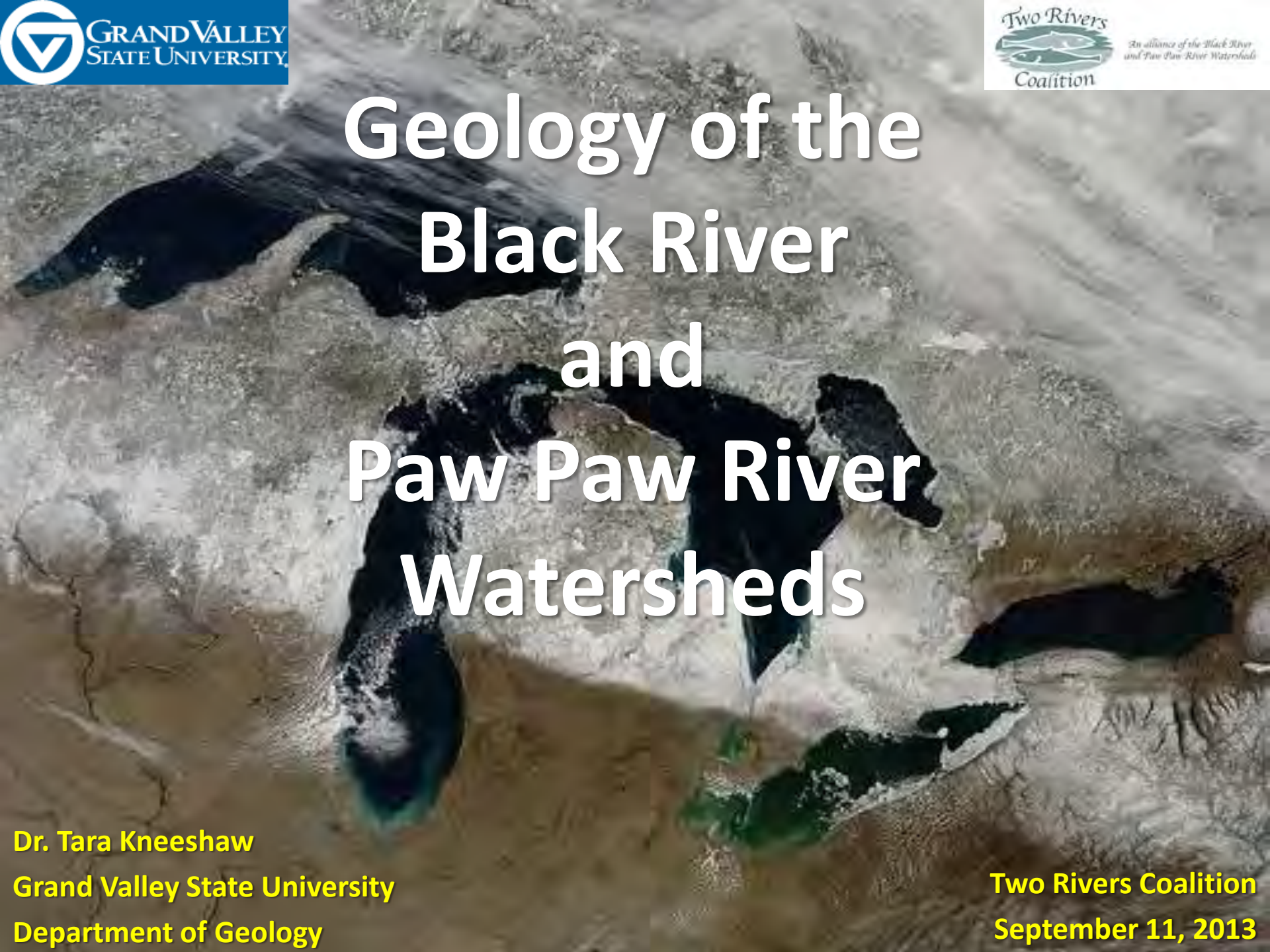


Geology of the Black River and Paw Paw River Watersheds

Dr. Tara Kneeshaw
Grand Valley State University
Department of Geology

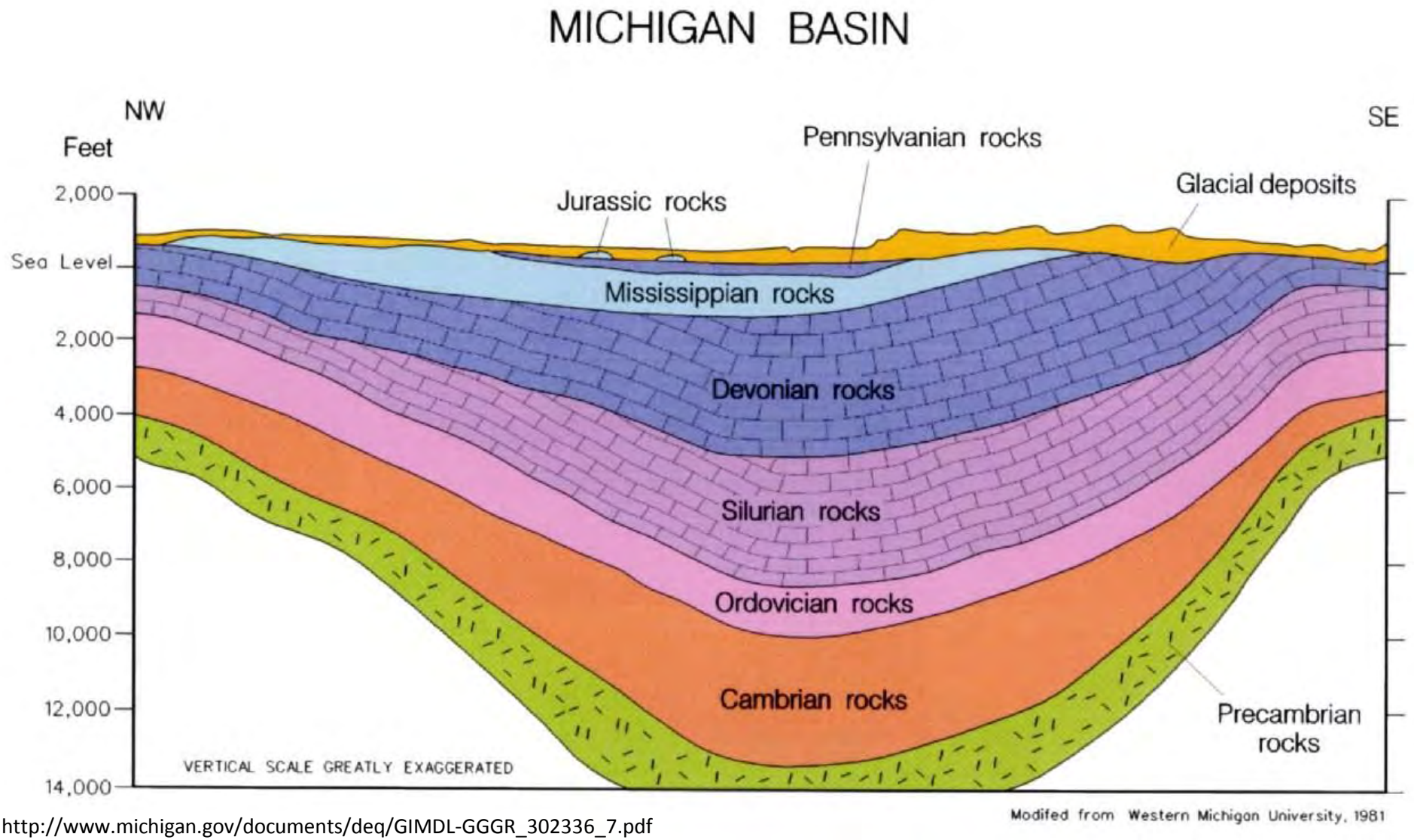
Two Rivers Coalition
September 11, 2013

There's nothing boring about Michigan's Geology!

We drive around on a glacial landscape consisting of soils that formed after the last Ice Age (~20,000 years ago)

But there's an exciting record hidden beneath those glacial sediments

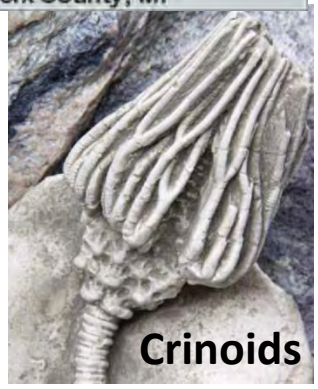
Limestones, sandstones and shales, which dominate the Michigan Basin of the lower peninsula, are approximately 500 million years old

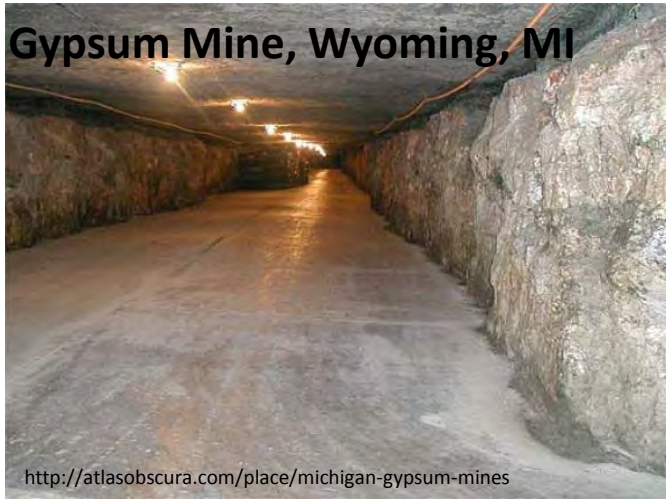


http://www.michigan.gov/documents/deq/GIMDL-GGGR_302336_7.pdf

What's beneath those glacial sediments?

- Tropical seas and coral reefs from a time when Michigan was literally in the tropics!



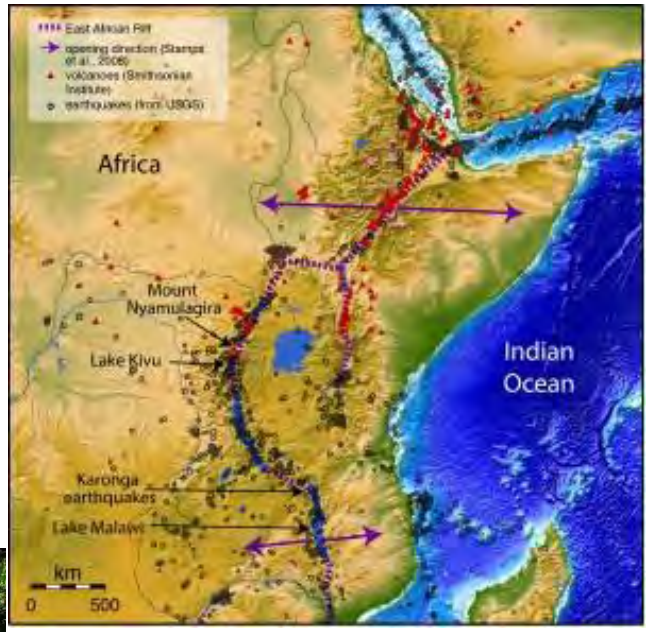


What's beneath those glacial sediments?

The geology of the U.P. is a completely different story…

- In the Keweenaw Peninsula the most extensive ***crustal rift*** on Earth is exposed at the surface

  →Ancient lava flows!!



Similar to the current East African rift

~1 BYA parts of the continent tried to separate, but were ultimately unsuccessful

Basalt with copper-filled vesicles

Geology of Michigan

Thanks to the glaciers, we probably have the most diverse assemblage of surface rocks on Earth!

Glaciers originated in Canada and bulldozed over some of the most ancient rocks on earth.

They brought along rocks and boulders containing info on interesting "firsts" in earth's history and left them behind.

This has happened other places, so why is Michigan so unique?

- It's the range of geologic history that's recorded here
  - In the Western U.P. there are rocks that are 3.6-3.7 billion years old!

Glacial History of the Great Lakes(Quaternary Geology)

The **Laurentide Ice Sheet** covered massive areas, multiple times during Quaternary glacial epochs.

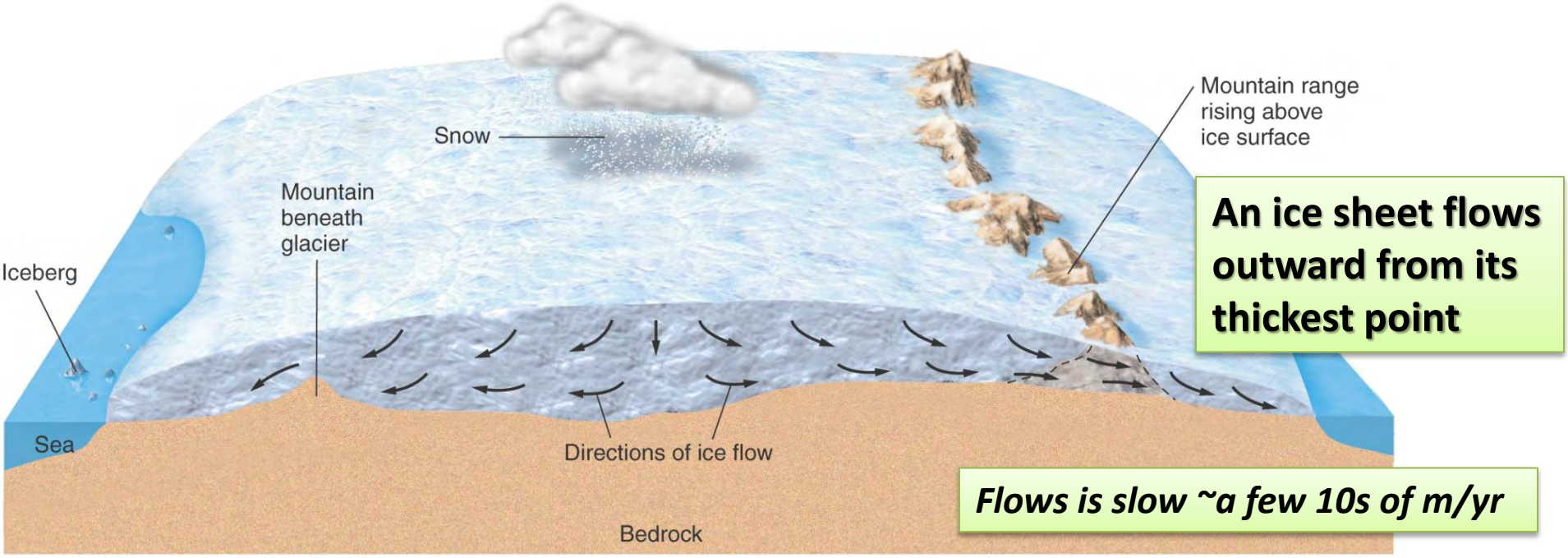
- Glacial activity began nearly two million years ago
- Most of our land formations formed during the **Wisconsin Glacial Age**
  - between 9,500 and 15,000 years ago.

Lobes of the Laurentide Ice Sheet in Michigan.

Glacial Ice

- Glacial ice forms when thick accumulations of snow are compacted under great pressure

- Glaciers flow ***plastically*** (like warm asphalt) and are capable of deforming and "flowing" under gravity



An ice sheet flows outward from its thickest point

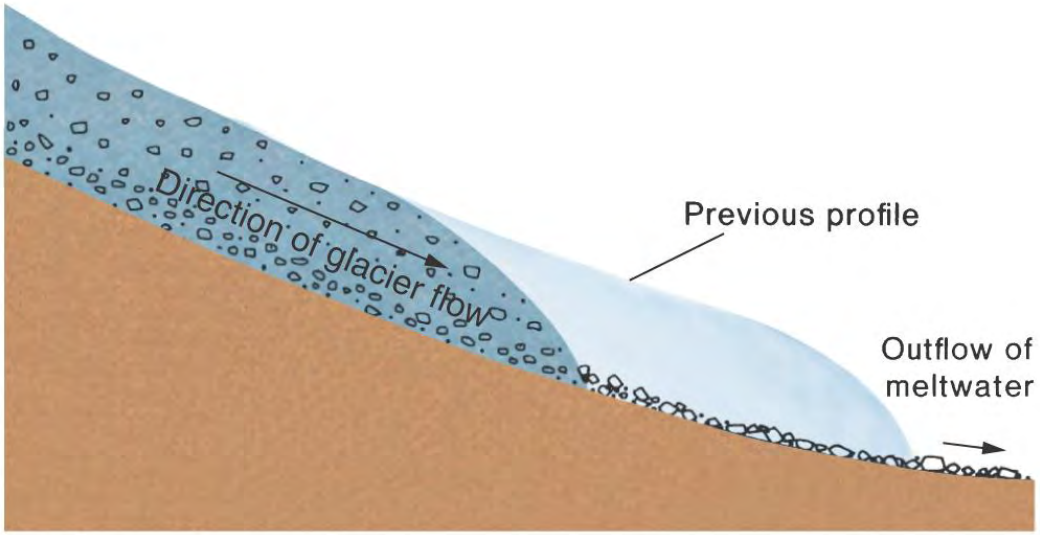
Flows is slow ~a few 10s of m/yr

Glacial Ice

Although ice is soft, it is capable of eroding soil and hard rock

A

Advance of the glacier moves both ice and sediment downslope.



B

Ablation (melting) causes apparent retreat of the glacier and deposition of sediment (till).

When the glacier melted from North America it left a mass of "glacial drift" over the area it had covered

The Great Lakes may have originated as drainages (rivers)….

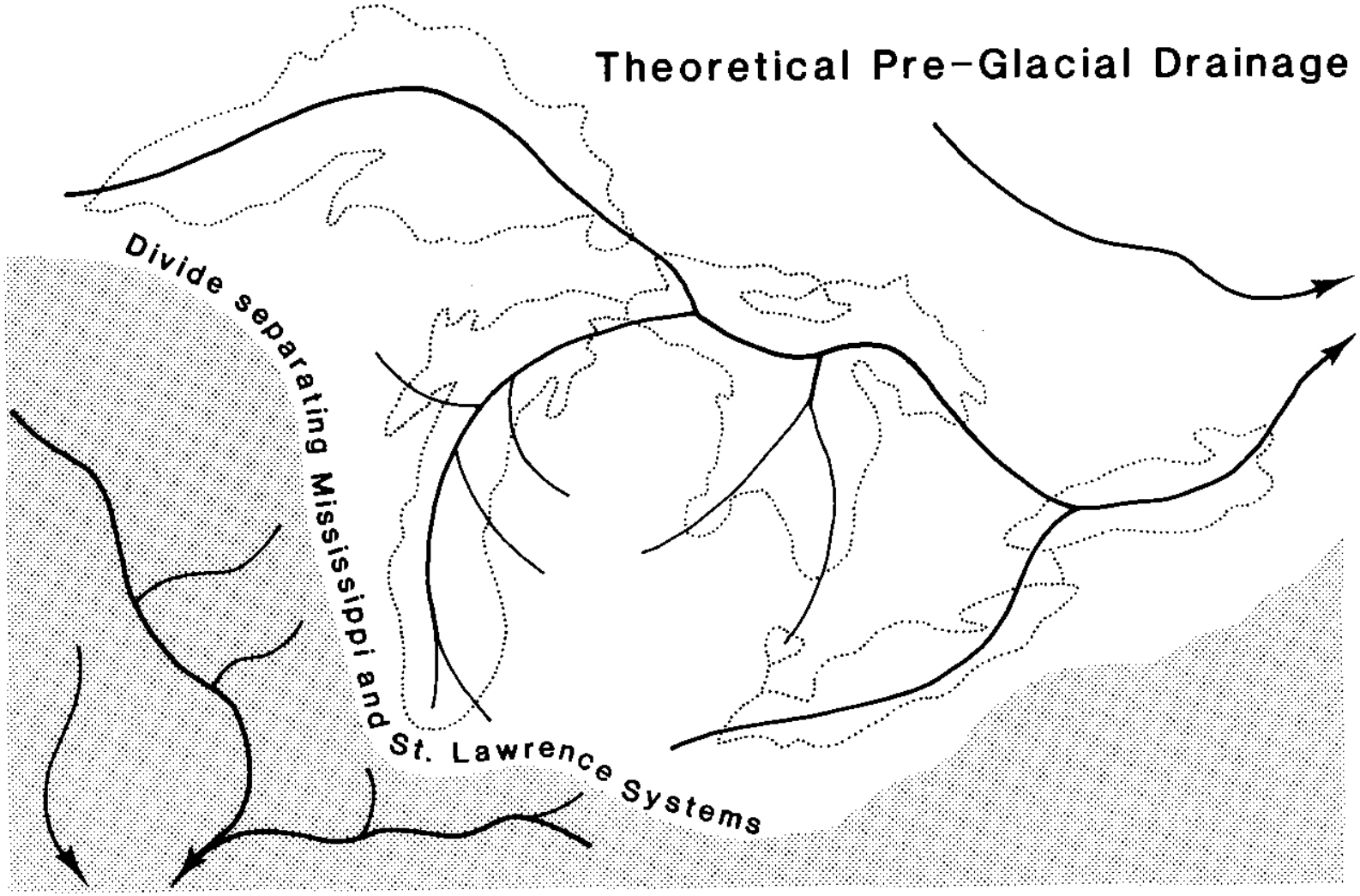


Figure 5: The drainage divide separating the old Mississippi and the preglacial St. Lawrence watersheds was probably situated near its modern counterpart.

The glaciers advanced into the Great Lakes region as a series of ice lobes, each lobe seeking out the lowest preexisting spots on the landscape.

- The lobes moved slowly southward out of the old widened river valleys
  - The ice front didn't separate into distinct lobes until the ice melted back into southern Michigan

The lobes were welded together south of the Great Lakes region

Most of our land formations formed during the last retreat when the lobes were really apparent.

The lobes of the Laurentide Ice Sheet in southern Michigan.

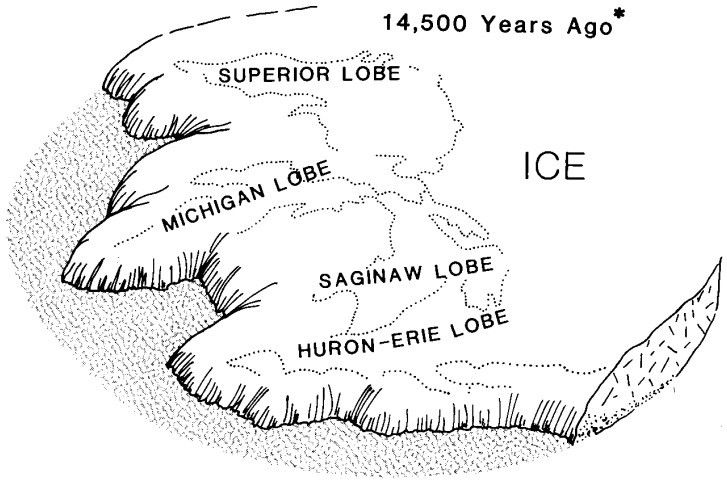


Figure 6: The retreating ice front halted and built the Valparaiso-Charlotte-Ft. Wayne Moraine. As the ice left this position the first known lakes began to form.

- Ice retreat left behind glacial moraine systems.

Till Plains (ground moraines)

Moraines

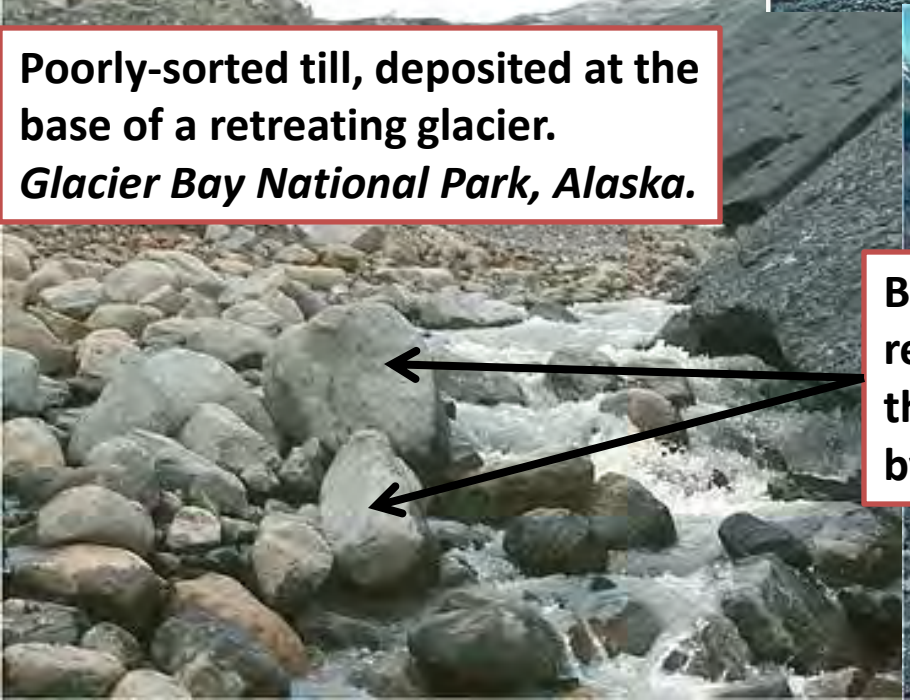
Outwash Plains

Retreating glacier in Denali National Park, Alaska.

Till is characteristically angular and poorly sorted material

Coarse glacial till in the Chugach Mountains, *Chugach National Forest, Alaska.*

Poorly-sorted till, deposited at the base of a retreating glacier. *Glacier Bay National Park, Alaska.*



Boulders are a lag deposit resulting from the removal of the finer grain-sizes in the till by the ice-marginal stream.

Till Plains

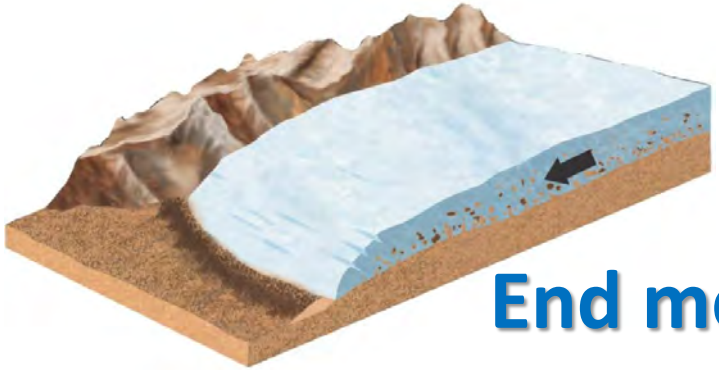
Extensive flat plains of glacial till that forms as ice melts in place depositing the sediments it carried.

Sometimes called ground moraine if topography is irregular with gently undulating lands

Generally fertile, with soils that are predominately clay loams and sandy loams, capable of supporting diversified agriculture

Glacial Landforms- Moraines

Moraine is a landform made of till….there are many types



End moraines

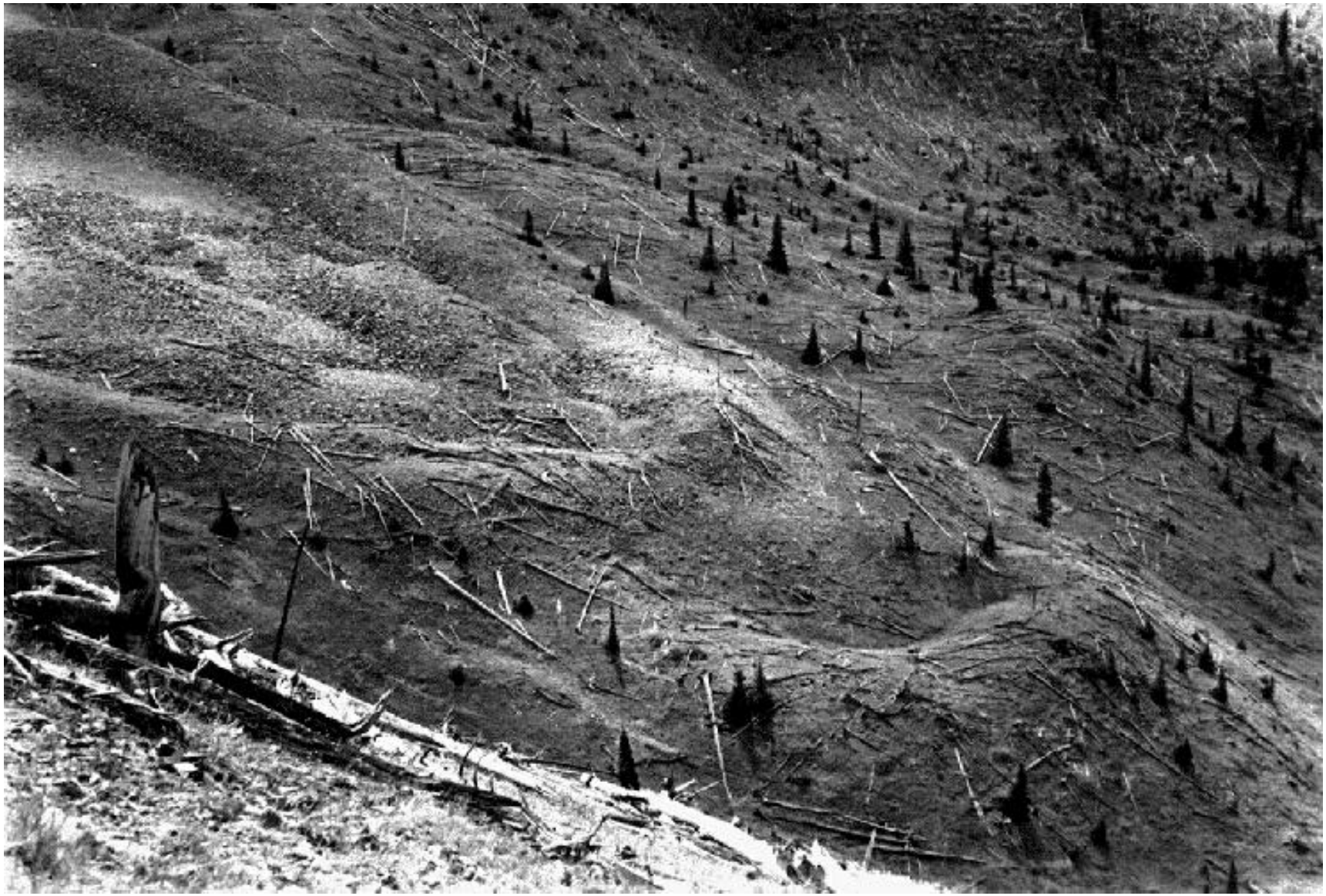
Created by repeated annual advances and retreats when the extent of the glacier is constant for many years

Glacier acts like a conveyor belt delivering sediment to the end of the glacier.

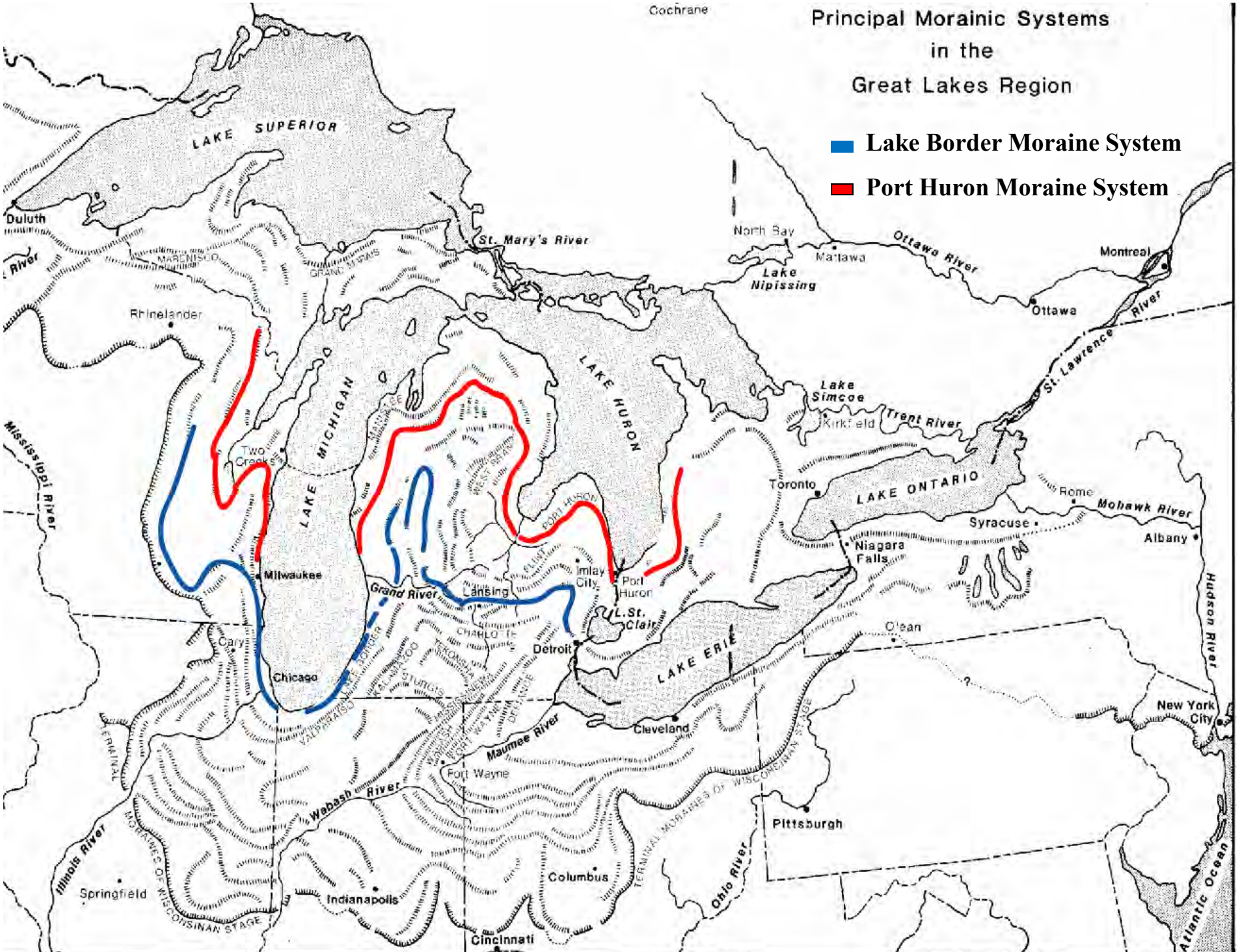
Morainic soils consist of materials ranging from boulders to fine clay and silts

–Can have all possible gradations from coarse gravel to fine sand!

Moraines – after a recent glacial retreat

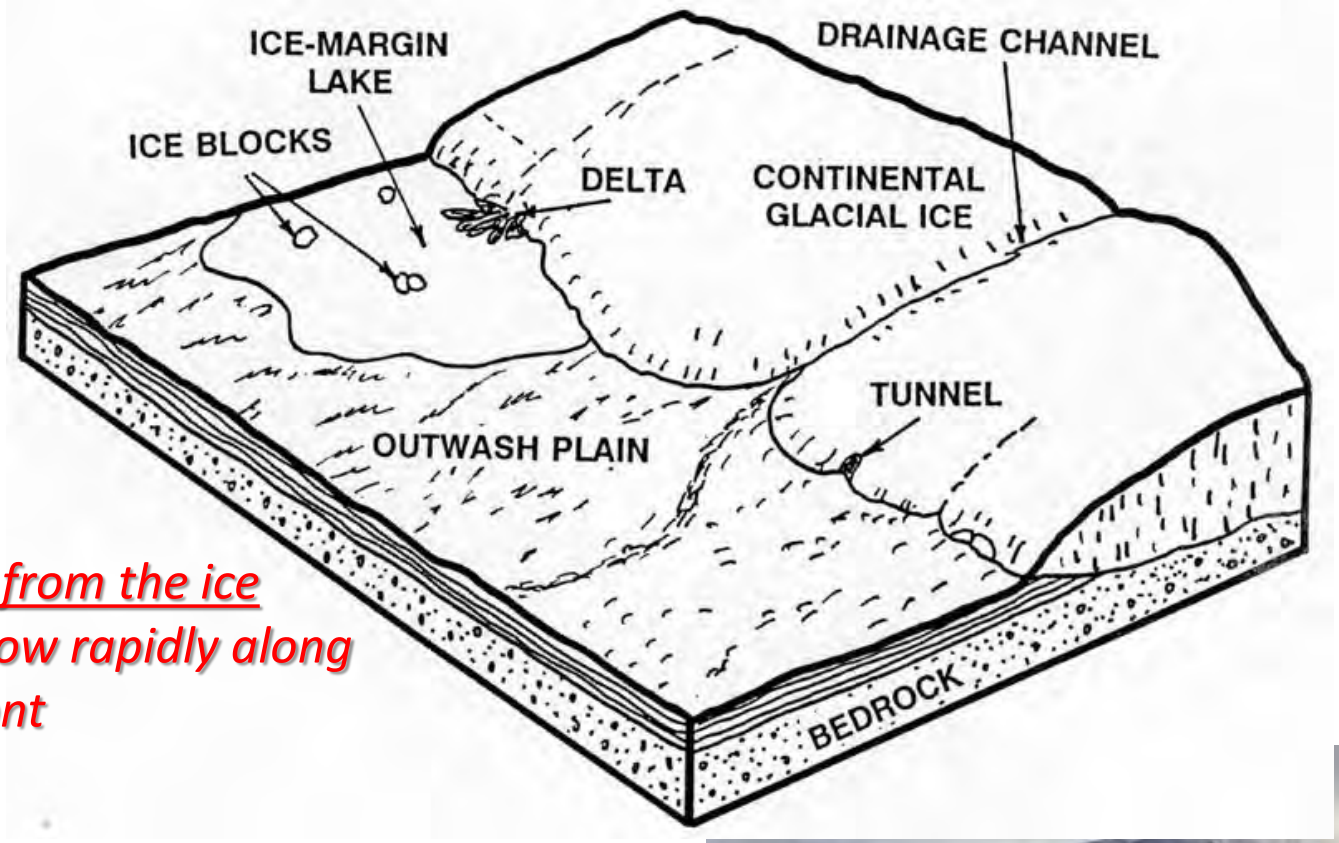



End moraines: Wisconsin Age
End moraines: Illinoian Age
0 150 mi
0 150 km
Driftless area
Extent of Wisconsin glaciation
Extent of Illinoian glaciation


Principal Morainic Systems
in the
Great Lakes Region
Lake Border Moraine System
Port Huron Moraine System
Cochrane
LAKE SUPERIOR
Duluth
St. Mary's River
North Bay
Mattawa
Ottawa River
Montreal
Lake Nipissing
Ottawa
St. Lawrence River
Rhinelander
LAKE MICHIGAN
LAKE HURON
Lake Simcoe
Kirkfield
Trent River
Two Creeks
Mississippi River
Toronto
LAKE ONTARIO
Rome
Mohawk River
Syracuse
Albany
Niagara Falls
Milwaukee
Grand River
Lansing
Imlay City
Port Huron
L. St. Clair
Detroit
Cary
Chicago
LAKE ERIE
Clean
Cleveland
New York City
Hudson River
Maumee River
Fort Wayne
Wabash River
Pittsburgh
Illinois River
Springfield
Indianapolis
Columbus
Ohio River
Cincinnati
Atlantic Ocean

Outwash Plains

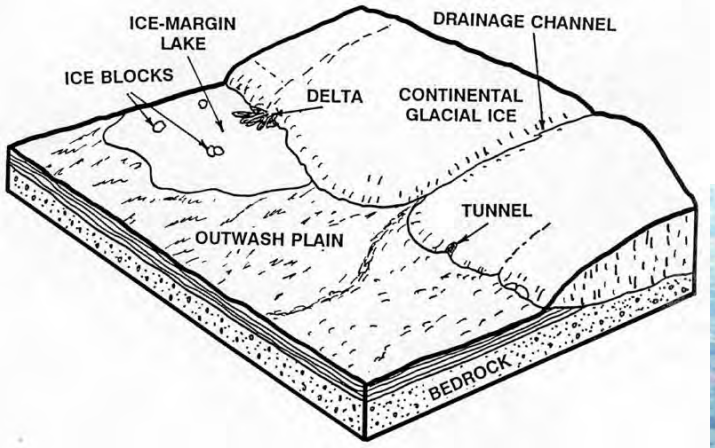
Ice-marginal lakes (or proglacial lakes) form when the land in front of the ice margin slopes toward the ice, allowing meltwater to pond directly in contact with the ice



When land slopes away from the ice broad sheets of water flow rapidly along or away from the ice front

Water sorts and carries sediment out away from the moraine creating stratified gravelly, gently undulating to flat plains = the flatlands of southwest Michigan!

Kettles



Broken blocks of ice from the ice front were frequently buried by glacial debris and did not melt until long after the ice had passed.

When they did melt they left deep, steep-sided depressions, some of which filled with water. Such depressions are named "kettles"

Kettles, as well as the depressions caused by unequal bulk of deposited morainic material, account for the hundreds of lake basins we now find

Near Argentine, Michigan.

Glacial Outwash Plains

Glacial Outwash Plain

In Michigan the old outwash plains and channels are often seen today as "wet prairies"

They are typically near coarse-textured moraines within stream or river floodplains, lake margins, and isolated depressions

Till Plain vs. Outwash Plain

Till Plain

- Behind (towards the direction of retreat) of a moraine
- unsorted material (till) of all sizes with much clay
- Gently undulating to hilly surface
- *Abandoned farms; hardwood forests*

Outwash Plain

- In front of the moraine
- Mainly stratified (layered and sorted) gravel and sand
- Flat or very gently undulating (where it is a thin veneer on the underlying till)
- *flourishing farms; conifers*





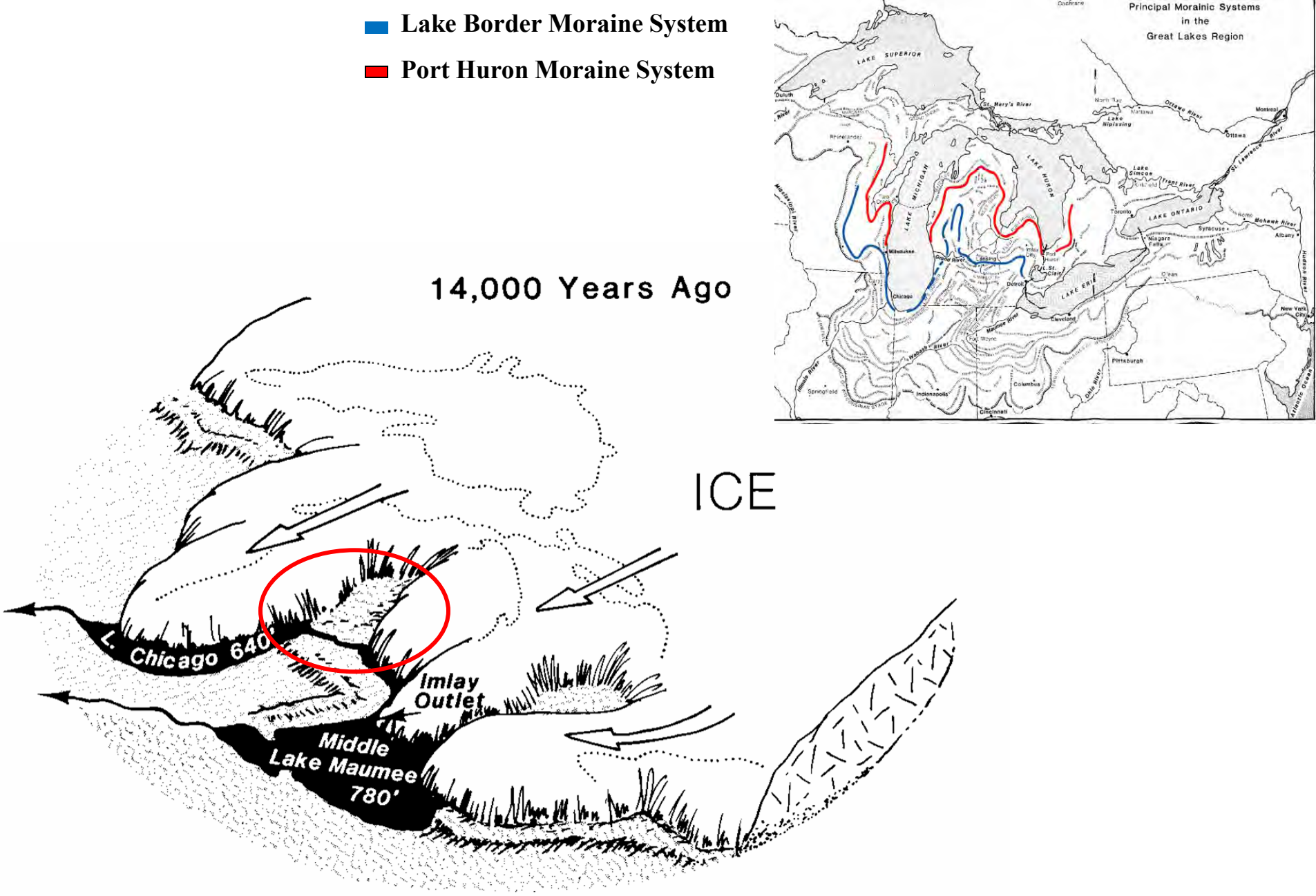



Figure 7: Advancing temporarily, the glacier almost forced Early Lake Chicago out of its basin. The Lake Border Moraine was built at this time.

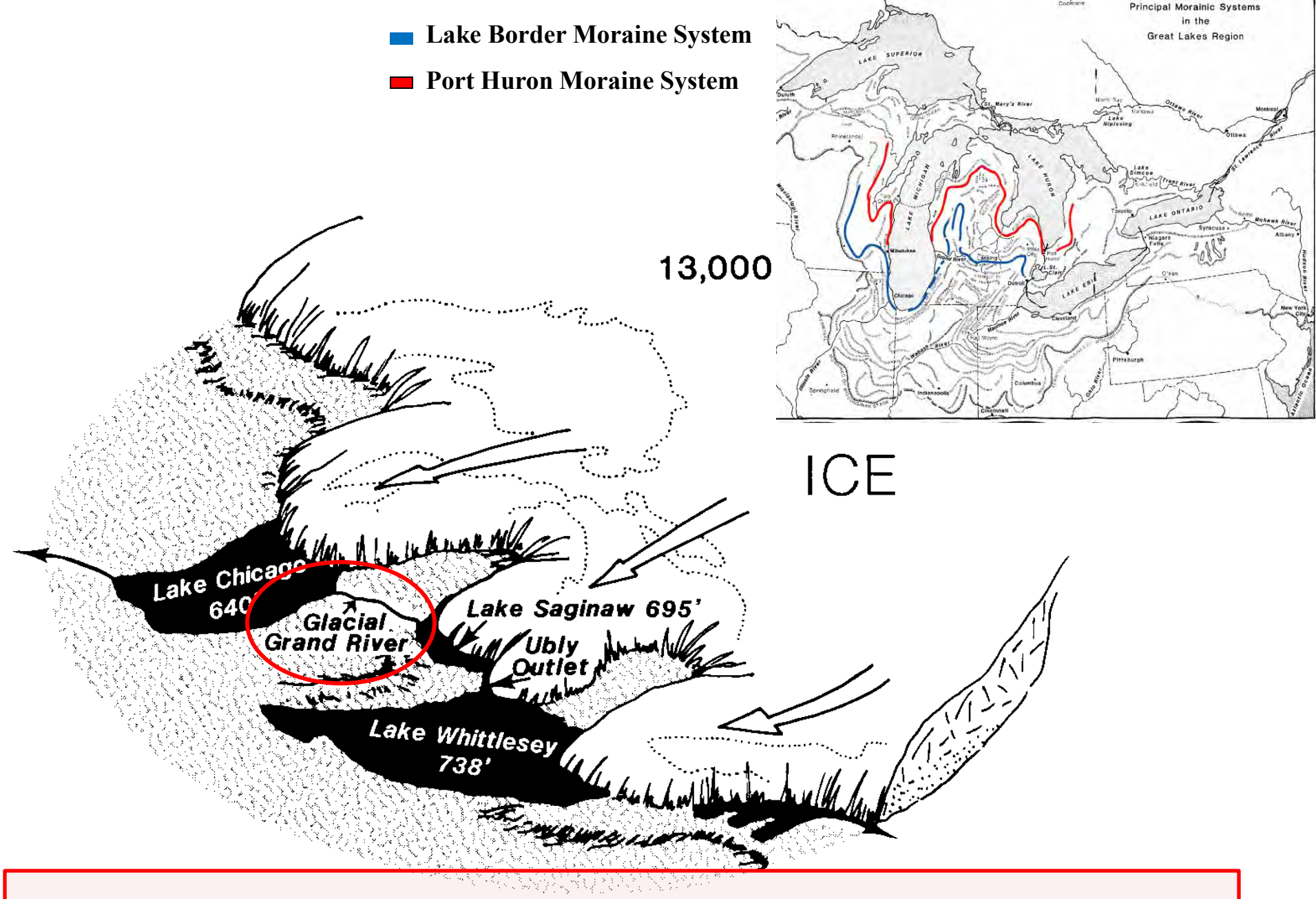
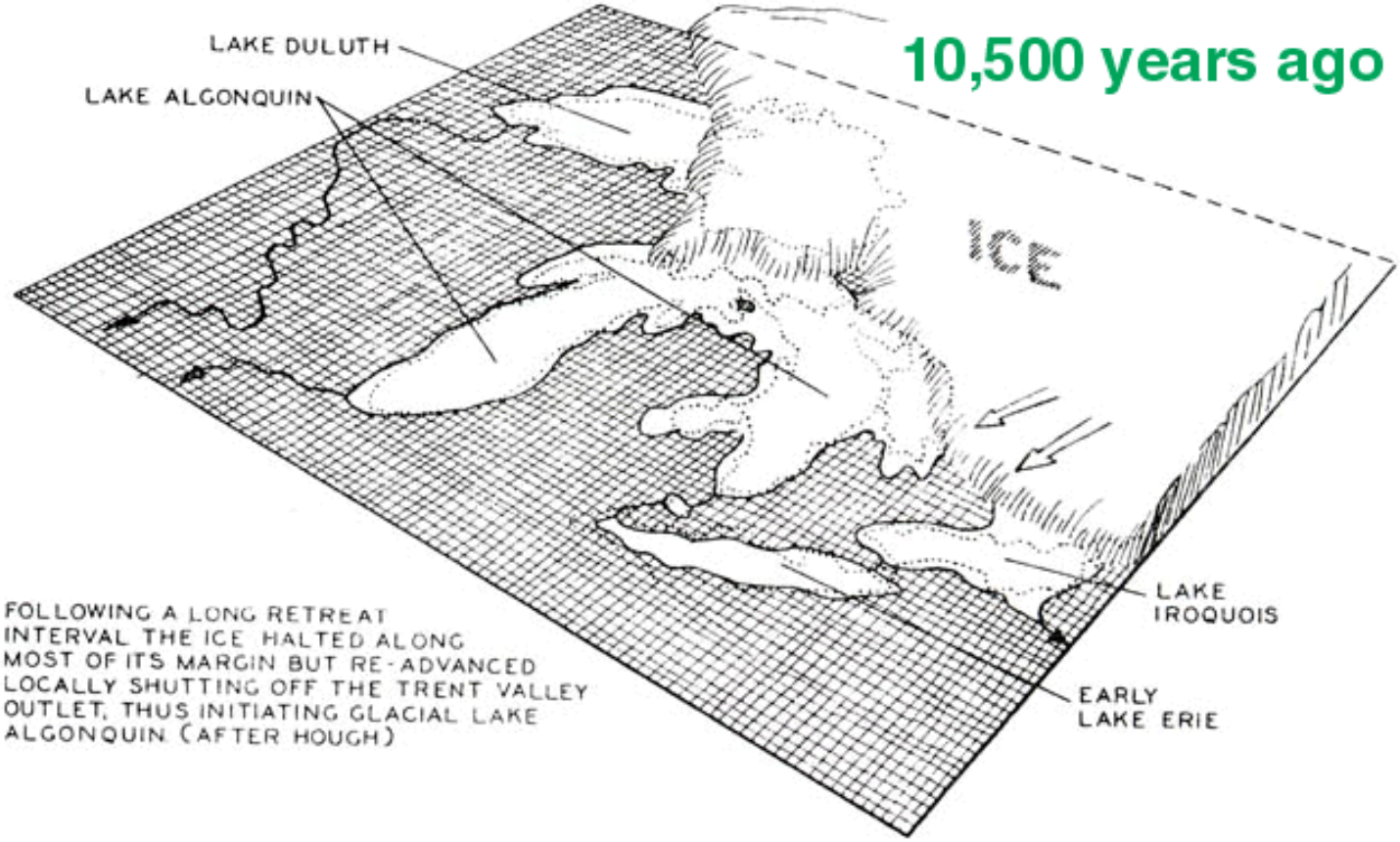
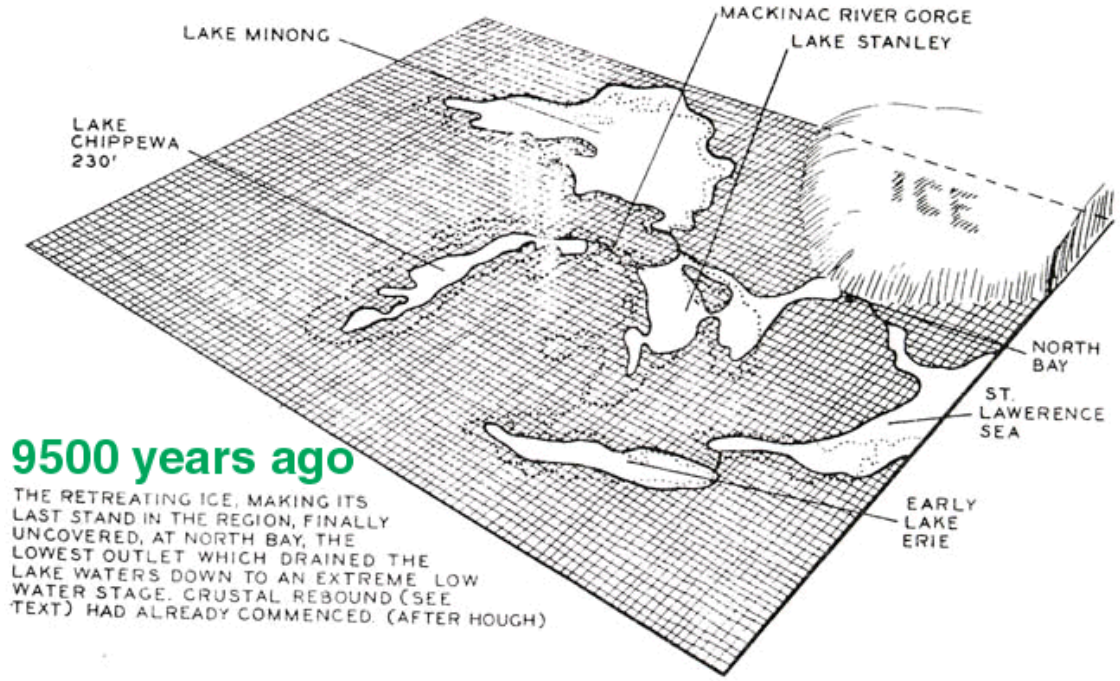


Figure 8: After making one last strong re-advance, the ice front halted and built the most prominent topographic feature in the region, the Port Huron Moraine.

The way the Great Lakes looked 10,500 years ago

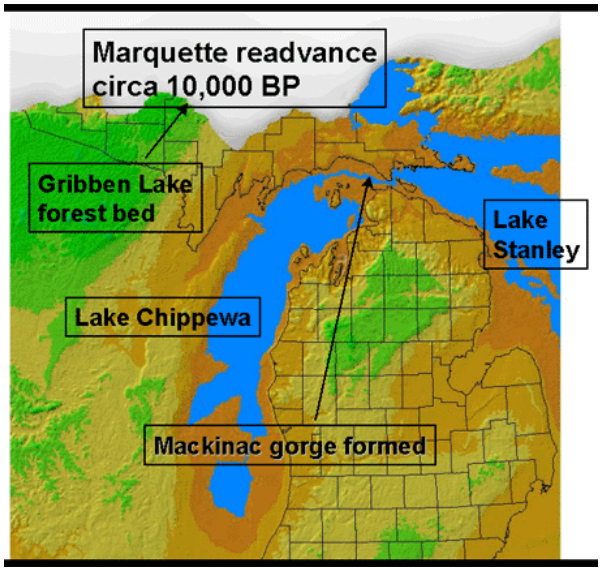


The way the Great Lakes looked 9,500 years ago

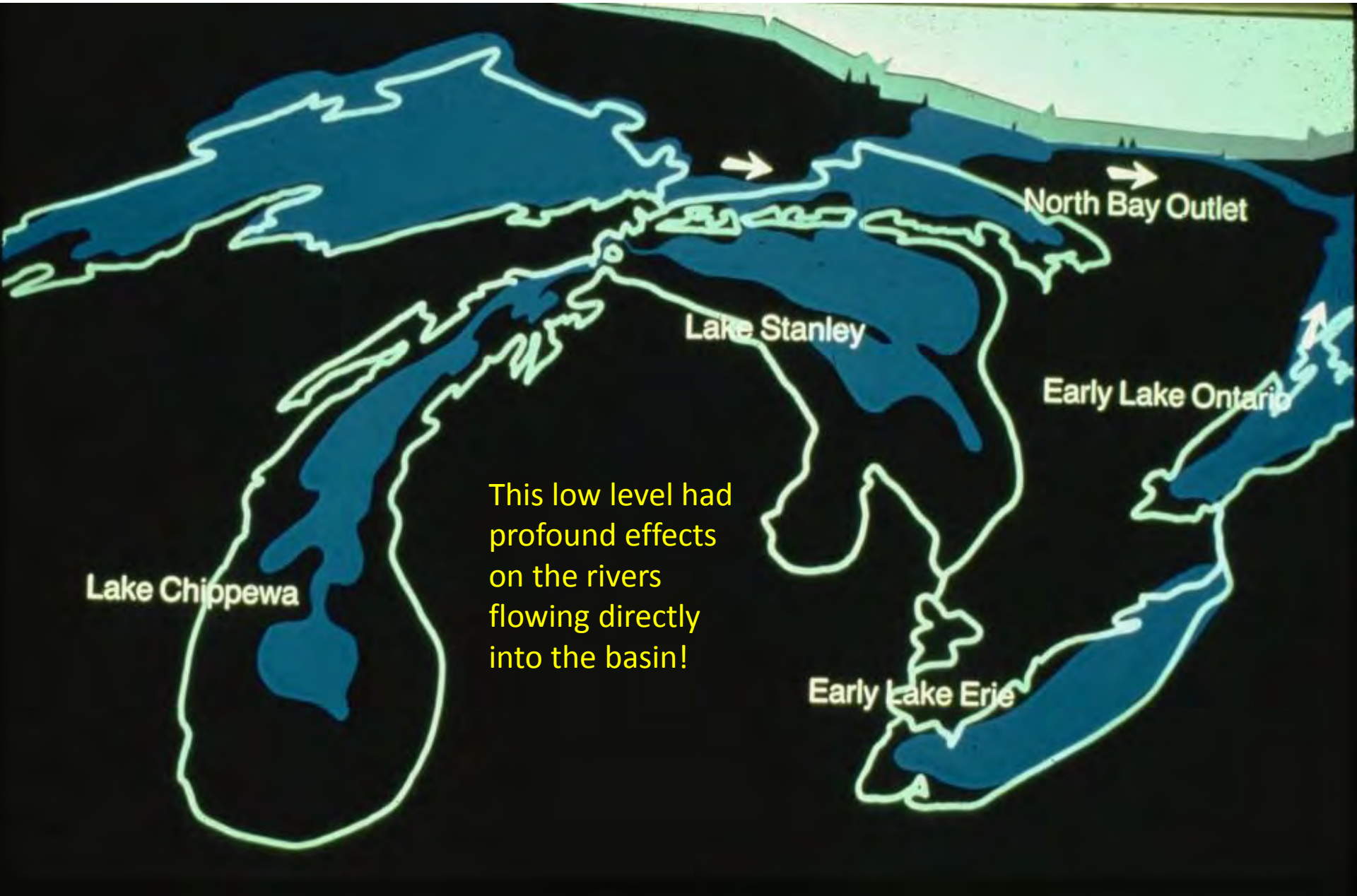


- The lowest lake levels occurred as the ice retreated and removed the barrier to the Gulf of St. Lawrence

Detailed map of the Chippewa low lake stand



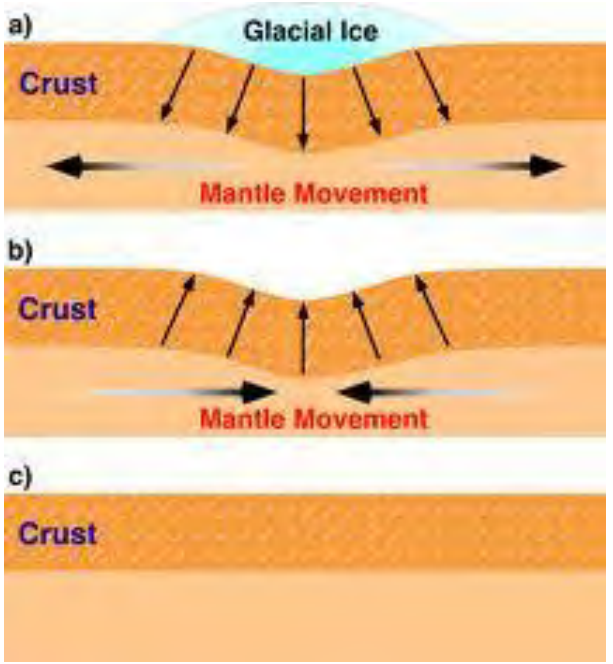
Lake Chippewa stage – Lowest lake stage in Great Lakes basin



6,000 and 4,000 years before present

As land was relieved of the huge weight of the ice sheets **"isostatic rebound"** of the earth's crust from its "depressed" state began to accelerate.

- The rise of the outlet of ancestral Lake Superior (at North Bay, Ontario) caused lake level to rise relatively quickly to a level roughly 13 m (40 feet) higher than present Lake Superior.



Lake Nippissing – late high level of Great Lakes – produces many coastal features

Lacustrine Deposits – where lake sediments cover an area, topography tends to be level and sediments well-sorted

Lake Nippissing – Coastal lakes & dune systems

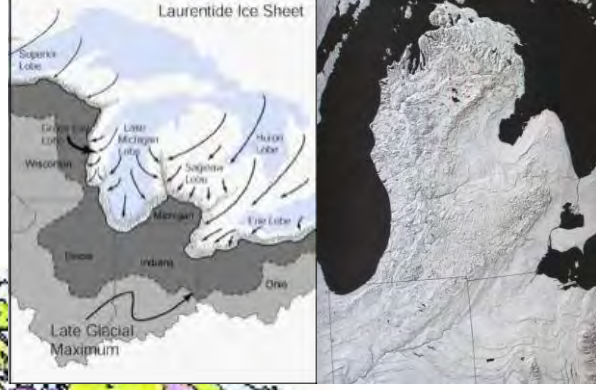
Sooo…..it was these events during the Holocene Epoch

(last 10,000 years) that ultimately resulted in the lakes and landforms as we know them today.

Due to:

- period of crustal adjustment
  - (isostatic rebound)
- climate changes

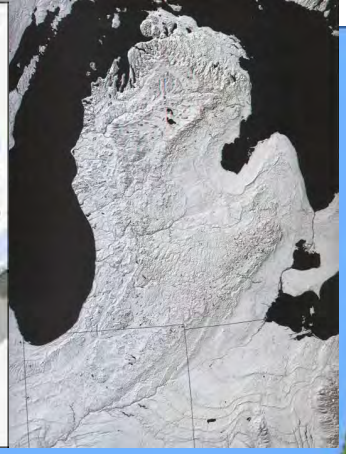
Quaternary Geology of Southern Michigan



- Peat and muck
- Postglacial alluvium
- Dune sand
- Lacustrine clay and silt
- Lacustrine sand and gravel
- Glacial outwash sand and gravel and postglacial alluvium
- Ice-contact outwash sand and gravel
- Fine-textured glacial till
- End moraines of fine-textured till
- Medium-textured glacial till
- End moraines of medium-textured till
- Coarse-textured glacial till
- End moraines of coarse-textured till
- Thin to discontinuous glacial till over bedrock
- Artificial fill
- Exposed bedrock surfaces
- Water

Black River and Paw Paw River watersheds

http://www.egr.msu.edu/igw/GWIM%20Figure%20Webpage/index.htm



Fennville

Kettles

South Haven

Black River Watershed

Bangor

Lake Michigan
Approx. Elev. 581 ft.

Paw Paw River Watershed

Paw Paw

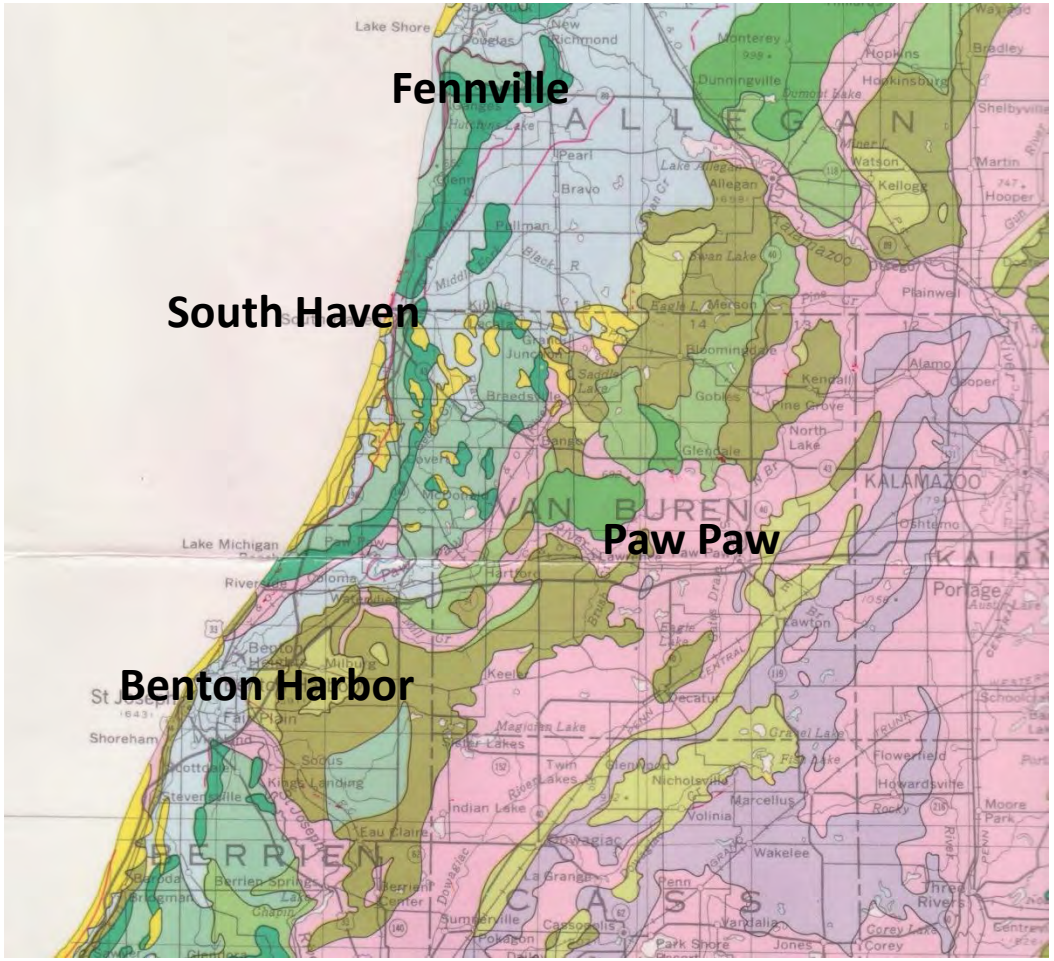
Kalamazoo Moraine
Approx. Elev. 1051 ft.

Watervliet

Benton Harbor

Characterized in the headwaters by glacial end moraine and ice-contact ridges with associated kettle depressions

General Sediment Descriptions



Blue = lacustrine sand

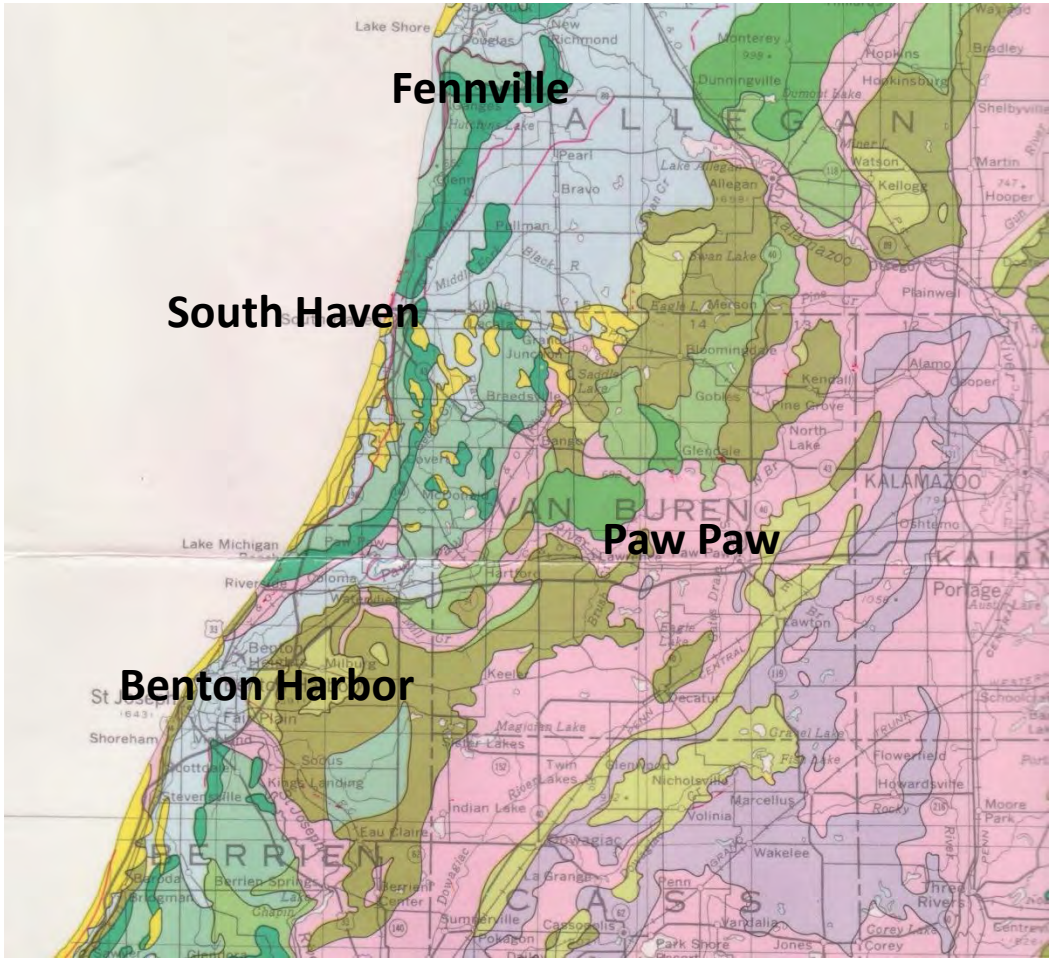
Yellow = dune sand

Greens = moraines

Pink and **Purple** = outwash

General Sediment Descriptions

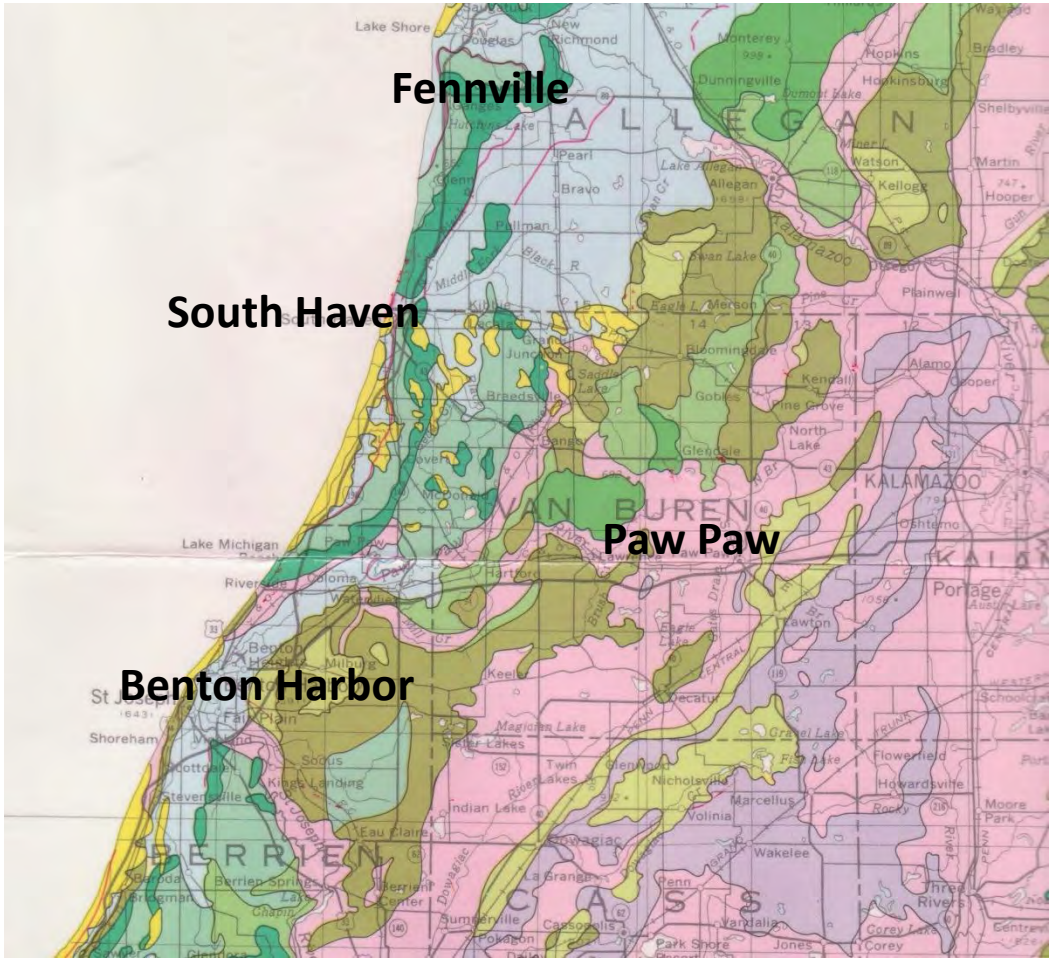
Blue = lacustrine sand



- ***pale brown, to pale-reddish brown, fine to medium sand***
- Commonly includes beds of lenses of gravel
- **Occurs chiefly as former beach and near-offshore littoral deposits of glacial Great Lakes**
- May include lacustrine clay
- Locally veneered by discontinuous sheets or small dunes of eolian sand
- May include considerable areas of organic soil
- 1-30 m thick or more

General Sediment Descriptions

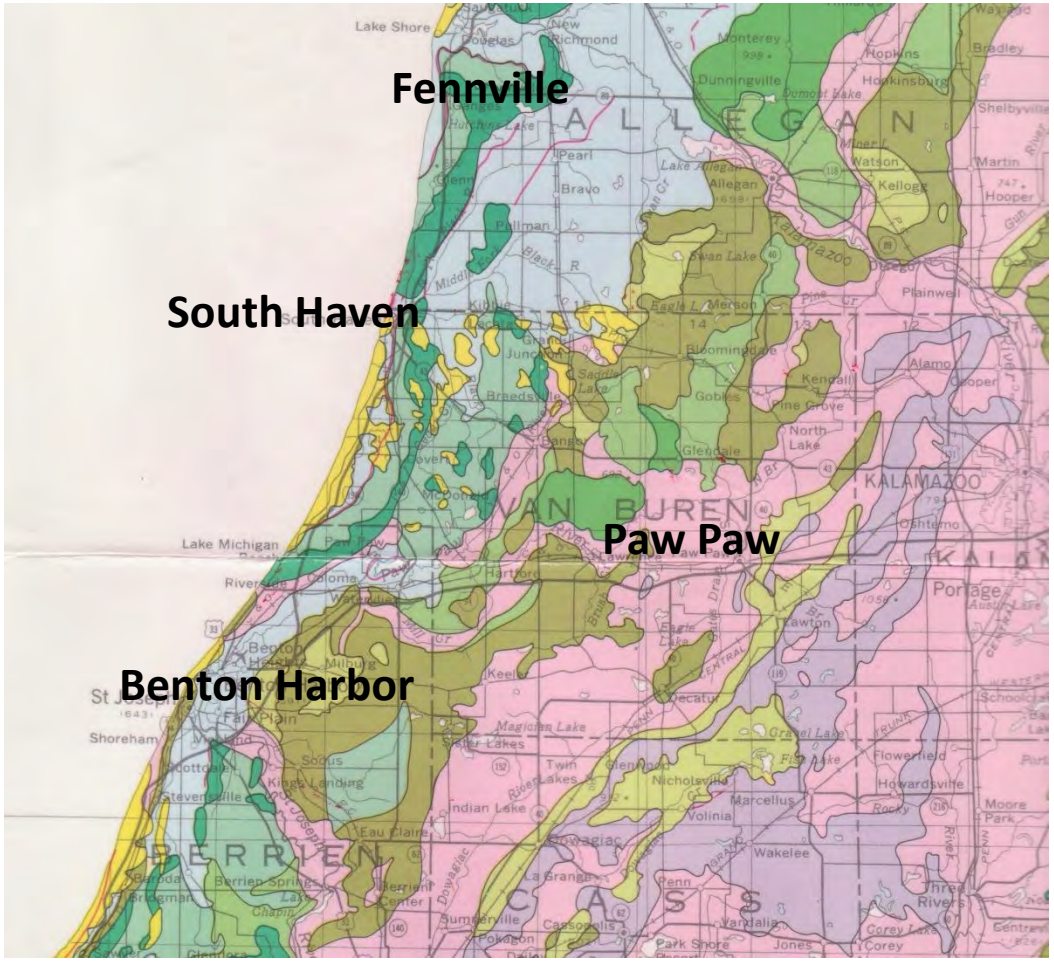
Yellow = dune sand



- ***pale brown, well-sorted, fine to medium sand***
- Chiefly quartz with some heavy minerals
- **Occurs chiefly in massive dune ridges, parallel to present leward shore lines**
- **Also occur as parbolic dunes on former lake and outwash plains**
- Subject to continued movement where vegetation cover is disturbed

General Sediment Descriptions

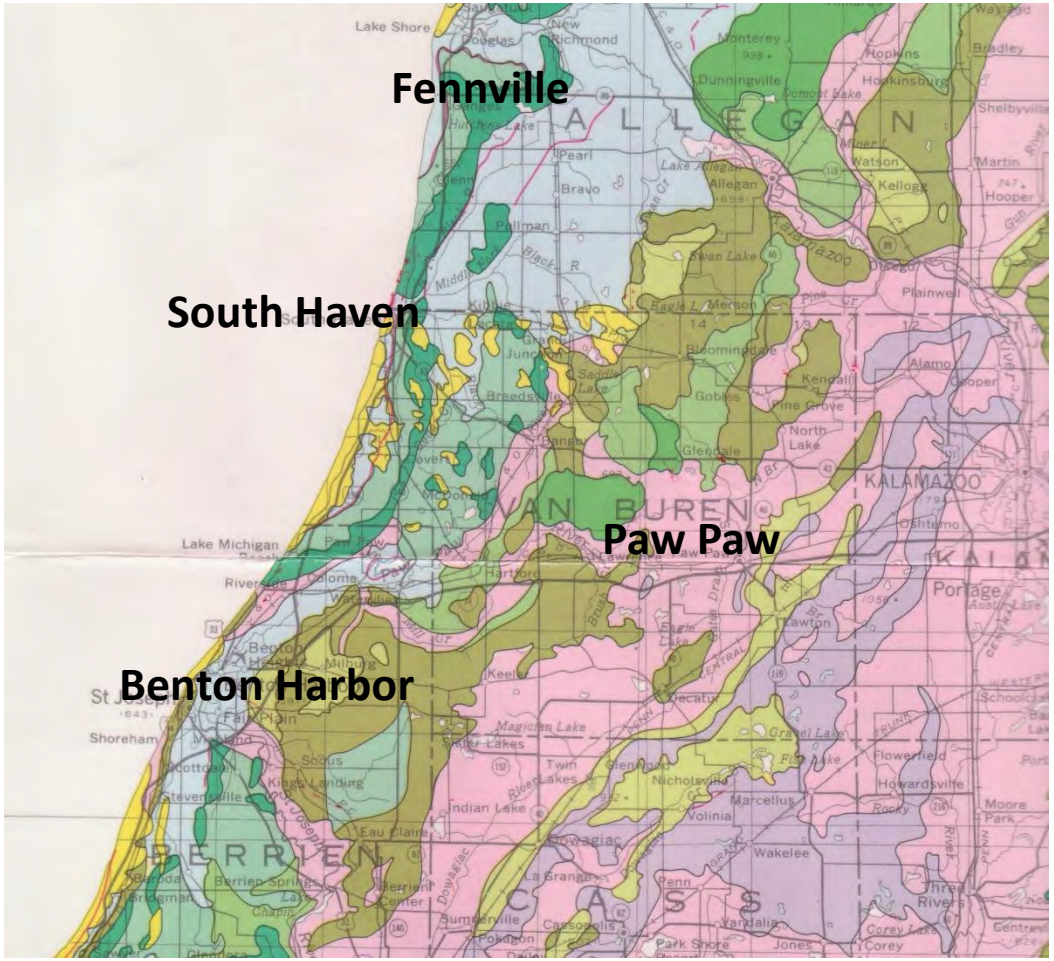
Purple = ice-contact outwash sand and gravel



- pale brown, fine to coarse sand with abundant gravel, cobbles and occasional boulders
- poorly sorted, poorly stratified
- Commonly marked by kettle holes
- 1-30 m thick or more

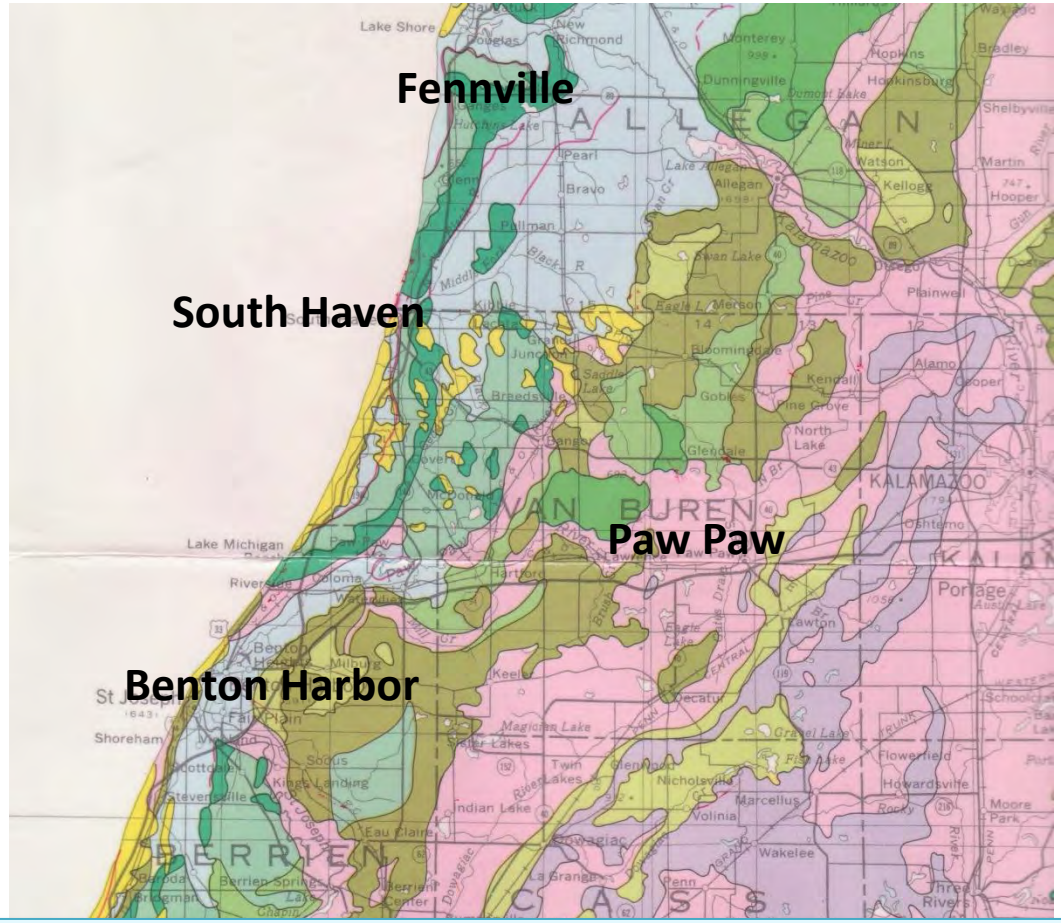
General Sediment Descriptions

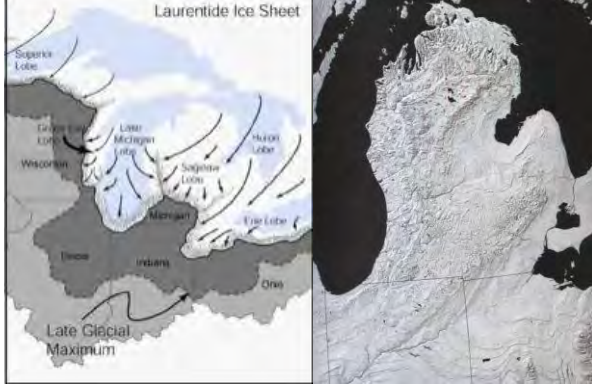
Pink = glacial outwash sand and gravel and post-glacial alluvium



- Pale brown to pale reddish-brown, fine to coarse sand alternating with layers of small gravel to heavy cobbles
- Well to poorly sorted, well stratified
- 1-120 m thick

Dark Green =end moraines of coarse textured till

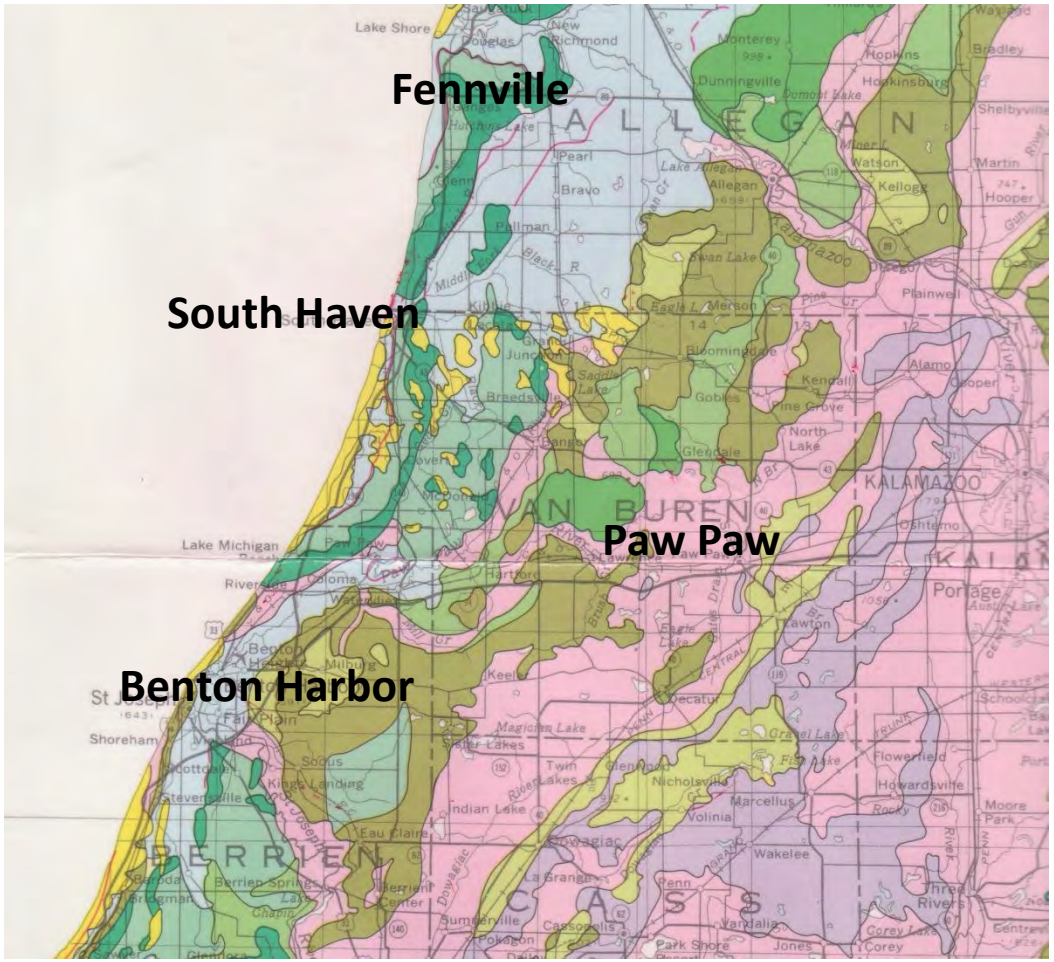




- Gray, grayish brown or reddish brown, non-sorted glacial debris
- Dominately sandy clay loam, sandy loam, or loamy sand texture
- *Mark former still-stands of ice sheet margin*

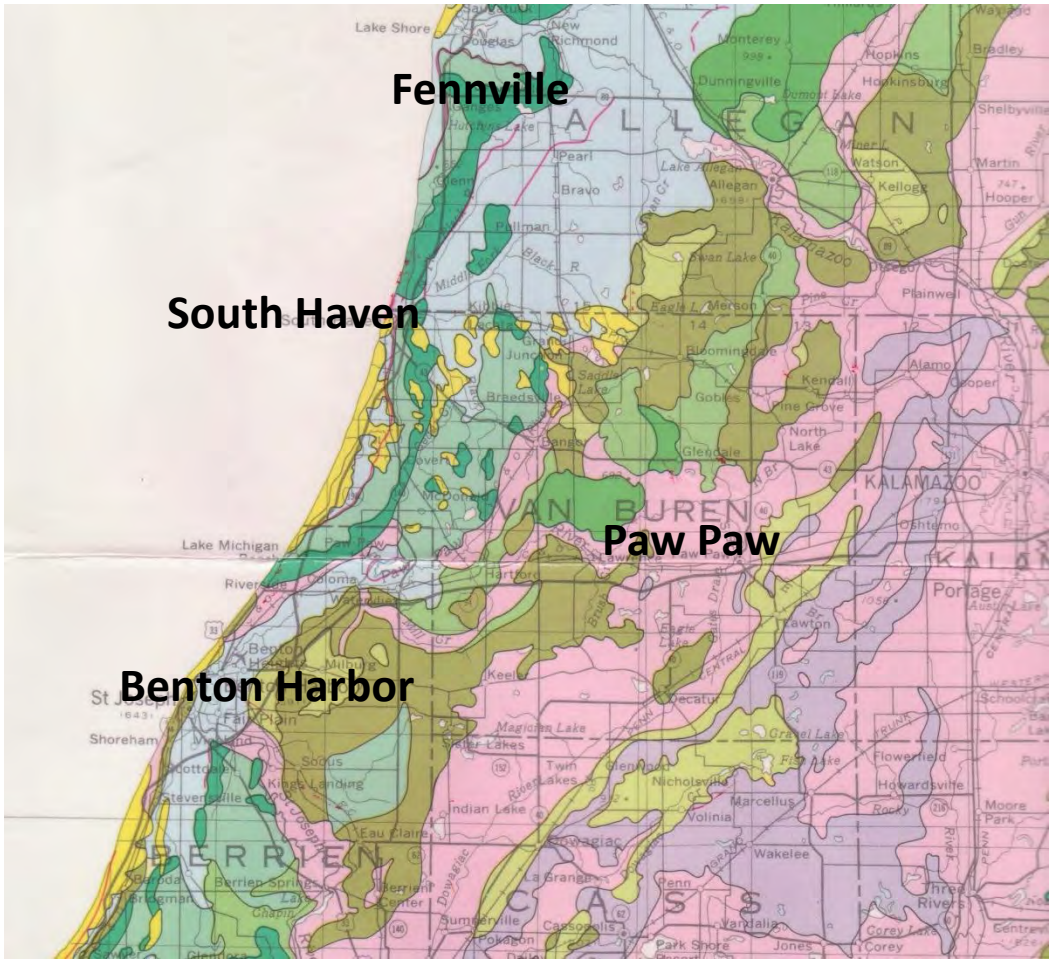
*The coarse textured deposits result in **groundwater contributions** in the headwaters and along certain portions of the mainstem of the rivers as well as depressional storage in the form of wetlands, ponds and small lakes*

Yellow-Green= coarse textured glacial till



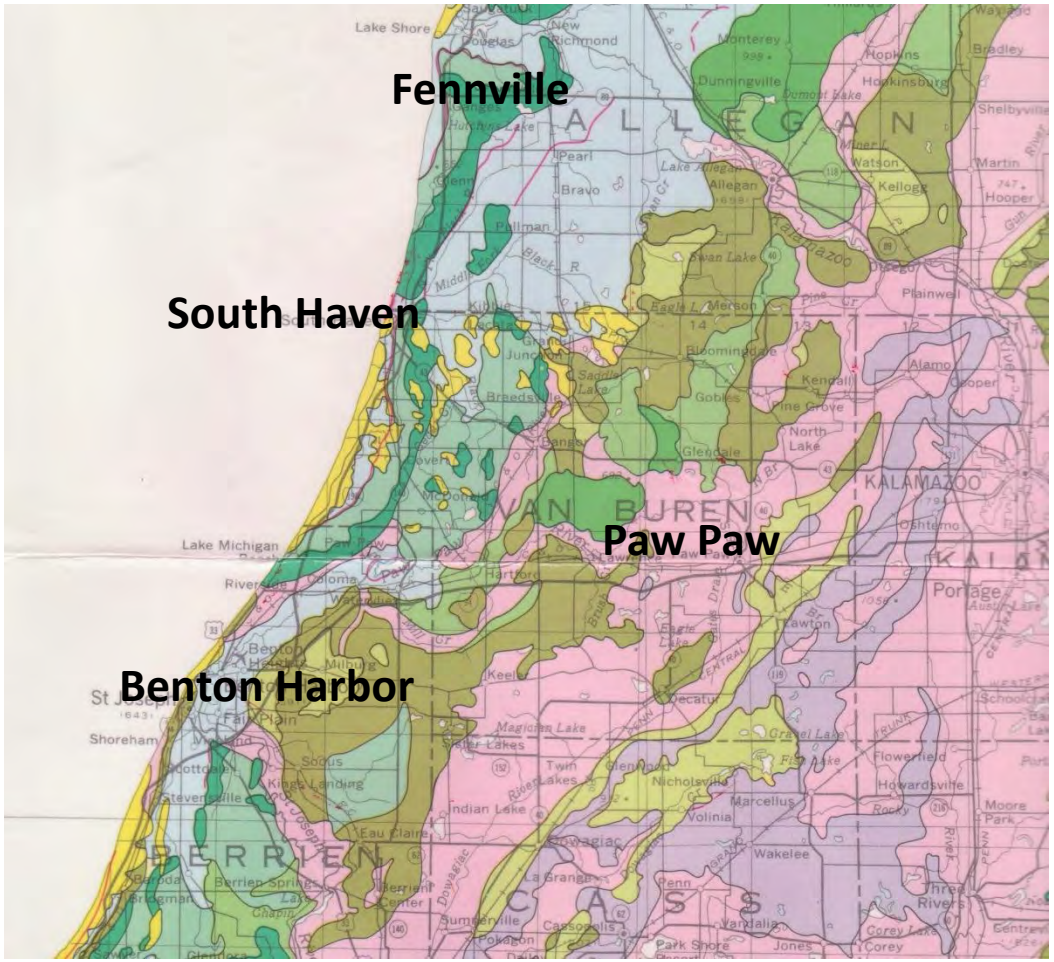
- Gray, grayish brown or reddish brown, non-sorted glacial debris
- Dominately sandy clay loam, sandy loam, or loamy sand texture
  - *Same as dark green but occurs as ground moraine or ground moraine-end moraine complexes*

Bright Green= end moraine of fine-textured till



- Same as other "green" deposits but occurs in narrow belts
- Marks former still-stands of ice sheet margin

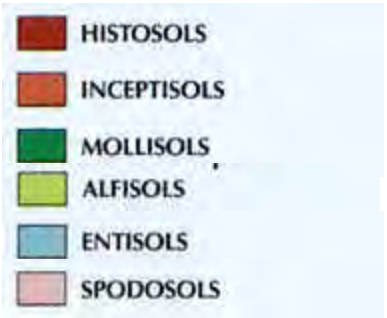
Mint Green= fine-textured glacial till

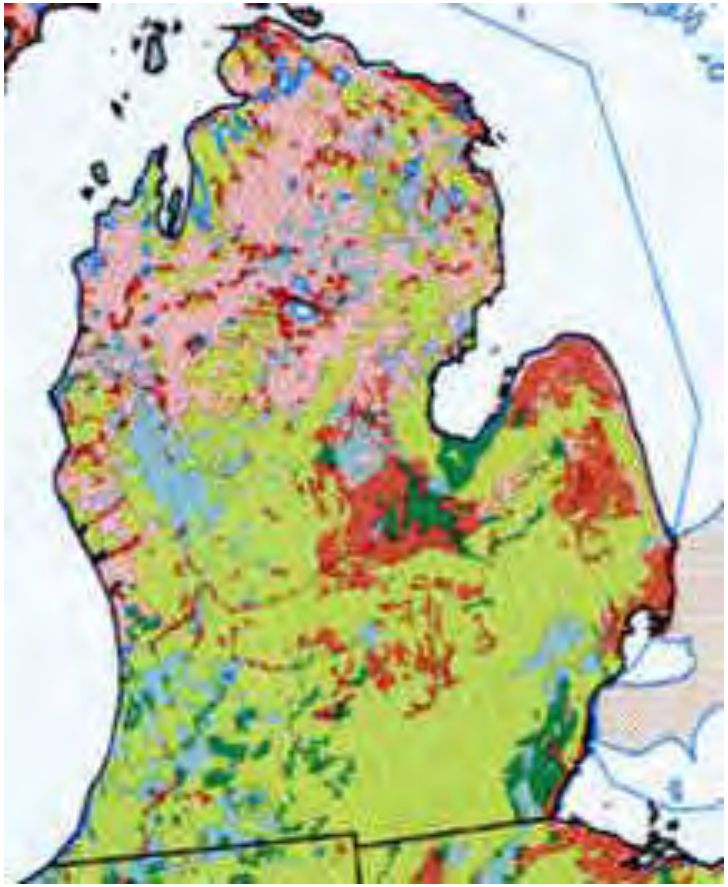


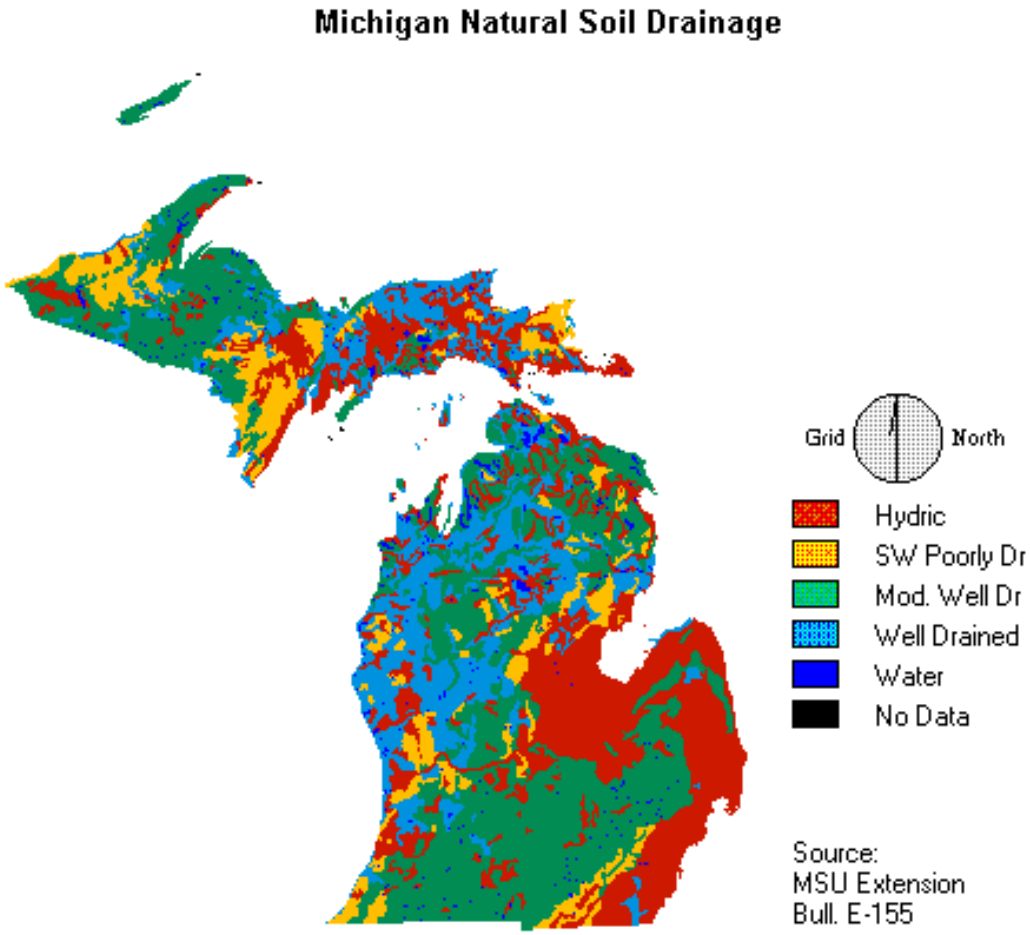
- Same as others but occurs as ground moraine (or till plains)

What do these glacial sediments have to do with our soil properties and what we can do with the land?

Michigan Glaciation and Soils







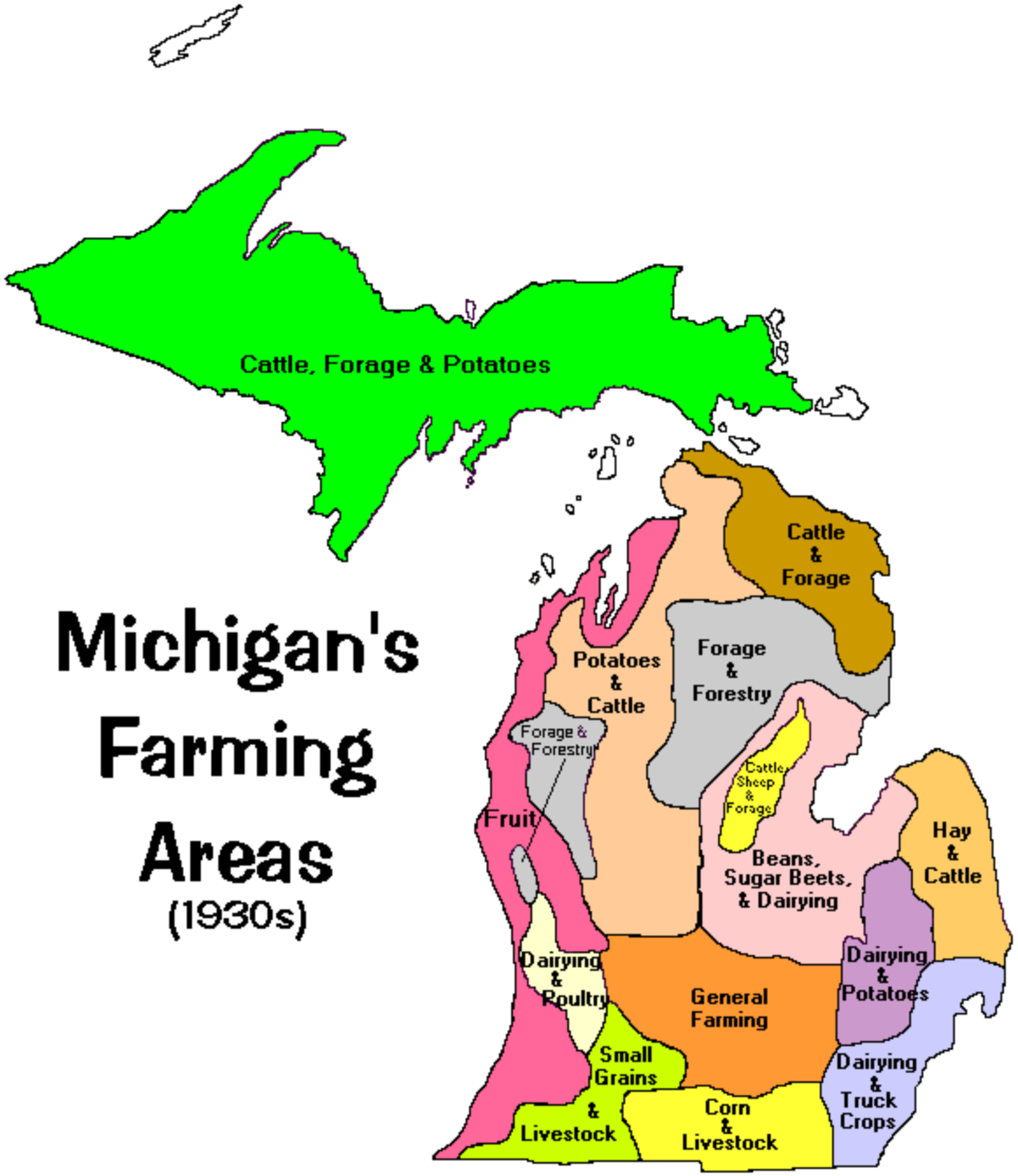
Mollisols- Grassland (base-rich and calcareous and include limestone, loess, or wind-blown sand

Alfisols- Hardwood (Al, Fe rich)

Entisols- unconsolidated sediment

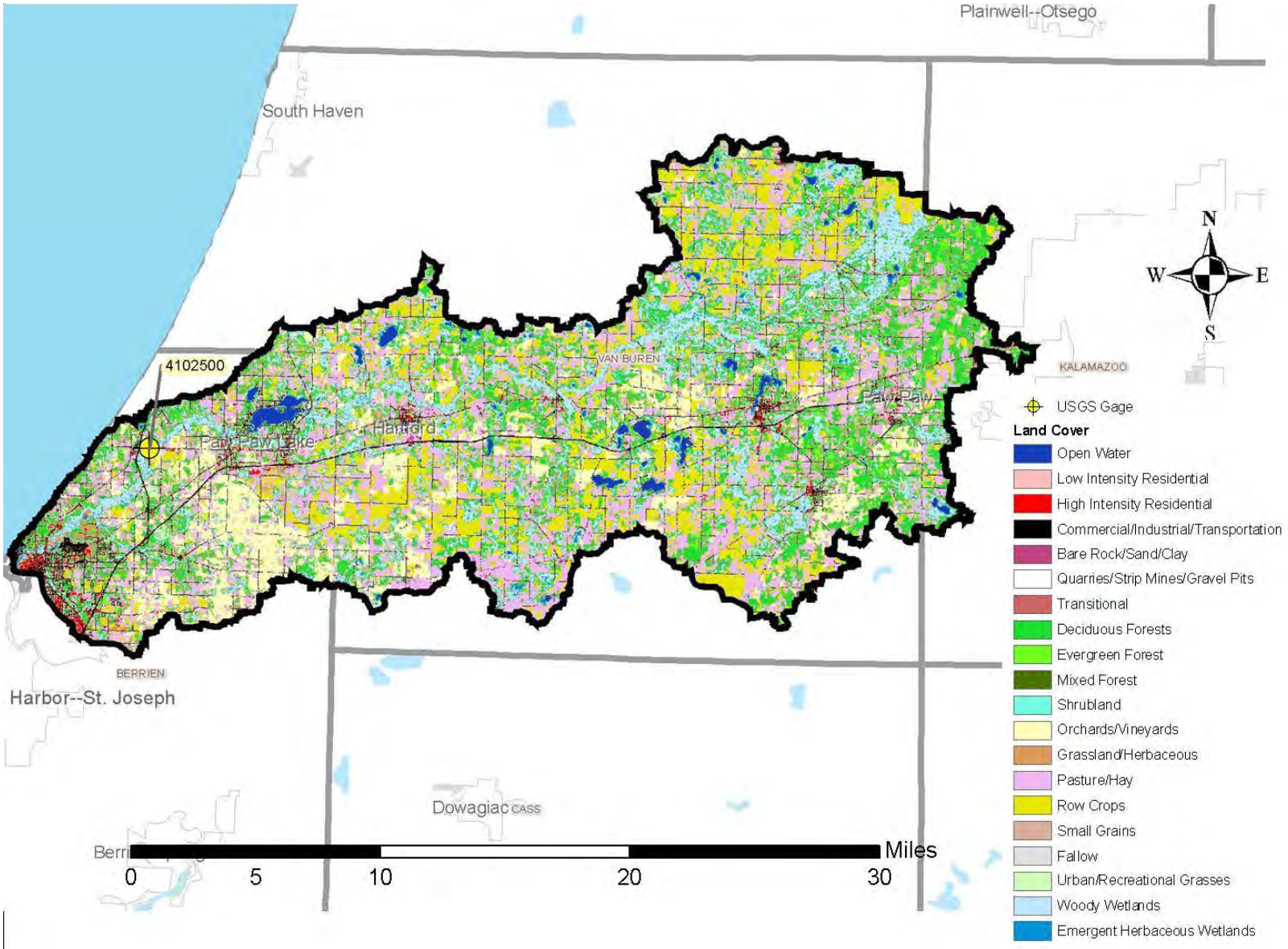
Soil and Agriculture

- Much of the swamp land of Michigan was drained for agriculture.
  - This accounted for the loss of 50% of Michigan's wetlands.



Based on a map from *Michigan History Magazine*, 1938, Vol. 22, p. 316.

Paw Paw River Watershed Landcover



Questions?

Thank You!

References

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