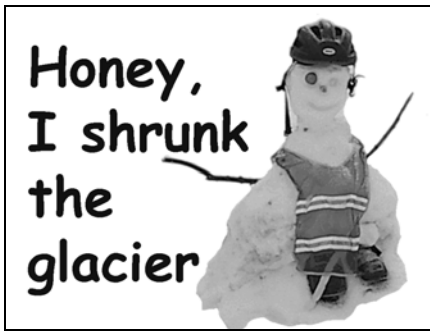

Slide 01



This is the "PowerPoint Companion" for "Honey, I Shrunk the Glacier"

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Steven E. Wilson

MI DEQ OGS

PO Box 30256

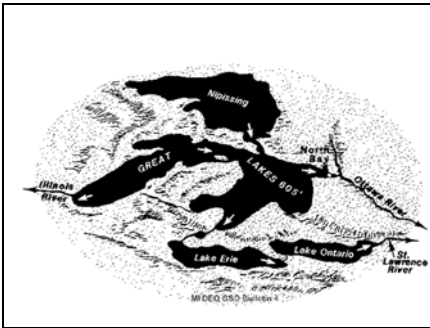
Lansing 48909

email wilsons15@michigan.gov

Resource materials are available on the web.

Digital Image created by Steven E. Wilson, DEQ, OGS

Slide 02

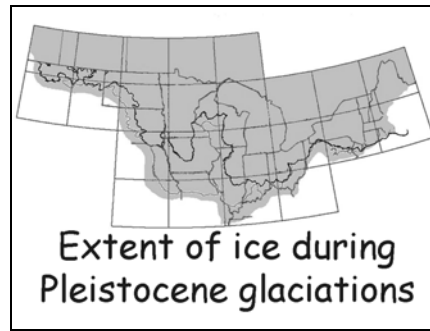


Glaciers have cover Michigan at least four (4) times in the last 1.8 million years. During The last glacial period - called the Wisconsinan glaciation - the massive ice sheet bull dozed most, if not all, of the deposits from the earlier glaciations. The record it left is extensive, interesting and well worth learning more about.

This animation shows (VERY BRIEFLY) the retreat of the Wisconsinan glaciers and some of the resulting lakes and landforms.

Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN: 1988; Farrand, W. R.; Explains the formation of the Great Lakes. Digital image made by Steven E. Wilson, DEQ OGS

Slide 03



This map shows the extent of ice sheet coverage during the Pleistocene glaciations for the northeastern US and adjoining Canada.

Source: U.S. Geological Survey Digital Data Series DDS-38 - Digital Representation of a Map Showing the Thickness and Character of Quaternary Sediments in the Glaciated United States East of the Rocky Mountains

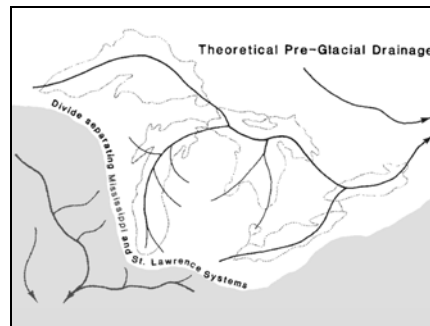
Slide 04



Extent of the Wisconsinan glaciers (in gray maximum advance marked in green) in the Great Lakes area

Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN: 1988; Farrand, W. R. Digital image made by Steven E. Wilson, DEQ OGS.

Slide 05



Michigan was covered by several lobes that extended from a massive ice sheet to the north. The main flow of the glacial lobes followed river drainage systems that existed before the ice advance.

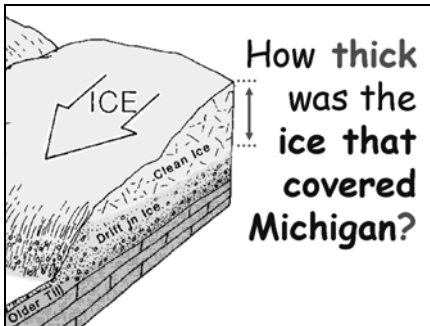
Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN: 1988; Farrand, W. R. Digital image made by Steven E. Wilson, DEQ OGS.

Slide 06

How thick ?

Just how thick was the glacier

Slide 07



There are a variety of estimates. And as you can easily imagine it varied over time. The ice would also be thicker as one progressed toward the north from the southern edge or terminus of the glacier.

In some aspects, glaciers can be compared to pancakes. That is they are thicker in the center, but not by a whole lot. The edges drop off rather quickly. Glaciers would move something like pancake batter - only more slowly. If there is something large enough in the path of pancake batter it will flow around the object - if it does not "pick" it up and move it. Think of it like a half of a peach, a strawberry and a small blue berry. The peach and strawberry would likely stay in place. The blueberry would likely get moved. Keep in mind that glaciers moved LARGE blocks of rock (some the size of a car) as they moved over the land.

Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN: 1988; Farrand, W. R. Digital image made by Steven E. Wilson, DEQ OGS.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

Slide 08

Nobody can say for sure how thick the ice was that covered Michigan during the last glaciation. One could easily assume there was 2 kilometers (~1.25 miles).

Nobody can say for sure just how thick the ice was that covered Michigan during the last glaciation, which is one of the reasons a spreadsheet was developed. One of the basic premises is that you can select or change the thickness you want and the other dependent numbers are recalculated. This is a simple form of data modeling.

I used 2 kilometers (~1.25 miles) an easy number to remember (the numbers are secondary to the underlying ideas).

If one were to scale (or shrink) the 2 kilometers thick glacier to the height of an average person (my number is 1.68 meters ~5 ½ feet {{students can surf the Web to find additional data if that works into your curriculum - or determine the class average}}). Then, how tall would the average person be if they were scaled (or shrunk) the same amount as the 2 km thick/tall glacier? The answer is the thickness of a dime.

If your students are less than 1.68 meters tall they could mark a door jam, or a broom handle, or stack milk cartons, or whatever to equal 1.68 meters just for reference. Even if the "full" 1.68 meters is not used the students can much more readily understand the size or scale of a glacier from a personal perspective. Changing the size of the person does not change the analogy to the dime any appreciable amount.

Source: Honey I Shrank the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 09

Another way to look at 2 kilometers of ice is - how many people would have to stand on each others shoulders to see over the top of the glacier.

Another conversion that does not involve changing shapes or sizes is to calculate how many people would have to stand on each others shoulders to see over the top of the glacier. Using a full 1.68 meters per person it would take 1,200 people. What changes would have to be made to the model to account for the fact that a person who is 1.68 meters tall is not that height at the shoulders. Will it take more or fewer people to make a 2 kilometer high stack of people? Students could measure their height, then measure their height to their shoulders. This is the real or effective height each person adds to the "tower" as they attempt to look over the top of the glacier.

P. S. this is just a mental exercise; this should not be attempted at school or at home.

Source: Honey I Shrank the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial

Slide 10

How would
you figure
this out?

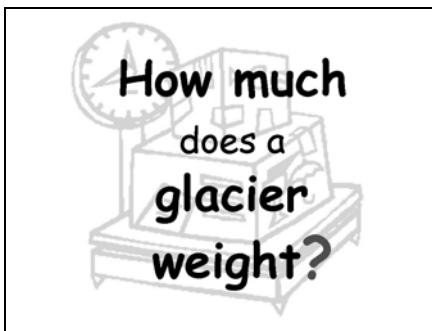
Rhetorical question, please see next slide

Slide 11

How
much ?

Go to the next slide ...

Slide 12



How much did the glacier weigh? For fun I have calculated an average weight and picked a number for the world population multiplied the average weight (another web search project for more/better data) and came up with a weight of the human population.

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan>

(deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 13

What
happens when
water
freezes?

Rhetorical question, please see next slide

Slide 14

Does ice weigh
more or **less**
than the same
amount of
water?

Water is less dense when it freezes. Water is most dense at 4° centigrade.

Slide 15

How much does
a **cubic foot** of
ice weigh?

How much does
a **cubic mile** of
ice weigh?

See the Honey I Shrunk the Glacier spreadsheet

Slide 16

How **thick** was
the glacier?
What was the **length &**
width (area) of the glacier?
Of what was the
glacier **made?**

No one knows for sure but there was at least a 2 kilometer (~1.25 miles) (maybe more) thick blanket of ice that covered Michigan and a lot of north eastern North America.

Slide 17

How would you compare the **weight of a glacier** to the **weight of ... say the population of the world ?**

How much did the glacier weigh? For fun I have calculated an average weight and picked a number for the world population multiplied the average weight (another web search project for more/better data) and came up with a weight of the human population.

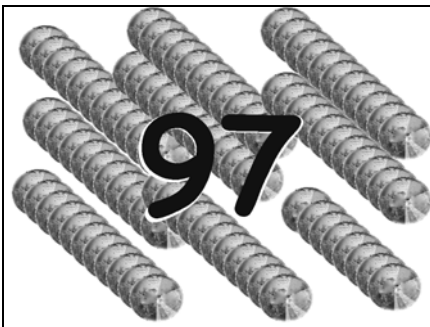
Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well. For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 18



Population of the earth in 2000 was ~6,000,000,000 (six BILLION) people.
digital image created by Steven E. Wilson, DEQ, OGS

Slide 19



If every person weighted 150 pounds it would take 97 populations of the earth standing IN MICHIGAN to equal the weight of the ice in a 2 kilometer thick glacier
digital image created by Steven E. Wilson, DEQ, OGS

Slide 20

Is the **weight of the glacier** that covered Michigan measured in **hundreds, thousands, millions, trillions, quadrillions or quintillions of kilograms (or pounds) ?**

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well. For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 21

What did the weight of the glaciers do to the land it covered?

Talk about glacial rebound.

What evidence do we see for glacial rebound in Michigan?

{elevated beach lines, entrenched streams}

Is rebound the same across the state, if not how does it vary?

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 22

How many ice rinks would the glacier fill?

Additional points to ponder (more story problems) An average ice rink uses 10,000 gallons of water - how many ice rinks would the glacier fill? 10,000 gallons of ice (one ice rink) would make about 82,000 snow cones. How many snow cones could you get from the glacier? How many snow cones is that for each and every person on the earth?

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deggeologyinmichigan> (deg geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 23

How many snow cones could you make from the glacier? (for each and every person on earth)

10,000 gallons of ice (one ice rink) would make about 82,000 snow cones. How many snow cones could you get from the glacier? How many snow cones is that for each and every person on the earth?

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deggeologyinmichigan> (deg geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 24

How big ?

Rhetorical question, please see next slide

Slide 25

How much area did the glaciers cover ?

See maps found in BU 04-R THE GLACIAL LAKES AROUND MICHIGAN: 1988; Farrand, W. R. and or U.S. Geological Survey Digital Data Series DDS-38 - Digital Map Showing the Thickness and Character of Quaternary Sediments in the Glaciated United States East of the Rocky Mountains both available at www.michigan.gov/deggeologyinmichigan

Slide 26

According to the **National Snow and Ice Data Center (NSIDC)**, if all glaciers melted today the seas would rise about **70 meters** (about 230 feet).

Information is on the slide

Slide 27

During the last ice age, **glaciers covered more land area than today, sea level was about 400 feet lower than it is today.** At that time, glaciers covered almost one third of the land.

Information is on the slide

Slide 28

During the last **warm spell, ~125,000 years ago**, the seas were about **6 meters** (~18 feet) **higher** than they are today.

Information is on the slide

Slide 29

About **three million years ago** the **seas** could have been up to **55 meters** (~165 feet) **higher**.

Information is on the slide

Slide 30

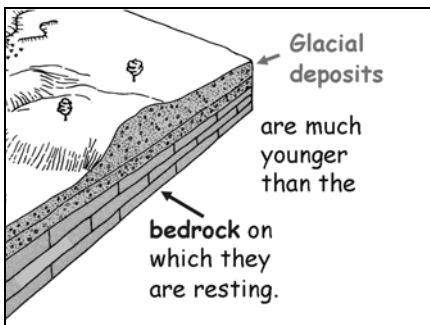
How did the glacier retreat?

How did the glacier retreat? - one swift move to the north - a complex set of advances and retreats over time - what did that do to what are now the great lakes?

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft Excel spreadsheet as well.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 31



The concept of geologic time
Student activity

What is the age of the bedrock in your area? What is the age of the glacial deposits? What is the difference in the ages?

Source: Honey I Shrunk the Glaciers - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were. Explanatory text for the Microsoft

Excel spreadsheet as well.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) - Resources about glaciers in Michigan are found under "Glacial Lakes around Michigan"

Slide 32

How thick is the glacial material in **your** area of the state?

What is the drift thickness in the state, in your area? How would you find out? {from water well records, oil & gas well records, drift thickness maps} records you can get to on-line include:

<http://dwrp.deq.state.mi.us/wellogic/>

-- online DATABASE of water well data

<http://www.deq.state.mi.us/well-logs/default.asp>

-- water well records as PDFs

<http://www.deq.state.mi.us/mir/>

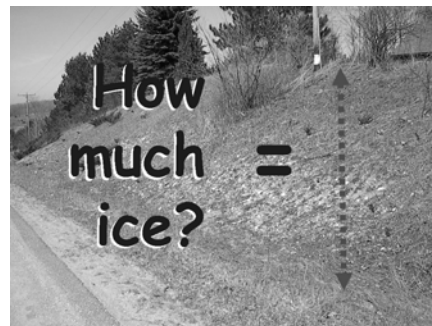
-- Oil and Gas Data base

Slide 33

How much 'stuff' (sands, gravels & clays) was carried by the glaciers?

Rhetorical question, please see next slide

Slide 34



How much stuff was carried by the glaciers? What if 1 % of the glacier was sand gravel clay boulders etc - how much material would be left behind?

5280	feet / mile
------	-------------

How would you add this to our model?

12	63,360	inches / mile
1.25	79,200	inches of glacier
1%	792	inches
12	66	feet ~ 20 meters

Source: Honey, I Shrunk the Glacier - Digital image made by Steven E. Wilson, DEQ OGS.

Slide 35

How
would **you**
find out?

See information for slide 34

Slide 36

What is the **drift
thickness** in the
state, in your
area?

What is the drift thickness in the state, in your area? How would you find out? (from water well records, oil & gas well records, drift thickness maps) records you can get to on-line include:

<http://dwrp.deq.state.mi.us/wellogic/>

online DATABASE of water well data

<http://www.deq.state.mi.us/well-logs/default.asp>

water well records as PDFs

<http://www.deq.state.mi.us/mir/>

Oil and Gas Data base

Slide 37

How much
material
was in the
glacier?

Slide 38

When?
Were there glaciers?

Rhetorical question, please see next slide

Slide 39

Multiple **glacial
events** are
recorded in the
geologic record.

Information is on the slide

Slide 40

Geologic age	millions of years ago
• Pleistocene	3
• Permian	250-220
• Ordovician	450
• Precambrian	900-650
	2,300

Information is on the slide

Slide 41

Which **glacial
period** has the
**most complete
geologic record?**

Please go to the next slide

Slide 42

The most recent glaciation - The one that occurred during the Pleistocene

Information is on the slide

Slide 43

Why study glaciers ?

Rhetorical question, please see next slide - WHY is a good question to ask (often).

Slide 44



The glaciers left a number of very valuable resources in the form of clays, sands and gravels.

Source: left image: ECONOMIC GEOLOGY of the SAND and SANDSTONE RESOURCES of MICHIGAN; Geological Survey Division, Report of Investigation 21, By E. William Heinrich
image right side image: digital image created by Steven E. Wilson, DEQ, OGS

Slide 45

Uses
Amount
Value

Rhetorical information is on the slide

Slide 46

Uses
Construction
concrete and mortar
road and roadbed construction
asphalt
construction fill and landscaping
concrete blocks
bricks & pipes
shingles
treating icy roads
railroad ballast
water filtration
glass
abrasive sand
foundry sand (molded metal parts)

Specific percentages on the uses of construction sand and gravel are not available. This is because a little more than 50% of the sand and gravel consumed for construction is for "unspecified" purposes. However, it is reported that the remaining 50% is used to make concrete, for road construction, for mixing with asphalt, as construction fill, and in the production of construction materials like concrete blocks, bricks, and pipes. It is also used to make roofing shingles, on icy roads in the winter, railroad ballast and water filtration. Industrial sand and gravel is used to make glass (39%), as foundry sand (22%), as abrasive sand (5%). The remaining 34% is used for an assortment of other uses.

Substitutes and Alternative Sources

Crushed stone is an alternative material for construction applications.

There are suitable substitutes for blasting (abrasive) sand, foundry and refractory applications, but not for glass making. The use of sand and gravel as a commodity falls into two separate categories. Some is used in construction where it may be mixed with other materials or used as is. The second use is industrial where the sand and gravel are used in some way in the production of other materials. Because so much sand and gravel is consumed in each category, the United States Geological Survey (USGS) keeps track of sand and gravel consumption in these two separate categories.

Slide 47

Amount
76,900,000
metric tons
Value
\$ 293,000,000
annually

One can easily see that a LOT of sand and gravel is removed from the state and that it have a significant value. The value reported is for material sold not the value of what was made with it or the jobs created ...

Based on 2001 information from the USGS Minerals Yearbook: The Mineral Industry of Michigan

Slide 48

Lets review
the geology
of Michigan

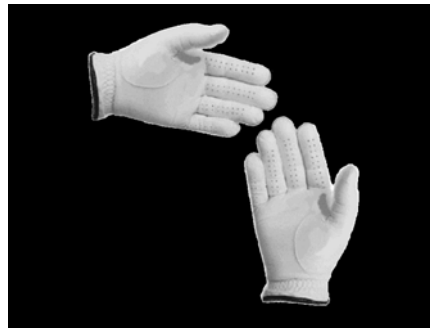
Go to next slide

Slide 49

Everyone knows
what the map
of Michigan
looks like

We should take a little bit of time discussing some general concepts of the Geology in Michigan.
One place to start is with geologic maps.

Slide 50



It is easy to spot a Michigander - especially when asked, "Where do you live?"

Lets look at a different kind of map ...

For more information about the Geology in Michigan - - go to

<http://www.michigan.gov/deqgeologyinmichigan>

(deq geology in michigan - all lowercase - no spaces) -

A sampling of the files that might be of interest:

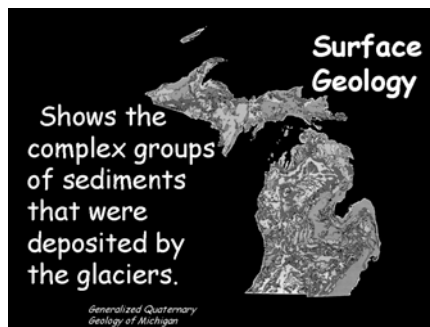
Explanation of Geologic Maps - What are these maps trying to show?

Generalized Maps Geology in Michigan brief - The quick and easy explanation of the geologic history of our State. Good for general audiences

Geology in Michigan - The geology of the state in more detail. Good for more advanced audiences.

Source: Digital image made by Steven E. Wilson, DEQ OGS from Microsoft clipart.

Slide 51



Glacial or Quaternary Geology is what we see across most of the state. What we see are glacial landforms mad of sands, gravels and clays left by the retreating glaciers

Source: "QG 01 QUATERNARY GEOLOGY OF MICHIGAN"; 1982; Farrand, W. R.; Colored "surface geology" of the State. Includes both peninsulas, 1:500,000, 2 sheets. Digital image made by Steven E. Wilson, DEQ OGS.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan>

(deq geology in michigan - all lowercase - no spaces) -

A sampling of the files that might be of interest:

Explanation of Geologic Maps - What are these maps trying to show?

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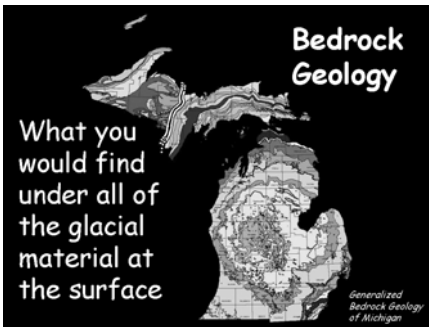
Slide 52



If we remove all of the glacial sands, gravels and clays we don't have a blank ...

Digital image made by Steven E. Wilson, DEQ OGS.

Slide 53



What we have is the bedrock geology - what you would see if you removed all of the glacial sands, gravels and clays. The colors would be different but the pattern would be very close to what you see here.

Source: "BG 01 BEDROCK GEOLOGY OF MICHIGAN", 1987; Wilson, S. E.; Colored map of the aerial extent of geologic formations. Includes both peninsulas; 1:500,000, 2 sheets. Digital image made by Steven E. Wilson, DEQ OGS.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) -

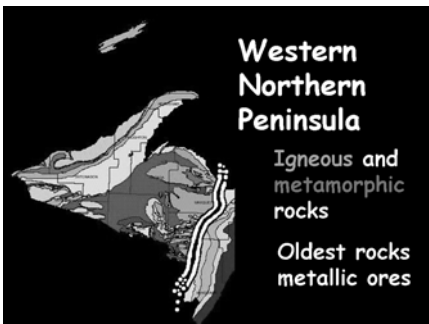
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Slide 54



This shows the western northern ("upper") peninsula in more

detail. This is where we find igneous and metamorphic rocks as major components of the bedrock. There are also ancient sedimentary rocks as well. These are the geologically oldest rocks in the state, many measured in BILLIONS of years, not just millions.

Some of the most complex geology in the state is in this area. This is where the Metallic mines are located. The copper mines are found in the Keweenaw Peninsula while the banded iron formations are found in several areas. Other ore deposits exist in the area as well.

The Value of the iron and copper deposits have meant more to the State and National economies than the infamous "gold rush" in California.

Source: "BG 01 BEDROCK GEOLOGY OF MICHIGAN", 1987; Wilson, S. E.; Colored map of the aerial extent of geologic formations. Includes both peninsulas; 1:500,000, 2 sheets. Digital image made by Steven E. Wilson, DEQ OGS.

Slide 55



The eastern northern peninsula and all of the southern peninsula are made up of sedimentary rocks. These rocks formed in what is called the Michigan Basin. These sedimentary rocks hold the vast and varied non-metallic resources of our state. These include: limestone and dolomite, shale, sandstone, gypsum and rock salt. One commonly overlooked resource is oil and gas - more about that later. Source: "BG 01 BEDROCK GEOLOGY OF MICHIGAN", 1987; Wilson, S. E.; Colored map of the aerial extent of geologic formations. Includes both peninsulas; 1:500,000, 2 sheets. Digital image made by Steven E. Wilson, DEQ OGS.

Slide 56



To better understand what the Michigan basin is, let's look at just the southern peninsula.

Let's tilt it (gently),

(click) Let's use the super saw to cut it into four pieces (~quarters),

(click) Let's separate the pieces,

(click) Let's add in the pattern that is revealed (primarily from oil & gas) geologic records,

(click) And with a dash of color we can see why there is a

circular pattern to the rocks.

The youngest rocks in the state (Jurassic) are found in the center of the southern peninsula. As one moves away in any radial direction from the "center" the bedrock one might encounter is progressively older and older (eventually to Cambrian age rocks in the northern peninsula (and elsewhere out state)). The rocks are all tilted or dipping toward the center like a collection of nested bowls or measuring cups. Geologically, such structures are called basins. Source: "BG 01 BEDROCK GEOLOGY OF MICHIGAN", 1987; Wilson, S. E.; Colored map of the aerial extent of geologic formations. Includes both peninsulas; 1:500,000, 2 sheets. And illustration by D. Bell in Door and Eschman, "Geology of Michigan". Digital images made by Steven E. Wilson, DEQ OGS.

Slide 57

Glacial landforms in Michigan

Almost all of what we see on the surface of our great state - the landforms - are the results of glacial activity.

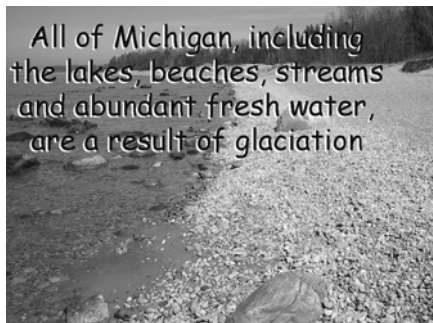
Slide 58



What the earth around Michigan might look like from space on a day without clouds, fog or smog.

Source Michigan Department of Environmental Quality (deq) poster

Slide 59



Source: Digital image made by Steven E. Wilson, DEQ OGS.

Slide 60

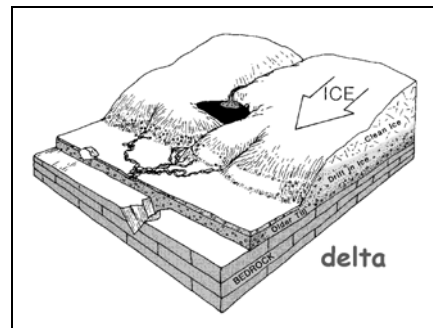
{CLICK} When you click on the mouse, a block diagram of a glacial feature found in Michigan will appear.

{CLICK} When you click on the mouse a second time the name of that feature will appear in the lower right corner of the slide. This was done to help you become familiar with the terms and what they mean

This is meant as a review for students

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces) -

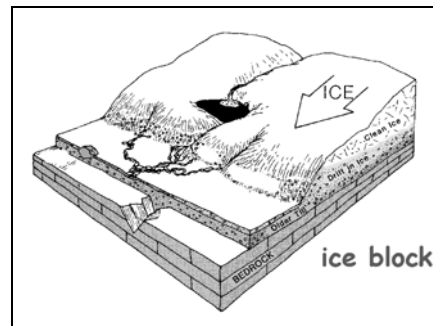
Slide 61



Delta - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

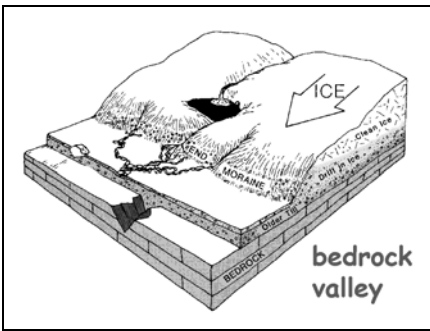
Slide 62



Ice block - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

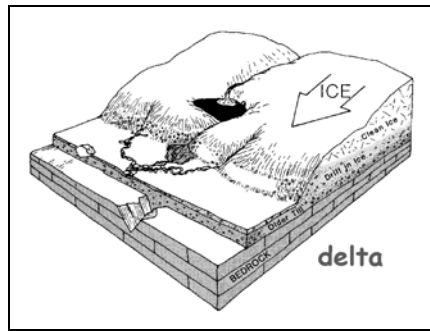
Slide 63



Bedrock valley - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

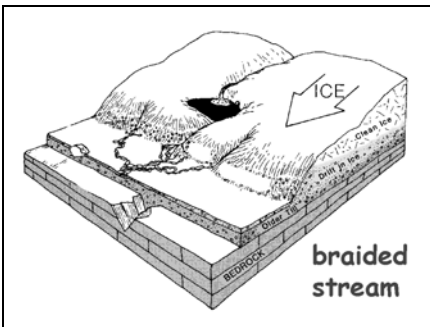
Slide 66



Delta - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

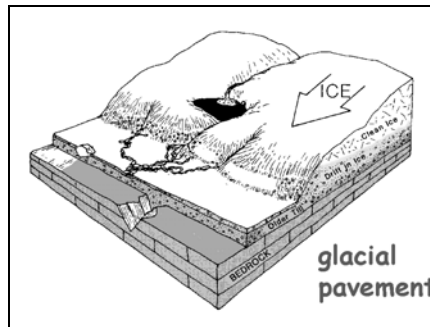
Slide 64



Braided stream - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

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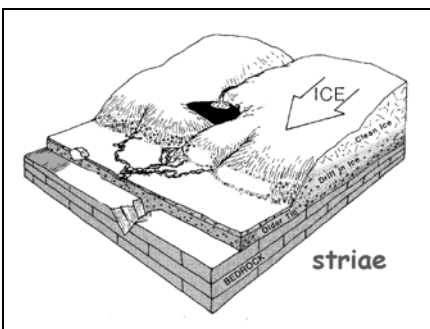
Slide 67



Glacial pavement - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

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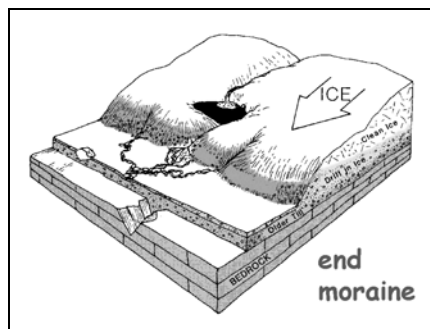
Slide 65



Striae - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

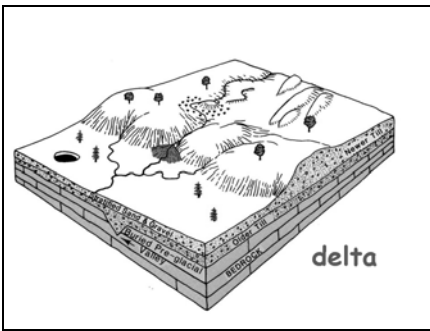
Slide 68



End moraine - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

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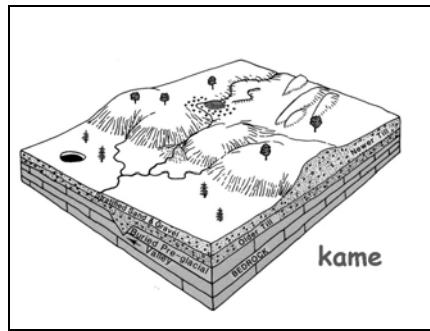
Slide 69



Delta - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

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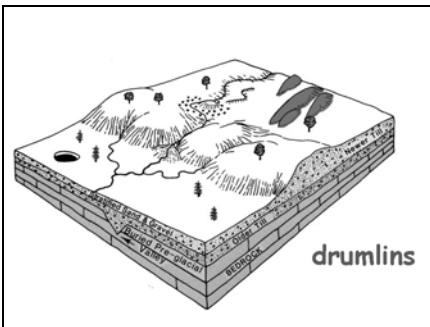
Slide 72



Kame - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

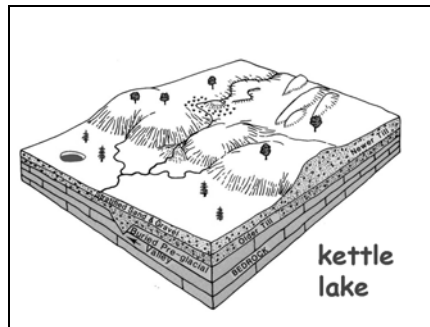
Slide 70



Drumlins - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

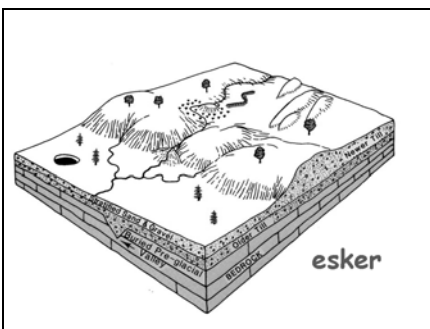
Slide 73



Kettle lake - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

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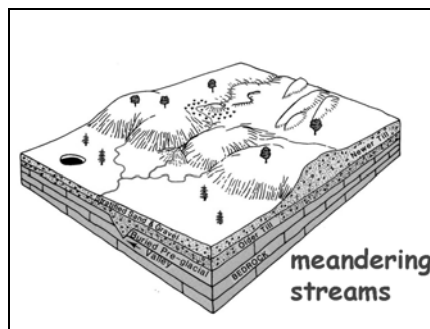
Slide 71



Esker - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - - go to <http://www.michigan.gov/deqgeologyinmichigan> (deq geology in michigan - all lowercase - no spaces)

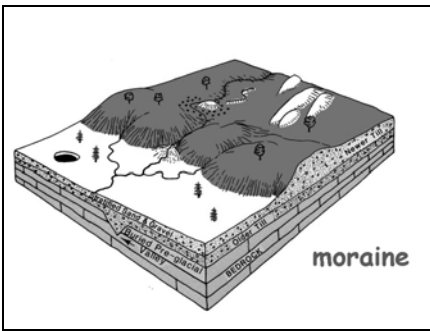
Slide 74



Meandering streams - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

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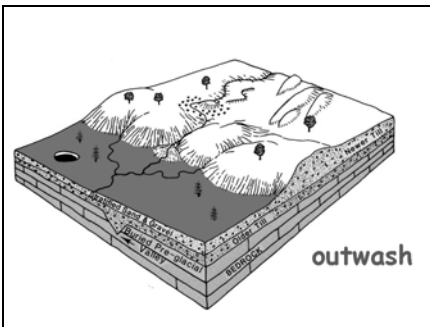
Slide 75



Moraine - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deggeologyinmichigan> (deg geology in michigan - all lowercase - no spaces)

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Outwash - Source: Adapted from, BU 04-R THE GLACIAL LAKES AROUND MICHIGAN Digital image made by Steven E. Wilson, DEQ OGS based on BU 04.

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deggeologyinmichigan> (deg geology in michigan - all lowercase - no spaces)

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See how many glacial landforms you can find in your area of the state.

See how many glacial landforms you can see on your next trip.

Rhetorical question -

For more information about the Geology in Michigan - go to the Digital Geology Library

<http://www.michigan.gov/deggeologyinmichigan> (deg geology in michigan - all lowercase - no spaces)

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Please forward any ideas, feedback, comments, suggestions, tips, tricks, traps, alterations, permutations, variations, changes, deletions, and / or additions to Steven E. Wilson, MI DEQ OGS, PO Box 30256, Lansing 48909 email wilsons15@michigan.gov

For more information about the Geology in Michigan - go to <http://www.michigan.gov/deggeologyinmichigan> (deg geology in michigan - all lowercase - no spaces)

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References on the WEB slide 1 of 2

For more information about the Geology of Michigan - go to www.michigan.gov/deggeologyinmichigan to access:

Glacial Lakes around Michigan - BU 04 Glacial Lakes around Michigan

BU 04 **Glacial Lakes Flip Book** - Student activity to 'animate' glacial movement across the state. Cut out the illustrations, stack 'em, staple 'em and watch the glaciers move.

BU 04 **Glacial Lakes Illustrations** - Illustrations from Glacial Lakes around Michigan full page size for student use and reference.

Honey, I Shrunk the Glacier - An exercise in modeling, scaling and coming to grips with How thick, How big, and How much the glaciers were.

How thick, How big, How much - You can printout and use the sheets as is or have the students discover or modify them to suit their interests.

Information on slide

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References on the WEB slide 2 of 2

For more information about the Geology of Michigan -- go to www.michigan.gov/deqgeologyinmichigan to access:

1982 Glacial Geology Map - A map showing the surface of the State as seen by geologists, based on QG 01 "Quaternary Geology of Michigan"

1987 Bedrock Geology Map - The Bedrock Geology of Michigan

2001 Oil & Gas Map - A map showing the distribution of Oil & Gas wells.

Explanation of Geologic Maps - What are these maps trying to show?

Generalized Maps - A grouping of maps - hopefully to make it easier to select the one(s) you want.

Geology of Michigan brief - The quick and easy explanation of the geologic history of our State. Good for general audiences

Geology of Michigan - The geology of the state in more detail. Good for more advanced audiences.

Information on slide

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References

Michigan Geological Survey

the following were used in preparing this presentation

BG 01 BEDROCK GEOLOGY OF MICHIGAN", 1987; Wilson, S. E.

BU 04-R THE GLACIAL LAKES AROUND MICHIGAN: 1988; Farrand, W. R.

QG 01 QUATERNARY GEOLOGY OF MICHIGAN"; 1982; Farrand, W. R.

Information on slide

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References U.S. Geological Survey

U.S. Geological Survey **Minerals**

Yearbook: The Mineral Industry of Michigan

U.S. Geological Survey **Digital Data**

Series DDS-38 - Digital Map Showing the Thickness and Character of Quaternary Sediments in the Glaciated United States East of the Rocky Mountains

Information on slide