



# Geology of Michigan

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# Geology – The Earth Beneath Our Feet

- Geology is the surface of the Earth and the soils, sands, gravels and solid bedrock deeper into the earth
- Sometimes we are interested in what is a few hundred feet down, sometimes thousands of feet down.

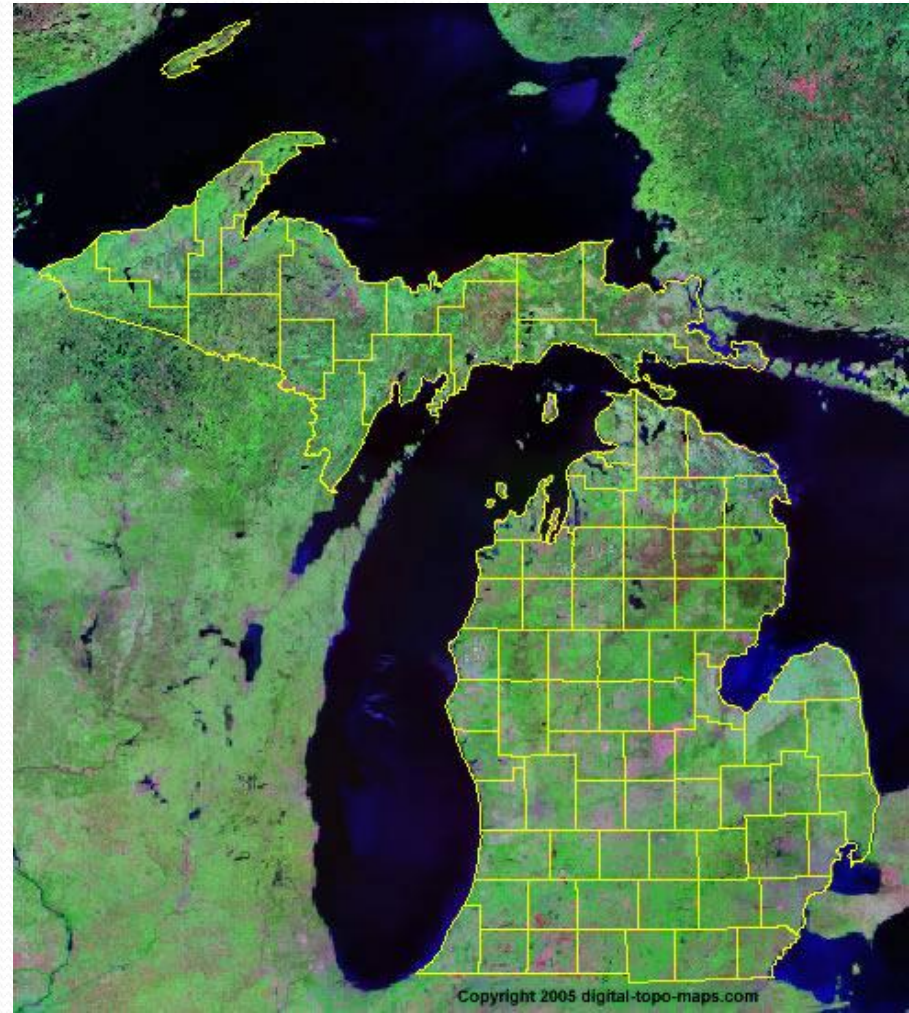


# How Do We Describe Geologic Materials?



# How do we know about the Geology of Michigan?

- We look around Michigan and observe the landforms, soils, beaches, etc. at the surface and also look for areas of solid bedrock, mostly along the lake shores, in river valleys and in quarries that we dig. Also we can sample rock layers by drilling wells.



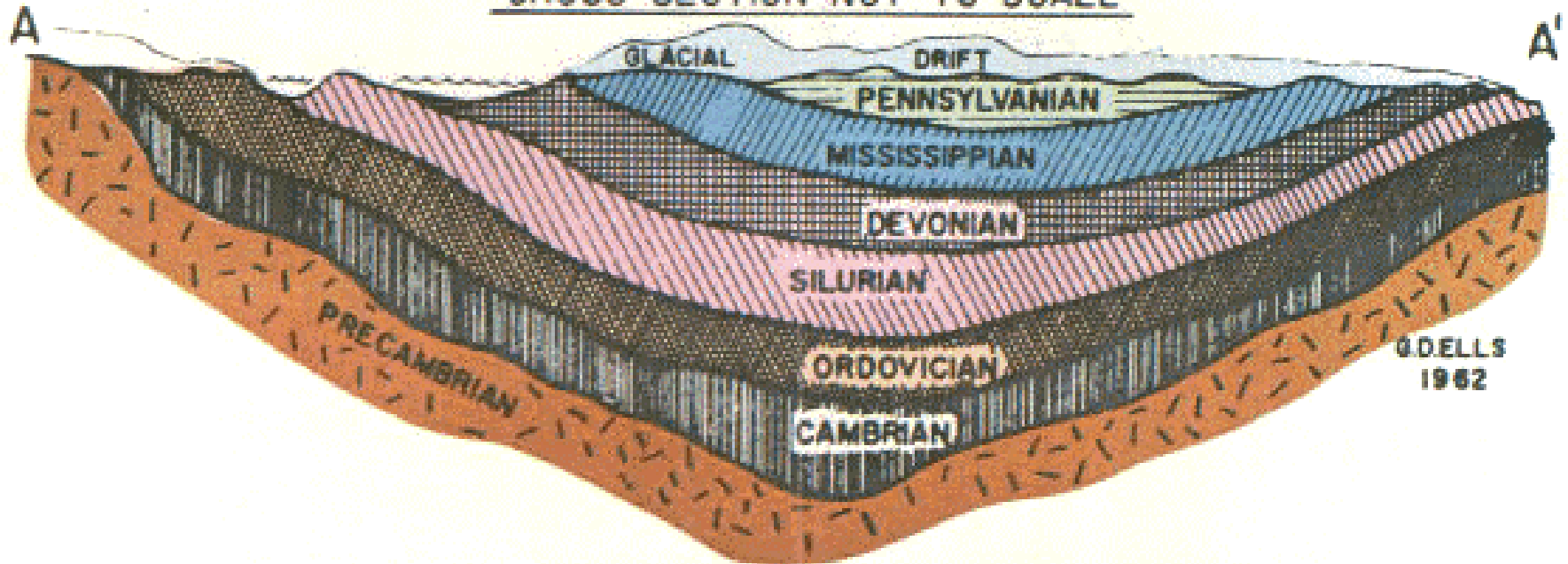


# Variation in Geology around the State

- The thickness and types of geologic materials vary from region to region in Michigan
- The thickest column of these formations is in Central Michigan and thinning occurs towards the edges
- Surface geology may vary, especially in the Upper Peninsula
- Types of rocks deeper in the subsurface may change around the State

# Geologic Cross Section of Michigan

CROSS SECTION NOT TO SCALE



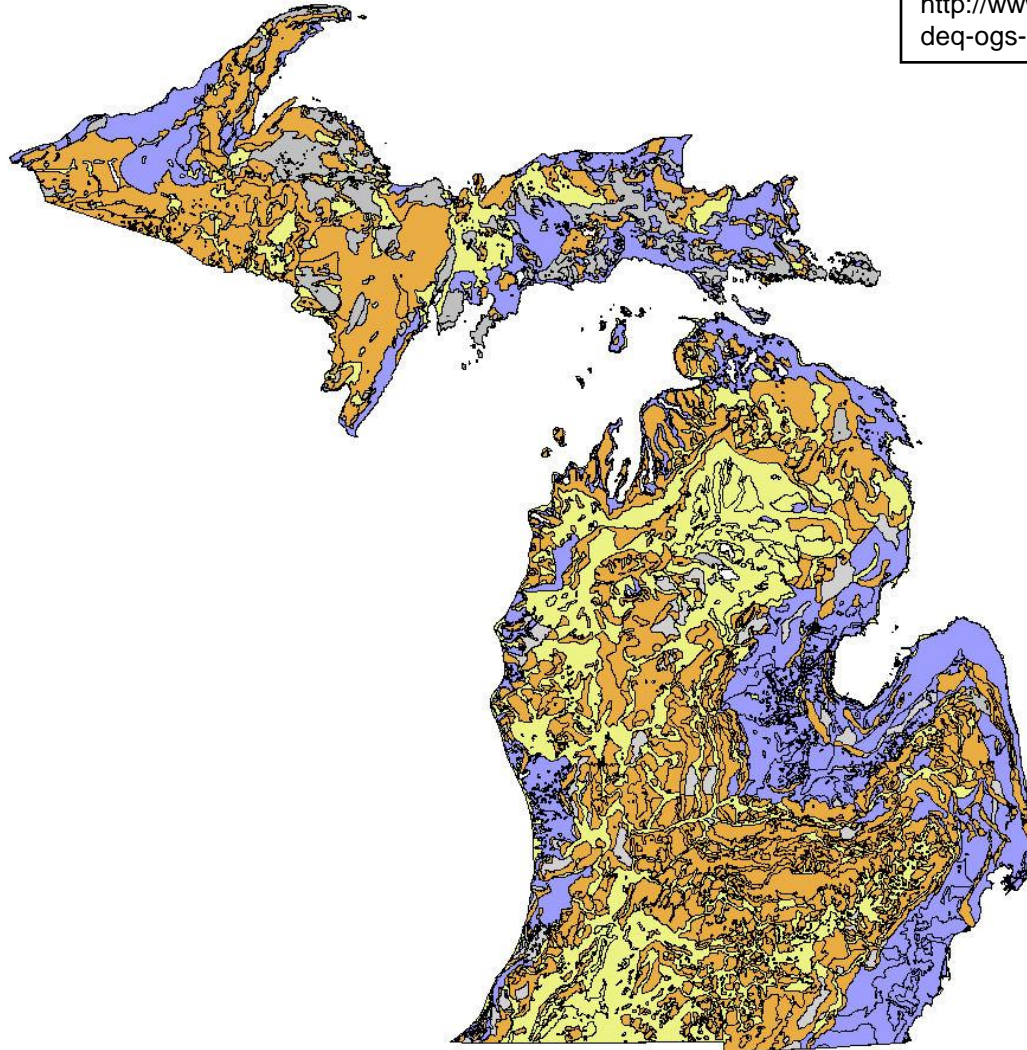
# Introduction-Geology of Michigan

- Geologic data for most of Michigan is derived from sparse natural outcrops, quarries and abundant well data with logs, samples and cores
- Surface geology of Michigan is dominated by Pleistocene Glacial deposits and landforms
- Subsurface geology is mostly the Paleozoic sedimentary rocks of the Michigan Basin
- Surface and subsurface geology of Western Upper Peninsula is Pre-Cambrian crystalline igneous and metamorphic with some sedimentary and metasedimentary rocks



# Glacial Geology in Michigan

Steve Wilson, 2006  
[http://www.deq.state.mi.us/documents/deq-ogs-gimdl-GTLH\\_geo.pdf](http://www.deq.state.mi.us/documents/deq-ogs-gimdl-GTLH_geo.pdf)

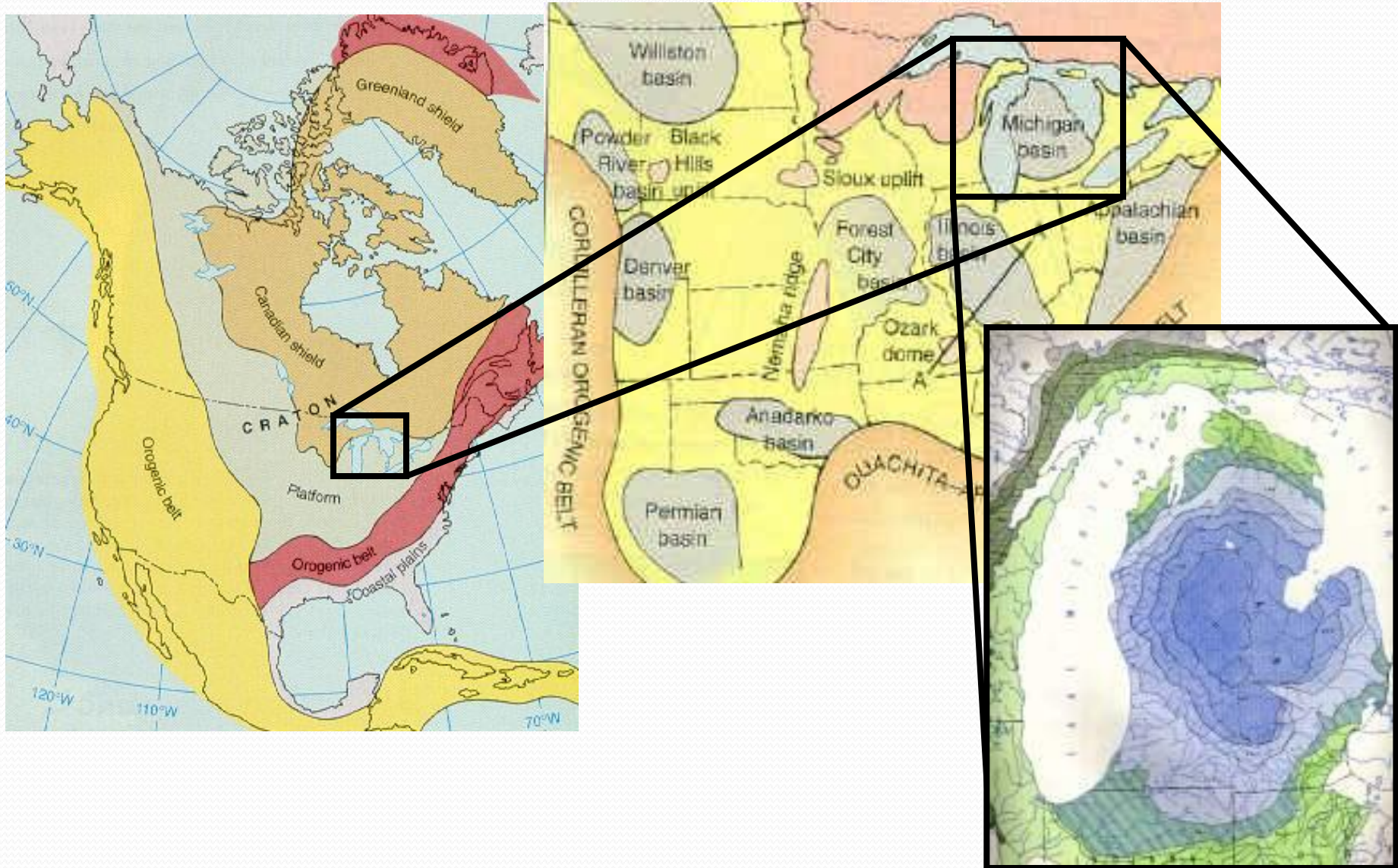


# Glacial Gravel Quarry, near Petoskey, MI

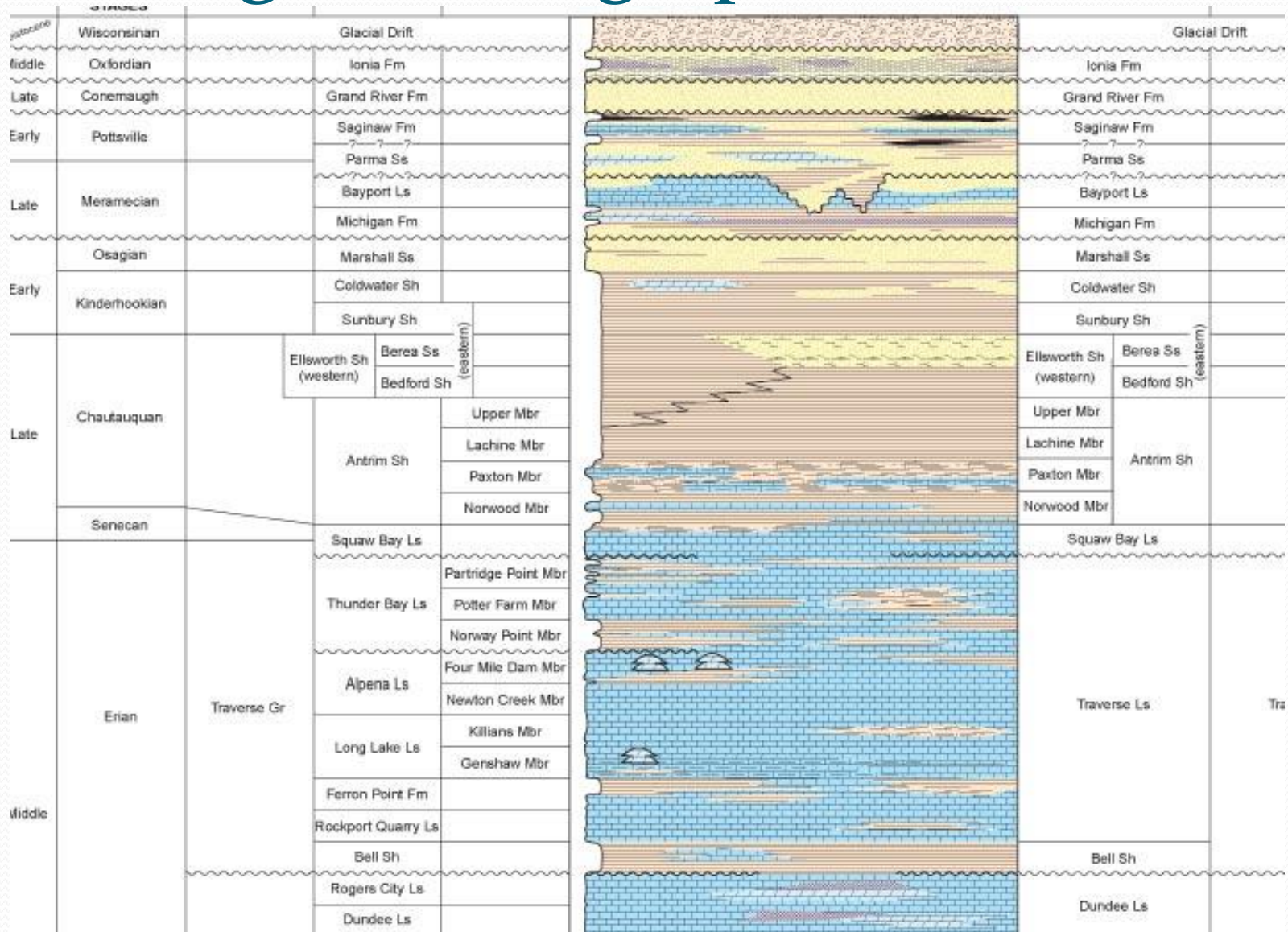




# Geologic Setting of the Michigan Basin

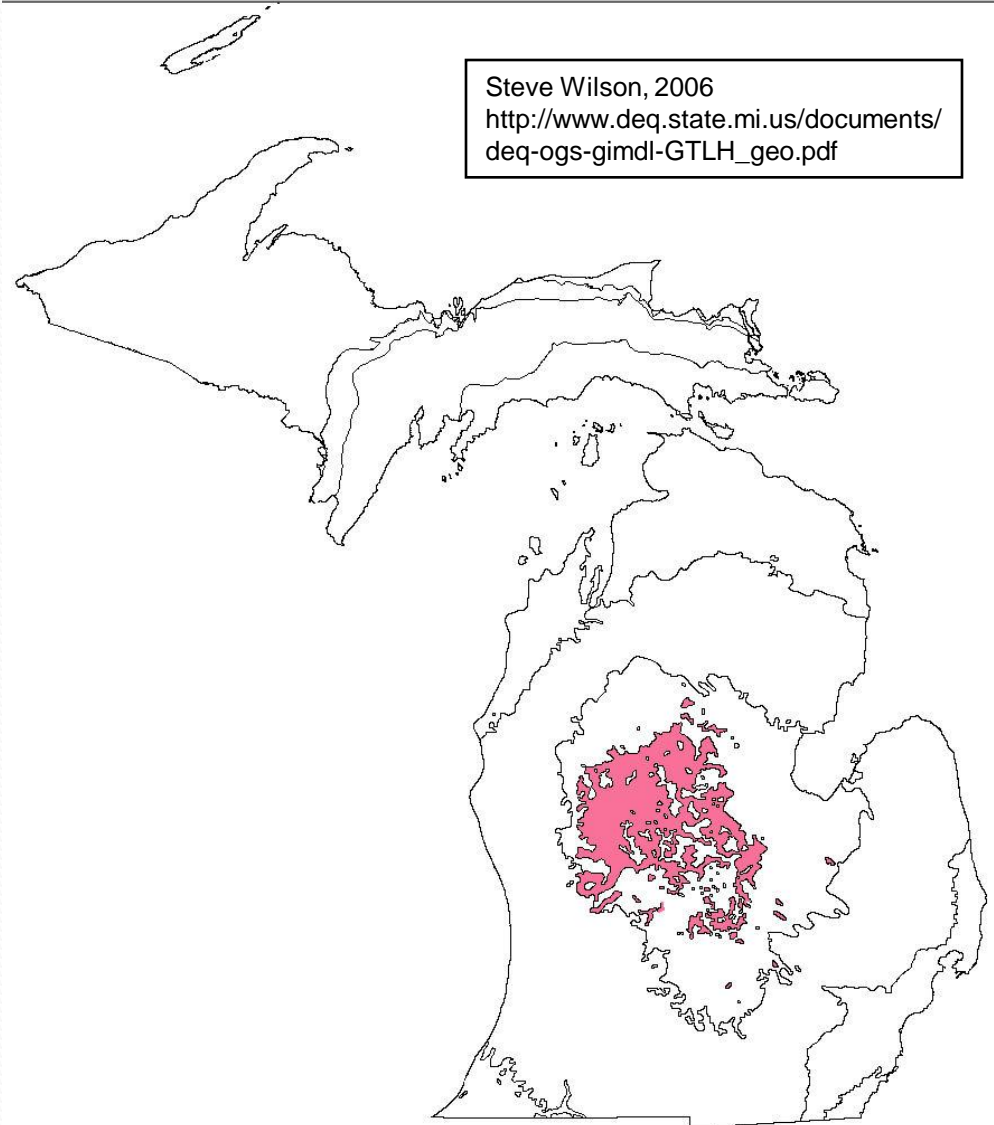


# Michigan Stratigraphic Column



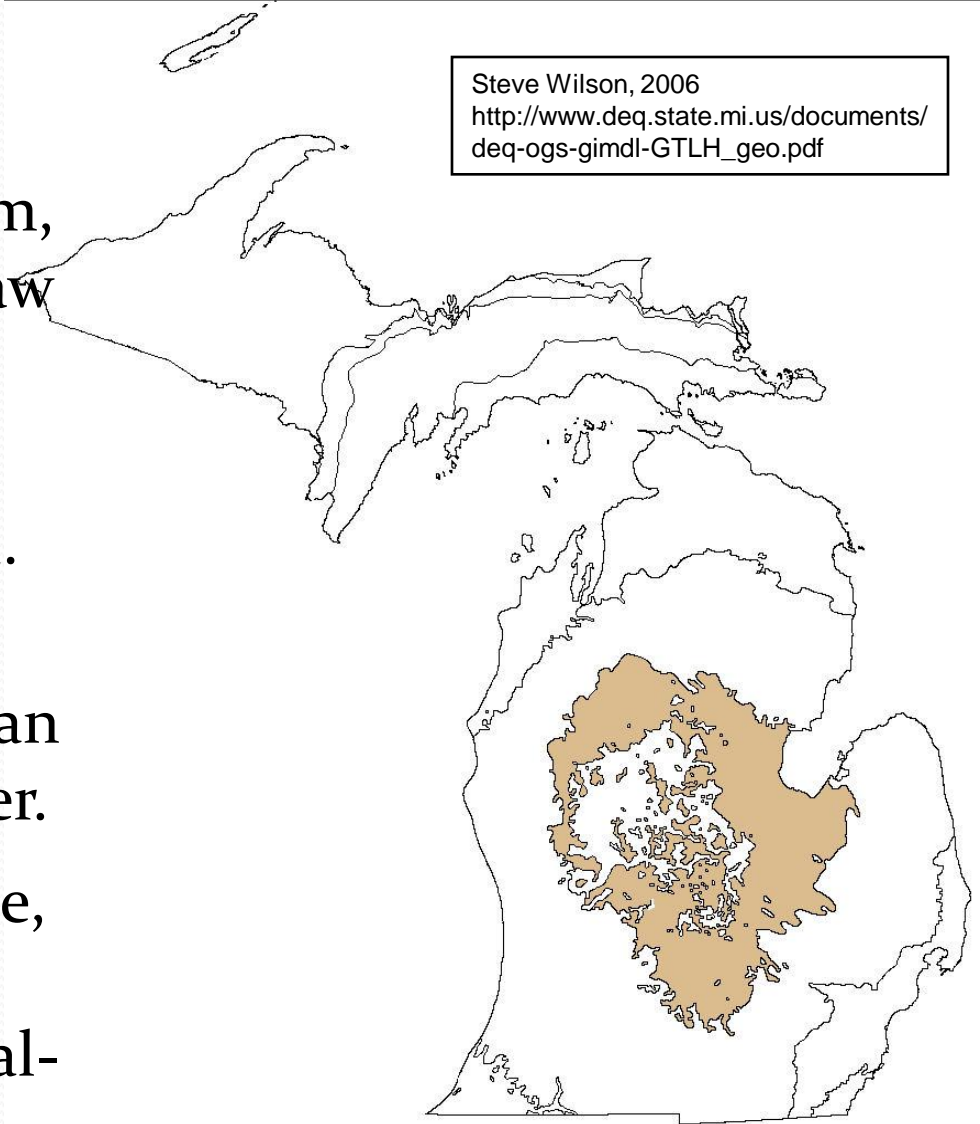
# Jurassic Subcrop

- Jurassic outcrops are not found in Michigan, strata is only known from oil and gas drilling samples that contain fossil spores and pollen of Jurassic age.
- Ionia Sandstone is only known formation.
- Lithology is medium to fine red sandstone probably deposited in a terrestrial setting.



# Pennsylvanian Subcrop

- Isolated outcrops occur in Arenac, Branch, Calhoun, Clinton, Eaton, Huron, Ingham, Ionia, Jackson, Ottawa, Saginaw and Shiawassee counties.
- Major natural resources are limestone, sandstone and coal.
- Several units are regional bedrock aquifers and serve as an important source of fresh water.
- Lithology is mixed sandstone, shale, siltstone, coal and limestone deposited in a fluvial-deltaic setting.



# Pennsylvanian Sandstones at Grand Ledge, MI

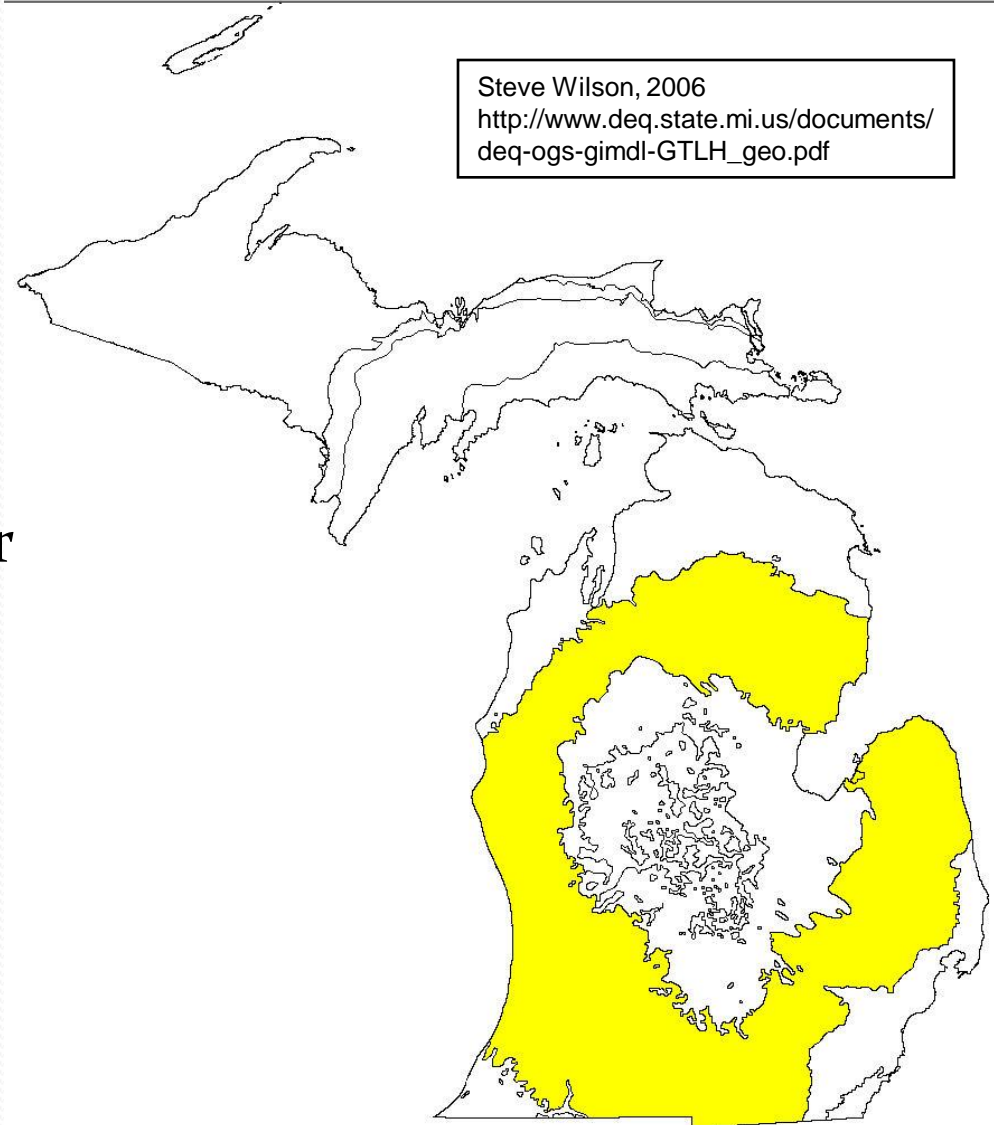


[http://www.msstate.edu/dept/geosciences/CT/TIG/WEBSITES/LICAL/Summer2003/Fessenden\\_Lisa/7day1.html](http://www.msstate.edu/dept/geosciences/CT/TIG/WEBSITES/LICAL/Summer2003/Fessenden_Lisa/7day1.html)



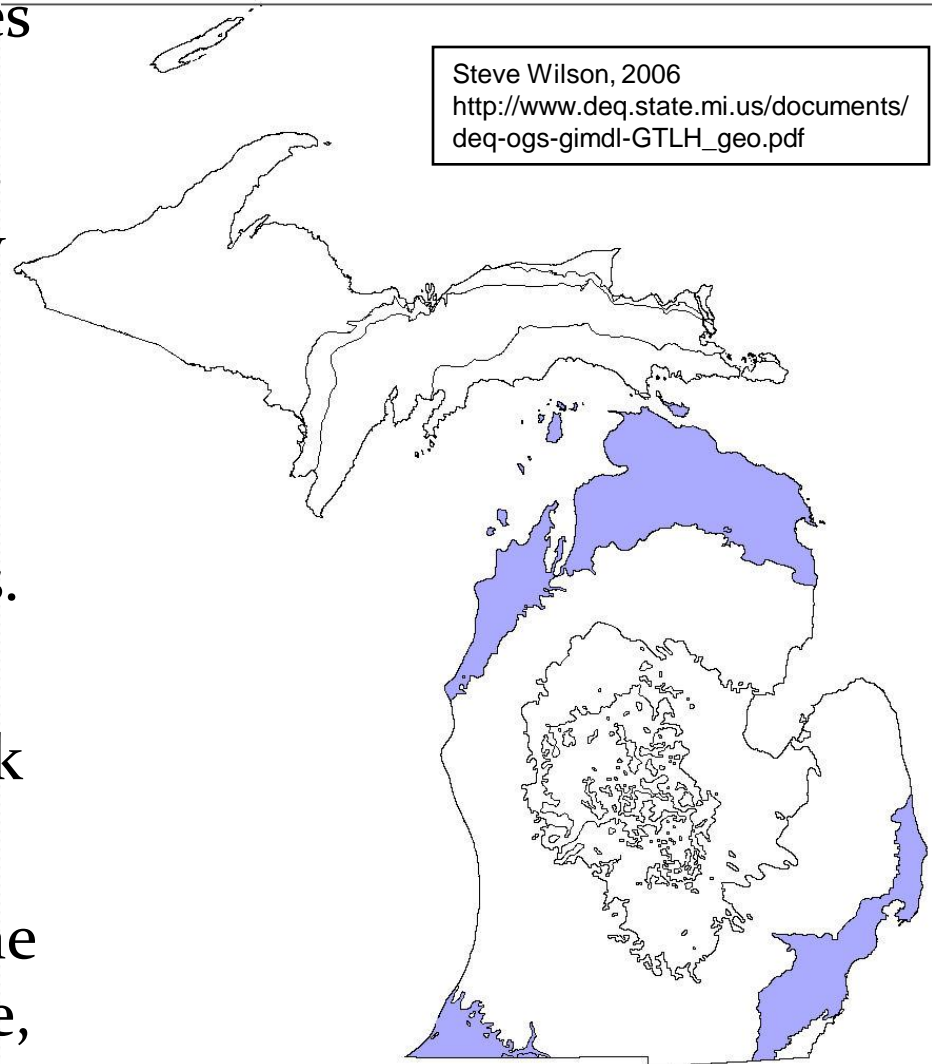
# Mississippian Subcrop

- Largest area of subcrop for any geological system in the Lower Peninsula.
- Major natural resources are limestone and fine-grained sandstone.
- Marshall Sandstone is major regional bedrock aquifer and serves as an important source of fresh water.
- Lithology is mixed sandstone, shale, siltstone, coal and limestone deposited in a shallow marine setting.

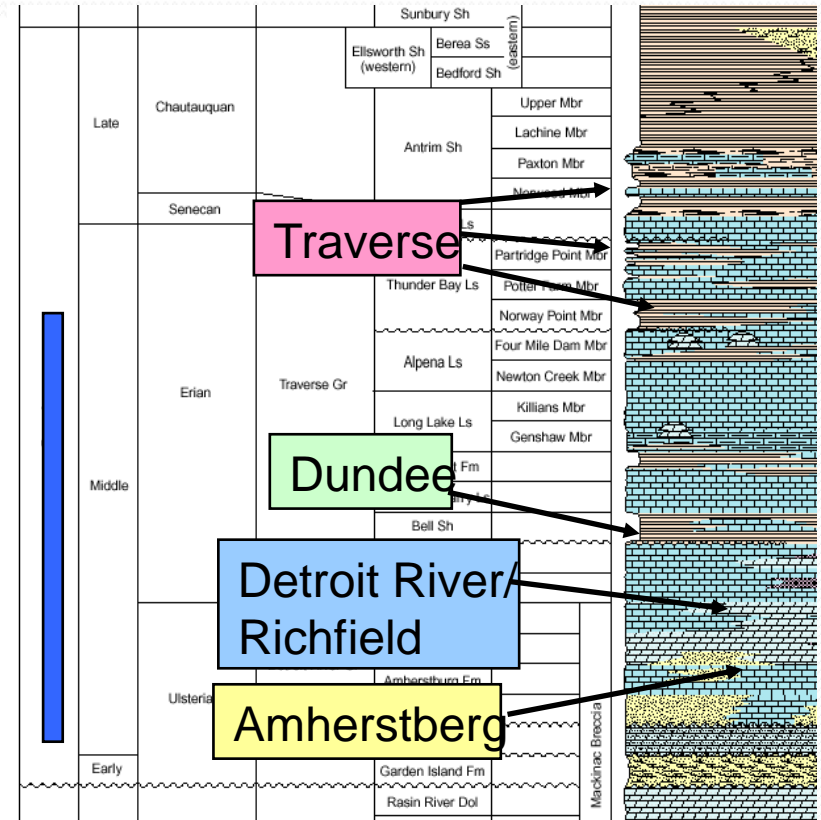


# Devonian Subcrop

- Natural outcrops and quarries are relatively abundant, especially near the Great Lakes margins. Bedrock is commonly near the surface, with thin glacial veneer.
- Major natural resources are limestone and a few clay shales.
- Fractured and karsted Limestone are regional bedrock aquifer in northern L.P.
- Lithology is mostly Limestone and Dolomite with minor shale, evaporites and sandstone.



# Middle Devonian Rocks in Michigan



Middle Devonian reservoirs include Traverse Limestone, Dundee Formation, Detroit River Group and Amherstberg Fm. Subcrop of these rocks shown

From Michigan Geological Survey Presentation – “The Rock Cycle”

# Antrim Shale Localities near Norwood, MI and Kettle Point, ONT



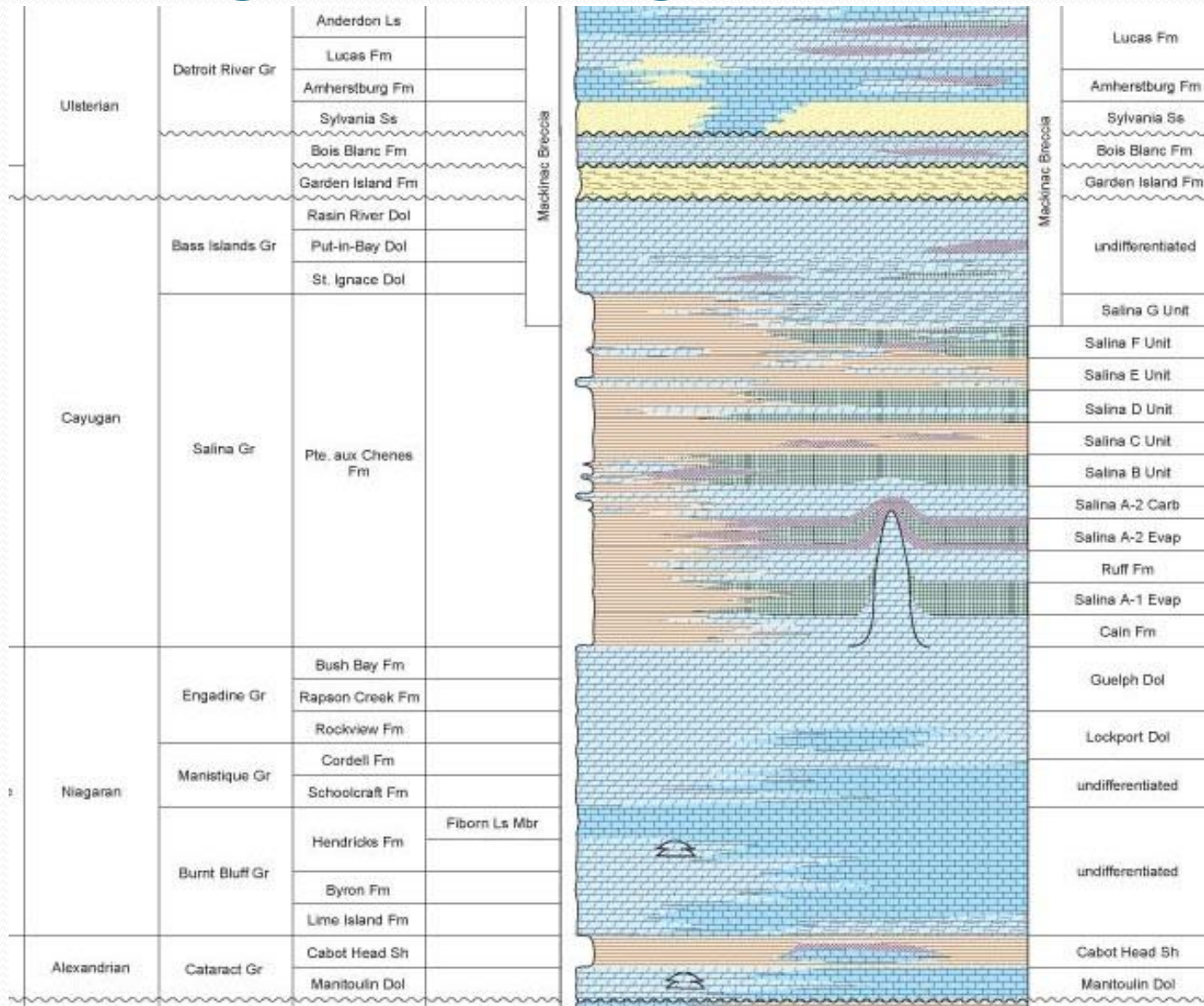
# Traverse Lime, near Charlevoix, MI and Squaw Bay, near Alpena, MI



# Rogers City and Dundee Limestones, Near Rogers City, MI

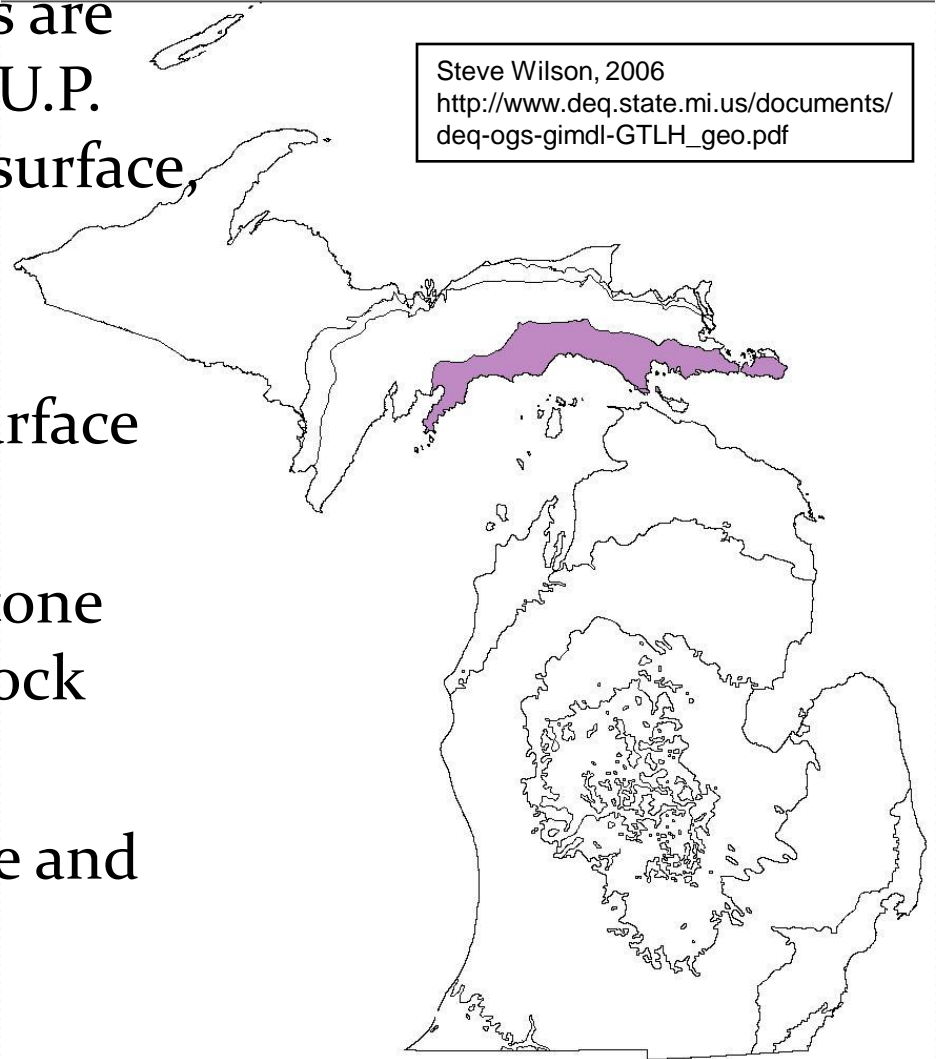


# Michigan Stratigraphic Column



# Silurian Subcrop

- Natural outcrops and quarries are fairly common in southeastern U.P. Bedrock is commonly near the surface, with thin glacial veneer.
- Major natural resources are limestone and dolomite near surface and salt in subsurface.
- Fractured and karsted Limestone and dolomite are regional bedrock aquifer in southeastern U.P.
- Lithology is mostly Limestone and Dolomite with minor shale and abundant basinal evaporites.



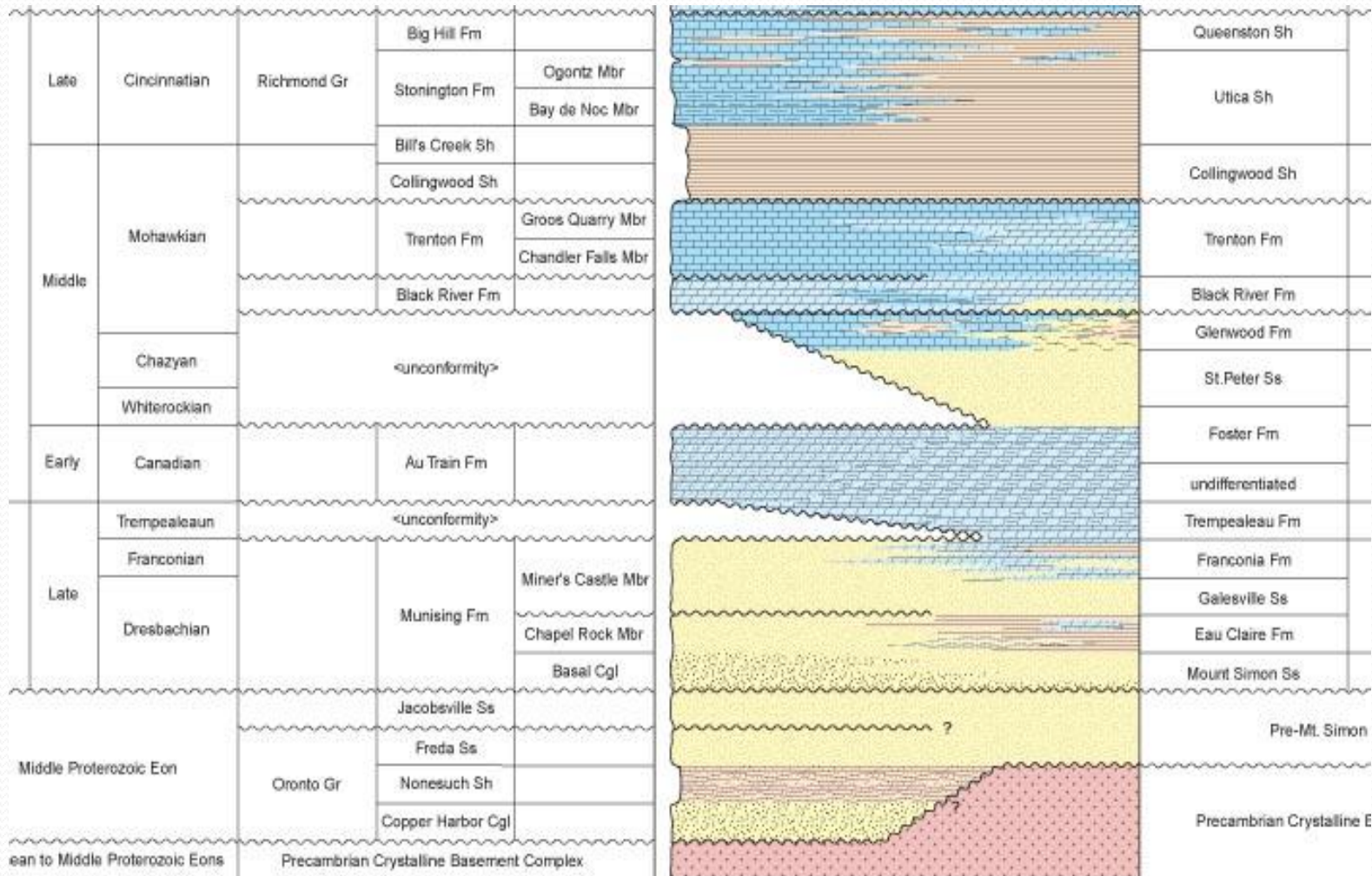
Steve Wilson, 2006  
[http://www.deq.state.mi.us/documents/deq-ogs-gimdl-GTLH\\_geo.pdf](http://www.deq.state.mi.us/documents/deq-ogs-gimdl-GTLH_geo.pdf)



# Silurian Engadine Fm. Northeast of St. Ignace, MI

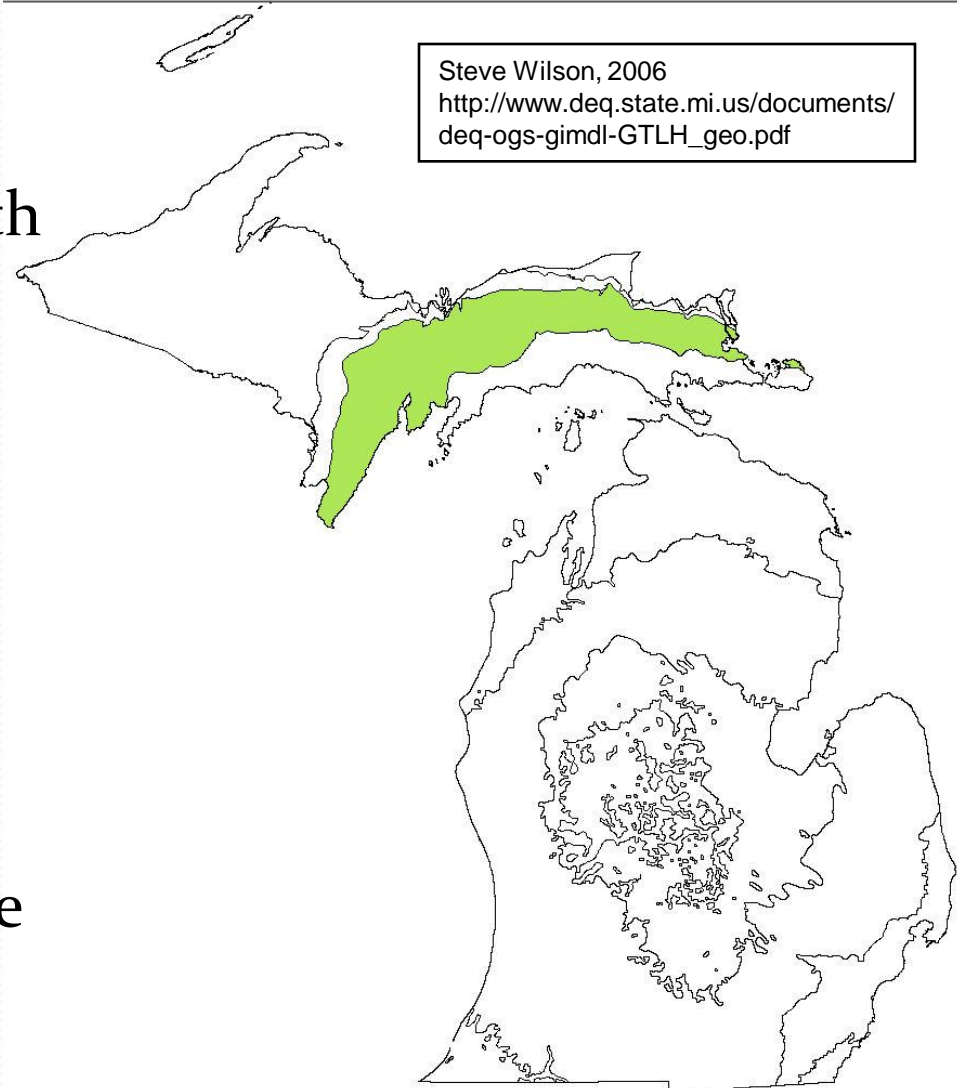


# Michigan Stratigraphic Column



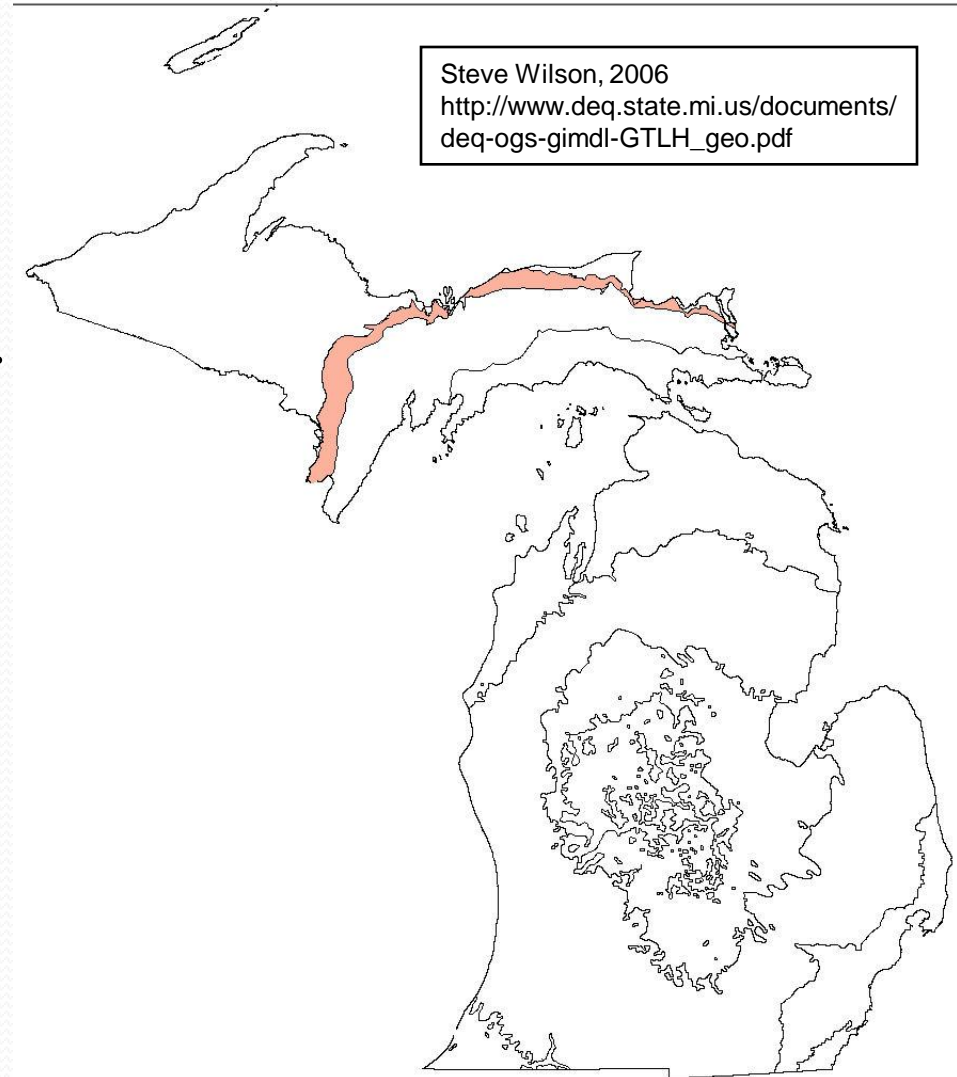
# Ordovician Subcrop

- Natural outcrops uncommon in central U.P. Bedrock is commonly near the surface, with thin glacial veneer.
- Major natural resources are limestone and dolomite.
- Fractured and karsted Limestone and dolomite are regional bedrock aquifer in central U.P.
- Lithology is mostly Limestone and Dolomite with minor shale and sandy dolomite.

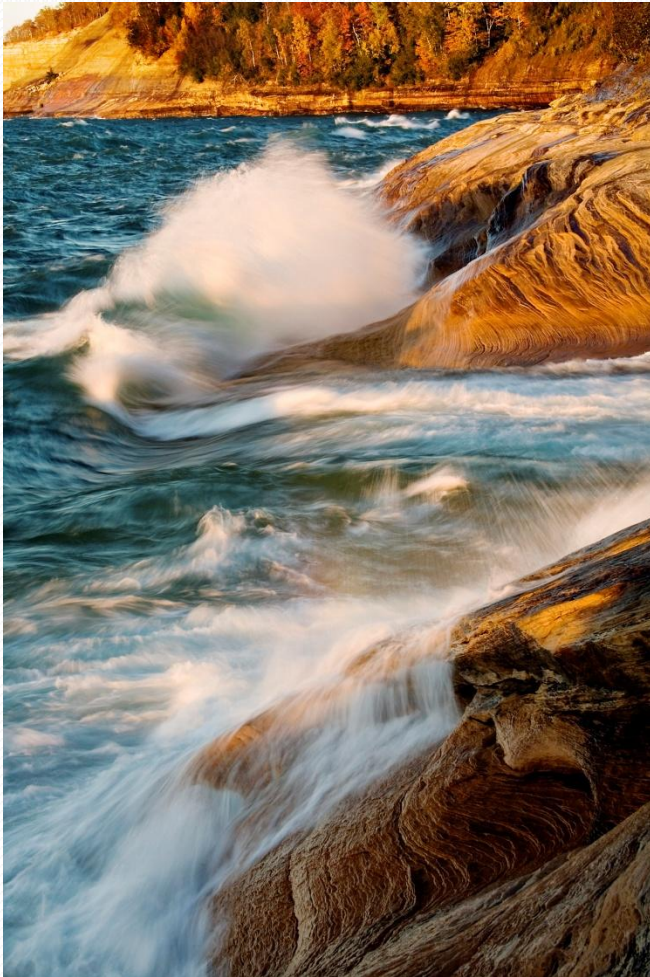


# Cambrian Subcrop

- Natural outcrops abundant along Lake Superior shoreline. Bedrock is commonly near the surface, with thin glacial veneer. Major waterfall forming unit in U.P.
- Major potential natural resource is Sandstone.
- Sandstone is local bedrock aquifer in northern U.P.
- Lithology is predominately Sandstone.

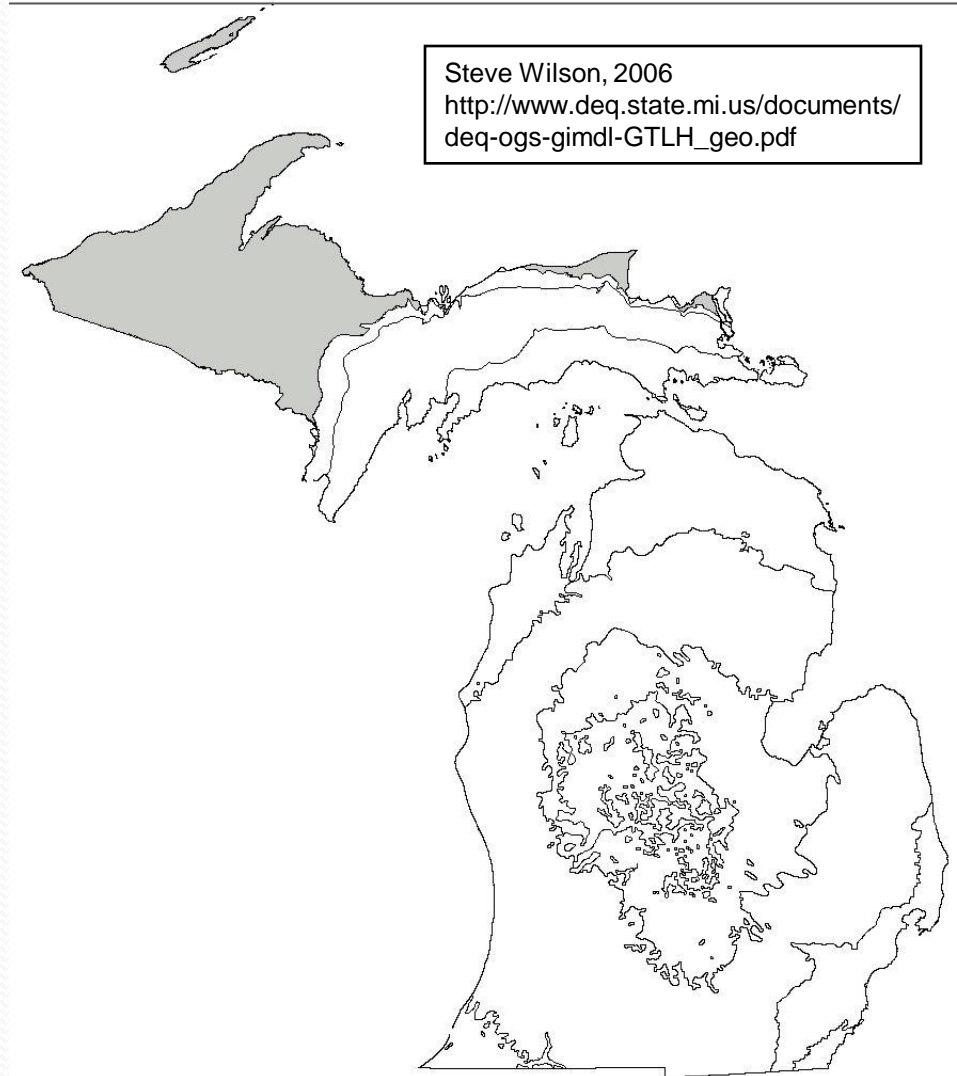


# Munising Ss. Pictured Rocks National Lakeshore



# Pre-Cambrian Subcrop

- Natural outcrops and mines abundant in western U.P.
- Major source of metallic ores, especially iron and copper.
- Generally poor local bedrock aquifer.
- Lithology is varied, mostly crystalline igneous and metamorphic along with sediments and metasediments.



# Pre-Cambrian outcrops in Western U.P.



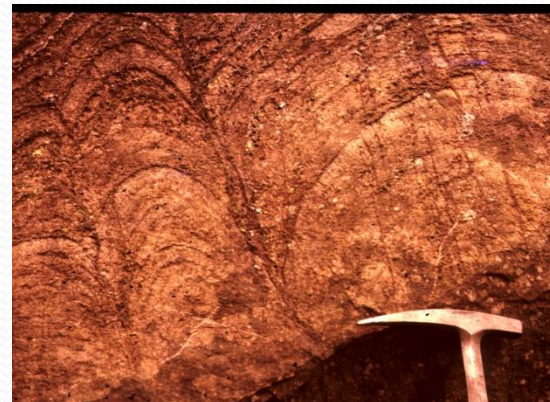
Glacial Polish on Mesnard Quartzite



Basalt Dikes through Granite



Republic Iron Mine



Stromatolites in Kona Dolomite

# MGRRE at W.M.U. in Kalamazoo, MI Houses Michigan Subsurface Data





# Michigan Subsurface Geology

- Geologic strata in the Michigan Basin range in age from Pleistocene glacial drift and the youngest Jurassic-aged bedrock through Cambrian to Pennsylvanian sedimentary bedrock that reaches a maximum thickness of about 16,000 feet in the basin center
- Strata thin and are eroded to progressively older units moving toward the basin margins
- Data from several hundred thousand shallow water wells and over 58,000 oil and gas and mineral wells
- Data includes logs, drill cuttings samples and cores, as well as limited seismic profiles and gravity and magnetic geophysical measurements



# Core Samples



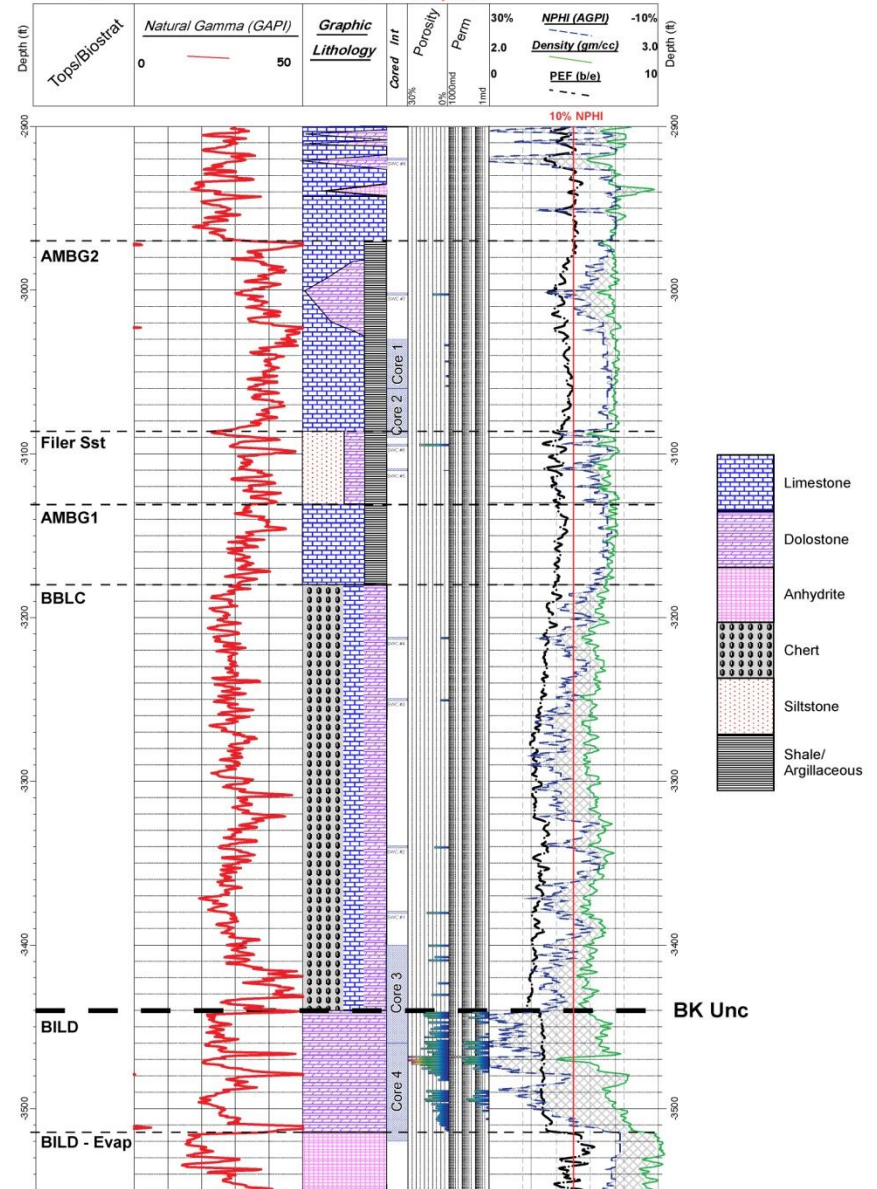
# Typical Log format for describing portion of a well

Red, Black, Blue and Green Lines are electrical sensor logs

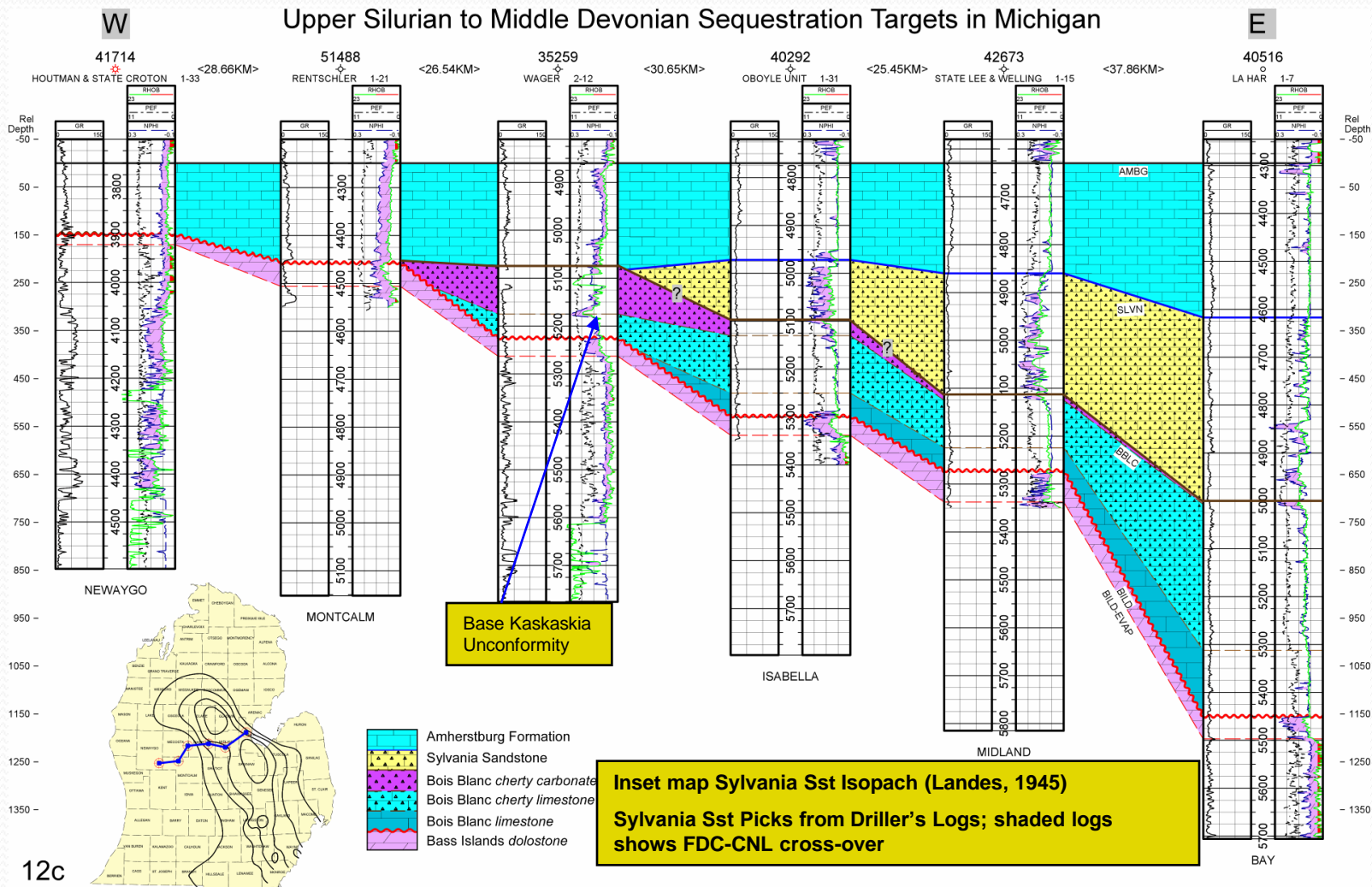
Lithologic column describes rock type

Well Name/ Permit **State Charlton 4-30/P# 57916 (30-31N,1W)**

Total Depth: 5850' Latitude: 45.043917  
 Elevation (Datum: KB): 1201' Longitude: -84.485306  
 Drilling Date: 11/06 Operator: Core Energy LLC  
 Geophysical Logger: SCHLUMBERGER  
 Lithology Logged By: WMU Well Status: **Completed**



# Lower Devonian-Upper Silurian Regional Stratigraphic Cross Section



# Isopach and structural contour maps on selected horizons using well data

