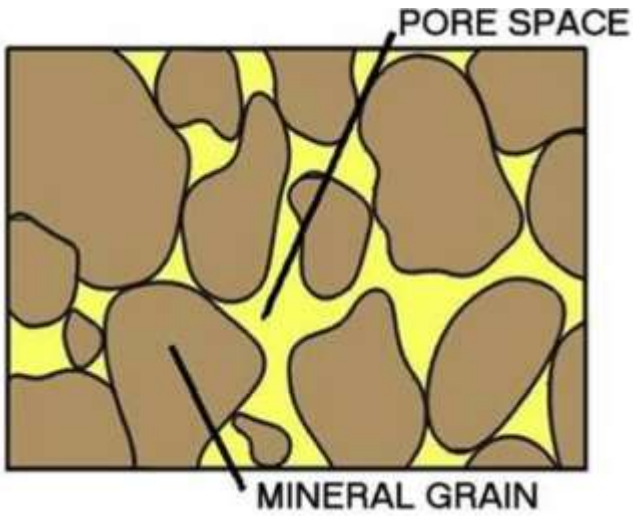
Wisconsin's Aquifers

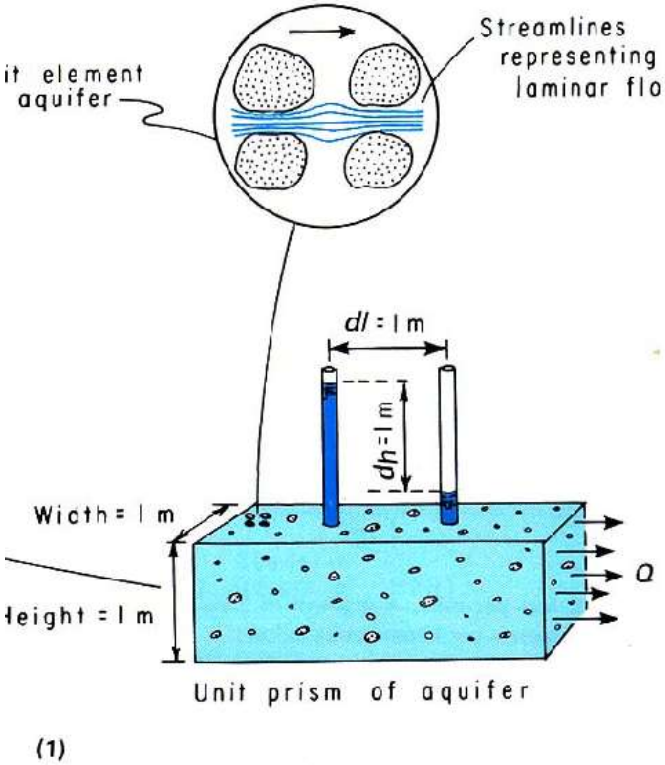
David Hart

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





Porosity – percent of void spaces in rock or sediment

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

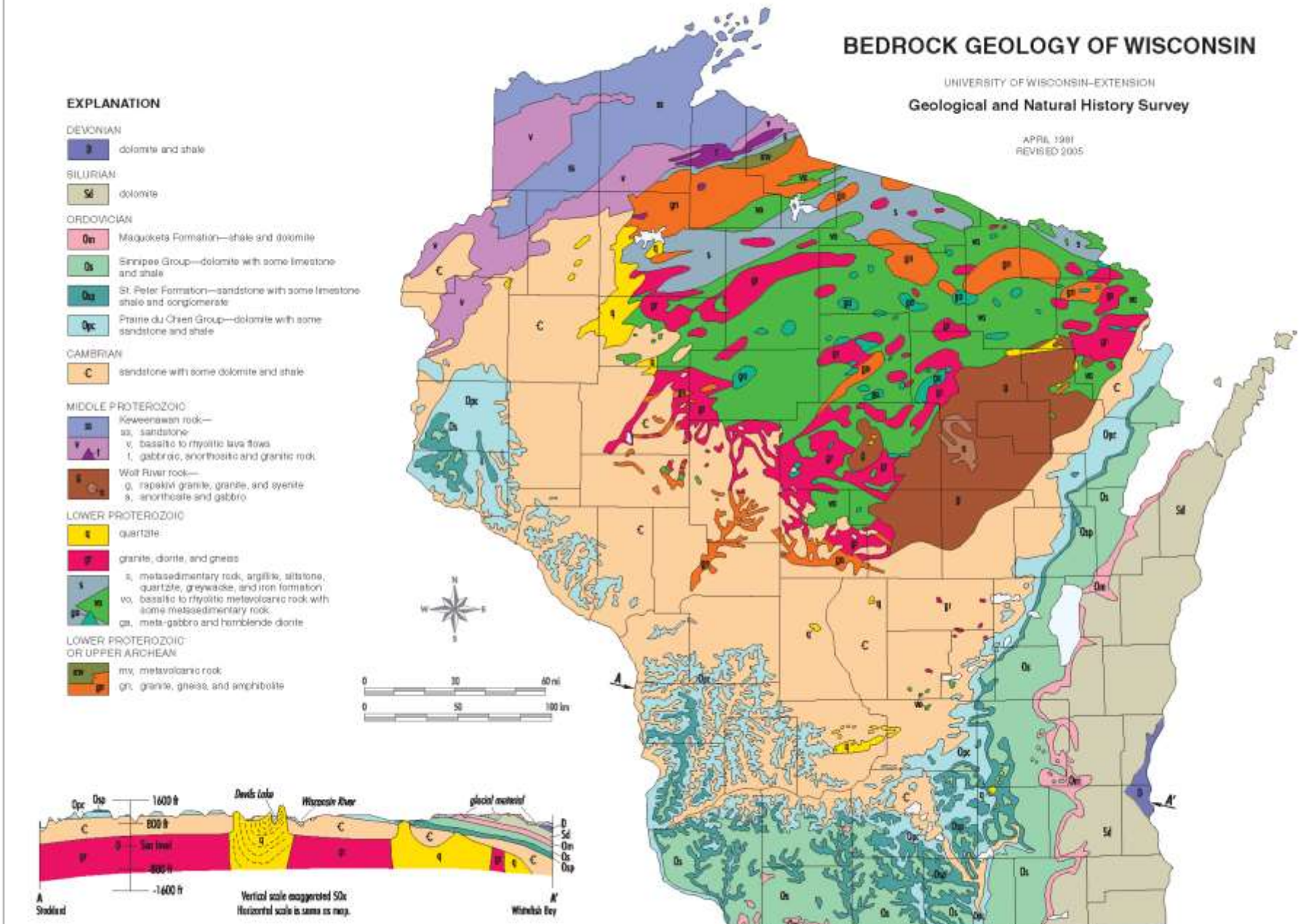
Different rocks and sediment have different hydraulic properties

- Sandstone – ↑ porosity, ↑ conductivity

- Shale – ↑porosity, ↓ conductivity

- Dolomite – ↓ porosity, ↑ conductivity (fractures)

- Crystalline Bedrock – ↓ porosity, ↓ conductivity



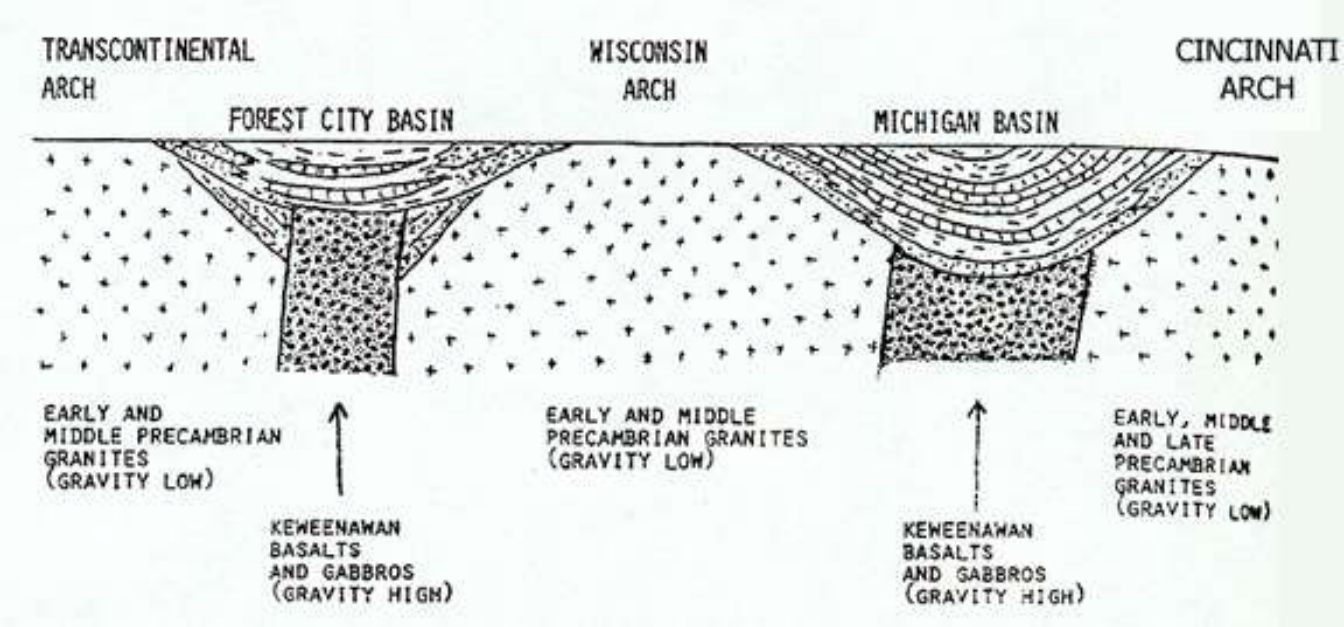
http://wgnhs.uwex.edu/pubs/M067/

Wisconsin Geology - A very brief history
Part 1

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

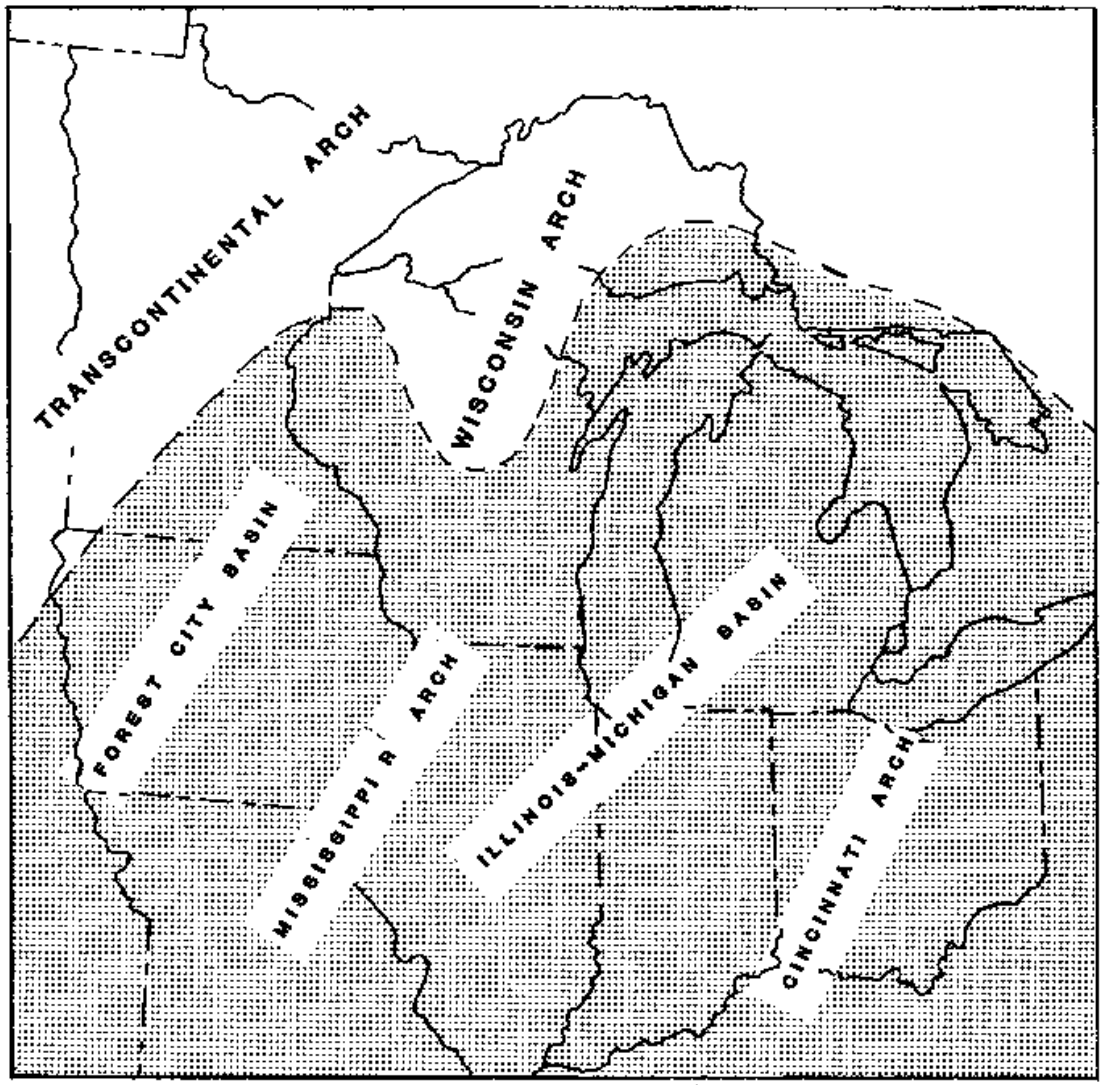
LaGerge (1994) Geology of the Lake Superior Region

Part 1 cont.…



LaGerge (1994) Geology of the Lake Superior Region

Part 1 ends with basins and arches beginning to form



LaGerge (1994) Geology of the Lake Superior Region

Wisconsin Geology - A very brief history
Part 2 – Shallow Seas

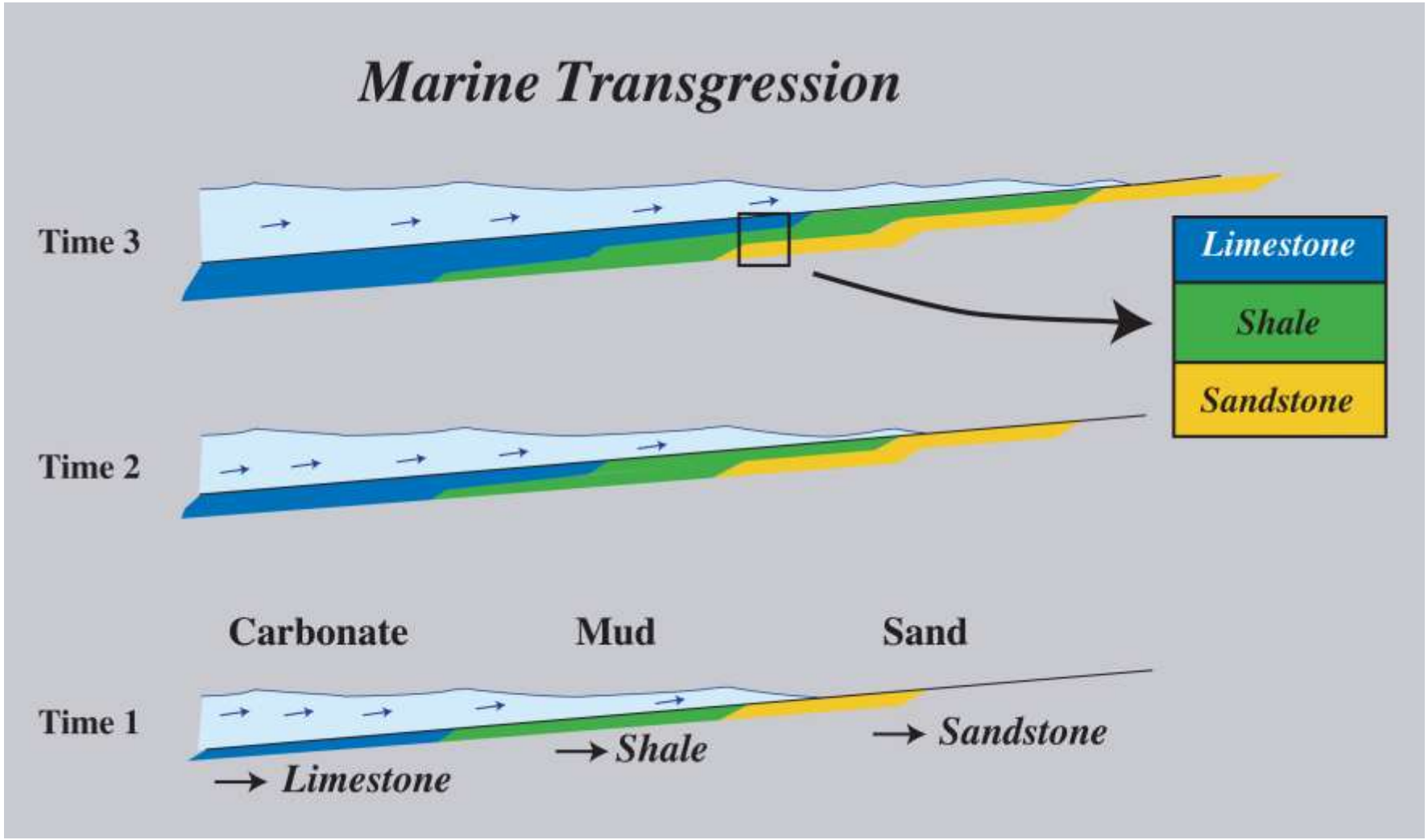
- 600 million – 300 million years ago: shallow seas came and went at least 5 times over southern Wisconsin
  - Beach environments - sandstones
  - Deeper water - shales and dolomites

Dolomite

Sandstone

http://www.uwgb.edu/dutchs/SITEMAP.HTM

Sea level changes create layers



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

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

- Om — Maquoketa Formation—shale and dolomite
- Os — Sinnipee Group—dolomite with some limestone and shale
- Osp — St. Peter Formation—sandstone with some limestone shale and conglomerate
- Opc — Prairie du Chien Group—dolomite with some sandstone and shale

CAMBRIAN

- C — sandstone with some dolomite and shale

MIDDLE PROTEROZOIC

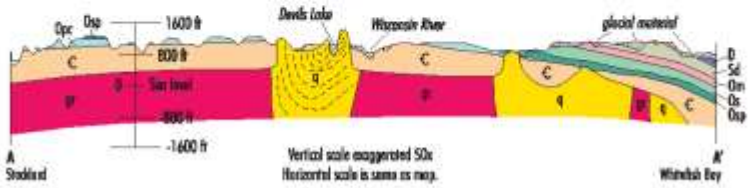
- Keweenawan rock—
  - ss, sandstone
  - v, basaltic to rhyolitic lava flows
  - i, gabbroic, anorthositic and granitic rock
- Wolf River rock—
  - g, rapakivi granite, granite, and syenite
  - a, anorthosite and gabbro

LOWER PROTEROZOIC

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

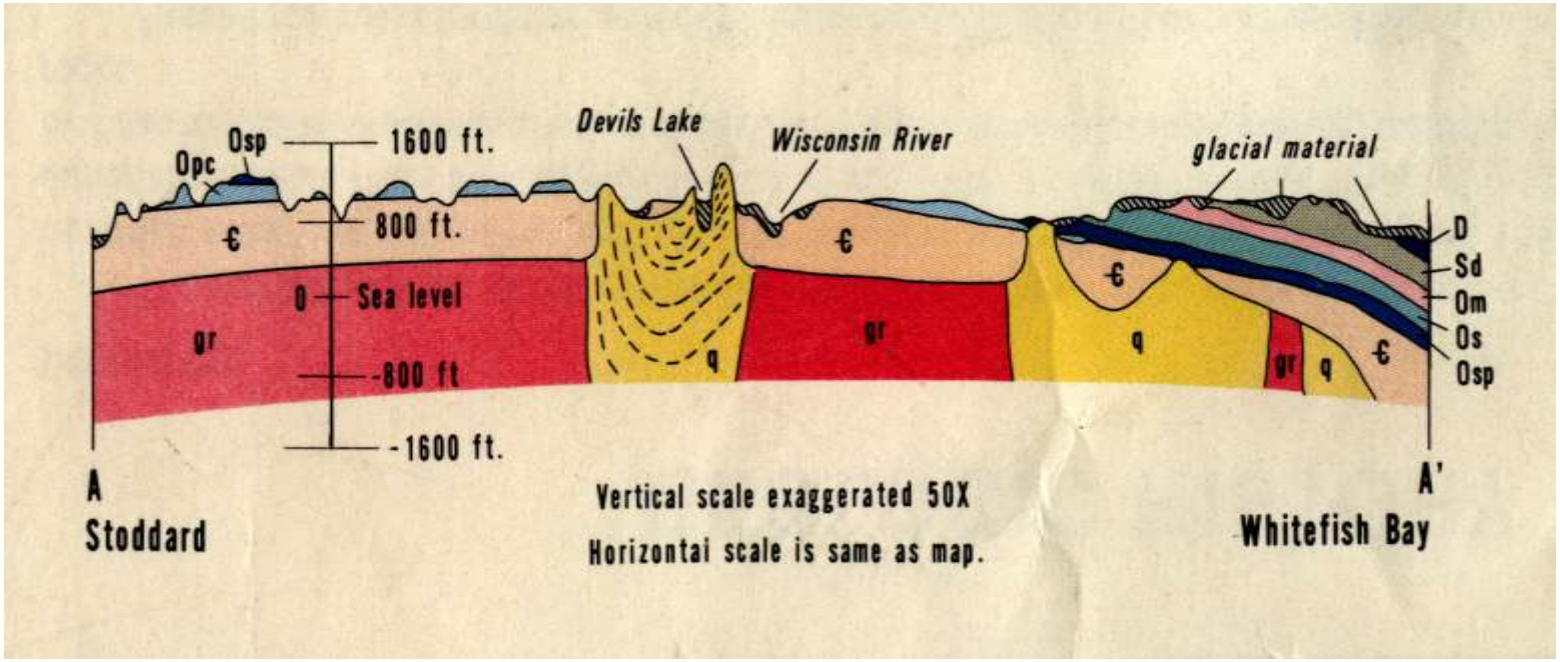
LOWER PROTEROZOIC OR UPPER ARCHEAN

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

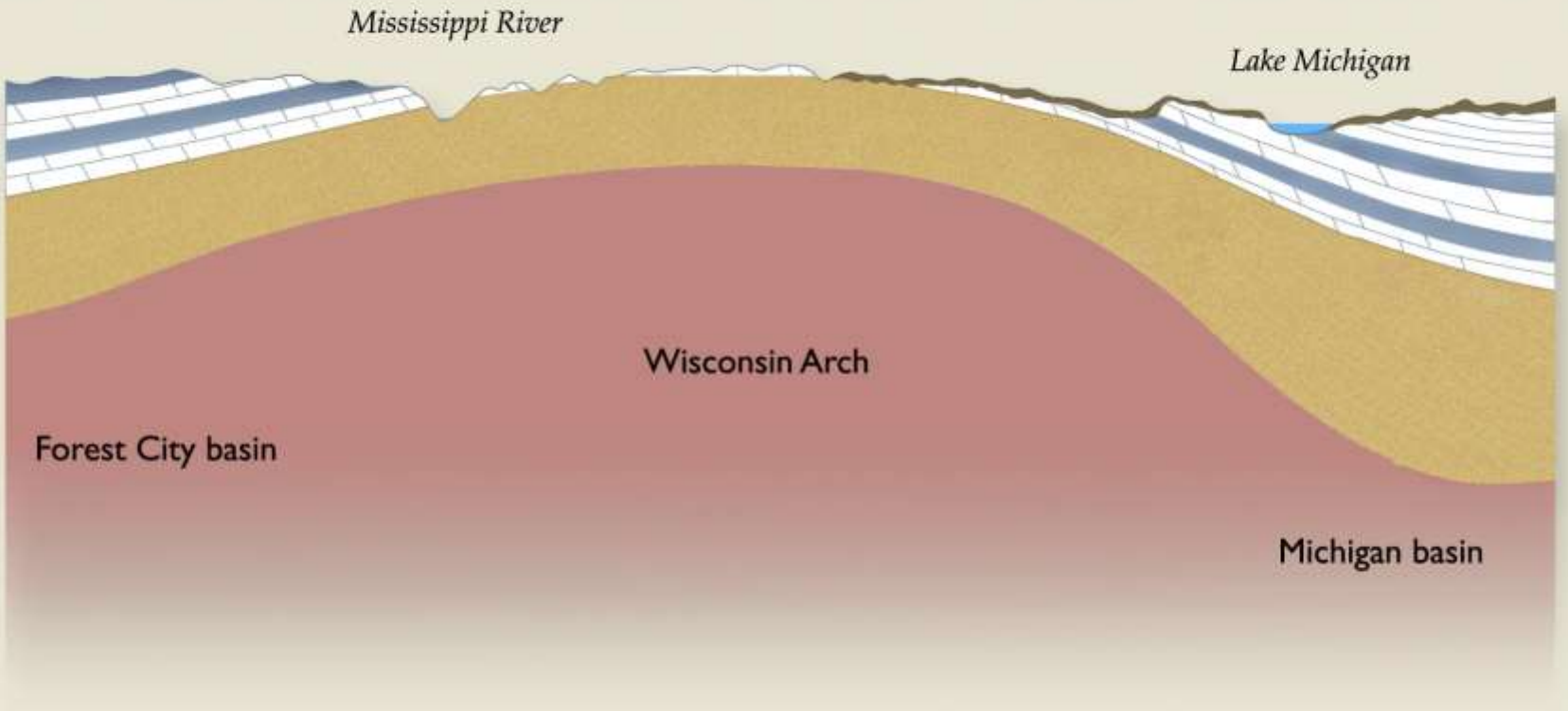


More Wisconsin Geology

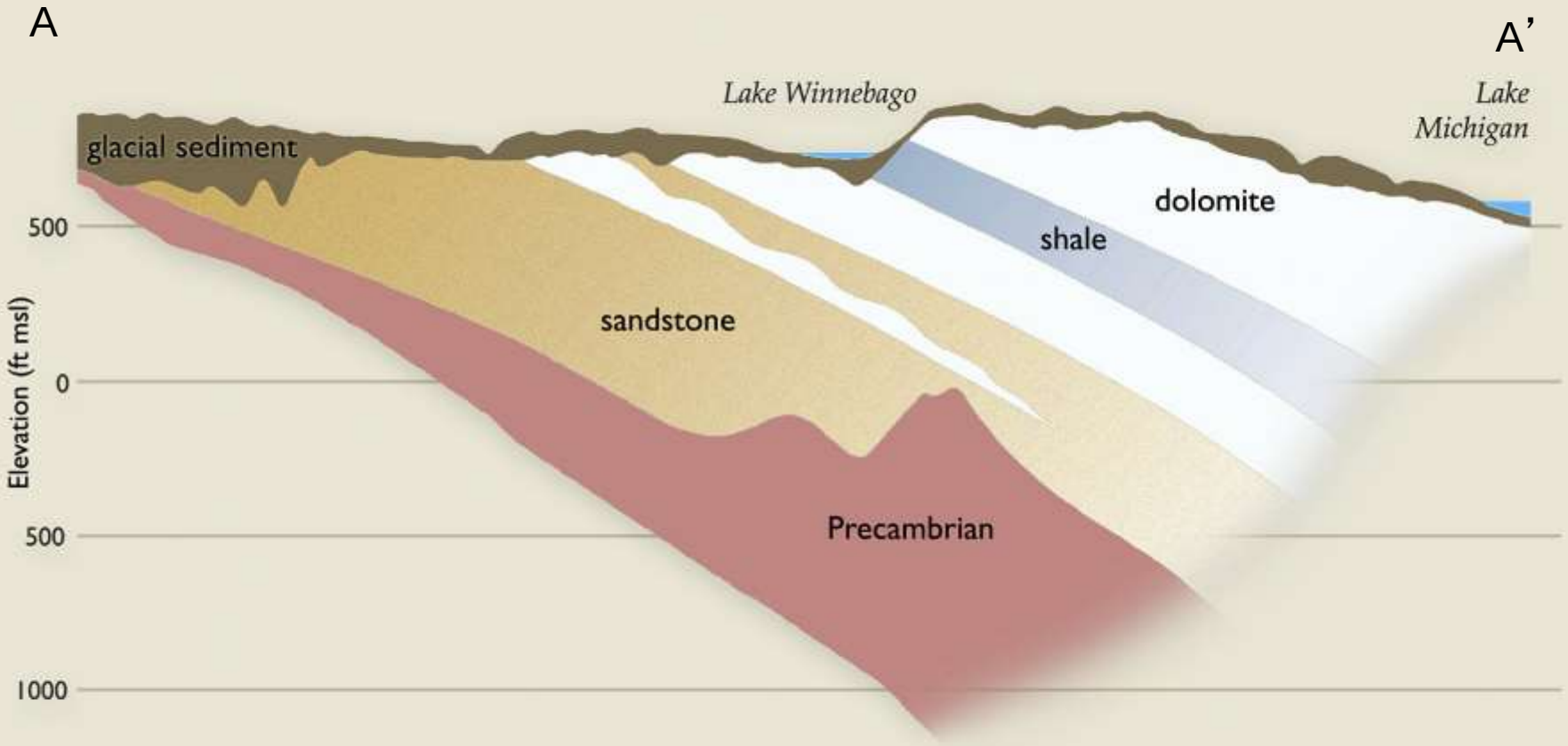
View of a Cross Section



Wisconsin arch



Bedrock geology of eastern Wisconsin



Wisconsin's Bedrock Aquifers

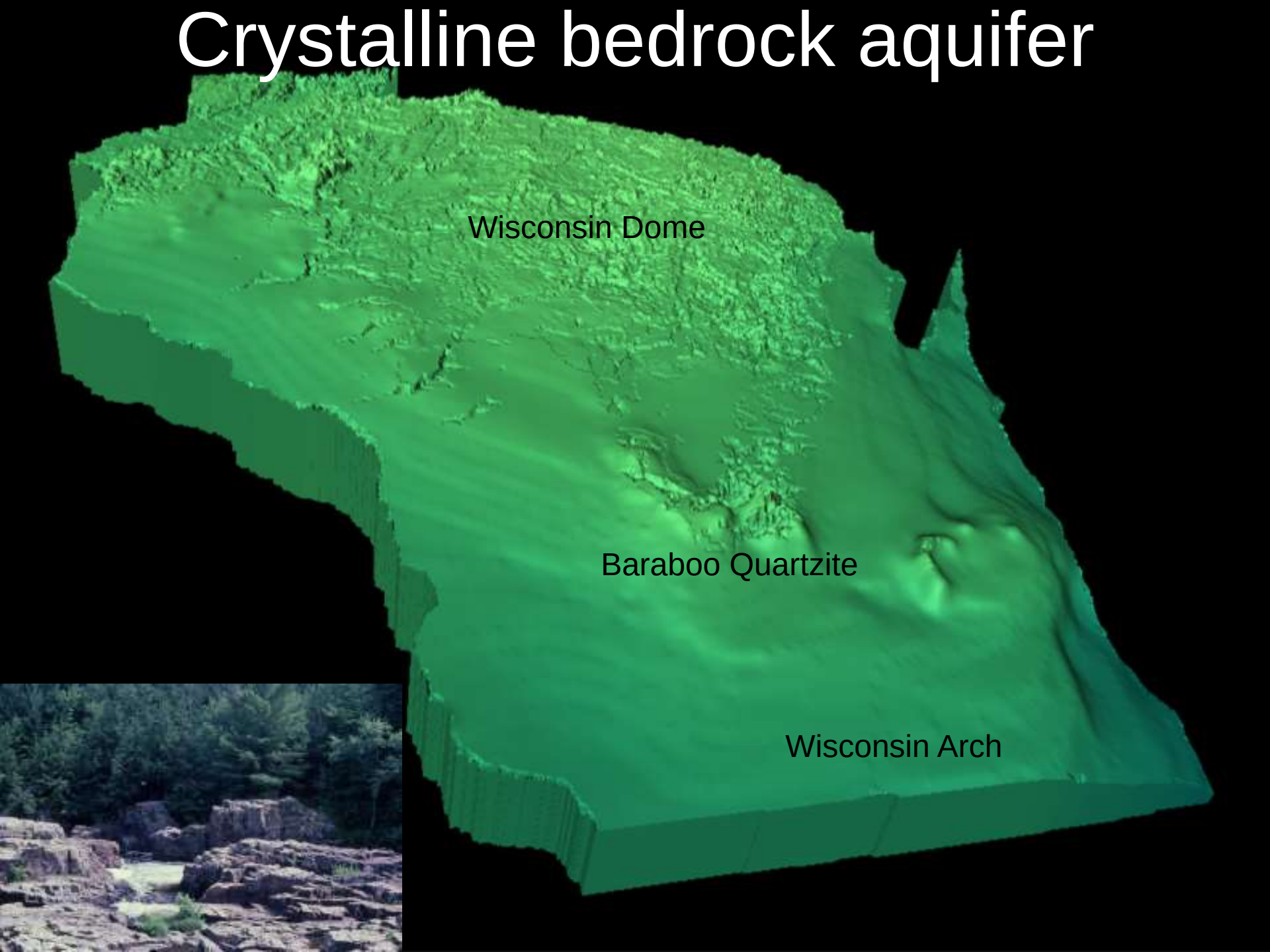
PreCambrian aquifer:

-crystalline (granite, quartzite)

-fracture dominated flow

-generally low well yields

Crystalline bedrock aquifer



“Sandstone” aquifer:

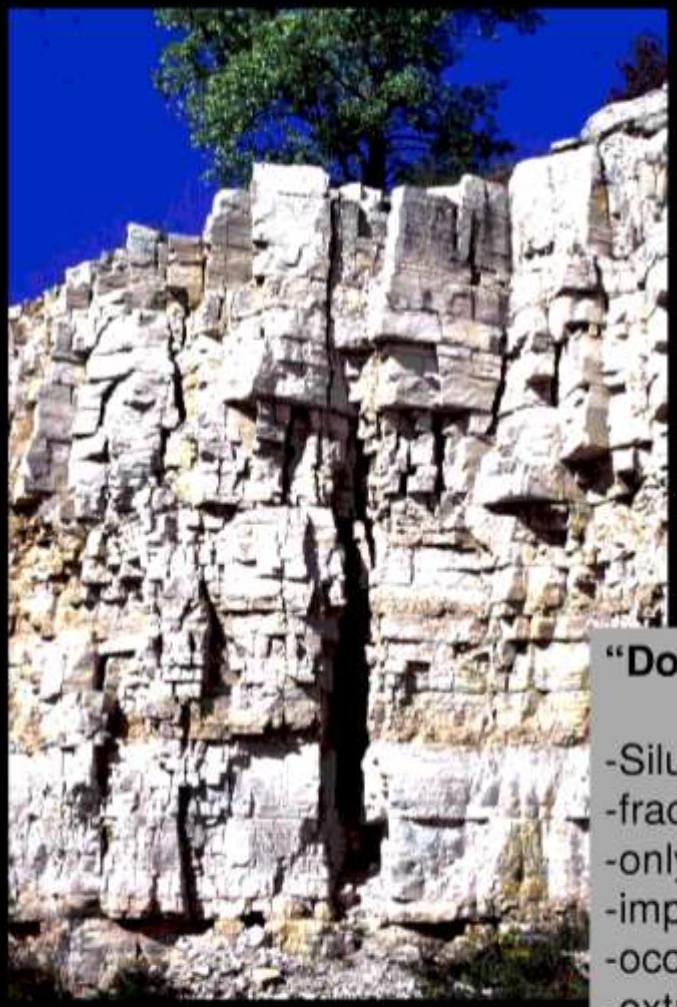
-sandstone, dolomite
-regionally extensive
-excellent aquifer
-porous flow
-most high-capacity wells
-occurs beneath shale in east

Sandstone and dolomite aquifer

Aquifer was eroded by glaciers

Wisconsin River Valley

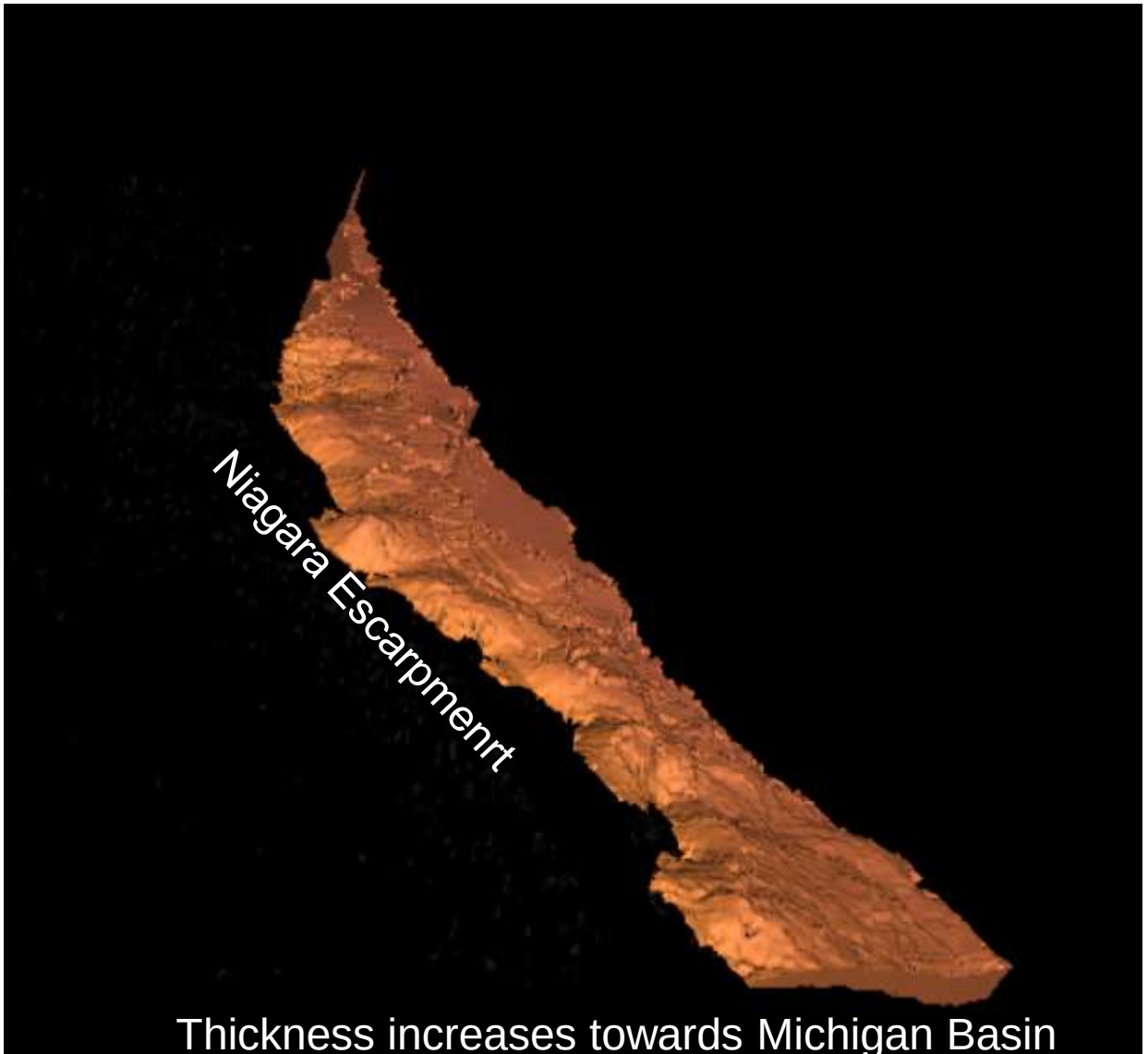
Wisconsin Arch

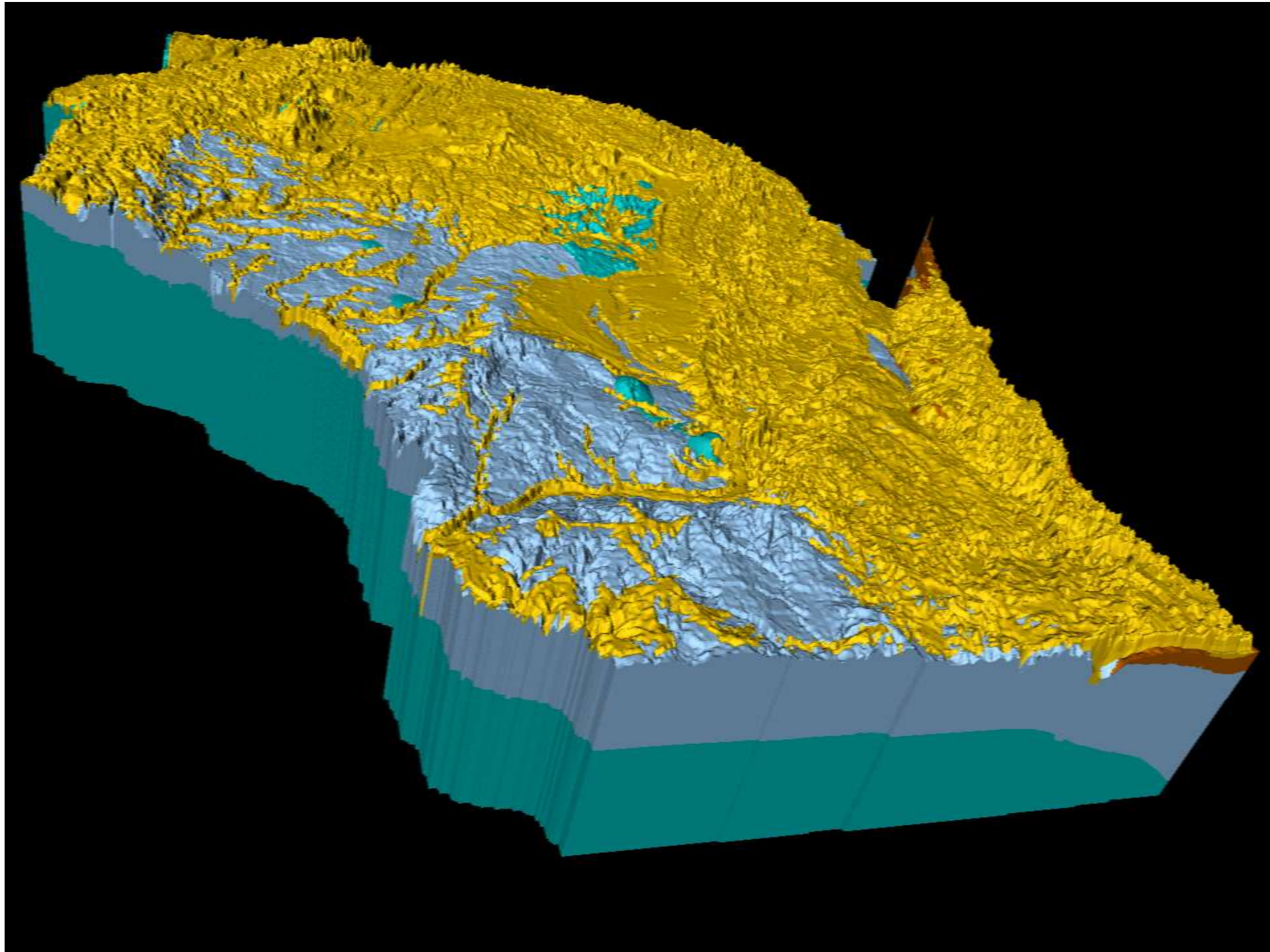


“Dolomite” aquifer:

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

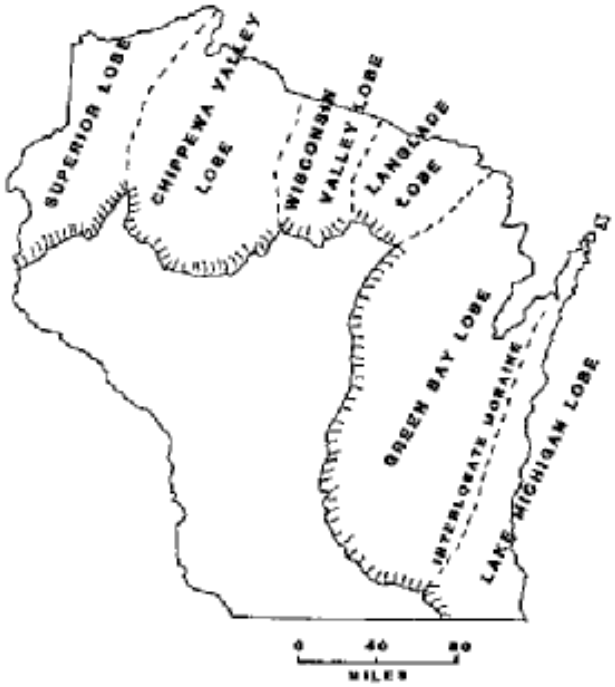
Eastern dolomite aquifer



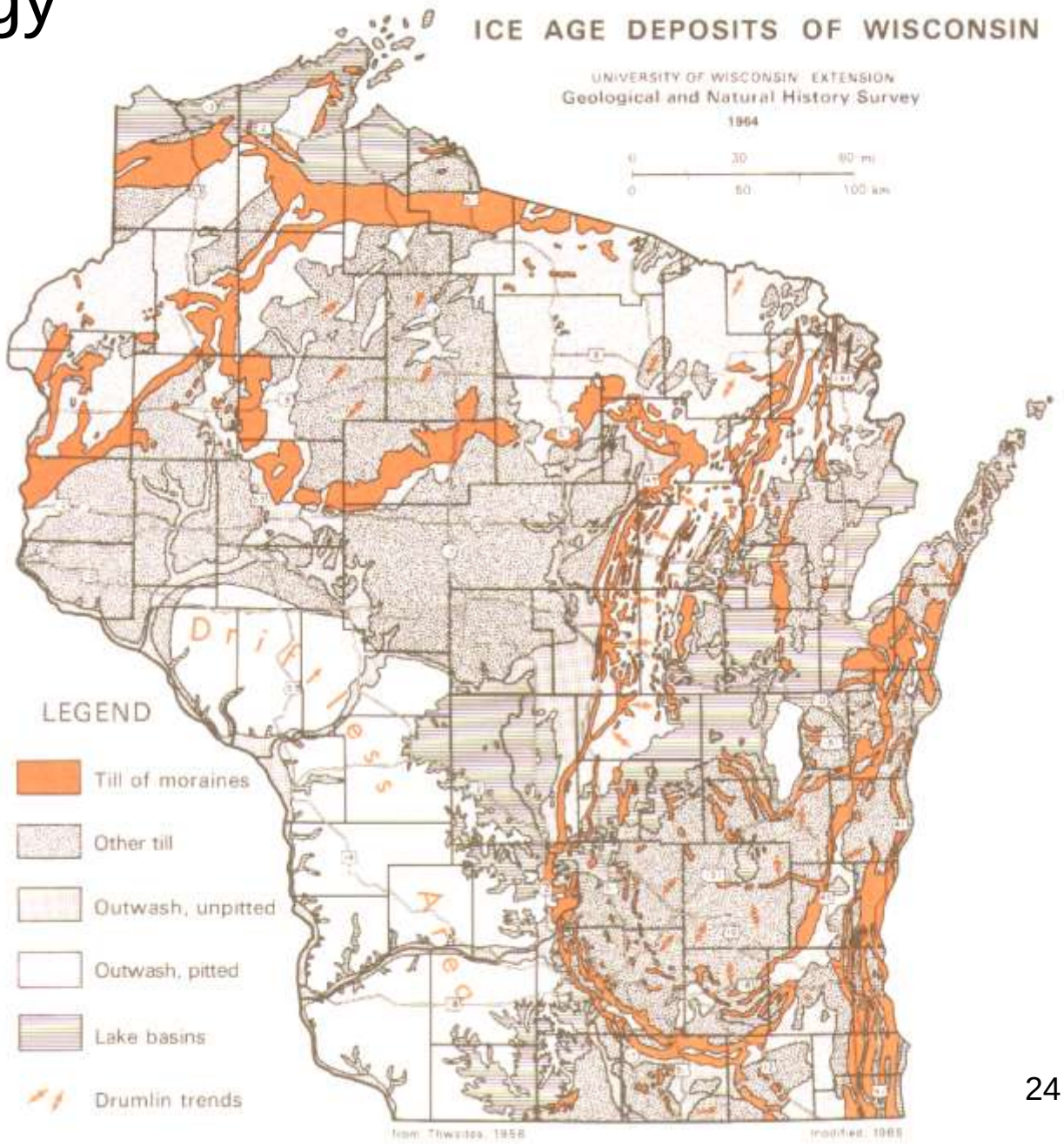


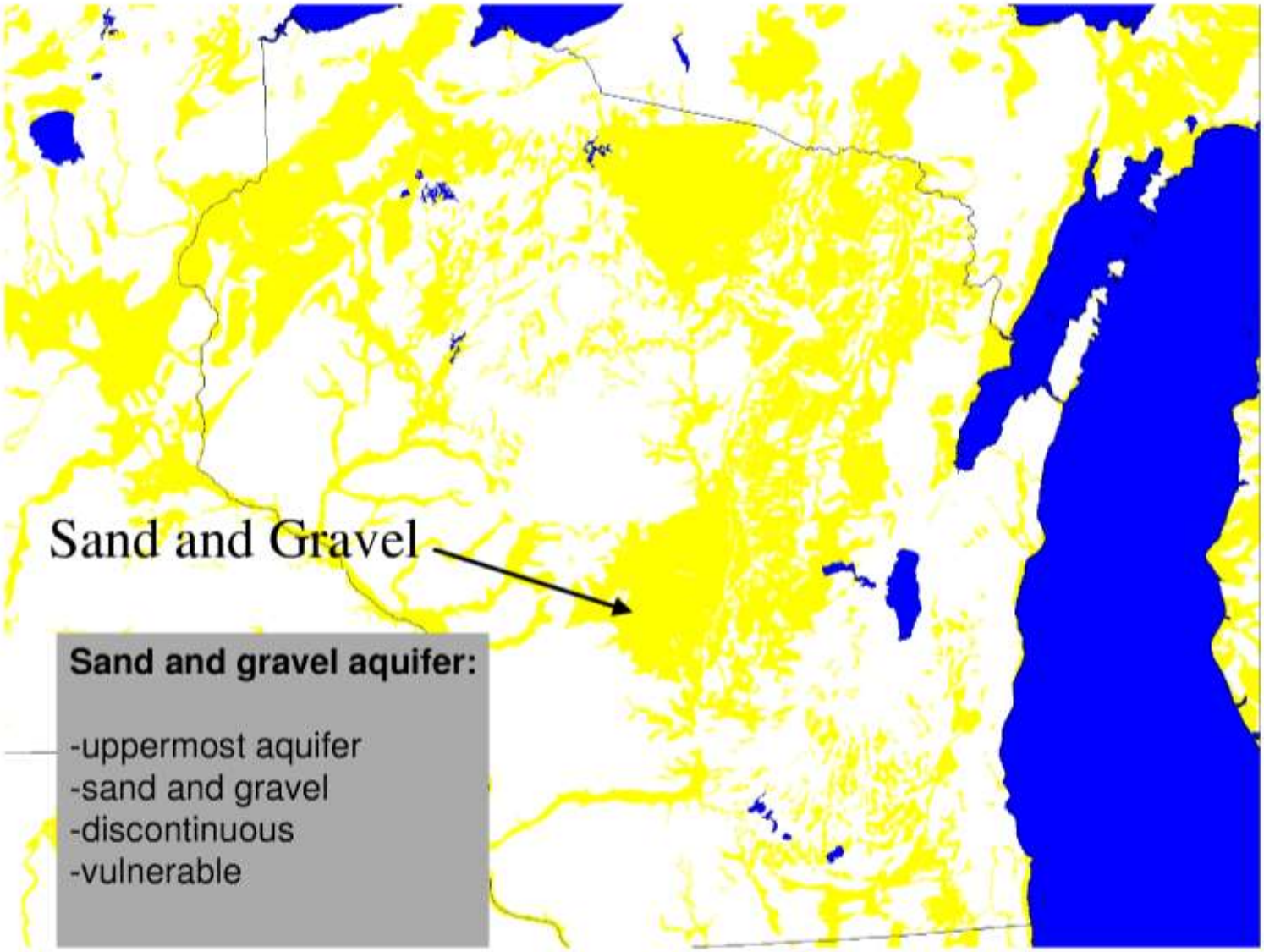
Wisconsin Geology - A very brief history
Part 3 - Glaciers

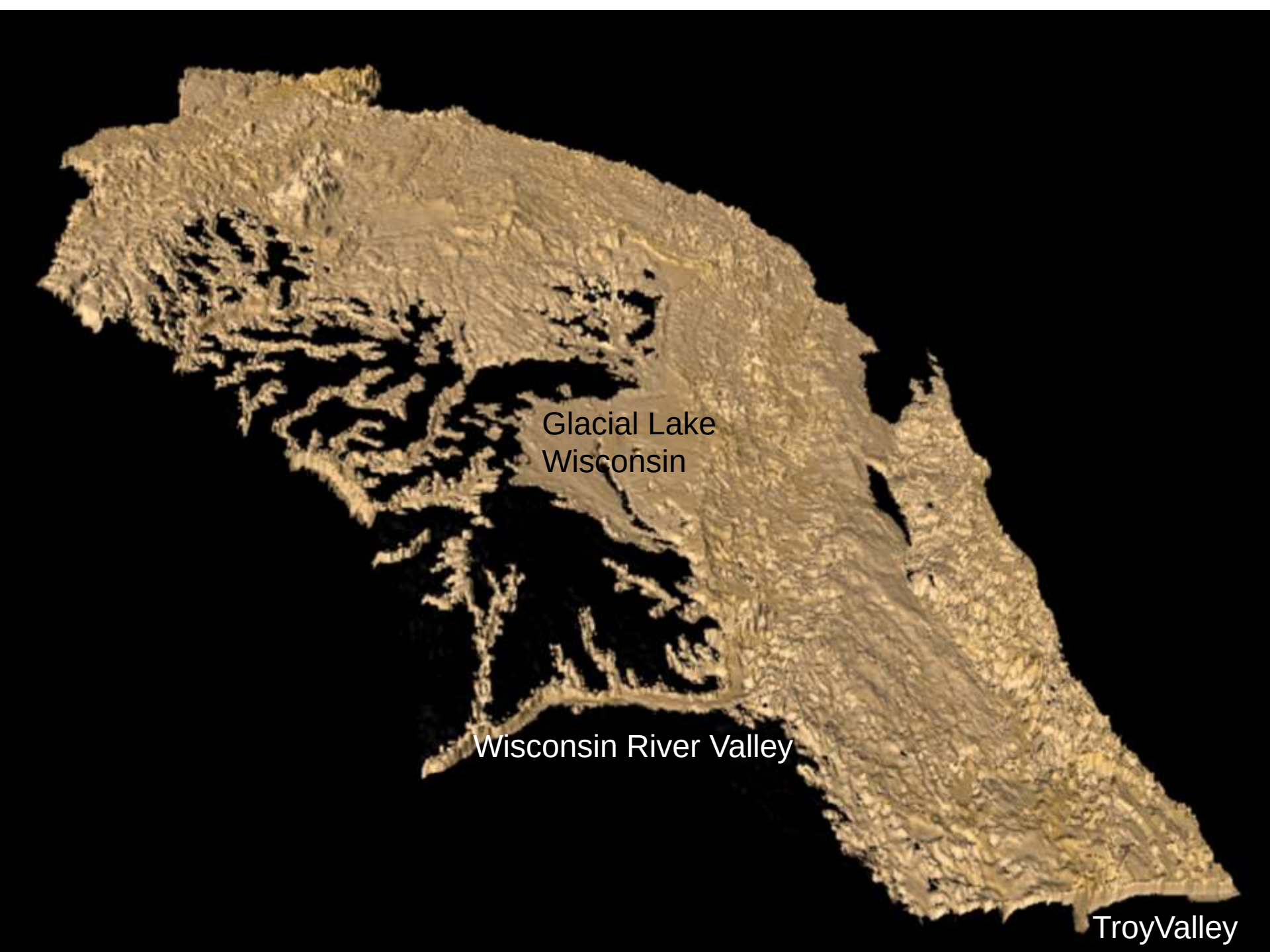
- 3 million – 12,000 years ago: Glaciers came and went at least 4, maybe 10 times.



Glacial Geology




Sand and Gravel
Sand and gravel aquifer:
-uppermost aquifer
-sand and gravel
-discontinuous
-vulnerable

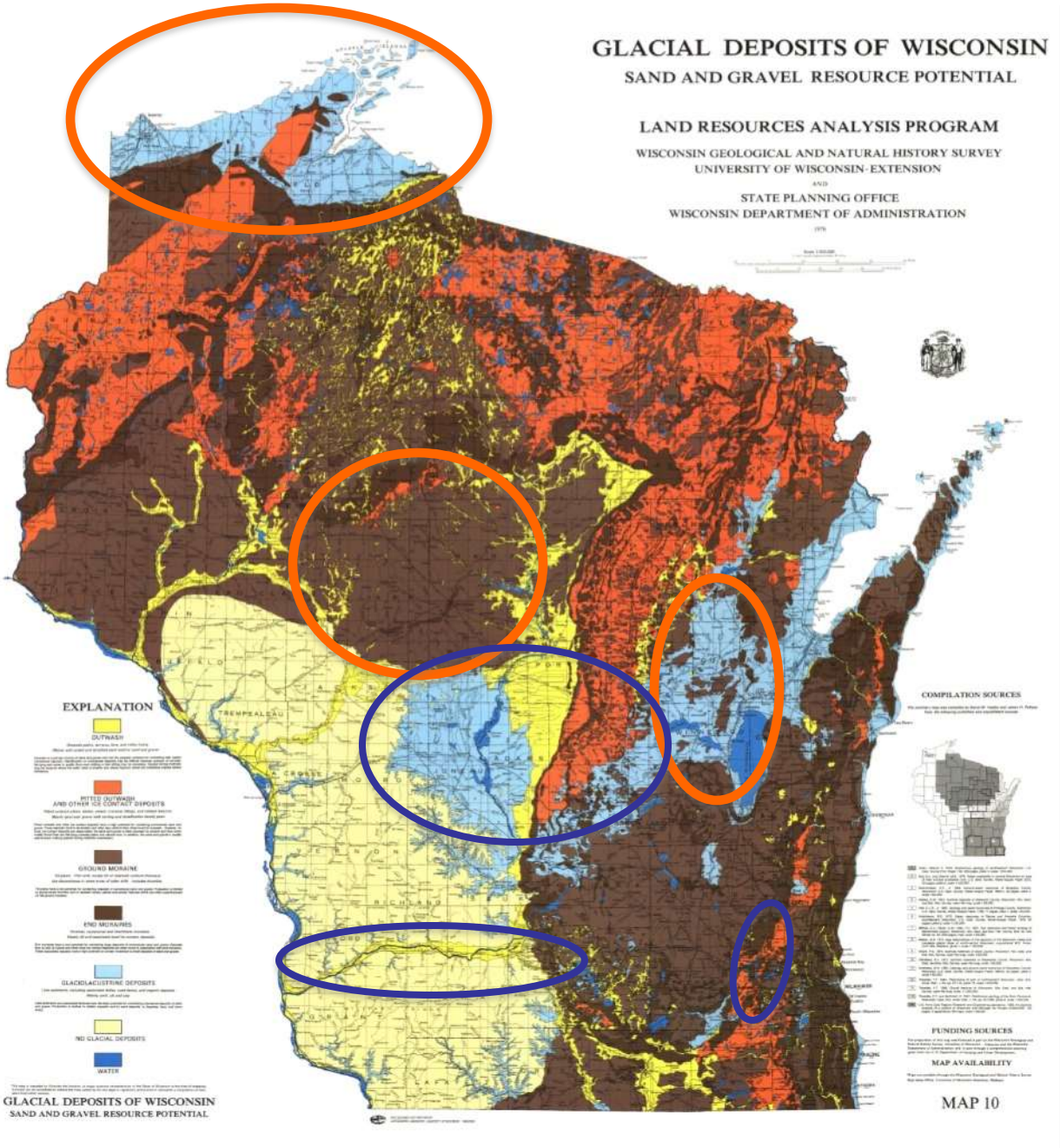

Glacial Lake
Wisconsin
Wisconsin River Valley
TroyValley

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

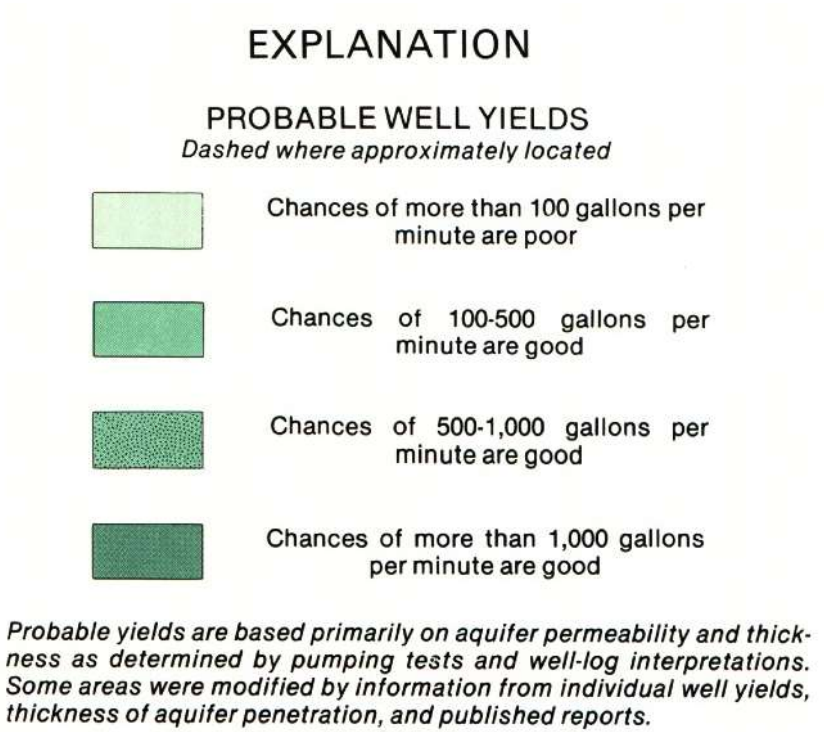


Next three maps are available from the Wisconsin Geological and Natural History Survey Web page

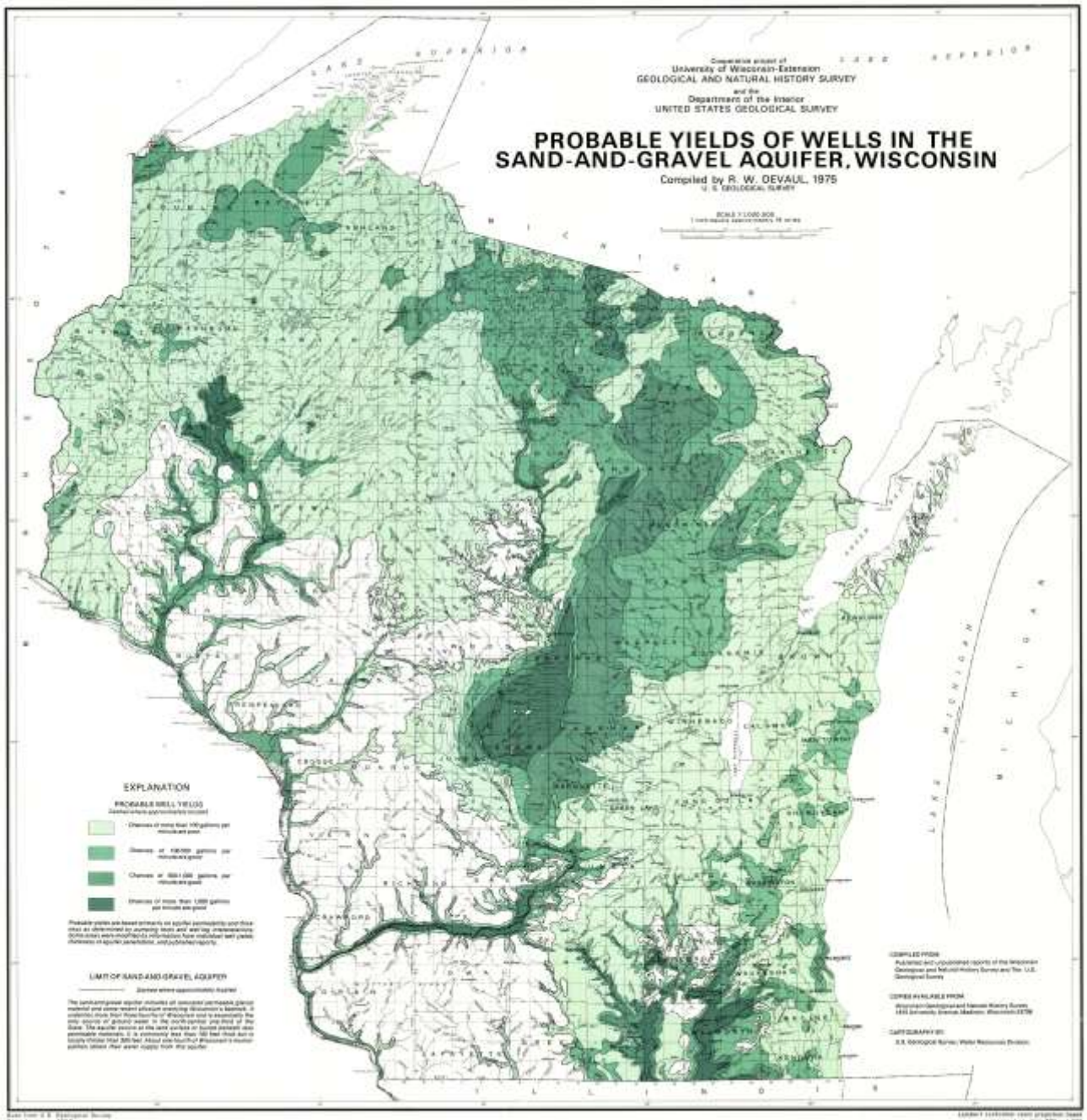
Sand and Gravel Aquifer
http://wgnhs.uwex.edu/pubs/download_m054/

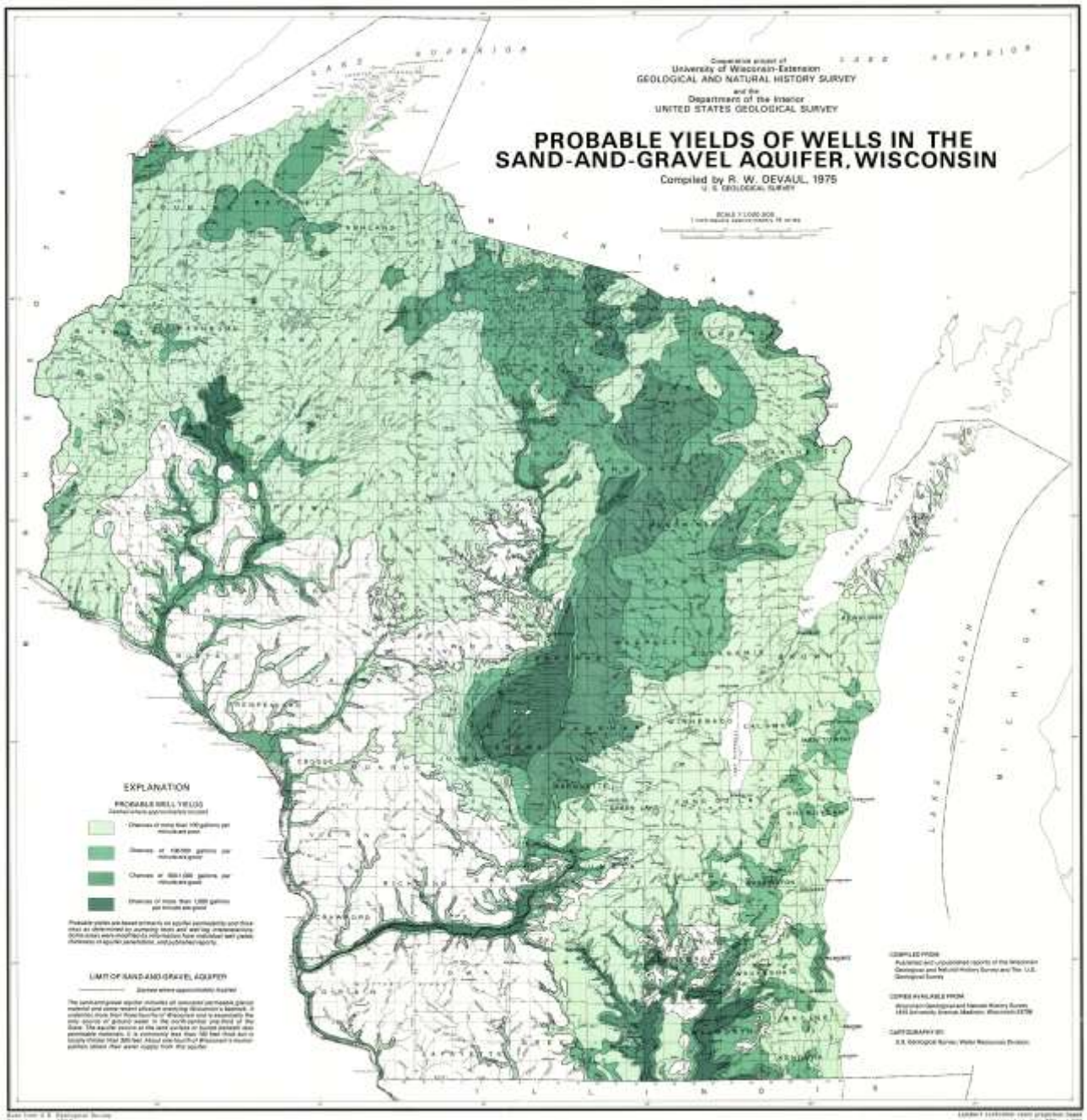
Sandstone Aquifer
http://wgnhs.uwex.edu/pubs/download_m055/

Niagara Dolomite Aquifer
http://wgnhs.uwex.edu/pubs/download_m056/



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


Cooperative project of
University of Wisconsin-Extension
GEOLOGICAL AND NATURAL HISTORY SURVEY
and the
Department of the Interior
UNITED STATES GEOLOGICAL SURVEY
PROBABLE YIELDS OF WELLS IN THE SAND-AND-GRAVEL AQUIFER, WISCONSIN
Compiled by R. W. OEVAUL, 1975
U. S. GEOLOGICAL SURVEY
SCALE 1:1,000,000
EXPLANATION
PROBABLE WELL YIELDS
Chances of more than 100 gallons per minute are good
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
LIMIT OF SAND-AND-GRAVEL AQUIFER
Dashed where approximately located
COMPILED FROM
OFFICES AVAILABLE FROM
CARTOGRAPHY BY
LAKE SUPERIOR
LAKE MICHIGAN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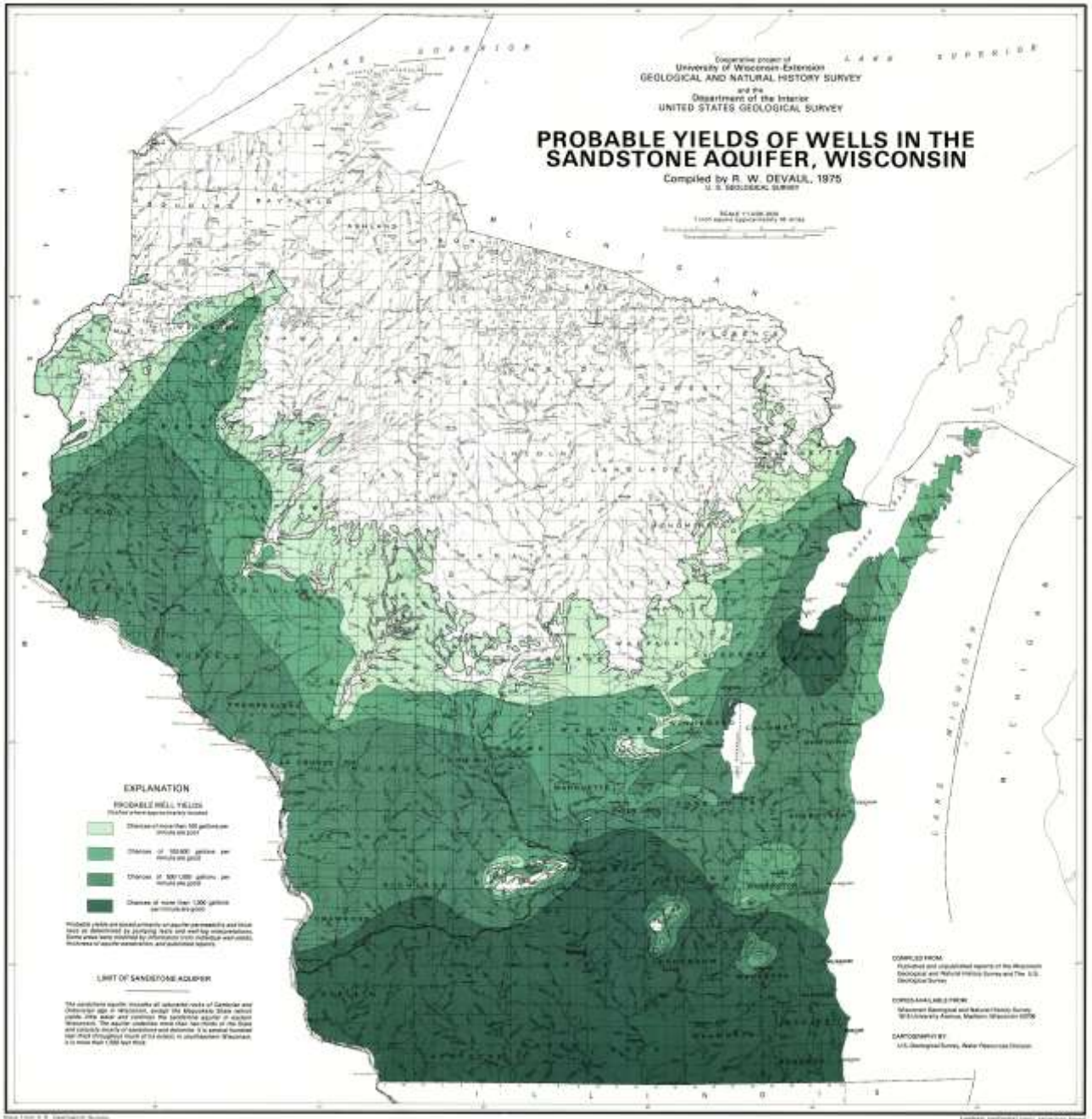
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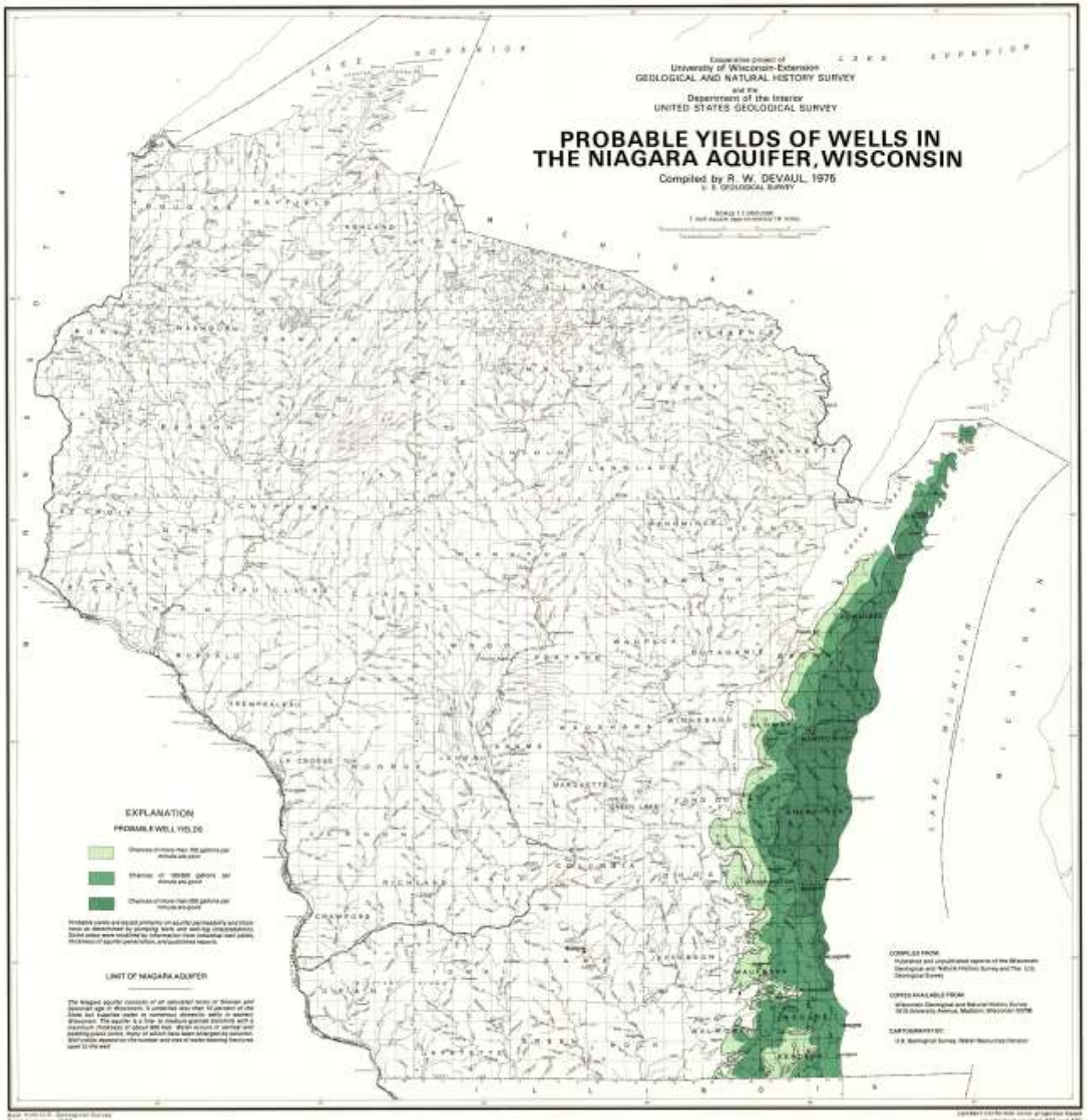
PROBABLE YIELDS OF WELLS IN THE SANDSTONE AQUIFER, WISCONSIN
Compiled by R. W. DEVAUL, 1975
U. S. GEOLOGICAL SURVEY
EXPLANATION
PROBABLE WELL YIELDS
LIMIT OF SANDSTONE AQUIFER
COMPILED FROM:
CAPTION BY: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PROBABLE YIELDS OF WELLS IN THE NIAGARA AQUIFER, WISCONSIN
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U. S. GEOLOGICAL SURVEY
EXPLANATION
PROBABLE WELL YIELDS
LIMIT OF NIAGARA AQUIFER
LAKE MICHIGAN

Crystalline Bedrock Aquifer

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