

Wisconsin's Aquifers

David Hart



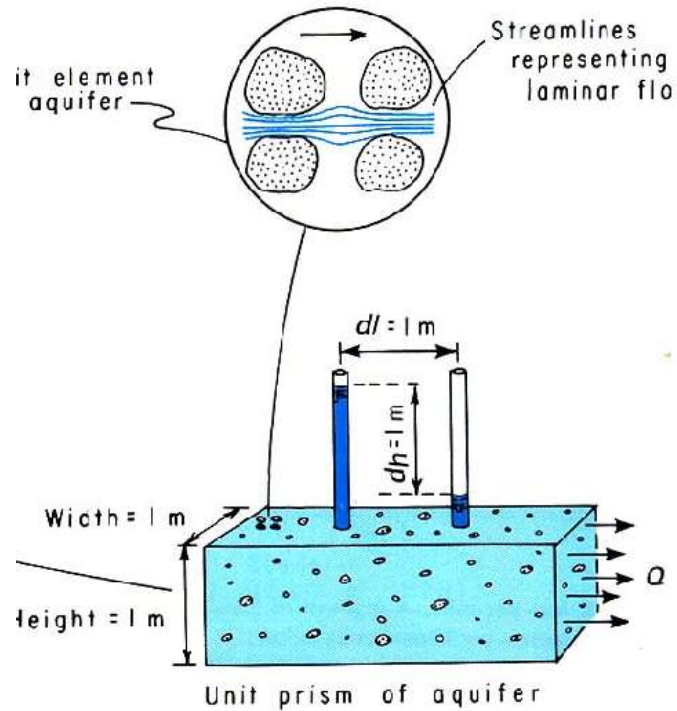
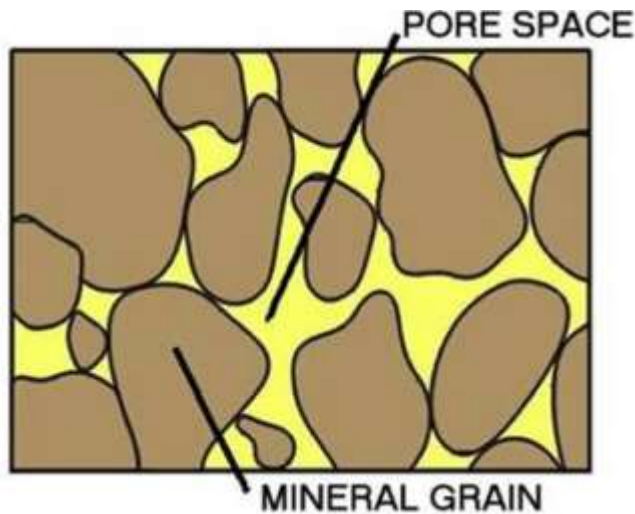
Wisconsin Geological and Natural History Survey

Researching, mapping, and reporting on
Wisconsin's rocks, soils, and groundwater

Objectives

- Understanding of Wisconsin's different aquifers.
 - The different rocks and sediments have different flow properties.
 - Wisconsin's geology controls the availability of groundwater.

Different rocks and sediment have different hydraulic properties



(1)

Porosity – percent of void spaces in rock or sediment

Hydraulic conductivity - the ease with which water can move through pore spaces or fractures

Different rocks and sediment have different hydraulic properties

- Sandstone – \uparrow porosity, \uparrow conductivity



- Shale – \uparrow porosity, \downarrow conductivity



- Dolomite – \downarrow porosity, \uparrow conductivity (fractures)



- Crystalline Bedrock – \downarrow porosity, \downarrow conductivity



BEDROCK GEOLOGY OF WISCONSIN

UNIVERSITY OF WISCONSIN-EXTENSION
Geological and Natural History Survey

APRIL 1981
REVISED 2005

EXPLANATION

DEVONIAN

D dolomite and shale

SILURIAN

Sd dolomite

ORDOVICIAN

- On** Maquoketa Formation—shale and dolomite
- Ds** Sinnipee Group—dolomite with some limestone and shale
- Du** St. Peter Formation—sandstone with some limestone shale and conglomerate
- Dpc** Prairie du Chen Group—dolomite with some sandstone and shale

CAMBRIAN

C sandstone with some dolomite and shale

MIDDLE PROTEROZOIC

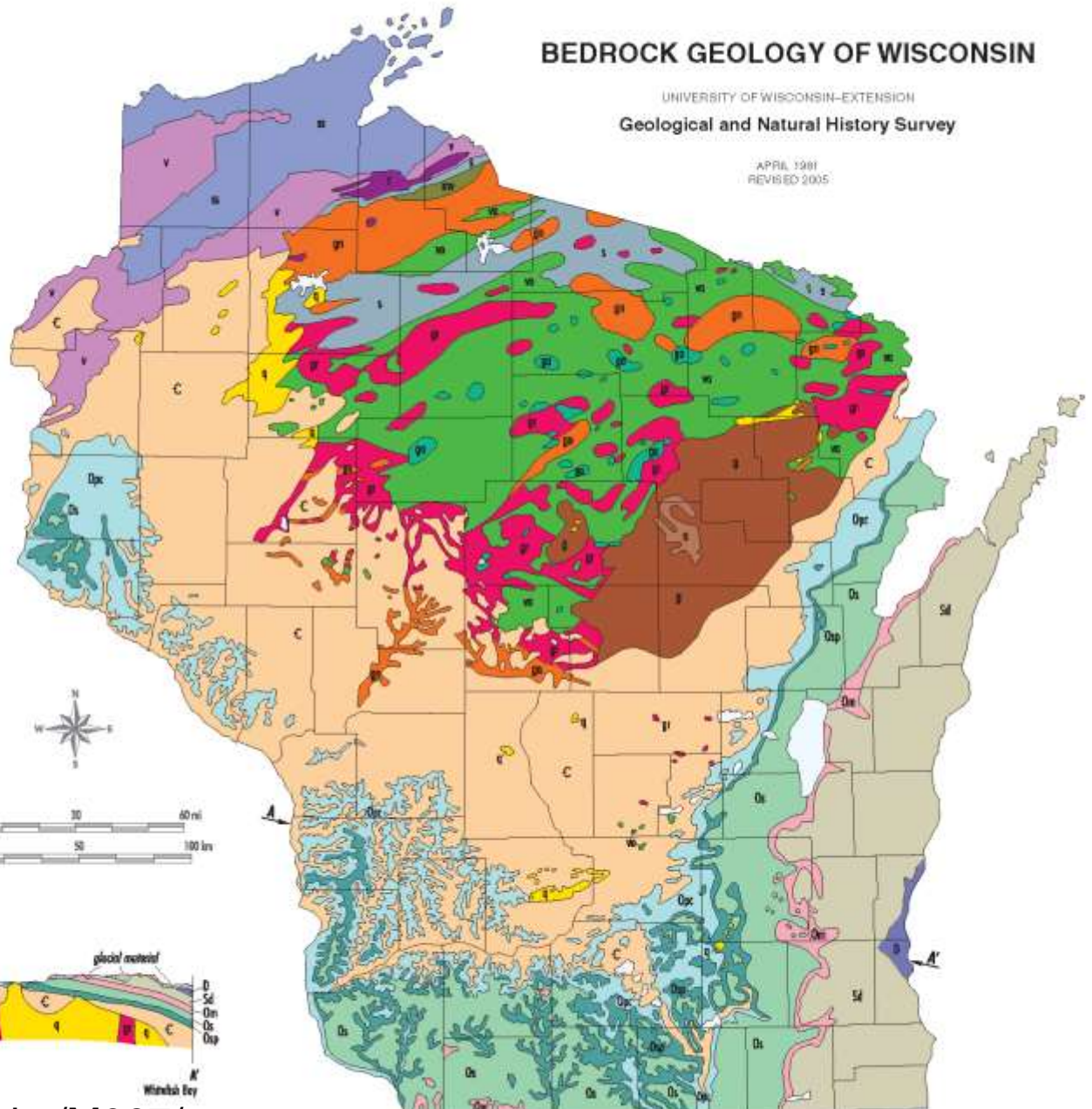
- Keweenaw rock—**
- ss** sandstone
- v** basaltic to rhyolitic lava flows
- t** gabbroic, anorthositic and granitic rock
- Wolf River rock—**
- g** rapakivi granite, granite, and syenite
- s** anorthosite and gabbro

LOWER PROTEROZOIC

- q** quartzite
- g** granite, diorite, and gneiss
- s** metasedimentary rock, argillite, siltstone, quartzite, greywacke, and iron formation
- vo** basaltic to rhyolitic metavolcanic rock with some metasedimentary rock
- gm** meta-gabbro and hornblende diorite

LOWER PROTEROZOIC OR UPPER ARCHEAN

- mv** metavolcanic rock
- gn** granite, gneiss, and amphibolite



Wisconsin Geology - A very brief history

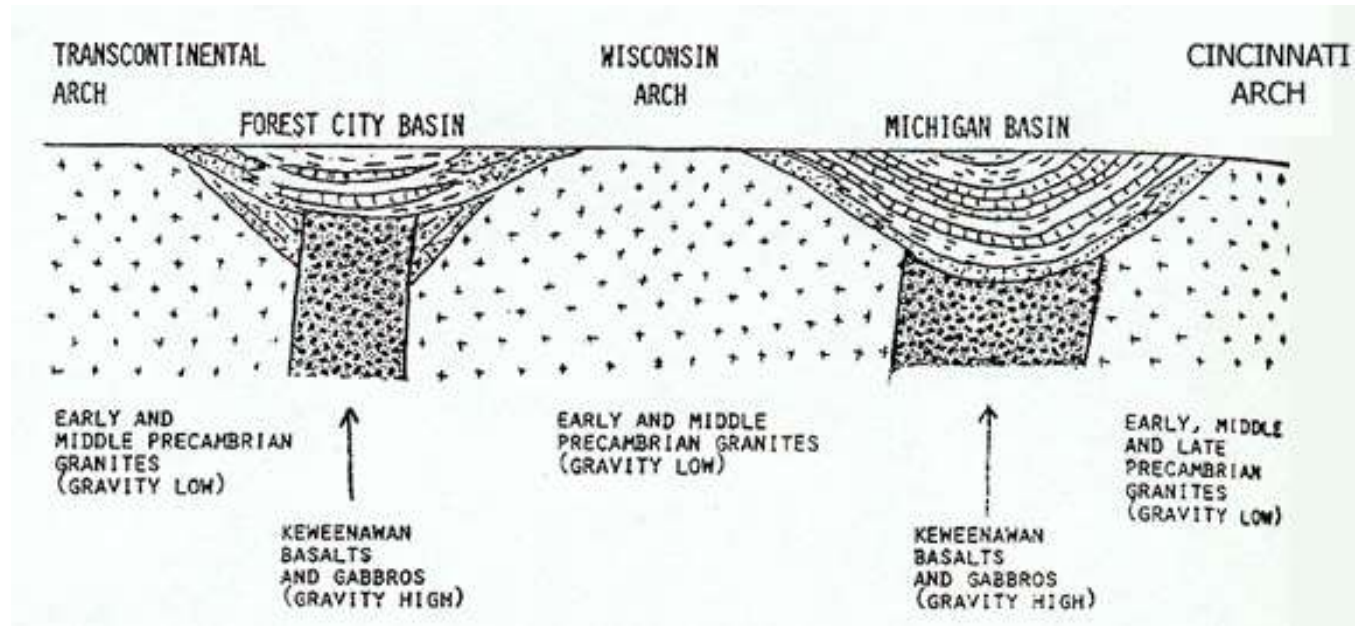
Part 1

- Up to 1 billion years ago: volcanoes, mountains, granitic intrusions, continental rifting



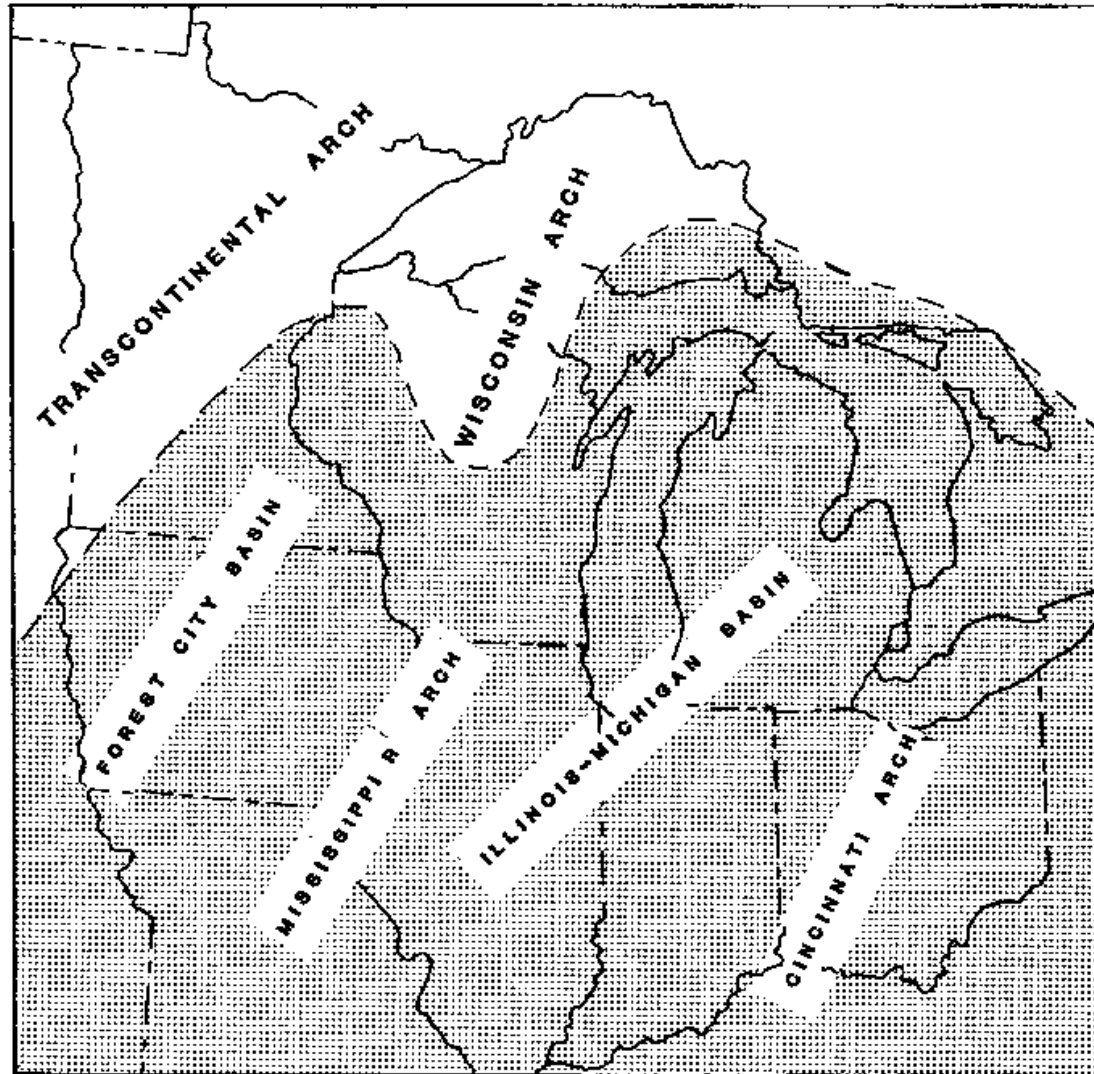
LaGerge (1994) Geology of the Lake Superior Region

Part 1 cont....



LaGerge (1994) Geology of the Lake Superior Region

Part 1 ends with basins and arches beginning to form



Wisconsin Geology - A very brief history

Part 2 – Shallow Seas

- 600 million – 300 million years ago: shallow seas came and went at least 5 times over southern Wisconsin
 - Beach environments - sandstones
 - Deeper water - shales and dolomites

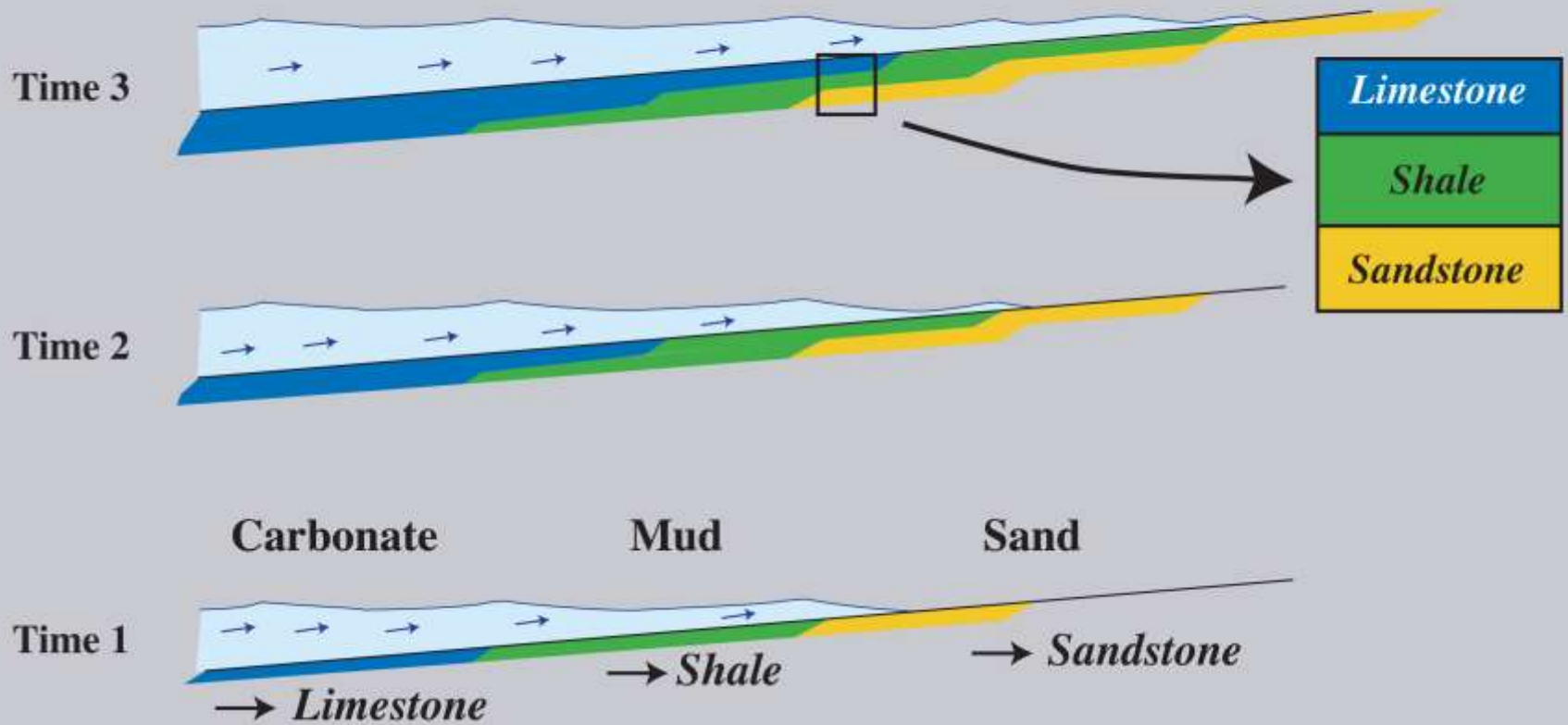


Dolomite

Sandstone

Sea level changes create layers

Marine Transgression



<http://geologictimepics.files.wordpress.com/2012/04/transgression.jpg>

2/15/2016

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C sandstone with some dolomite and shale

MIDDLE PROTEROZOIC

Keweenaw rock—
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v basaltic to rhyolitic lava flows
t gabbroic, anorthositic and granitic rock

Wolf River rock—
g rapakivi granite, granite, and syenite
s anorthosite and gabbro

LOWER PROTEROZOIC

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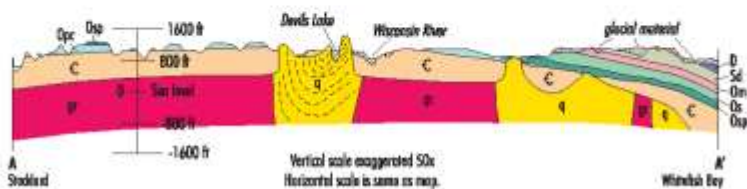
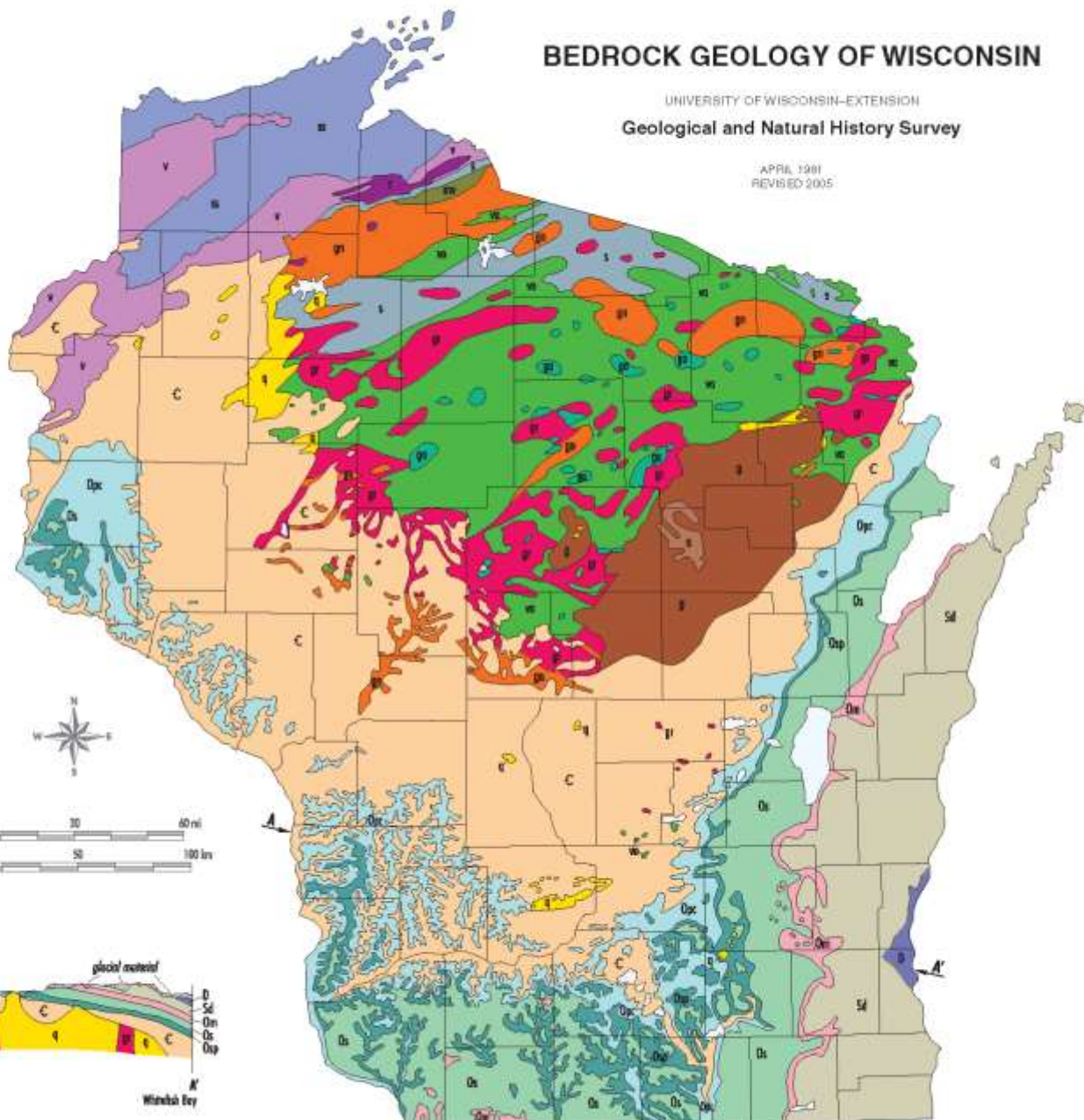
w basaltic to rhyolitic metavolcanic rock with some metasedimentary rock

gt meta-gabbro and hornblende diorite

LOWER PROTEROZOIC OR UPPER ARCHEAN

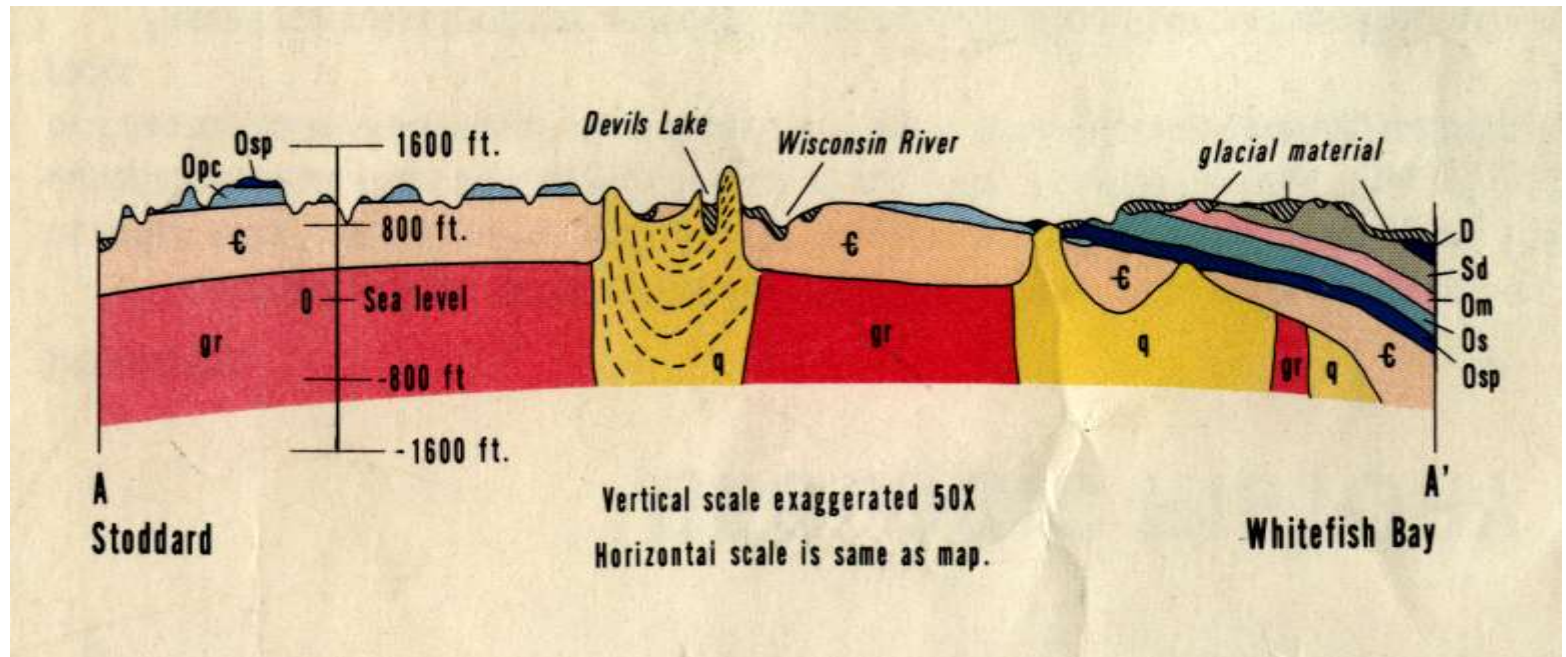
mv metavolcanic rock

gn granite, gneiss, and amphibolite

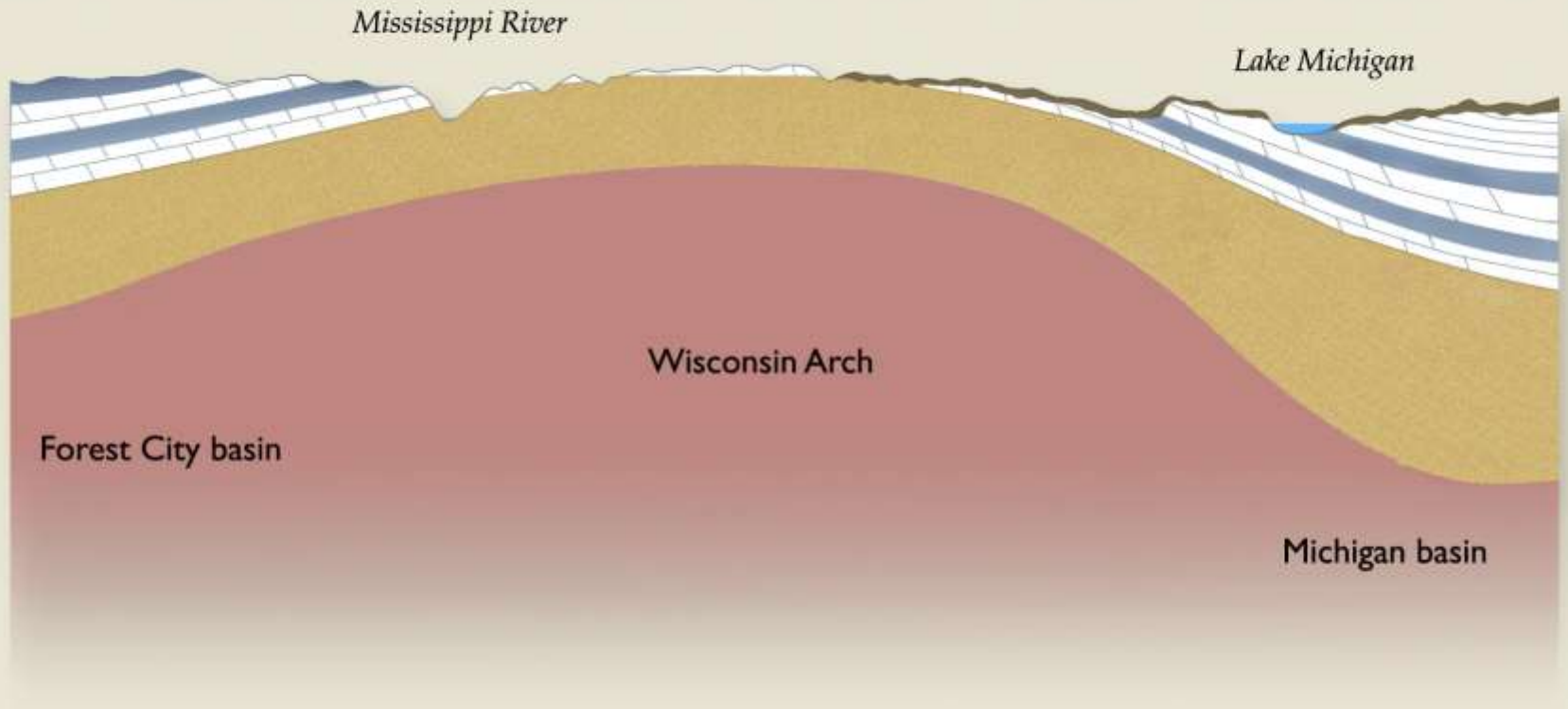


More Wisconsin Geology

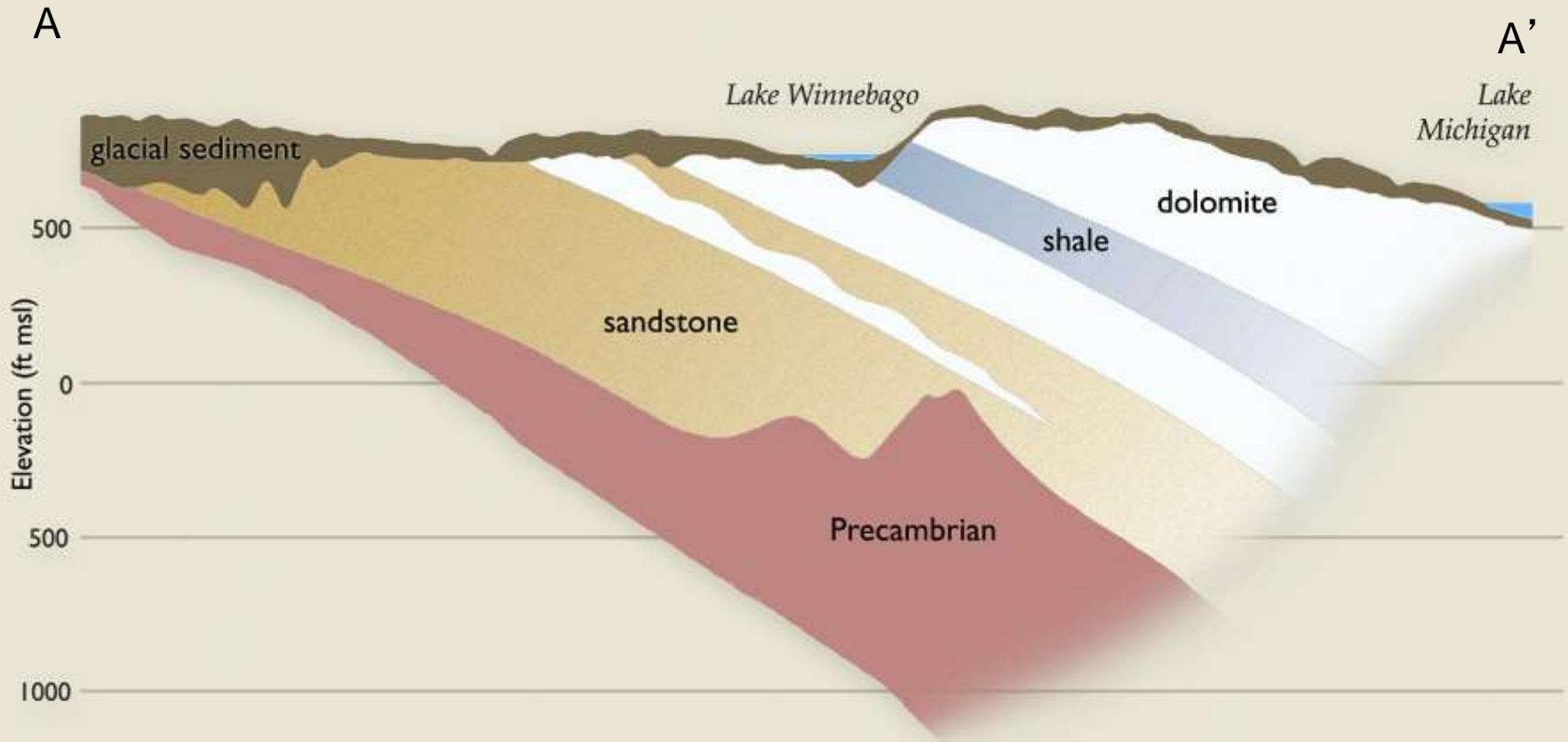
View of a Cross Section



Wisconsin arch



Bedrock geology of eastern Wisconsin



Wisconsin's Bedrock Aquifers



PreCambrian aquifer:

- crystalline (granite, quartzite)
- fracture dominated flow
- generally low well yields



Crystalline bedrock aquifer

Wisconsin Dome

Baraboo Quartzite

Wisconsin Arch



“Sandstone” aquifer:

- sandstone, dolomite
- regionally extensive
- excellent aquifer
- porous flow
- most high-capacity wells
- occurs beneath shale in east



Sandstone and dolomite aquifer

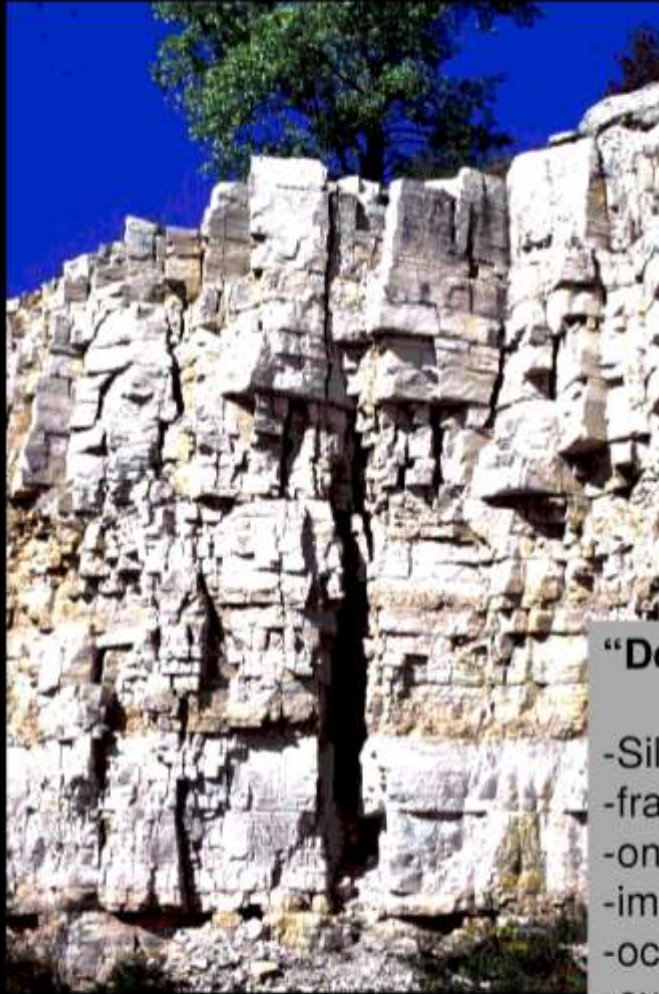
Aquifer was eroded
by glaciers



Wisconsin River Valley

Wisconsin Arch

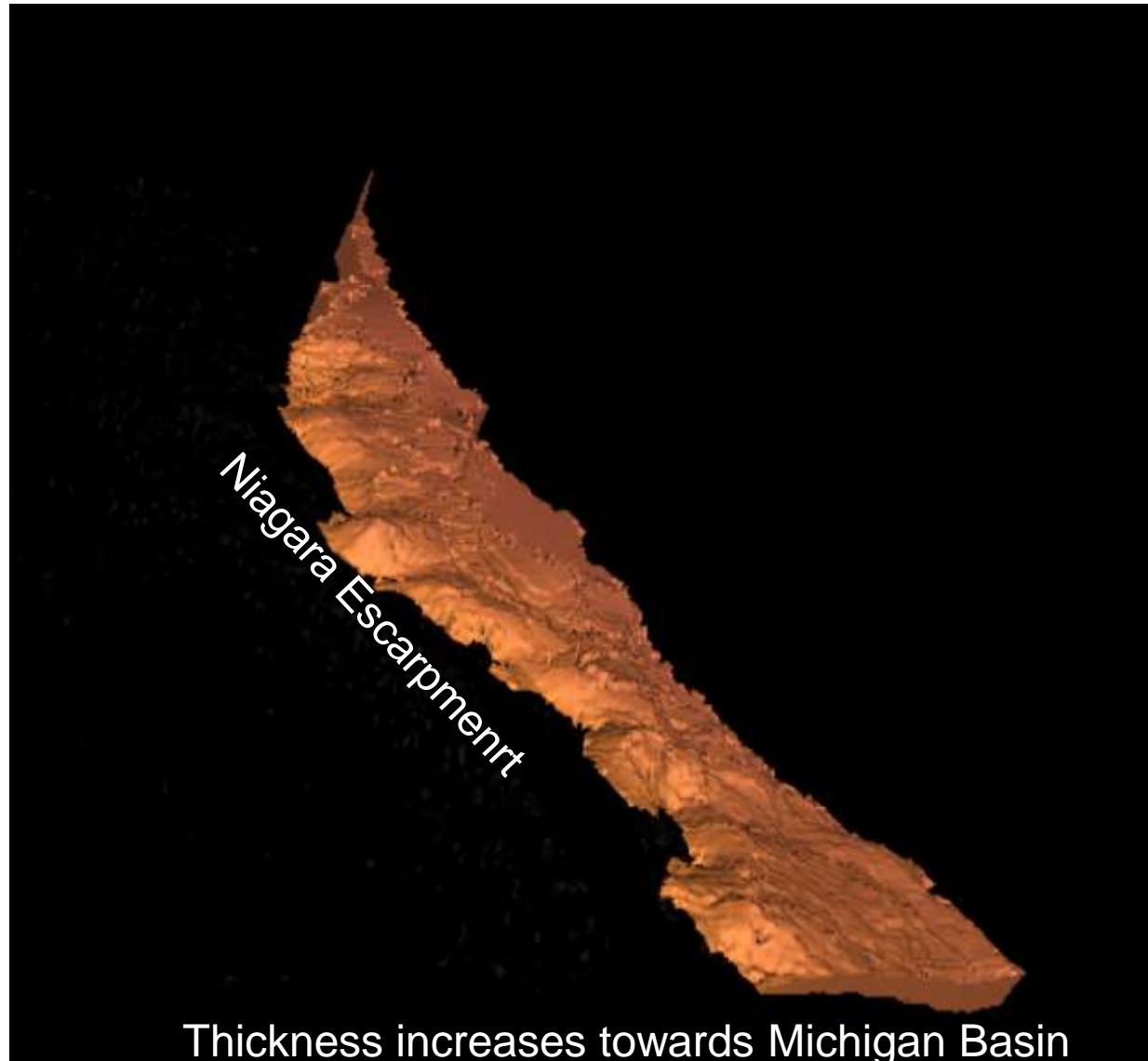


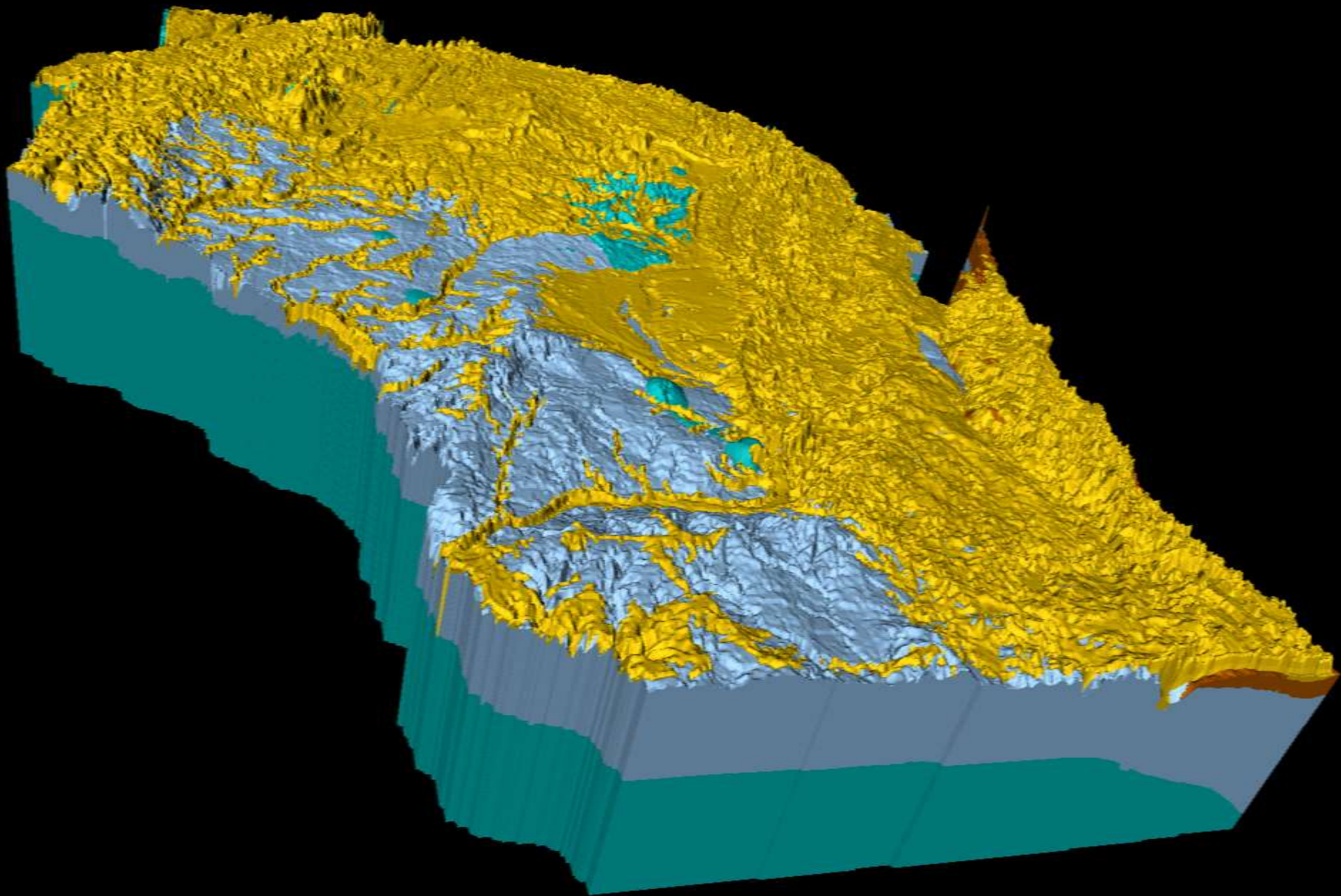


“Dolomite” aquifer:

- Silurian dolomite
- fracture dominated flow
- only present in east
- important for municipal and domestic wells
- occurs above Maquoketa Shale
- extremely vulnerable if exposed

Eastern dolomite aquifer





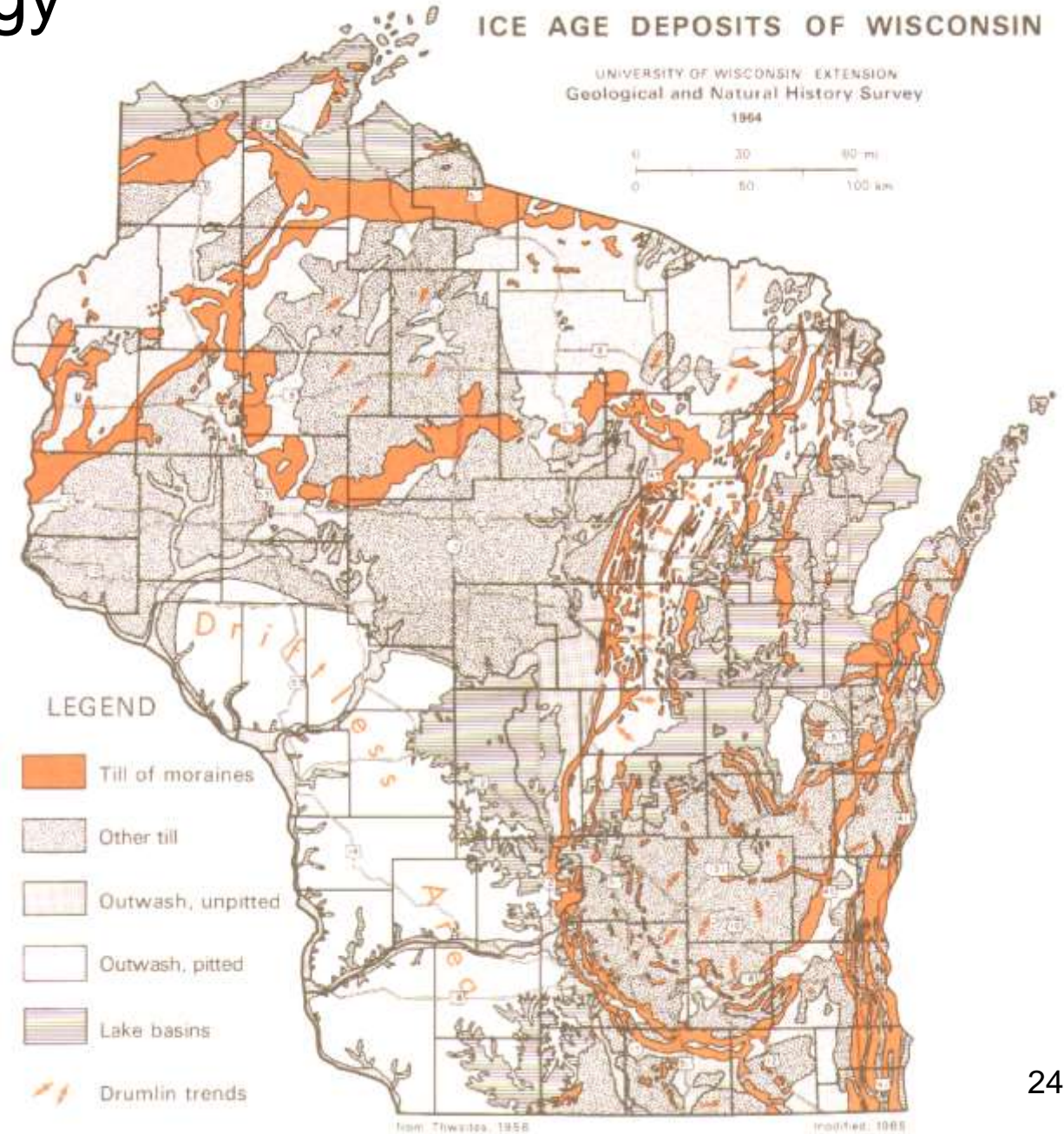
Wisconsin Geology - A very brief history

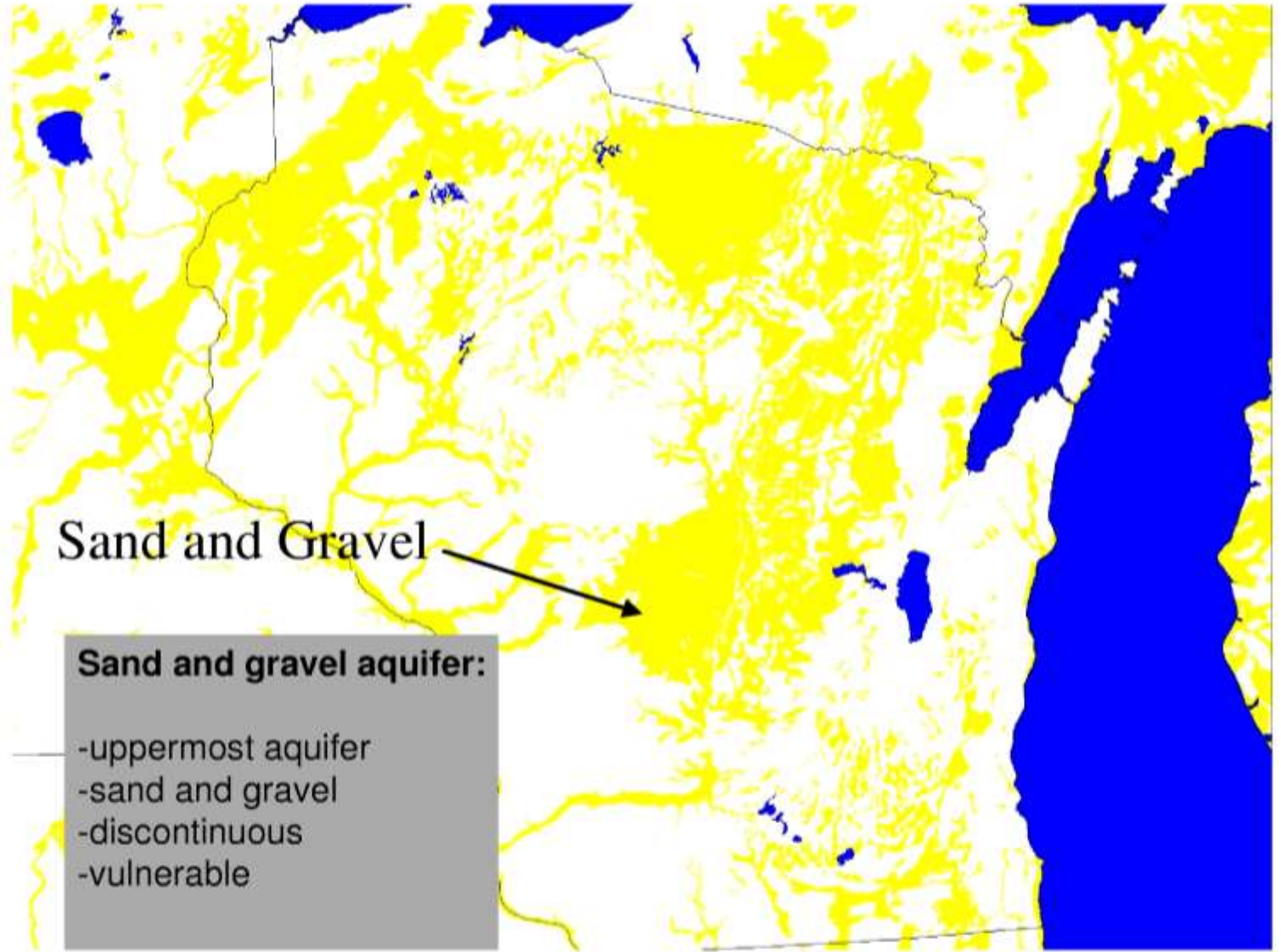
Part 3 - Glaciers

- 3 million – 12,000 years ago: Glaciers came and went at least 4, maybe 10 times.



Glacial Geology







Glacial Lake
Wisconsin

Wisconsin River Valley

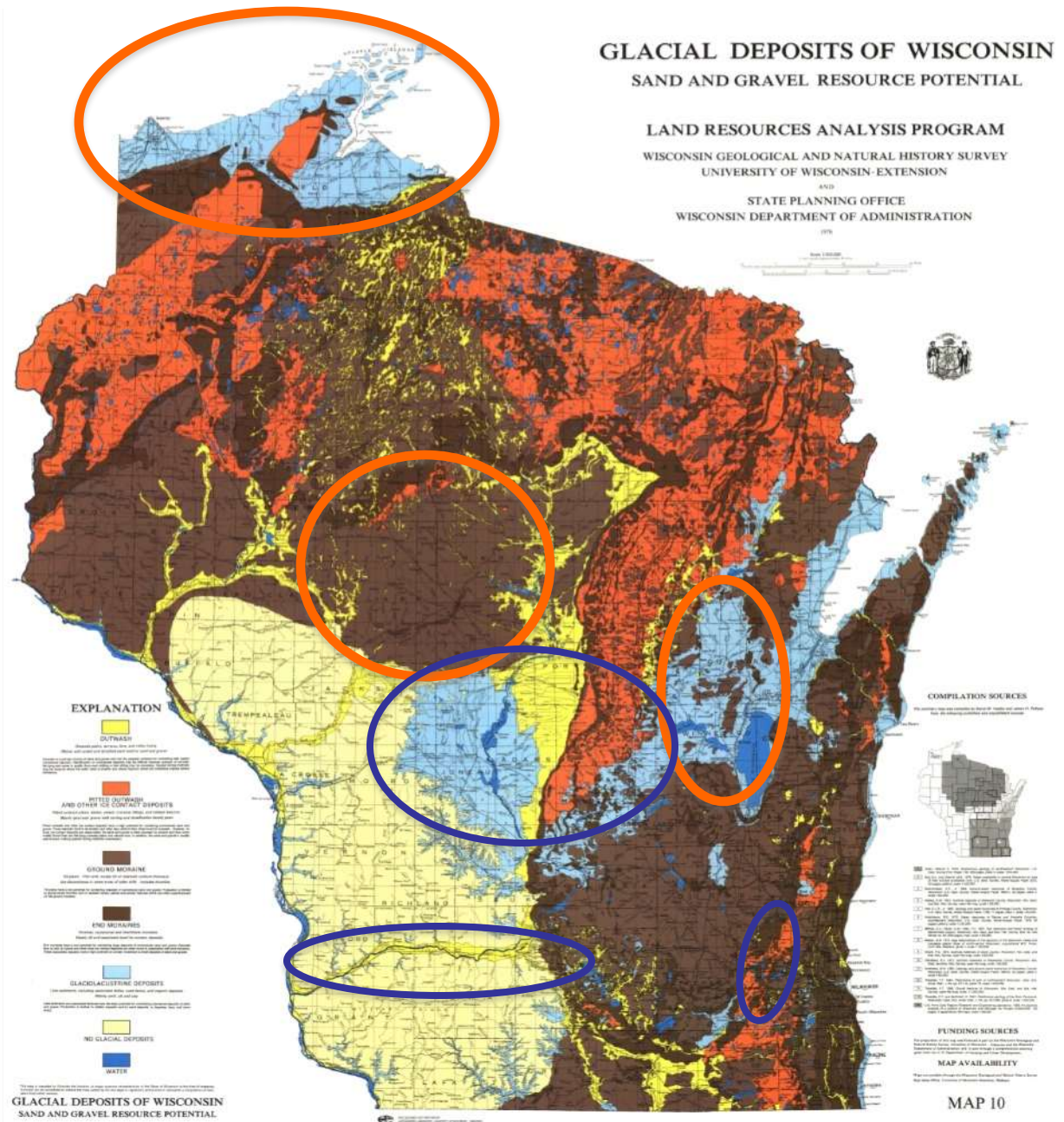
Troy Valley

Geology controls where we get our groundwater

Some glacial deposits provide lots of water while others provide very little

High well capacity
Sands and gravels

Low well capacity
Silts and clays



Next three maps are available from the Wisconsin Geological and Natural History Survey Web page



Sand and Gravel Aquifer

http://wgnhs.uwex.edu/pubs/download_m054/



Sandstone Aquifer

http://wgnhs.uwex.edu/pubs/download_m055/



Niagara Dolomite Aquifer

http://wgnhs.uwex.edu/pubs/download_m056/

EXPLANATION

PROBABLE WELL YIELDS

Dashed where approximately located



Chances of more than 100 gallons per minute are poor



Chances of 100-500 gallons per minute are good



Chances of 500-1,000 gallons per minute are good



Chances of more than 1,000 gallons per minute are good

Probable yields are based primarily on aquifer permeability and thickness as determined by pumping tests and well-log interpretations. Some areas were modified by information from individual well yields, thickness of aquifer penetration, and published reports.

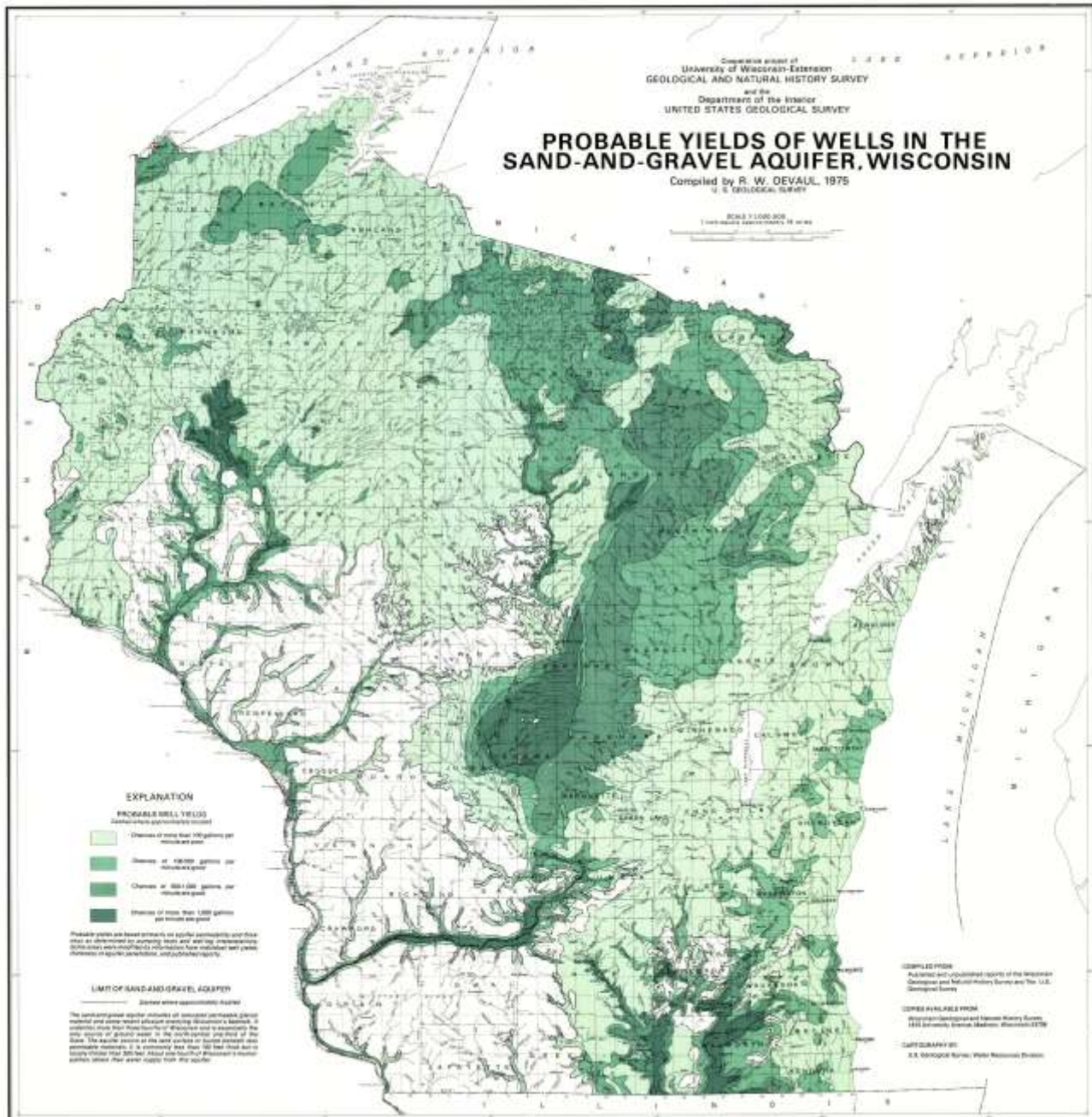
For scale here, a garden hose is
at 5 gallons per minute

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 Department of the Interior
 UNITED STATES GEOLOGICAL SURVEY

PROBABLE YIELDS OF WELLS IN THE SAND-AND-GRAVEL AQUIFER, WISCONSIN

Compiled by R. W. DEVAUL, 1975
 U. S. GEOLOGICAL SURVEY

SCALE 1:100,000
 1 inch equals approximately 16 miles



EXPLANATION

PROBABLE WELL YIELDS

(Areas where aquifers are not mapped)

- Yields of more than 100 gallons per minute are good
- Yields of 50-100 gallons per minute are good
- Yields of 20-50 gallons per minute are good
- Yields of more than 1,000 gallons per minute are good

Probable yields are based primarily on aquifer permeability and flow rates as determined by pumping tests and well logs and are not intended to be used as a guide in estimating yields from individual wells. Yields also are affected by aquifer characteristics and hydrologic regime.

LIMIT OF SAND-AND-GRAVEL AQUIFER

Boundaries where aquifers are not mapped

The sand and gravel aquifer consists of unconsolidated permeable glacial material and some related alluvium extending throughout a belt across a substantial part of the northern half of Wisconsin and to a lesser extent the only source of potable water in the northwestern part of the State. The aquifer consists of the sand and gravel or coarse material and permeable materials, it is composed of sand, silt, fine sand, and gravel, and is usually 10 to 20 feet thick. About one-fourth of Wisconsin's water supply comes from sand and gravel aquifers.

COMPILED FROM:
 Published and unpublished reports of the Wisconsin Geological and Natural History Survey and the U.S. Geological Survey

CONTRIBUTORS FROM:
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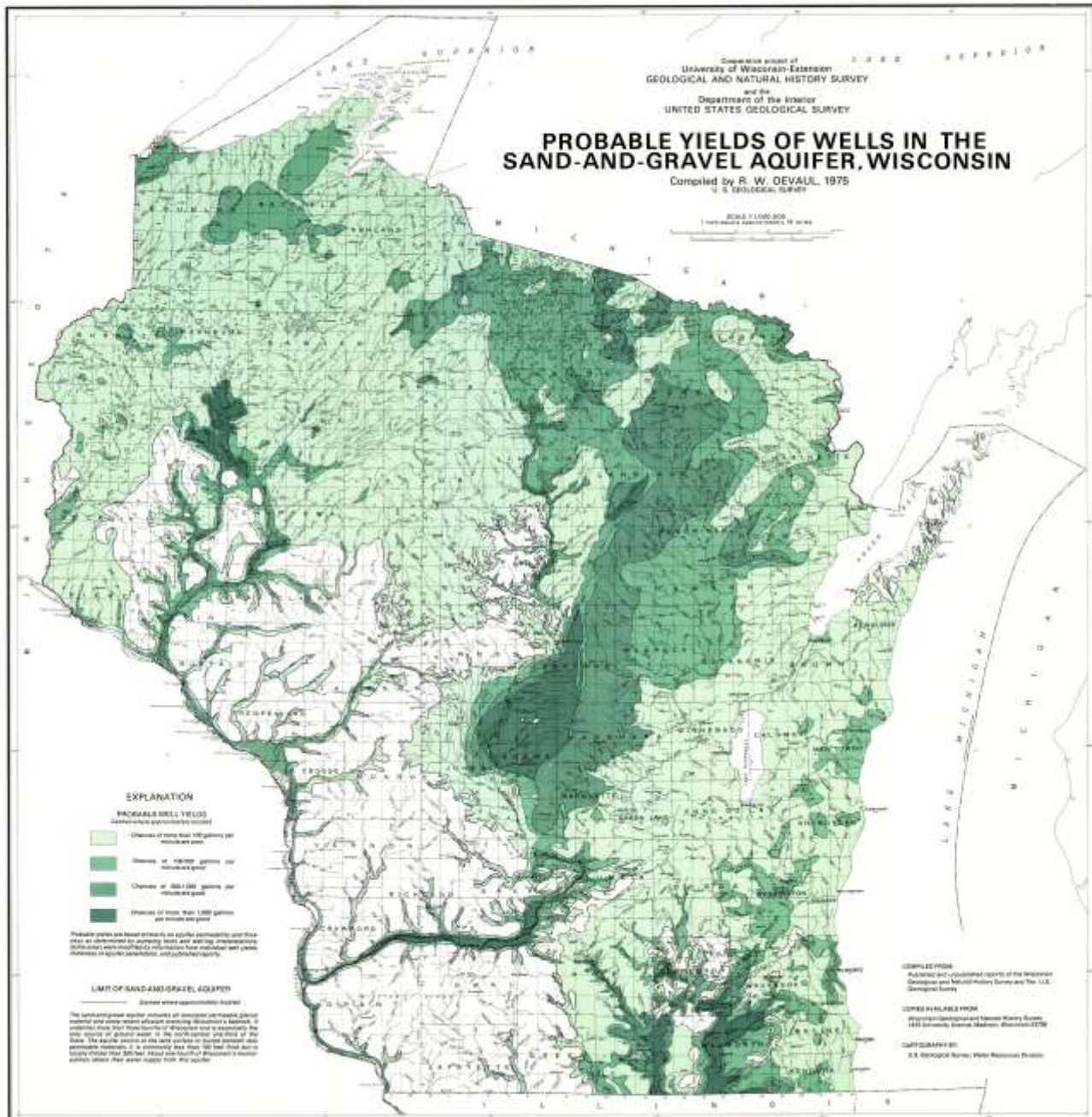
CARTOGRAPHY BY:
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PROBABLE YIELDS OF WELLS IN THE SAND-AND-GRAVEL AQUIFER, WISCONSIN

Compiled by R. W. DEVAUL, 1975
 U. S. GEOLOGICAL SURVEY

SCALE 1:100,000
 1 inch equals approximately 16 miles



EXPLANATION

PROBABLE WELL YIELDS (based on data approximately located)

- Yields of more than 100 gallons per minute are good
- Yields of 50-100 gallons per minute are good
- Yields of 20-50 gallons per minute are good
- Yields of less than 20 gallons per minute are good

Probable yields are based primarily on specific permeability and flow data that are determined by pumping tests and are not necessarily the only source of data for water in the sand-and-gravel aquifer of the State. The specific permeability and flow data are based on data from pumping tests, and are not necessarily the only source of data for water in the sand-and-gravel aquifer of the State.

LIMIT OF SAND-AND-GRAVEL AQUIFER

The sand-and-gravel aquifer consists of unconsolidated sand and gravel material and other material having permeability characteristics similar to sandstone that has been formed of sandstone and is considered the only source of data for water in the sand-and-gravel aquifer of the State. The specific permeability and flow data are based on data from pumping tests, and are not necessarily the only source of data for water in the sand-and-gravel aquifer of the State.

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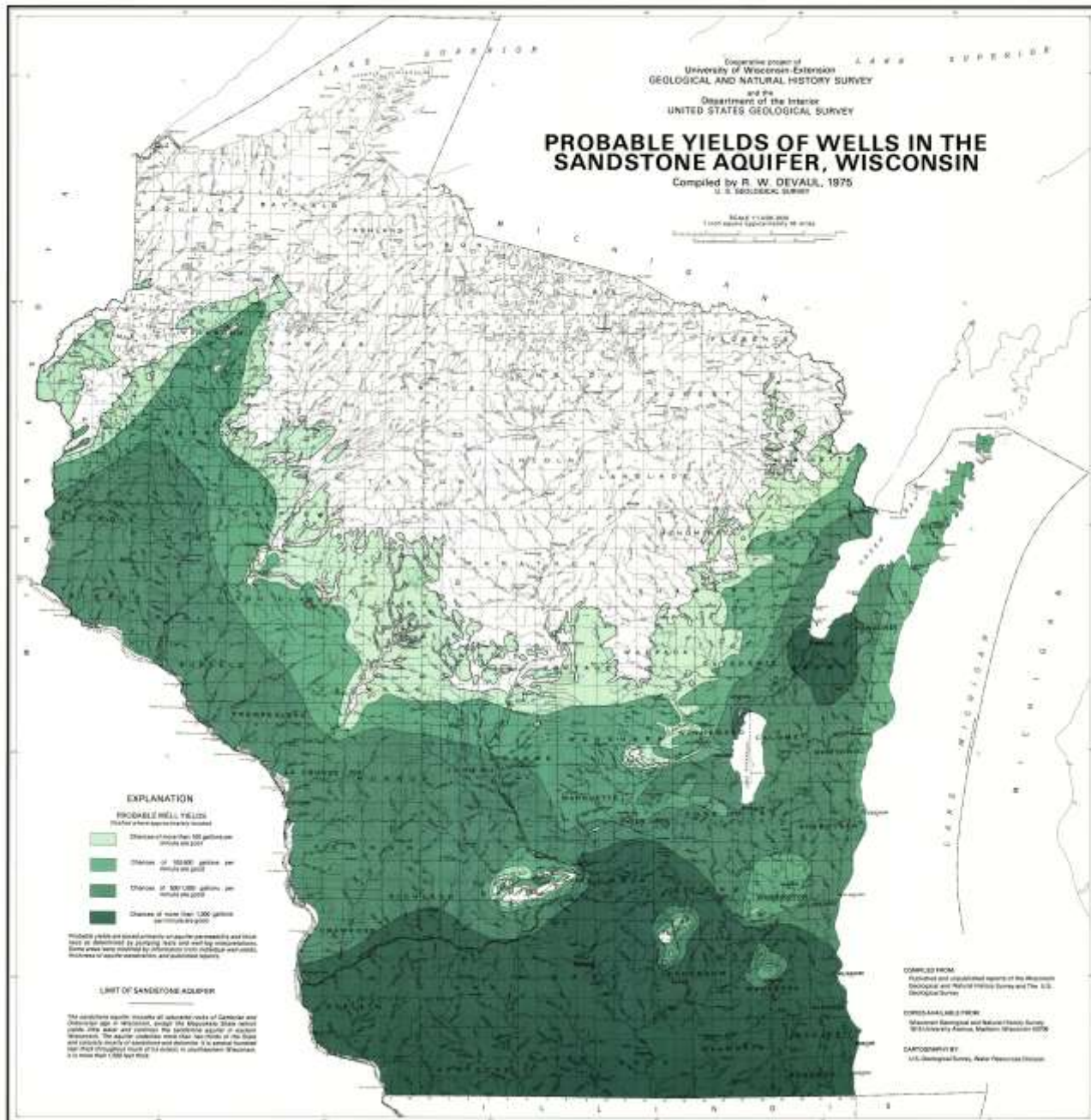
CARTOGRAPHY BY:
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PROBABLE YIELDS OF WELLS IN THE SANDSTONE AQUIFER, WISCONSIN

Compiled by R. W. DEVAUL, 1975
 U. S. GEOLOGICAL SURVEY

Scale 1:500,000
 1 cent equals approximately 64 miles



- EXPLANATION**
- PROBABLE WELL YIELDS**
 (Yields where approximately located)
- Yields of 100-200 gallons per minute per well
 - Yields of 200-500 gallons per minute per well
 - Yields of 500-1000 gallons per minute per well
 - Yields of more than 1000 gallons per minute per well

Probable yields are based primarily on aquifer permeability and thickness as determined by geologic maps and well logs. Some areas have been modified by information from individual well logs. Locations of major cities, towns, and villages are shown.

LIMIT OF SANDSTONE AQUIFER

The sandstone aquifer consists of various beds of Cambrian and Ordovician age in Wisconsin, and in the St. Lawrence River valley south of Lake Michigan. The aquifer underlies most of the State and extends southward into Illinois. It is a general feature of the St. Lawrence River valley in southeastern Wisconsin. It is more than 1000 feet thick.

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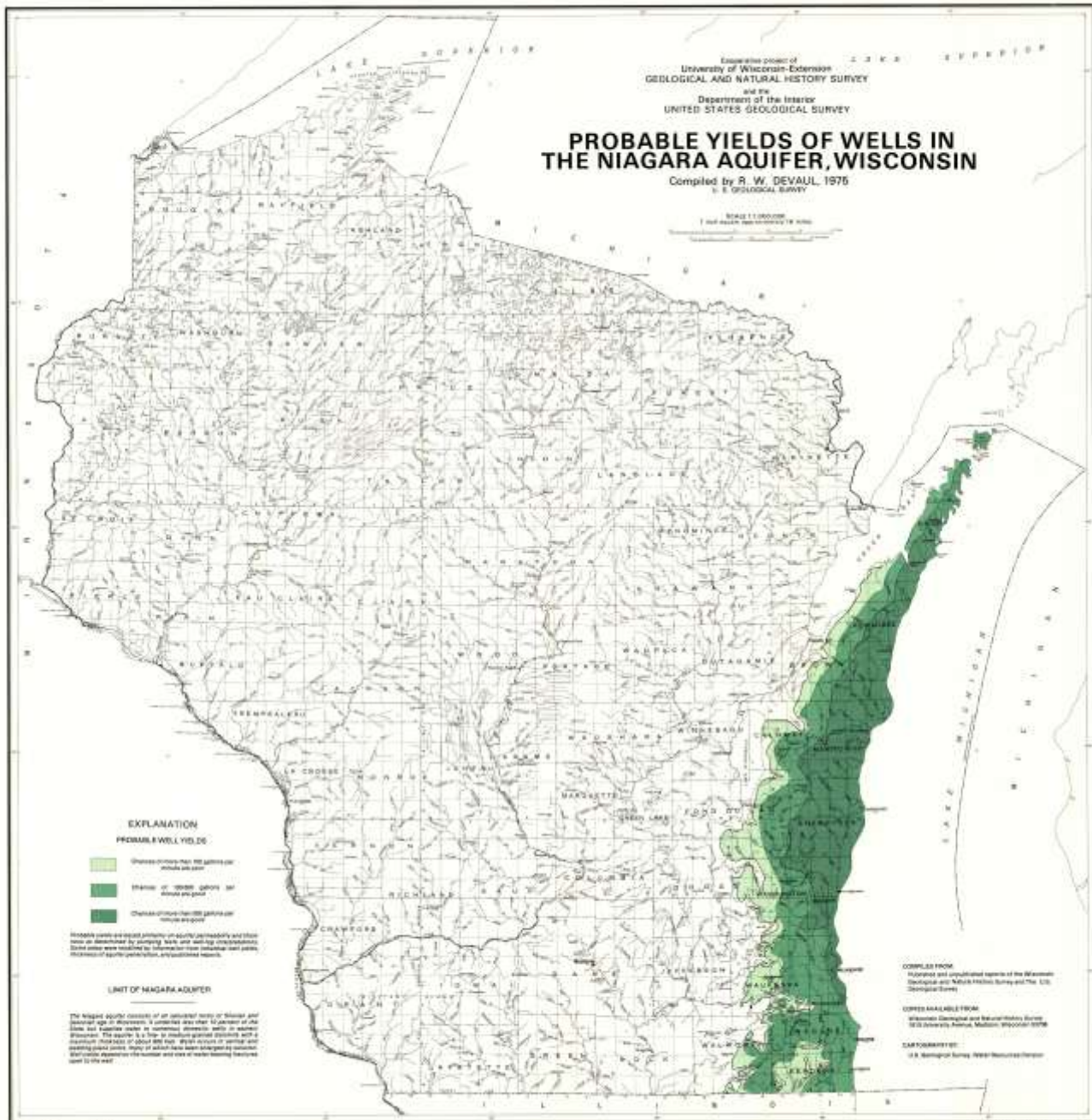
CARTOGRAPHY BY
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PROBABLE YIELDS OF WELLS IN THE NIAGARA AQUIFER, WISCONSIN

Compiled by R. W. DEVAUL, 1975
 U. S. GEOLOGICAL SURVEY

SCALE 1:500,000
 1 inch equals approximately 16 miles



- EXPLANATION**
- PROBABLE WELL YIELDS**
- Yields of 100-200 gpm per well per year
 - Yields of 200-500 gpm per well per year
 - Yields of 500-1000 gpm per well per year

Yields are based primarily on aquifer permeability and flow rates as determined by pumping tests and existing observations. Data were not available for interpretation from intensive test-pump observations of specific production, unconsolidated deposits.

LIMIT OF NIAGARA AQUIFER

The Niagara aquifer consists of an unconsolidated series of glacial and post-glacial age in Wisconsin. It contains water under 10 atmospheres of flow and fluctuates under its natural pressure with its water table. The aquifer is a trap in hydrogeological terms and is a natural recharge of about 100 feet. When a well is drilled in certain unconsolidated areas, many of which have been developed by intensive agriculture, the number and size of water-bearing horizons may be small.

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Crystalline Bedrock Aquifer

No map because more than 100 gpm are not expected anywhere in the aquifer, even after hydrofracturing.