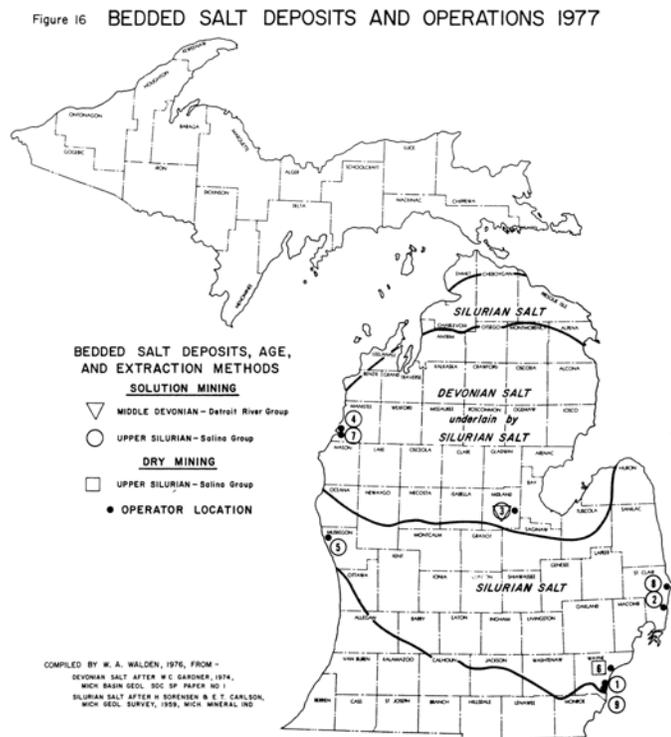


Solution mining of bedded salt is done by pumping water into a known bed of solid salt within the bedrock in the ground. The salt is dissolved by the water and produces an artificial brine, or sodium chloride rich water. The artificial brine is then pumped out of the ground and salt and other chemicals are removed from it by different

methods. The remaining salt and chemical companies listed use this method.

The accompanying map shows the extent of the various ages of bedded salt deposits. The location and type of extraction and geologic age of the salt beds are indicated.

[Figure 16 - Bedded Salt Deposits - 1977]



## SAND AND GRAVEL

Sand and Gravel are important nonmetallic mineral commodities in this State. Michigan consistently ranks in the top 2nd to 4th place in the U.S. in the value of sand and gravel produced annually. In 1976 over 47 million short tons of sand and gravel valued at over 79 million dollars were produced. The 1977 preliminary figures are greater for both production and value. These values include both construction sand and gravel and industrial sand.

When the glaciers grew and pushed across the state many thousands of years ago they bulldozed around a tremendous amount of broken rock, sand, and clay. When the glaciers finally melted away about 10,000 to 15,000 years ago they left the materials behind in a number of forms. Some of the material was left as a mixture in the form of end moraines, ground moraines, etc. In other locations the melt waters reworked the material and sorted out areas of sand, areas of gravel, and some of mostly clay. Along the shores of the Great Lakes the water and wave action has done more sorting and breaking down of materials and the prevailing westerly winds have built large sand dunes along the western coast of the state. It is in the sorted out areas

where good deposits of clean sand, sand and gravel, or clay are now available for extraction for use by man.

Construction sand and gravel and industrial sand are actually separate commodities with different specifications and uses. Thus, they are handled separately on the following pages.

## CONSTRUCTION SAND AND GRAVEL

Just under 42 million short tons of construction sand and gravel, valued at slightly over 58 million dollars, were produced in Michigan in 1976, down slightly in both production and value from 1975. The production rate rises and falls with the economy. As construction, especially of roads, increases or decreases, so does the rate of production of construction sand and gravel.

Generally, sand and gravel is a relatively heavy, bulky commodity and the per ton value is low, so the cost of transportation becomes a very important item. Thus, the distance between the source pit and the construction site is usually kept to a minimum. Unfortunately, not all areas of the state are blessed with abundant sand and gravel deposits so costs vary greatly depending upon location.

The use of construction sand and gravel is greater in urban areas due to more construction there, but urban areas frequently build over sand and gravel deposits, forcing the transportation of building materials from more distant, but usable, sites. If more geologic insight were used in urban and highway planning and zoning, known areas of good sand and gravel deposits, or other potentially usable minerals, may be excluded from urbanization until the mineral commodities are extracted and the mining surface reclaimed. This would result in more efficient utilization of our nonrenewable resources. Like the old saying "Gold is where you find it", we do not have the choice of obtaining minerals where we would like them to be, but must be able to obtain them from where they actually are.

Following is a list of the known construction sand and gravel producers in the state, information on their types of operations and counties in which they operate. Also included is a list of State owned sand and gravel pits which are periodically leased and operated by various operators. Additional sand and gravel pit locations are frequently established by lease on Federally owned lands also.

A more comprehensive listing of active and inactive, privately and publicly owned sand and gravel pits is available. The list is arranged by county, includes county maps showing pit locations, and abrasion and soundness test results are given when available. Copies of the "Aggregate Source Inventory" may be obtained for \$12.00 plus postage and sales tax, prepaid, from: Publications Unit, Contract Section, Dept. of State Highways and Transportation, P. O. Box 30050, Lansing, Michigan. 48909.

## STATE OWNED PITS

There are a number of state owned sand and gravel pits which are frequently mined by private firms through obtaining a mineral permit. These pits are on lands under the jurisdiction of the D.N.R. and are mined according to a mine plan which includes the overall reclamation of the pit site upon completion of the sand and gravel removal operations. For information concerning specific locations, contact the nearest D.N.R. Area Forester, or D.N.R. Forest Management Division, P. O. Box 30028, Lansing, Michigan 48909.

Following is a listing of the current D.N.R. sand and gravel pits arranged by county.

[For tables see unconverted PDF file]

## INDUSTRIAL SAND

Michigan's 1976 production of Industrial Sand was nearly 5½ million short tons worth almost 21 million dollars. Both the volume and the value were up from the 1975 production figures of just under 4 3/4 million tons valued at just over 16½ million dollars.

Industrial sand uses include the following: Foundry molding, glass making, sand blasting, fire or furnace sand, engine or traction sand, and metallurgical sand. Only sand deposits meeting specific standards of purity, grain size and shape are usable.

The 18 industrial sand mining operations in Michigan produce material from several types of deposits. These include: 1) Sand dunes along the Lake Michigan shore and some inland dunes; 2) Glacial outwash or other melt-water sorted deposits; 3) High purity consolidated sandstone; 4) and sand dredged out of Saginaw Bay of Lake Huron.

Those readers who are interested in a more comprehensive discussion of industrial sand are referred to the 1975 booklet, "Michigan's Industrial Sand Resources", by Jerry D. Lewis. The publication is Circular 11 of the Geological Survey Division, Michigan Department of Natural Resources, Lansing. Cost is fifty cents, plus tax. Copies are available by mail from the Information Services Center, Michigan D.N.R., Box 30028 Lansing, MI 48909.

## STONE

Under this heading we include the subheadings of Limestone and Dolomite, Sandstone, and Miscellaneous Stone which includes Traprock, or Basalt, and Marble. The total stone production in 1976 amounted to nearly 41½ million short tons valued at over \$82 million.

### LIMESTONE AND DOLOMITE

Limestone and Dolomite are quarried for a number of uses in Michigan, the largest uses are for crushed construction and road aggregate, flux stone for steel making, and raw material for making cement and lime.

Other uses include riprap, dimension building stone, agricultural limestone, and railroad ballast.

[Figure 17 - Michigan Industrial Sand Operations - 1977]



Most of the larger quarries are located along the shores of Lakes Michigan and Huron which allow less expensive boat transportation of the processed stone to the down-lake markets. Many smaller quarries are scattered throughout the state wherever good limestone or dolomite occurs near the land surface in an area of possible economic use. The accompanying map indicates the location of the limestone and dolomite resources and quarries.

### MISCELLANEOUS STONE

This heading currently includes only Traprock or Basalt, and Marble. The traprock is actually waste rock from old copper mines and is processed for construction aggregate. Marble is mined for use as a flux stone and as landscape aggregate. In the recent past the following were also mined: Granite, Pink Feldspar, and Amphibolite.

The Miscellaneous Stone quarry locations are included on the map entitled "Michigan Miscellaneous Stone and Sandstone Operations".

### SANDSTONE

Sandstone is currently mined by two producers in Jackson County for use as rough dimensional stone. There is one sandstone producer in Wayne County who turns out industrial sand for use in glass making and as foundry sands, and also produces sandstone aggregate material.

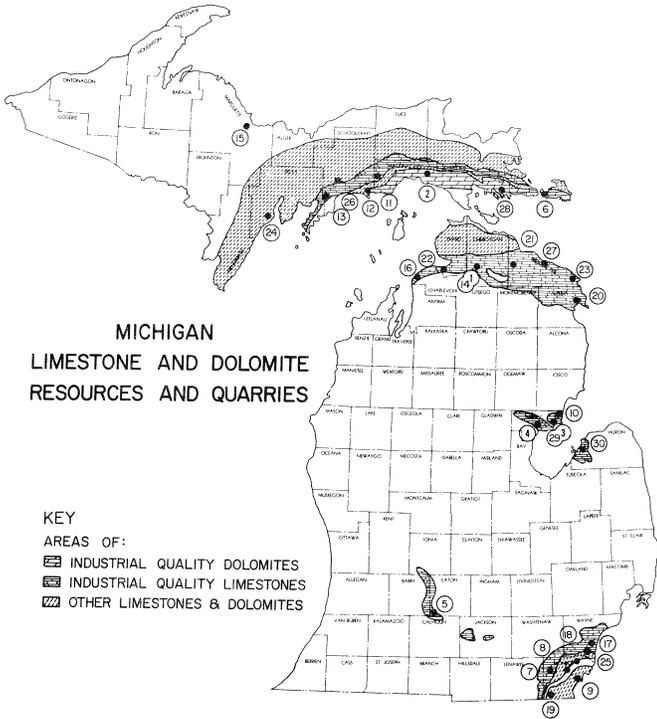
Around the turn of the century there were at least two large sandstone quarries located in the Upper Peninsula which produced brown and red dimensional sandstone blocks which were used for fancy building fronts.

Another abandoned industry quarried a gritty sandstone for the manufacture of grindstones in Huron County.

The current sandstone producers are located on the map showing "Miscellaneous Stone and Sandstone Operations."

[Figure 18 - Michigan Limestone and Dolomite Resources and Quarries - 1977]

Figure 18  
LIMESTONE AND DOLOMITE RESOURCES AND QUARRIES 1977



## SULFUR

Some sulfur crystals are found in vugs in dolomite rock within the Detroit River Group of middle Devonian age in parts of southeastern Michigan. However, the sulfur produced in Michigan is a byproduct of oil refinery operations.

## SOME SUGGESTED READINGS

### FROM INDUSTRY

#### Limestone --

"Limestone Purifies Water", 1977, 33 p.  
National Limestone Institute, Inc.  
Suite 501, 3251 Old Lee Highway  
Fairfax, VA 22030

This booklet discusses uses of limestone, its effect upon rainfall, aquatic life, etc., and is best described by a partial list of the Table of Contents: Introduction; Limestone and its uses; Limestone benefits aquatic life - streams - ponds and lakes; Reaction of pH and water acidity; Neutralization of coal mine drainage; The threats of acid rain; A matter of priorities; Guidance.

[Figure 19 - Michigan Miscellaneous Stone and Sandstone Operations - 1977]

Figure 19 MICHIGAN MISCELLANEOUS STONE AND SANDSTONE OPERATIONS - 1977



[Table 4 - Stratigraphic Succession in Michigan]

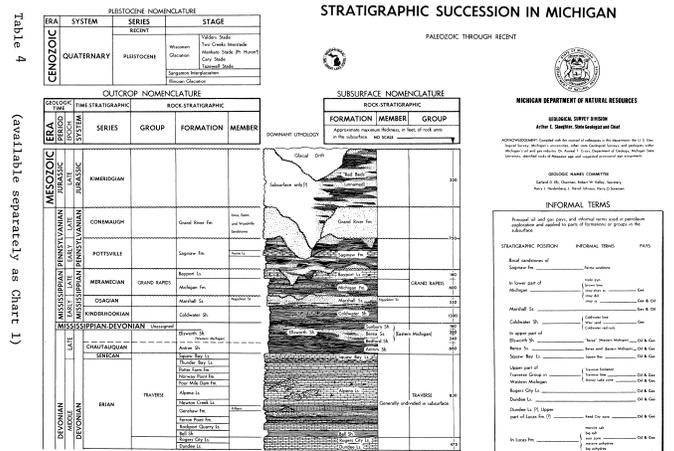
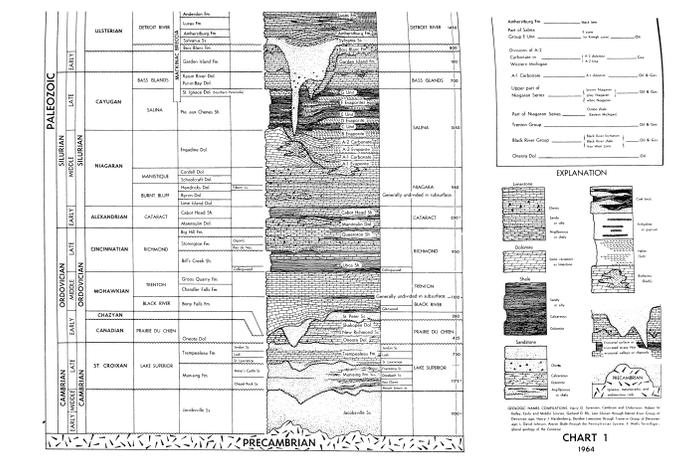
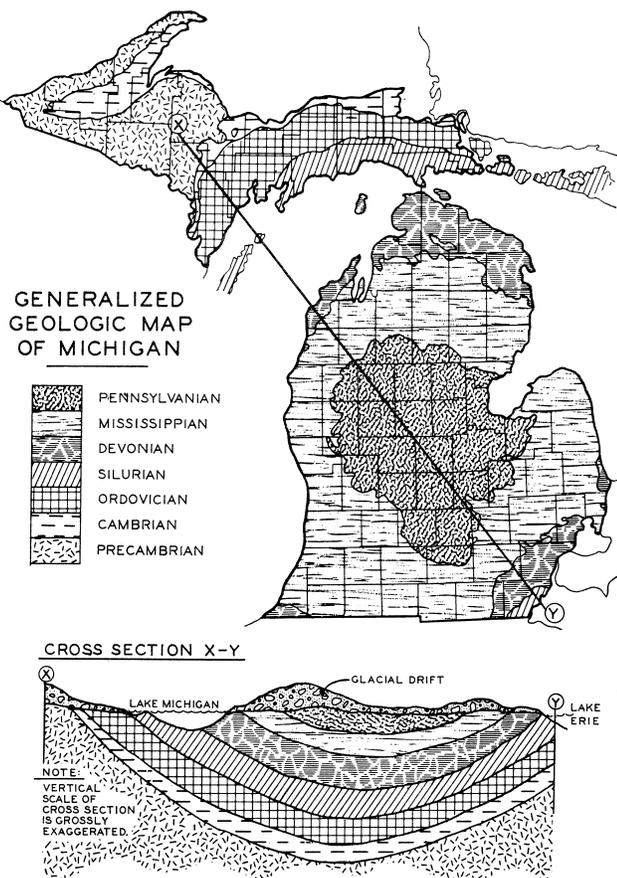


Table 4 (available separately as Chart 1)



[Figure 20 - Generalized Geologic Map of Michigan]

Figure 20



## Reclamation

Shetron, S.G.; et al., "Establishing Vegetation on Alkaline Iron and Copper Tailings" Report of Investigation 17, 1977, 13+ pg., \$2.00. This report covers the methods used and results realized from a five year research program to establish vegetation on mine tailings as part of a mine reclamation program.

## List of Publications

Currie, William W.; "Annotated List of the Publications of the Michigan Geological Survey 1838-1977", Circular 16, 1978, 38+ pg., \$2.00. This well organized list is indexed by author, mineral, and county.

## Price Lists

\_\_\_\_\_"Available Maps of the Michigan Geological Survey", Map List 1, 1978, free. A detailed listing of available geological maps and their prices.

\_\_\_\_\_"Publications Available from the Geological Survey Division", List 20, 1978, free. A detailed list of available publications and their prices.

## Limestone

Johnson, Allen M., and Sorensen, Harry O.; "Drill Core Investigation of the Fiborn Limestone Member in Schoolcraft, Mackinac, and Chippewa Counties, Michigan", Report of Investigation 18, 1978, 51+ pg., \$2.00. From the abstract "Progress on evaluation of high-purity, high-calcium limestones of the Middle Silurian Fiborn member of the Henricks Formation, Burnt Bluff Group in the eastern portion of the Northern Peninsula is presented". This publication covers part of the work done as a joint effort of the Geological Survey Division and the Institute of Mineral Research at Michigan Technological University, Houghton, Michigan.

## Sand Dunes

\_\_\_\_\_"Designated Sand Dune Areas", Series I, 1978. This booklet lists, and has maps of, the designated sand dune areas in Michigan as required by the Sand Dune Protection and Management Act (Act No. 222, P. A. 1976). The Act is included. This booklet is ONLY available directly from----Reclamation and Mining Control Unit, Geological Survey Division, Michigan Department of Natural Resources, Box 30028, Lansing, Michigan, 48909.

## FROM THE U.S. BUREAU OF MINES

### Statistics and Industry Information

Peterson, Edward C.; Middlewood, Esther A.; "Minerals in the Economy of Michigan", State Mineral Profiles 7, 1978, 14+ pg., free. This brief booklet includes a number of short accountings of happenings within the State's mineral industry in 1977. Production figures are given, as well as state and federal legislation and program changes, state and federal income from mineral royalties and severance taxes, etc. This will prove to be a handy new annual series produced by the U.S.B.M

## Cement and Disposal of Waste-Oils and PCB's

Patzias, Terry; "Disposal of Waste-Oils and PCB's in Cement Kilns", 1978, Pit and Quarry, Vol. 70. No. 8, Feb. pp. 88-90.

Article describes how the experimental disposal of waste-oils and PCB's was done by introducing the materials into a high temperature cement kiln. Tests proved that this was an efficient way to dispose of PCB's, and the waste-oils accounted for a 9% kiln fuel savings. PCB's helped produce a lower alkaline cement product.

## FROM MICHIGAN DEPARTMENT OF NATURAL RESOURCES, GEOLOGICAL SURVEY DIVISION

### Industrial Sand

Ayres, Lewis, Norris and May, Inc.; Chapman, Michael J.; "An Economic Study of Coastal Sand Dune Mining in Michigan", Report of Investigation 20, 1978, 19+ pg., \$2.00. This report covers a study required by the Sand Dune Protection and Management Act (Act 222, Public Acts of 1976), and discusses the various aspects of sand dune mining, uses of sand, various properties which determine how the sand can be used, etc.

Peterson, Edward C.; Middlewood, Esther, A.; "The Mineral Industry of Michigan", from "1975 Minerals Yearbook", 1978, U.S. Bureau of Mines and "Annual Statistical Summary 25, Michigan Department of Natural Resources, Geological Survey Division, 26 pg., free. This annual booklet presents detailed mineral commodity production and value information as well as industry news and law changes which affect the mineral industry.

\_\_\_\_\_ "Mineral Commodity Profiles", U.S.B.M 1977 + 1978, free. These short publications are described as "A new series presenting timely data on selected mineral raw materials". As of December 1978 there were 25 booklets in this series, a number of which cover materials found or produced in Michigan. Consult the U.S.B.M. for the current listing.

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Unless a specific address is given, these publications may be ordered from their proper agency address below.

Michigan Department of Natural Resources  
Information Services Center  
Box 30028  
Lansing, MI 48909  
(Michigan residents add 4% state sales tax)

U.S. Bureau of Mines  
State Liaison Office - Michigan  
Room 200, Corr Building  
300 E. Michigan Ave.  
Lansing, MI 48933

### Popular books about the Geology of the State

These books may be ordered from your local bookstore.

Dorr, John A., and Eschman, Donald F.;  
"Geology of Michigan", 1970,  
484 pg., \$15.00.  
The University of Michigan Press  
839 Greene Street  
Ann Arbor, MI 48106

This hardbound textbook explains the geology of Michigan and includes many illustrations and lists of collecting areas, museums, etc. General geology concepts are explained and Michigan examples are given.

Paull, Rachel Krebs, and Paull, Richard A.;  
"Geology of Wisconsin and Upper Michigan",  
1977, 232 pg., \$6.95.  
Kendall/Hunt Publishing Company  
2460 Kerper Boulevard  
Dubuque, Iowa 52001

This well written, and illustrated, softbound book covers the geology of Wisconsin and Upper Michigan and parts of adjacent states. Concepts of general geology are explained and a 13 page glossary of geological terms are included. One nice feature of this book is that it covers the geology of an area beyond stateline boundaries.

[Geological Survey Division Personnel]

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