# DIGITAL MAPPING TECHNIQUES 2025

The following was presented at DMT'25
May 18 - 21, 2025

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2025)
http://ngmdb.usgs.gov/info/dmt/

**Surficial Geology of Cass County, Michigan StoryMap**

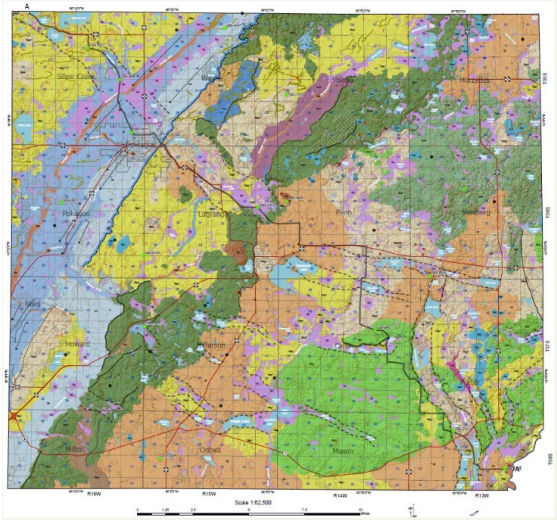
Cass County contains complex glacial landforms and sediments that formed during advance and retreat of the Lake Michigan and Saginaw Lobes of the Laurentide Ice Sheet during the last glaciation. The Lake Michigan Lobe (LML) advanced from the NW and the Saginaw Lobe (SL) advanced from the NE into the county resulting in complex and often overlapping interlobate deposits in the eastern portion of the county. The prominent uplands of the SW-NE trending LML-Kalamazoo Morainic complex and associated large southeast sloping outwash fans dominate the western half of the county. It consists of two main ridges, the Outer Kalamazoo Moraine to the east and the Inner Kalamazoo Moraine to the west, both of which broadly climb in elevation to the NE. In places there is a third ridge between them. The location and orientation several tunnel valleys also provide evidence that both the LML and SL occupied Cass County different times.

Glacial Lake Dowagiac which was a major glacial lake and glacial meltwater sluiceway at about 19,000 years ago running NE to SW the between the Valparaiso ice to the NW and the Inner Kalamazoo Moraine to the SE. It cut several streamlined residual ridges, a terrace above the floor of the valley and a linear escarpment on the east side of the Inner Kalamazoo moraine all providing evidence for the large volumes of water that flowed through the valley as a result of the catastrophic overflow of proglacial Lake Dowagiac as part of the Kankakee Torrent.

Other glacial features within the county include eskers, parallel thrust ridges, streamlined features, meltwater channels and glacial drainageways and numerous ice-walled lake plains on the morainal uplands. A large sand sheet and dune field as well as many isolated inland dunes occur mostly in the NW part of the county associated with Dowagiac River valley.

The bedrock topography, bedrock valleys and drift thickness, and were mapped using the HVSR passive seismic method. As series of NW trending buried bedrock valleys occurs in the north half of the county and are extensions of deep bedrock valleys that run NW across Van Buren County to the north. Glacial deposits average 310 feet thick and range in thickness from 115 to 717 feet which is the thickest known in the southern half of the Lower Peninsula of Michigan! A previously unknown gravel aquifer was discovered in one of the bedrock valleys.

# Surficial Geology of Cass County, Michigan StoryMap



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USGS Digital Mapping Techniques 2025, Norman, Oklahoma, May 21, 2025

SURFICIAL GEOLOGY OF CASS COUNTY, MICHIGAN

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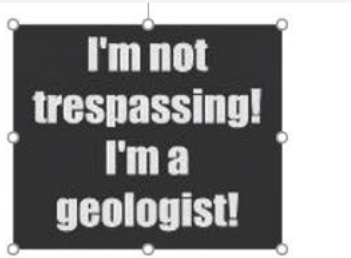
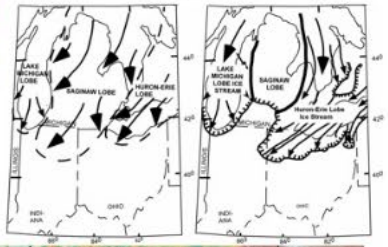
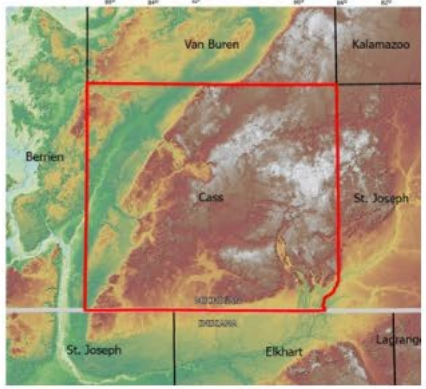
Esch, J.M., 2025, Surficial Geology of Cass County, Michigan, Geological Society of America Abstracts with Programs. Vol. 57, No. 3 doi: 10.1130/abs/2025NE-408996

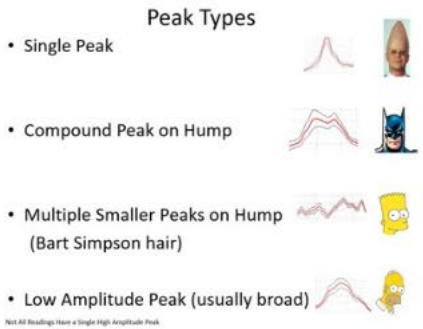
- This presentation is from an ArcGIS StoryMap. These are screen captures from the original Surficial Geology of Cass County, Michigan StoryMap presented at GSA in March 2025 and at DMT 2025. The StoryMap is DRAFT and is not for distribution.
- This StoryMap will likely be modified and likely go live later in 2026.










# Cass County, Michigan - Surficial Geological Mapping DRAFT

Cass County is a geological dead zone as far as recent surficial geological (glacial) mapping, geological research, or basic geological data

**John Esch**

March 29, 2025



## DRAFT Not for Distribution

# Acknowledgements

We thank Professor Dr. Alan E. Kehew (deceased, Western Michigan University) for providing much of the geologic framework that guided our conceptual understanding of the glacial geology of southwestern Michigan. Alan was a mentor to many geologists, a world class geologist, and a gentleman.

Field mapping of Cass County was completed by Dr. Alan Kehew and John Esch, with assistance from John Yellich. Sebastian Huot conducted the OSL analyses. The Illinois Geological Survey's drill crew provided most of the wireline coring.

# Introduction

From 2016-2020 the Michigan Geological conducted a surficial geological mapping program Cass County, Michigan.

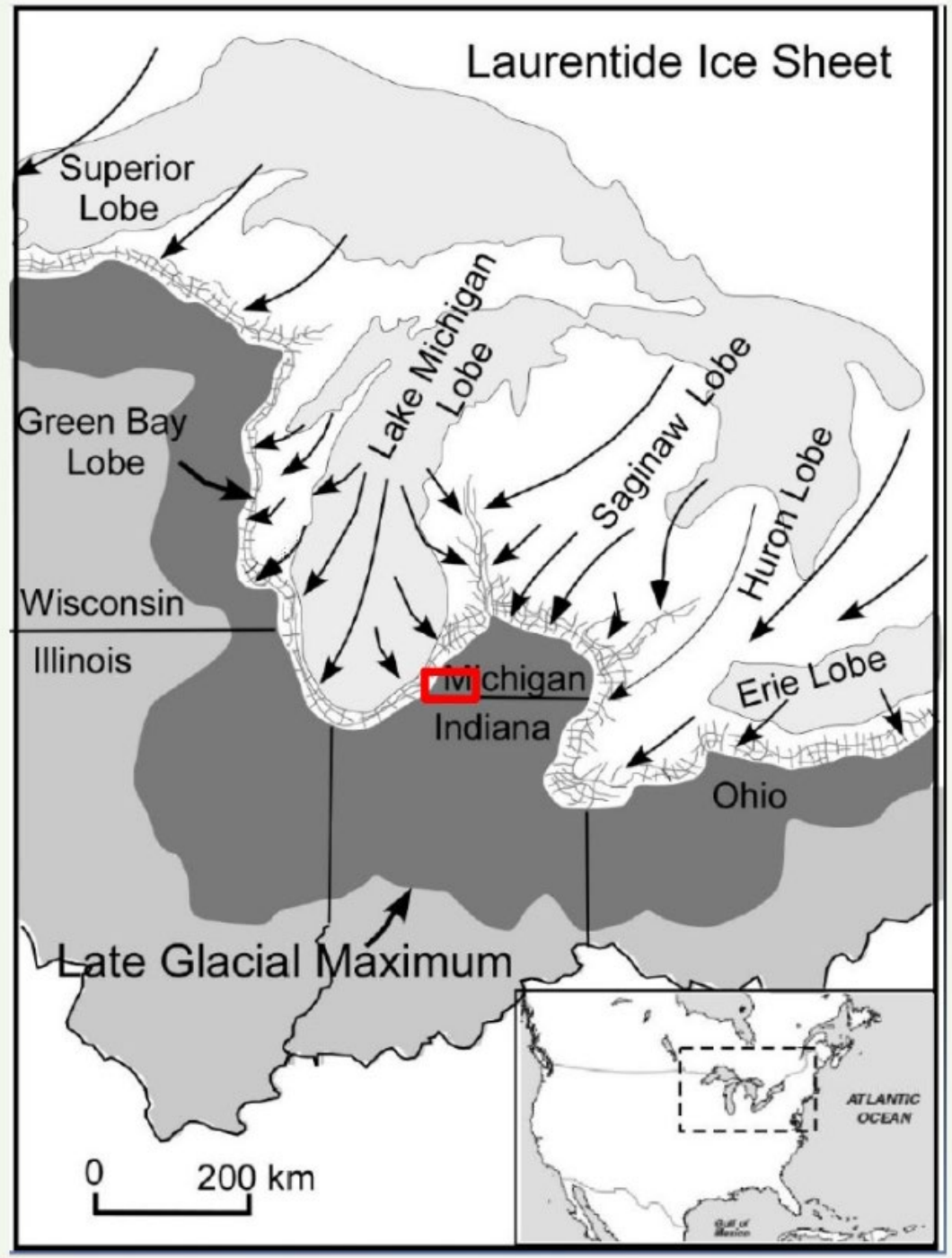
Cass County Michigan is a geological dead zone as far as recent surficial geological (glacial) mapping, geological research, or basic geological knowledge.

All the surrounding counties including in those in the neighboring Indiana to the south have had recent surfical geological mapping and some basic research.

Cass County is Ground Zero on in the area of high volume aquifer agricultural irrigation withdrawals

Cass County is Ground Zero in the debate between farmer and Michigan's  environmental agency on the use if the Water Withdrawal Tool and the permitting of high volume aquifer agricultural irrigation wells

Highest elevations of SW Michigan with the thickest glacial deposits in the southern half of the Lower Peninsula


Laurentide Ice Sheet
Superior Lobe
Lake Michigan Lobe
Saginaw Lobe
Huron Lobe
Green Bay Lobe
Wisconsin
Illinois
Michigan
Indiana
Erie Lobe
Ohio
Late Glacial Maximum
0
200 km
ATLANTIC OCEAN













## Desktop Survey

•LiDAR Elevation data

•Review existing borehole data: water wells, exploration borings, environmental borings

•Soil survey data

•Aerial photos

•Review existing water well logs & Oil & Gas logs

•Cross-sections every mile and 3D visualization

- Review existing literature and maps

**Field Methods**

•Drive all the roads making observations

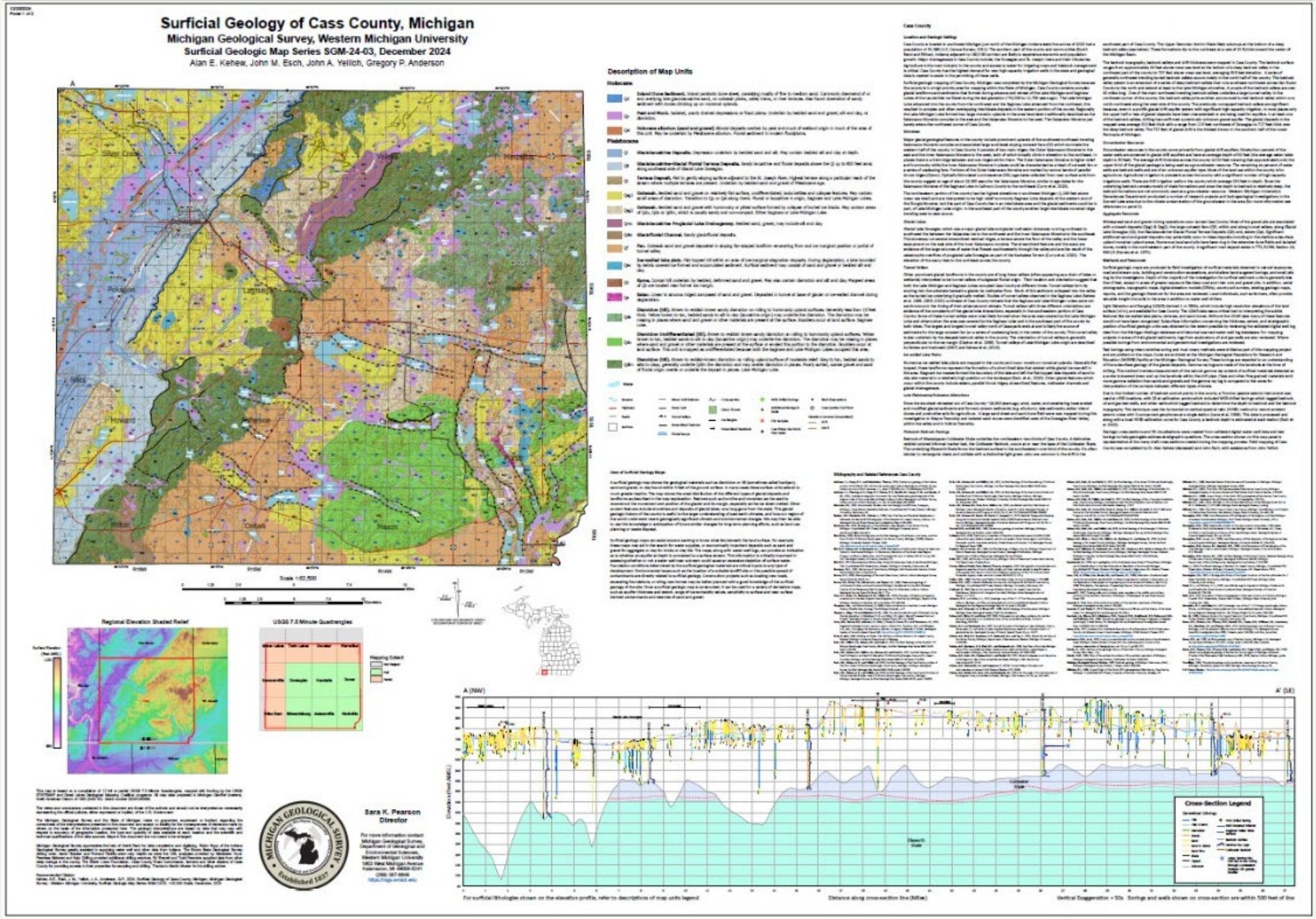
•Hand augered borings• Road cuts, natural exposures, gravel pits, foundations

•Drilling/Coring to bedock (if possible)

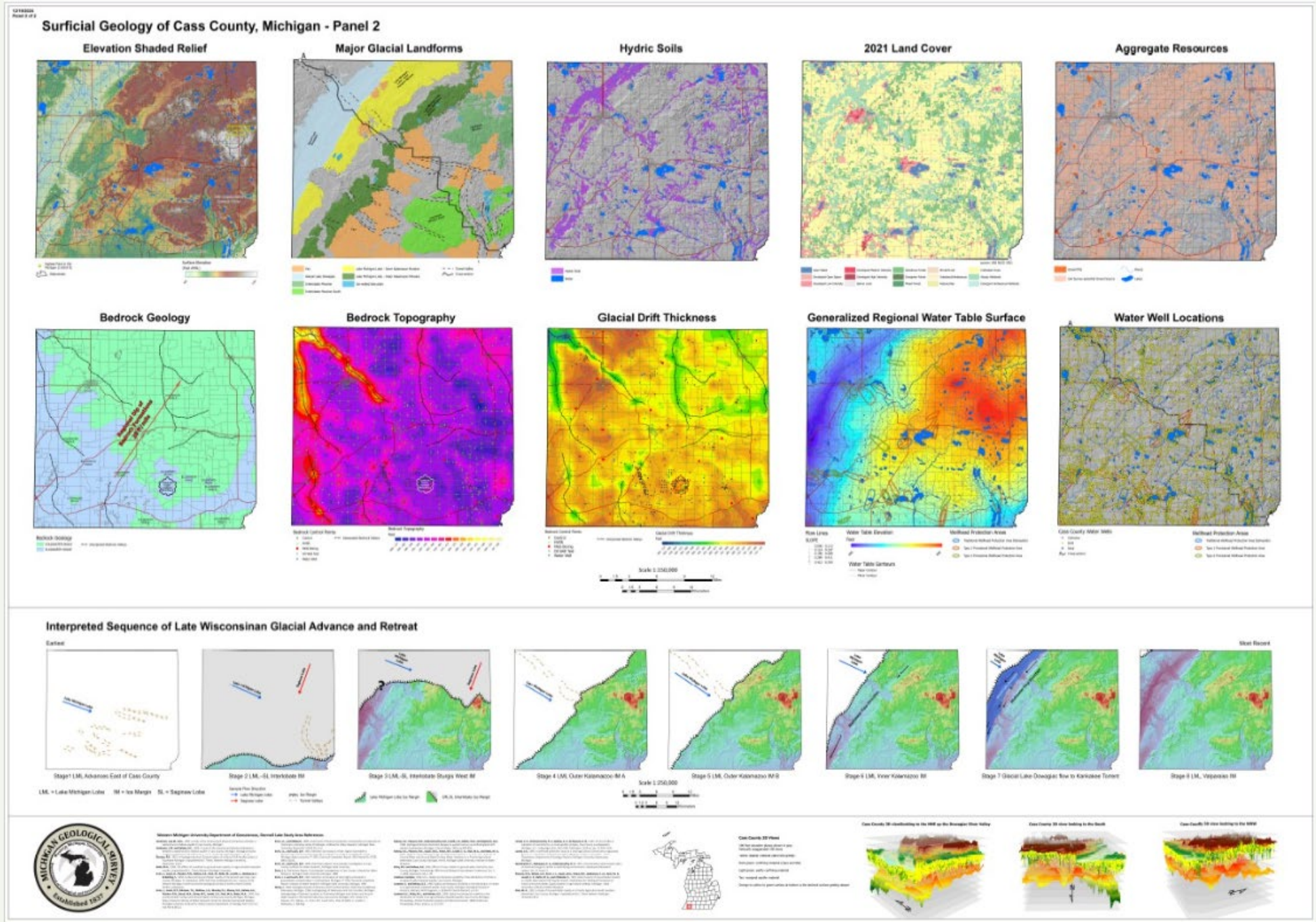
•Gamma-ray logging existing wells & new borings

•HVSR - Passive Seismic for bedrock depths

•OSL sampling/age dating



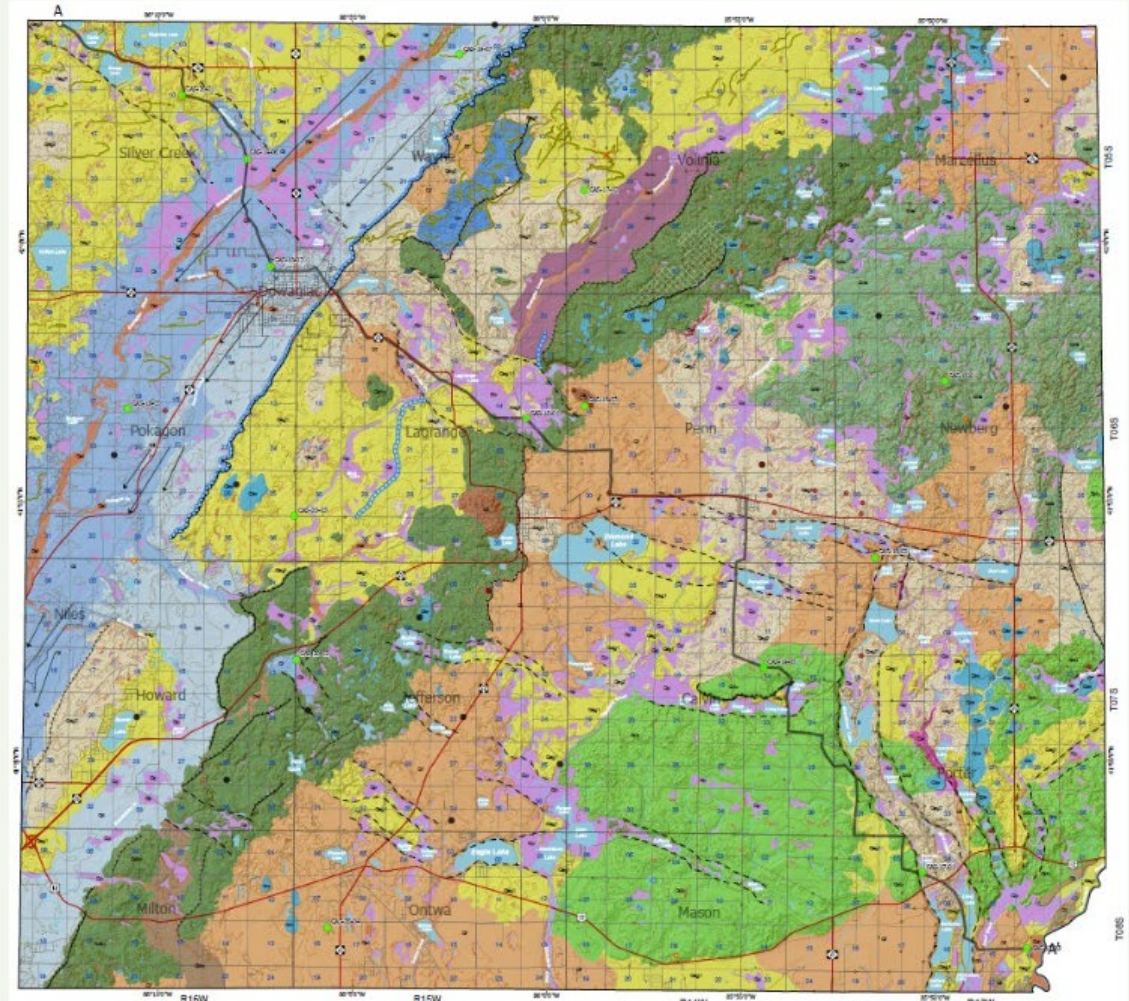

Cass County Surficial geology Panel 1

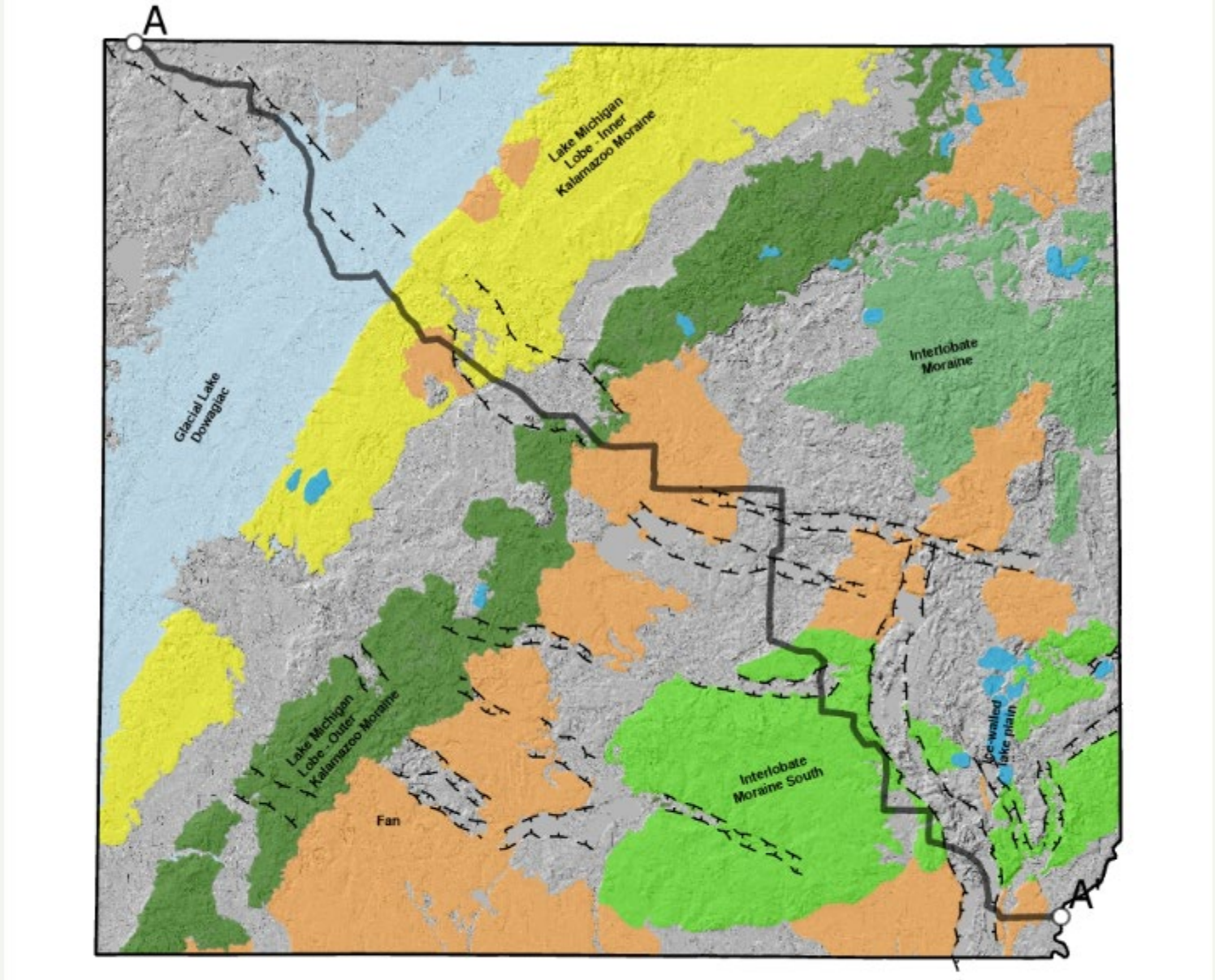



Cass County Surficial geology Panel 2

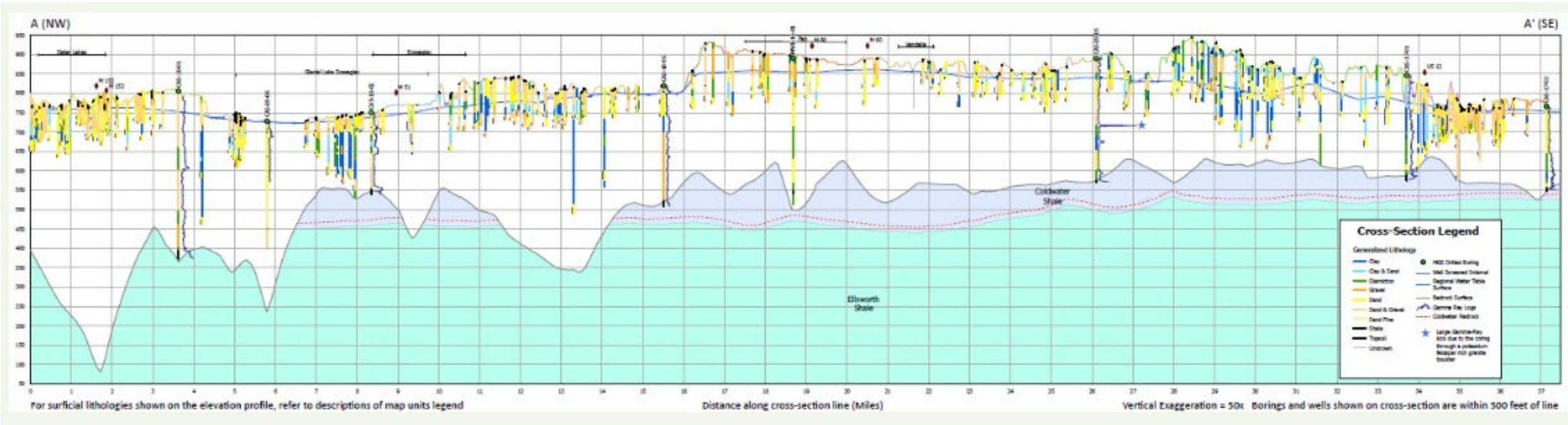
Download Cass County Map

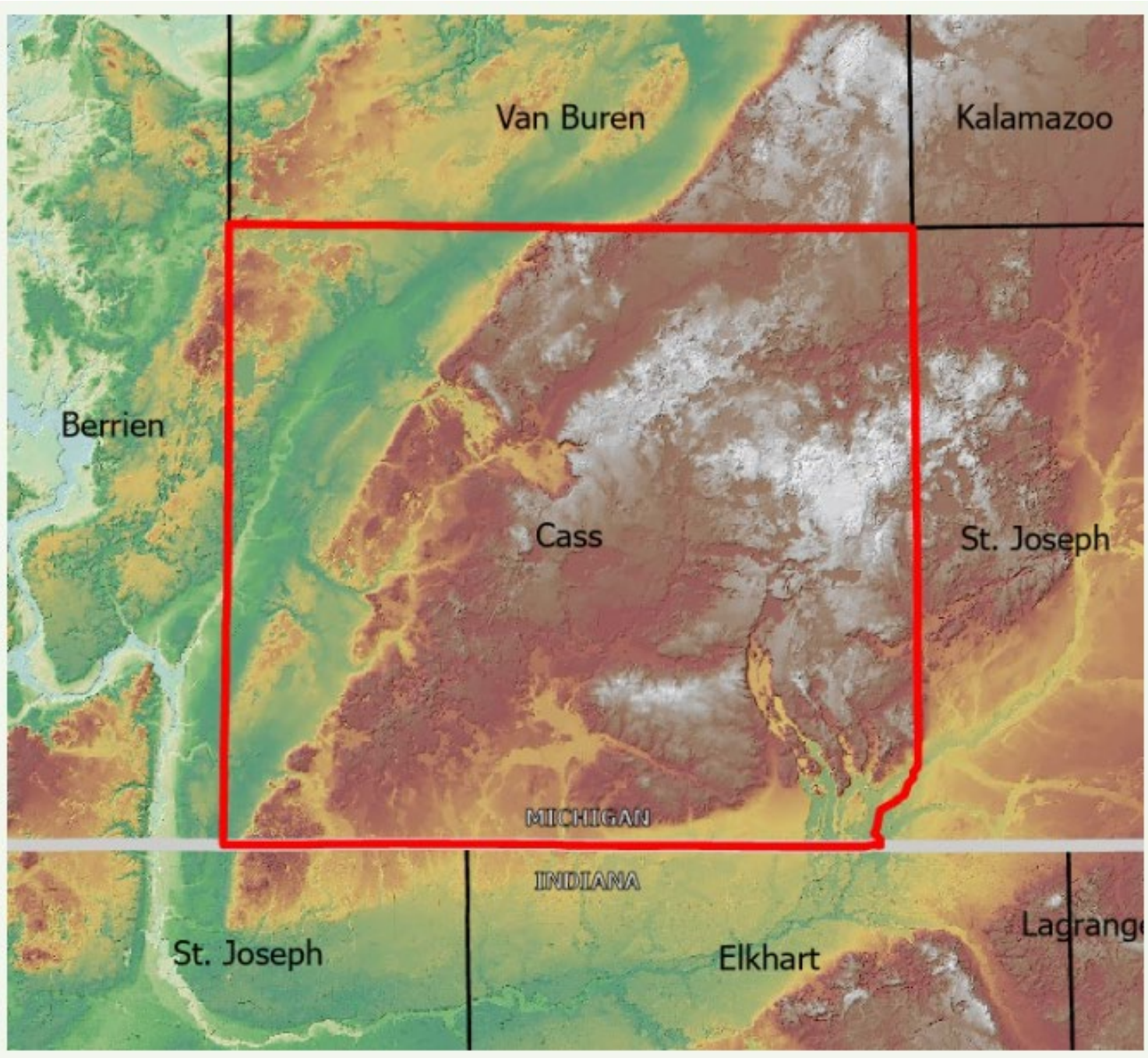
Download Map GEMs Database

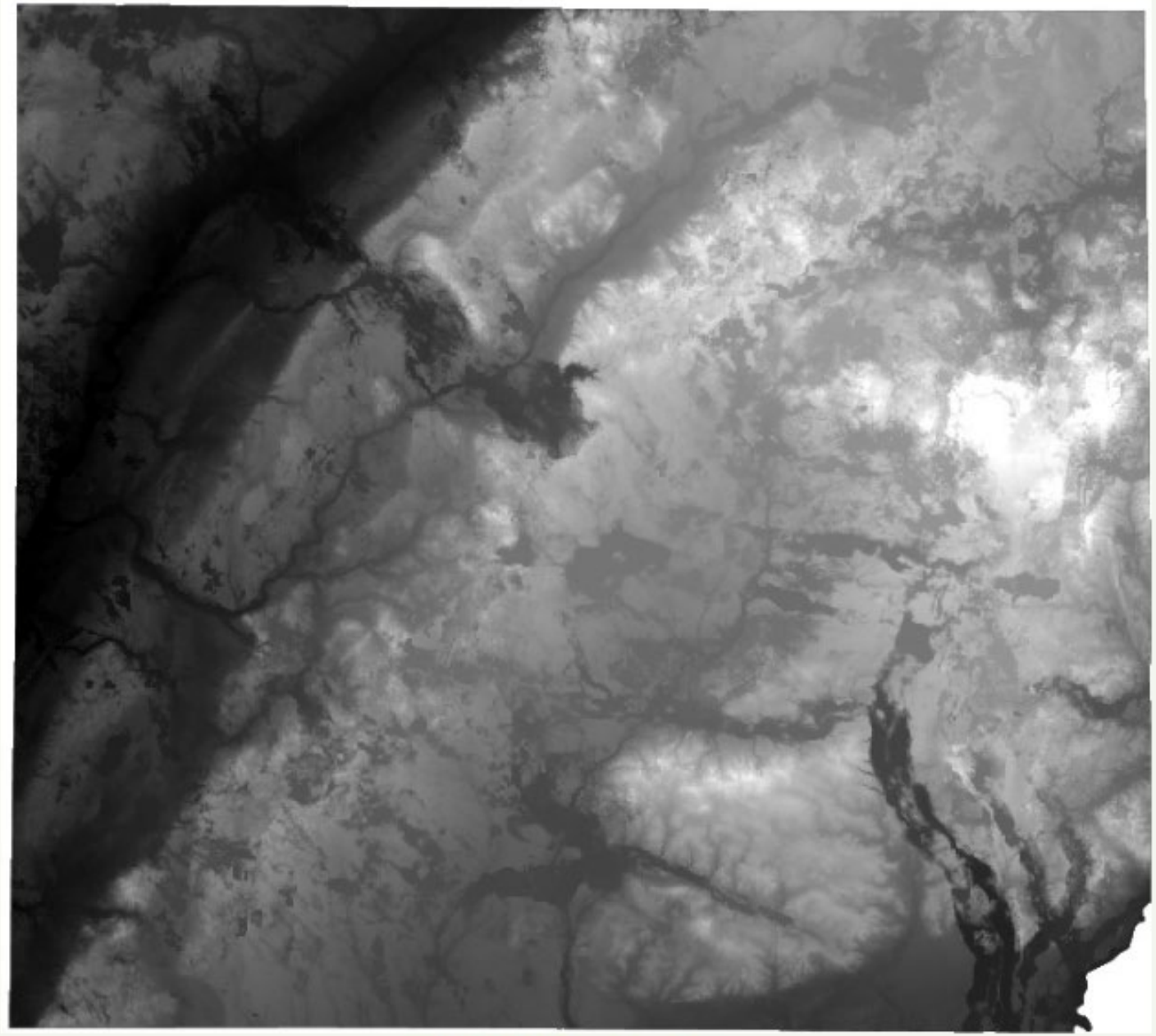





Cass County Major Glacial Landforms

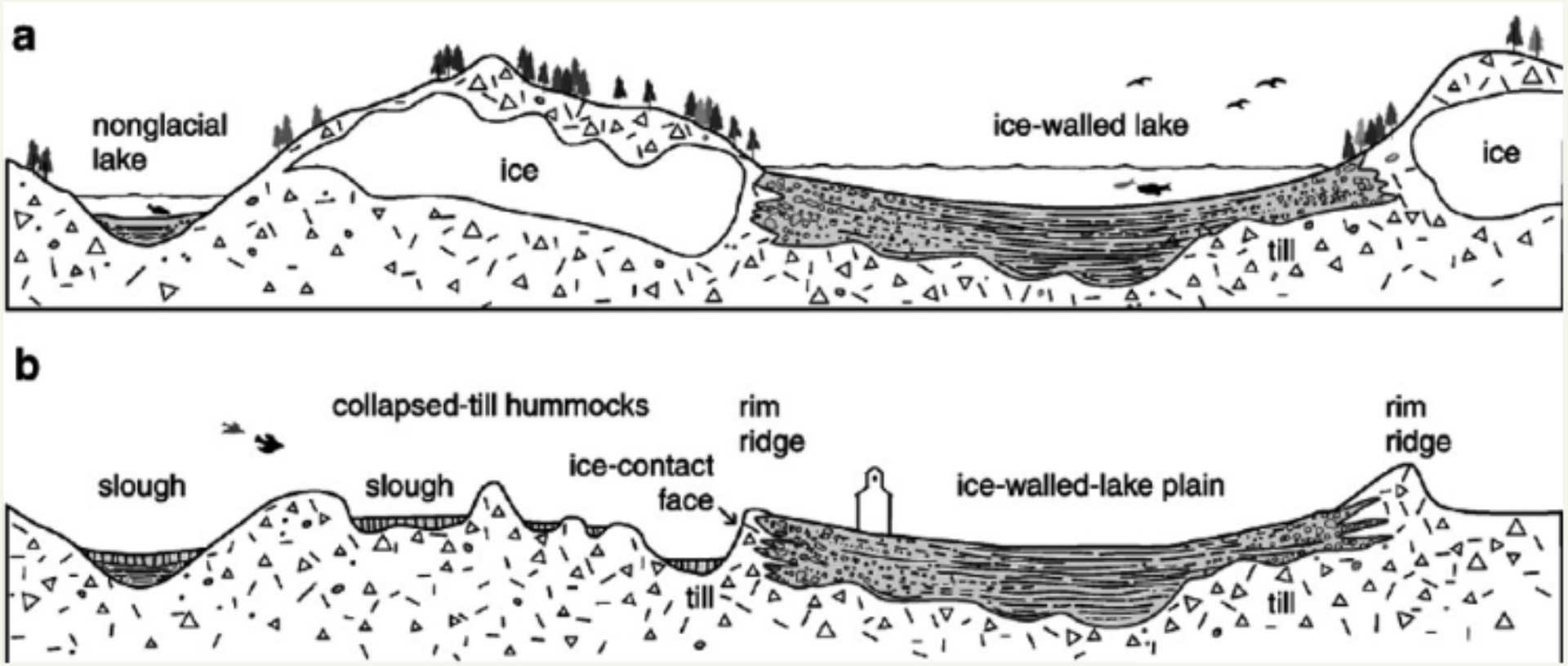

A (NW)
A' (SE)
Coldwater Shale
Ellsworth Shale
Cross-Section Legend
For surficial lithologies shown on the elevation profile, refer to descriptions of map units legend
Distance along cross-section line (Miles)
Vertical Exaggeration = 50x
Borings and wells shown on cross-section are within 500 feet of line


Van Buren
Kalamazoo
Berrien
Cass
St. Joseph
MICHIGAN
INDIANA
St. Joseph
Elkhart
Lagrange

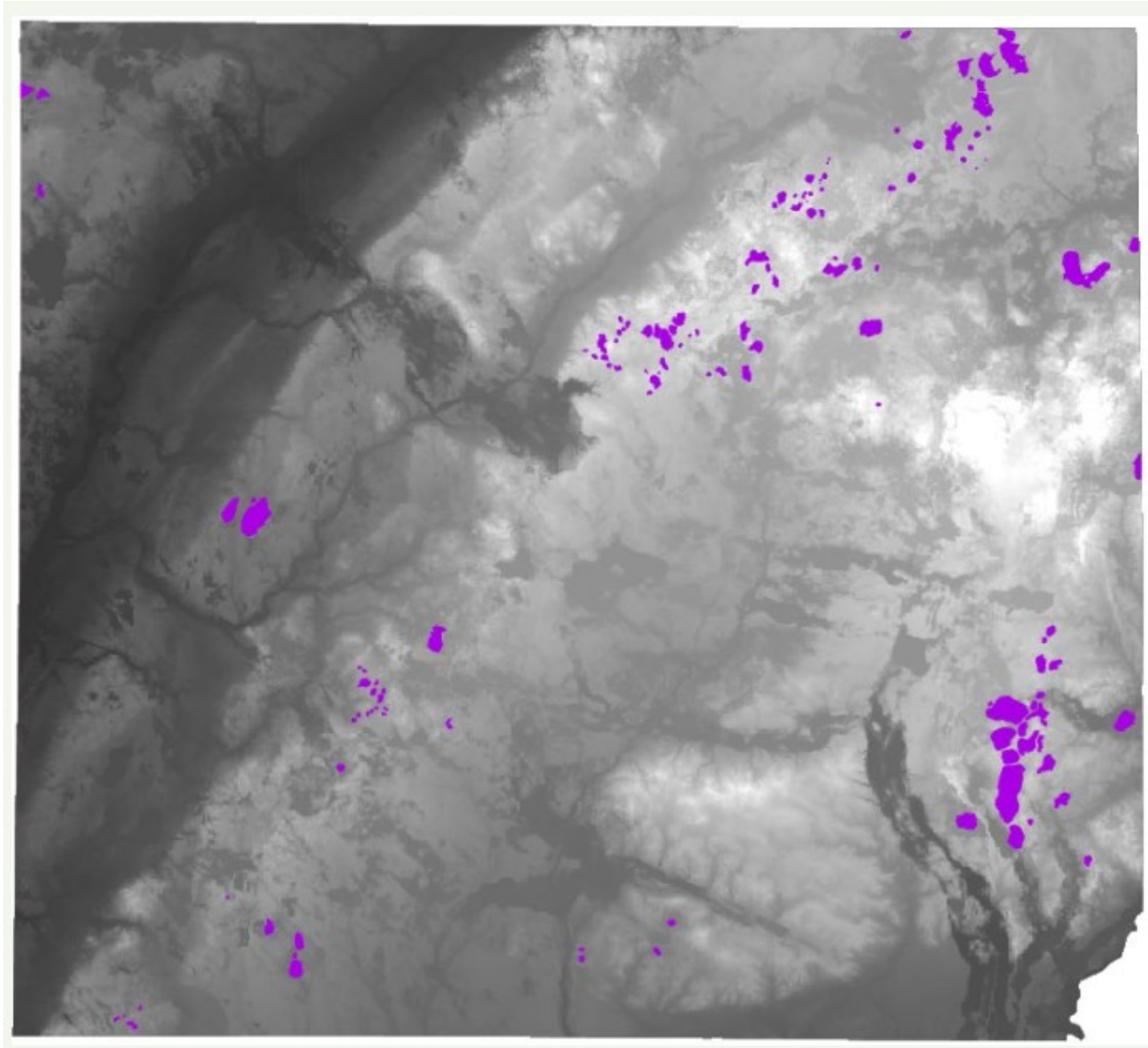


LiDAR DEM Grey Grey Scale

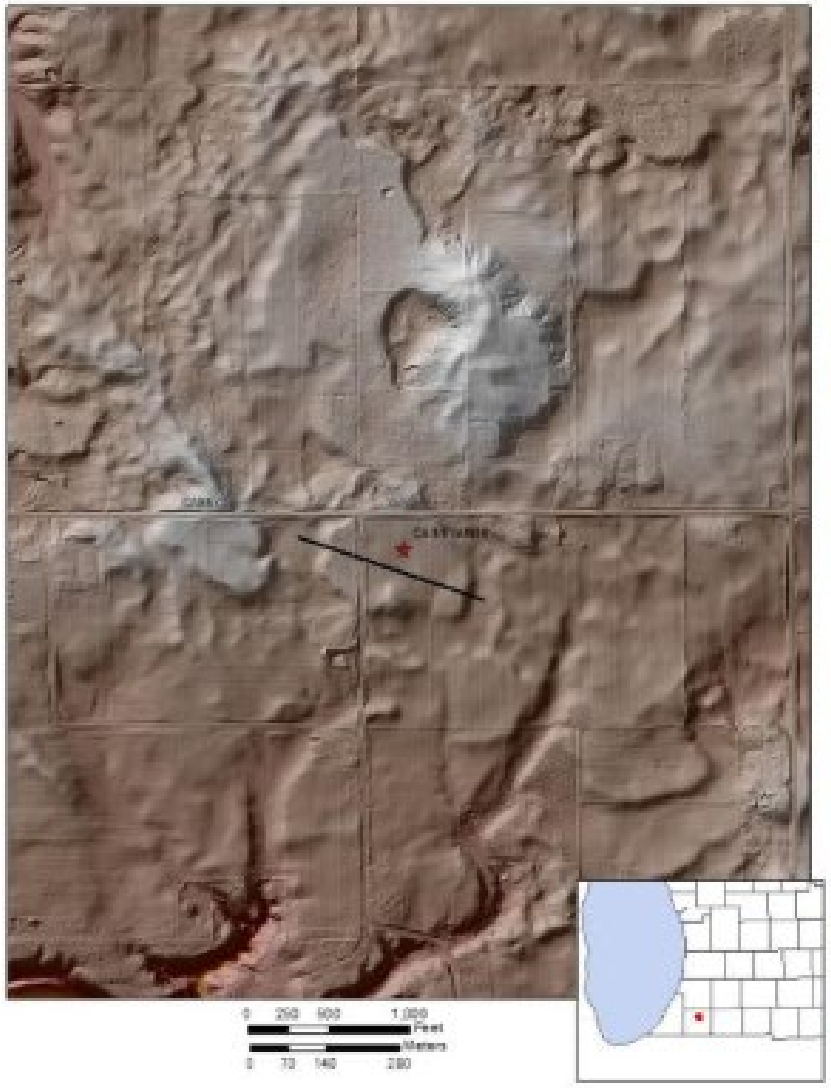
# Ice-Walled Lake Plains

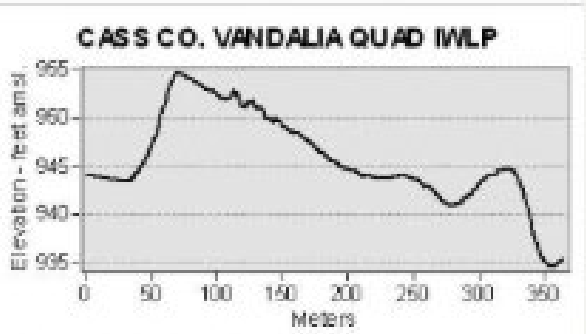



Clayton, L., Attig, J.W., Ham, N.R., Johnson, M.D., Jennings, C.E., and Syverson, K.M., 2008, Ice walled-lake plains: Implications for the origin of hummocky glacial topography in middle North America: Geomorphology, v. 97, p. 237-248.



# CASVAN29 HAB 5.5’



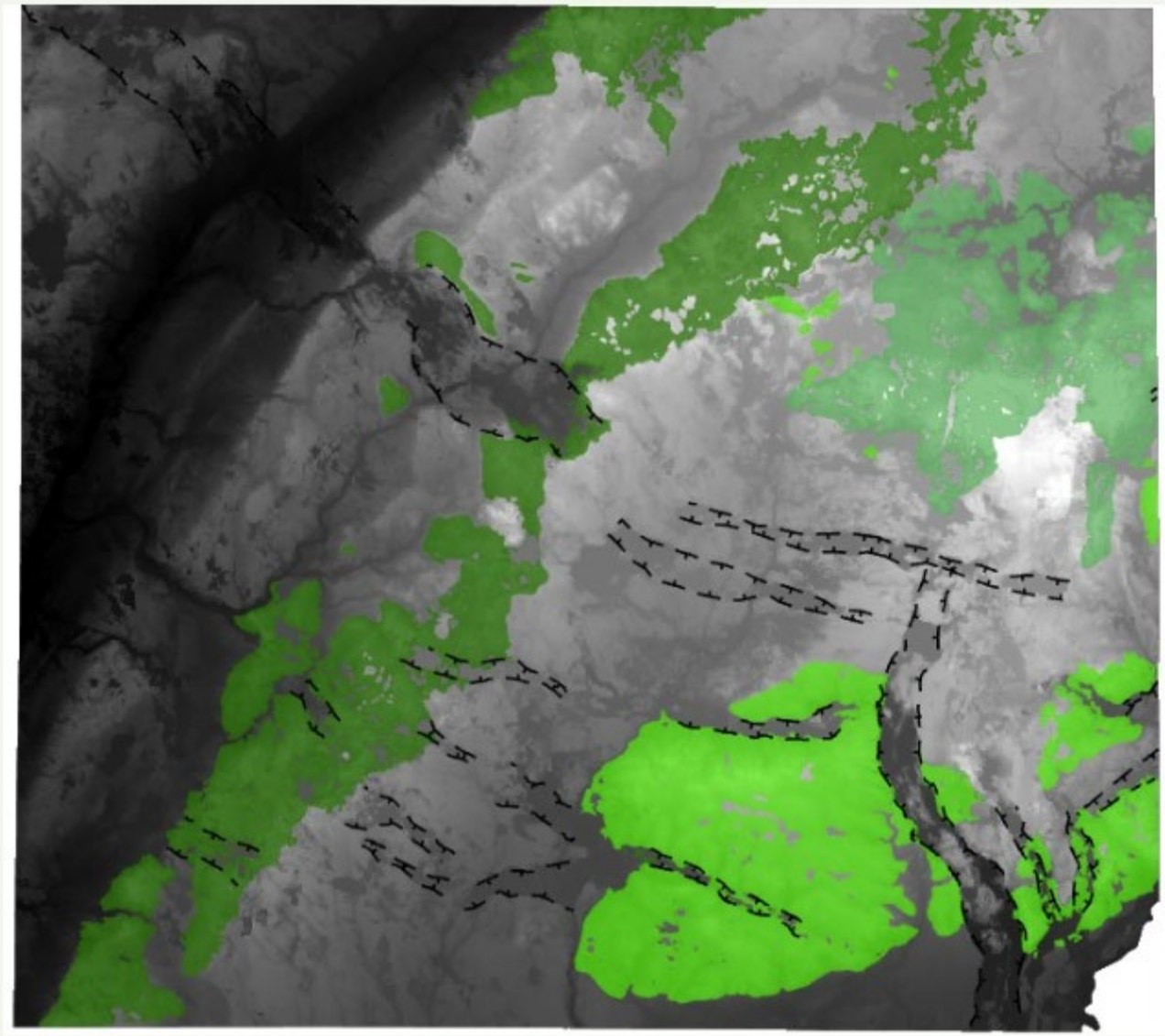



*Elevation Profile NW>SE*

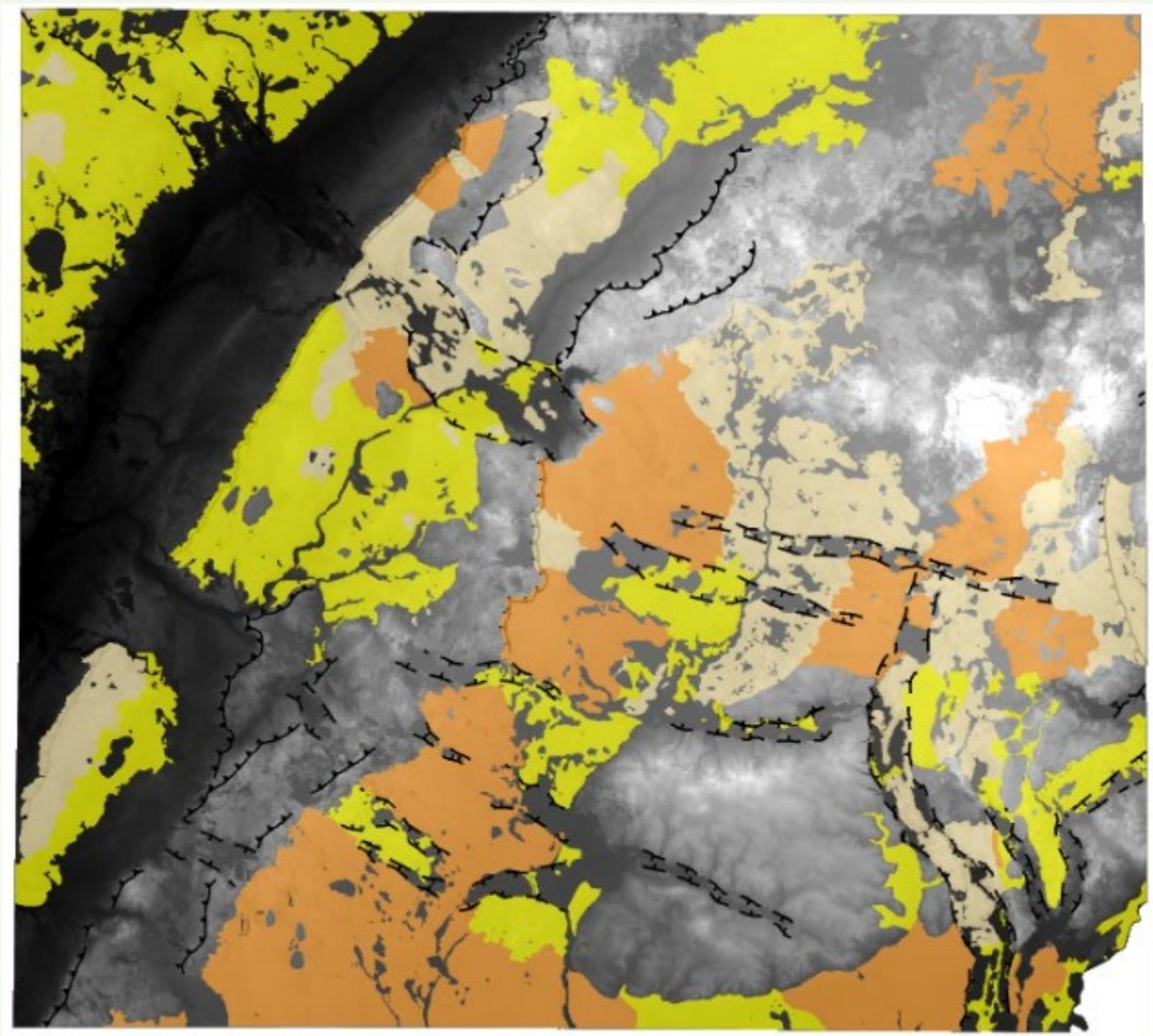
**Relief on the IWLP is ~10 feet**

**The lacustrine sediments are at least 5.5 feet thick**

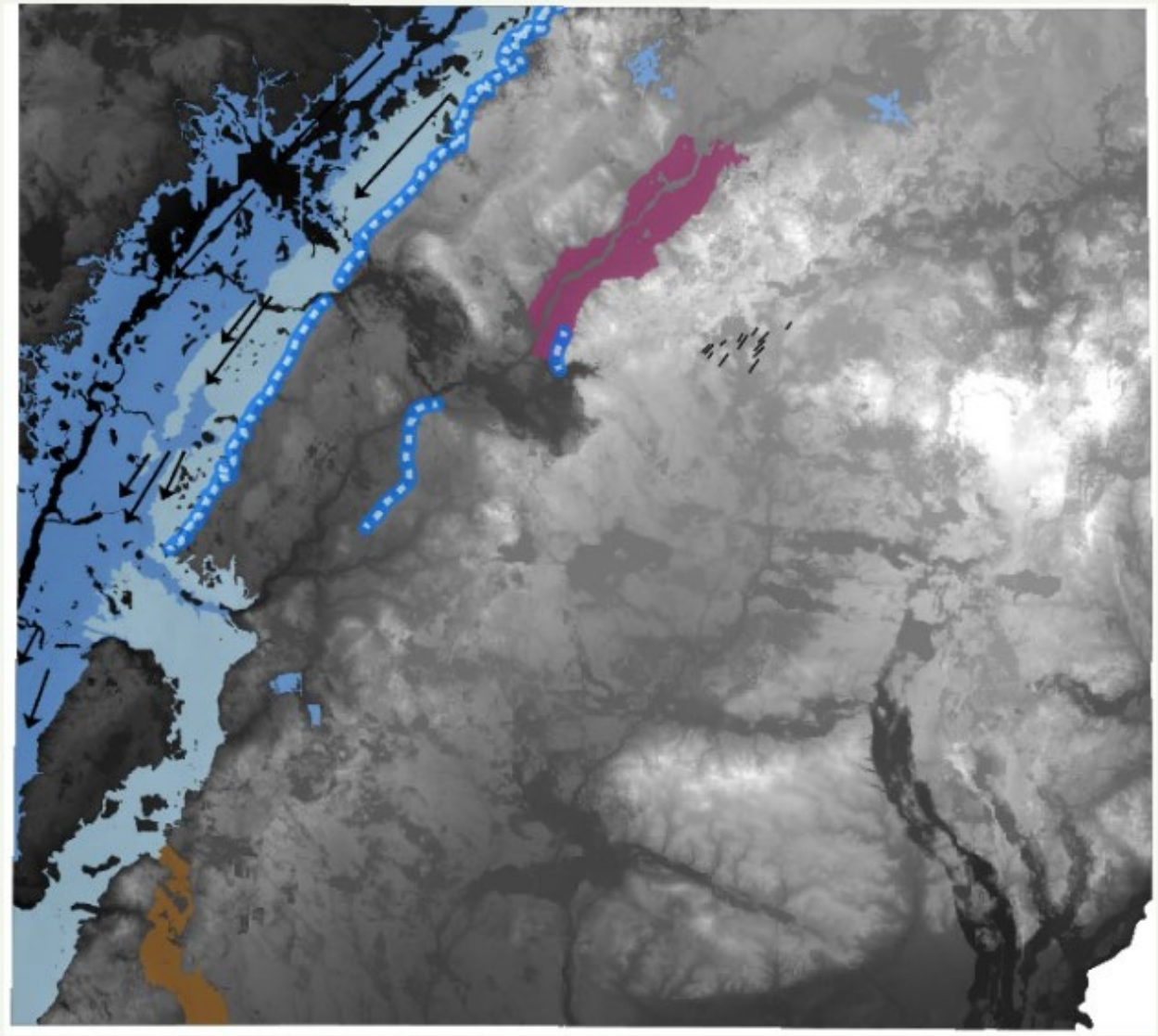
# Diamicton Units and Tunnel Valleys



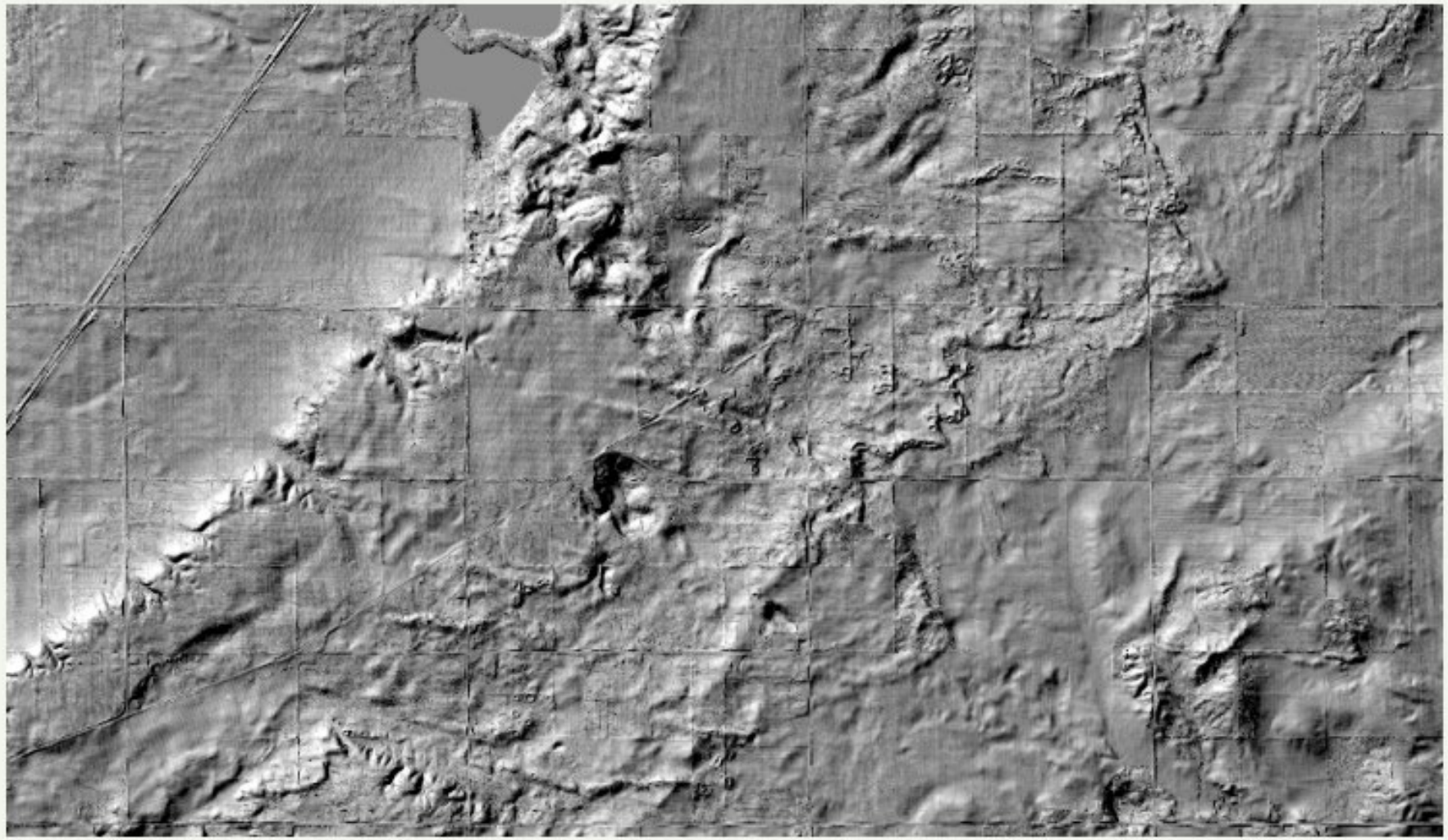
# Outwash, Collapses Outwash and Fans



# Glaciolacustrine, Terraces, Meltwater Channels, Fluvial Scarps



# Inland Sand Dunes and Sand Sheet



Yellow: aquifer material (sand and gravel)

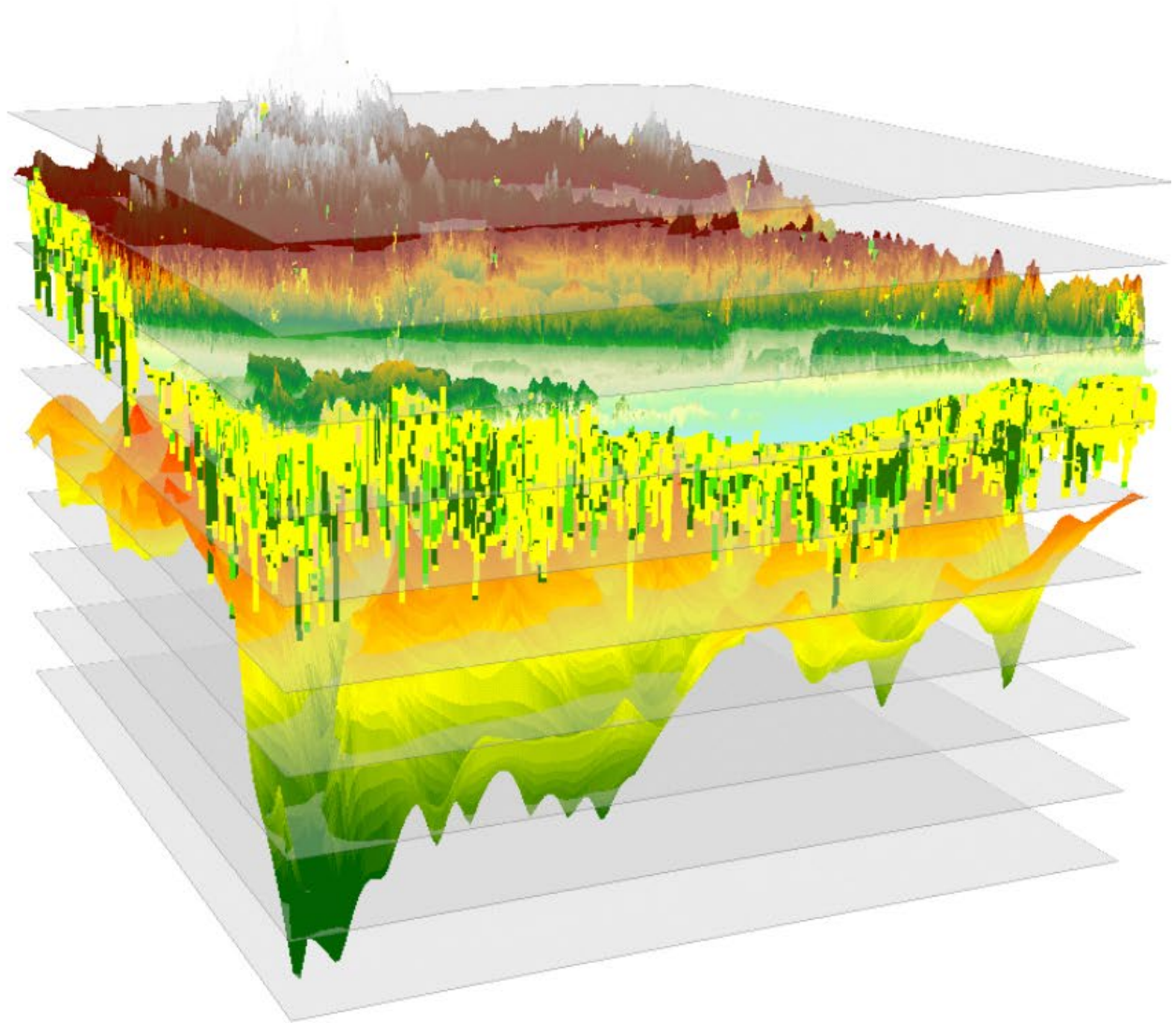
Dark Green: Confining material (clays and tills)

Light green: partly confining material

Tan: Marginal aquifer material

Orange to yellow to green surface at bottom is the bedrock surface getting deeper

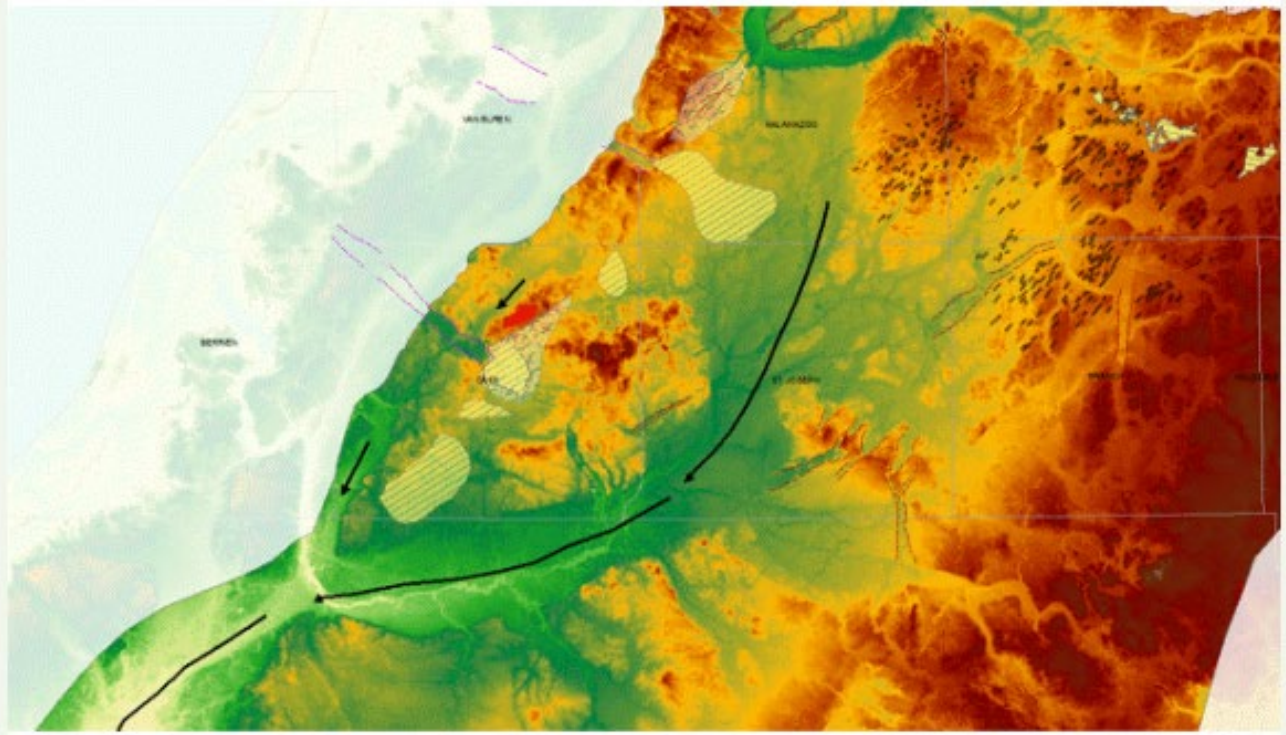
Grey: horizontal planes every 100 feet



Animation

# Southwest Interpreted Late Wisconsinan Glacial Advance and Retreat

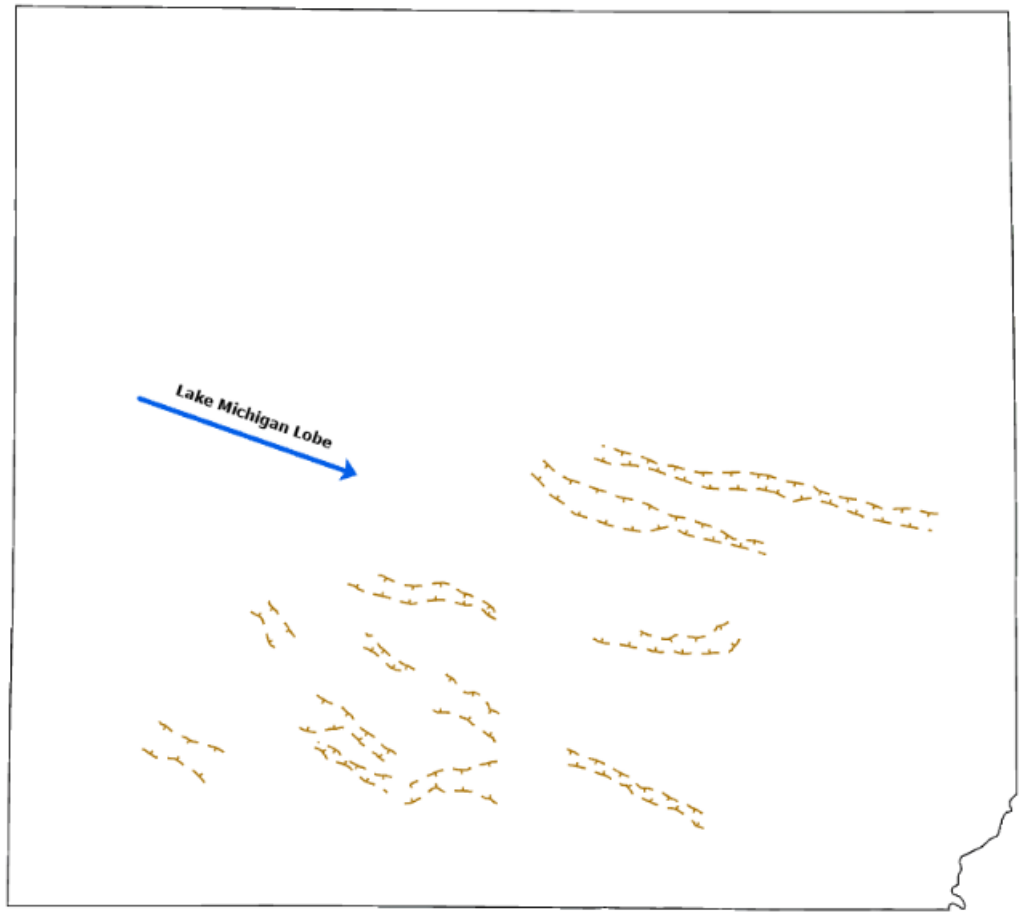
Lake Mi Lobe Retreat to Kalamazoo Mid Margin



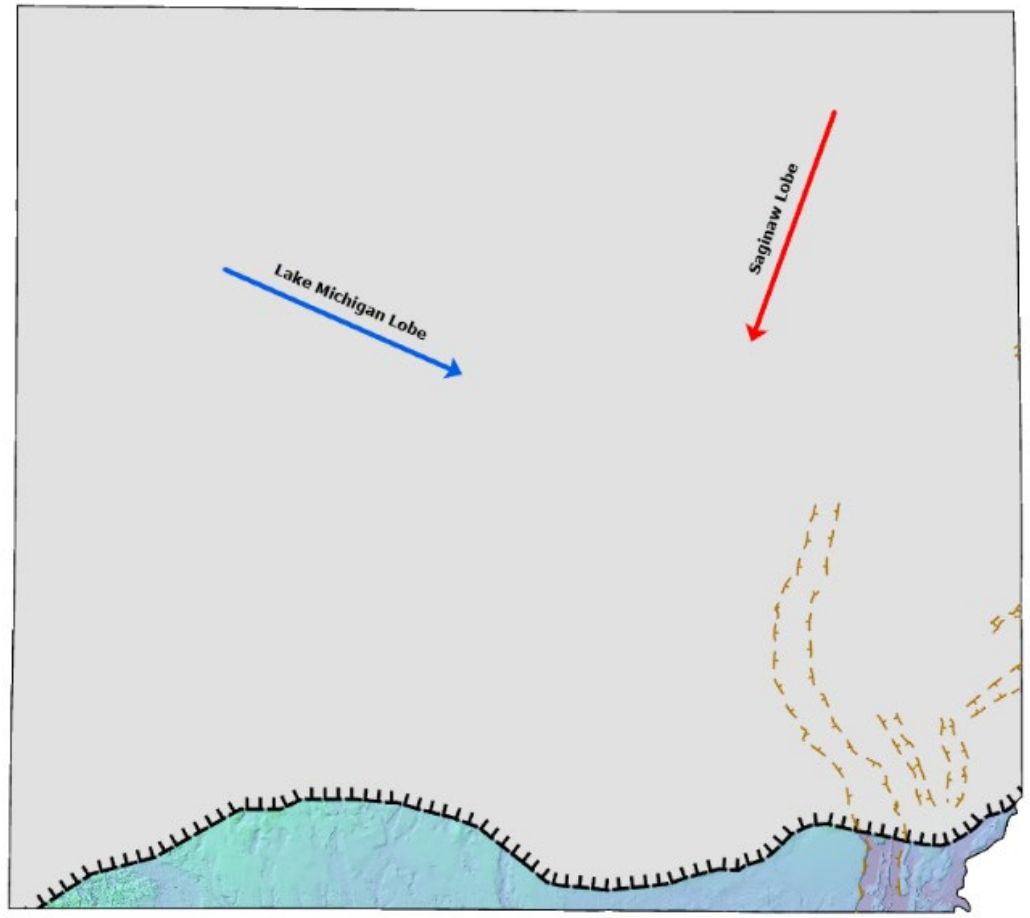
Note Tunnel Valleys and Fans at Ice Margin

Animation

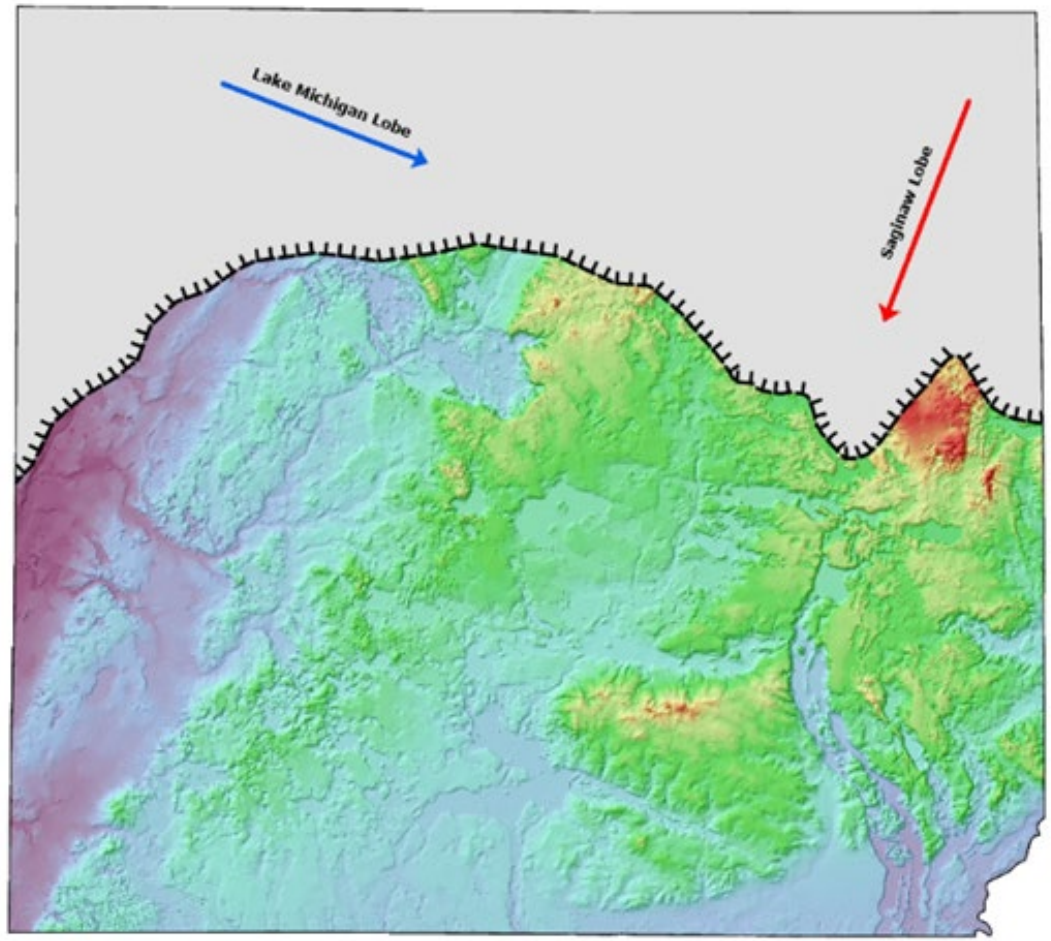
# Cass County Interpreted Late Wisconsinan Glacial Advance and Retreat



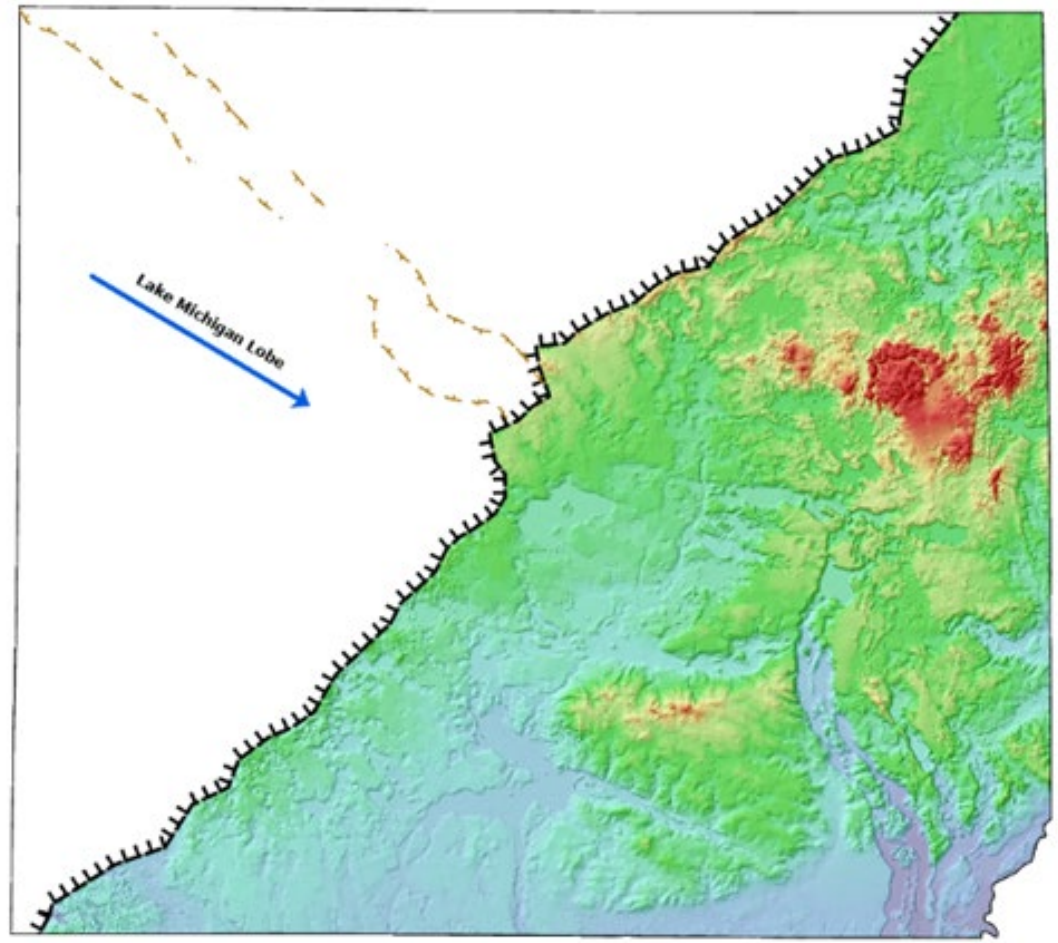

Stage 1 LML advances east of county



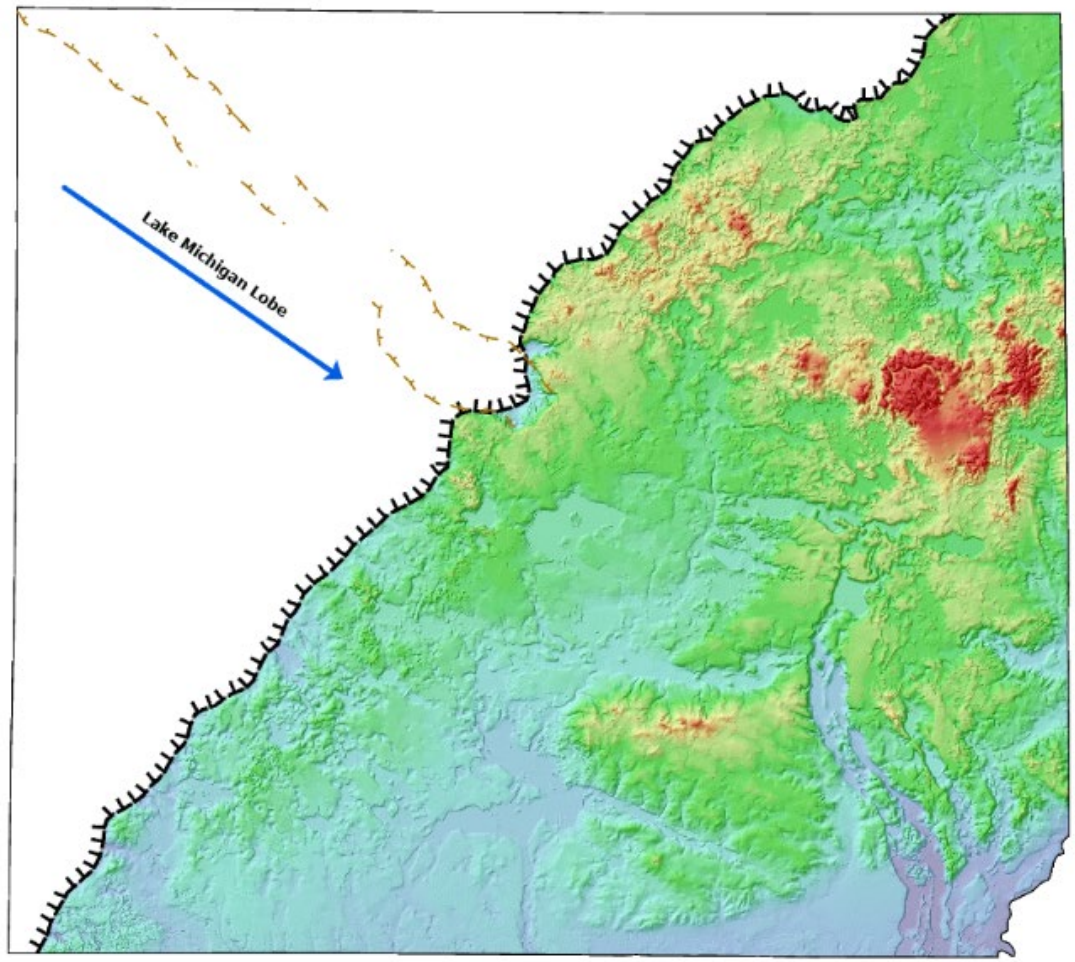

Stage 2 LML-SL Interlobate IM



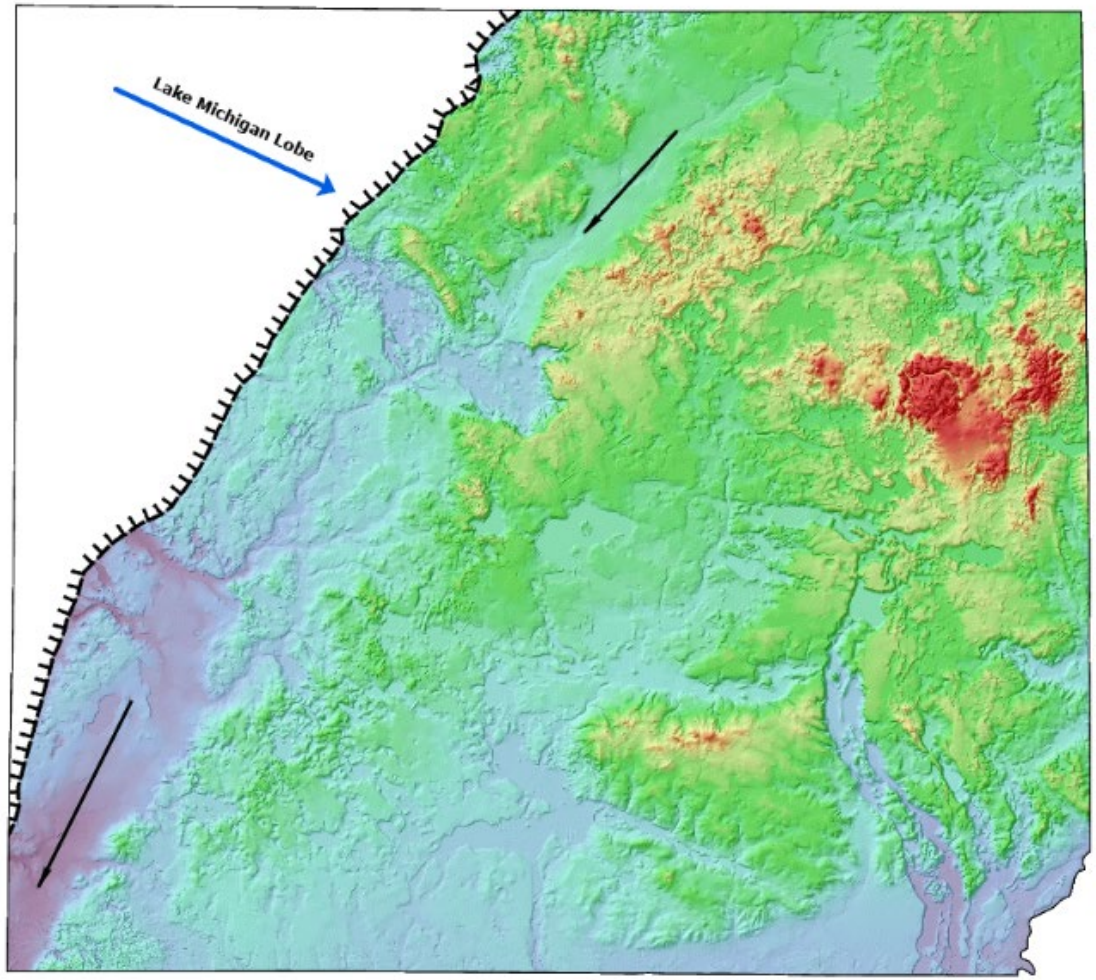

Stage 3 LML-SL Interlobate Sturgis West IM



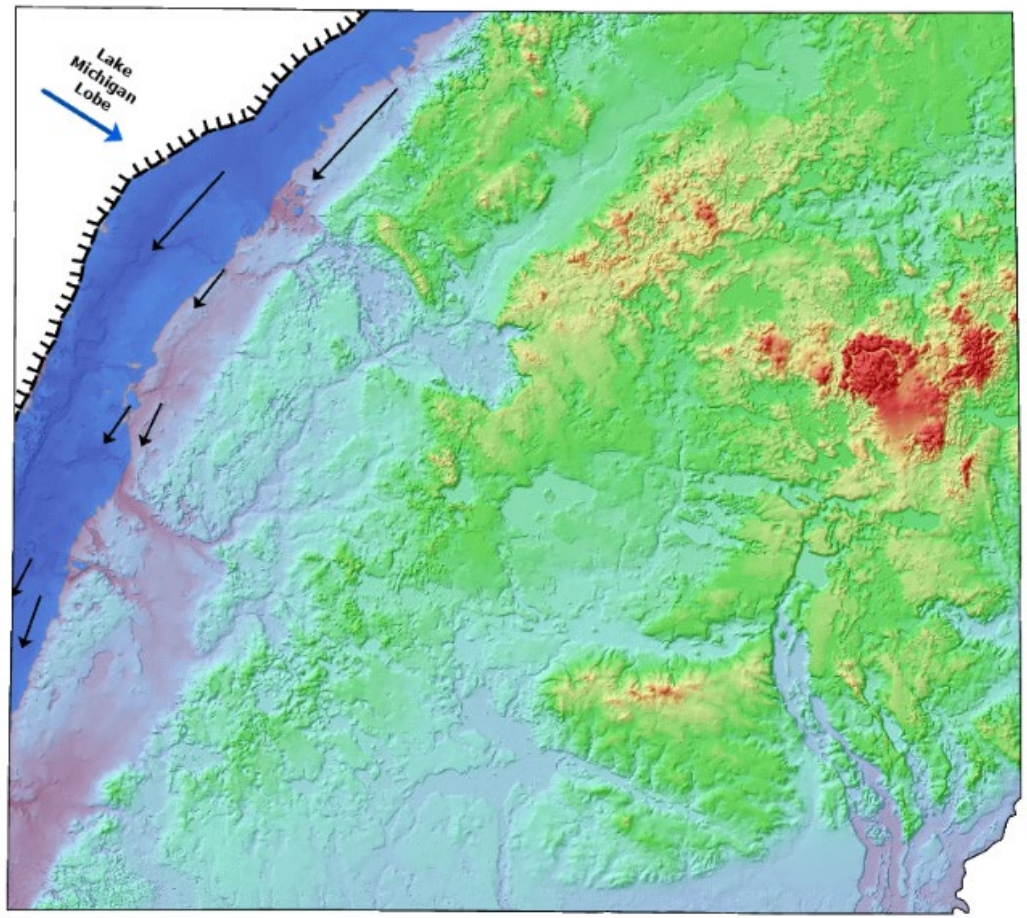

Stage 4 LML Outer Kalamazoo IM A



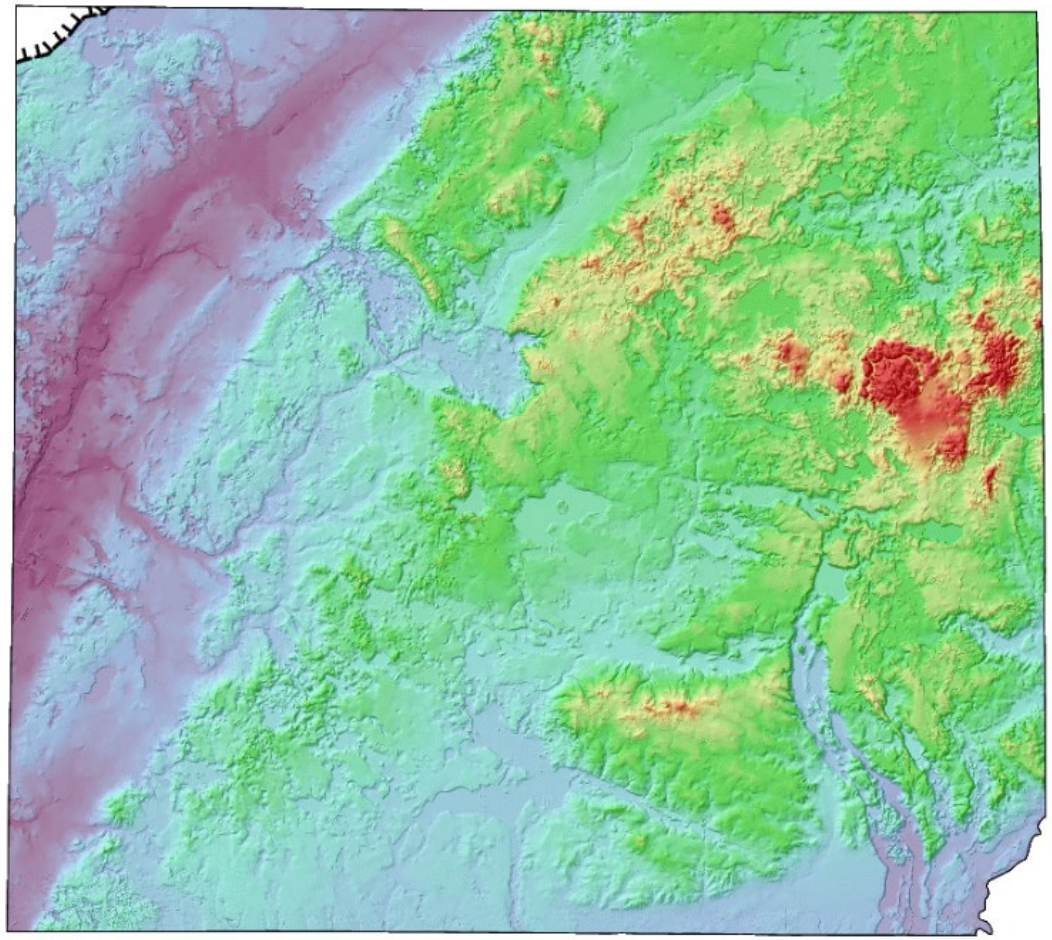

Stage 5 LML Outer Kalamazoo IM B




Stage 6 LML Inner Kalamazoo IM

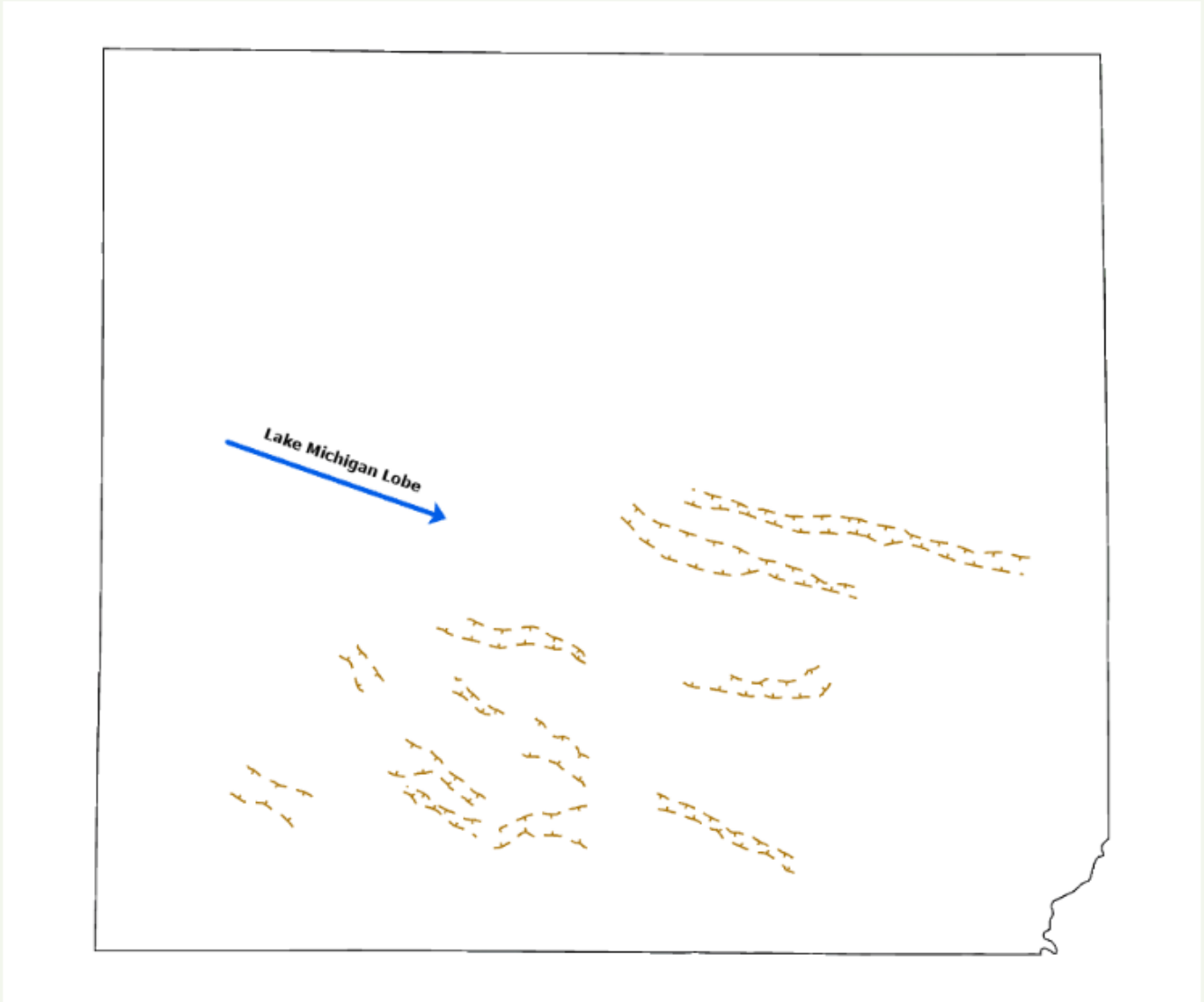



Stage 7 **Glacial Lake Dowagiac** Flow to **Kankakee Torrent**



Stage 8 LML Valparaiso IM

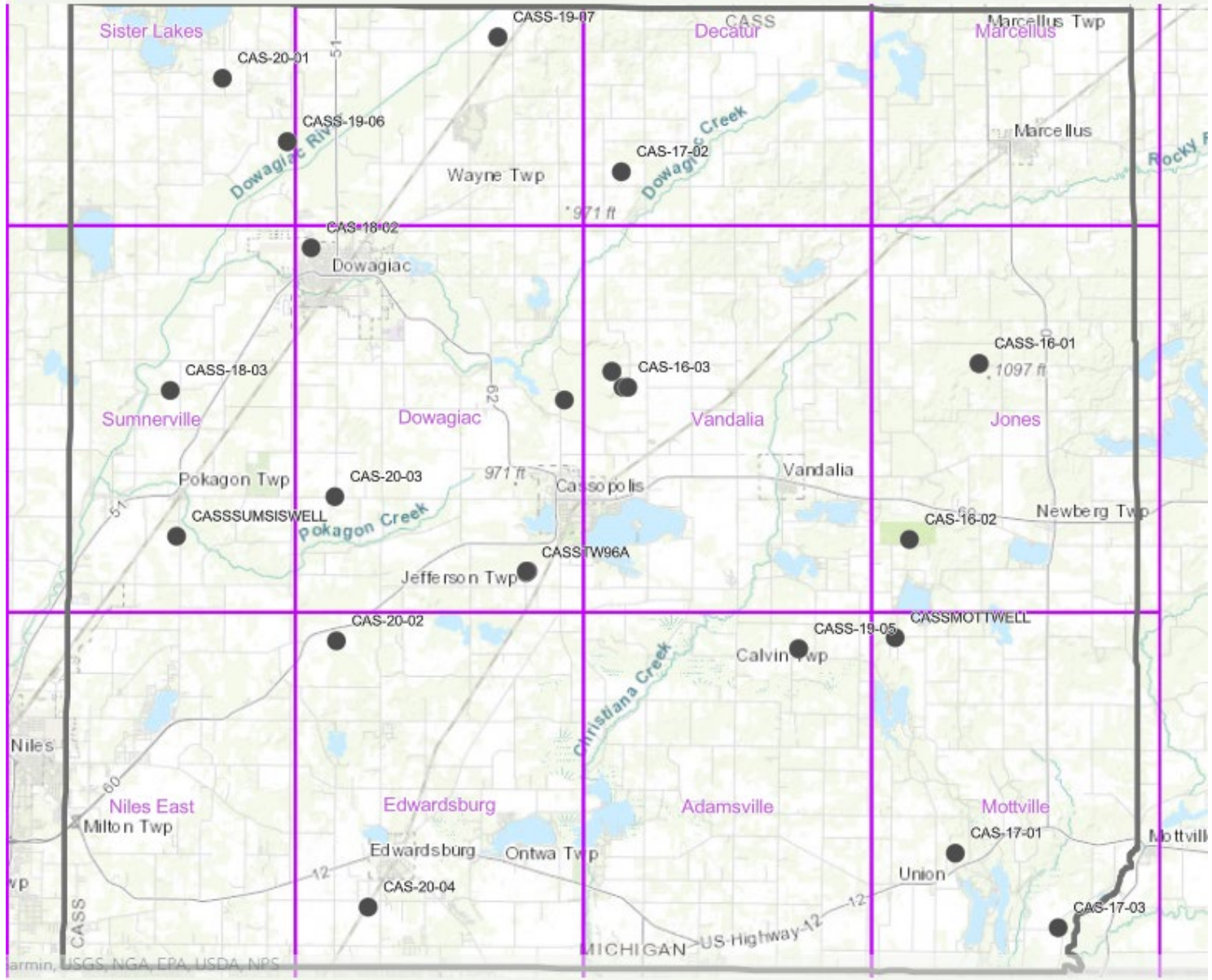
# Cass County Interpreted Late Wisconsinan Glacial Advance and Retreat



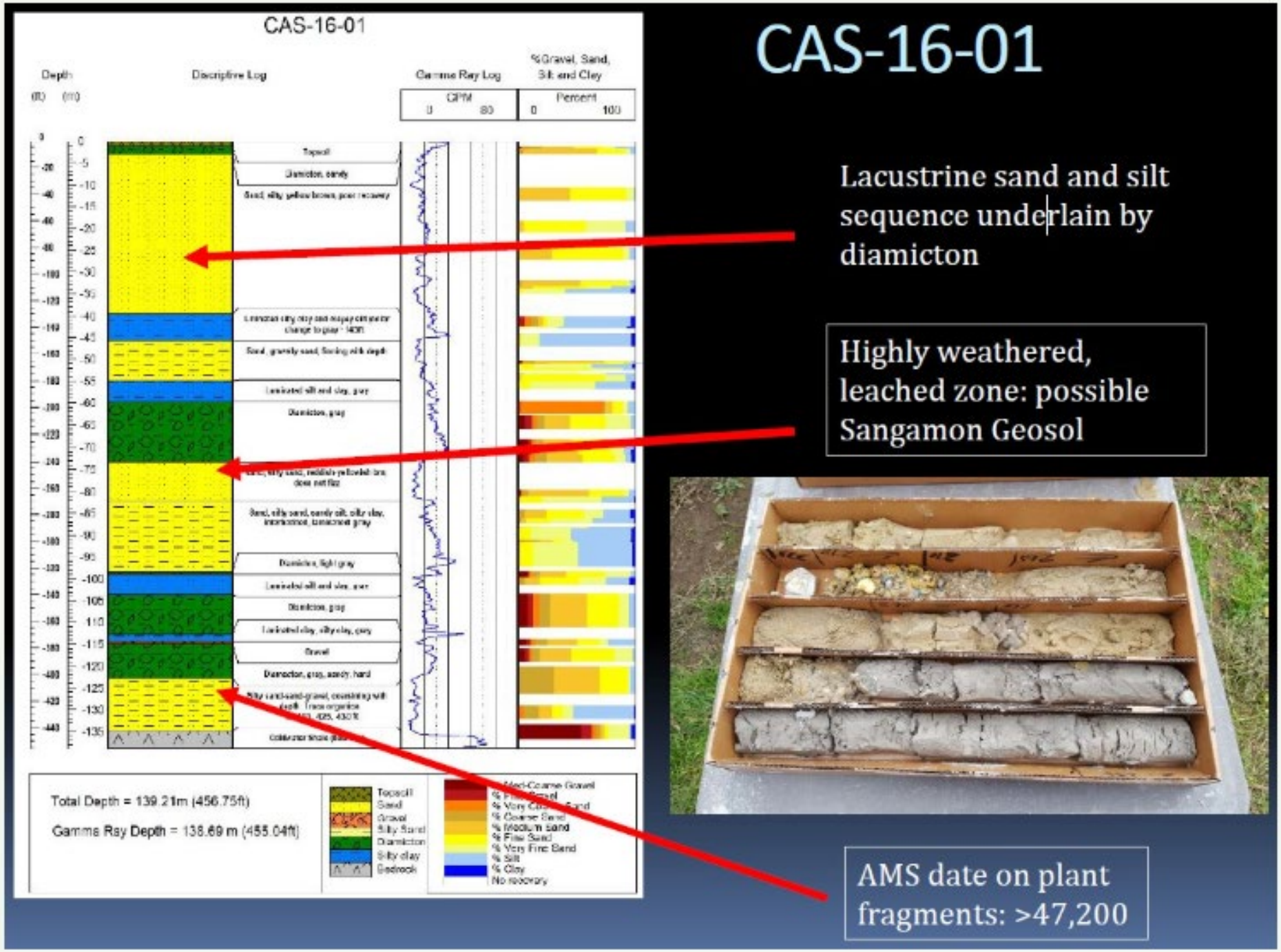

Stage 1 LML advances east of county

Animation

# Drilling/Coring Results




Cass County Borings

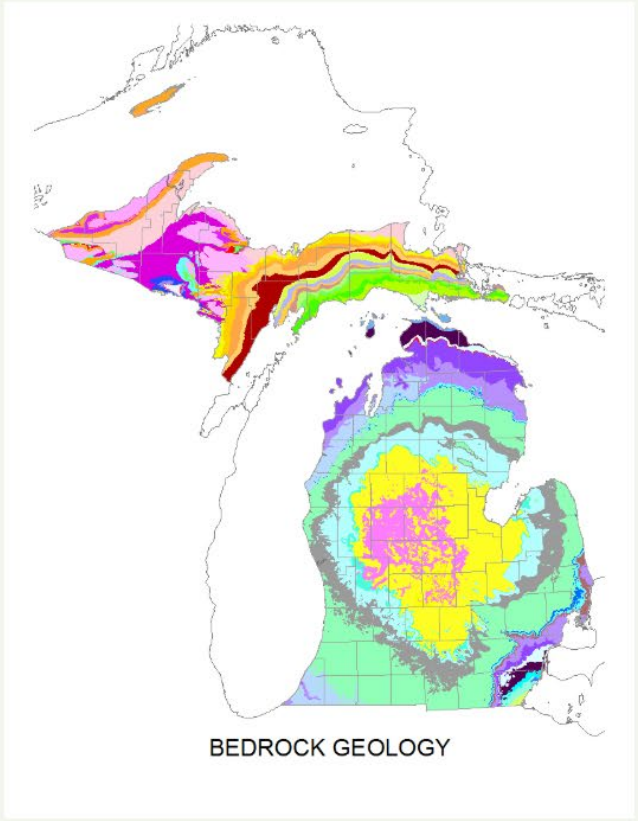

CAS-16-01
Depth
Descriptive Log
Gamma Ray Log
%Gravel, Sand, Silt and Clay
GPM
Percent
Topsoil
Diamicton, sandy
Diamicton, gray
Diamicton, light gray
Diamicton, gray
Gravel
Diamicton, gray, sandy, hard
Total Depth = 139.21m (456.75ft)
Gamma Ray Depth = 138.69 m (455.04ft)
Topsoil
Sand
Gravel
Silty Sand
Diamicton
Silty clay
Bedrock
% Clay
No recovery
CAS-16-01
Lacustrine sand and silt sequence underlain by diamicton
Highly weathered, leached zone: possible Sangamon Geosol
AMS date on plant fragments: >47,200

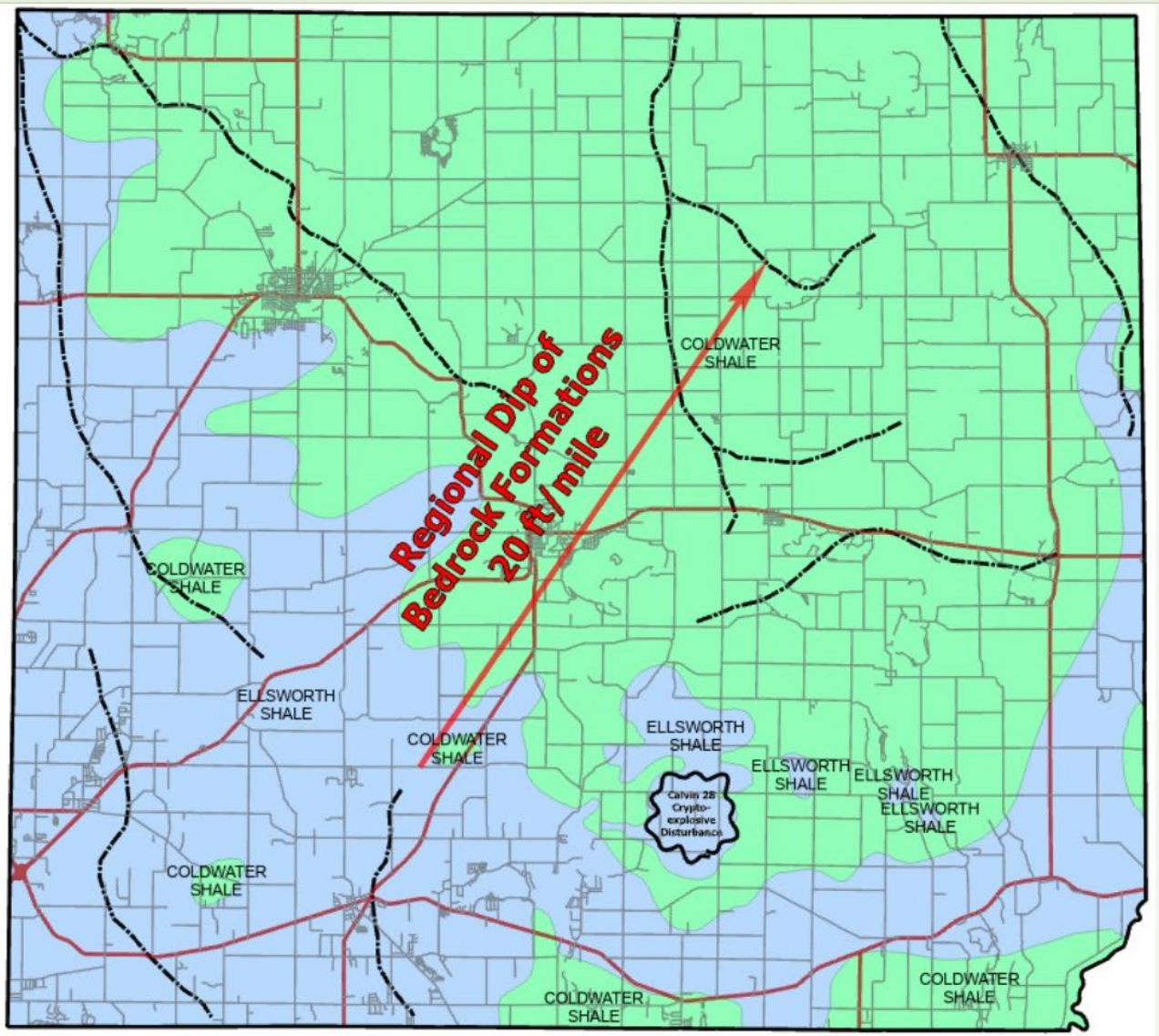
# Bedrock Geology

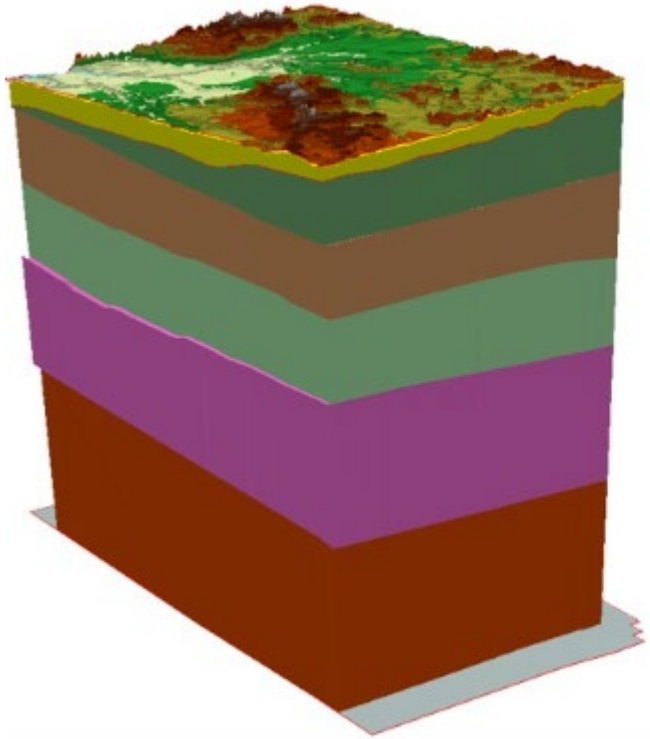
Cass County, Michigan - Surficial Geological Mapping DRAFT

DRAFT Not for Distribution | Introduction | Methods | Inland Sand Dunes and Sand She... | Southwest Interpreted Late Wis... | Cass County Interpreted Late W... | Drilling/Coring Results | Bedrock Geology | Bedrock Topography, Glacial Dr... | OSL Age D →

**Paleozoic Bedrock Geology**






Generalized Stratigraphic Column in St. Joe County to the east

Mississippian **Coldwater Shale** underlies the northeastern two-thirds of Cass County.

A distinctive reddish colored informal marker bed, the **Coldwater Redrock**, occurs at or near the base of the Coldwater Shale.

The underlying Devonian **Ellsworth Shale** forms the bedrock surface in the southwestern one-third of the county. It's often tabular to rectangular clasts and cobbles with a distinctive light green color are common in the drift in the southwest part of Cass County.

The Upper Devonian **Antrim Shale** likely subcrops at the bottom of a deep bedrock valley (see below).

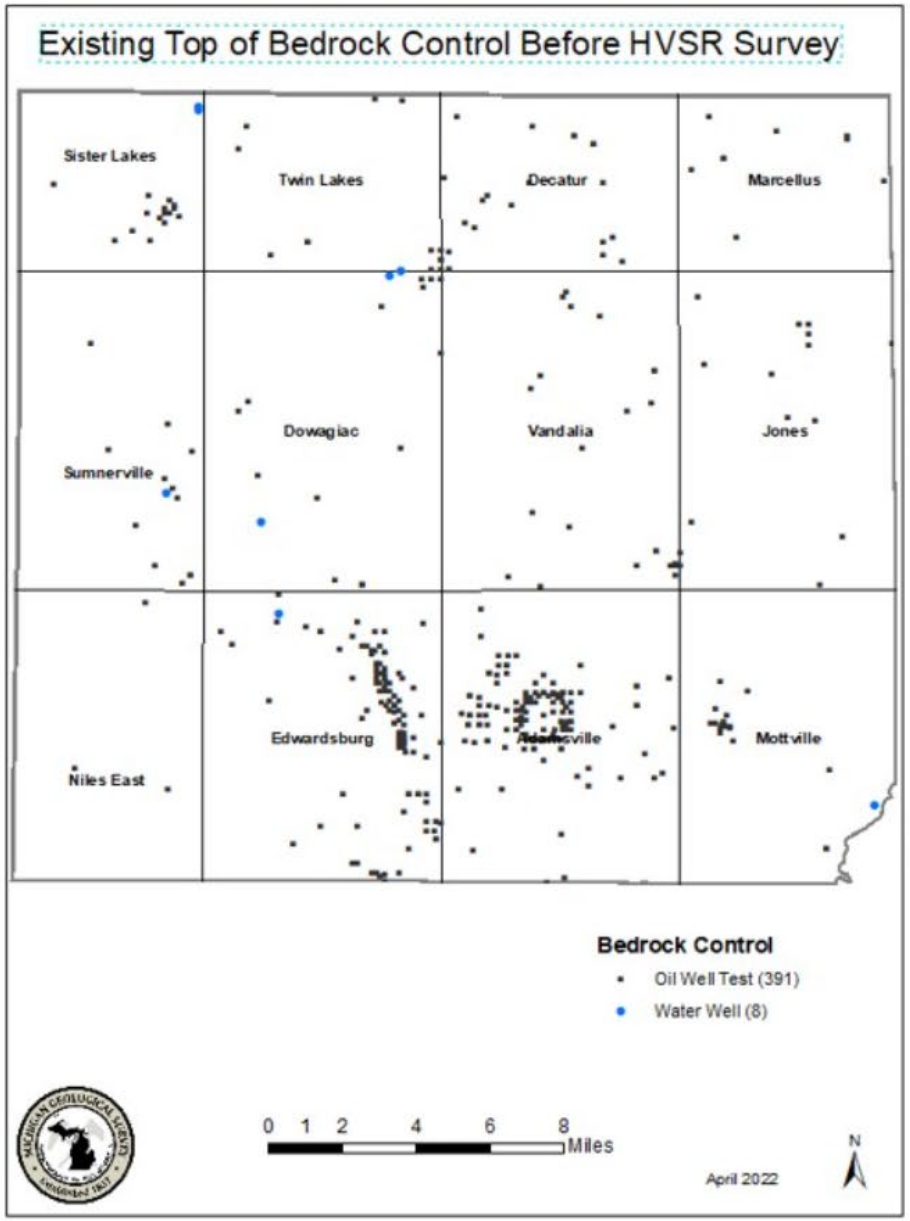
These formations dip to the northeast at a rate of 20 ft/mile toward the center of the Michigan Basin.

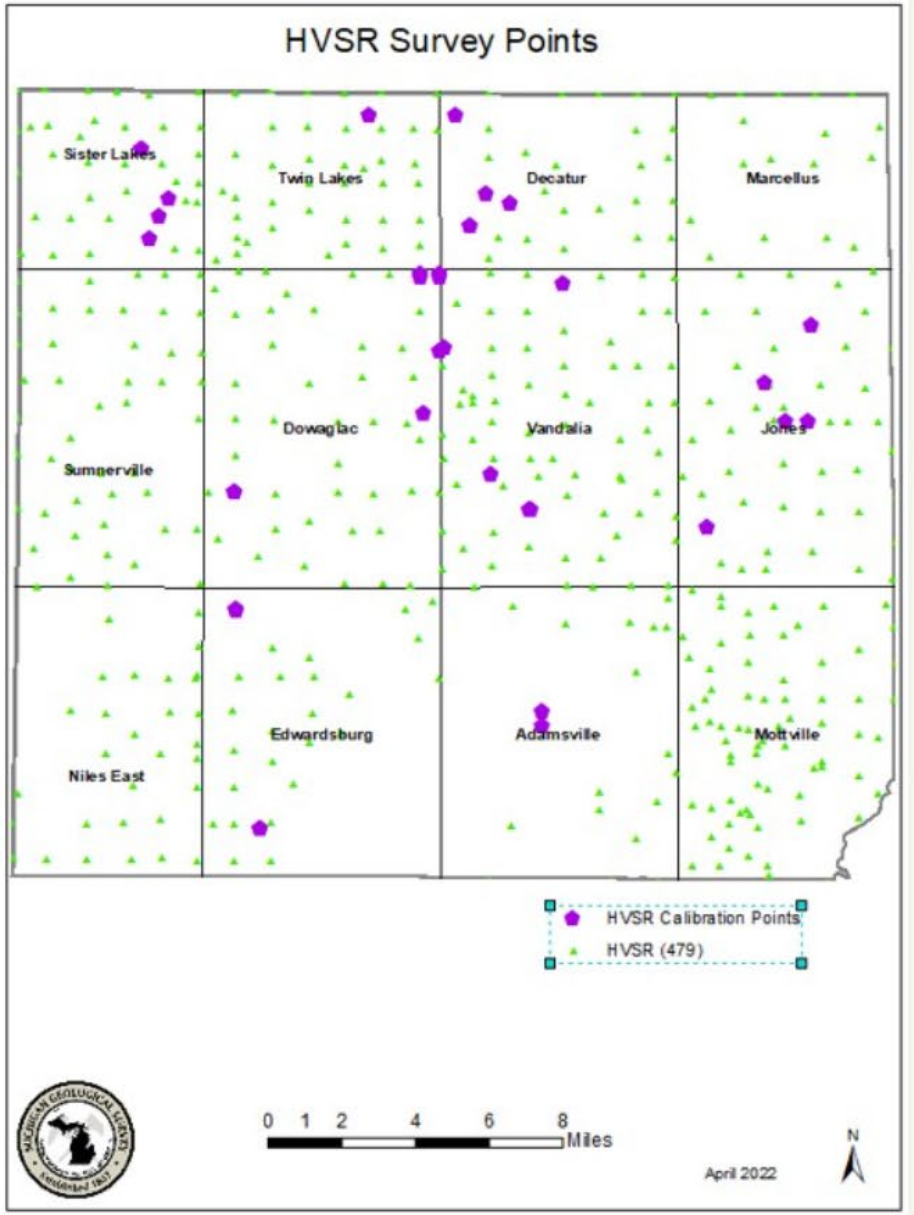
**Coldwater Shale with Coldwater Redrock informal marker bed (purple colored core in box in foreground. CAS-17-01 core**

## HVSR Horizontal-to-Vertical Spectral Ratio Method

•HVSR- Method•Passive/Ambient Seismic Technique –Uses natural and anthropogenic noise•Used to Determine/Estimate Depth to bedrock (drift thickness)•Single station measurements•Resonance Frequency related to bedrock depth–Low Frequency deeper bedrock depth–High Frequency shallow bedrock depth•Calibration Points/Curve generally needed •HVSR records Ambient Seismic Noise (3 components)

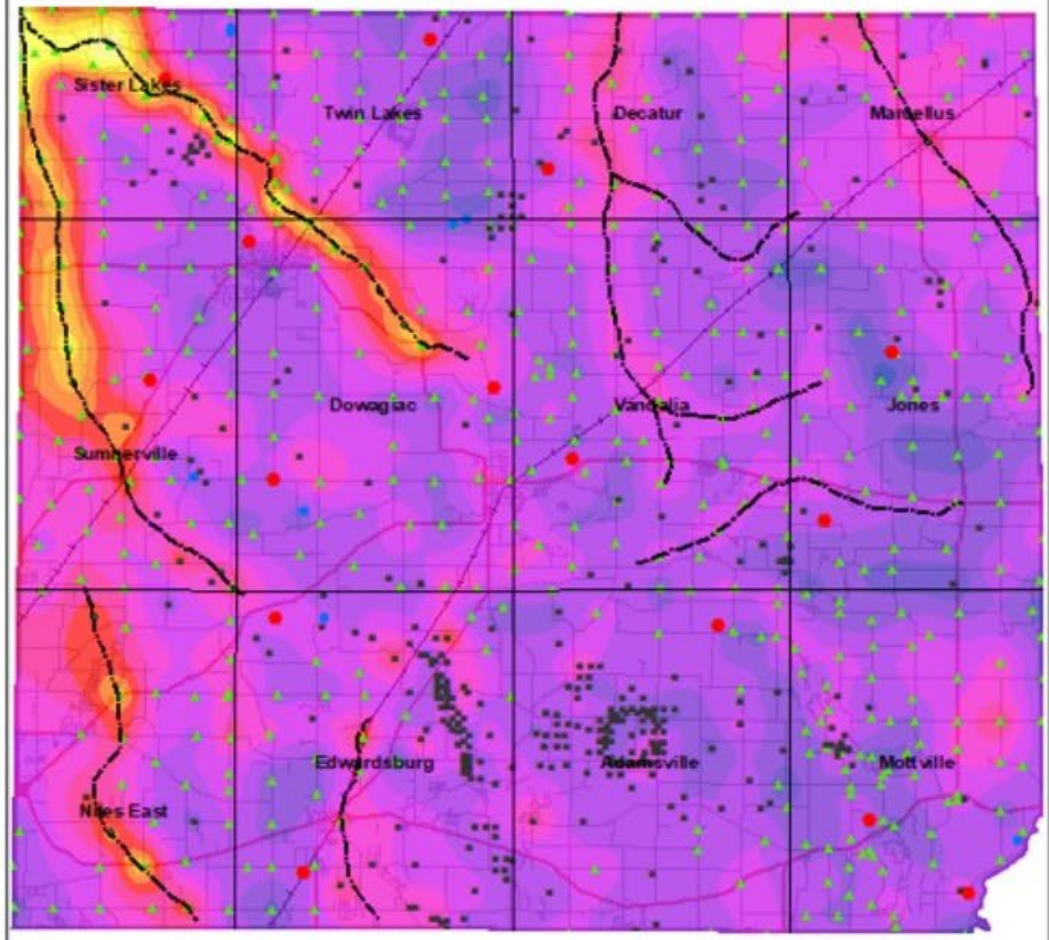
HVSR Passive Seismic to fill in the bedrock depth data gaps for drift thickness and bedrock topography mapping




Collected >500 HVSR readings of those 29 are Calibration Readings.
Didn't use 29 due to poor quality of readings

# Cass County Bedrock Topography




Bedrock Elevation Feet amsl.

Feet

| | | |
|---|---|---|
| 683 - 727 | 507 - 550 | 242 - 285 |
| 639 - 682 | 463 - 506 | 197 - 241 |
| 595 - 638 | 418 - 462 | 153 - 196 |
| 551 - 594 | 374 - 417 | 109 - 152 |
| | 330 - 373 | 64 - 108 |
| | 286 - 329 | |

Bedrock Control

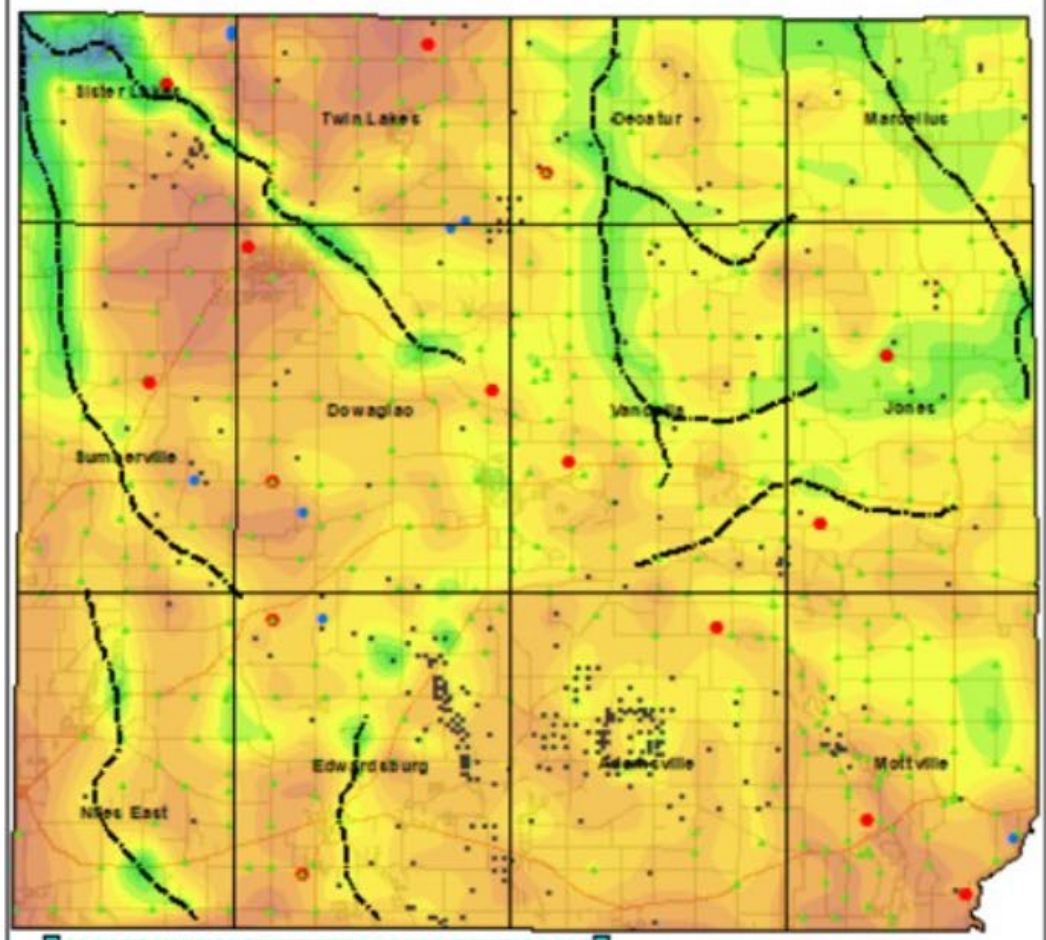
- Control
- HVSR
- MGS Boring
- Oil Well Test
- Water Well
- Buried Bedrock Valley

0 1 2 4 6 8 Miles

N

April 2022

# Drift Thickness




Drift Thickness Feet

Feet

| | | |
|---|---|---|
| 683 - 715 | 516 - 548 | 282 - 314 |
| 650 - 682 | 482 - 515 | 248 - 281 |
| 616 - 649 | 449 - 481 | 215 - 247 |
| 583 - 615 | 416 - 448 | 181 - 214 |
| 549 - 582 | 382 - 415 | 148 - 180 |
| | 349 - 381 | 114 - 147 |
| | 315 - 348 | |

Bedrock Control

- Control
- HVSR
- MGS Boring
- Oil Well Test
- Water Well
- Buried Bedrock Valley

0 1 2 4 6 8 Miles

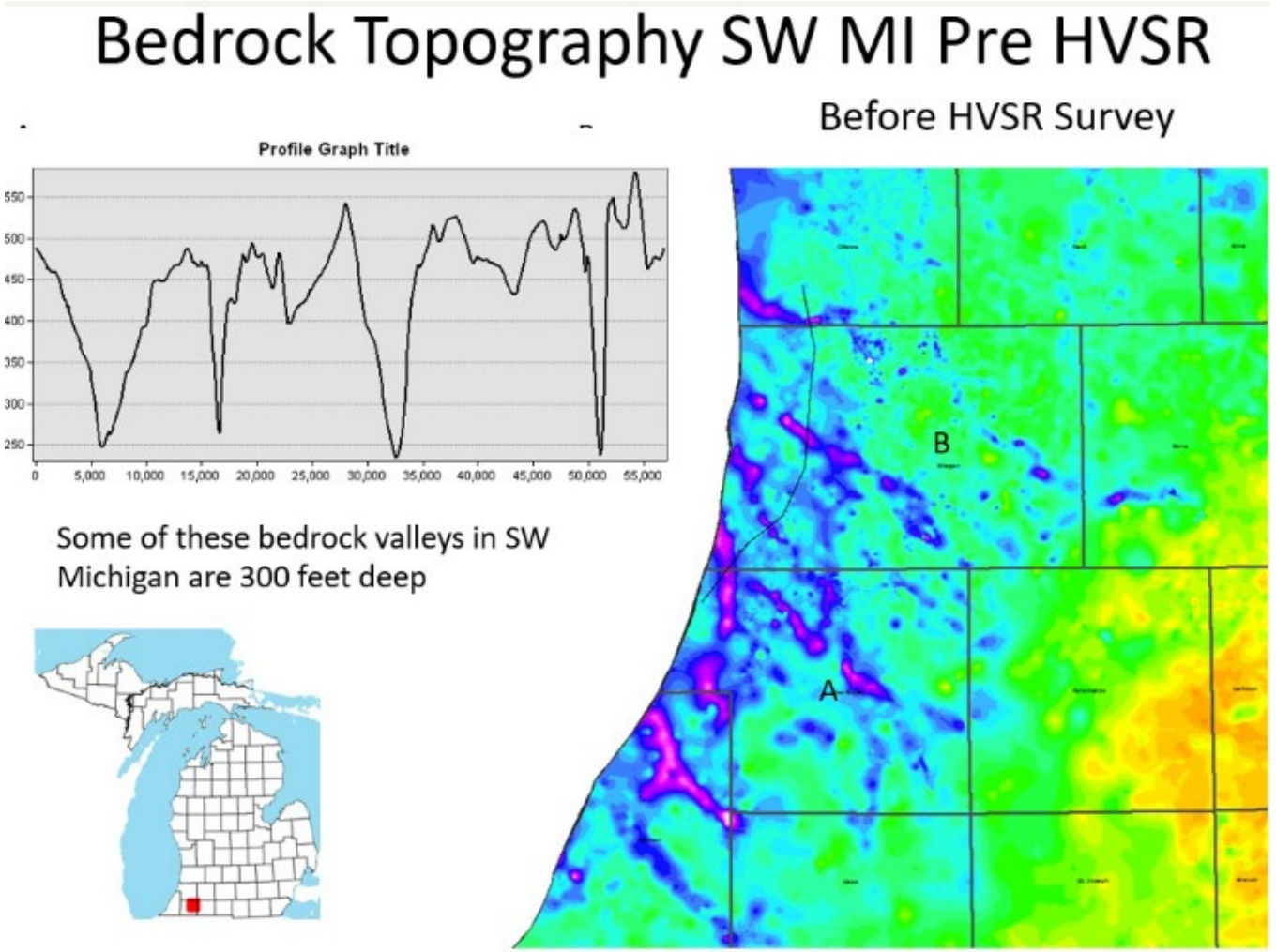
N

April 2022

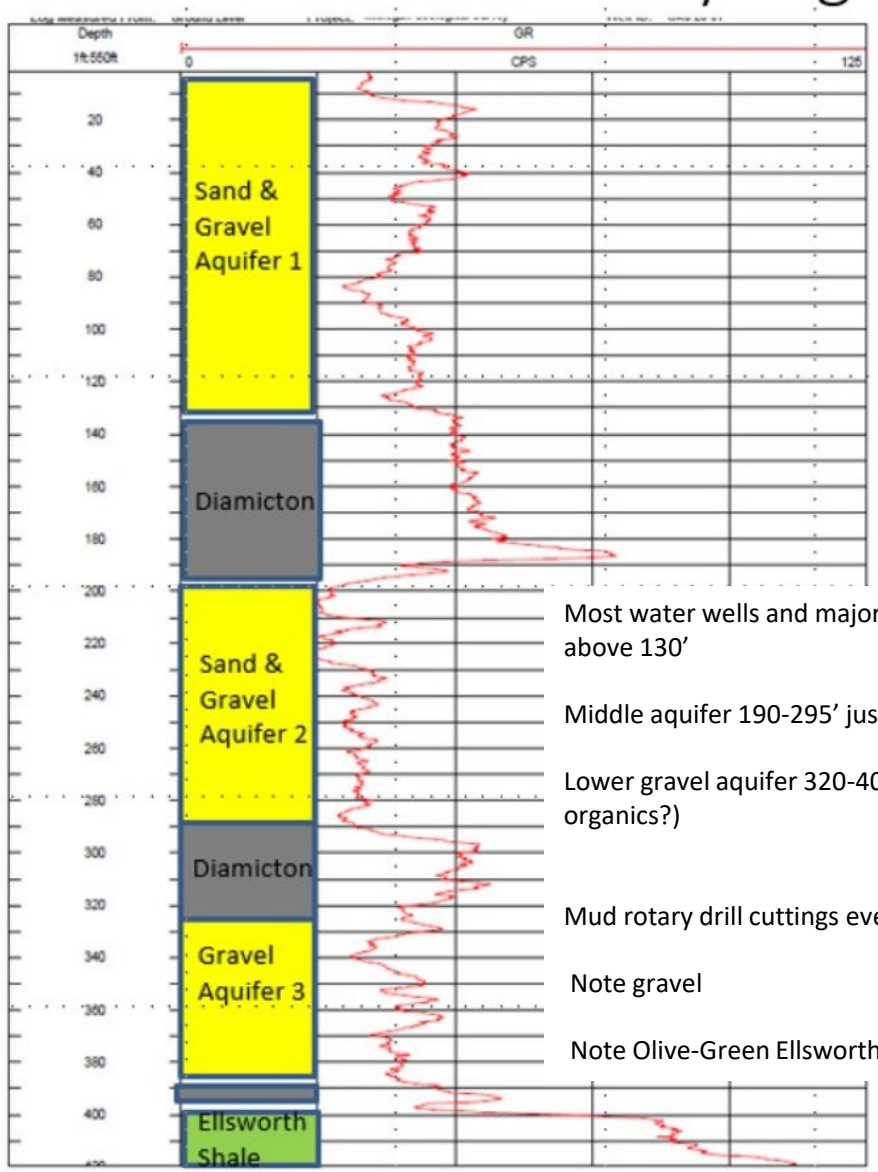
## Bedrock Topography and Drift Thickness

The bedrock topography, bedrock valleys and drift thickness were mapped in Cass County. The bedrock surface ranges from approximately 64 feet above mean sea level at the bottom of a deep bedrock valley in the northwest part of the county to 727 feet above mean sea level, averaging 535 feet elevation. A series of generally northwest trending buried bedrock valleys occurs mostly in the north half of the county. This bedrock valley system is an extension of a series of deep bedrock valleys that runs southeast-northwest across Van Buren County to the north and extend at least to the Lake Michigan shoreline. A couple of the bedrock valleys are over 40 miles long. One of the main northwest trending bedrock valleys underlies a large tunnel valley. In the northwest corner of the county, this bedrock valley joins another pronounced buried bedrock valley which runs north-northwest along the west side of the county. The previously unmapped bedrock valleys are significant because, even in a prolific glacial drift aquifer system with significant high-capacity irrigation, in most places only the upper half or less of glacial deposits have been characterized or are being used for aquifers. In at least one of the bedrock valleys, drilling has confirmed a previously unknown gravel aquifer. The glacial deposits in the mapped area average 310 feet thick with a range from 115 feet northwest of Dowagiac to 717 feet thick over the deep bedrock valley. The 717 feet of glacial drift is the thickest known in the southern half of the Lower Peninsula of Michigan.

HVSR Passive Seismic was used to fill in the bedrock depth data gaps for drift thickness and bedrock topography mapping



# CAS-20-01 Gamma-Ray Log




Most water wells and majority of irrigation wells screened in aquifer above 130’

Middle aquifer 190-295’ just a few irrigation wells

Lower gravel aquifer 320-400’ no wells screened in this aquifer (buried organics?)

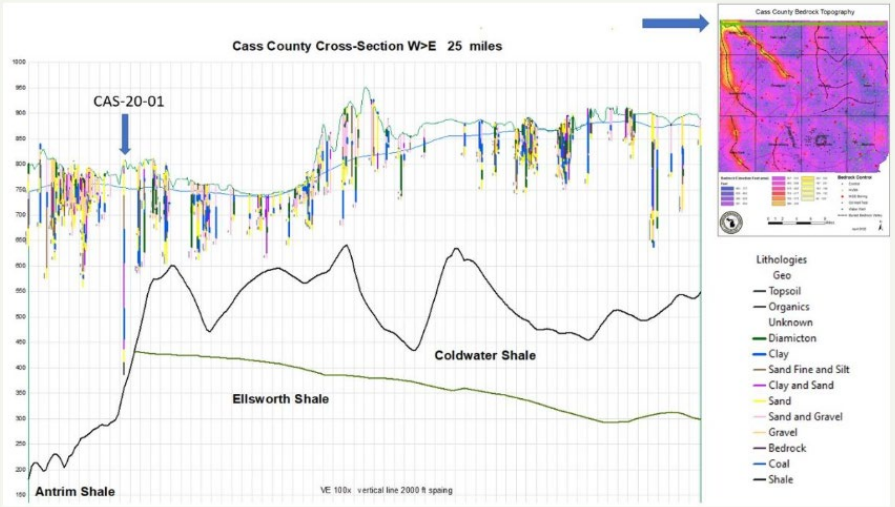
Mud rotary drill cuttings every 5 feet

Note gravel

Note Olive-Green Ellsworth Shale bedrock and gravel

## Unidentified deep gravel aquifer discovered in bedrock valley

Deep boring by the Michigan Geological Survey in Cass County, as part of a county-wide surficial geology mapping project encountering previously unknown deep gravel aquifer in a high irrigation agricultural area. Edge of major bedrock valley, likely not in the thalweg.




W>E cross-section along the north county line

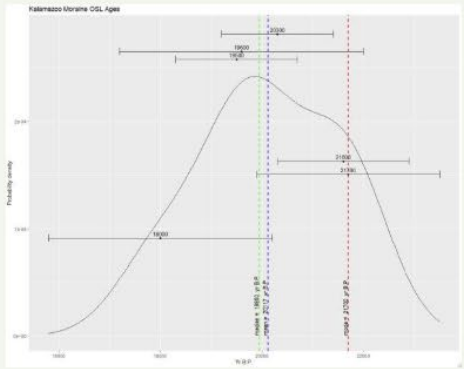

Mud rotary drill cuttings every 5 feet

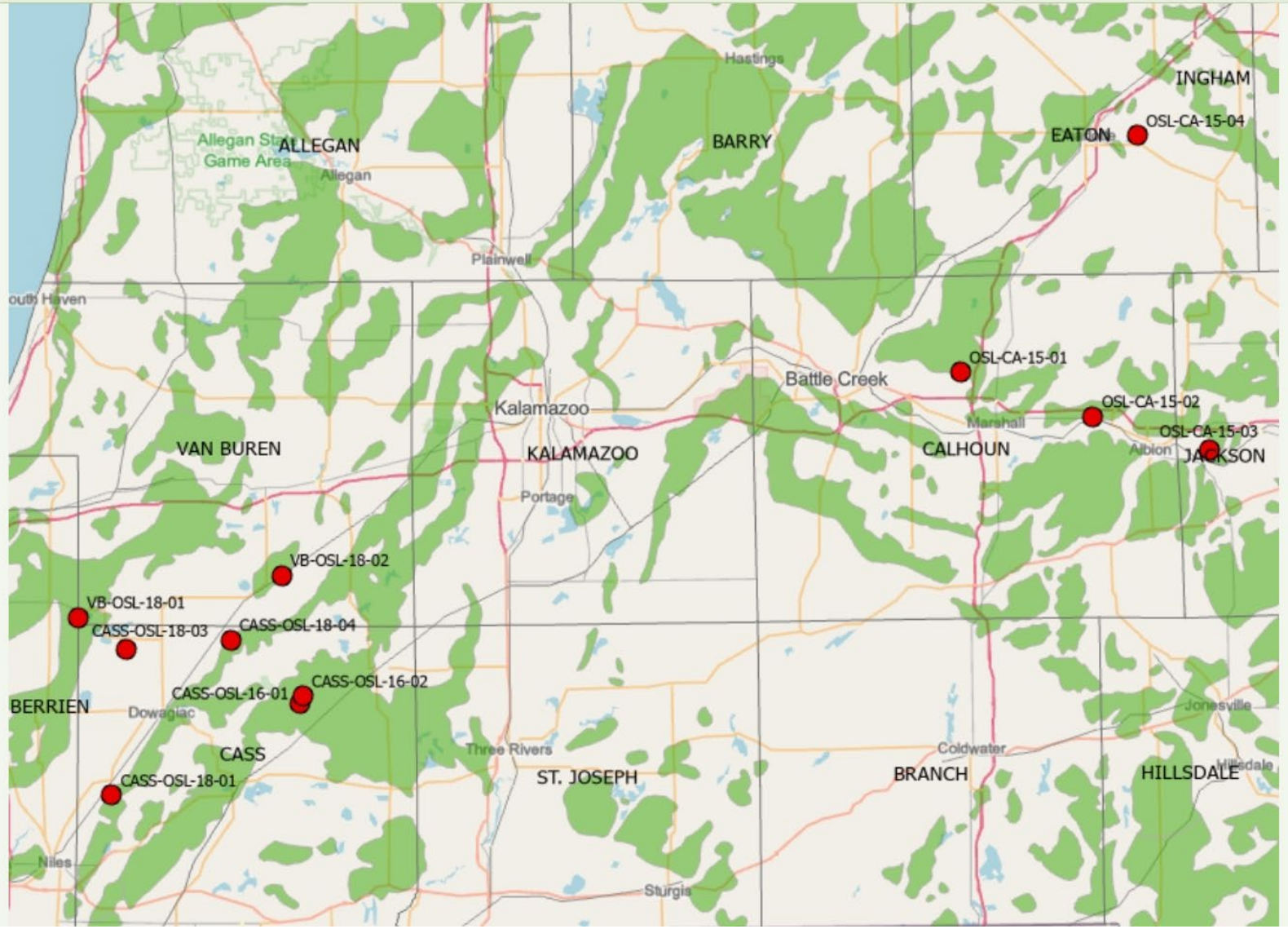
# OSL Age Dating: OSL Samples from the Kalamazoo and Valparaiso/Charlotte Moraines

Cass County, Michigan - Surficial Geological Mapping DRAFT

DRAFT Not for Distribution | Introduction | Methods | Inland Sand Dunes and Sand She... | Southwest Interpreted Late Wis... | Cass County Interpreted Late W... | Drilling/Coring Results | Bedrock Geology | Bedrock Topography, Glacial Dr... | OSL Age D →

OSL-CAS-16-02





# Kankakee Torrent

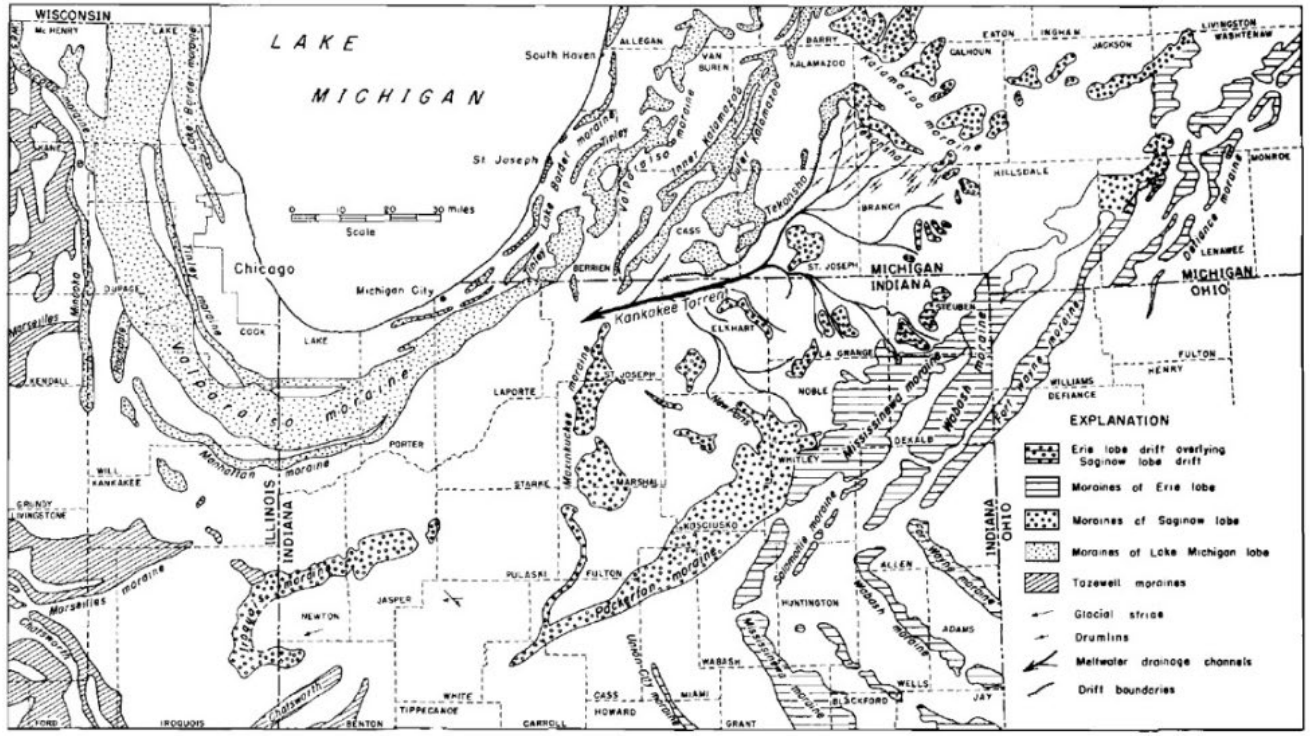
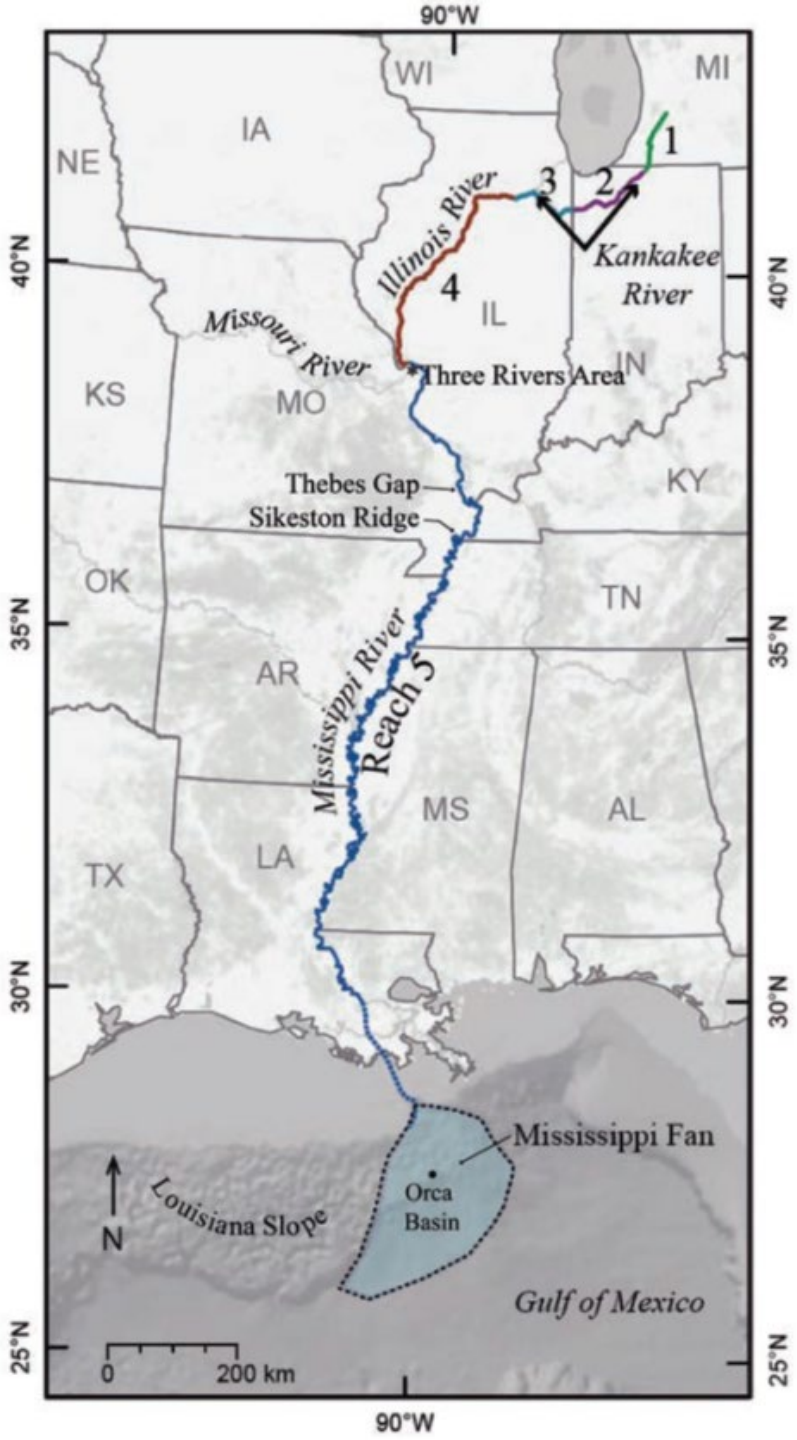
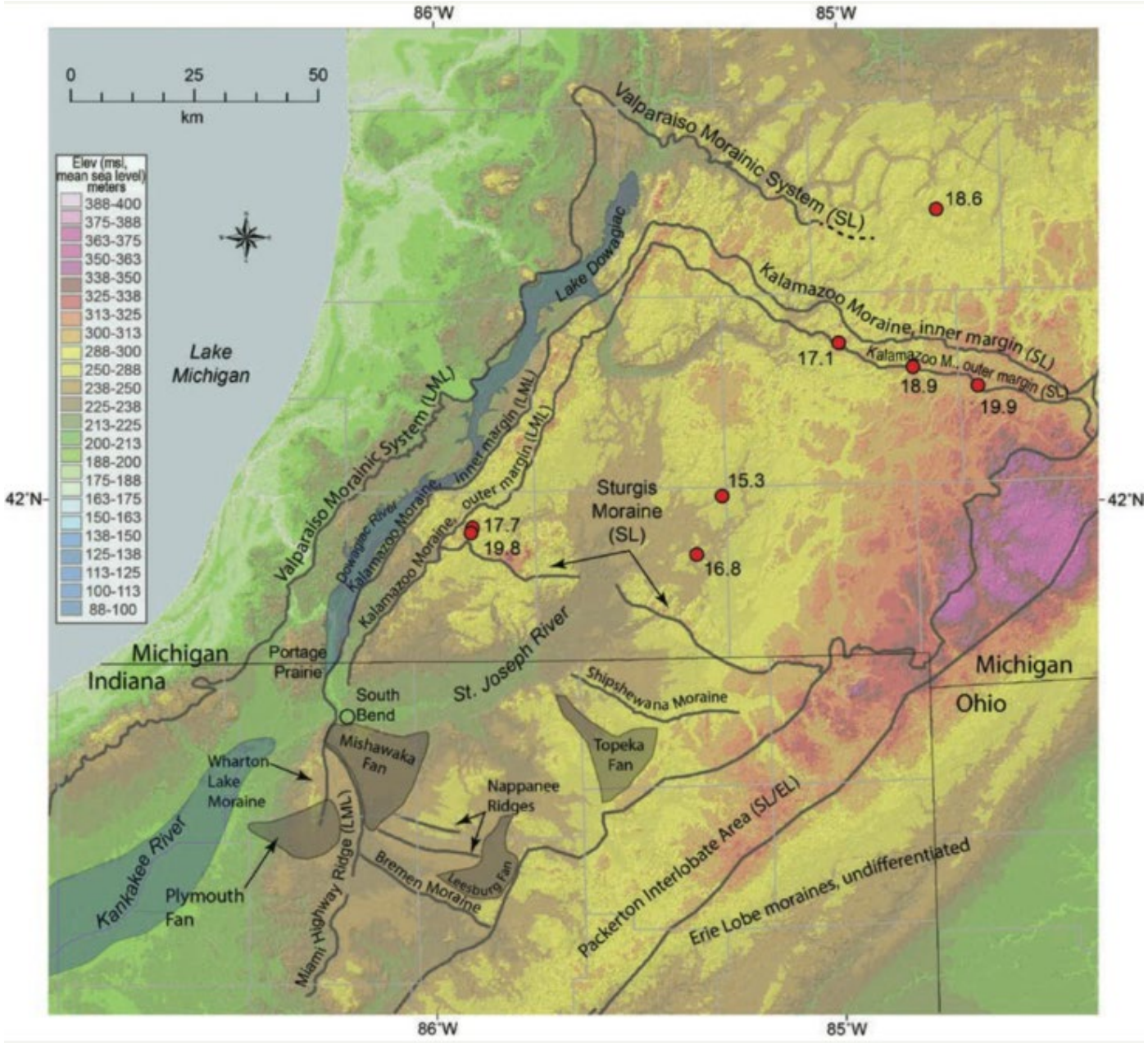


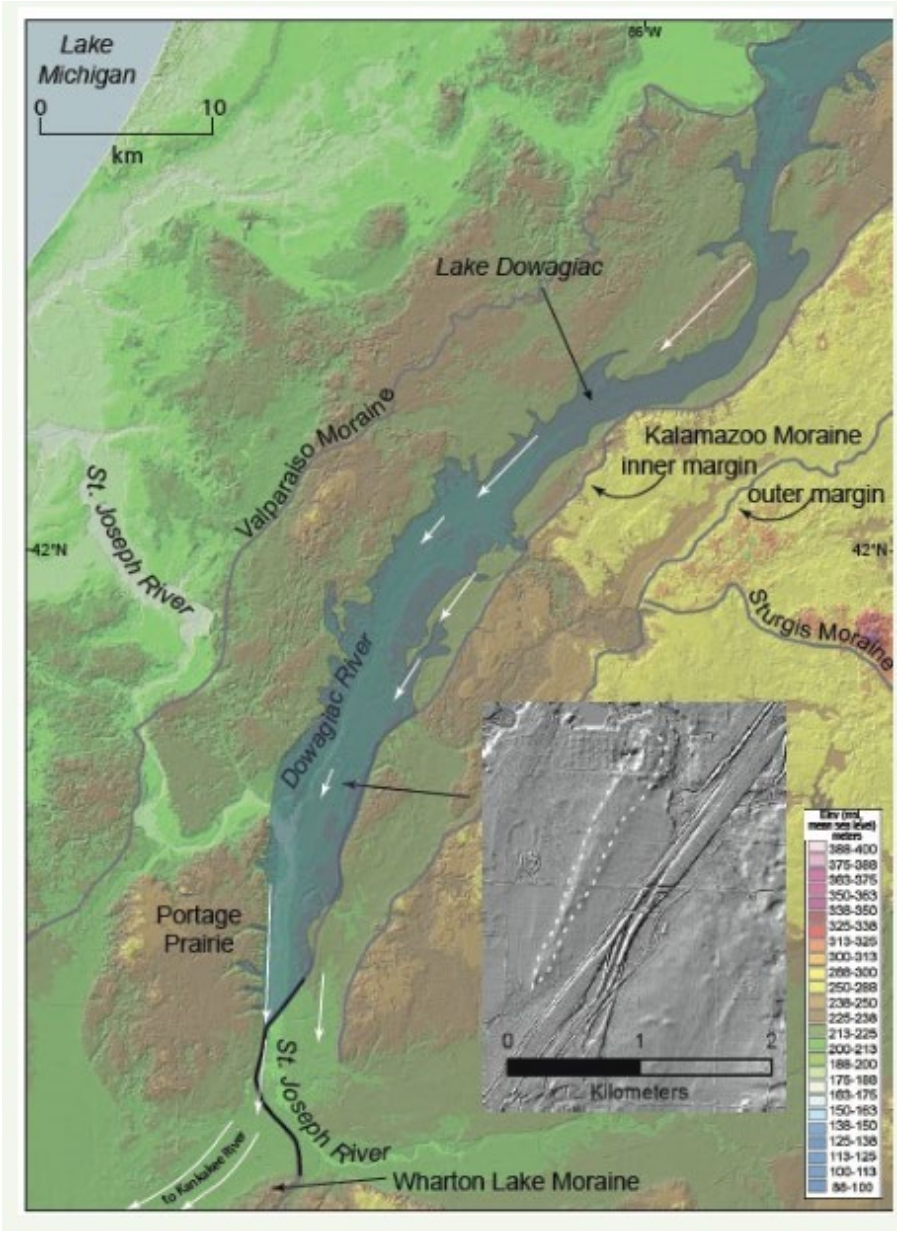

FIGURE 1.—MAP OF WISCONSIN AGE MORAINES, NORTHEASTERN ILLINOIS, NORTHERN INDIANA, SOUTHERN MICHIGAN, AND NORTHWESTERN OHIO

Zumberge, 1960



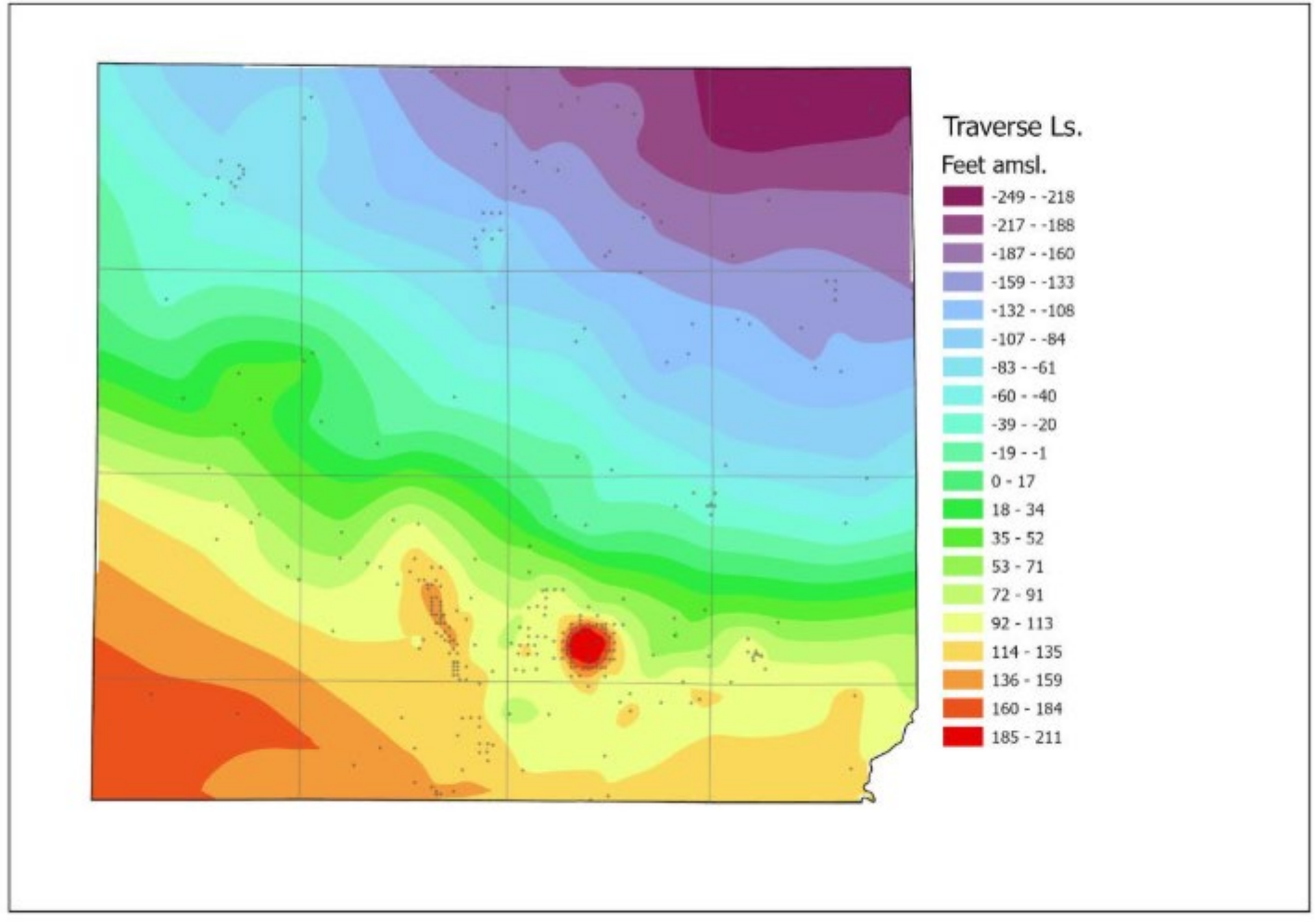

Curry, B.B., Kehew, A.E., Antinao, J.L., Esch, J., Huot, S., Caron, O.J., and Thomason, J.F., 2020, Deglacial Kankakee Torrent, source to sink, in Waitt, R.B., Thackray, G.D., and Gillespie, A.R., eds., Untangling the Quaternary Period—A Legacy of Stephen C. Porter: Geological Society of America Special Paper 548, https://doi.org/10.1130/2020.2548(16) .




Curry, B.B., Kehew, A.E., Antinao, J.L., Esch, J., Huot, S., Caron, O.J., and Thomason, J.F., 2020, Deglacial Kankakee Torrent, source to sink, in Waitt, R.B., Thackray, G.D., and Gillespie, A.R., eds., Untangling the Quaternary Period—A Legacy of Stephen C. Porter: Geological Society of America Special Paper 548, https://doi.org/10.1130/2020.2548(16) .

# Oil & Gas

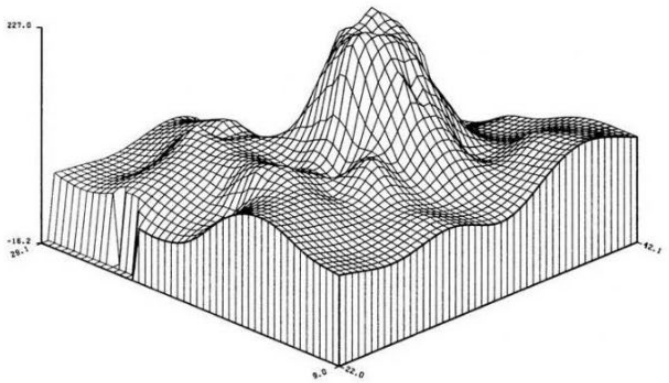



Traverse Limestone Structure Map

# Calvin 28 Cryptoexlosive Structure

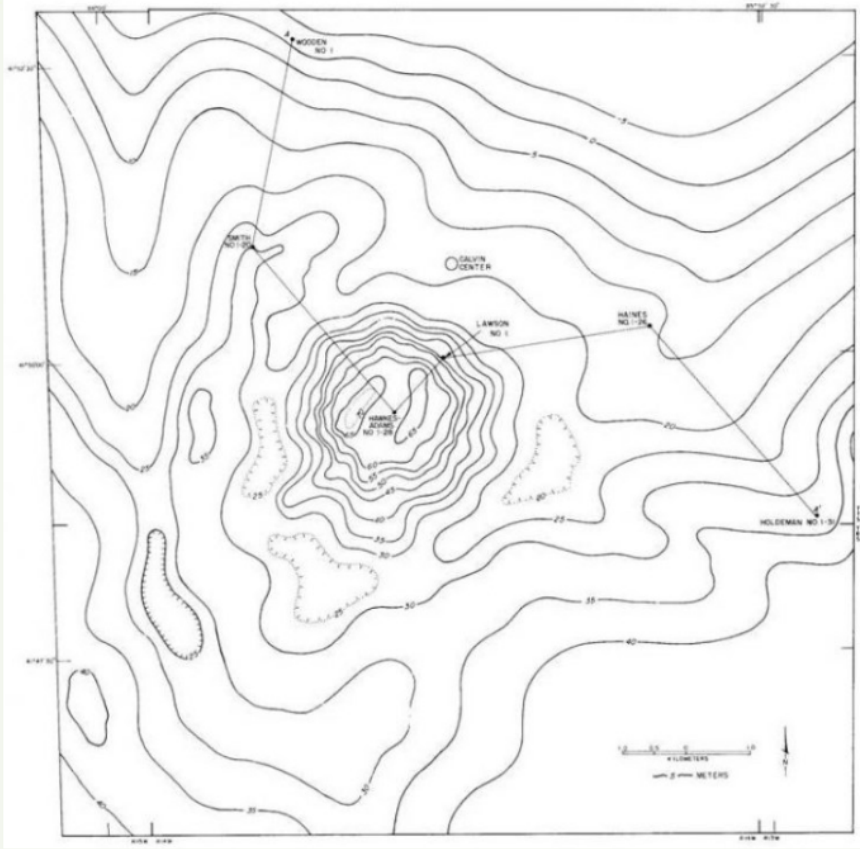
IMPACT ORIGIN OF THE CALVIN 28
CRYPTOEXPLOSIVE DISTURBANCE,
CASS COUNTY, MICHIGAN

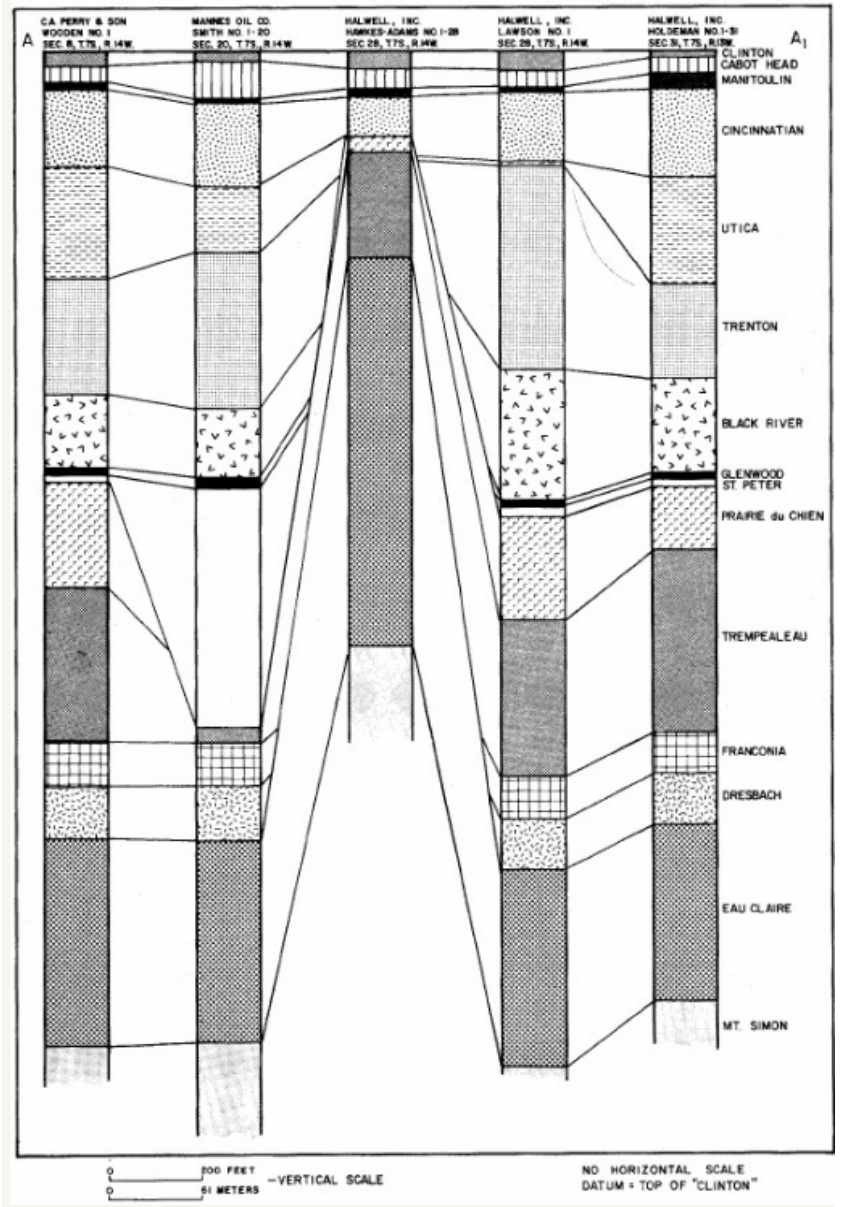
RANDALL L. MILSTEIN




Report of Investigation 28

Geological Survey Division
Michigan Department of Natural Resources
DNR



# Dowagiac Diamonds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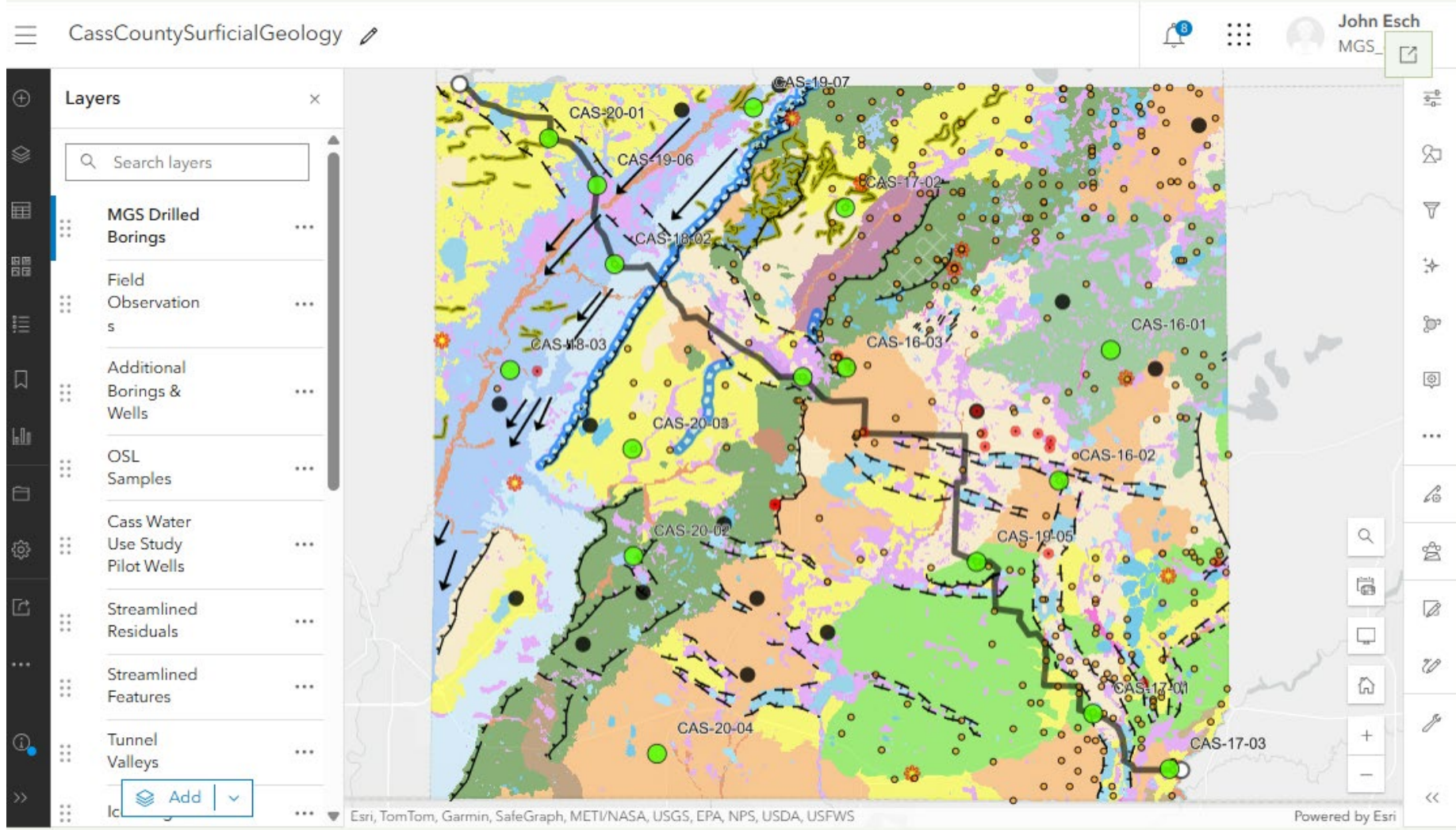
# Interactive Map




Map Viewer

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