MICHIGAN TODAY

BULLETIN
No. 307

Published by
EUGENE B. ELLIOTT
Superintendent of Public Instruction
Lansing, Michigan
1938

STATE OF MICHIGAN
DEPARTMENT OF PUBLIC INSTRUCTION

MICHIGAN TODAY

Its Human and Physical Resources as They Affect Education

BULLETIN No. 307

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EUGENE B. ELLIOTT
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Superintendent of Public Instruction

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FOREWORD

Michigan Today is the third publication of major scope to appear in the Michigan program of curriculum revision. It was preceded by the *Instructional Guide for Elementary Schools,* published in August, 1936 and reprinted in a second edition in January, 1937, and by *What Does Research Say?,* published in August, 1937.

The purpose of this series of curriculum publications is obvious. Written for the teacher, they are designed to give a better understanding of the child's environment and a better command of techniques and practices of the art of teaching. To a teacher who is content to let the child's mind nourish itself solely on the information that is imprisoned between book covers, *Michigan Today,* and for that matter its companion volumes as well, will be of little value. In Michigan, however, such teachers are rare. This book has been prepared for the far greater number who realize that living yields the choicest subject matter for learning, and who therefore are constantly on the alert for learning situations in the child's own time and place.

Though still in its early stages, the Michigan program of curriculum revision has been entered into with interest and eagerness by the teachers of our state. The Curriculum Steering Committee began its work in the fall of 1935. At that time there was hardly a clue to the tremendous amount of latent interest in curriculum change that was shortly to be made manifest. I should like to record my sincere admiration for the way in which the Curriculum Steering Committee and the groups which it has created or with which it has allied itself have organized our professional resources and used them so as to enlist the support and confidence of the teaching profession.

From high school and elementary school teachers I anticipate a cordial welcome for *Michigan Today.* The committee and the authors have performed a noteworthy task in preparing a bulletin on the social and economic trends in Michigan with their educational implications. They have combined scholarship, workmanship, and skill in choosing and presenting items of interest and value. This much the bulletin says for itself. What it can not tell is the zeal, the self-sacrifice, and the long hours of patient preparation that were involved in the project.

To the members of the committee and other contributors I offer sincere thanks.

EUGENE B. ELLIOTT
Superintendent of Public Instruction

PREFACE

In the preparation of this bulletin the authors have had one major purpose in view; to present clearly, simply, and accurately such facts concerning the physical and human resources of Michigan as will enable educators to adjust the school curriculum in the light of the implications these resources have for the education of children. To achieve this end the authors have described *Michigan Today* in such a way as to stimulate the understanding and imagination of the reader. It is hoped that the picture of Michigan here presented will give the reader impressions which will guide him in a choice of further studies of the resources of the state and their effect on education. An understanding of the social and economic status of Michigan with its educational implications will help to erect a series of guide-posts for the construction of a new school curriculum.

The authors wish to acknowledge the aid of the various firms and institutions which furnished illustrative material: United Air Lines, Ford Motor Company, Chrysler Corporation, General Motors, New York Central System, National Education Association, United States Office of Education, Michigan Department of Conservation, Greyhound Management Company, Great Lakes Transit Corporation, Reo Motor Car Company, Pennsylvania-Central Airlines, Michigan Emergency Welfare Relief Commission, Michigan Education Association, State Highway Department, State Department of Aeronautics, Michigan Historical Commission, Michigan State College, State Planning Commission, and United States Department of Agriculture.

The chairman gratefully acknowledges the work of the authors who gave freely the benefits of their knowledge and experience.

GEORGE H. FERN
Chairman

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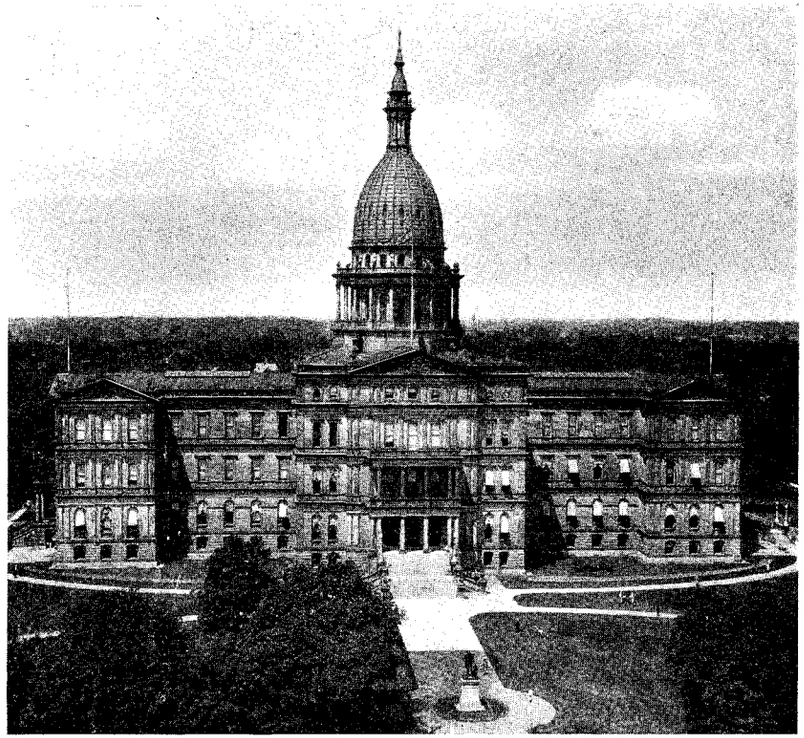

FROM THE MICHIGAN HISTORICAL COMMISSION

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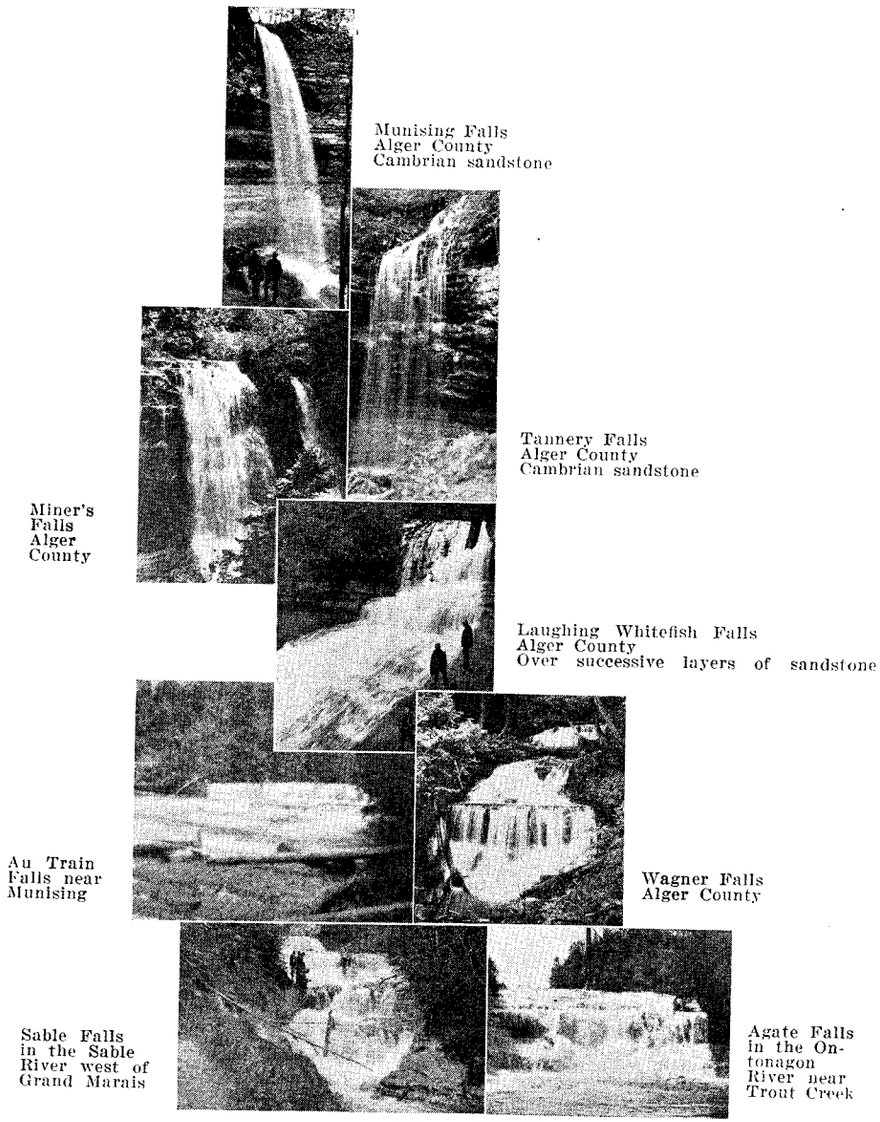


FROM THE MICHIGAN EDUCATION ASSOCIATION

FIGURE 1. MICHIGAN WATERFALLS

CHAPTER ONE

THE GEOLOGICAL AND PHYSICAL FEATURES OF MICHIGAN

By Helen M. Martin

Research Geologist

Geological Survey Division, Department of Conservation

Almost from the time that the North American Continent was formed on the surface of the Earth planet, the area we now know as Michigan has been unique and set apart: first, as a geologic unit through long geologic ages of millions of years; second, as a physiographic unit where the retreating ice of the Great Ice Age left records different from its records in other parts of the continent; and finally, as a geographic unit of 57,980 square miles with boundaries man-made on the basis of boundaries erected by Nature thousands and millions of years before man arrived on the planet.

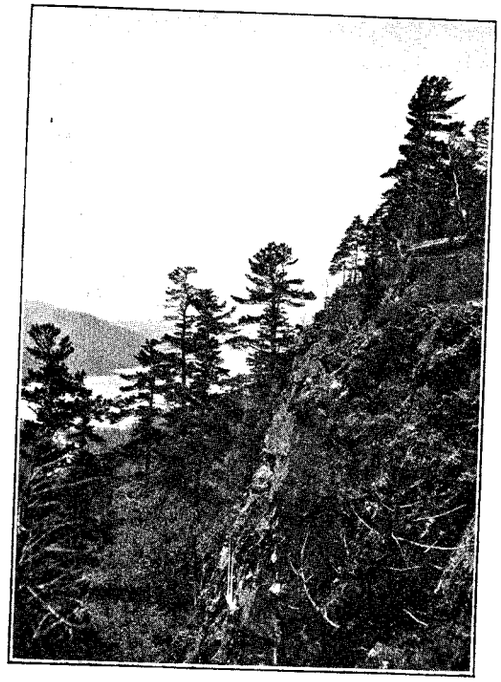
The Geologic Record

Briefly, the Michigan area has always been an irregularly circular-shaped basin bordered by land masses of granites which are still visible in Canada and Wisconsin but are buried elsewhere. Along the northwestern rim of the basin which bordered on an ancient land mass, volcanic activity of the convulsive rather than the violent eruptive type disturbed the edge of the basin. Lavas welled upward from the interior of the continent, lifted the overlying rocks to mountain heights, turned the flat lying rocks on edge, and tip-tilted some of them so that they are almost overturned (*folded*). Erosion wore these ancient mountains almost to their roots and exposed the rocks which, by virtue of volcanic and ground water chemistry, contain the copper, iron, silver, gold, and other valuable metals and minerals. So was formed the area we now know as the western half of the Northern Peninsula,—the Copper Region and the Iron Districts. The Huron Mountains and the Porcupine Mountains, in which is the highest peak in the state (2,023 feet), are remnants of this ancient range.

Frequently the rocks were cut by vertical cracks (*joints*). In places we find that the rocks on either side of the joint do not match; that some movement along the crack, either vertically or horizontally, or both, has separated the edges. The rock is then said to be *faulted* and the crack a *fault*. Nature objects to empty spaces. Therefore most of the cracks were filled by minerals first dissolved from the rocks by water and then re-deposited as the water evap-

orated. It is in such mineralized *veins* and in the ancient lava flows that the wealth of the mining regions is found.

Faults are much more common in the tipped-up rocks of the region west of Marquette than in the basin proper, and are of much greater extent. The longest fault extends from the tip of Keweenaw Peninsula, Bete Grise Bay, to the southern border of Ontonagon County south of Lake Gogebic. This part of the state has many other faulted areas with faults of varying length and showing various degrees of movement on them. The whole problem of the geology west of Marquette is perplexing even after one hundred years study. The lava flows, faulting, and slipping of the rocks as well as the subsequent erosion have jumbled the whole area but have also produced magnificent scenery and vast mineral wealth in copper, silver, iron, gold, marble, verde antique, and semi-precious stones as well as granites and other rocks of economic value.



FROM THE DEPARTMENT OF CONSERVATION

2. LAKE OF THE CLOUDS
From the summit of Porcupine Mountains, the highest peaks in Michigan

Geologically this part of Michigan is classed as pre-Cambrian—the oldest area of the state. The remainder of the state is the Michigan Basin proper which extends from Lake Superior into Ohio.

Lake Superior lies in a trough bordering the northern rim of the basin which was produced by earth disturbances during the pre-Cambrian time.

Geologic history is a record of the making and destruction of rocks, of the wrinkling of the earth surface into mountains and basins, and the wearing down of the mountains and filling of the basins. So through a long geologic history of one or two billion years the Michigan Basin was at times filled with a sea, at times was land, in whole or in part, and at times land with a shallow sea or swamp covering. At times desert conditions prevailed and the sea waters were excessively salt; in other ages the water was warm and teemed with animal life. Several times the basin was emptied by evaporation of the sea or by earth movements which actually spilled the seas from the basin. When the seas re-entered, swift rivers from the land masses brought sands to cover the bottom and edges of the basin. When the waters were shallow, warm, and clear, lime was deposited; when the surrounding land masses were covered with vegetation the rivers brought to the sea fine sediments, clays, fine sands, silts, and dissolved minerals. As the shelled animals and corals living in the seas died, the shells or skeletons fell to the bottom and were buried by the sediments. In time many of them became "petrified" leaving an animal record which we know as *fossils*. As the seas slowly evaporated, the dissolved minerals were left behind as salt and gypsum mixed with other sediments (and so impure) or on top of them (and so pure).

Ages passed. The sands hardened to sandstones, the clays to shales, the limes to limestones and dolomites, the salt to rock salt, and the gypsum to rock gypsum and alabaster. These rocks known as *sedimentary* rocks vary in all degrees of purity, hardness, and porosity; we have limey sandstones and shales; shaley limestones and sandstones; sandy shales and limestones; sandy salt beds and pure rock salt; sandy, limey, shaley gypsums; glistening pure white gypsum and white and pink alabaster. We have *massive* sandstones and limestones with beds many feet in thickness and *thin bedded* rock strata with beds and laminae only a few inches thick. The shales usually are thin bedded to almost paper thin (*fissle*). The sandstones and limestones may be very porous and filled with water, gas, or oil; or very "tight"—so tightly cemented no water, gas, or oil can enter. Shales as a rule are non-porous and impervious to oil, water, or gas. The rocks also vary in color; the limestones from black through grays and blues to a dazzling white; the shales from jetty and brown-black to light blue gray and often green and red; the sandstones from all the shades of red-brown to gray, blue, and white. Each layer of rock is a *stratum,* several layers are *strata.*

The Seven Major Geologic Periods

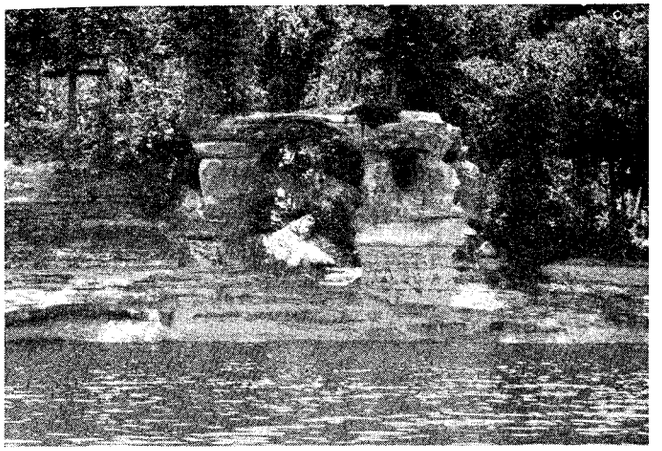
These processes were repeated in whole or in part over and over until there were seven periods of maximum sea invasion, the Cambrian, Ozarkian, Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian. During this time the rock register shows twenty-four to thirty major invasions and retreats of the sea and consequently, between drownings, long periods of time when the basin was alternately practically out of water and again practically submerged. During the major invasions there were minor retreats and periods of evaporation and minor times when land was at the surface. During the times of maximum emergence there were times of short submergence. All the basin was not entirely submerged or wholly out of water at the same time.

Rock Saucers the Characteristic Geologic Formation

Curiously, too, the seas were not always deepest at the same place. So we have a rock basin filled with sets of rock saucers (*formations*) of sandstone, limestone, shale, rock salt, gypsum, laid down as irregularly shaped saucers of varying thickness. Each set and each saucer fits into the one above and the one below like a nest of huge rough rock mixing bowls, because each succeeding sea was smaller and shallower than the one before. All rocks excepting the pre-Cambrian of the western half of the Northern Peninsula slope *(dip)* into the basin centering west of Saginaw Bay.

The rocks deposited during the major sea invasions are grouped together for convenience of study and reference as *groups,* then sub-divided into *formations, members, beds,* and also for convenience they are named. Because the English geologists studying the rocks of Wales were first in the field with results of their studies published in English, the names which they gave the sedimentary rocks of that area have been given all over the world to rocks which are in the same relative position and carry the same fossils. The rocks found to be the oldest of the sedimentaries English geologists named the Cambrian (from Cambria in Wales)—hence our term pre-Cambrian for all older rocks whether they are sedimentary or volcanic or *metamorphosed* (sedimentary or volcanic rocks changed to some other form, i.e., limestone to marble, shale to slate and many others). The succeeding Ordovician and Silurian were named from ancient British tribes that inhabited Wales; the Devonian from the rocks of Devonshire; the Carboniferous because those rocks showed so much evidence of plant life and held the great coal beds of Europe. In America this term was too inclusive and so American geologists divided it into the Mississippian and the Pennsylvanian and added a third division, Permian, from the province of Perm in Russia. Also

it was found that in America another set of rocks are between the Cambrian and Ordovician. They are named Ozarkian.



FROM THE MICHIGAN EDUCATION ASSOCIATION

3. CHAPEL ROCK, PICTURED ROCKS
Erosional remnants of Lake Superior (Cambrian) sandstone on rim of lowest rock saucer of Michigan Basin

Taken together rocks of these periods are the Paleozoic or early life, as the life records (fossils) are all of the more primitive type. After the Paleozoic came a long period of time—measured in millions of years—the Mesozoic (middle life) and the Cenozoic (modern life) during which life developed to its present stage with man at the top of the scale. This long time is, however, a geologic blank in Michigan.

The Michigan rock saucers do not have smooth surfaces nor present a smooth curve from rim to rim. Slow earth movements have caused them to be warped, wrinkled, domed, and broadly arched and troughed. An up-wrinkle, arch or fold is known as an *anticline;* the downfold or trough is the accompanying *syncline.* In the Michigan Basin the direction of the major folds across the saucers is from the southeast to the northwest. In some places earth movements have caused minor folds in the opposite direction (*cross folds*) which close one end of the anticline so that it is something like an upturned canoe and is known as a *structure* important as the trap in which oil and gas accumulate. Some faults are known in the Paleozoic rocks of the basin but they are small and, in so far as we know now, are of minor importance. Some evidence exists that a long fault extends from southwestern Shiawassee County across

FIGURE 4. GEOLOGIC SYSTEMS OF ROCK FORMATIONS

Livingston County through Howell. Faults in the sedimentary rocks are important as they cause traps for the accumulation of oil and gas as well as affect the movement of the waters, fresh and brine, in the rocks.

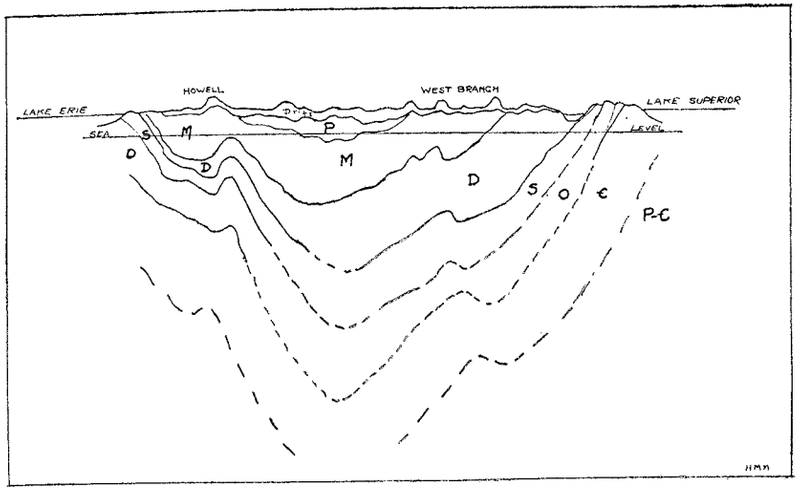


FIGURE 5. DIAGRAMATIC CROSS SECTION OF THE MICHIGAN BASIN
From Lake Superior to Lake Erie through West Branch, Ogemaw County and Howell, Livingston County, showing sets of rock saucers filling basin and indicating their irregularities. Based on records of deep drilling

P—Pennsylvanian
M—Mississipian
D—Devonian
S—Silurian
O—Ordovician
C—Cambrian
P-C—Pre Cambrian

The vertical scale is greatly exaggerated.

The Cambrian Rocks

The lowest and oldest of the rock saucers is the Cambrian, the edge of which we can see in the reddish sandstones which form the Pictured Rocks along Lake Superior, and make the ledges over which the rivers fall to reach the lake—the Au Train, Tahquamenon and others. Elsewhere the beveled edges of this saucer are buried. We do not know how deep the Cambrian rock is in the basin. A well in Newaygo County over 6,600 feet deep did not reach it and a well in St. Clair county on the rim drilled into granite below 4,700 feet.

The rock saucer within the Cambrian is the Ozarkian which outcrops in a few places just south of the arc of the Cambrian outcrop and forms ledges where rivers cross it to reach Lake Superior.

Next above and within is the Ordovician set, made up of smaller saucers of limestones and some shales. The northern rim of this

saucer is also exposed in the Northern Peninsula but covered to the south. Next above this is the Silurian set, mainly dolomitic limestone with two shale and one limestone saucers, a 200-1,200 feet thick bed of pure rock salt, and some petroleum. Silurian rocks are exposed in the southeastern part of the Southern Peninsula and in the Northern Peninsula.

Devonian Formations

Above and enclosed by the Silurian rocks are the Devonian sandstones, limestones, and shales. By Devonian time the basin was so filled and the sea so small that its shores encircle the present Southern Peninsula. Some of the rocks of this period were not so hard, a fact to be remembered later when the Great Lakes basins are discussed. Devonian rocks *outcrop* (are exposed at the surface), in Monroe, Wayne, Alpena, Presque Isle, Cheboygan, and Charlevoix counties. The lowest formation of the Devonian set is the Sylvania sandstone, important because it is made up, at its outcrop in Monroe County, of a pure white sand suitable for the manufacture of the finest glassware and optical glass. Near the middle of this saucer set is found the Dundee limestone, at present the greatest source rock for petroleum in the central part of the state and of limestone for blast furnaces at its outcrop. The largest limestone quarry in the world is in the Dundee strata at Rogers City. A stratum of dark shale above the Dundee is used at its outcrop in Presque Isle County for cement. Next above is the Traverse saucer, important for limestone at the outcrop in Alpena, Presque Isle, and Charlevoix counties and in the central part of the state for the oil it contains.

The Carboniferous Coalfields

Following the Devonian age came the Carboniferous, the time when trees and plants became so abundant on the earth that they were more important than any other form of life and left more significant remains—the coal fields. During this time the seas were not very deep and great swamps existed in which grew huge trees, not like our present forest of pine, maple, beech, or oak, but great ferns and gigantic horsetail rushes. Some of their descendants live today in the tropical forests and others have dwindled to the weeds and rushes we know as the horsetail rushes that grow along the railroad tracks and swampy lake shores.

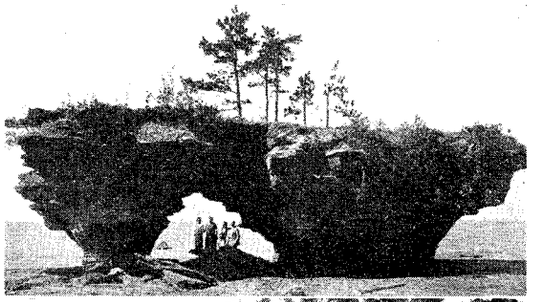
As the trees fell they filled the swamps, were buried, and through the centuries were pressed and baked to soft coal (*bituminous*). Where the earth movements caused greater pressure and baking, the soft coal became metamorphosed to *anthracite*. Similar processes are taking place today in the formation of peat, near the

surface and with the action of air, in the shallow swamps of peat bogs.

Mississippian Shales, Sandstones, and Limestones

As stated before, the Carboniferous age has been sub-divided into the Mississippian, Pennsylvanian, and Permian. In Michigan, the Mississippian sea was almost an inland lake or a brakish water lagoon of the greater sea in the central part of the continent. The bottom of the Mississippian saucer is a black shale, Antrim shale, which contains some gas and out-crops in Alpena, Antrim, and Grand Traverse counties. A part of this saucer is covered by a

A.



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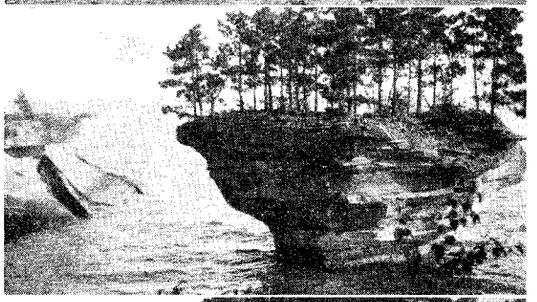


C.

6. EROSIONAL REMNANTS OF MARSHALL (Mississipian) SANDSTONE

A. "Double Turnip" rock, near Oak Beach, Huron County
B. "Uncle Sam's Turnip" rock, Pointe aux Barques, Huron County
C. "Flat Rock", at Port Austin, Huron County

coarse grey sandstone, the Berea, important as a gas reservoir in Muskegon and Arenac counties and as a source of salt brines in Huron and St. Clair counties, and oil in Saginaw county and elsewhere.

The Berea and the rest of the inner Mississippian saucer is covered by the Coldwater shales, outcropping near Coldwater and used for cement manufacture. Above the Coldwater shales is the Marshall formation of sandstones. This formation is one of the most important in the state. Near the outer rim the sandstones contain water and are the great source of pure water in the state. In the central part of the state, however, the waters have become charged with enormous quantities of salt, bromine, magnesium, calcium, and other minerals and are one of the most important economic resources of the state, not only for salt, but for bromine (used for ethyl gasoline, kodak films, and medicine); for magnesium (for Dow metal and medicine); and for thousands of other chemicals. These sandstones outcrop in Jackson and Calhoun counties. They are scenically beautiful at Pointe Aux Barques in Huron County.

Above and within the Marshall saucer are the sandstones, limestones, and gypsum of the Michigan series. These rocks have been of commercial importance for over one hundred years. They were explored for salt by drilling as early as 1834 and the gypsum of their outcrop at Grand Rapids was early used as a fertilizer—"land plaster". Now the gypsum is used for building purposes and the alabaster found in Iosco and Arenac counties is of so fine a quality that it is used for the bed upon which optical glass is poured. In some of the sands in the central part of the state natural gas was trapped. From this sand, "The Michigan Stray", come some of the largest gas wells.

The Pennsylvanian Problem

The gypsum and salt show that Mississippian time closed with almost desert conditions for they are the deposits left by the evaporation of the sea of that age. Then came the invasion of another sea, the Pennsylvanian, filling the basin in the Mississippian rocks. First a sparkling sandstone was spread over the basin. This is now a source of water not so palatable as the Marshall water, and which often becomes salty in the wells. Above this sandstone black carbon-filled muds and vegetable material settled to form the coal beds of the Saginaw valley, Jackson, and Grand Ledge. Pennsylvanian rocks outcrop at Grand Ledge and Ionia. Geologists are not certain what happened after the swamps disappeared. The drilling records of wells drilled for oil, gas, and water in the central part of the state show that a red shale with gypsum and sandy beds is above

the coal formation and may belong to the Permian. This is just another little problem in geological time. But the red rock and gypsum mean that the region was almost a desert and the water of the small sea covering the inner part of the coal formation saucer became brakish, bitter water which left the gypsum, on evaporation, as desert conditions continued and the last sea dried up.

The Geologic-Physiographic Record

For millions of years during the time known as Mesozoic and Cenozoic, the Appalachians were being folded up into mountain ranges, worn down to *base level* (a gentle plain sloping to the sea), lifted again as a great plateau, and again cut by rivers to the present Appalachian mountains. The Great Plains were being built and the Rockies and Sierras were being lifted to rugged mountains. Life changed from sea to land forms. Huge reptiles appeared during the Mesozoic era and quadrupeds, followed at last by man, during the Cenozoic period.

While all this was taking place elsewhere, exactly what happened in the Michigan Basin is not known definitely. No more rocks were deposited but there is evidence to indicate that rivers and the weather combined to cut down what previous centuries had built up. During this time, the edges of the saucers were beveled, the rock evidences of channels to the continental seas were destroyed, and the softer rocks around the rim of the basin were removed leaving wide valleys in which rivers flowed. In what direction they drained the land is still a question which may never be solved. But the valleys formed at that time are occupied by Lakes Michigan, Huron, and Erie.

At the close of this time, of which there is so little record in Michigan and during which the continent of North America assumed almost its present form, a climatic change took place. The winters became not so much colder but longer, so long that the snows of one winter were not melted by the summer sun before another winter set in. This time we know as the Pleistocene, the age of the great continental glaciers which built the final rock chapter in the history of Michigan.

The Physiographic Record

During hundreds of years snows accumulated around the region of Hudson's Bay and as they increased in depth packed into ice just as old snow drifts do today. Finally they became so thick they pushed outward by their own weight just as a mass of dough spreads outward on a bread board. Once started to move, the mass of snow-

ice became a glacier. Then through thousands of years snow accumulated, packed to ice estimated to be eventually from two to six miles thick, and moved outward until its southward movement had carried it 1,600 miles from the center into the Ohio Valley.

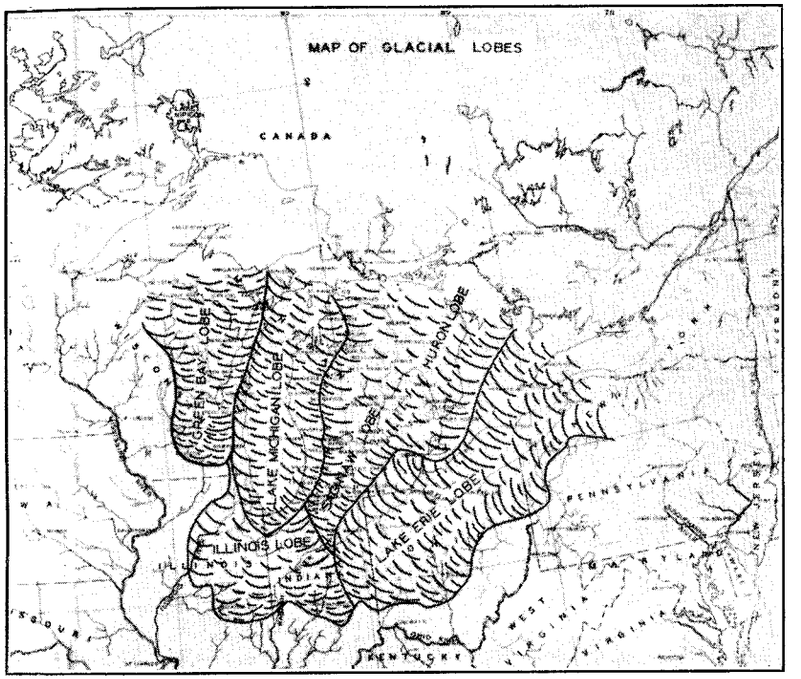
Another climatic change caused the summers to be longer and the ice to melt at its southward front and on top. But it did not melt rapidly because it was not clean ice. As the glacier moved from its center it froze onto and picked up all loose soil and rock over which it passed. The great weight of the ice caused the granite boulders frozen in its base to act as ploughs which ploughed, gouged, and scraped the rock over which it passed, and the finer rock sand and clay frozen in the base scratched (*striated*) and polished the rock surfaces. These gouges, scratches, striations, and polished surfaces are the record the ice left to show where it came from, and its direction of movement. Boulders (*erratics*) torn from bed rock to the north were left on totally unlike rocks to the south to show where the ice started and where it moved.

How Nature Writes History

Nature is very generous with the records she leaves for future study when we learn the key. Rock material was accumulated from all the rock over which the ice passed. Granites, limestones, sandstones, huge boulders, small pebbles, dust, and the shales ground back to clay were all mixed together within the ice. So that when the ice melted, rock waste which the ice brought from the north was left in the south and mixed with rock from places on the way.

At times the glacier pushed forward from the north as rapidly as its front was melted off at the south so that the rock waste was piled up in hummocky ridges in front of the ice. Such ridges in front of present day glaciers in Switzerland are known as *moraines*. So although the ice is gone, similar moraines form the hummocky hill ridges which stretch from the Ohio valley to Canada to mark the stops or halts of the retreating glacier. Streams flowing from the front of the ice washed out the rock waste, sorted it, and carried the finer material farther from the front to form *outwash aprons* or *plains* which are gravelly near the moraine and finer farther south. When the sun could melt faster than the ice pushed forward, the rock waste was left just where the melting ice carried it and so built up *till* or *boulder clay plains* between the moraines. In places large boulders are left scattered over the till and outwash plains. Sometimes the cold was greater than the heat and the ice pushed forward over the outwash plain and into the moraine next to the south—just to complicate matters for the future student. But in the main the retreat, although halted, was steady.

As the ice pushed southward, for ease of movement it took advantage of any valleys in its path and moved forward rapidly in the valleys just as the Alpine glaciers do today. If the valleys were in soft or easily eroded rocks (like the great salt beds, and the soft shales of the Silurian and Devonian rock discussed earlier) the ice gouged them wider and deeper. As explained in an earlier paragraph, such valleys had been *eroded* (carved) from the softer saucers around the rim of the Michigan basin. Naturally the ice would be thickest in these valleys.



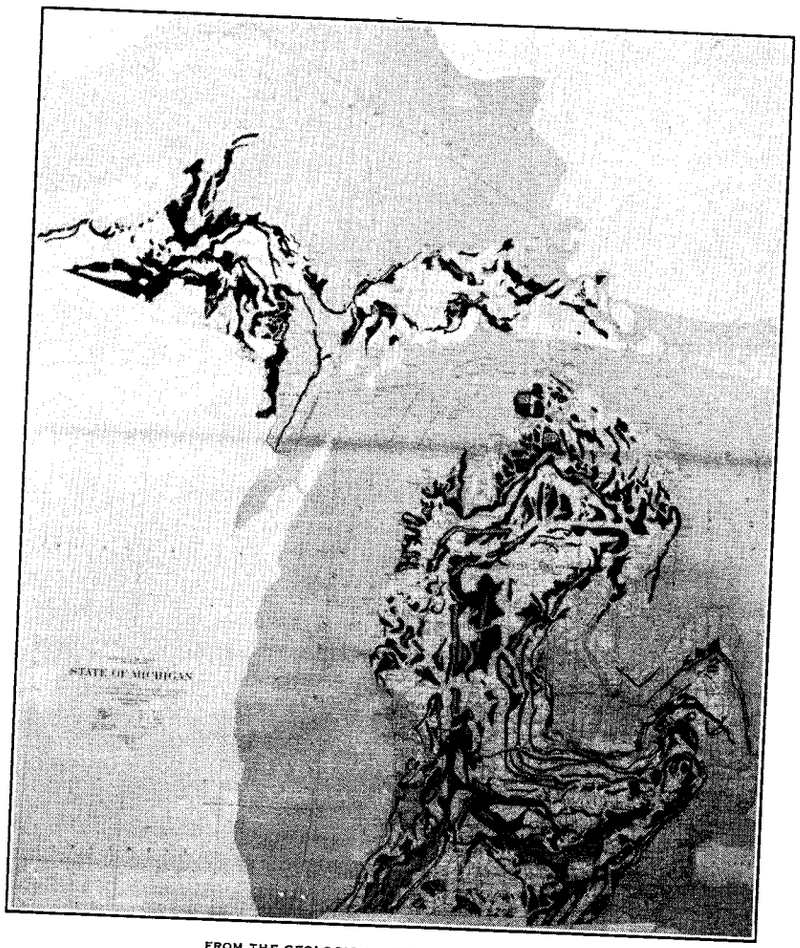
FROM THE GEOLOGIC SURVEY DIVISION, DEPARTMENT OF CONSERVATION

FIGURE 7. LOBES OF THE GREAT GLACIER

Ice Lobes Form Moraines and Lakes

As the ice melted on the highlands between the valleys it left the thicker ice as tongues of ice or *lobes* in the valleys. Moraines left around the ends of the lobes mark their position. So we find the Lake Michigan lobe occupied the valley later to be filled with Lake Michigan, a lobe in the Huron valley united with one in the Erie Valley to form the Huron-Erie lobe, later to be again divided by melting. A smaller tongue or small lobe extended into the Saginaw valley, to become the Saginaw lobe. Retreats and halts of the

glacier left moraines, till, and outwash plains festooned about the valleys marking the positions of the former ice fronts. The most noticeable festoons are the narrow moraines and broad outwash plains marking rapid retreats and short halts as the ice melted into the Saginaw valley. The most striking hills are those of Oakland and Washtenaw counties where the moraines of the Huron and Erie lobes met and pushed together forming a jumble of high hills; and in the high area of Wexford, Missaukee, Roscommon, and Ogemaw counties where the moraines of the Michigan and Saginaw lobes meet. The moraines in northern Osceola County are the highest in the state. One of the hills near the Wexford-Osceola county line about seven miles south of Cadillac has an altitude of over 1,700 feet.



FROM THE GEOLOGIC SURVEY DIVISION, DEPARTMENT OF CONSERVATION

FIGURE 8. DISTRIBUTION OF MORAINES (after Leverett)

The Great Lakes

The retreat of the ice was marked by another phenomenon which was to make Michigan the Land of the Inland Seas. Where the built moraines or pre-glacial rock ledges were so high that the melt water could not flow away, it formed a lake in front of the ice, a lake with moraine shores on the land sides and ice shores toward the glacier. In the beginning, the lakes were very small. The first to be formed was in front of the Lake Erie lobe just east of the moraine at Fort Wayne, Indiana. The lake managed to produce an outlet through a low place (*col*) in the moraine and the waters escaped down the valley of the Maumee westward to the Ohio and the Mississippi. A similar lake at the foot of the Lake Michigan lobe was drained southwestward through the valley of the present DesPlaines and Illinois Rivers to the Mississippi. In time Lake Duluth was formed at the western edge of the Superior lobe and drained southward also to the Mississippi.

Drainage Channels Become Today's River Valleys

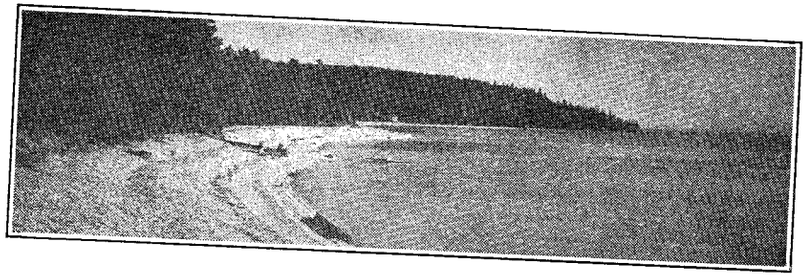
These old drainage channels still exist but are occupied by small rivers flowing eastward in a wide valley which narrows to the east, whereas normally a river valley narrows upstream. Historically they have been routes of travel and trade from the east to the west. The outlet of early Lake Chicago is now occupied by the Chicago Ship and Drainage Canal. Recently, when it was proposed to deepen this channel, Ohio, Wisconsin, and Michigan protested, and carried the case to the United States Supreme Court. An argument of their protest was that if Lake Michigan once flowed to the Mississippi, deepening the channel might destroy the ledge of limestone at Chicago which holds Lake Michigan in its present valley, and permit it to be drained southward.

Physiographic History Repeated

Present day lakes are making shore lines—beaches, strands, and shore ridges where the waves wash sediments onto the shores; streams are building deltas into the lakes; heaps of sand distinct from other sands are being piled along the shore by the waves and sorted and carried farther by the wind. If the lake dries up, such records are left and show where the lake once was; as water seeks a level, these shores are level-horizontal; if the lake becomes smaller new shores, dunes, etc., are built at the lower level and again are horizontal.

So, too, the early lakes in the Maumee and DesPlaines valleys at the foot of the ancient ice mass left their horizontal shores, beaches, and shore ridges as evidence of their position. One may walk for

miles along these horizontal shores; in fact they are so level that they are used for highways. For example, the Ridge Road along Lake Erie is an old beach. If we cross the beach in the direction of the ice retreat we enter a flat plain, the old lake bed. An interesting illustration of this can be found on U. S. Highway 112 from Ann Arbor to Detroit. Summit Street, Ypsilanti, a high ridge which drops abruptly to a flat plain to the east, is the high shore of the first of the glacial lakes. Traveling on to the east several other beaches are crossed. Some are rather faint and look as if they had been flooded, as they were; others are marked by heaps of yellow sand—the old dunes along the ancient shores. Similarly all roads leading to Detroit or Monroe cross the old ridges of the lakes in the Erie valley. A similar, but not so striking, tale may be told of the other lake valleys.



FROM THE DEPARTMENT OF CONSERVATION

9. BEACH LOOKING SOUTH FROM BRITISH LANDING, MACKINAC ISLAND
A beach of the modern lakes to show characteristics typical of beaches left by ancient great lakes. Step notches in headland in background are beach cliffs made by lakes Algonquin and Nipissing

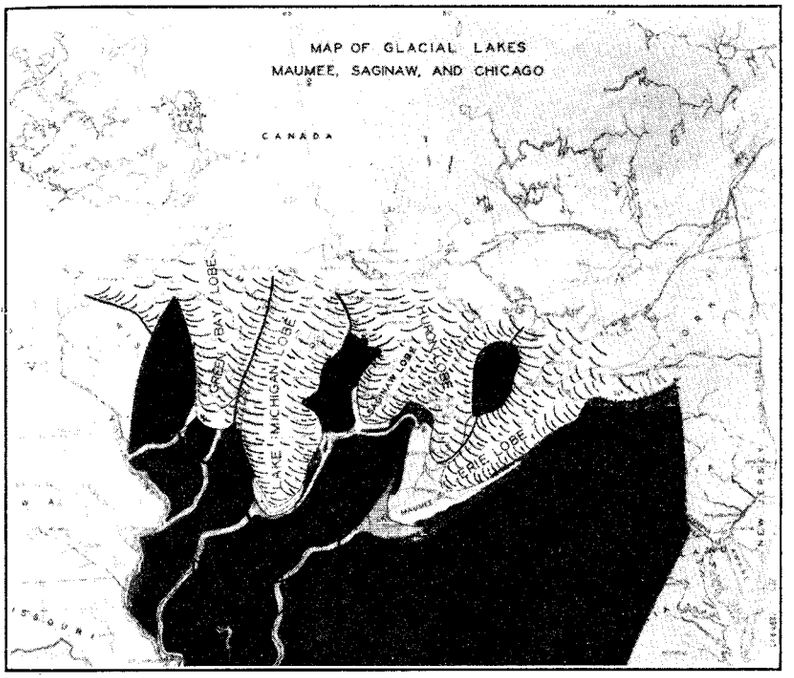
What the Ice Left

From these and other records it is evident that in the halting retreat of the ice from Michigan the lakes steadily increased in size to the northward and left beaches at each stage where an ice halt caused the melt water to be ponded in front of it.[1] Sometimes the ice actually readvanced and then the melt waters washed over but did not always quite obliterate the old beaches. New outlets were established as the ice retreated northward and uncovered lower levels for the water to escape.

In the first stage the lakes had outlets through several small lakes to the Mississippi. During the second great stage (Maumee II), the lake waters flowed from the Erie basin northward past Imlay City to a lake in the Saginaw valley, thence across Michigan to make the

[1]Numbers appearing thus in the text refer to the bibliography placed at the end of each chapter.

wide valley in which the Grand River now flows; a later stage poured the lake waters through the Finger Lakes region of New York into the Atlantic. Still later, the lakes had an outlet through the Mohawk River past Rome, New York, which made the first excavation for the Erie Canal. A later outlet was through the Ottawa River in Canada to Lake Champlain; then through Georgian Bay to the Ontario basin. Finally, the lakes reached their greatest expansion, and in the northern part of Michigan built the highest beaches found today at the tops and bases of the cliffs about



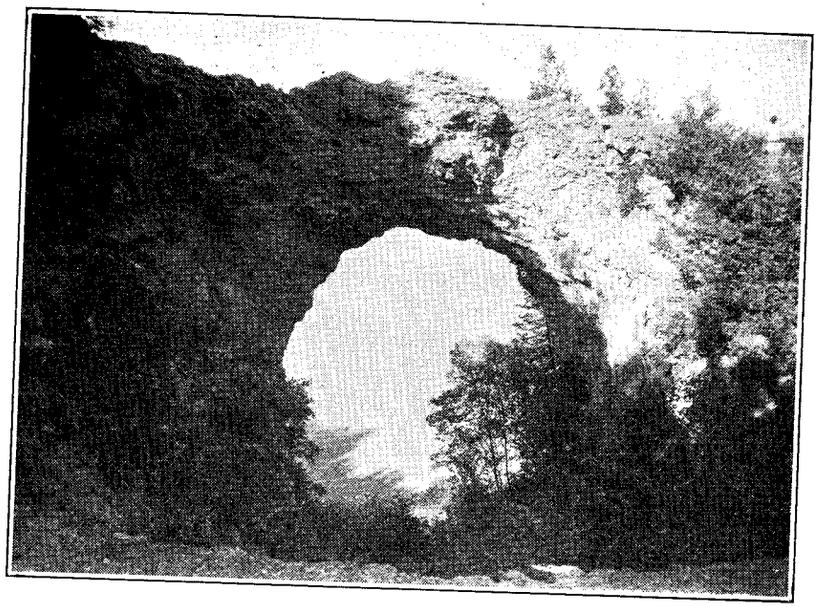
FROM THE GEOLOGIC SURVEY DIVISION, DEPARTMENT OF CONSERVATION

FIGURE 10. LAKE DEVELOPMENT IN THE MAUMEE STAGE
(Modified after Leverett and Taylor)

the upper lakes and also about the great inland lakes, Torchlight, Charlevoix, Walloon, Mullet, Douglass, Burt, and others. In the region of Mackinac Island the wave work of the lakes was very intense, making such shore features as The Stack and Arch Rock on Mackinac Island as well as shore cliffs and beaches. This is known as the Algonquin stage.

Finally the ice retreated from southern Canada. Then the Great Lakes almost reached their present state but with the outlet through

Lake Nipissing in northern Ontario, Canada, to the Ontario Basin. Lake Erie was not part of the Great Lakes during "Nipissing" times.



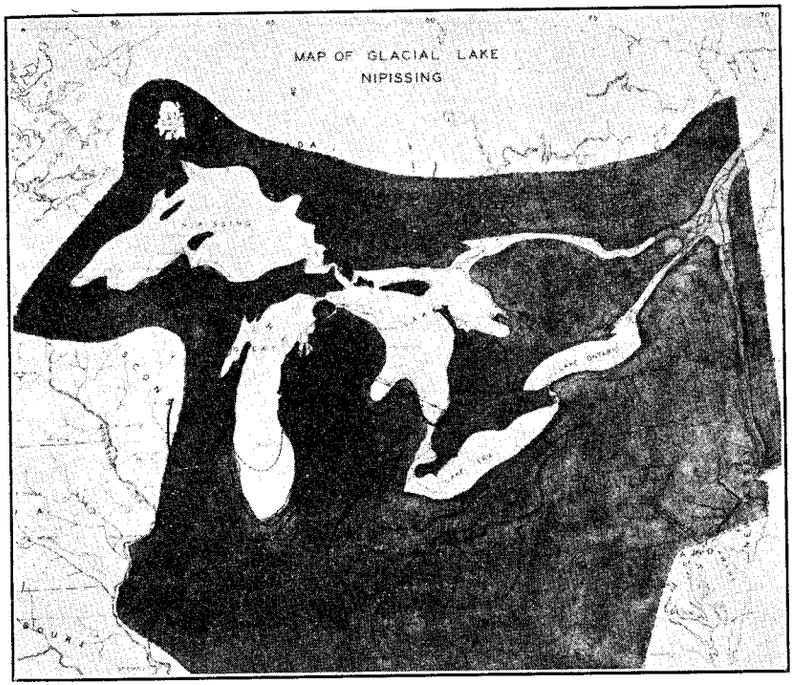
FROM THE DEPARTMENT OF CONSERVATION

11. ARCH ROCK ON MACKINAC ISLAND
A record of wave work of glacial Lake Algonquin in Devonian rock

When the Continent Tilts

But something else happened with the oncoming and retreat of the ice mass. It is evident that ice from two to six miles thick must have had great weight and must have pressed down the part of the earth over which it accumulated and moved. When the pressure of this ice was released, the earth must have uplifted to seek its own level again and be in equilibrium. The beaches of the old lakes show that this is just what did happen. Beaches are horizontal yet the Algonquin beaches northward suddenly tilt upward. Water does not make a tilted beach; something else tilted them. Years of study have shown that all the beaches north of a line extending from near Port Huron to Manistee are tilted like the upcanting of a trap door and so this line is called the *hinge line*. The effect of the first uplift along the hinge line was to spill the waters of the great lakes back into the Erie basin through the St. Clair and Detroit Rivers, and the present Great Lakes came into existence.

The present day effects of the tilting of the continent in its effort to regain equilibrium are the little earthquakes noticed in the lake region and which may be expected until equilibrium is attained; the fact that trees which early settlers reported as being well back from the Lake Superior shore are now at the waters edge; streams which entered the lake over falls now enter through a valley; and rapids and falls have developed in the streams entering the lake from the north. Measurements of the beaches show that North America is rising at the rate of one inch every ten years for each 100 miles north of the hinge line. So that if left alone the Great Lakes might again drain to the Mississippi but are prevented from doing so by dams, canals, and diversion of water for electric power. A continuation of the earth shocks in the lake region may be expected, but will not be serious enough to be disturbing.



FROM THE GEOLOGIC SURVEY DIVISION, DEPARTMENT OF CONSERVATION

FIGURE 12. LAKE DEVELOPMENT IN THE NIPISSING STAGE
(Modified after Leverett and Taylor)

The Drainage Pattern Becomes Established

The physiographic record, then, is made on the basis, first, of ice activity which built a new surface on top of the old surface carved on the bed rock. As always, as soon as the land was formed, the

agencies of weathering and rivers proceeded to change the face of Michigan. Rivers developed from the melt water of the ice and their story is bound up with the story of the Great Lakes but is even more detailed.

Rivers now flowing east, in their headwaters at least, once flowed west—the Raisin, Huron, AuSable. The St. Joseph, Kalamazoo, Grand, and Muskegon rivers once reached the Mississippi. The Raisin was once a part of the St. Joseph. The Huron successively emptied into the St. Joseph, the Kalamazoo, the Grand before its present eastward drainage was established. The Kalamazoo was a tributary of the St. Joseph; the Grand, of the Kalamazoo; the Muskegon, of the Grand; the AuSable, of the Muskegon. Many other interesting routes were followed by the streams before the lowering of levels to the present Great Lakes established the drainage pattern we know today,—routes fashioned to fit the morainic surface plastered over Michigan by the waning ice sheet.

Melting Ice Also Forms Lakes

The more than 5,000 lakes that help to make Michigan a great resort state were also created by the ice. Sometimes large blocks of ice became detached from the main mass and, covered with protective rock waste, did not melt until long after the melt water had made a plain in front of the moraine. It was probably centuries before the blocks melted. Even today, small blocks of ice buried in the sands of the Lake Superior shore will frequently remain nearly through a summer. When these great ice blocks did melt, they left steep walled pits into which water entered to make the many circular steep walled lakes we find on the plains and also in the hills. Other lakes and swamps were formed in the hollows of the moraines.

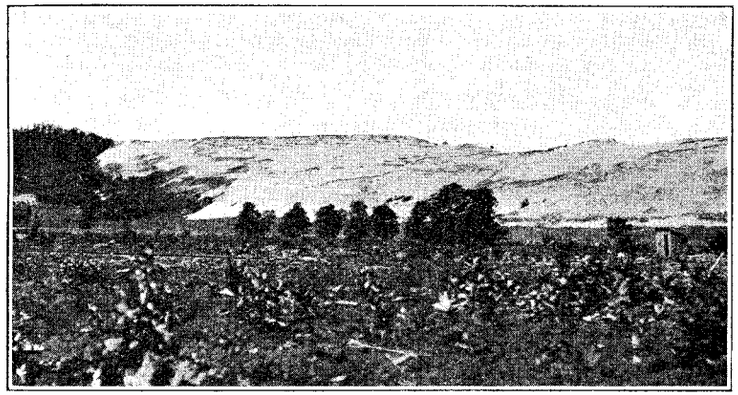
Geologically, lakes are anything but permanent features of a landscape. They exist only where the surface is young, and disappear by being drained away or by being filled by vegetation. The great drought of the past few years shows what may happen to lakes when the ground water level is lowered. Many resorters have found their lake-side cottages well back from the shore and a new beach being formed as the water level lowered and the lake dried up. Nothing can change the level of the pit lakes which have no outlet once the ground water level is lowered except prolonged times of rain. Drainage of swamps and clearance of river channels often lower the dam which holds water in the lakes. Once lowered, vegetation destroys the lake site. Houghton Lake, the largest in the state, (31 square miles) is being destroyed by vegetation, particularly wild rice, the delicacy liked by ducks.

Erosion Modifies Surface Contours

Wind, weather, frost, and all the forces of erosion have modified the character of the surface since the ice melted off. Studies of soil thickness are the basis for an estimate that the ice left the southern tier of counties of Michigan about 30,000 years ago and melted from the Superior region about 10,000 years ago. In only a few areas do the bed rocks appear to form the topography of the state. Elsewhere the state is covered by that plastering of rock waste made of all sorts of rock, coarse and fine, granite and limestone, coal from the youngest of the Pennsylvanian rocks mixed with boulders which are actually bits of the "petrified" shores of the Cambrian seas—all mixed together in a heterogeneous mixture of rock waste known as the *drift*. The *topography,* (the surface features) of the state is glacial, therefore it is young. The hills are moraines and the flats are till plains, outwash plains, lake beds, or wide river channels.

Eskers, Drumlins and Dunes

The long steep sided sinuous ridges or "hogbacks" called *eskers* are the waste which choked channels of rivers which flowed in tunnels in the glacier and which settled on the plain when the ice



FROM THE DEPARTMENT OF CONSERVATION

13. SLEEPING BEAR DUNE
North of Empire, Leelanau County

melted. Eskers are mainly gravel and so of great economic importance. They were first studied and named in Scandinavia and Ireland. The longest esker in the world extends from a few miles north of Lansing through Holt and Mason almost to Leslie. It is called the Mason "Hogback" or esker.* Other queer hills are those

*See p. 102.

long bottom-up canoe shaped hills made of clay, the *drumlins,* found on the plains in the southwestern and northwestern parts of the Southern Peninsula and in the Northern Peninsula. The lakes are the remnants of larger glacial lakes, or are pits and hollows in the moraines and plains filled with ground water. The swamps and peat bogs are remnants of undrained areas. The eastern half of the Northern Peninsula is largely swamp, muskeg, and bog because the ice left it so recently that drainage has not been established and also because the underlying bed rock does not permit rapid drainage. The dunes along the lake shores are glacial and lake sand blown up on shore. Many dunes along Lake Michigan such as Sleeping Bear Point are modern dunes perched on the dunes of the earlier lakes, *perched dunes.* The soils are varied also because they are either glacial deposits or sorted material brought by the ice. The moraines have all sorts of soil; the outwash plains are gravelly; the till plains, loam and clay of all varieties; the lake beds mainly sand, sandy loam, and clays; and the old river deltas are mainly sandy at the outer edge and gravelly at the inner edge.

How the River Systems Grew

Again because the topography of Michigan is glacial in origin, the drainage is very young and the story of the rivers is long and complicated. Some of the streams have cut their own channels and valleys but more of them occupy the wide channels of rivers which were old glacial spillways. The rivers receive their water supply from the rains that fall on the upland areas or from the more than 6,000 lakes and swamps they drain.

The headwaters of most of the eastward flowing streams once drained into rivers entering what is now Lake Michigan. As rapidly as the ice retreated a new river was formed at the halt. It flowed along in front of the moraine until it found a lower outlet. This accounts for the fact that so many streams have long branches entering from one direction. The river poured through the outlet often as a rushing torrent such as made the channel of the Grand when the valley was the outlet of the glacial lakes in the Erie and Saginaw basins. The valley and outlet were cut rapidly and the headwaters of neighboring streams diverted to the new lower outlet. The drainage map of the state shows that none of the rivers have the tree-like (*dendritic*) pattern we associate with rivers.

The story of the rivers is too long to be told here but a few physiographic facts about some of them may be of interest. The St. Joseph is the oldest river. It once drained to the Kankakee and the Mississippi. The Raisin and the Huron were once its headwaters; the Kalamazoo once entered it in the northern part of St. Joseph

County. The Grand is the longest river, but it is made up of older rivers which have been diverted from the original channels. Its valley is the channel of a mighty glacial torrent. The Muskegon has the longest and narrowest valley, 45 miles wide, with few tributaries and but one stream of any importance entering from the south.

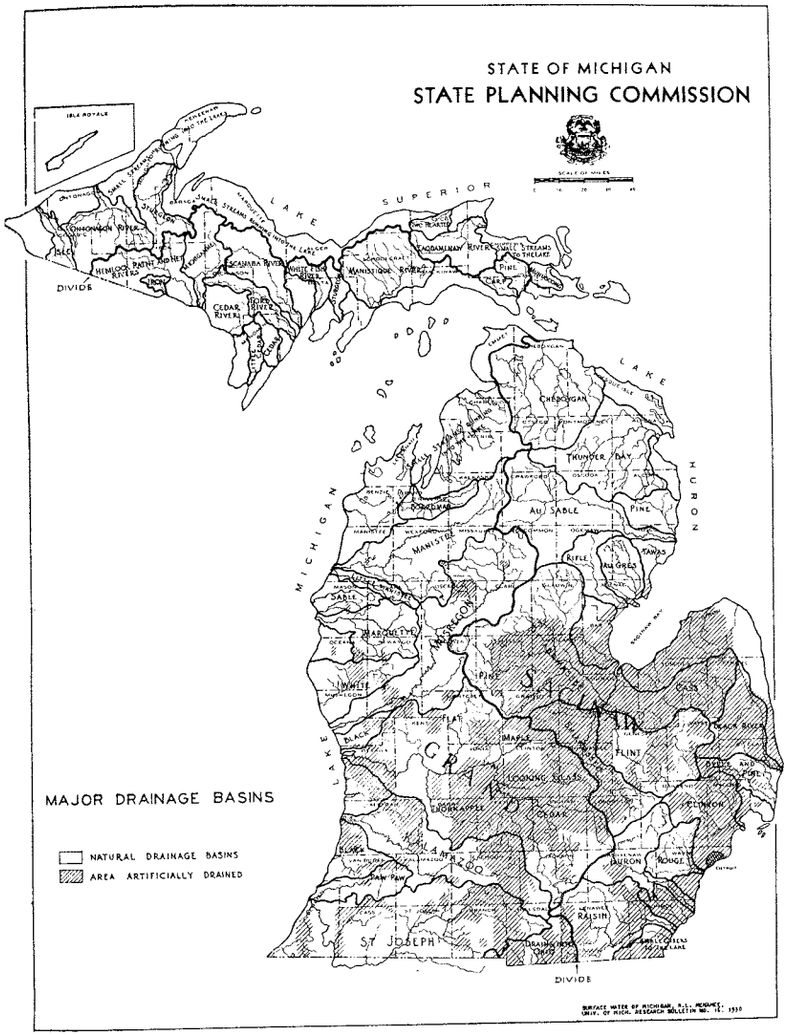


FIGURE 14. MAJOR DRAINAGE BASINS

The Saginaw is the shortest major river, 20 miles long, and its mouth is almost at the center of the Michigan Basin due to the

indentation of Saginaw Bay; but it has the largest drainage area of the state by virtue of its long tributaries the Tittabawassee, Shiawassee, Flint, and Cass. The Tittabawassee and Cass are interesting because of their arc-shaped courses and the fact that they have no tributaries on the Lake Huron side of their valleys. They flow close to a moraine.

FROM THE DEPARTMENT OF CONSERVATION

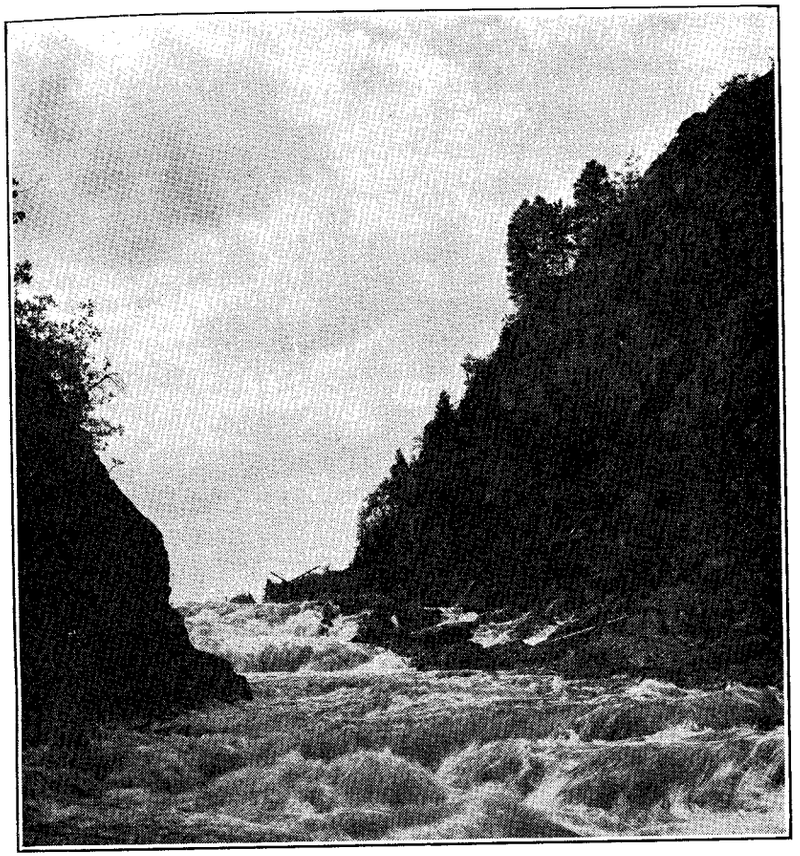
15. OCQUEOC FALLS, PRESQUE ISLE COUNTY
Only waterfall in the Lower Peninsula. Over Devonian Limestone

The AuSable is the swiftest river in the Southern Peninsula with a fall of 669 feet. The shorter Rifle is almost as swift as the AuSable and one of the few streams in the Peninsula which flow over rock rapids. The Ocqueoc in Presque Isle County is the only river in the Southern Peninsula having falls in its course. The falls are formed by the river flowing over outcropping ledges of Devonian limestone. The St. Clair is the third youngest river in the state and the only river in the world which flows from a lake, yet is building a delta. The Detroit River, although the widest, 2,200 feet at Woodward Avenue, Detroit, was the last river to be formed.

Northern Streams Are Different

The drainage of the Northern Peninsula is even younger than that of the Southern Peninsula. The streams have more rapids and falls and the uplands have more swamps. Most of the rivers drain to the

south. Those that enter Lake Superior are short and are characterized by falls where they tumble over the ledges of Lake Superior sandstone, the old Cambrian rim of the lowest of the rock saucers,



FROM THE DEPARTMENT OF CONSERVATION

16. RAPIDS OF THE MICHIGAMME RIVER, IRON COUNTY
Through a gorge cut in metamorphic rock

and over the Hermansville limestone. The eastward flowing Tahquamenon is the most interesting river because it has the largest falls* west of Niagara and is celebrated as the river down which Hiawatha sailed:

"Down the rushing Taquamenaw,
Sailed through all its bends and windings;
Sailed through all its deeps and shallows."

*See page 58.

The Manistique has many almost parallel northern but no southern tributaries. The Escanaba, Menominee, Manistique, and Sturgeon fall 1,000 feet from their headwaters to Lake Michigan in a series of rapids and smooth stretches. The Black and Presque Isle Rivers in Gogebic county are almost parallel. The Black is interesting because its mouth is almost directly north of its headwaters. These rivers entirely cross the state as their headwaters are just over the boundary line in Wisconsin. All the streams west of Marquette are marked by falls, cascades, and rapids and by the gorges which they have cut for their channels in the pre-Cambrian granites, volcanic rocks, and sandstones. The streams east of Marquette which flow north enter Lake Superior after tumbling over falls of Cambrian sandstone or Ozarkian limestone a short distance south of the lake. The southward flowing streams drain vast swamp areas. St. Mary's river is just a little older than the Detroit and spills over the cascades and the Falls of Sault Ste. Marie on the rim of the Michigan Basin.

Rivers Have Economic Importance

The economic importance of the streams has varied with the industrial progress of the state. Originally they served as highways for the birch canoes first of the Indians, then of the early settlers. Later they became the runways for logs during the lumbering days. Always they have been a source of food and water supply. They offer a potential as well as a utilized source of hydroelectric power. They, with the lakes, temper the climate and produce the scenic beauty, the fishing, and other sports that allure the tourist.

Climate

One of the after effects of the ice age important to the people of Michigan is the climate of the state. Although the remnants of the ice cap in Greenland and above the Arctic Circle have little direct and immediate effect on the present climate of Michigan, the great Ice Age did, for it carved the ancient valleys deeper and, in melting, left them filled with the Great Lakes. These great bodies of water absorb the heat of summer and release it during the winter thus making our winters warmer on the average than the winters of neighboring states. Likewise the waters, having cooled more slowly than the land, warm more slowly and thus the westerly winds blowing over the lakes carry cool breezes to modify the heat of summer. The great cold waves are robbed of some of their cold as they cross the lakes in winter or are deflected by the warmer water so that in the Southern Peninsula the great extremes of heat and cold are absent and the climate equable.

Michigan Fruit Belt Profits by Tempered Climate

The fruit belt along Lake Michigan exists because of this modifying influence. Across the lake in Wisconsin the winters average ten to twenty degrees colder. In spring the fruit buds are not opened too early because the cool lake modifies the hot winds from the southwest. Although the fruit belt does occasionally suffer from spring frosts, the loss is not so great as in the regions untempered by great lakes; early frosts are delayed and a longer growing season (160 days or more) results. But in the Northern Peninsula and at a distance from the lakes in the Southern Peninsula the growing season is shorter by ten or twelve days. The shortest growing season is 80 or less days in the Northern Peninsula and 90 in the Southern.

Temperature conditions in Michigan are about the same as in the states 150 to 200 miles to the south, averaging 43 to 50 degrees. In addition the growing days are longer due to the latitude. There are long days and short nights in summer and the opposite condition in winter. In June in the Northern Peninsula, daylight lasts from 3 a. m. to 9 p. m. In the Southern Peninsula the longest day is about fifteen and a half hours long. This condition serves agriculture by promoting growth with long hours of sunlight. The short nights prevent frosts in the spring and early frosts in the autumn. The long frosts of the winter aid the fertility, depth, and ease of working the soil.

The moraines stop the warm lake winds of winter and cause the great snowfall in those areas where the moraines are highest in the Southern Peninsula just as the highlands of the Northern Peninsula stop the winds and increase the snow depth, but also prevent the dissipation of heat across the state and conserve it. The modifying effect of the lakes is shown by the fact that during those few winters when Lake Michigan has been covered with floe ice the winters have been severe.

Adequate Rainfall Promotes Agriculture

Agriculture is profitable where the rainfall averages from 20 to 24 inches per year and has a proper seasonal distribution. Weather Bureau records kept for a long period of years show that the average rainfall for the state is 30.5 inches with the maximum 38 to 40 inches. As this rainfall comes mainly in the growing season there is sufficient moisture for crops. Occasionally in a drought year like 1930 or 1933 the precipitation falls to less than 23 inches. Berrien County is the wettest area of the state and Midland, on the lee of the high Lake Michigan moraine, the driest.

A favorable location protects the state from long-time droughts although short irregularly timed periods of drought may affect any part of the state in any season. In the cyclical repetition of climatic conditions, rainy and drought seasons are periodic over a long time.

The winds for the greater part of the year are from the west with an average velocity of twelve miles per hour in March and April and a minimum velocity of nine miles per hour in August. At times the winds reach tornadic (not cyclonic*) velocity and are accompanied by heavy rainfall. The path of such storms crosses the southern part of the state but occasionally one gets off the beaten track and the central part of the state suffers. Southerly winds are usually warm and moist; northerly winds cool and dry; easterly winds portend bad weather; and westerly winds settled weather. In summer the prevailing winds are southwesterly across Lake Michigan all along the western coast of the state. This clean, cool air, free from ragweed pollen is making that part of the state a medical haven for sufferers from asthma and hay-fever.

Geology Influences Industrial Development

The development of Michigan has been determined largely by its geological history. Early settlers were loath to enter the state believing it to be just an area of swamps and rocky lands fit for savages. Its vast forests were diversified because of the glacial soil upon which they grew and because they were so little removed from glacial time that the oaks had not advanced upon the younger forest types. Later its forests, maple and beech to the south, and pine and hemlock to the north, were opened for lumbering. The stand of pine and hardwoods proved to be one of the richest in the world.

Its varied soils became known as the forests were cleared. Its salt springs and mines were opened to secure cheaper salt and to meet the need for using the refuse of the lumber industry, and then expanded into a ranking industry as the lumbering days were forgotten. From the gravel beds in the glacial drift came, in most areas, a copious supply of pure water. Below the drift, each of the rock saucers produced its minerals, to add to the wealth of the state: water and coal from the Pennsylvanian; gypsum, limestone, pure water, natural gas, brine, petroleum, and shale for cement in descending saucers of the Mississippian set; limestone, glass sand, brine, salt, gas, and petroleum from the Devonian set of rock saucers; rock salt, limestone, and petroleum from the

*In this latitude a *cyclone* is a whirling mass of air which may move very slowly or very swiftly. It brings the weather changes. A cyclone, whirling counter clockwise across the country, brings bad weather. An anti-cyclone, whirling clockwise, brings fair weather. A *tornado* is a violent little whirl of destructive velocity within the cyclone or along its edge.

Silurian; pure water, limestone, and oil, from the Ordovician; building stone from the Cambrian; and copper, iron, gold, silver, marble, semi-precious stones, and building stone from the pre-Cambrian.

Natural Resources Determine Industrial Development

Limestones and other building material are obtained from the outcrops of these rocks. Natural gas, petroleum, brine, water, and salt have been reached by the drill. Gypsum and stone come from the quarries, and coal, rock salt, and metals from the mines. The proximity of limestone and iron ore and the cheap water carrier routes of the lakes have contributed to industrial development and have changed much of the Southern Peninsula from an agricultural to a manufacturing area. The mines have been the chief resource of the Northern Peninsula as well as the reason for building the St. Mary's canal which opened Lake Superior to commerce and led to the development of industry in the south after the forests had been cut.

The varied soils have led to a diversified agriculture. It has been said that Michigan could produce all its food needs except coffee because of its variable but equable climate and variety of soils. This climatic factor in addition to the scenic beauty of the state, the lure of lake and stream and the good roads made possible by the abundance of road material in the drift and the few outcrops, is rapidly increasing the second industry of the state—the recreational industry. Old glacial spillways have served as routes of primitive commerce and as trail and road routes for more civilized travel. In the lumbering days the streams now occupying the spillways and the newer streams of the state provided a logging route. Today the streams supply electric power although many of them, especially in the Northern Peninsula, are not yet power-harnessed.

Resources Satisfy Developing Needs

New discoveries and new needs tend to continue the search for economic materials within the state. Gypsum was first used as land plaster fertilizer. Commercial fertilizer took its place but the building trades found a use for the gypsum and an important industry arose. Limestone was first burned to secure agricultural lime for fertilizer; then used for stone fences, for building material, and road construction. Now the largest quarry in the world is operated at Rogers City because Michigan limestones are so pure that they are valuable as flux in steel manufacture. Bed rock was first penetrated by the drill in the search for pure water in areas

where the drift is thin and the water supply too variable. Later, in the search for salt, brines were found and much later the drill found the deep reservoirs of petroleum and natural gas. Quarries opened the limestone, gypsum, sandstone, trap rock, and glass sand deposits; mines penetrated the deposits of rock containing minerals and metals. So to "if you would see a beautiful peninsula, look about you" could be added "if you would seek a fruitful peninsula, look into it." The foundations of the development and progress of Michigan were laid when the basin was formed in the pre-Cambrian granites and were increased as the sets of rock saucers filled the basin and the glacier added a plastering of heterogeneous rock waste and the Great Lakes. Finally modern physiographic conditions carved it to be ready for his exploitation when man found it over 300 years ago.

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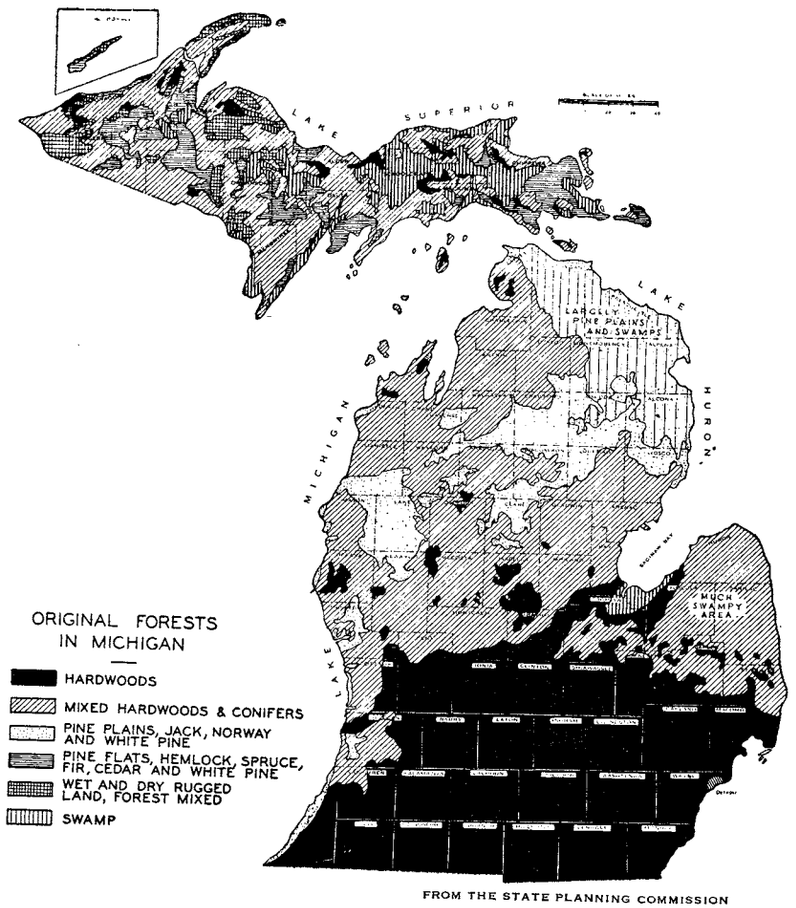


FIGURE 17. ORIGINAL FORESTS IN MICHIGAN

CHAPTER TWO

LAND AND FORESTS

By P. A. Herbert
Professor of Forestry
Michigan State College

The Virgin Forest Indicative of Land Use

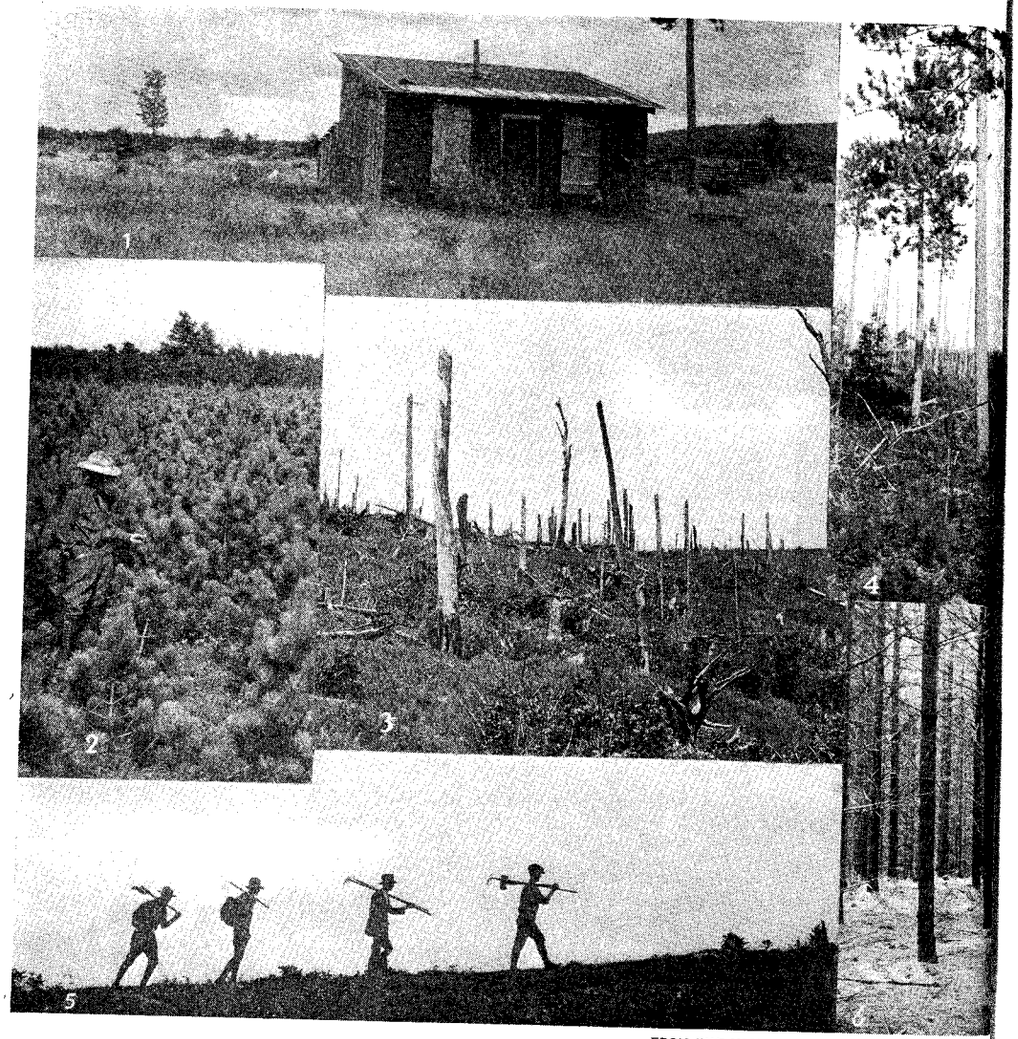
When the white man first came to Michigan he found a land clothed entirely with trees with the exception of small areas of prairie in the southwestern part of the state. The forests on the southern half of the Southern Peninsula were principally a mixture of hardwoods: maple, oak, ash, elm, hickory, and many others. On the northern half of the Southern Peninsula and on the Northern Peninsula pines, hemlock, fir, spruce, white cedar, yellow birch, hard maple, and beech were the common species.

Apparently, the significance of these differences in forest types was not fully understood by the settlers. As the land was cleared of timber in the southern portion of the state where settlement began, most of it was found to be fertile and the farmers who located thereon prospered. The lumberjack then pushed north into the region of pine and northern hardwoods. It was generally assumed that the plow could continue to follow the axe and the saw. So hundreds of thousands of acres of cut-over northern lands were cleared of stumps and plowed.

At first, the settlers in this north country managed to get along very well. Prosperous agricultural communities similar to those in the southern counties were envisaged for all of northern Michigan. The thin layer of leaf mold produced a satisfactory crop,the nearby lumber camps furnished a premium market for their products, and the pioneer farmers were able to secure winter work for themselves and their teams in these same camps. The wages thus obtained provided additional working capital during the following summer for further clearing and building on their little farms. They had high hopes of a prosperous future.

Soon, however, it became painfully apparent that nature grew pines and northern hardwoods instead of central hardwoods only because the land was sterile. The minerals in leaf litter were soon either consumed or washed to a depth of the sandy soil beyond the reach of the hungry plant roots. This leaf mulch also had retained the sparse rains that fell. But after it disintegrated, the moisture

in the soil either evaporated or sank into the deep sands, often leaving available a supply inadequate to mature the crops. Added to these misfortunes, when the lumber camps moved out of the neighborhood as the virgin timber was cut, the settler lost not only a premium market for products he actually did succeed in growing but also his opportunity for winter work.



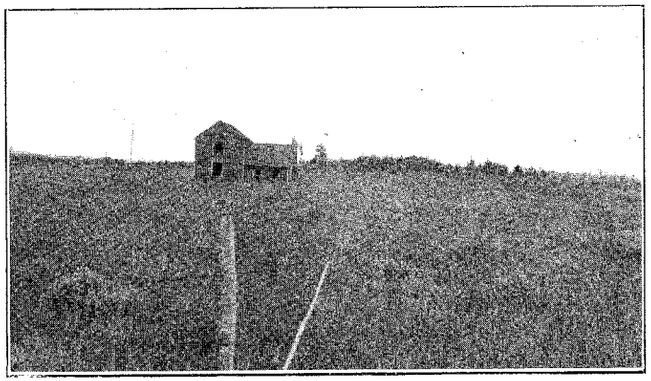
FROM THE MICHIGAN EDUCATION ASSOCIATION

18. SCENES IN THE CUT-OVER TIMBER LANDS

1. Worthless for farming
2. A reforestation project
3. After the forest fire
4. Cut-over timber land
5. The forester goes to work
6. Virgin timber

Farm Abandonment

Had the early settlers in northern Michigan recognized fully the fact that many of the forest types in that region were positive indicators of land unsuited to profitable agricultural development, much labor and capital expended in land clearing and many heartaches from disappointed hopes might have been avoided. Many "farms" with over one hundred acres of cleared land, house, and other farm buildings were later abandoned and reverted to the state for the non-payment of taxes. One township in northern Michigan where practically every section of land in 1890 included three or four farms is today entirely overgrown with trees and shrubs. As abandonment increased, roads were allowed to grow over, schools closed for lack of students, and townships had to be consolidated because there were not enough residents to hold the township offices. Thus, the lack of full understanding of land use values by the settlers, by their leaders, and by public officials, together with strong pressure by those who had cut-over land to sell and by other home community boosters, not only led to losses by misguided settlers, but retarded the entire social and economic development of northern Michigan.



FROM THE DEPARTMENT OF CONSERVATION

19. ABANDONED FARM

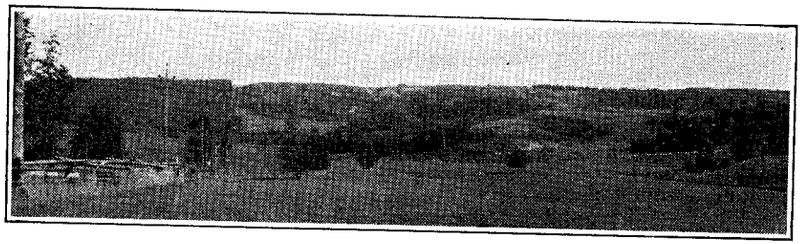
Wise land planning might have saved the labor that was used in trying to farm this sand soil

Soil Erosion

While the maladjustment of land use in northern Michigan as between forest and agriculture is most striking to the casual observer, there are many other land use practices that are wasteful to the state's natural resources. Much land has been cleared which, though fertile, is of such a character and on such a degree of slope

that it erodes easily. Often one hears of a hillside field that once grew bumper crops, but is now abandoned for no apparent reason. The reason, of course, is that the top soil has been washed away and only the coarser infertile subsoil remains. Millions of acres of agricultural soil in Michigan are being washed to lower levels—into the river valleys and depressions, so that the sloping uplands are progressively losing their fertility.

Federal and state farm extension efforts have for years called attention of landowners to the need of soil conservation by planting trees on steep slopes and other eroded lands, and to the practice of soil conserving agriculture on gently sloping lands. More recently, the Federal administration has initiated demonstration projects through the newly organized Soil Conservation Service. Such a project has been begun in Berrien County to illustrate to farmers the proper agricultural technic for conserving the soil. This year, too, farmers were paid by the Federal Government for planting soil conserving crops where they formerly grew soil depleting crops. Various grain crops such as corn, oats, wheat, etc., are considered soil depleting. Clover, vetch, and forest trees fall in the class of soil conserving crops.



FROM THE DEPARTMENTMENT OF CONSERVATION

20. WISE AND UNWISE USE OF LAND Near Petoskey
Logging and clearing the land in the foreground resulted in a productive field. But the bare, eroded upper slopes are mute testimony that they should never have been cleared but left in forest use similar to the slope on the left.

Multiple Use of Forests

On forest land, as on agricultural land, there are varying types of management to conform to the particular character of the land, the forest cover, and the interests of the owner and others who use the area. Forest land, for instance, is not only of value to produce wood for lumber, pulp, fuel, veneer, and so on, but such land may have a high value for various forms of recreation, for game production, stream control, and wind protection.

Many of these uses of forest land can be obtained simultaneously. Thus, a forest area with a meandering stream can include picnic

and camp grounds along the stream and opportunities for fishing, and away from the water the bulk of the tract can be used for wood production. Forest land will also provide excellent cover for game. But to raise a maximum supply of game will require that a part of the tract (perhaps a quarter to a third) must be used to grow food and shelter plants for the game animals rather than trees primarily for wood production. On other parts of the area, trees to produce wood can be given preference. Where watershed protection is necessary to conserve the water supply for irrigation or human consumption or to prevent erosion and floods, the forest cover must be kept rather dense and cutting for wood production must be modified accordingly. Nevertheless, such areas, with restrictions, can be used for wood and game production and for recreation.

FROM MICHIGAN STATE COLLEGE

21. MULTIPLE USE OF FARM WOODLOT

It can be seen, therefore, that most rural land not required for agriculture should be covered with some type of forest cover regardless of its present use. It also becomes apparent that these various forest land uses are readily adjustable. It is a simple matter to change forestry practices on wood producing areas if more land is needed for recreation. The land still remains covered with trees, most of the management practices remain the same, and about the same type and number of people are necessary to administer the property.

Rural Land Planning

While the change from one forest land-use to another does not always mean major adjustments in the community, the change from agriculture to forestry usually does. Such community changes together with losses to the individuals who are directly or indirectly affected by the shift in utilization make it very desirable to direct land utilization developments along sound and permanent lines. While it is not possible to foresee all future contingencies, experts with complete physical, economic, and social data on hand can plan the proper development of a community so that it will eventually support the maximum number of contented people.

Rural land planning requires as a basis carefully prepared maps showing the soil productivity, the vegetative cover, the topography, the stone, and any other physical feature of importance for all of the land in the community.

Information must be available on economic factors such as the type of ownership, tax burden, tax delinquency, location of roads, schools, homes, source and amount of income of the residents, value of property involved, location of trading centers, villages, banks, industries, in addition to such social factors as the racial characteristics and prejudices of the people, religious and fraternal affiliations, location of churches, lodges, and opportunities for recreation.

With this information in hand a rural land-use plan can be drawn designating certain areas or zones where agricultural development should be encouraged, others where it should be discouraged. Areas may be designated for recreational development and for wood production. Of course, many zones will have small tracts restricted to industry, to mining, to fishing, and so on, depending upon the resources present within the planned area.

Adherence to a land-use plan may be entirely educational or can be made compulsory. Public regulation of land-use seems necessary because the selfish pursuits of one generation may endanger the supply of natural resources available to those who come later. The natural tendency of the individual to acquire wealth for his own needs and for those immediately dependent upon him, if at the expense of future citizens, must often be restrained by society through legislation.

In this state such restraining legislation is represented by the rural zoning law (Public Act 44, 1935). This act gives broad, basic authority to zone for any or all natural resources on a county or inter-county basis. Individual townships have no control over zoning. Therefore, it should be possible to avoid influence against

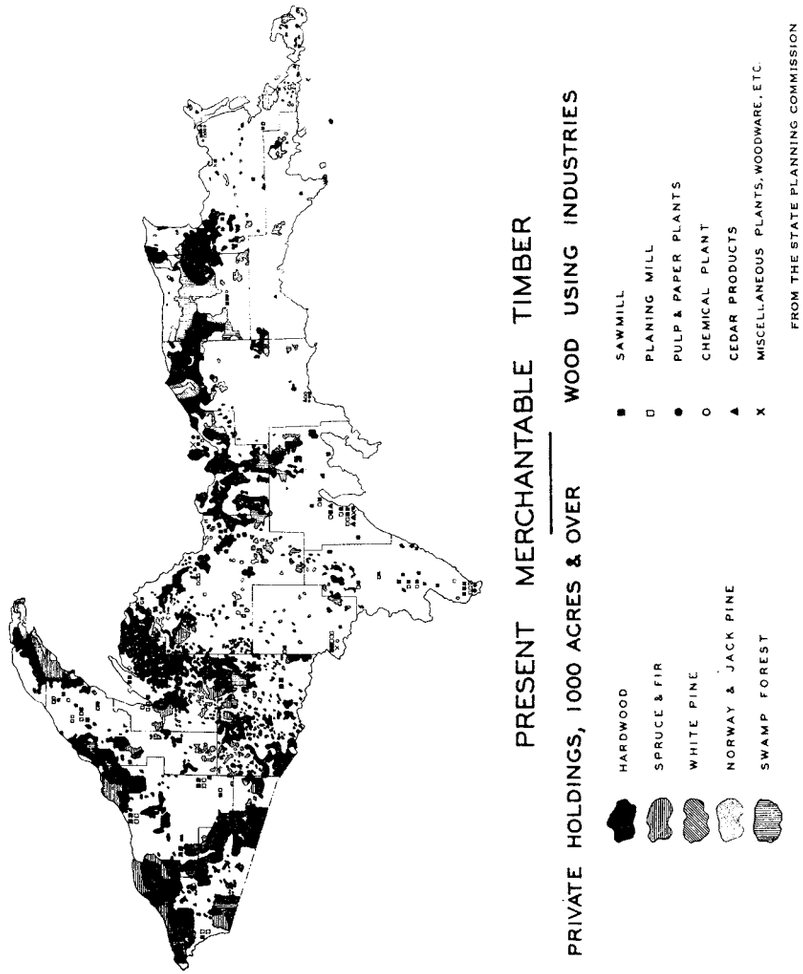


FIGURE 22. PRESENT MERCHANTABLE TIMBER
Only in the Upper Peninsula are there now timber tracts large enough to be commercially valuable

public interest by small selfish groups who might prevent adequate and proper zoning in particular localities.

Under the law it is possible, in the unincorporated portions of the counties, to regulate and restrict the location of industries and buildings, and to restrict and determine the areas within which given forms of land-use would be prohibited or encouraged. The county would be divided into districts of such number, size, and shape as necessary and regulations imposed in each, quoting the act, ". . . . . designating the use of land for trade, residence, recreation, agriculture, forestry, soil conservation, and water supply conservation . . . . . ", the purpose, of course, being ". . . . . to promote public health, safety, and general welfare . . . . . and the conservation of property values and natural resources . . . . . "

It is hoped that this state law will facilitate the withdrawal of marginal areas from agricultural production in addition to the usual benefits which accrue from zoning legislation such as lower governmental costs, more effective governmental service, protection of rural investments, less exploitation of ignorant land users, and concentration of rural settlement, all improving the social and economic status of the community. Three counties have already acted favorably upon the referendum (Delta, Marquette, and Menominee) and these three are now collecting the facts necessary to prepare land zoning ordinances.

Moving Settlers from Non-agricultural Land

However, as the law is not retroactive, i.e., does not apply to those who are already occupying and using land, other means of dealing with non-conforming land users are necessary. There are many farms located upon land that is sub-marginal for agriculture, on which the owners cannot make a satisfactory living. In Wisconsin, county authorities are purchasing these farms from the owners and using the land for its most profitable purpose, in most cases recreation, game, and wood production.

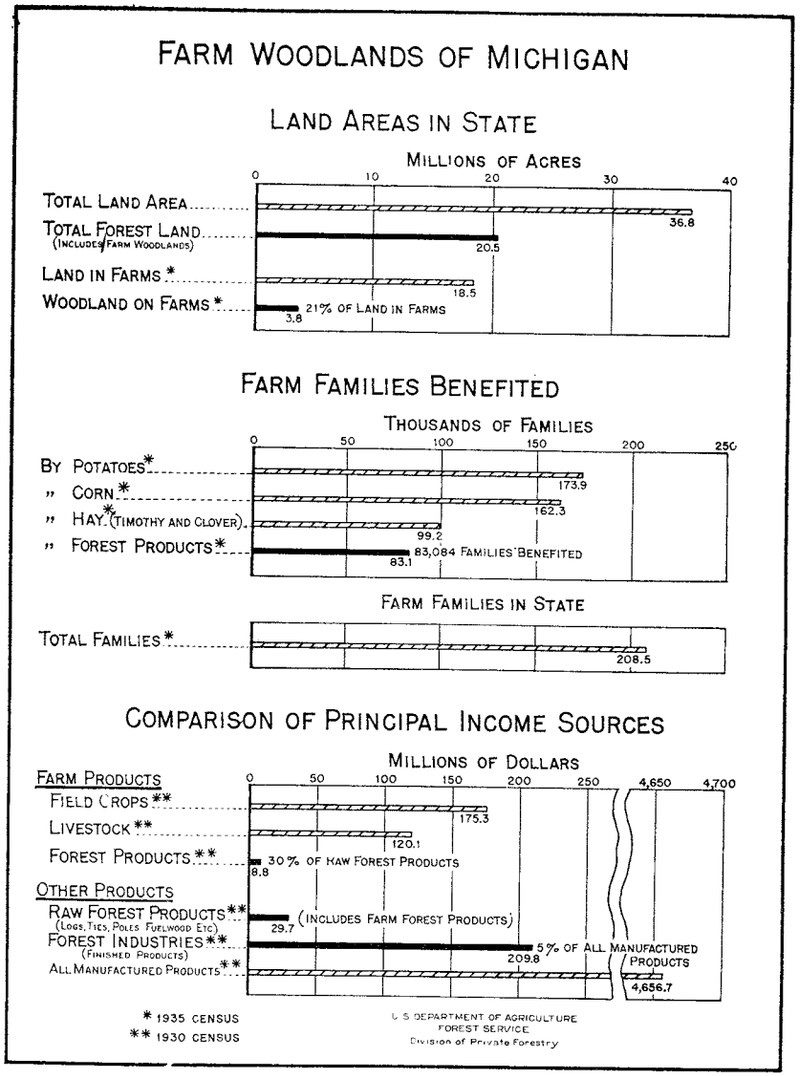
In Michigan, the Federal Government has several demonstration areas in the southern and northern parts of the state where it is purchasing land sub-marginal for agriculture and re-dedicating to their proper uses the lands so acquired. In northern Michigan the major use of these purchased lands is to grow trees for wood production. In the southern part of the state, where the demonstration areas are close to large urban centers, most of the land acquired will be converted to various recreational uses. Former owners of such sub-marginal farms are assisted, if they so desire, in the acquisition and development of farms on better agricultural soil.

The Federal Government hopes that these demonstrations will convince state and local authorities of the desirability and feasibility (1) of moving families from land unsuited to the purpose for which they are using it; (2) of assisting them to locate on better land, closer to a community center; and (3) of utilizing purchased land for its suitable purpose.

Only One-third of Michigan Agricultural Land

Studies show that with a total area of 36,787,200 acres in the state there are about 196,000 farms comprising half the area of the state. Of the 18,500,000 acres in farms not quite 12,000,000 acres are lands available for crops and of the remainder close to 4,000,000 acres are in woodland. It has been estimated that if families now located on farms sub-marginal for agriculture were resettled on worth-while agricultural land it would absorb all the remaining potential agricultural land in the state.

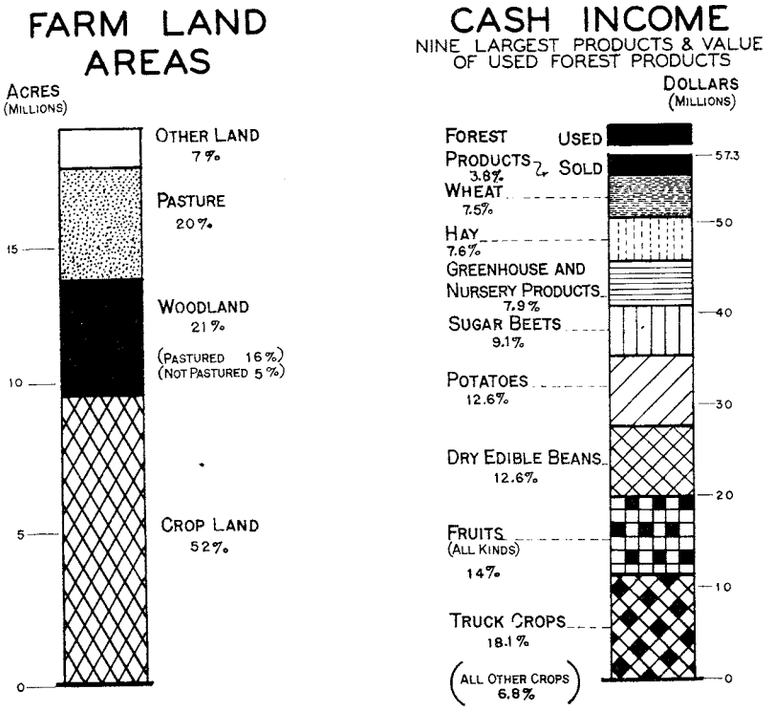
Careful observers believe that a further increase of land in farms is not to be expected in Michigan and that a decrease is more likely to occur. Forest land not in farms amounts to about 16,000,000 acres which with the farm woodlands brings the total of forest land to nearly 20,000,000 acres. Hence, it can be confidently predicted that more than half the area of Michigan will always be covered with forests for recreation, game, and wood production.



FROM THE U. S. DEPARTMENT OF AGRICULTURE

FIGURE 23. LAND USE AND CROP VALUES

FARM WOODLANDS OF MICHIGAN



FARM LAND USE*		Area (Acres)
Crop Land (all classes)		9,580,502
Pasture Land		
Plowable and "Other"		3,702,688
Woodland pastured (see Woodland)		
Woodland (all classes)		3,816.124
Woodland pastured	2,883,217	
Woodland not pastured	932,907	
Other Land		1,360,608
Total Farm Land		18,459,922
CASH INCOME FROM LEADING FARM PRODUCTS**		
Forest Products cut and sold, Year 1934		2,370.000
Rank among all crops		Ninth
Truck Crops	$11,144,000	
Fruits (all Kinds)	8,640,000	
Dry Edible Beans	7,725,000	
Potatoes	7,721,000	
Sugar Beets	5,567,000	
Greenhouse and Nursery Products	4,850,000	
Hay	4,688,000	
Wheat	4,626,000	
Forest Products	2,370,000	
Value of all Forest Products, used or sold, Year 1934		$4,627,000

*Census, 1935
**Estimates by Bu. Agr. Econ.

FROM THE U. S. DEPARTMENT OF AGRICULTURE

FIGURE 24. LAND USE AND VALUE OF CROPS PRODUCED

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CHAPTER THREE

MICHIGAN'S RECREATIONAL INDUSTRY

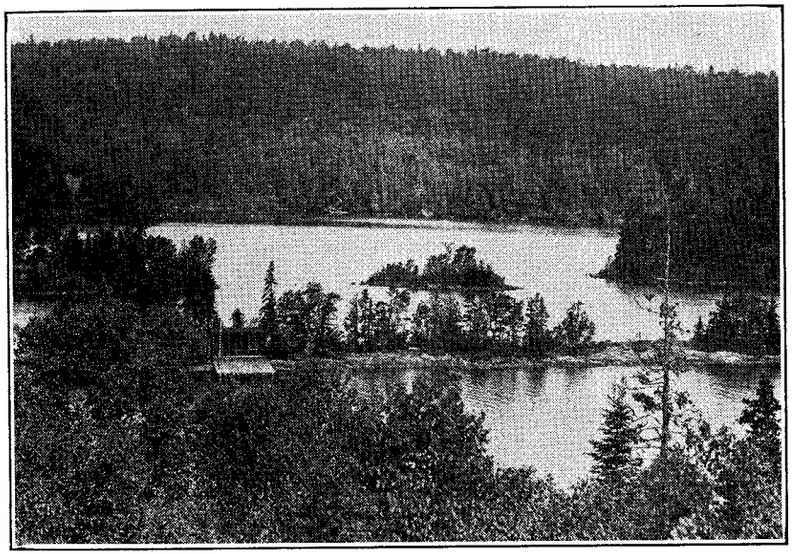
by C. A. Paquin

Chief of the Education Division

Department of Conservation

Increased leisure in recent years for those who labor in the office, the factory, the store, and the field, has naturally increased the demand for recreational facilities; for places to fish, to hunt, to camp, and to enjoy the out-of-doors.

As this condition has grown the recreational industry in Michigan has kept pace to the point where it is now ranked in economic importance second only to manufacturing. The annual income from this business has been variously estimated from $300,000,000 to $500,000,000. This income is derived from two sources, from people within the state and from visitors from other states.



FROM THE DEPARTMENT OF CONSERVATION

25. ISLE ROYALE, NOW A NATIONAL PARK

It has been said that Michigan's appearance on the map of the United States is its greatest advertisement. Surrounded almost entirely by blue waters, it is a focal point of attention. The state's

lakes and rivers, forests, and climate are other assets conducive to the continued prosperity of the recreational industry.

That those who travel through Michigan seeking recreation may be comfortable and may better enjoy its natural resources, the various local and state governmental agencies have contributed their share of "improvements."

Highways have been constructed to pass through areas of greatest scenic beauty. A system of 57 state parks has been developed geographically through the state. Almost two million acres of state forest lands have been made available to the public for camping. Roadside parks to please the eye have been constructed. One large state agency is engaged in maintaining a supply of fish and game. Forests are protected from fire, and lakes and streams from pollution. The health of recreationists is protected by inspections of water supplies and sanitary facilities.

FROM THE DEPARTMENT OF CONSERVATION

26. DUCK HUNTER

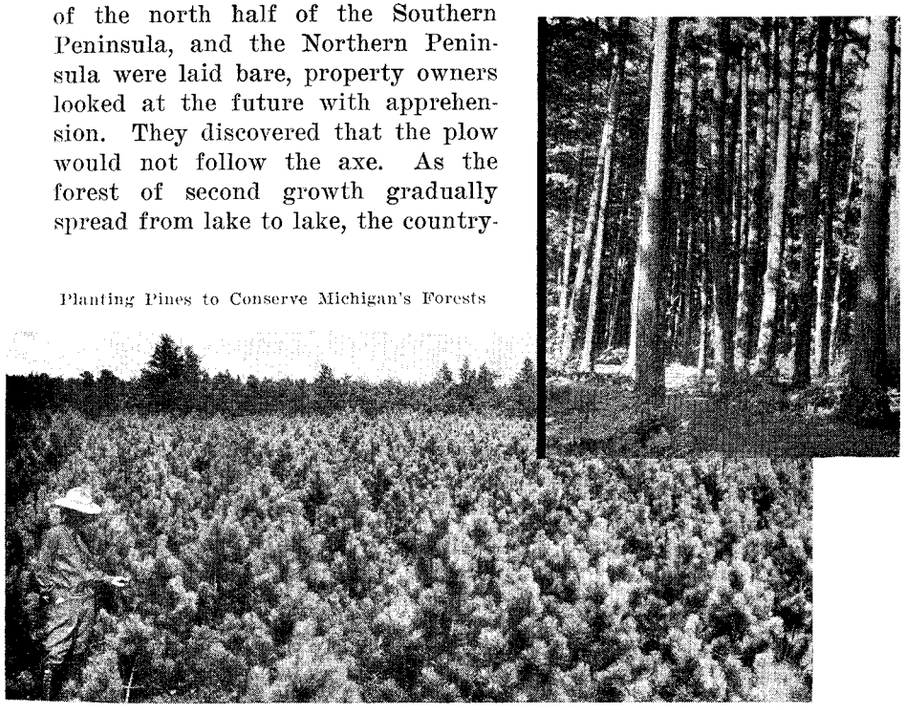
In an average year 9,000,000 people visit Michigan's state parks. While the majority of these people are Michigan residents who spend their week-ends and their vacations within the state, thousands come from all sections of the United States as well as from Canada and Mexico.

In Michigan there are more than 13,000,000 acres available to the public for hunting, and these lands are used by a half million small game hunters and 125,000 deer hunters. Deer, bear, rabbits, partridge, and ring neck pheasants are the principal game animals and upland game birds, while the fall flights of water fowl attract thousands of hunters to the innumerable marshes along the Great Lakes shores.

Some idea of the extent of the sport of hunting may be gained from the fact that approximately 40,000 buck deer are shot each fall and the kill of cock pheasants has been estimated at 750,000 annually.

As the timber was cut and the lands of the north half of the Southern Peninsula, and the Northern Peninsula were laid bare, property owners looked at the future with apprehension. They discovered that the plow would not follow the axe. As the forest of second growth gradually spread from lake to lake, the country-

Planting Pines to Conserve Michigan's Forests



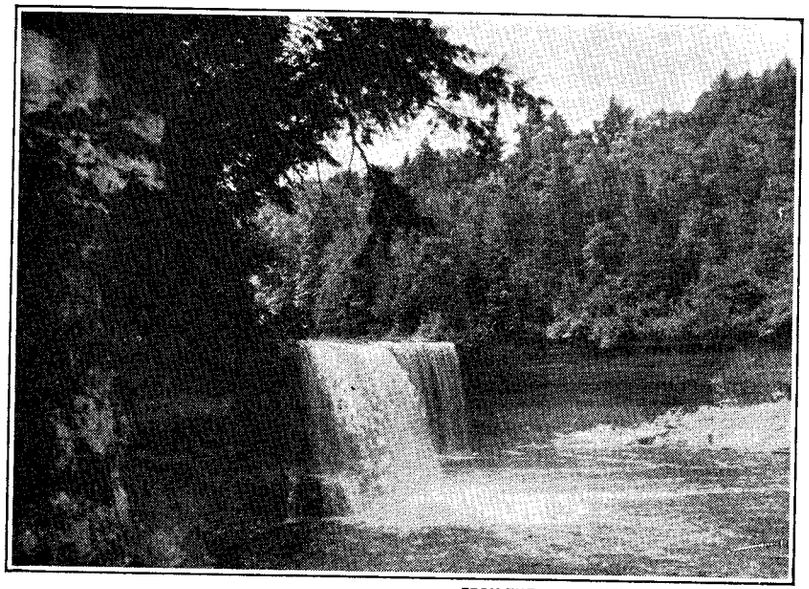
FROM THE MICHIGAN EDUCATION ASSOCIATION

27.—VIRGIN PINES, HARTWICK STATE PARK

side again became attractive and tourists began to arrive. In this tourist business a new industry was seen and encouraged until today the recreational industry has proved the salvation of northern Michigan. Probably as important economically as the climate and forests are the waters of the state.

Description of Michigan Waters

Four of the Great Lakes—Superior, Michigan, Huron, and Erie—create the two peninsulas of Michigan. In addition to the waters that form most of its borders, Michigan is penetrated by more than 5,000 miles of rivers and streams and is dotted with 5,000 inland lakes. The recreational industry owes its origin and its continued prosperity to the waters of Michigan.



FROM THE DEPARTMENT OF CONSERVATION

28. TAHQUAMENON FALLS, NOW A STATE PARK

Lake Superior, bordering the state on the north is the largest body of fresh water in the world. From the Wisconsin border on the west to Sault Ste. Marie on the east, Michigan has 492 miles of frontage on this lake. For the most part this shore line is made up of rocky cliffs and rugged boulders, but occasionally there are sand beaches and dunes. The rugged shore is rich in scenic beauty

with the world famed Pictured Rocks, the Grand Banks of the Sable, the Huron Mountains that rise precipitously from the water, and the Keweenaw peninsula.

Lake Michigan forms the western border of the Southern Peninsula and the southern border of the Northern Peninsula. Michigan's coast line on this lake extends for 855 miles with harbors and inlets adding another 90 miles. Along the shore line of the Southern Peninsula are giant sand dunes. From St. Ignace to Menominee the shore includes sand beaches and high banks, but much of it is low and there are occasional marshy stretches.

Lake Huron borders the state from Mackinaw City to Port Huron, a distance of 455 miles, and there is another 107 miles of shore line from St. Ignace to Detour. The Lake Huron shore line is markedly different from the Lake Michigan shore country since land levels are more nearly at water level, the shore sloping back gradually from the beaches. Most of the shore is rocky although there are some sand beaches. Three large indentations mark the shore, Thunder Bay, Tawas Bay, and Saginaw Bay.

Michigan has but 47 miles of shore line along Lake Erie and much of this is low, flat, and marshy.

In addition to these waters of the Great Lakes, other lakes and streams connect to form the water border of the state. St. Mary's River, connecting Lake Superior and Lake Huron, is 89 miles long and separates the Northern Peninsula from the Province of Ontario, Canada.

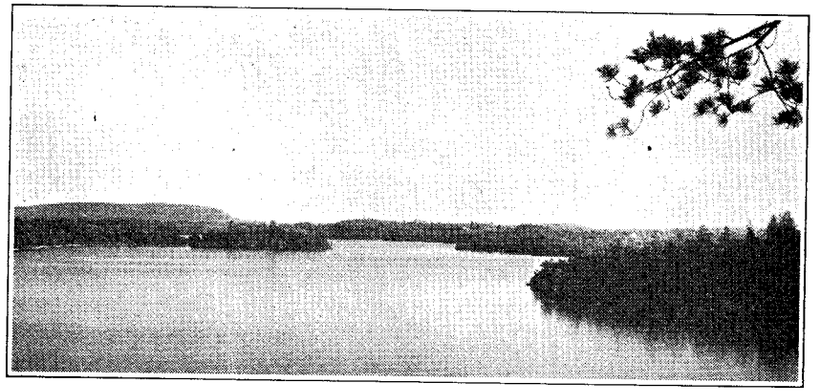
The St. Clair River, Lake St. Clair, and the Detroit River also form an international border. The St. Clair River between Lake Huron and Lake St. Clair has a Michigan shore line of 40 miles. Lake St. Clair has a coast line of 45 miles and the Detroit River stretches for 33 miles connecting Lake St. Clair with Lake Erie.

Inland Lakes Cover Many Acres

Michigan has 4,187 named inland lakes with an additional estimated 1,000 unnamed lakes, most of which are located in the wilderness areas of the north. These Michigan lakes range in size from Houghton Lake, the largest, with 18,950 acres, and Torch Lake with 18,000, down to lakes of ten acres or less. The state has nine lakes of 10,000 acres or more and ten lakes with areas of from 5,000 to 10,000 acres. About 3,000 of Michigan's lakes are used for fishing or bathing or other recreational purposes.

Artificial Lakes Add to Natural Beauty

Practically all of Michigan's larger rivers are used for the production of electric power. With the establishment of power dams, large ponds and lakes have been created. In addition to these large areas of impounded waters are hundreds of small mill ponds.



FROM THE DEPARTMENT OF CONSERVATION

29. BADWATER LAKE, UPPER PENINSULA

Rivers and Streams Numerous in Both Peninsulas

In the Southern Peninsula are several large river systems; principally the St. Joseph, Manistee, Muskegon, Grand, and Boardman emptying into Lake Michigan and the Thunder Bay, AuSable, Saginaw, and Huron emptying into waters bordering the east shore. The Northern Peninsula does not have so large river systems but the streams are more numerous.

Recreation for Everyone

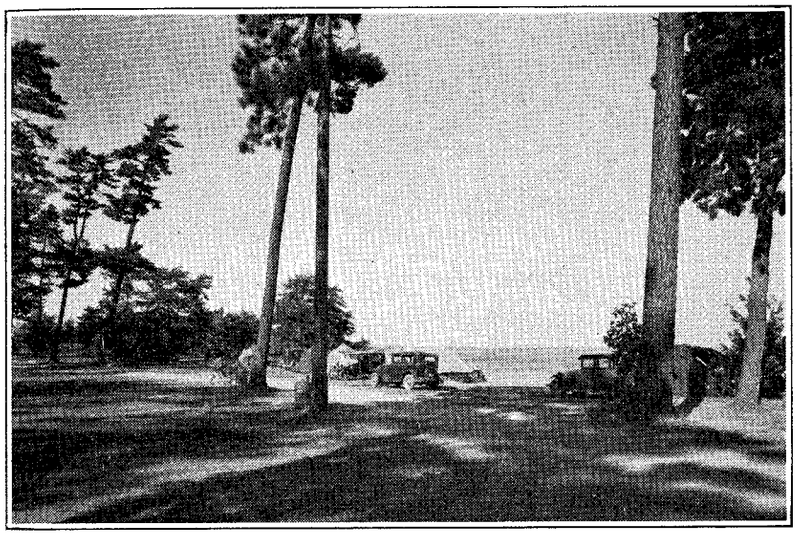
Fishing marked the first recreational use of Michigan's waters. The brook trout, formerly native to the southern part of the state was an inducement to the early settlers and part of their food supply came from this species found in practically every southern stream.

The famed grayling, too, now almost extinct in Michigan waters, once lived in the northern streams, more particularly the AuSable River and its branches. Many of Michigan's first out-of-state visitors were attracted by the glowing accounts in sportsmen's magazines of the wonderful fishing offered by the gamey grayling.

At the turn of the century resorts began to build up on the west side of the state, more particularly at Ludington, Charlevoix, Traverse City, and Petoskey. Chicago residents and people from

other cities and states were attracted by the cool breezes from Lake Michigan and by the absence of hay fever. Thousands of cottages and summer homes were built along the shore and this development gradually extended north to Les Cheneaux Islands and Mackinac Island in the northern section of Lake Huron.

Summer colonies flourished along Lake Michigan and the Straits of Mackinac a quarter of a century ago largely because of the ease of railway transportation from the larger centers of population. As road conditions improved and with the advent of the automobile similar developments spread to the east side of the state and large resorts grew on some of the inland lakes, more particularly Houghton, Mullet, Burt, and Torch lakes and other larger bodies of inland water.



FROM THE DEPARTMENT OF CONSERVATION

30. CAMP GROUNDS, STATE PARK, INTERLOCHEN

The automobile, as it brought increased business to the larger manufacturing centers, also brought prosperity to the northern resort section of the state. Michigan built an excellent system of roads. It not only built highways in the congested industrial southern counties, but stretched them to all parts of the two peninsulas. The result was that recreational areas not before accessible to the general public were opened up to large populations.

Of such importance has the recreational industry become that the highways in Michigan, first improved as market roads and

roads between centers of population, are being built today mainly to serve seekers of recreation. Ten years ago the main road north along the west coast of Michigan ran inland through the farming regions and behind the sand dunes. Lake Michigan could be seen at but very few points. Now this highway has been located close to the lake shore passing through the dunes country and affording frequent views of the water. A similar shore drive has been completed along Lake Huron. Plans have been announced for a road to skirt the waters of Lake Superior.

Recreational Travel Grows

Along with the increasing development of definite resort areas and the continued building of cottages and summer homes along Michigan's lakes and streams, has come, during the past decade, an amazing growth in recreational travel. During this period a large system of state parks has been built up until today there are more than 50 units under state administration, scattered strategically along the Great Lakes and on inland lakes and streams. At the same time, counties and municipalities have established hundreds of smaller parks and camp sites. First came thousands of "tent" campers; today the automobile house trailer is adding greater zest to this form of recreation.

FROM THE DEPARTMENT OF CONSERVATION

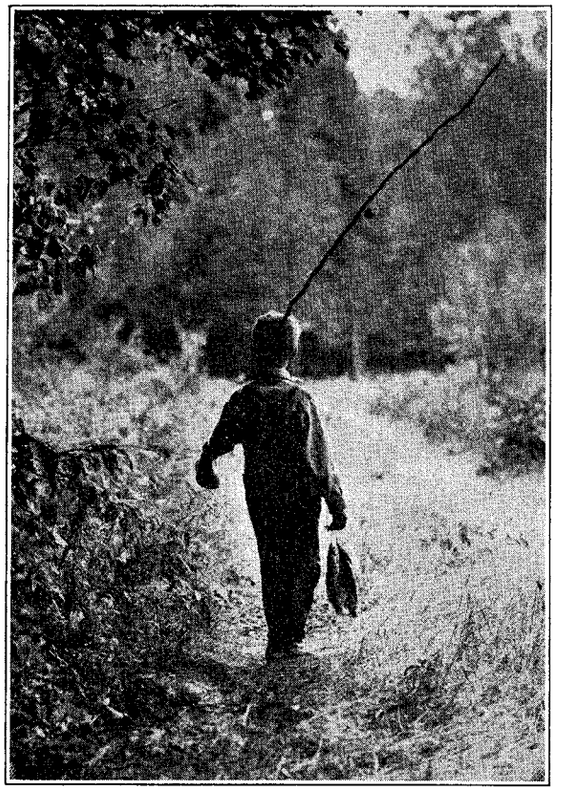
31. GRAND HAVEN STATE PARK

State Offers Many Opportunities for Boating

As resorts developed along the shores of the Great Lakes, the popularity of travel on these waters increased. Great steamship lines began to operate passenger boats, featuring tours of the Great Lakes. These lake voyages continue to make up a good share of Michigan's recreational industry. Canoeing, once the only mode of inland water transportation in Michigan, is becoming an increasingly popular sport. Today, local agencies are publishing "canoe routes", and the state is establishing canoe camps along the large streams to serve those who enjoy this sport.

Many Varieties Make Fishing a Popular Sport

Tourist and resort agencies and chambers of commerce say that more than 80 per cent of all the inquiries they receive from prospective visitors to Michigan have to do with fishing possibilities. The Great Lakes commercial fishing industry employs thousands of people who obtain an annual income of several millions of dollars. Fishing in the Great Lakes waters is also attractive to the sportsman. Along practically the entire Great Lakes shore line, perch fishing is a favorite sport. More recently sport fishing for lake trout in the waters of Grand Traverse Bay has become so popular that it has achieved national recognition.



FROM THE DEPARTMENT OF CONSERVATION

32. YOUNG FISHERMAN

Early each spring the diminutive smelt run up into the streams from the Great Lakes and hundreds of thousands of people participate in the "dipping" festivals now held at many points.

From a recreational viewpoint, most important of all fishing is the sport offered by the waters of the inland lakes and streams of the state. During the year 1937 these waters were utilized for fishing by more than a million people. Of this number 150,000 were non-residents of the state. Bass, pike, and bluegills, the most frequently fished species in the inland lakes, and brook, brown, and rainbow trout, the most popular stream fish, are largely responsible for the popularity of Michigan's waters.

Helpful Reading

1. Chater, Melville—"Michigan, Mistress of the Lakes." *National Geographic Magazine,* 55:3; March, 1928. Washington, D. C.: National Geographical Society.
2. *Conservation for Recreation.* Lansing, Michigan: Michigan Department of Conservation.
3. *Field Tours for Conservationists.* Lansing, Michigan: Michigan Department of Conservation.
4. *Isle Royale.* Lansing, Michigan: Michigan Department of Conservation.
5. *Michigan State Planning Commission Report 1934.* Lansing: Michigan State Planning Commission.
6. *Motion Picture Catalogue.* Lansing, Michigan: Michigan Department of Conservation.
7. *Recreational Information.* Lansing, Michigan: Michigan Department of Conservation.

CHAPTER FOUR

MINERAL RESOURCES

by S. G. Bergquist

Professor of Geology

Michigan State College

Mineral Resources Necessary to Industrial Development*

It is a well established fact that a nation is powerful and capable of industrial development and expansion in proportion as it possesses within its confines reserves of those raw materials in the form of minerals which are necessary to supply the machines of industry and transportation. In this modern age of machine culture, demands for raw mineral material are ever growing and will continue to increase as man becomes more possessed of leisure time in which to utilize and enjoy the products manufactured therefrom. For many years the United States has held a commanding position among the nations of the world in the production of minerals. Wars of conquest have been fought primarily to gain advantages in mineral wealth. That nation which normally possesses vast resources of a wide variety of minerals usually finds itself in a position to command greater security than one whose supplies are limited.

The United States has gained its position in the front rank of mineral production at great expense. Vast deposits of high-grade ores and minerals have been drawn on with but little or no consideration of the future. No serious effort has been made to enforce conservation measures for the protection of mineral industries. The policy of "first come—grab all" has been in vogue in this country almost since the beginning of mineral utilization. In many instances, private interests have grown rich by unwise utilization of mineral resources, which should have been administered with the welfare of the entire nation in mind.

Michigan has played an important role in the production of those mineral resources which have given this country its high standing. Her deposits of iron and copper have found their way into the industrial channels of the state, the nation, and the world. Vast resources of non-metallic minerals have placed Michigan in a formidable leading position in the production of salt and gypsum.

*In the compilation of this chapter the author has drawn freely on material contained in the various publications of the State Geological Survey.

Extensive deposits of high grade limestone and dolomite have gained for the state a strong position in the manufacture of cement and the production of fluxing limestones. Coal mines in the interior portion of the state have for many years supplied domestic and commercial fuels for local needs.

Unlimited potential supplies of high grade shale distributed through various parts of the state make possible the development of numerous brick and tile industries. Gravel, sand, and clay from surface glacial deposits have contributed to provide the state with material essential to the construction of one of the finest highway systems in the world. Recent discoveries of oil and gas in the central part of the state have placed Michigan in front rank among the oil producing states east of the Mississippi River.

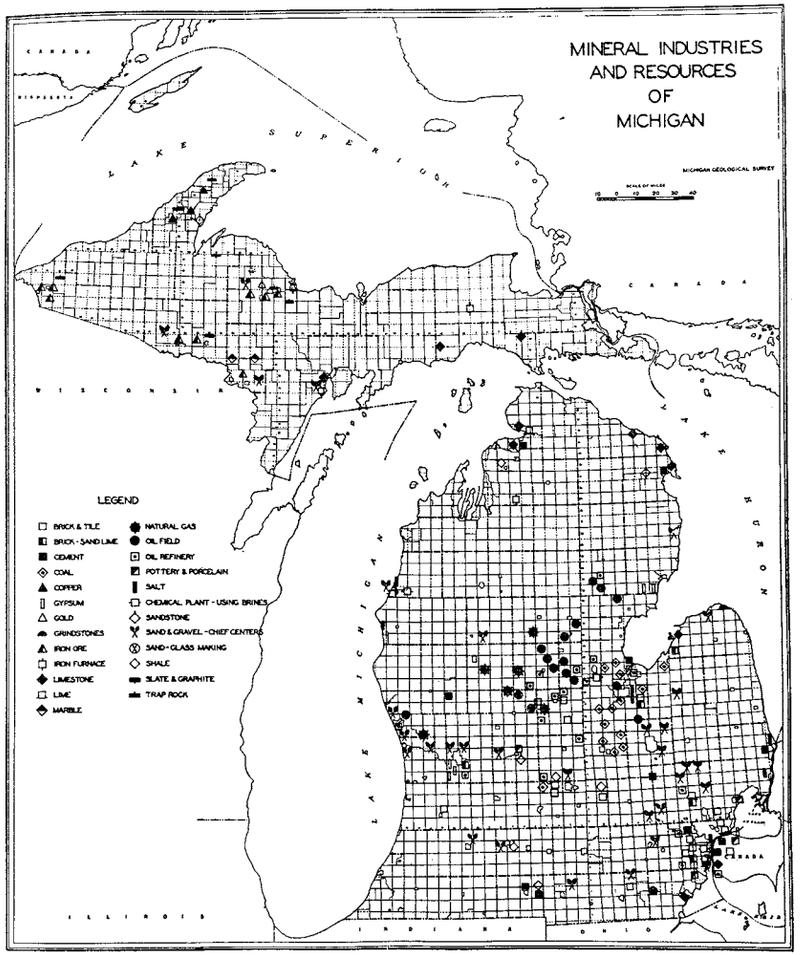
Mining as an industry in Michigan dates back to the early beginnings of the state. Several mining operations were started long before the timber was cleared from the areas where the deposits occur. In the early days of iron production the ore was smelted in crude stone stack furnaces by means of charcoal made from the wood of the adjacent forests. In several instances, mineral deposits such as salt were opened up and developed as by-product industries along with the lumbering operations.

Although many of Michigan's mineral deposits have been worked for nearly a century and have contributed greatly to the wealth of the state, there still remain resources ample for future development. The extent to which the reserves of non-metallic minerals are henceforth exploited will depend somewhat upon the demand for new products which may be manufactured from them.

Iron Ore in Michigan

Discovery of Iron Ore in Michigan

In his geological report for 1841, Dr. Douglass Houghton,[8] the first geologist of the State of Michigan, states "Although hematite ore is abundantly disseminated—it does not appear in sufficient quantity at any one point that has been examined to be of practical importance." It is no reflection on his ability as a geologist that Dr. Houghton failed to discover the iron deposits, for most of his examinations of the area were made by boat along the shore of Lake Superior. Had he traveled into the interior wilderness of the region there is no question but that he would have observed the outcrops of the iron formation.

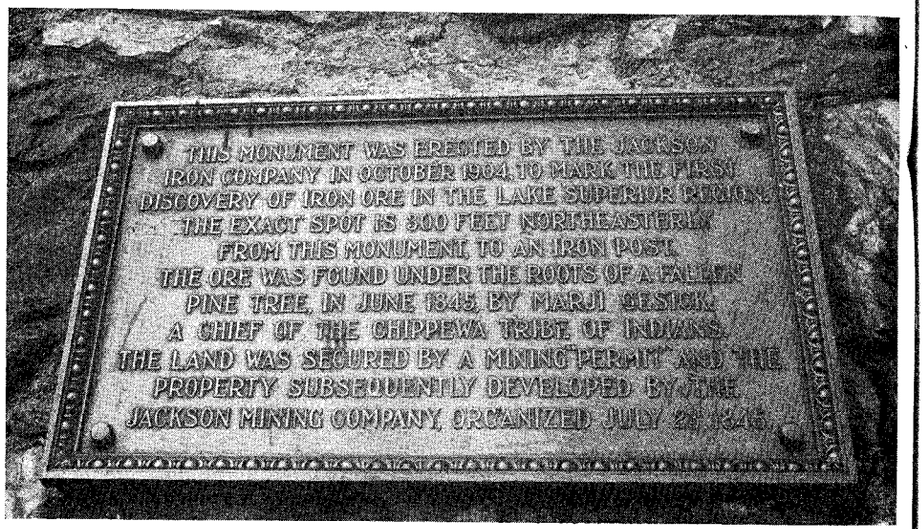


33. MINERAL INDUSTRIES AND RESOURCES

The earliest discoveries of commercial deposits of iron ore were made in 1844 by a party of United States surveyors under the direction of William A. Burt and with the guidance of two Indians. The first company organized for the purpose of mining the ore in northern Michigan was incorporated as the Jackson Iron Company. The articles of association of this company were executed at Jackson, Michigan, on July 23, 1845.

After several years of exploratory operations and testing of the material by working it into iron bars in a blacksmith forge, the Jackson Company finally opened up the first iron mine in Michigan.

According to Brooks,[2] the original shipment of iron ore from the Jackson pit, located near Teal Lake on the north edge of Negaunee in Marquette County, was made in 1852. "Seventy tons of hematite were taken to Sharon, Pennsylvania, and there made into pig-iron in the 'Old Clay Furnace.'" The first regular shipments of ore from the Jackson mine were begun in 1856, when 5,000 tons were removed.



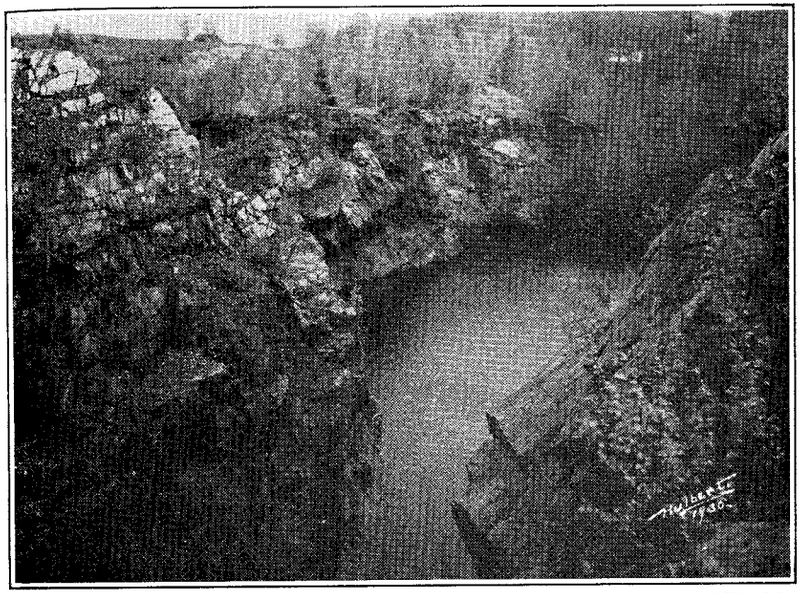
FROM THE MICHIGAN EDUCATION ASSOCIATION

34. FIRST IRON MINE, NEGAUNEE

Later discoveries of iron ore in the Northern Peninsula resulted in the opening and development of the Menominee Range in Dickinson County, with first shipments in 1877. Seven years later the Gogebic Range in the western end of the Peninsula was opened for the production and delivery of iron ore.

Millions of Tons of Ore Shipped Annually

In the eighty-five years since the first shipment of ore from the Jackson mine, Michigan has produced in excess of half a billion tons of iron ore. In the period from 1916 to 1935, inclusive, the annual shipments of iron ore from the state have averaged about 12,000,000 tons. The largest output during this twenty-year period was 18,812,972 tons in 1916. Much of this production was employed in the manufacture of armament for the World War which was then in progress. The lowest shipment was 978,371 tons during the trough of the depression in 1932.[13]



FROM THE DEPARTMENT OF CONSERVATION

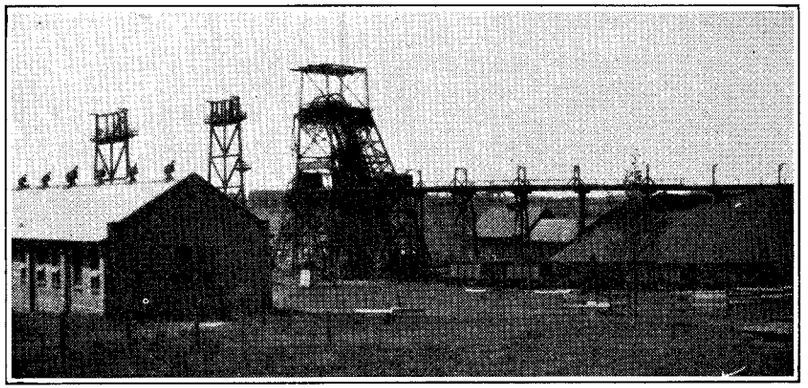
35. JACKSON IRON PIT

According to statistics compiled in the Minerals Yearbook for 1936[19] the estimated visible reserves of merchantable iron ore in Michigan have been placed at slightly less than 165,000,000 tons. At the normal rate of production, this known reserve of high-grade ore would be exhausted in a period of 15 to 20 years if it were not for the fact that ore is developed and new deposits are found in connection with mining operations. Pardee* makes the statement that "since 1911 the estimated visible reserves of iron ore in Michigan have never exceeded 200,000,000 tons and in that time some 300,000,000 tons have been shipped out of the state. These figures

*Pardee, Frank—Personal Communication.

show how new discoveries have maintained a large reserve of ore in spite of shipments, but a time will come when the high-grade ores will be exhausted or cost too much to extract. At that time the lower grade or marginal ore, of which there are immense tonnages in reserve, will be treated or beneficiated and the industry will continue to exist for many years thereafter."

With the exception of a rather limited area in Wakefield on the east end of the Gogebic Range, where open pit methods of mining are employed, the bulk of high-grade iron ore produced in Michigan is mined through shafts. Low grade siliceous ores of iron are mined through surface operations in the vicinity of Marquette and Iron Mountain. The iron mines of Michigan are relatively deep when compared with those of other iron districts throughout the world, some of the deeper shafts extending to vertical depths exceeding 3,000 feet.



FROM THE DEPARTMENT OF CONSERVATION

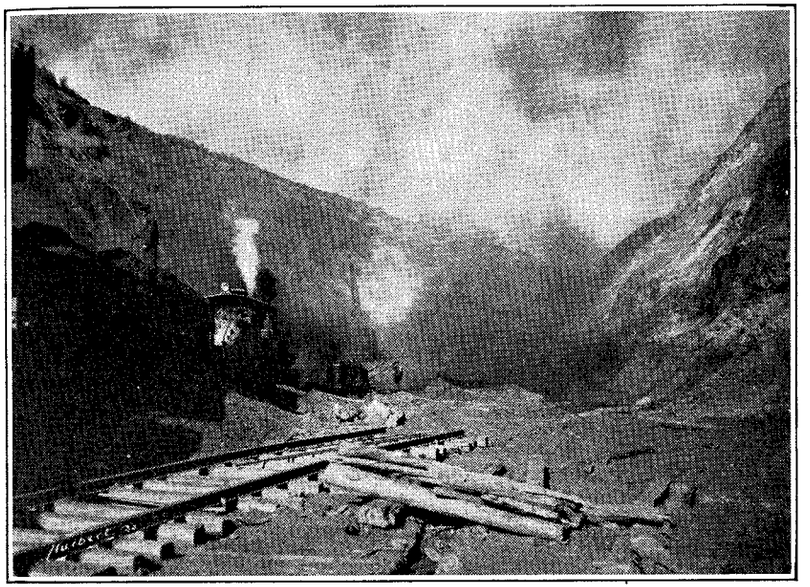
36. SURFACE SHAFT—IRONWOOD

Value of Annual Shipments

Osgood,[13] in his report on the Iron Industry of Michigan, states that "values placed on iron mining properties by the State Tax Commission increased from $82,000,000 in 1913 to $117,000,000 in 1921, and have since that time shown a gradual decrease until on January 1, 1935, the total recommended valuation was set at $63,000,000. The valuation placed on the iron mines represents but one per cent of the total valuation of the state, but on the other hand, it comprises nearly 25 per cent of the total valuation of the Northern Peninsula." He states further that "approximately 8,500 men were employed in the iron mines in 1930, earning an average annual wage of about $1400. The low point of employment was reached in 1933, when only 2,739 men were employed, but 1934 and

1935 have seen improved conditions and 1936 will probably be the best year since 1930."

In the period 1930-1935, the average cost of mining and transporting iron ore to the lower lake port furnaces amounted to $4.36 per ton. This in itself is most certainly a remarkable achievement in view of the fact that the ore must be moved during the relatively short period when the lakes are free of ice. "One of the marvels of this great industry is the efficiency with which it extracts these large tonnages from mother earth and moves them to the furnaces."



FROM THE DEPARTMENT OF CONSERVATION

37. OPEN PIT—WAKEFIELD

Use of Scrap Iron and Alloys Conserves Natural Ore

According to information obtained from Pardee, "the average iron ore shipped down the lakes carries about 50 per cent metallic iron, which means that it requires about two tons of iron ore to produce one ton of pig iron or steel. If it were not the case that immense tonnages of scrap iron go back to the furnaces each year there would of necessity be many more mines in operation to supply the needs of the country." The use of scrap material in the steel industry goes a long way in conserving the natural iron ore resources of the state.

A program of conservation is being forced upon the iron mining industry by steel manufacturers. The use of alloys of other metals

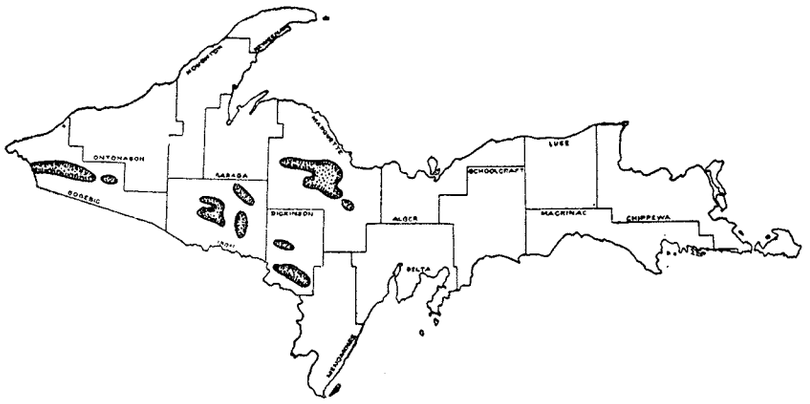


FIGURE 38. LOCATION OF THE IRON DISTRICTS
There is no iron in the Lower Peninsula

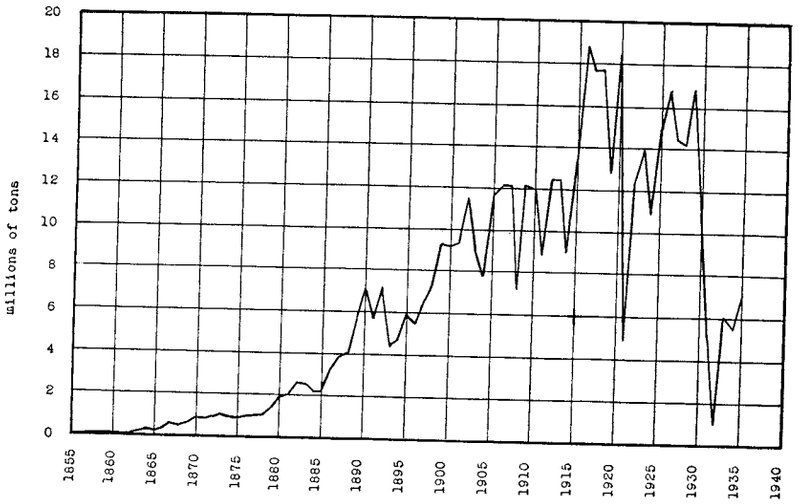


FIGURE 39. PRODUCTION OF IRON ORE IN MICHIGAN

in producing high-grade steels lessens, to a certain degree, the amount of iron required in the process. In the fabrication of many steel products, various types of plating are employed. These serve to protect the surface of the metal from excessive corrosion and thus aid in prolonging its life.

Copper in Michigan

Indians Discover Copper in Michigan

The first references to the existence of copper in Michigan are made in a book published by LaGarde in Paris in 1636. The reports and narratives of the early Jesuit missionaries who roamed the wilderness tracts of the Great Lakes in the early decades of the 17th century contain fragmentary sketches of the occurrence of copper along certain of the shores of Lake Superior. Subsequent explorations by French, German, English, and American prospectors, engineers, and surveyors laid the ground work for what later was to become one of Michigan's most important and profitable industries.

The earliest records of mining in Michigan are contained in the old "Indian Pits" which have been found scattered through the region of Isle Royale and the Keweenaw peninsula. In the vicinity of these prehistoric pits have been uncovered piles of charcoal and half burned sticks, together with crudely shaped implements of copper and stone. These evidences all seem to point to the conclusion that the early Indians were the original miners and artisans of the metal in Michigan.

Mining of Copper Begins

Although copper in its native state was known to exist in the Isle Royale and Keweenaw districts long before white men set foot on their shores, mining of copper as an industry did not begin until 1845. In that year the state produced 26,880 pounds of the metal, obtained by prospectors and independent miners mostly from outcrop veins and shallow deposits. From this small beginning nearly a century ago, the copper industry in Michigan made rapid strides to become one of the greatest of its kind in the world. For a period of forty years, from 1847 to 1887, Michigan was the foremost producer of copper among the states of the Union. To the close of the year 1935, Michigan had produced a total of almost nine billion pounds of copper.

Osgood,[13] in his report on *The Copper Industry of Michigan* published in 1936, states that "in 1930 the valuation of the copper mines