

Mapping the Mahomet Aquifer

(using Helicopter-based Time-Domain Electromagnetics)

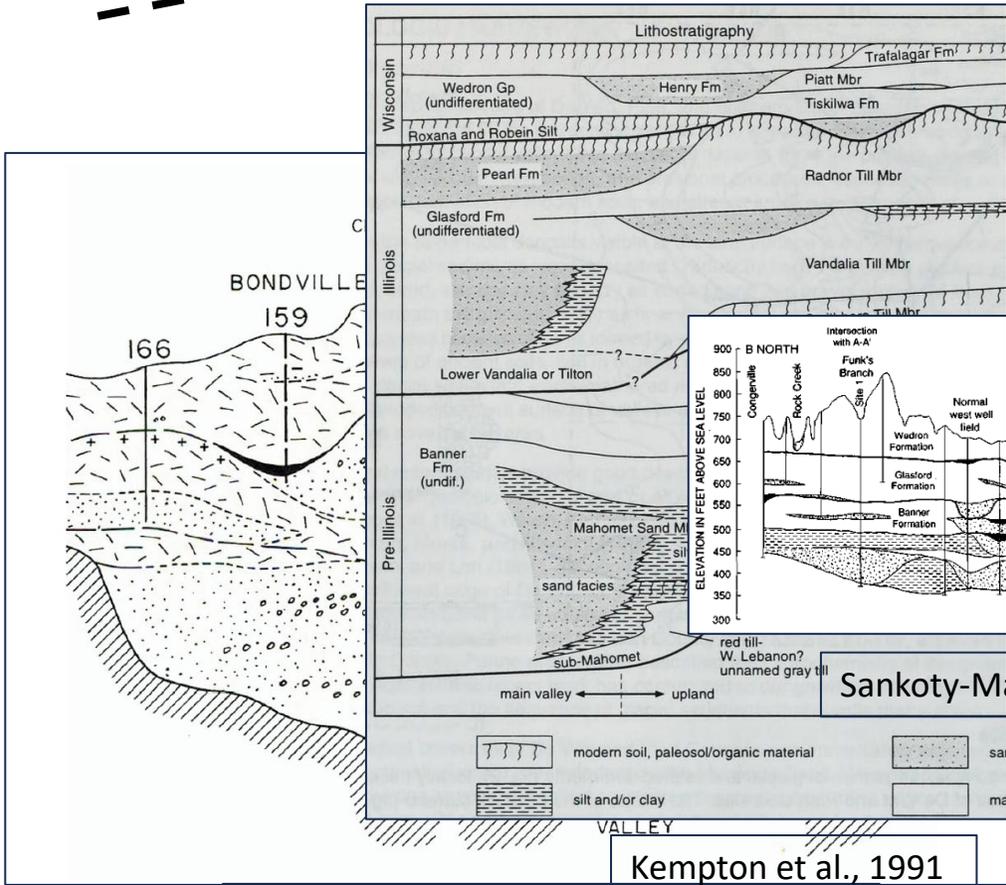
Jason Thomason and Kisa Mwakanyamale-Gilkie

Illinois State Geological Survey
Prairie Research Institute
University of Illinois



Research Origins

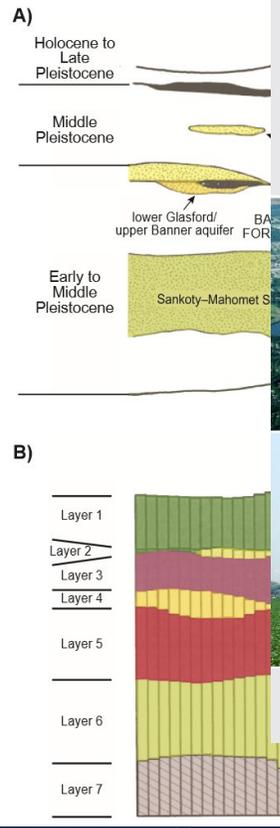
Mahomet Aquifer Research



Mahomet Bedrock Valley (Horberg, 1953)

Kempton et al., 1991

McLean/Tazewell Counties (Herzog, Wilson, Larson, et al., 1995)



ILLINOIS STATE WATER SURVEY
 PRAIRIE RESEARCH INSTITUTE

Contract Report 2011-08

Meeting East-Central Potential Impacts of the Mahomet Aquifer and

George S. Roadcap, H. Vernon

ILLINOIS

The Future of Science of the Mahomet Aquifer

Steven E. Brown, Jason F. Thomason, and Kisa E. Mwakanyamale

Illinois State Geological Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign

Circular 594 2018

ILLINOIS STATE GEOLOGICAL SURVEY
 Prairie Research Institute
 University of Illinois at Urbana-Champaign

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 Illinois State Geological Survey
 PRAIRIE RESEARCH INSTITUTE



Collaborators!

- **Champaign County Board**
- **Champaign County 1st, City of Champaign, City of Urbana, Village of Thomasboro, Frasca Airport, Prairieview-Ogden School District #197**....list goes on and on!!!
- **ISGS Staff:** Don Keefer (ret.), Tim Larson (ret.), Steve Brown, Andy Stumpf, Chris Stohr (ret.), Dick Berg.....
- **ISWS staff:** George Roadcap, Walt Kelly, Daniel Abrams, Dan Hadley, Devin Mannix, Steve Wilson, etc....
- **United States Geological Survey**
- **Mahomet Aquifer Consortium**
- **State legislators:** Chapin Rose, Scott Bennett, Carol Ammons, Tim Johnson
- **State Agencies/Organizations:** IDNR, IEPA, IDPH, IGA...
- **Students!** UIUC and ISU!



Mapping the Mahomet Aquifer Using Airborne Geophysics



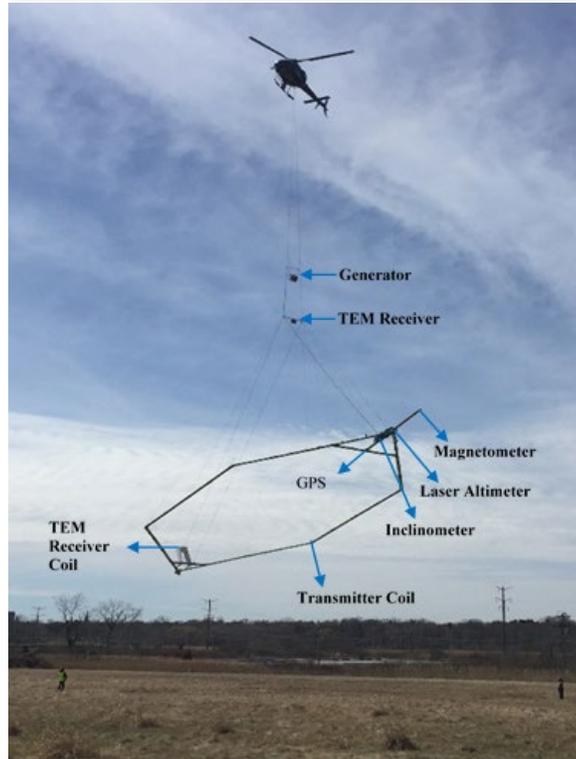
Media Day for airborne mapping project
 (December 2022)



Collaborators and supporters

- Champaign County Board
- Champaign County 1st and Local Leaders
- State and Federal legislators
- Mahomet Aquifer Consortium and other advocacy groups
- Scientists across PRI
- Many motivated citizens

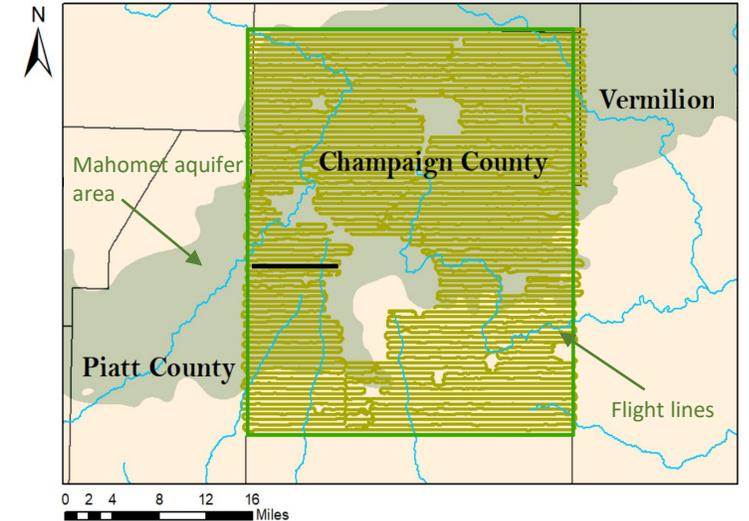
Airborne electromagnetics system by SKYTEM



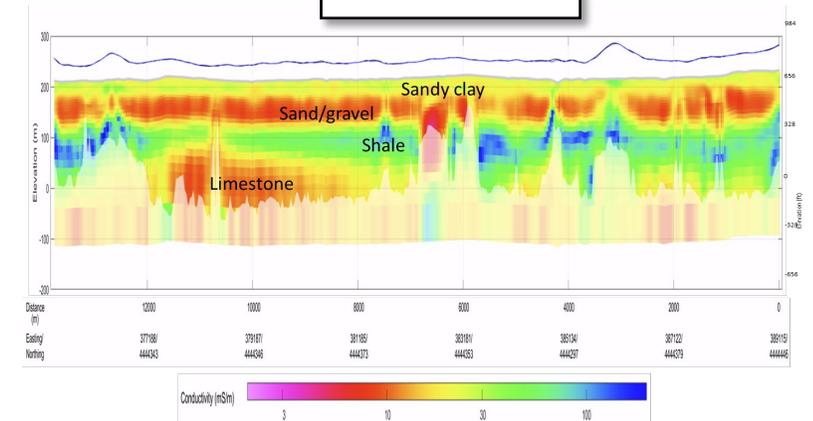
Airborne mapping system (HTEM, Helicopter Time-domain Electromagnetics)

- Emits electromagnetic field via helicopter
- Penetrates up to 500 meters below land surface
- Measures electrical properties below ground
- Interpret electrical properties as geology

Flight lines across Champaign County



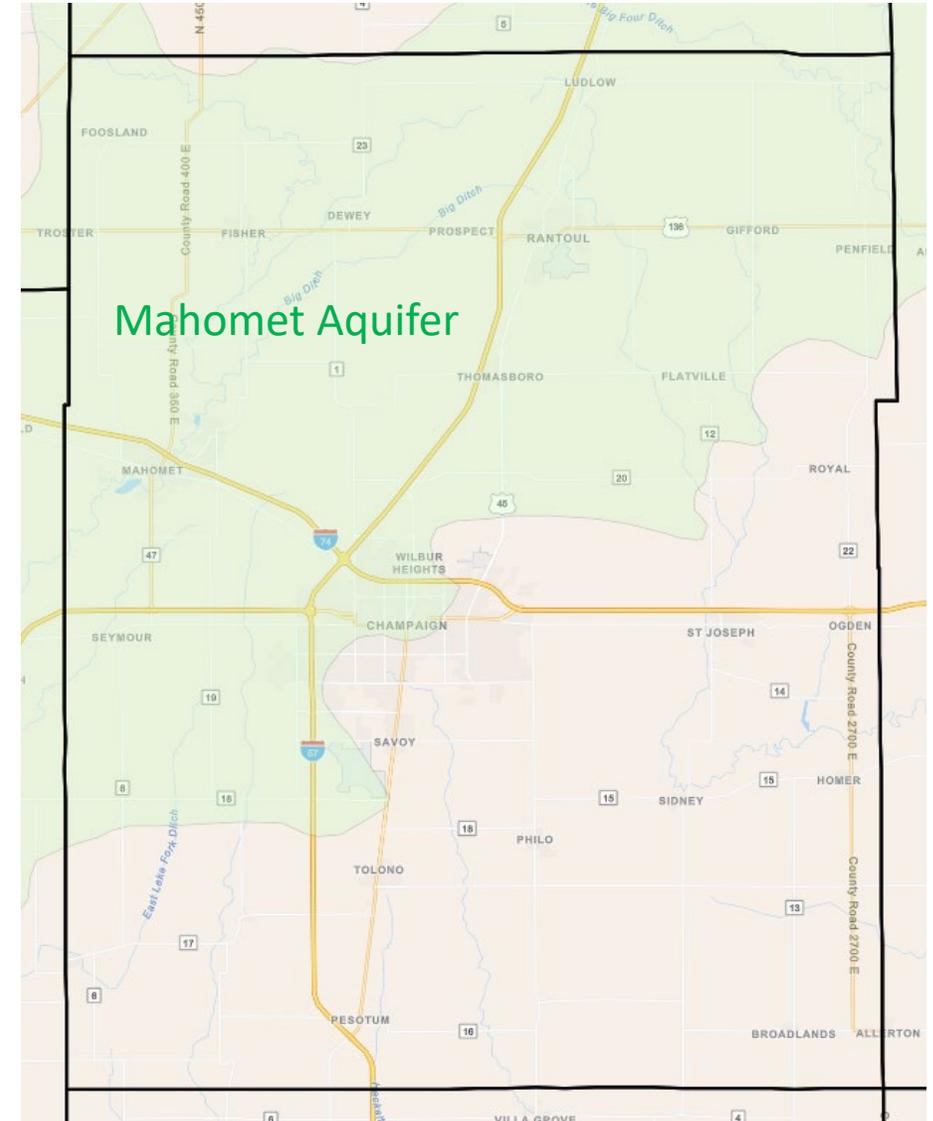
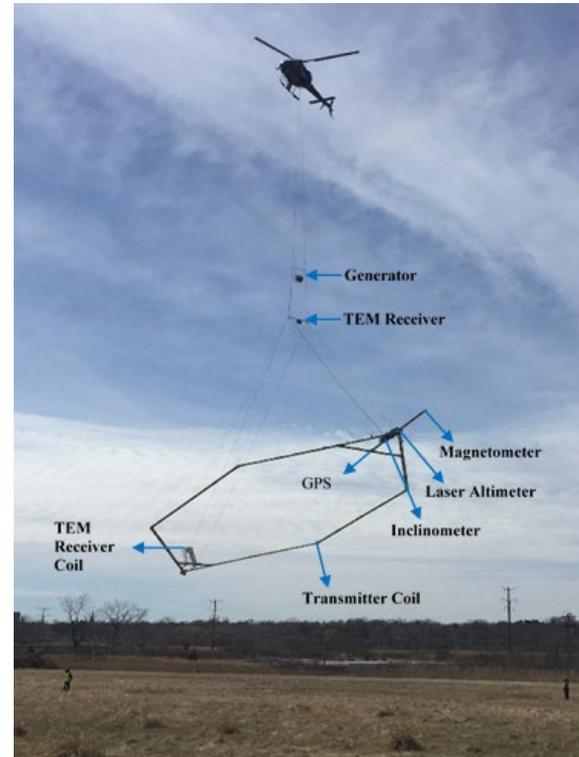
Example of data



Champaign County

Objectives

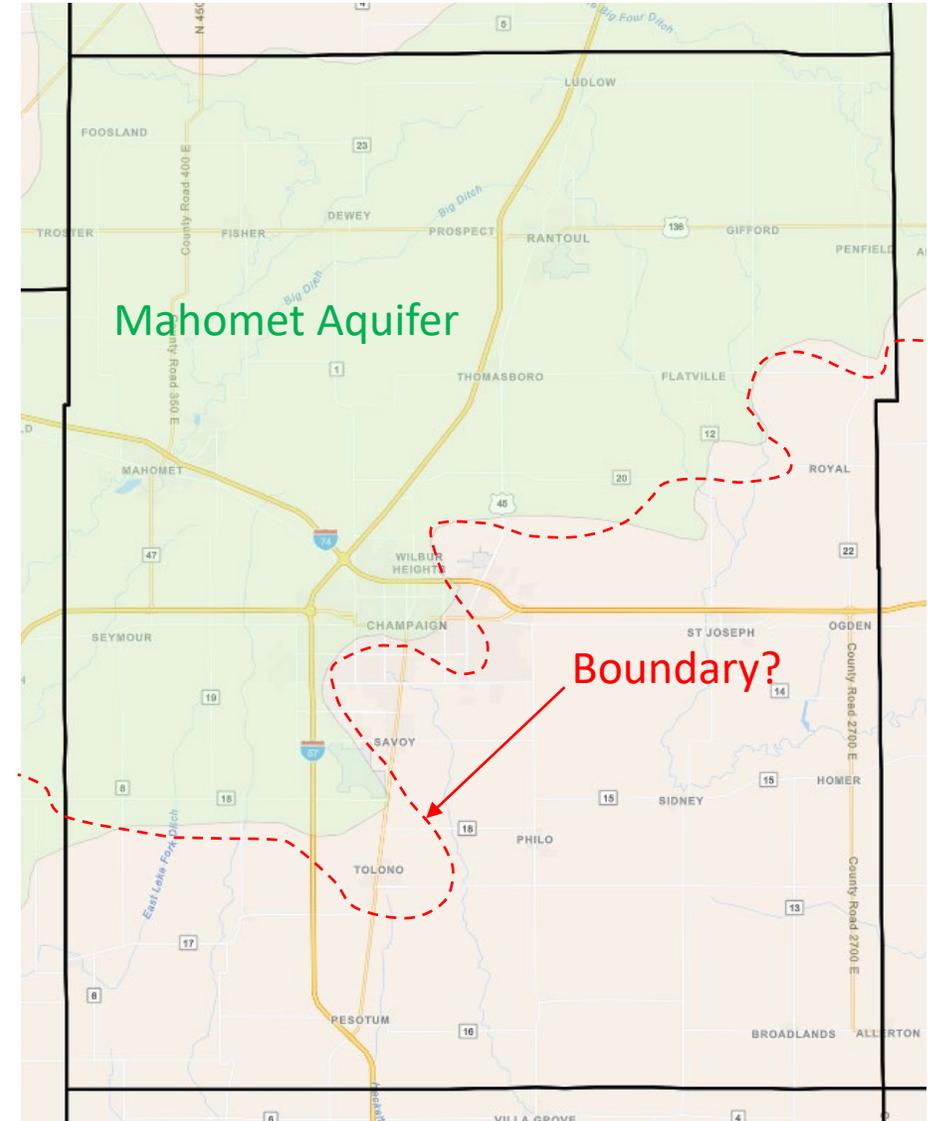
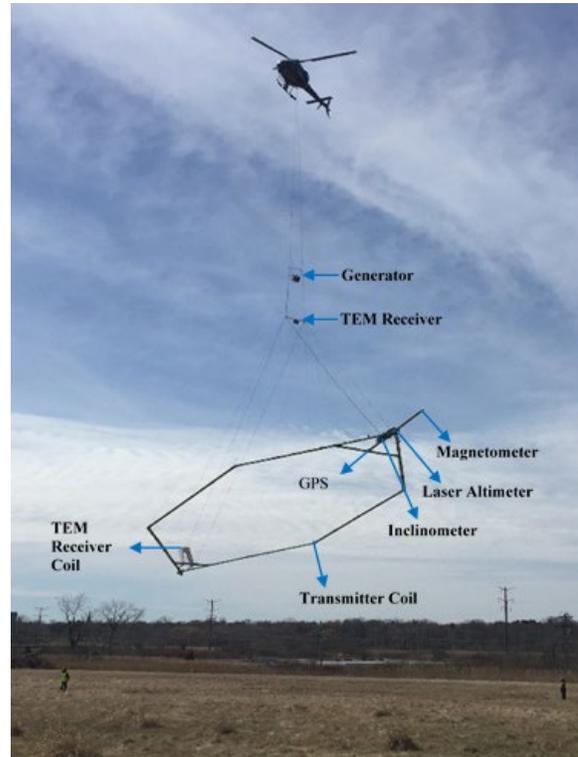
- **Better map and characterize the container**
 - Aquifer boundary
 - “Where is it.....exactly?”
 - Aquifer characteristics
 - “What is it like?”
- **Also address bedrock geology**
 - Bedrock lithology (shale, carbonate, both?)
 - Bedrock structures (folds, faults, etc)
 - Bedrock surface topography
- **Deliver 3-D geologic information/models to public**
- **Ultimately improve groundwater models**
 - Integrate into ISWS regional/local models



Champaign County

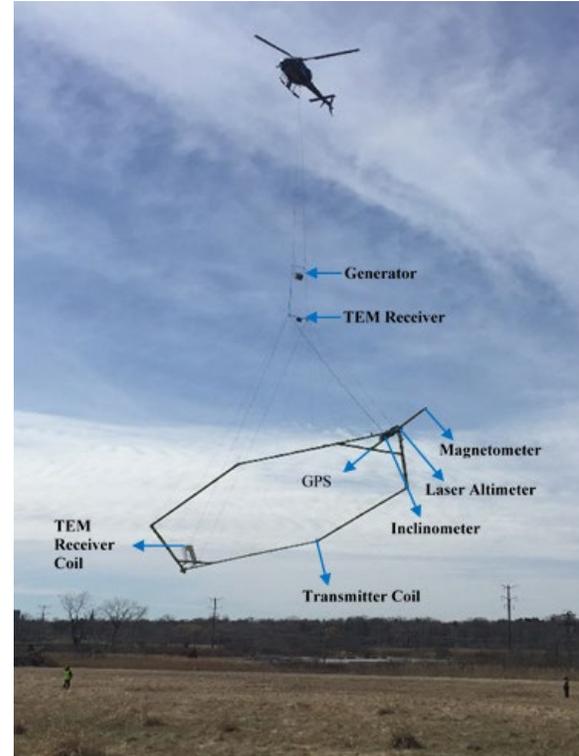
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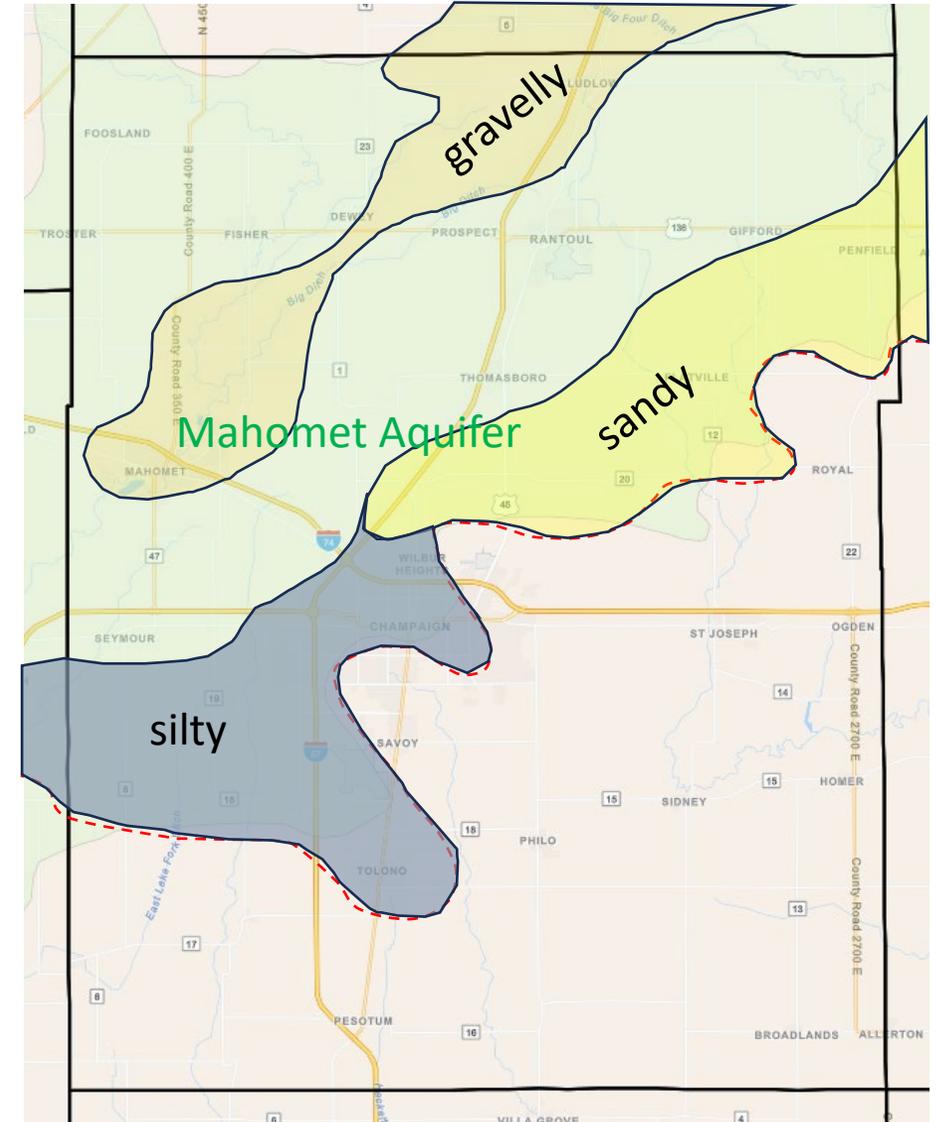


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Champaign County

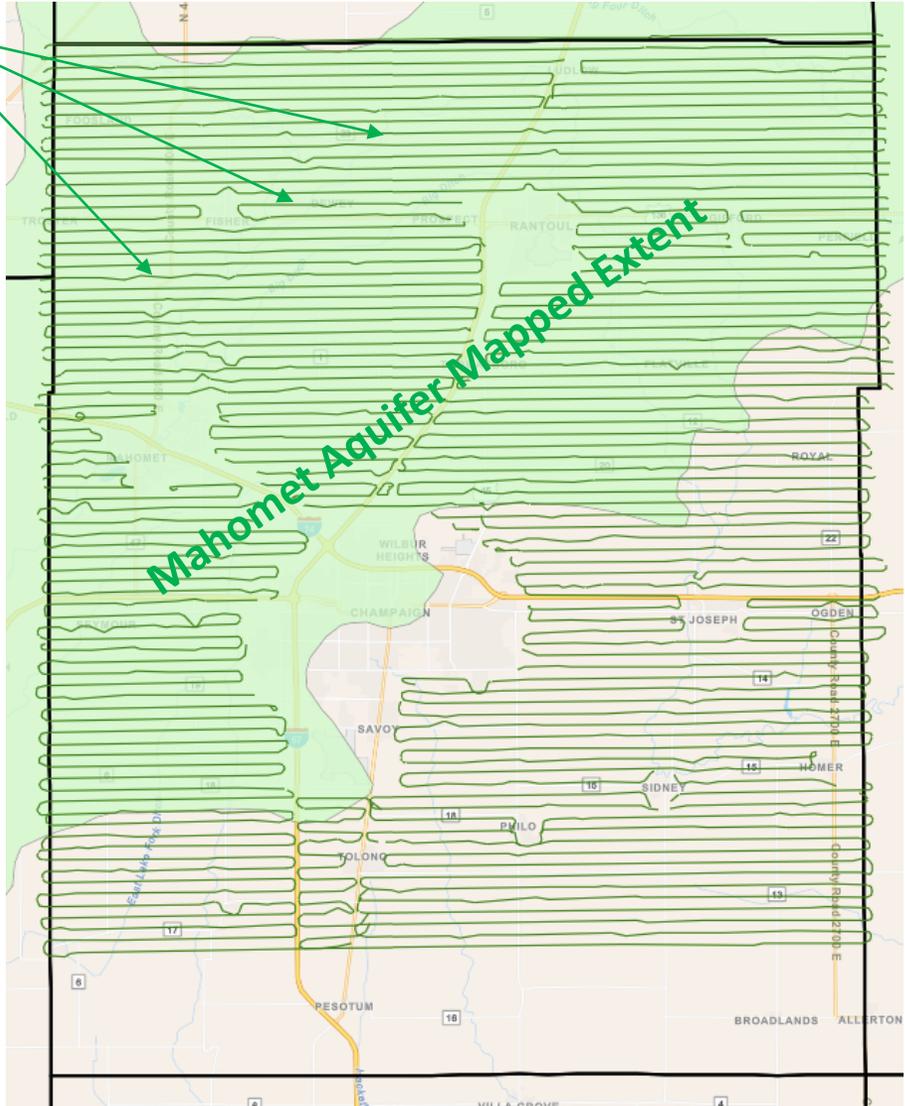
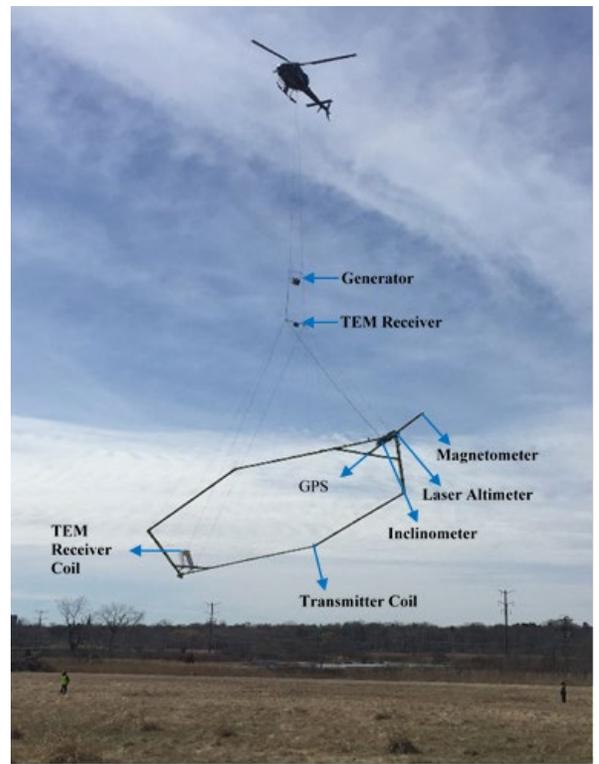


Champaign County

How to do this?

- **Acquire highest resolution geophysical data to date**
 - E-W transects every 650 meters
 - Penetration depth of around 300 meters (1000 feet)
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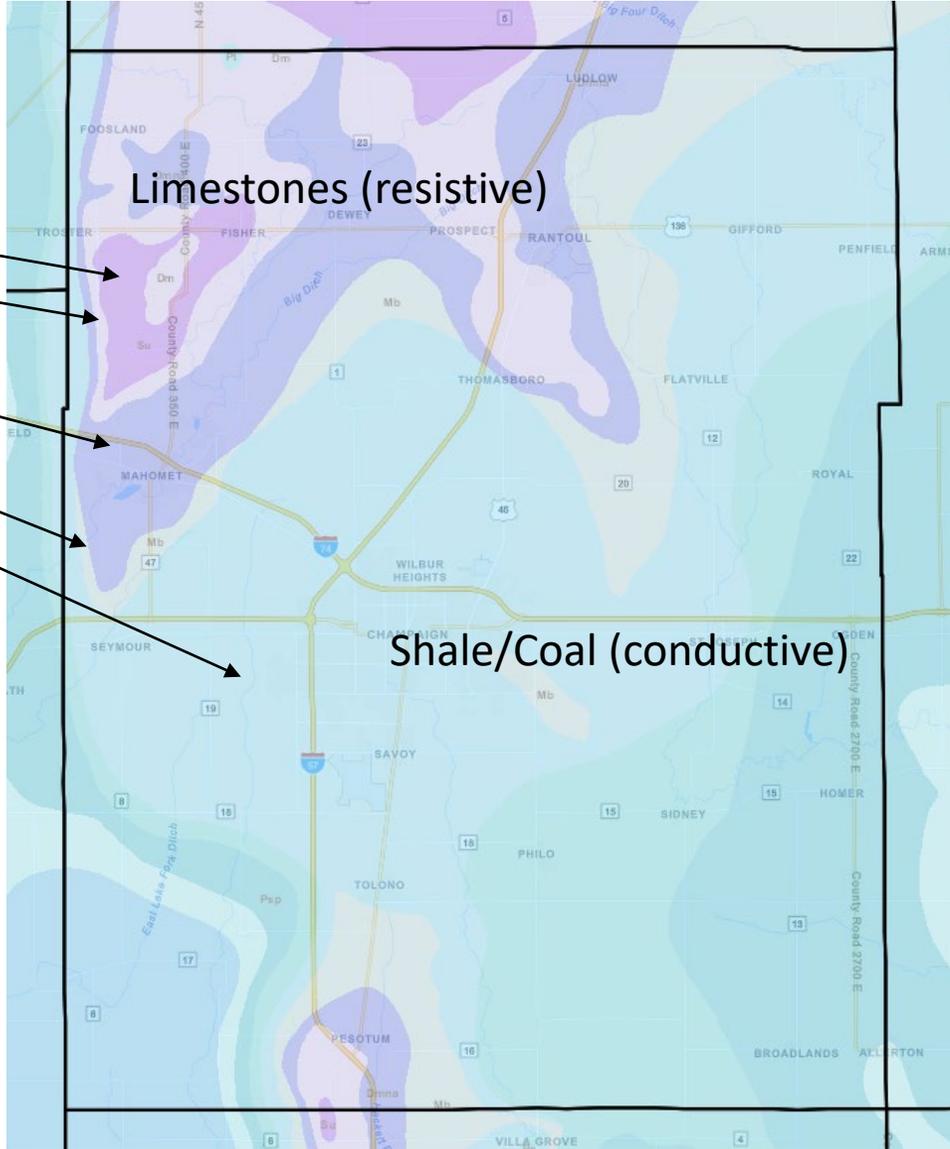
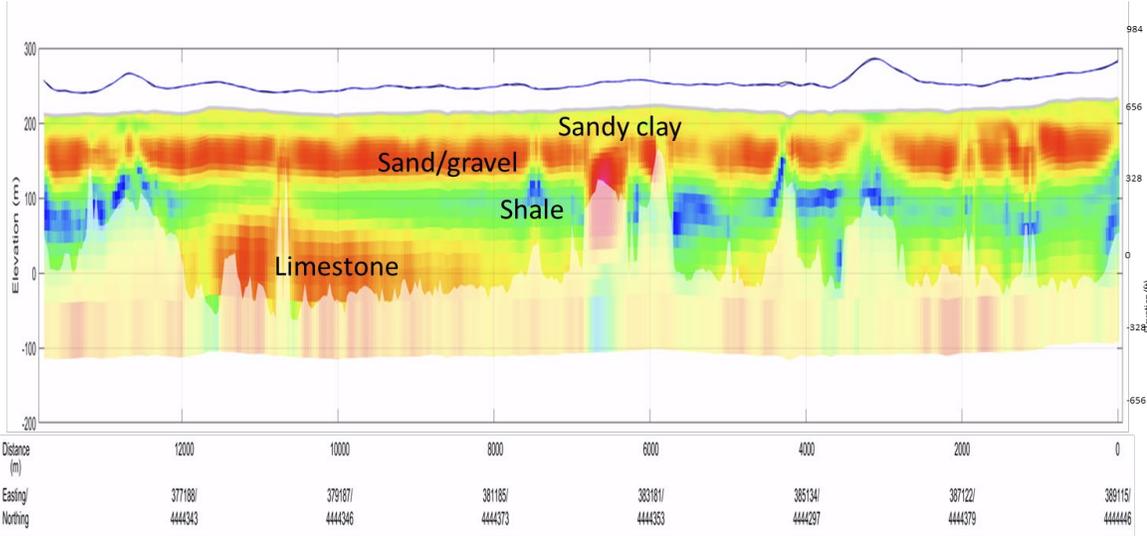


Bedrock geology of Champaign County

What can we see with HTEM?

Bedrock Units (electrical properties)

- Silurian Dolomites (**resistive**)
- Devonian Limestones (**resistive**)
- Devonian Shales (**conductive**)
- Mississippian Limestones (**resistive**)
- Pennsylvanian Shales/Coal (**conductive**)



Bedrock geology of Champaign County

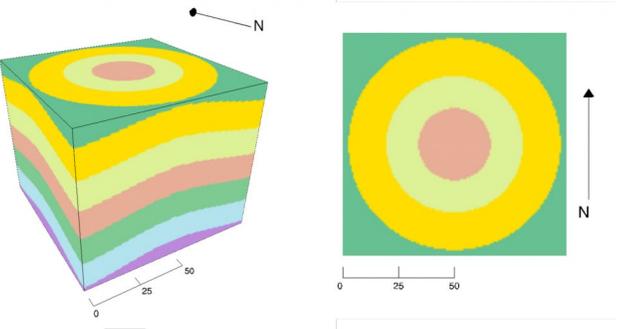
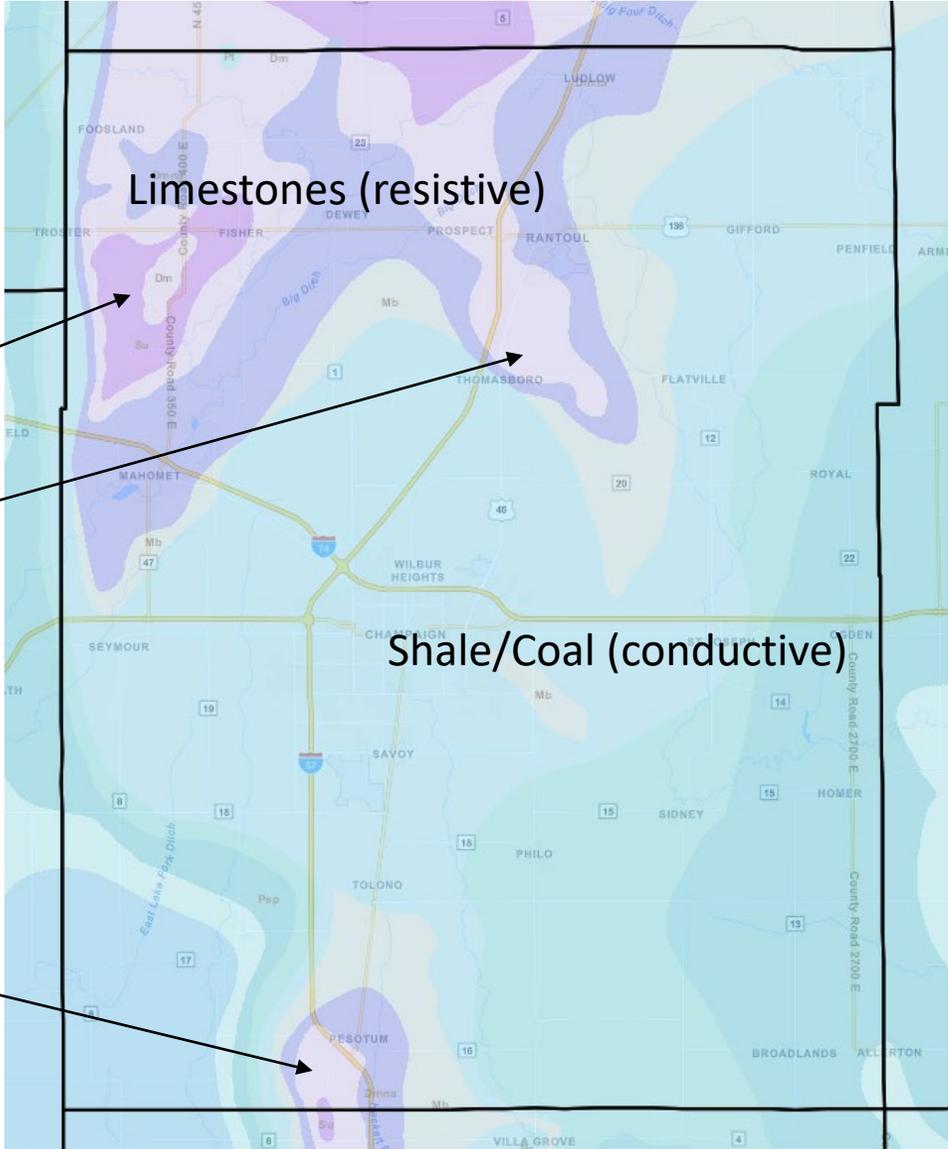
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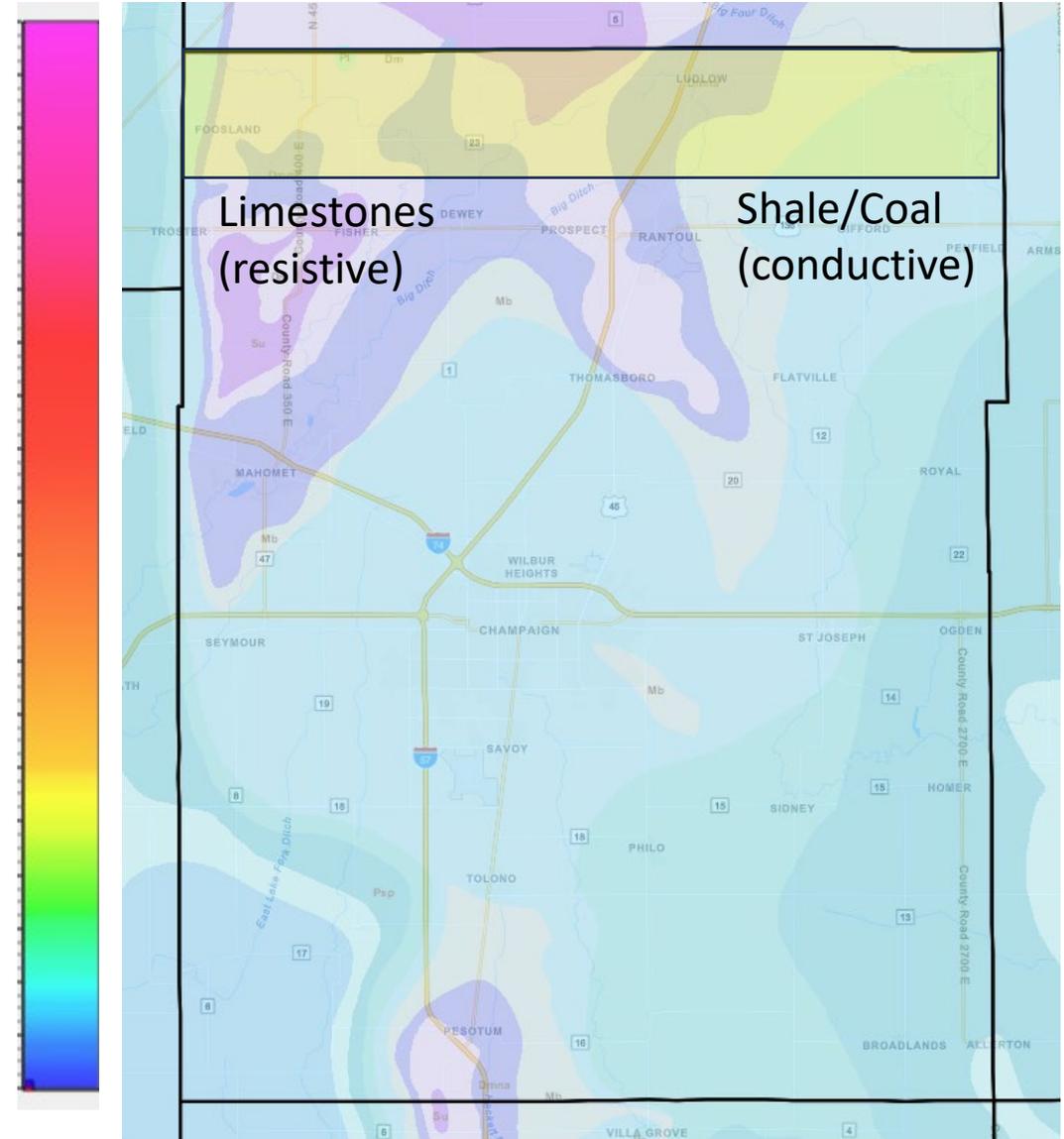
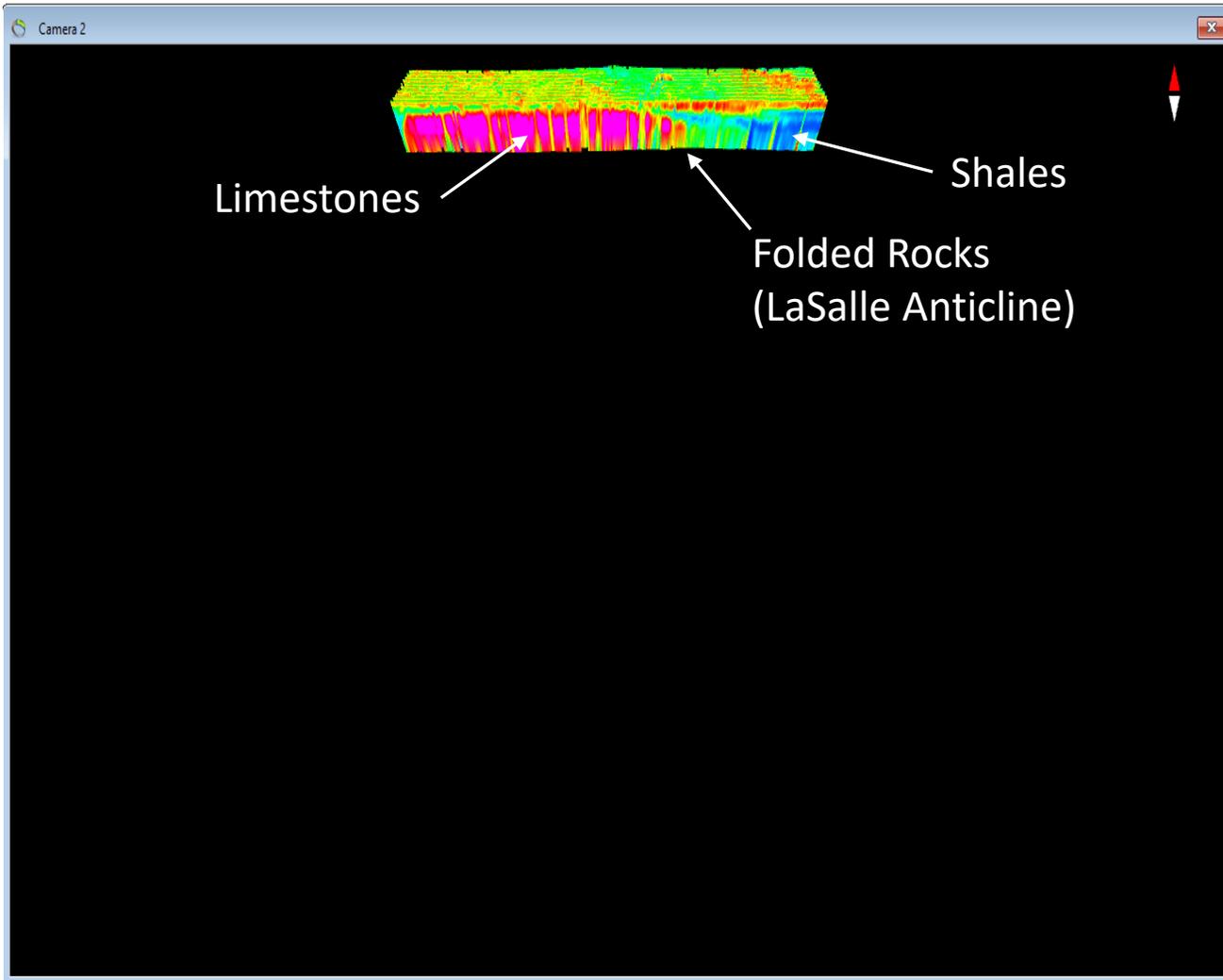
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Bedrock Structures

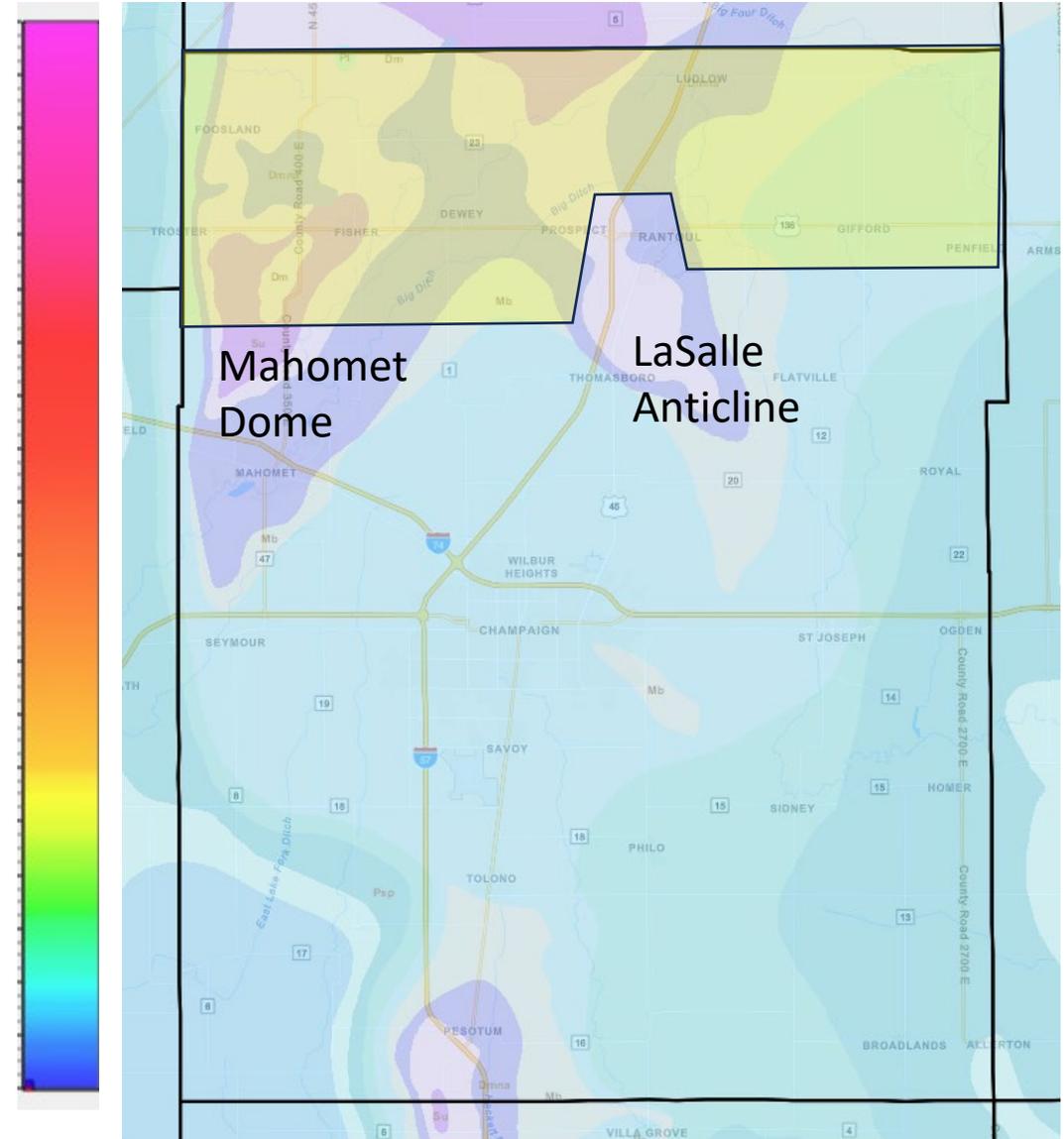
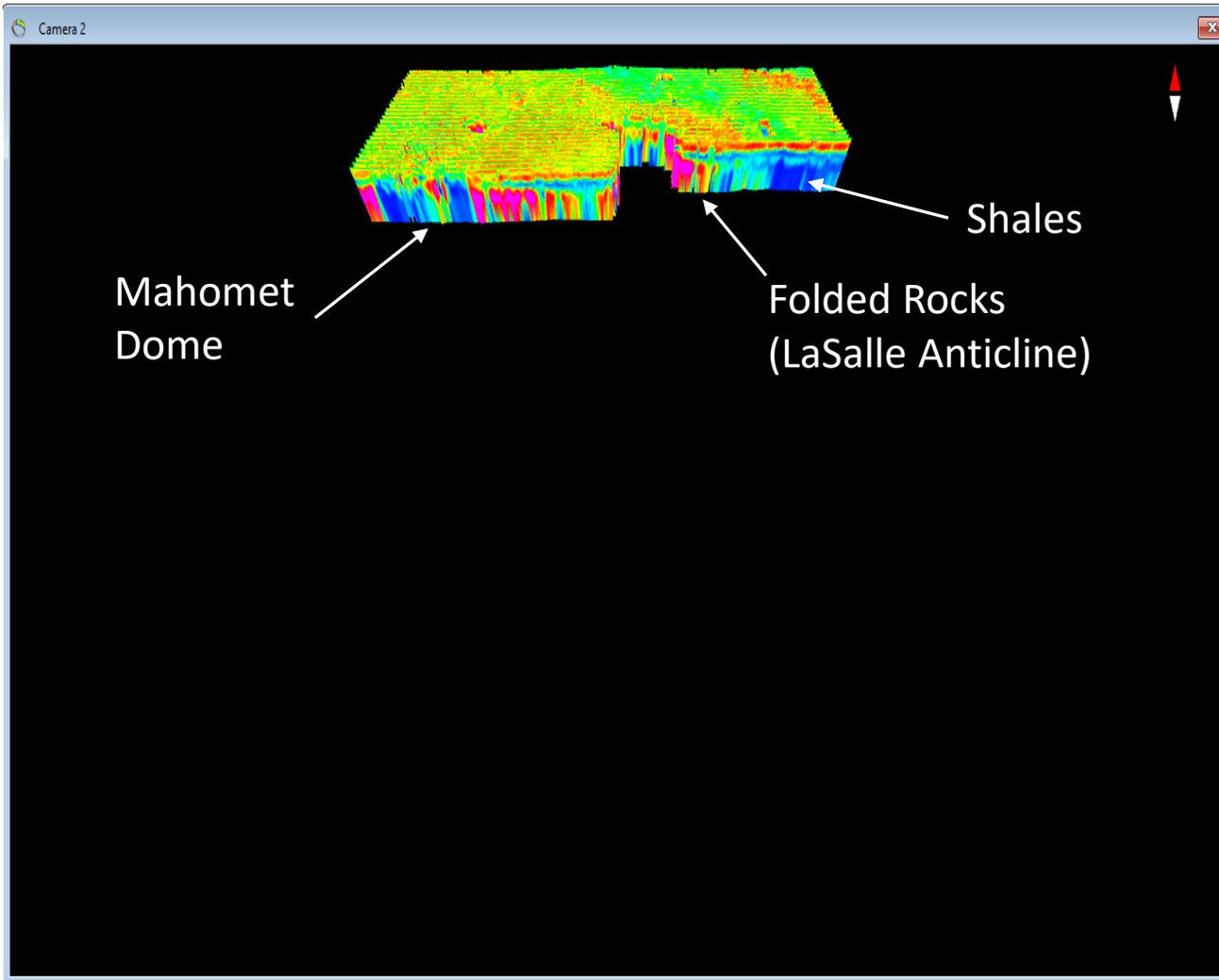
- Mahomet Dome
- LaSalle Anticline
- Tuscola Anticline



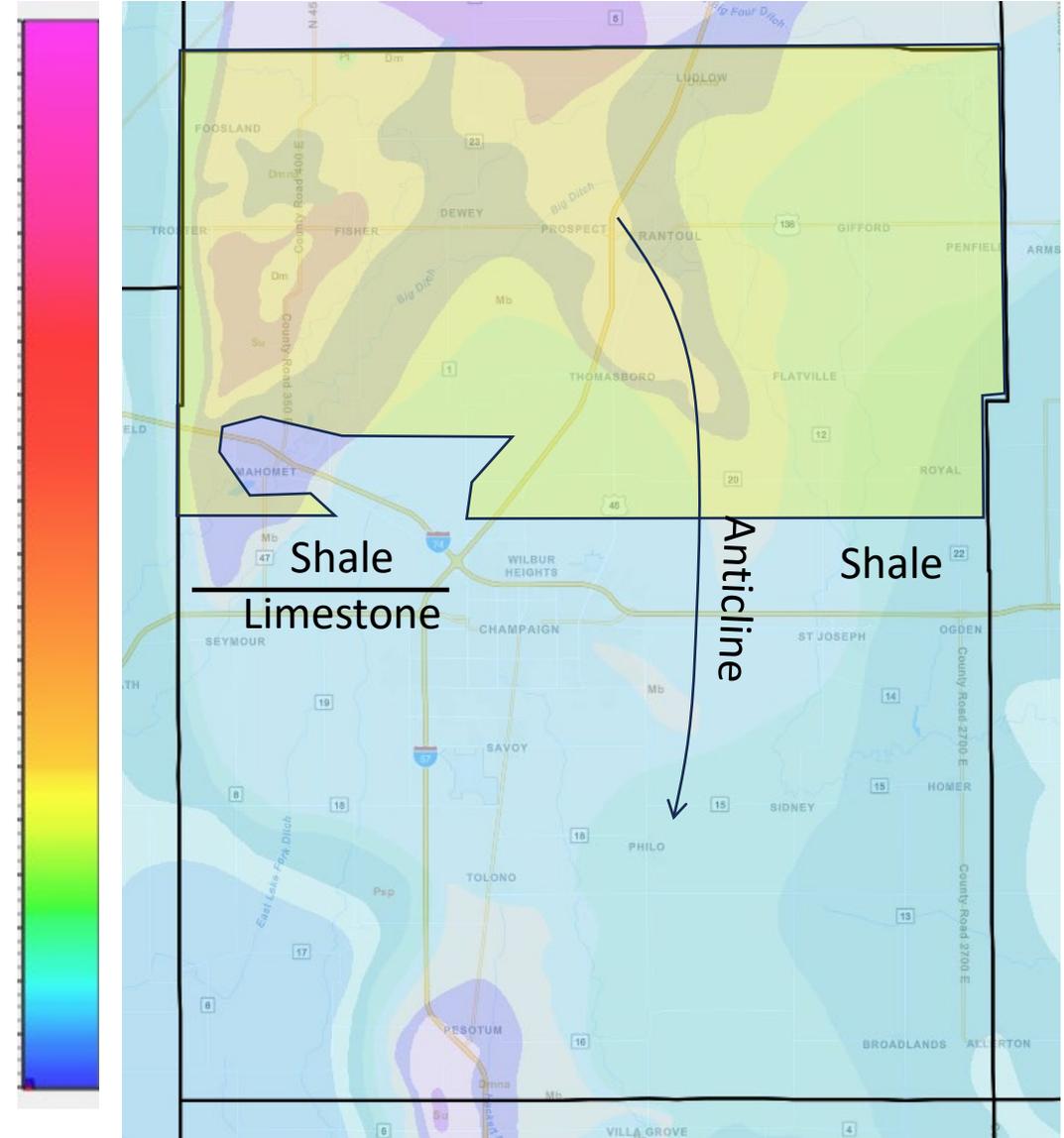
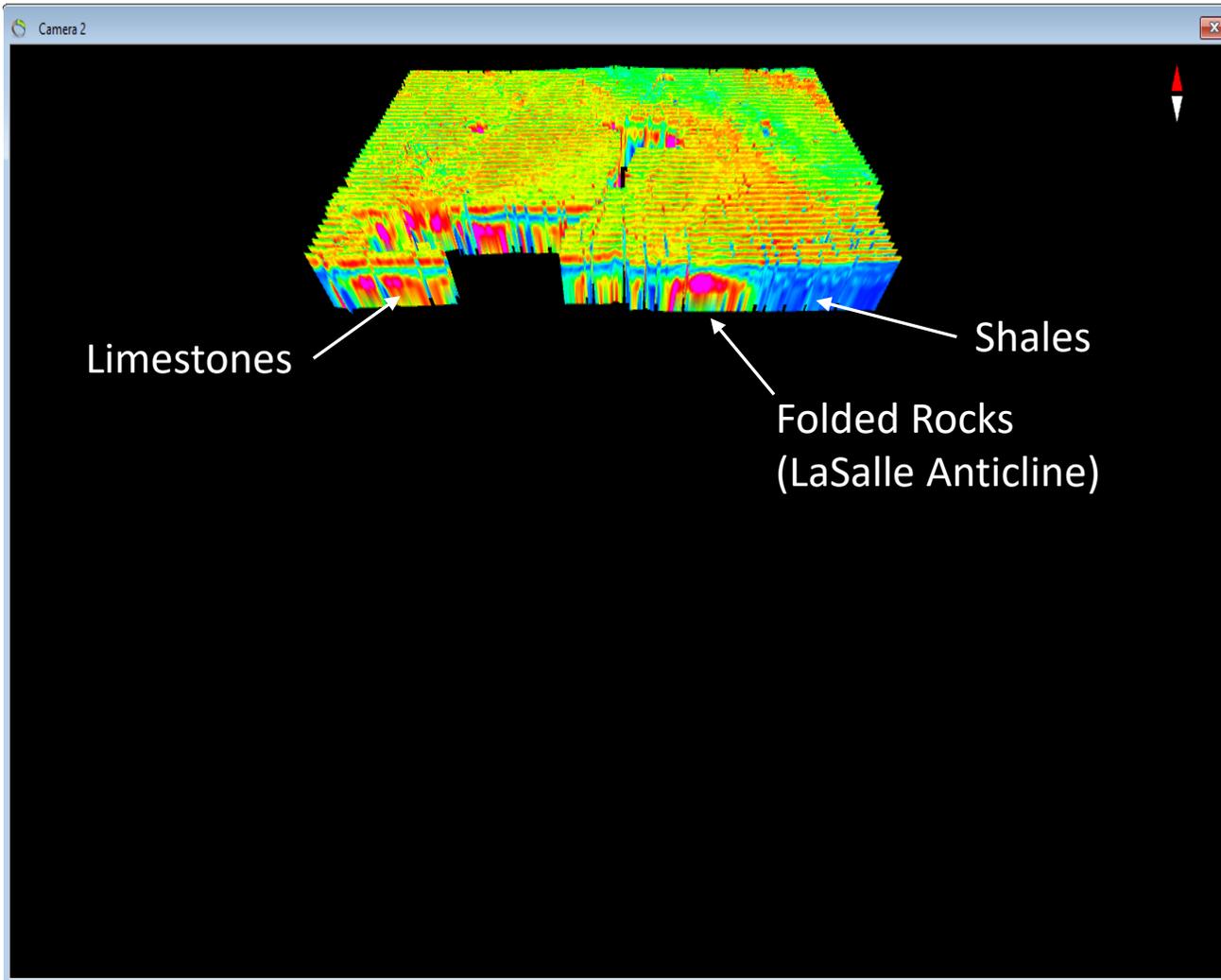
Preliminary HTEM Data- Bedrock



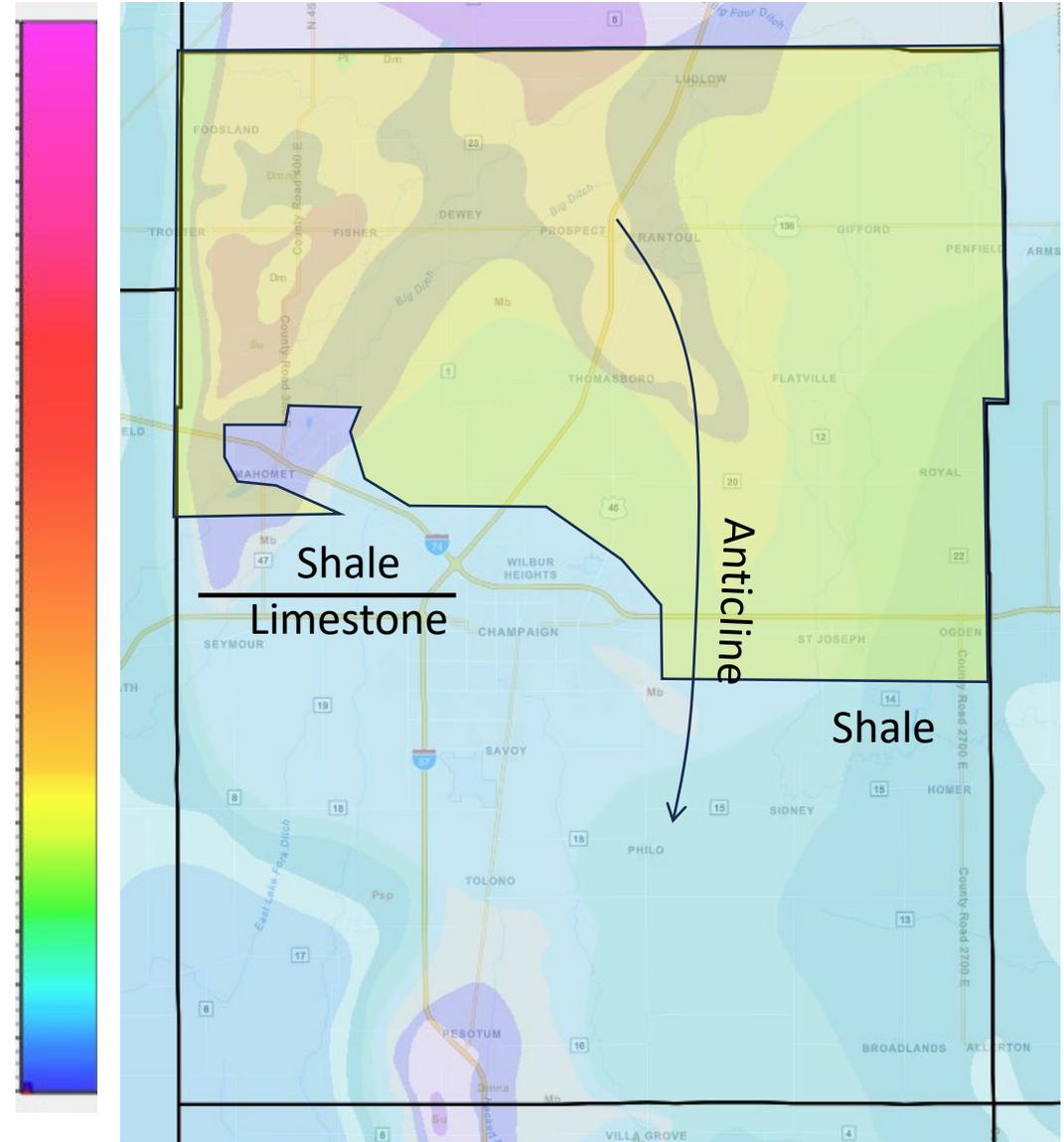
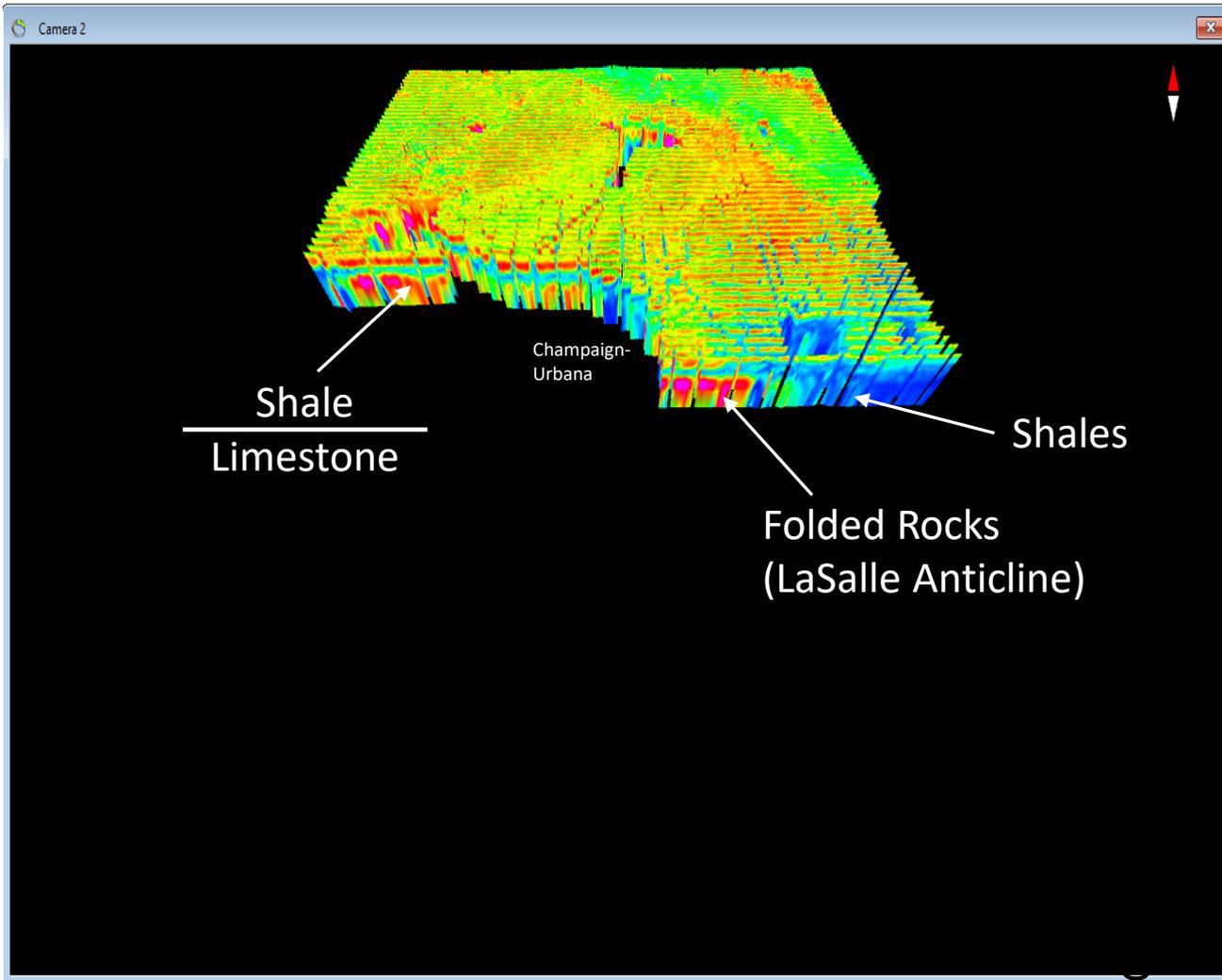
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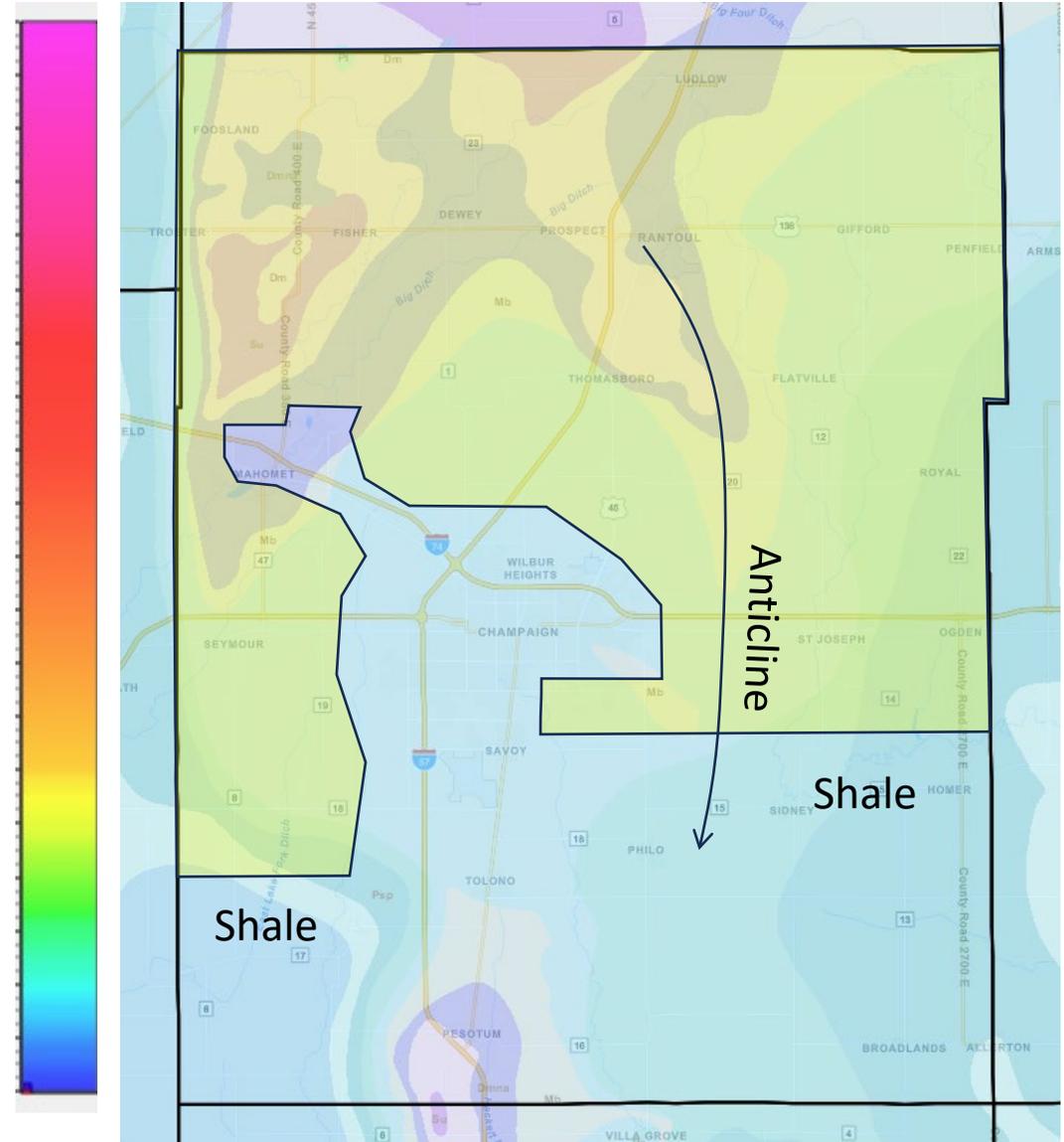
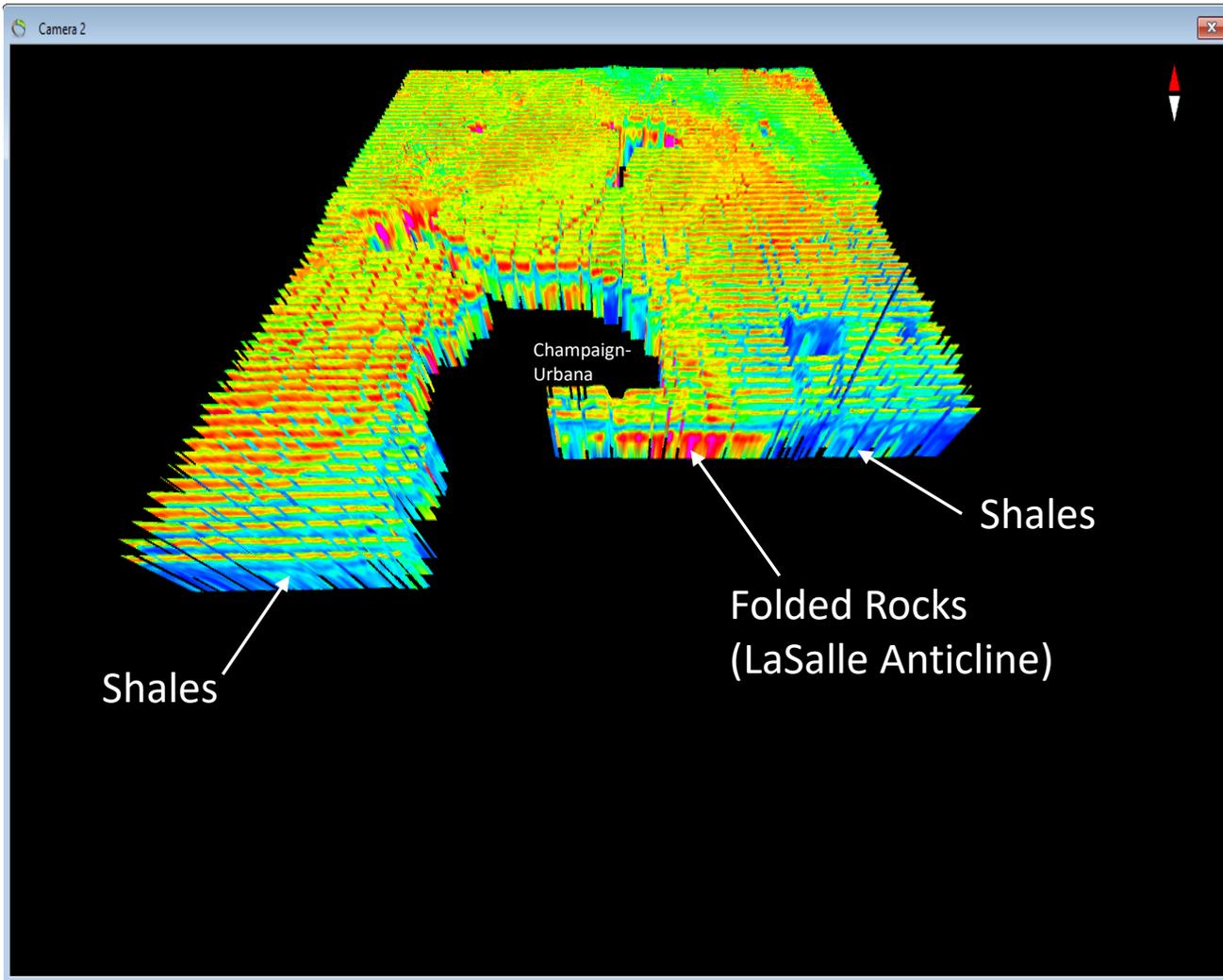
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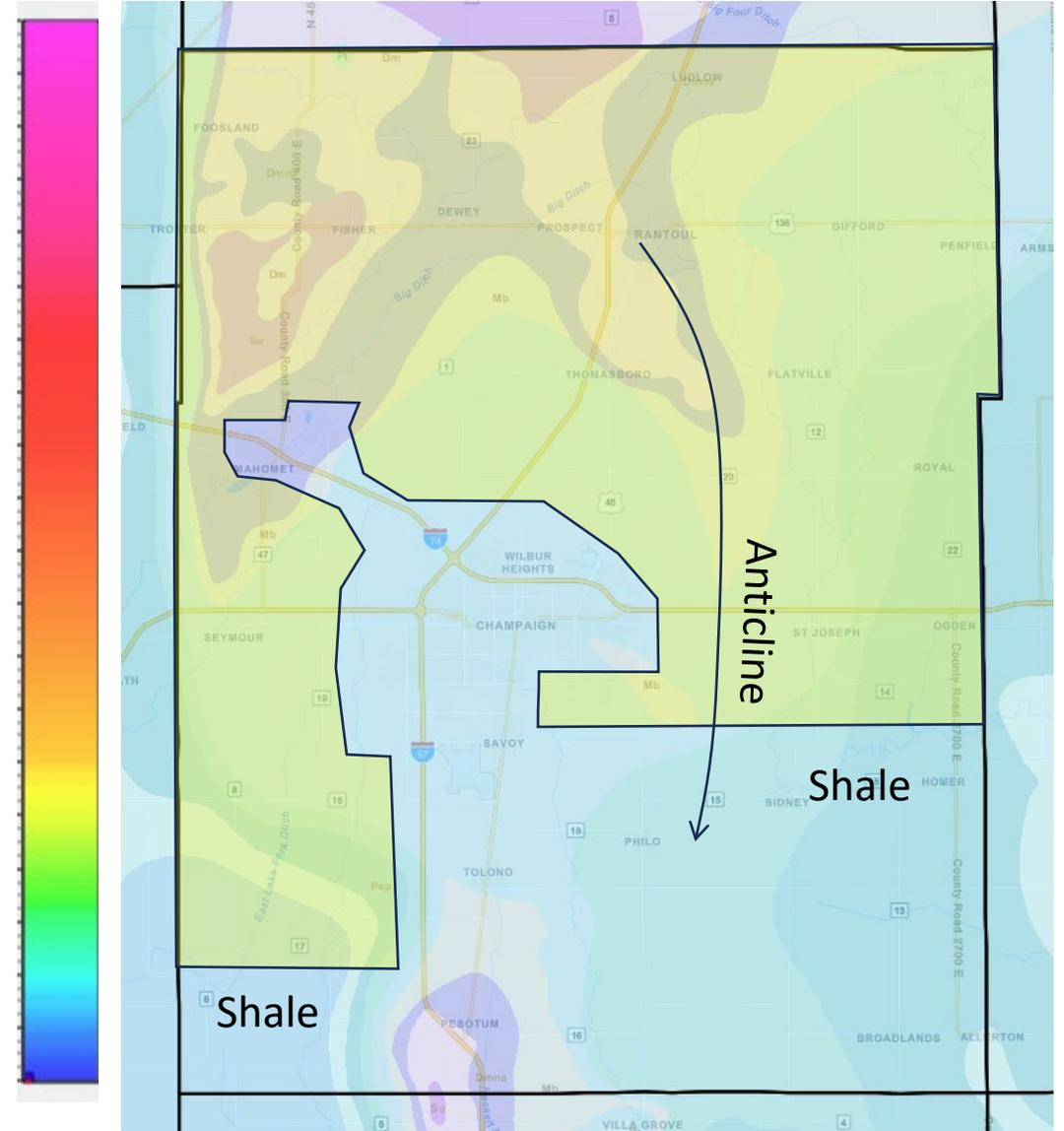
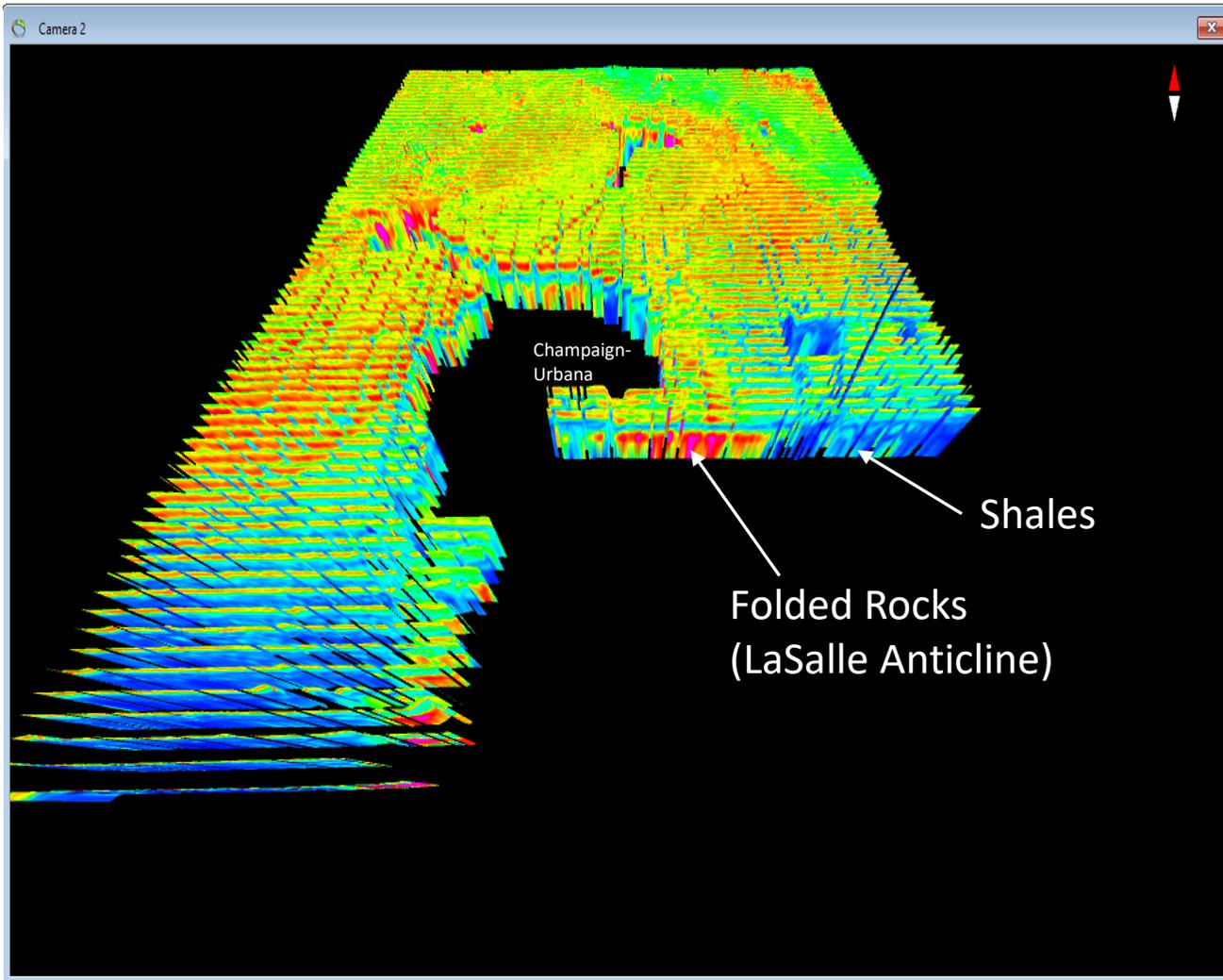
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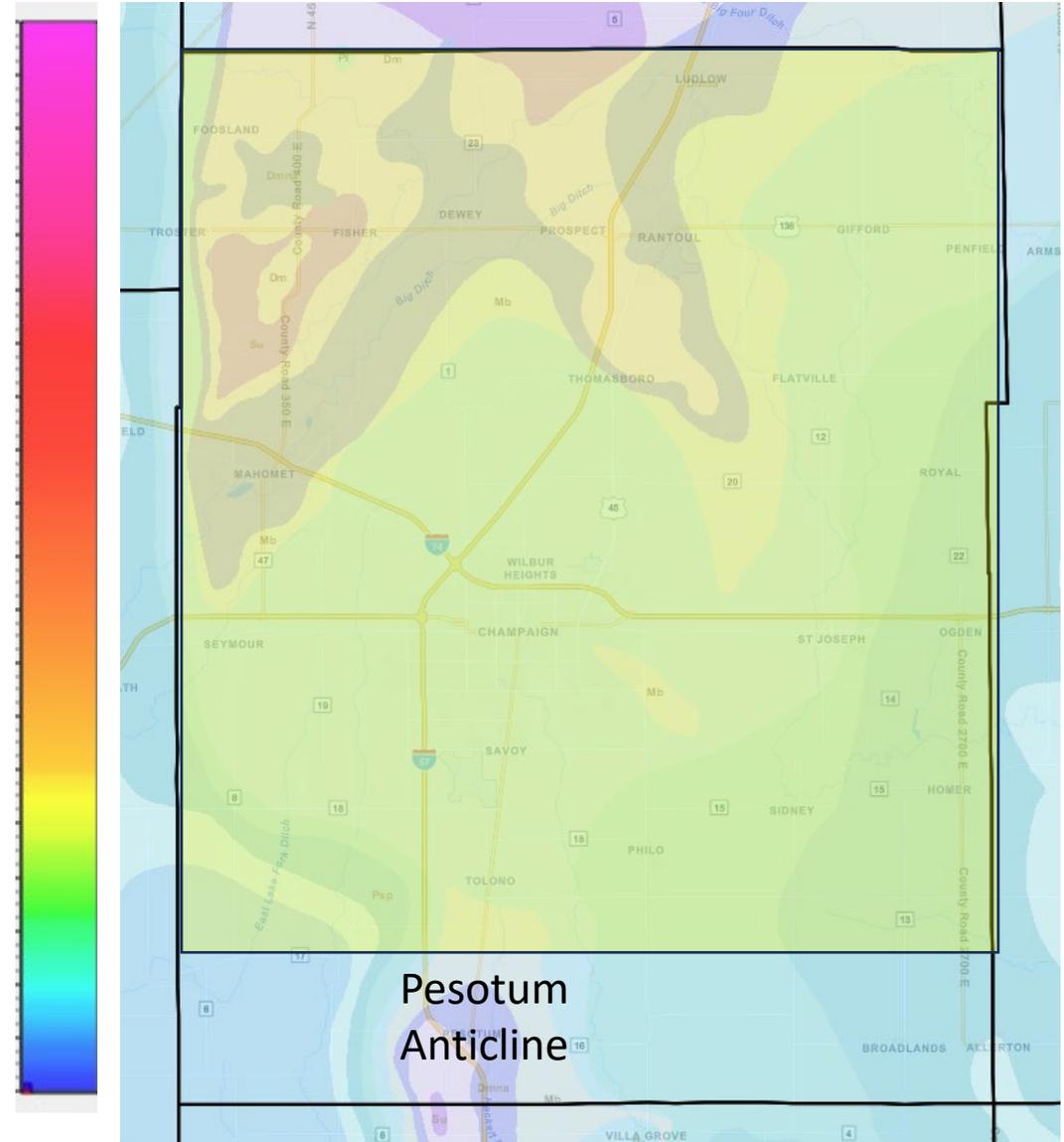
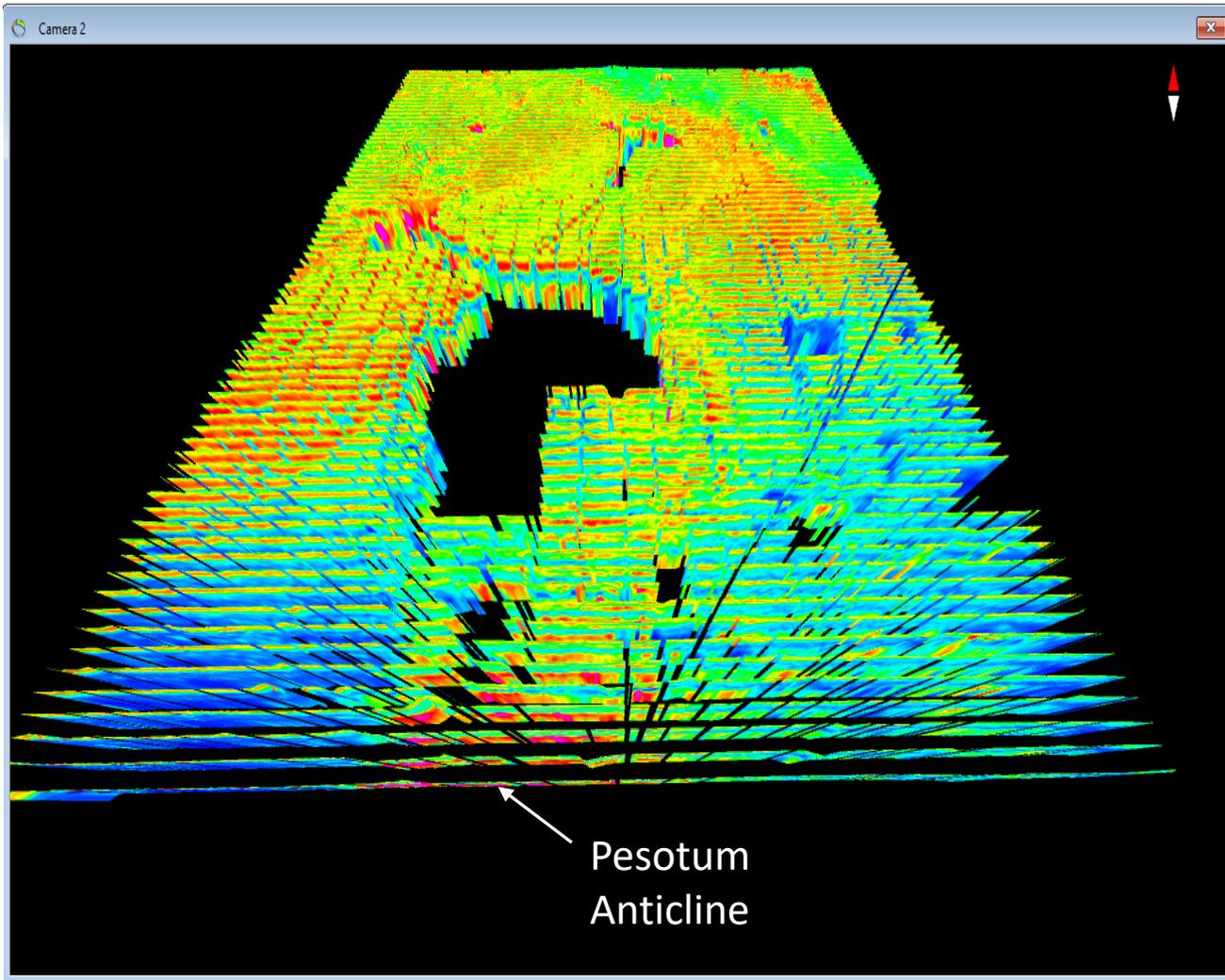
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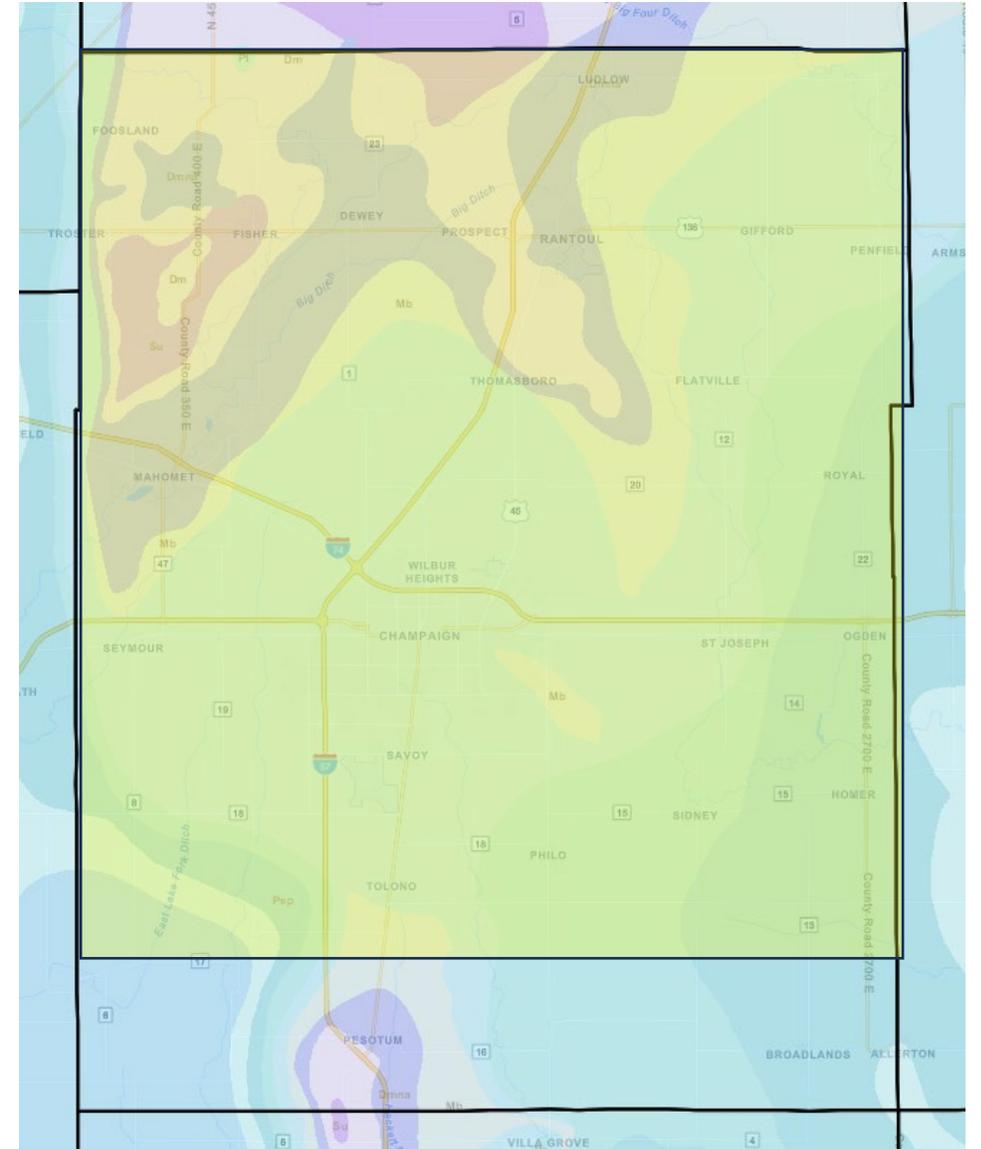
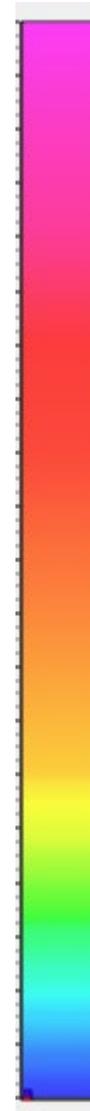
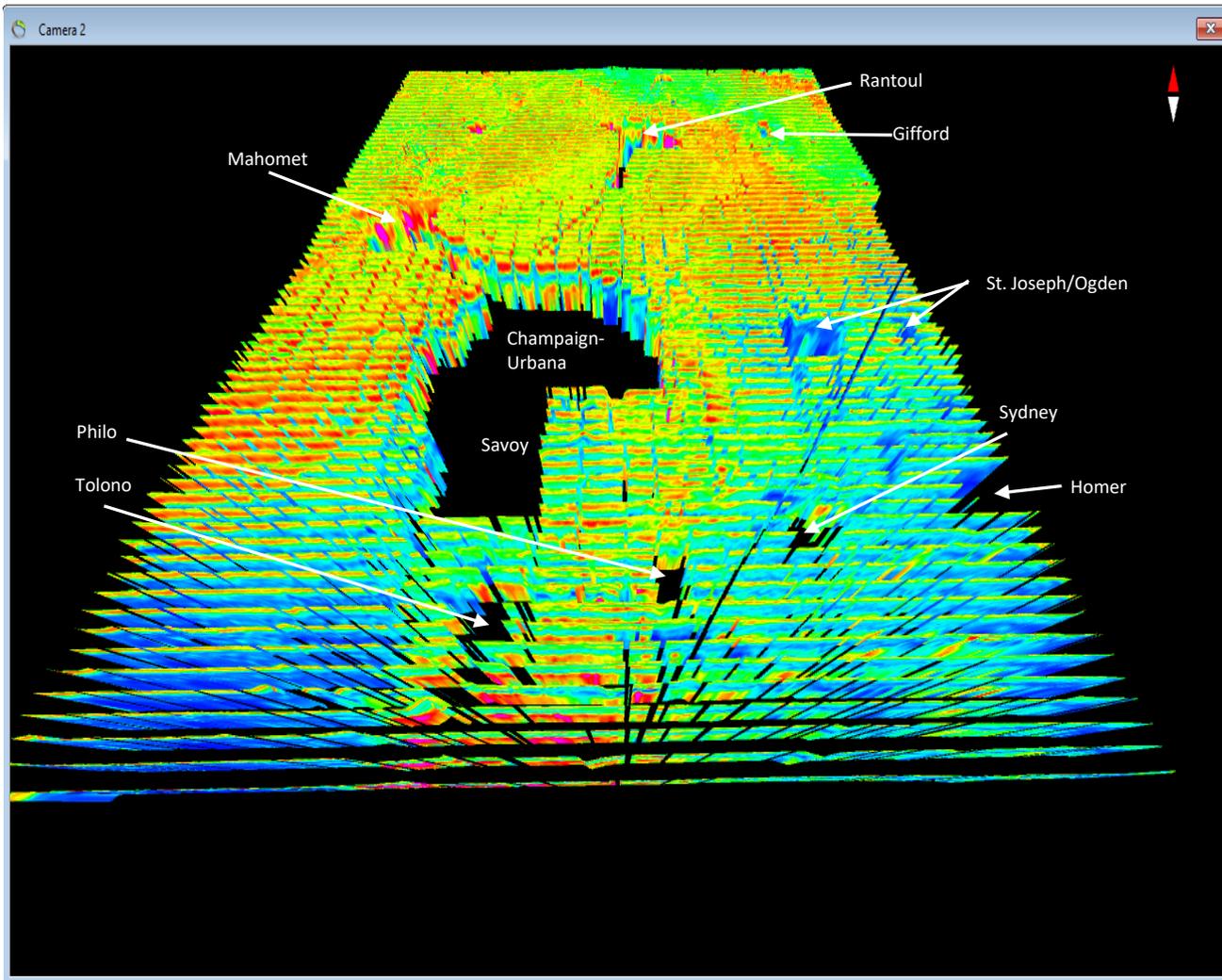
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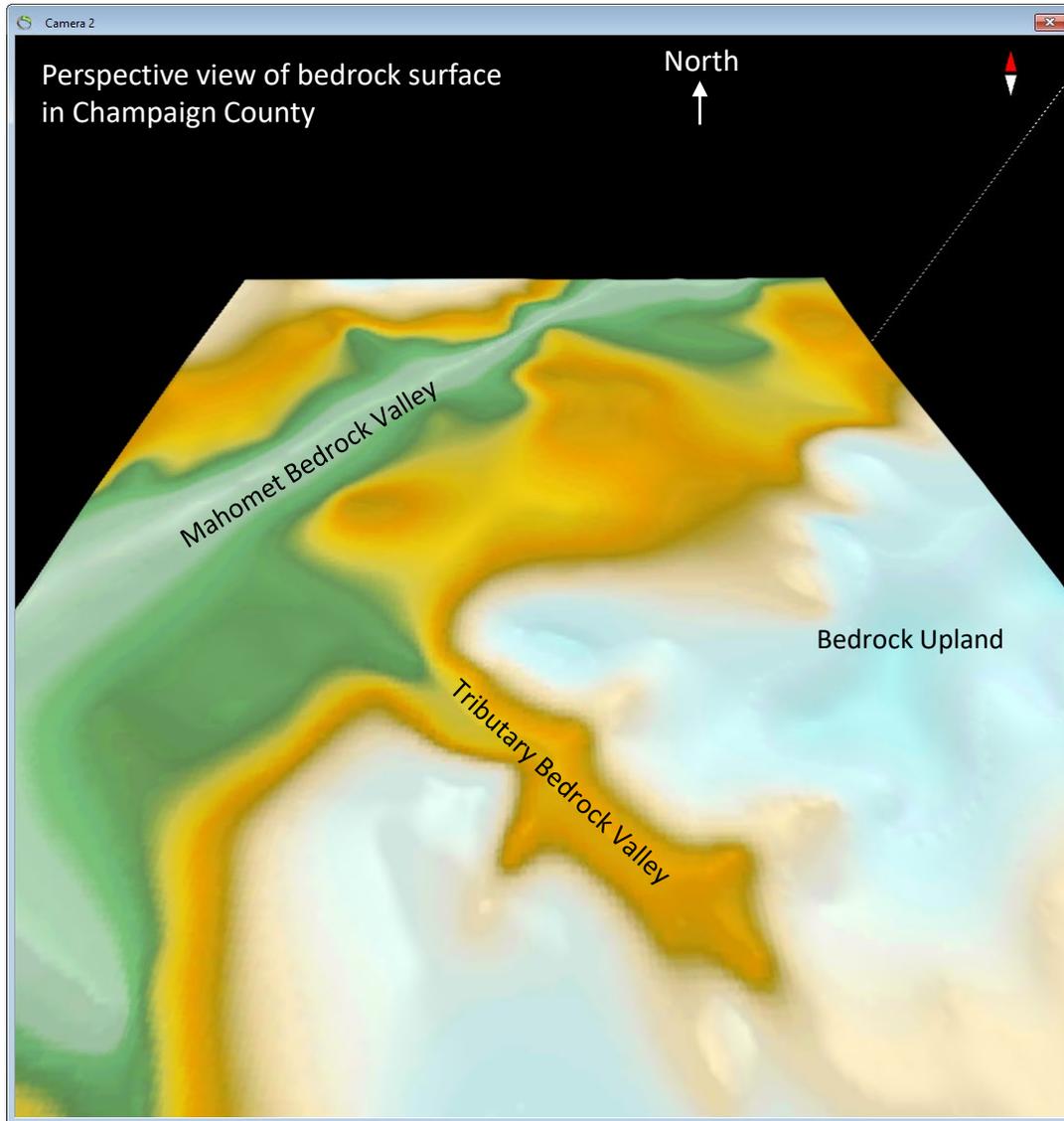
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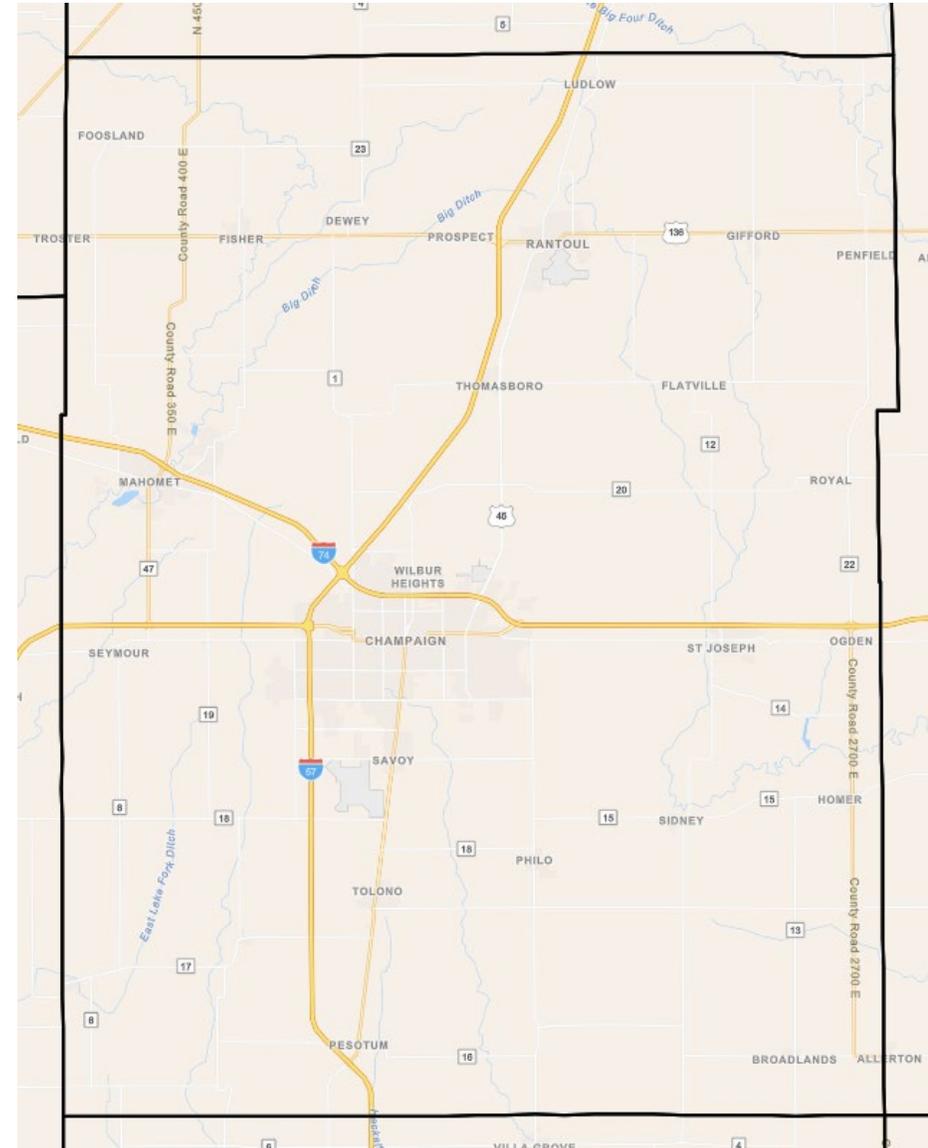
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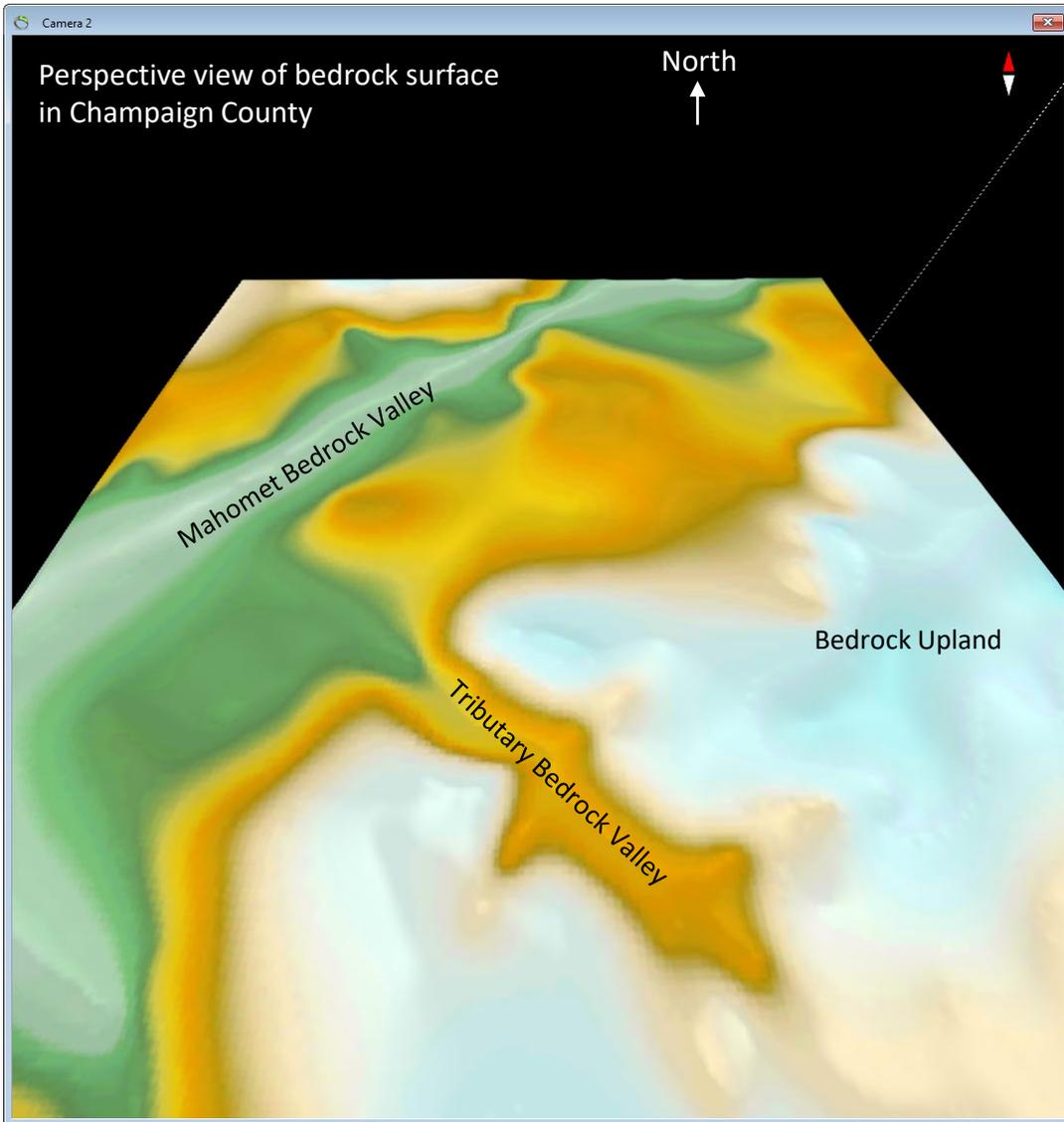
Bedrock Surface



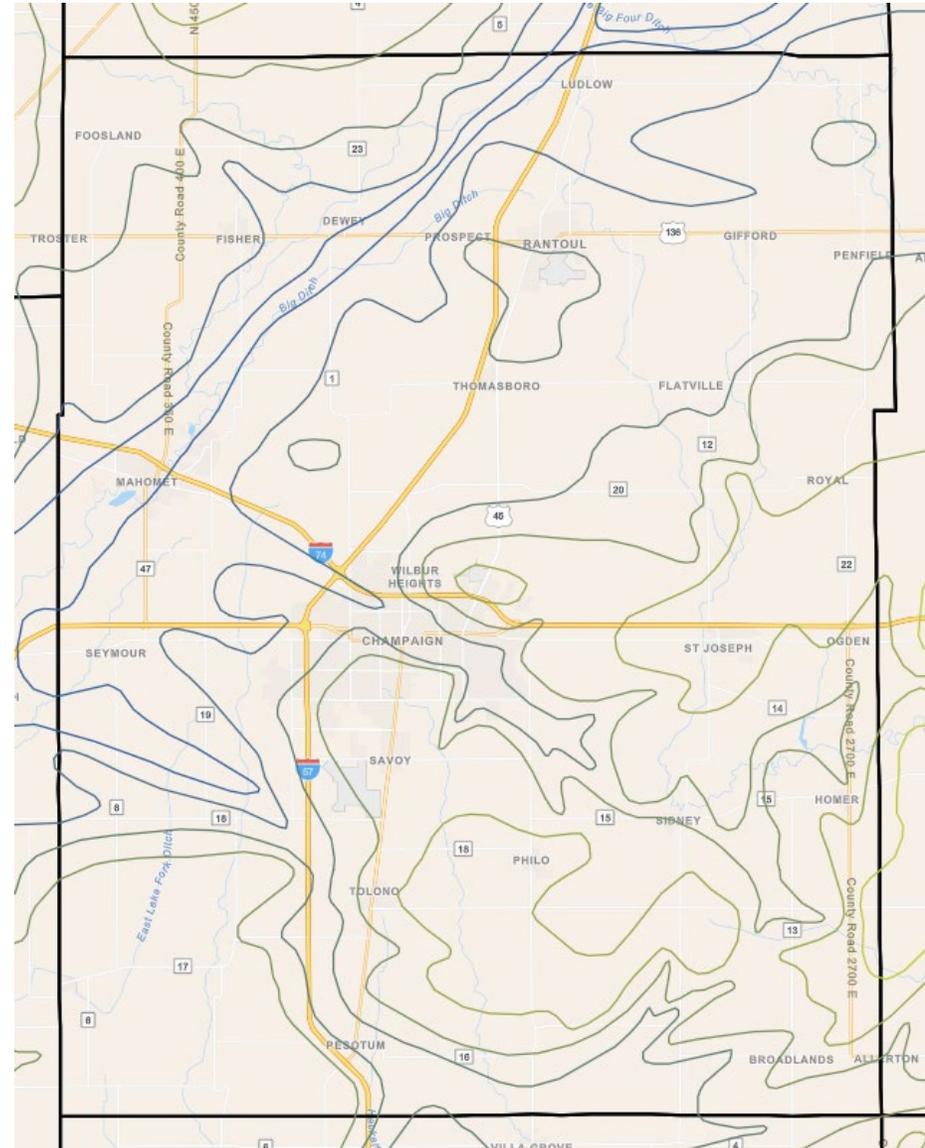
Champaign County



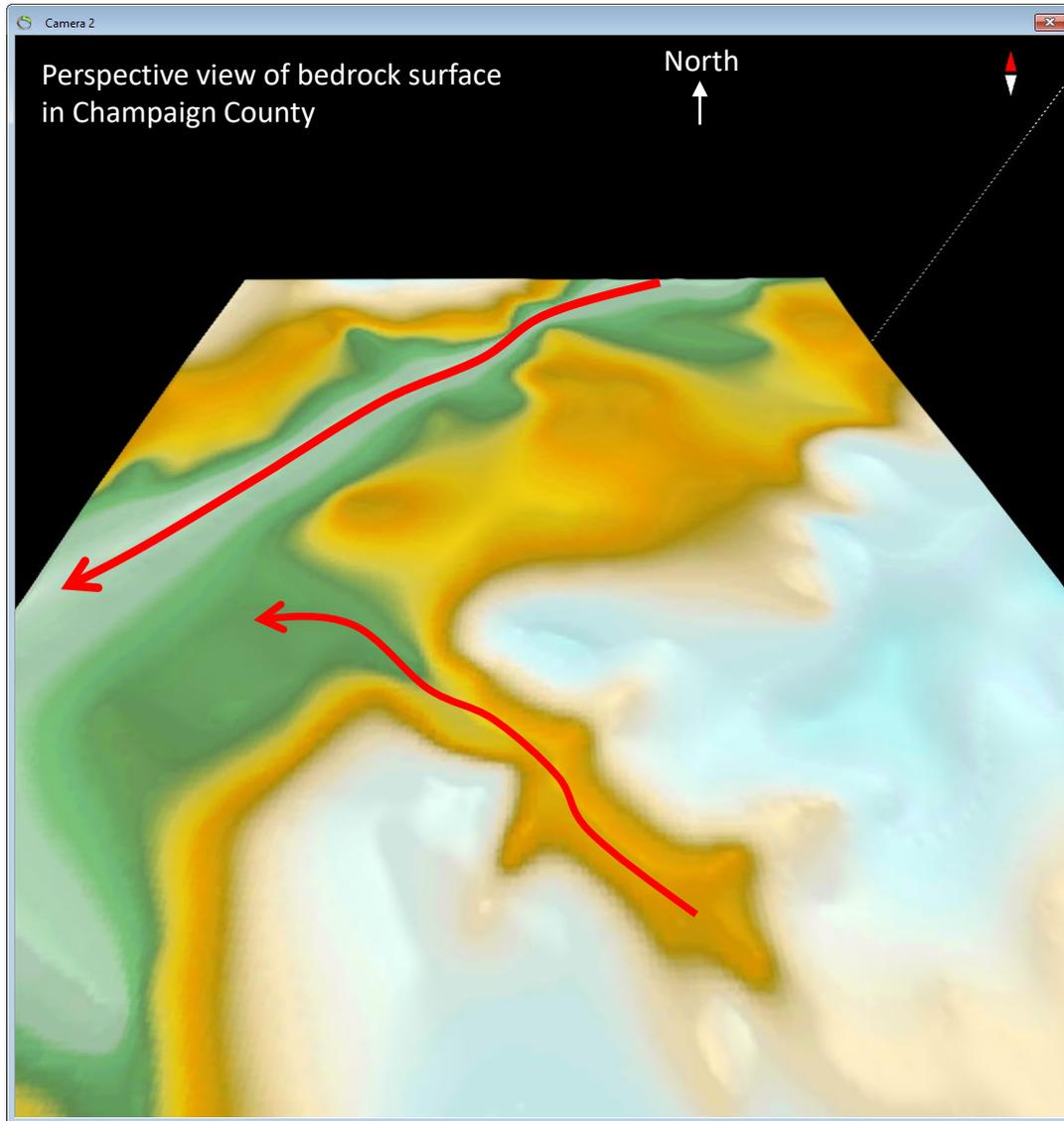
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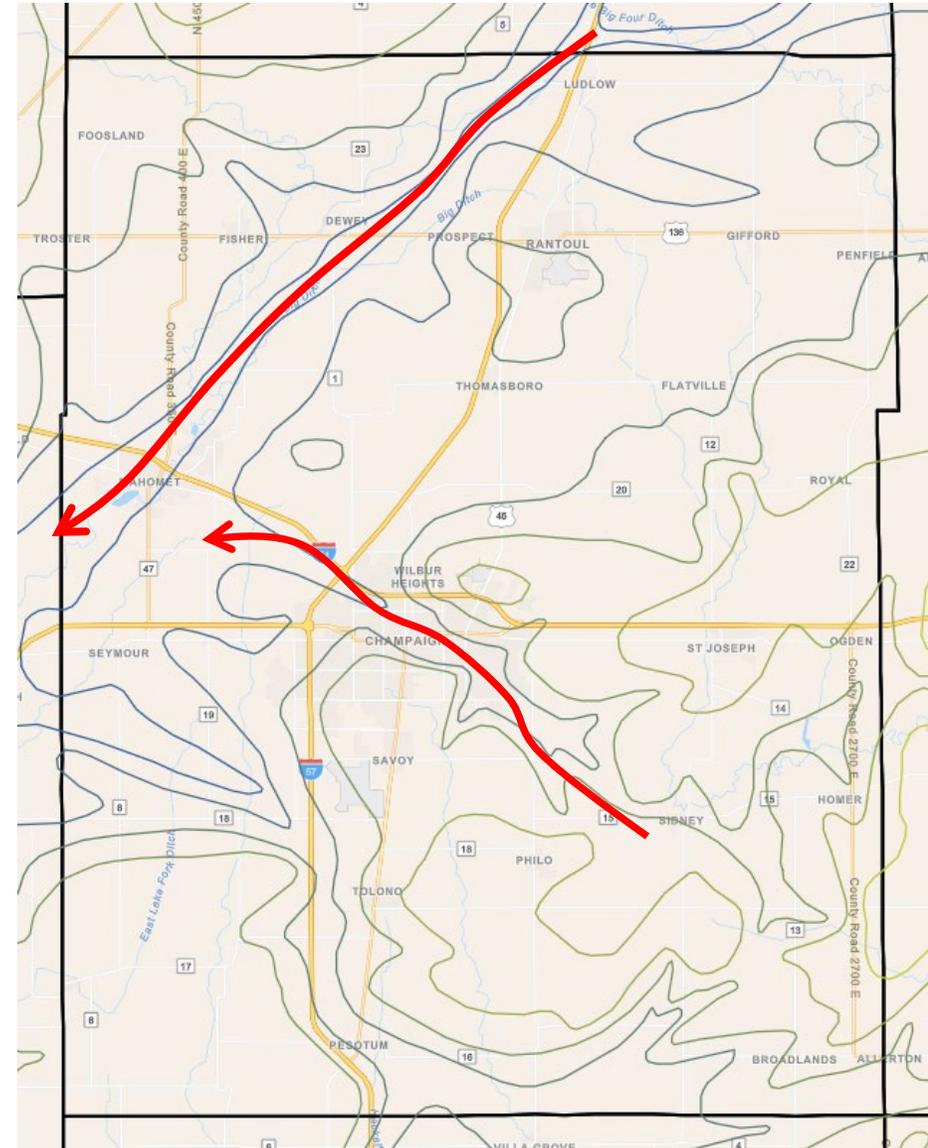
Bedrock Topography Contours



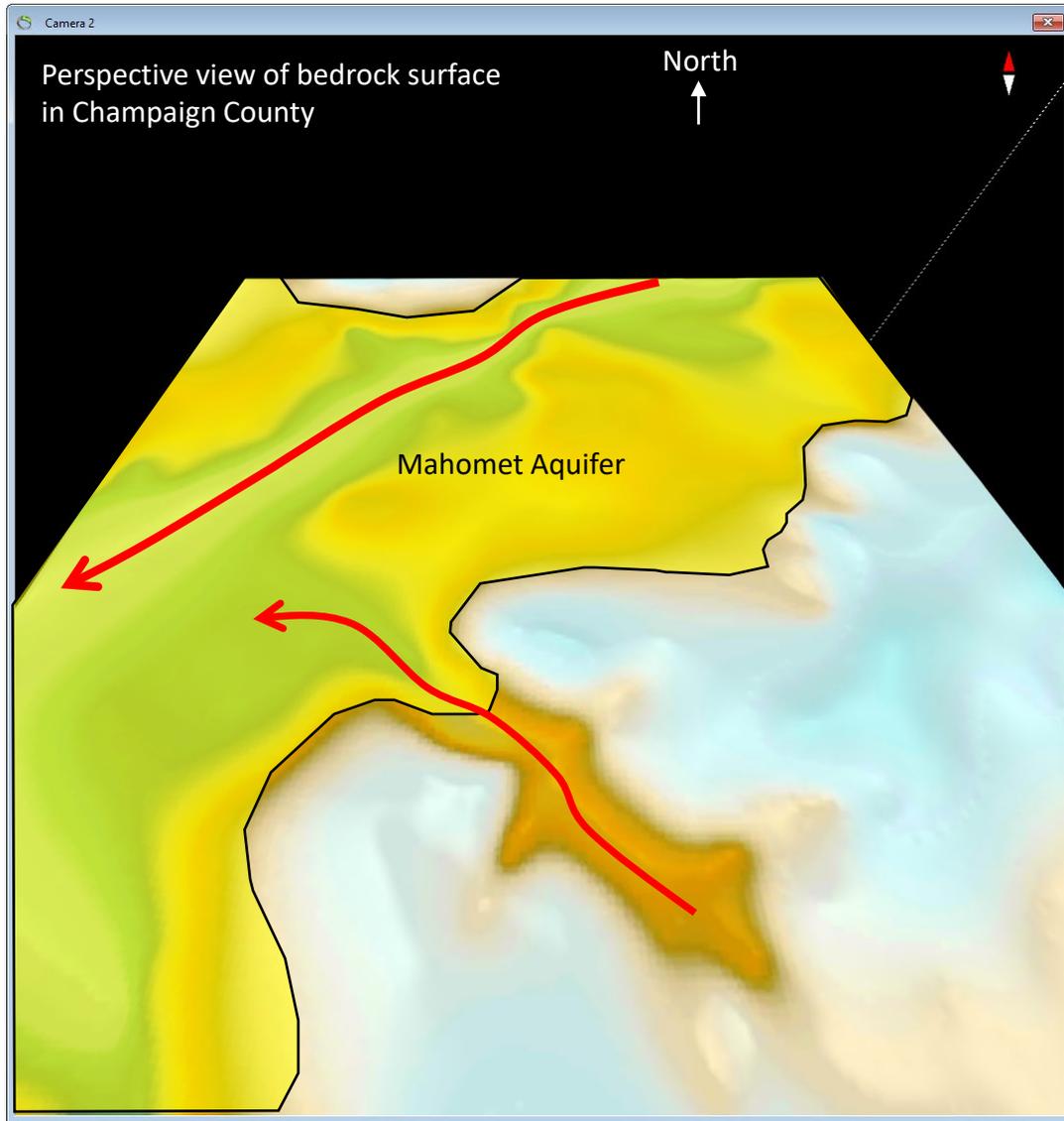
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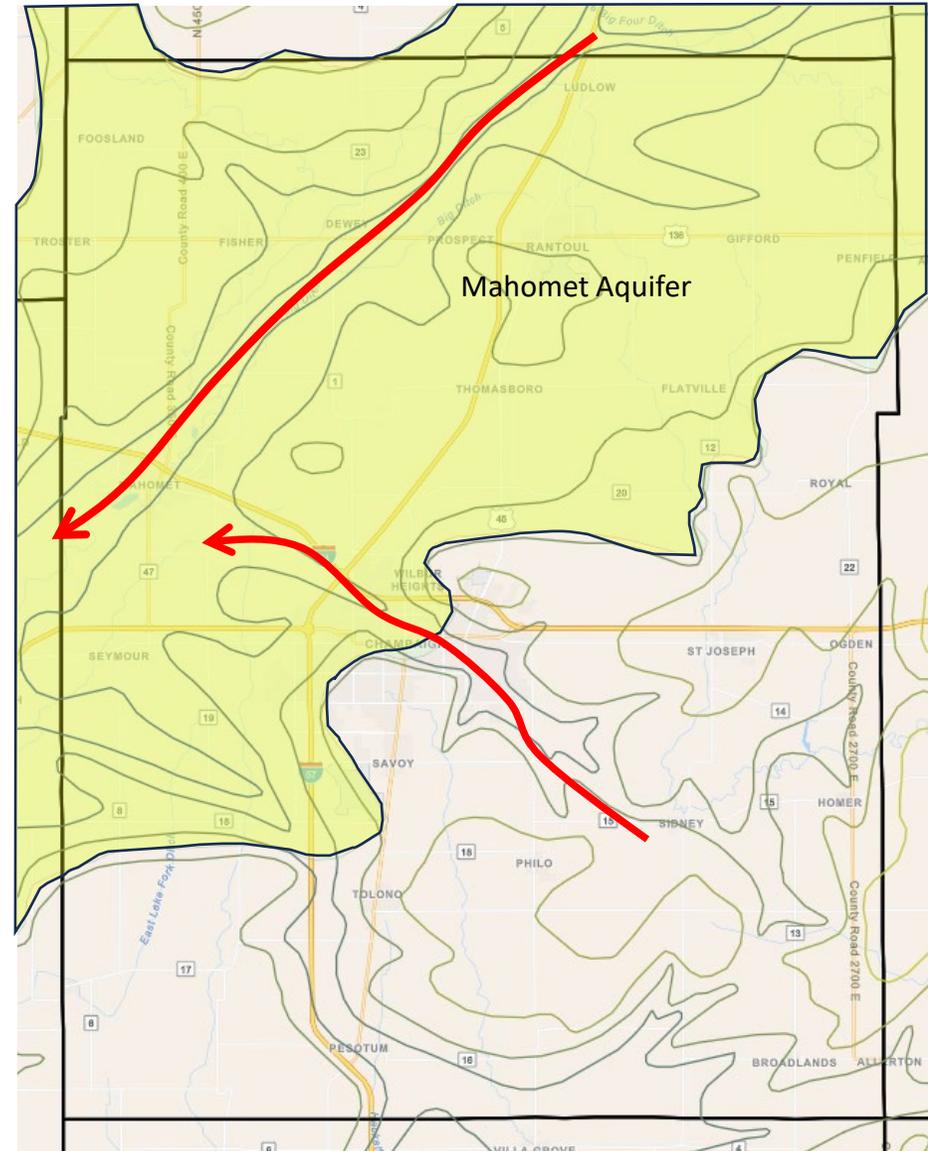
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Bedrock Surface



Mahomet Aquifer



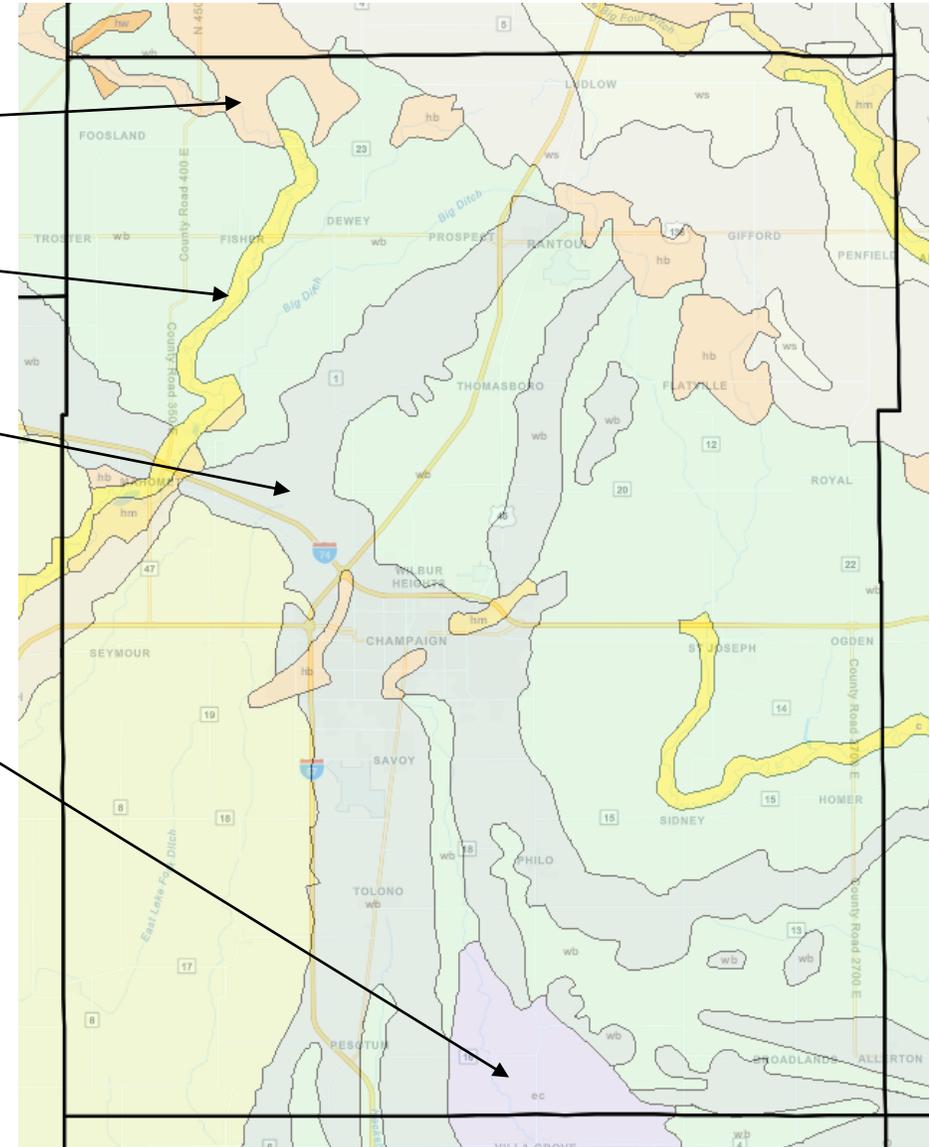
What can we see with HTEM?

Glacial Units (electrical properties)

- Glacial Outwash (**resistive**)
- Stream deposits (**resistive**)
- Glacial Till
 - Shallow tills (**conductive**)
 - Deeper tills (**resistive**)
- Glacial lake deposits (**conductive**)

Landscape features

- Outwash fans
- Outwash Valleys/Streams
- Moraines/Ridges
- Till plains



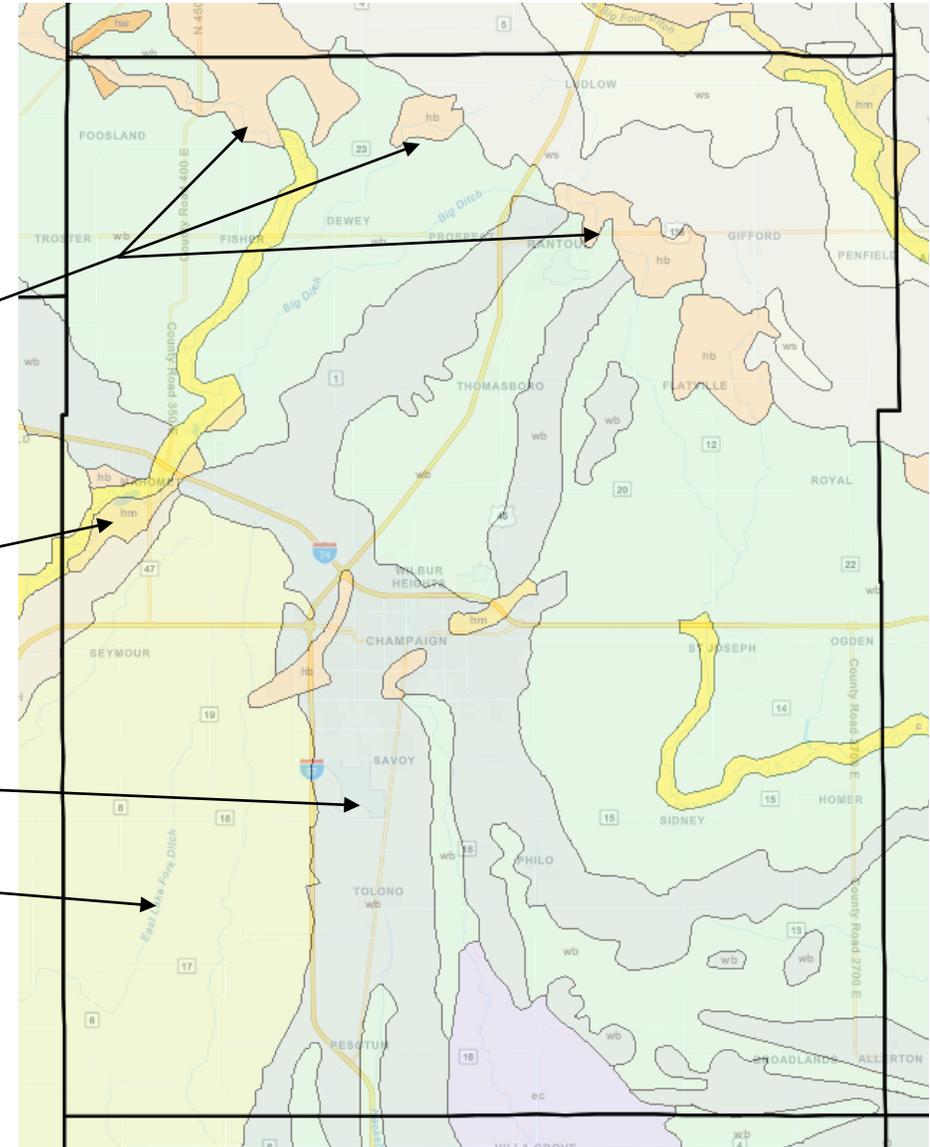
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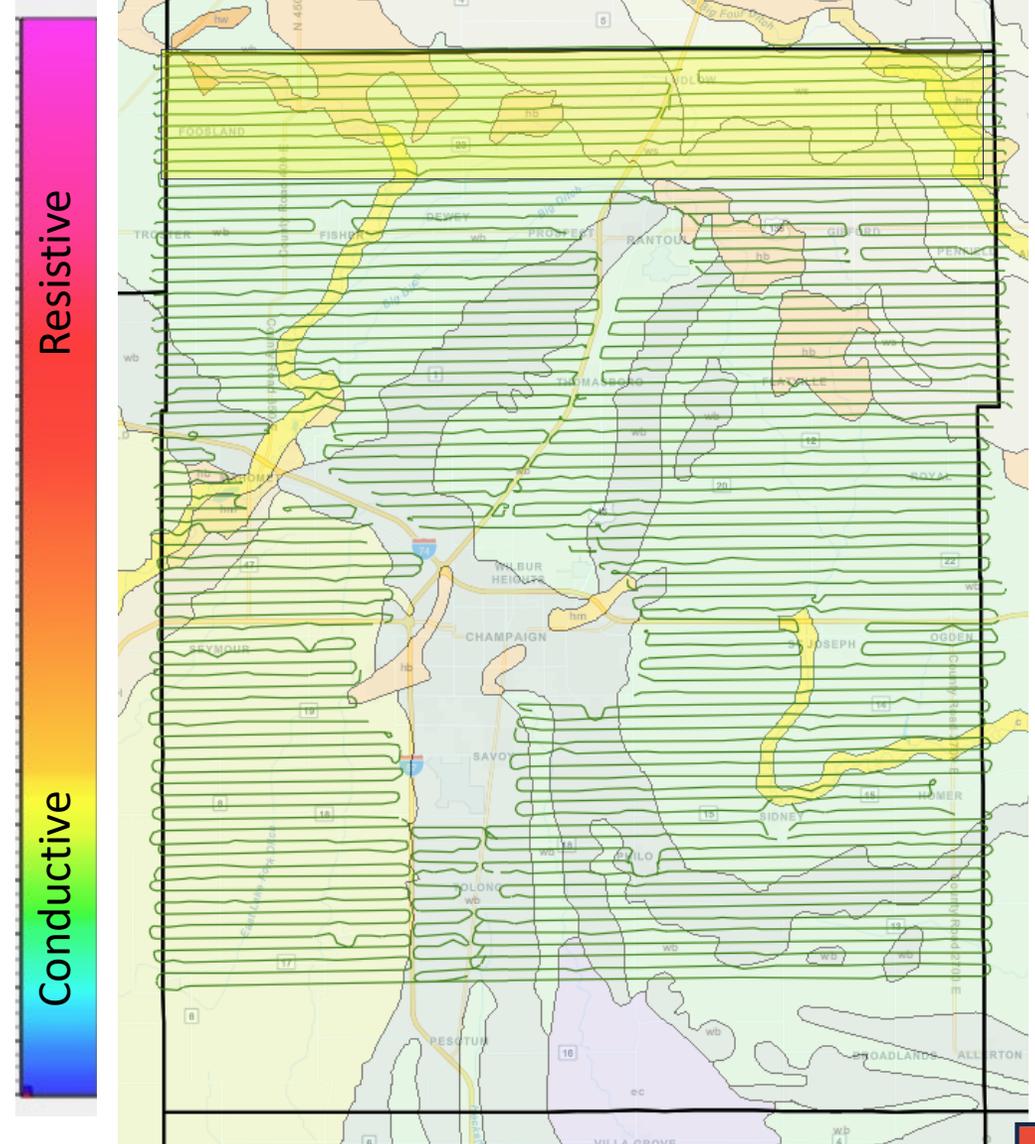
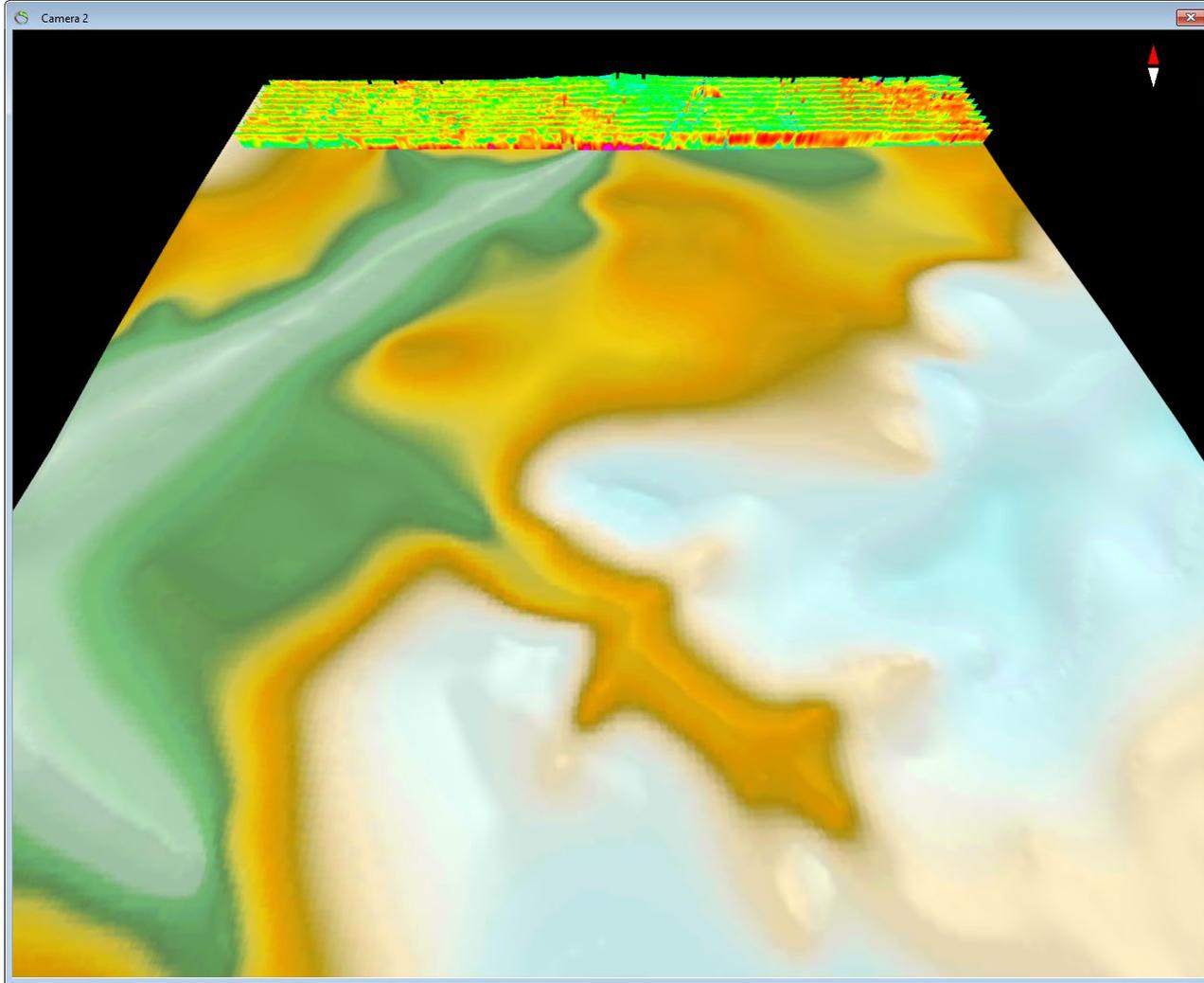
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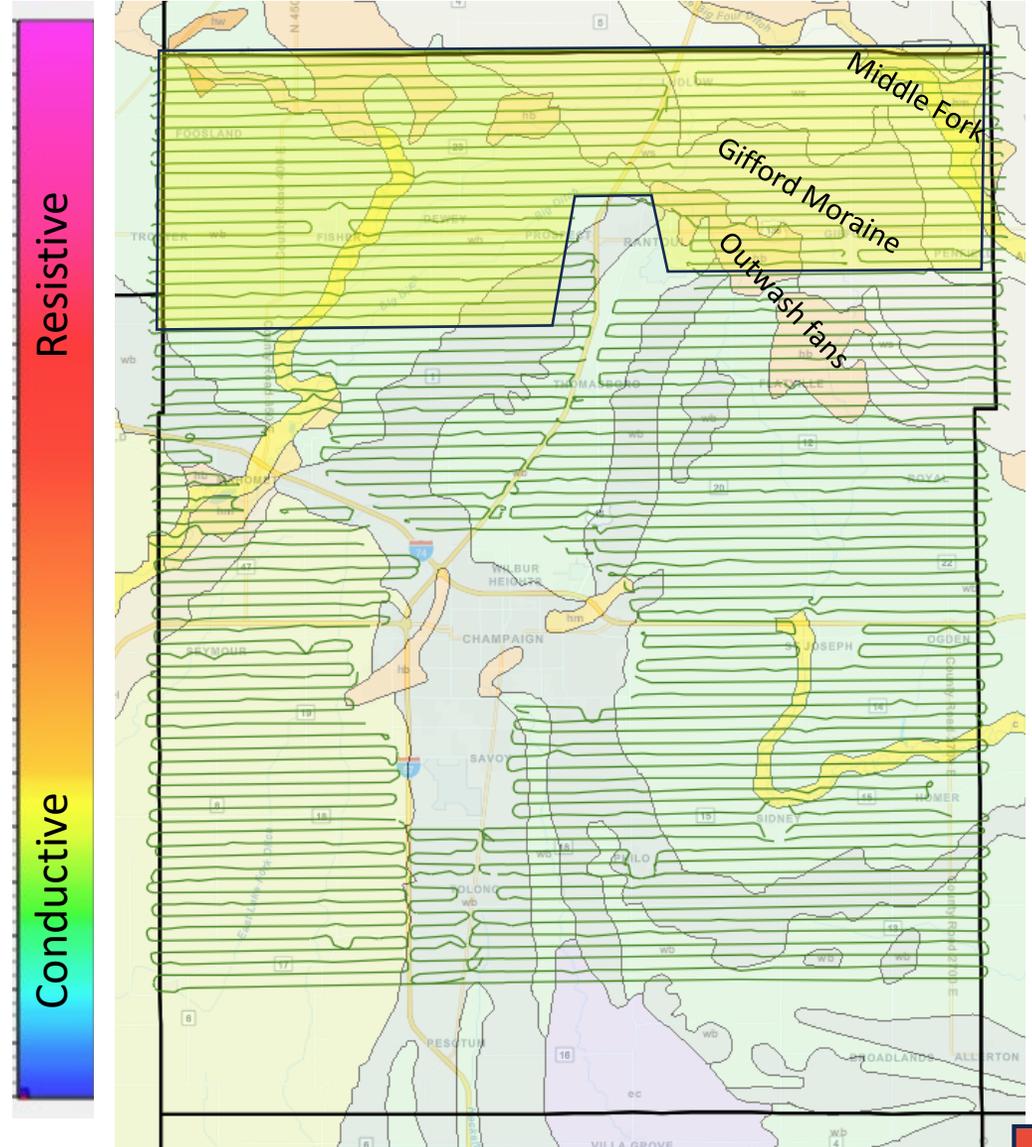
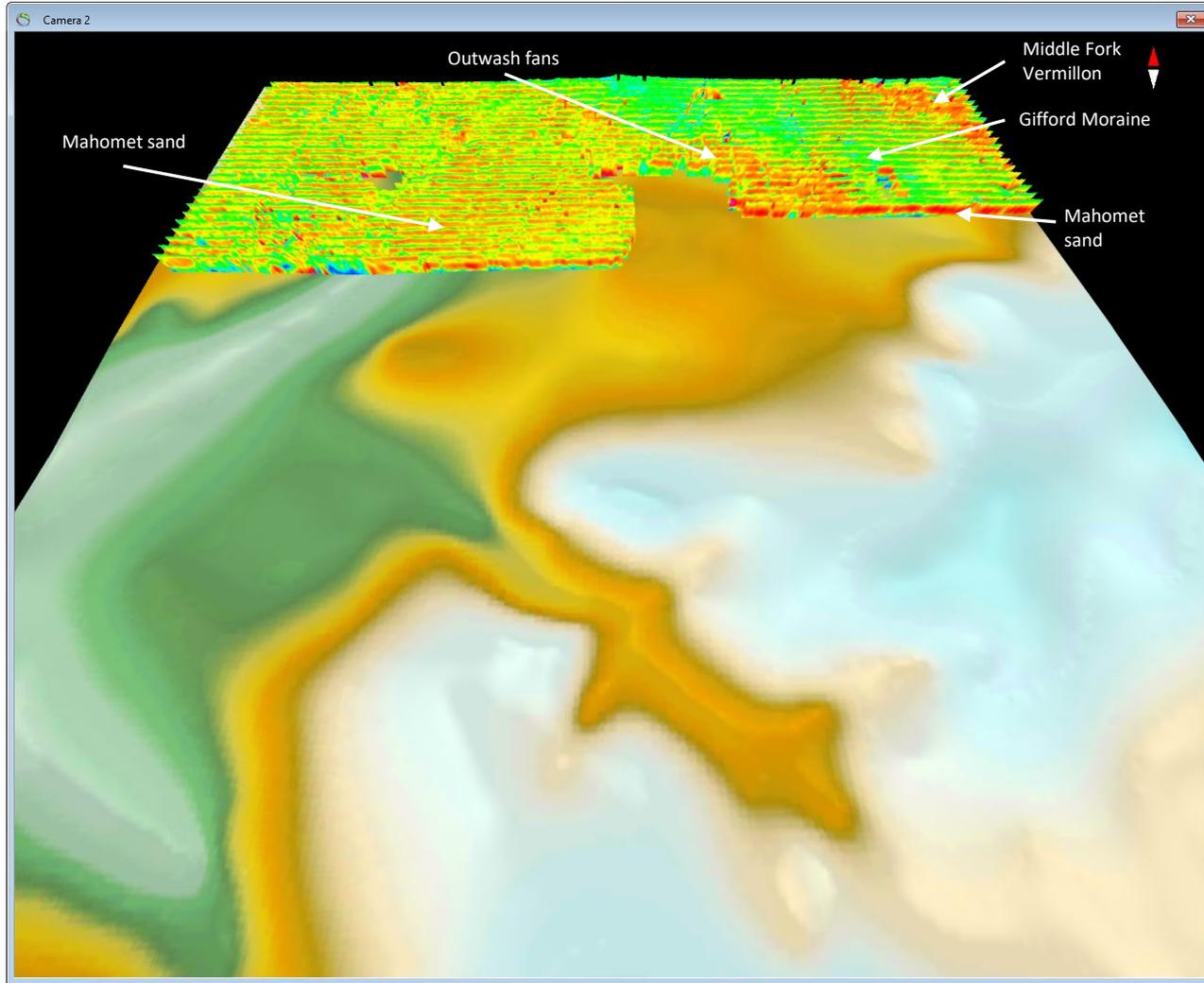
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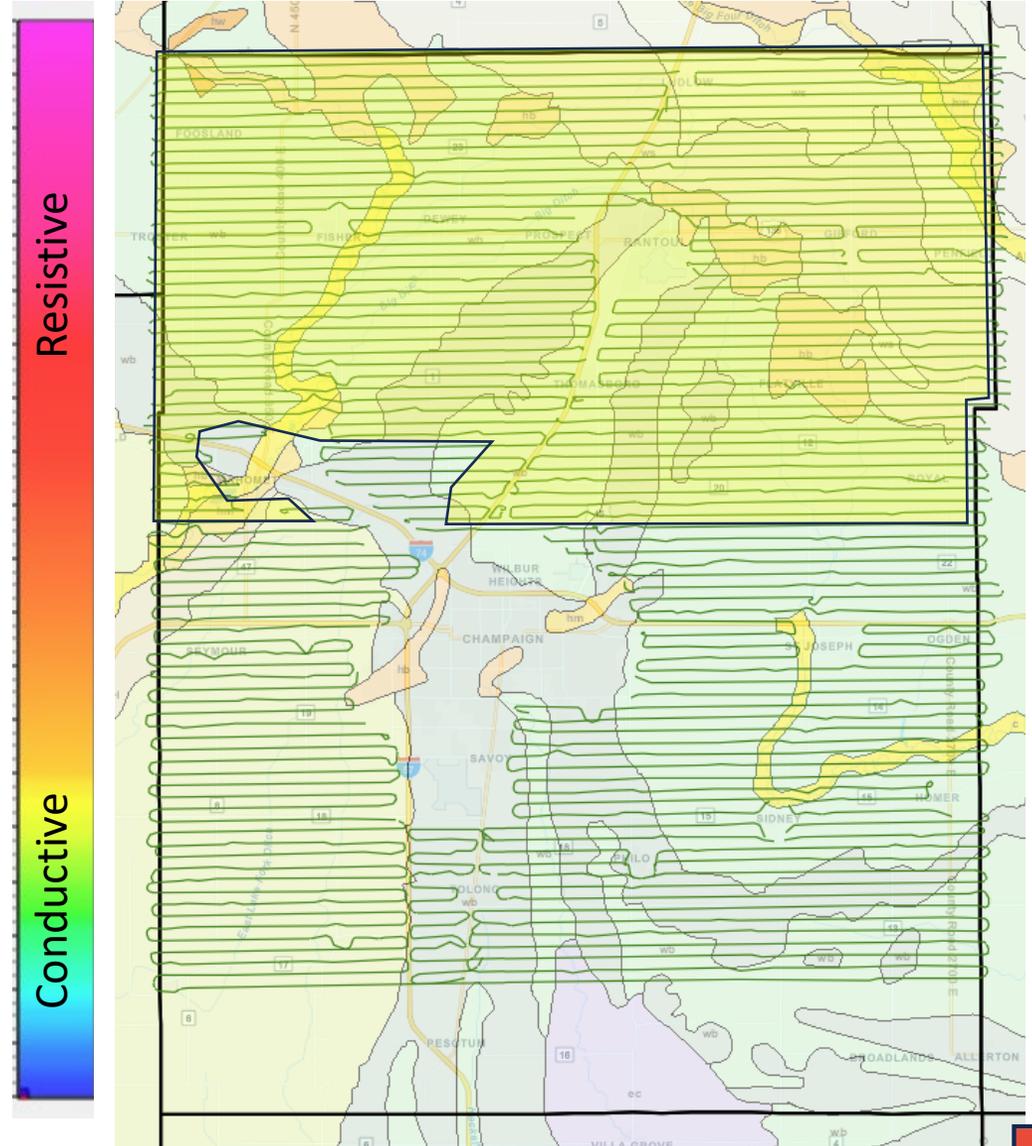
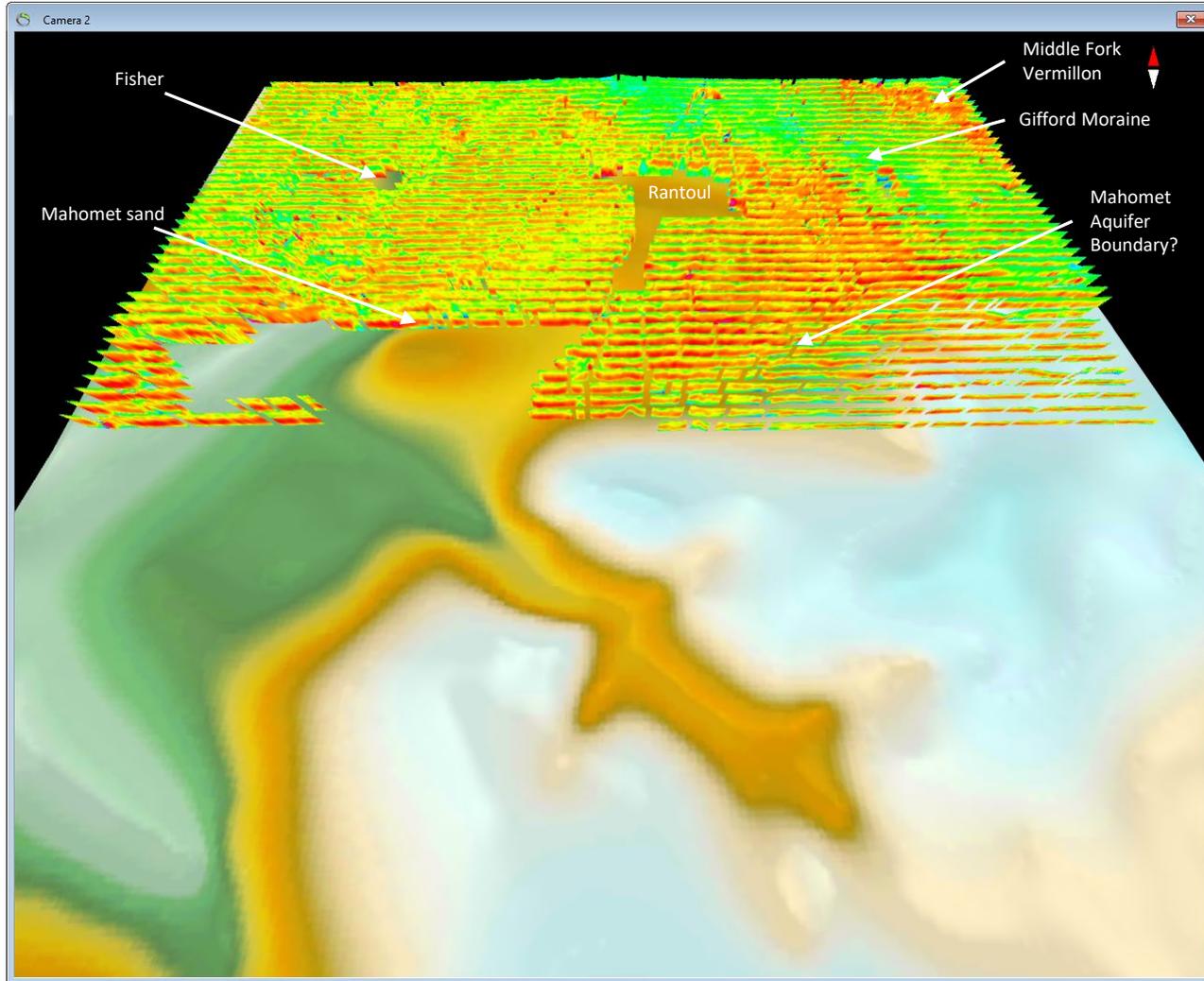
Preliminary HTEM Data- Glacial Sediments



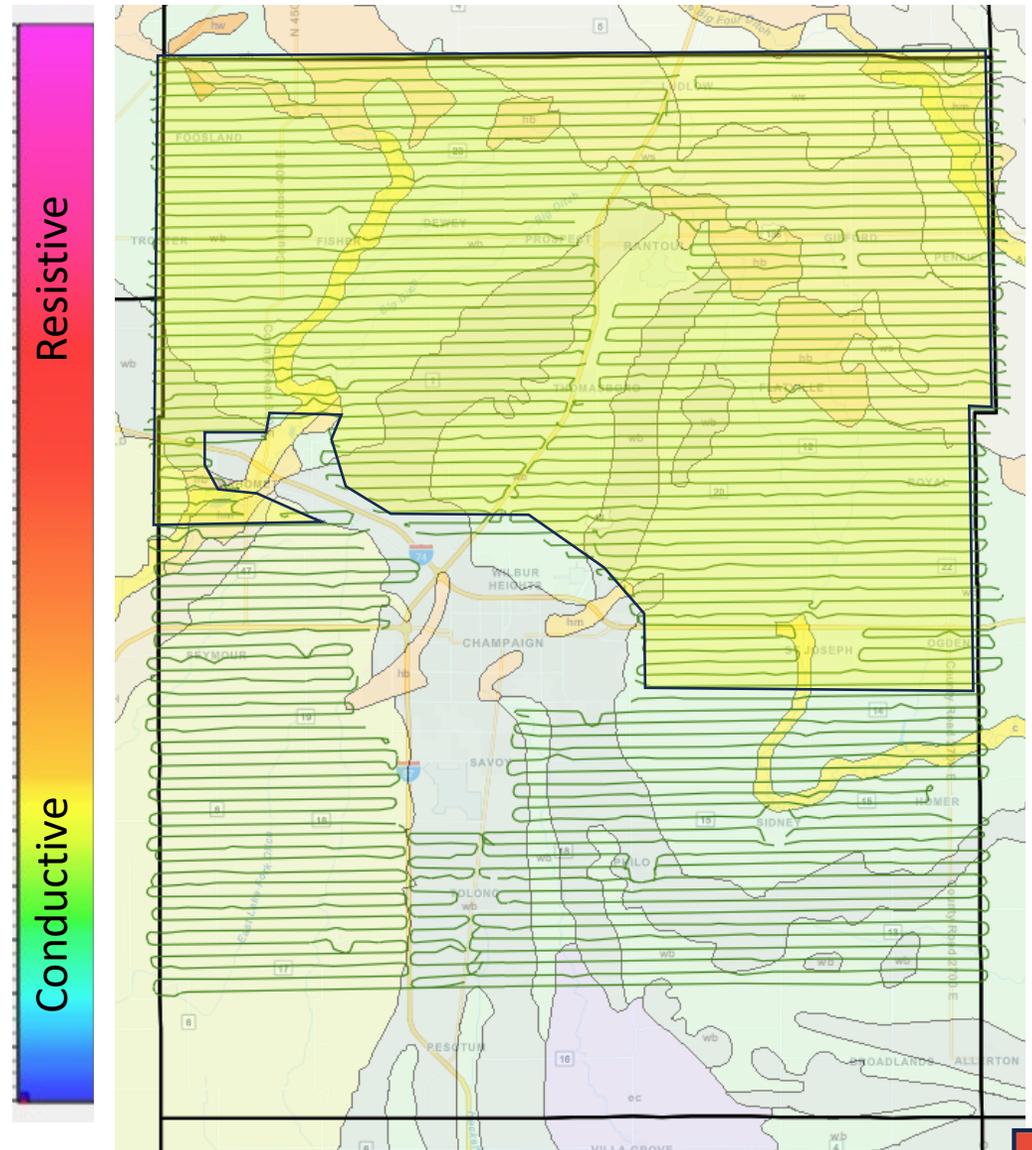
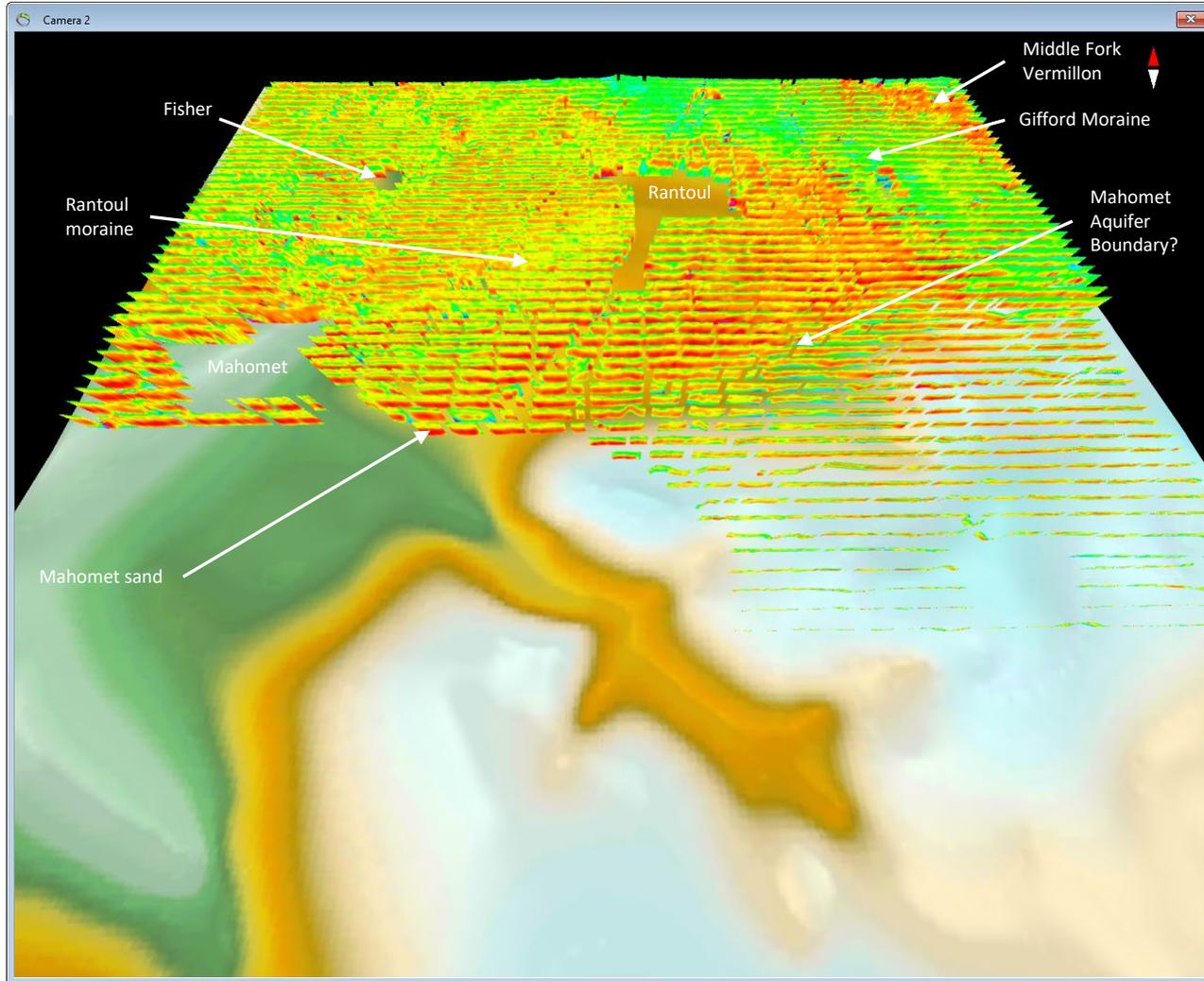
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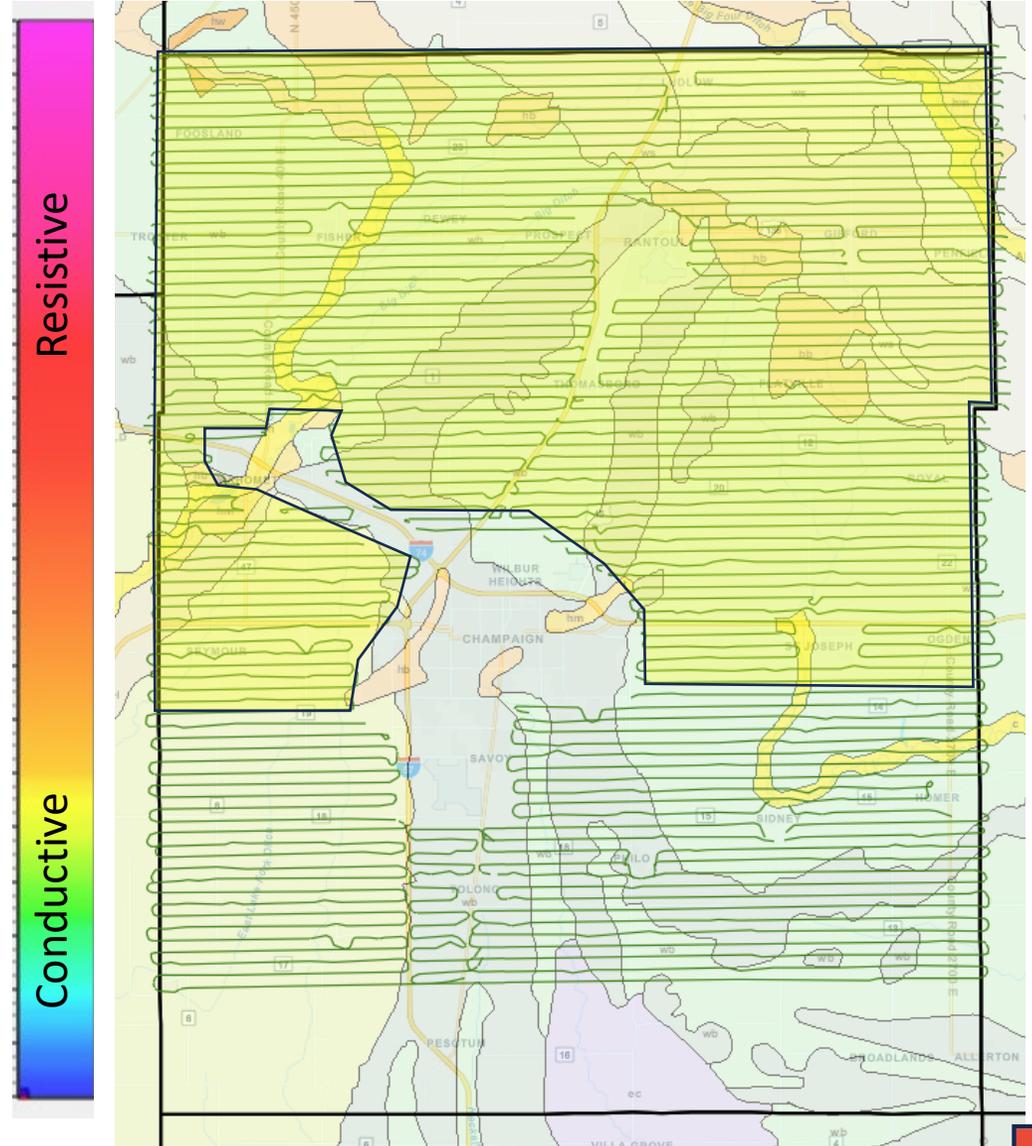
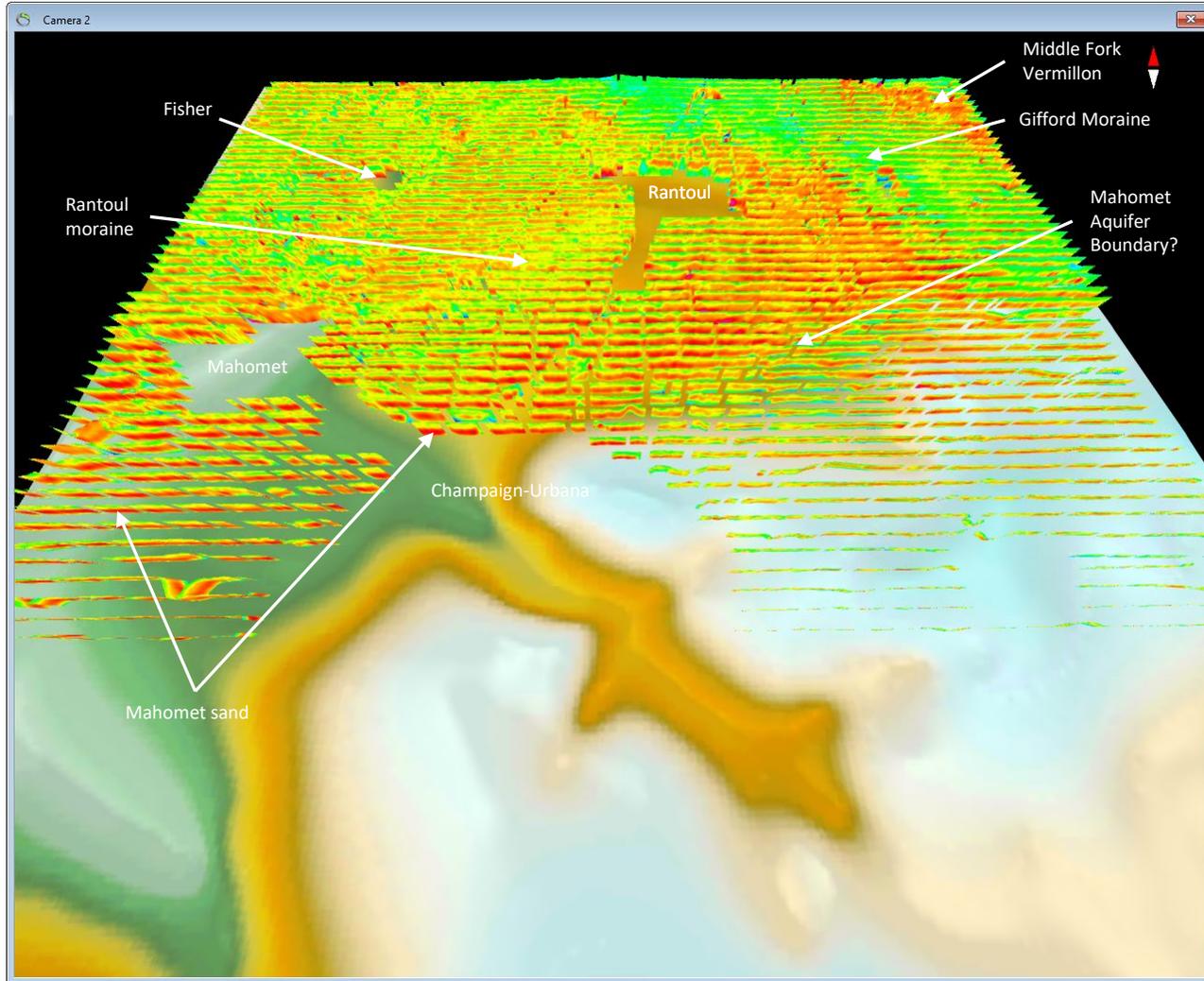
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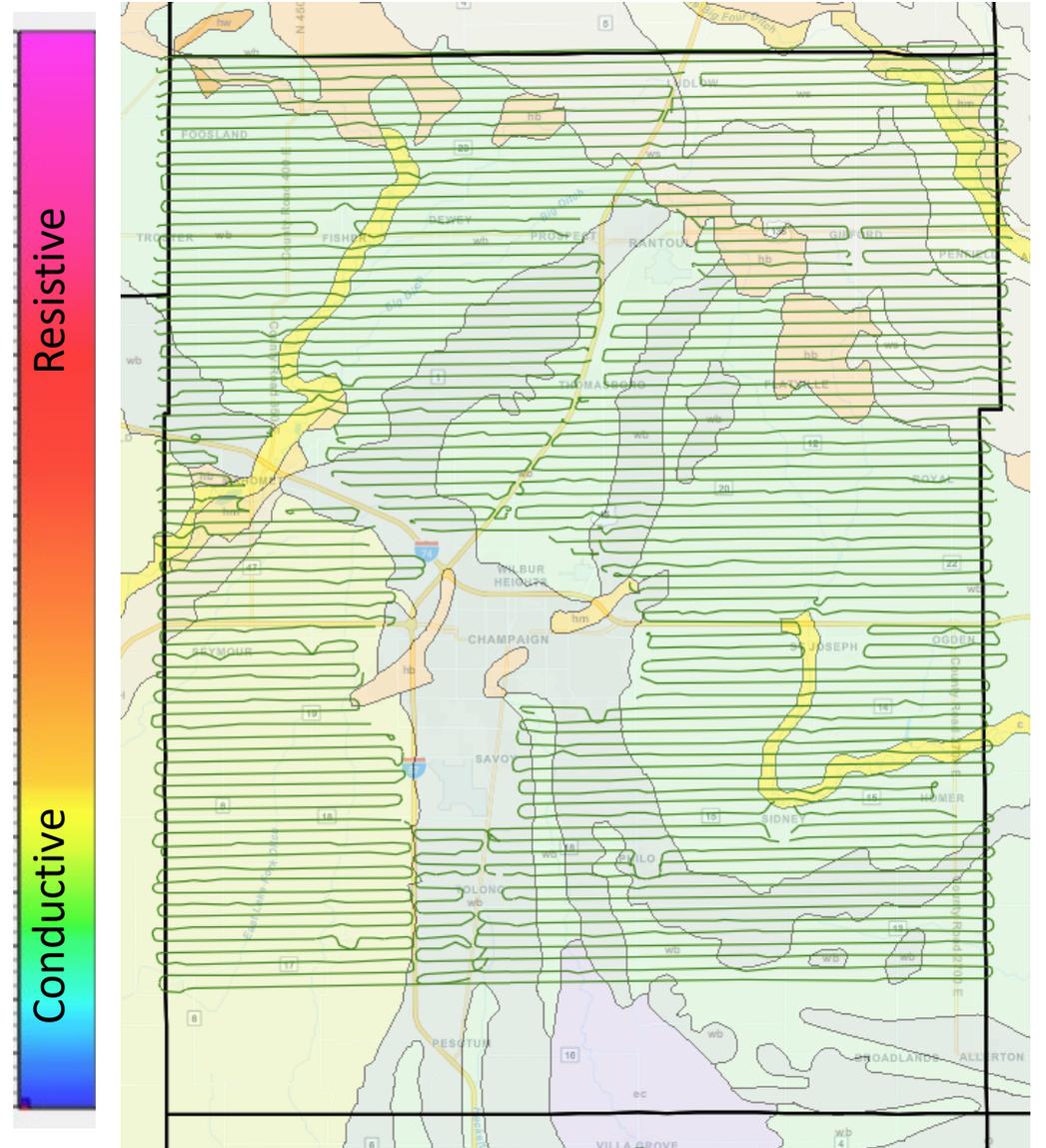
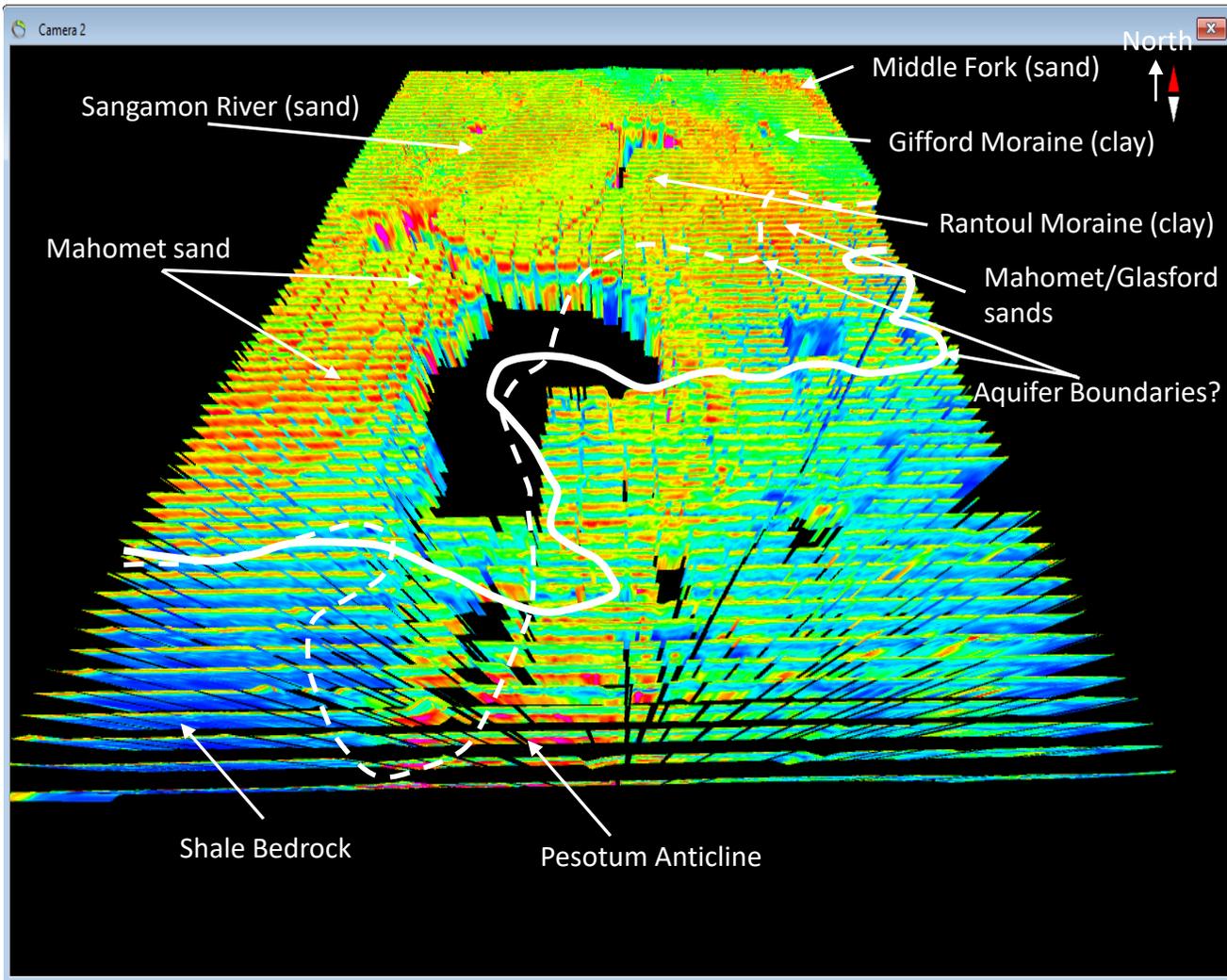
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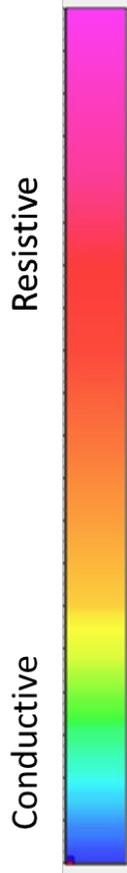
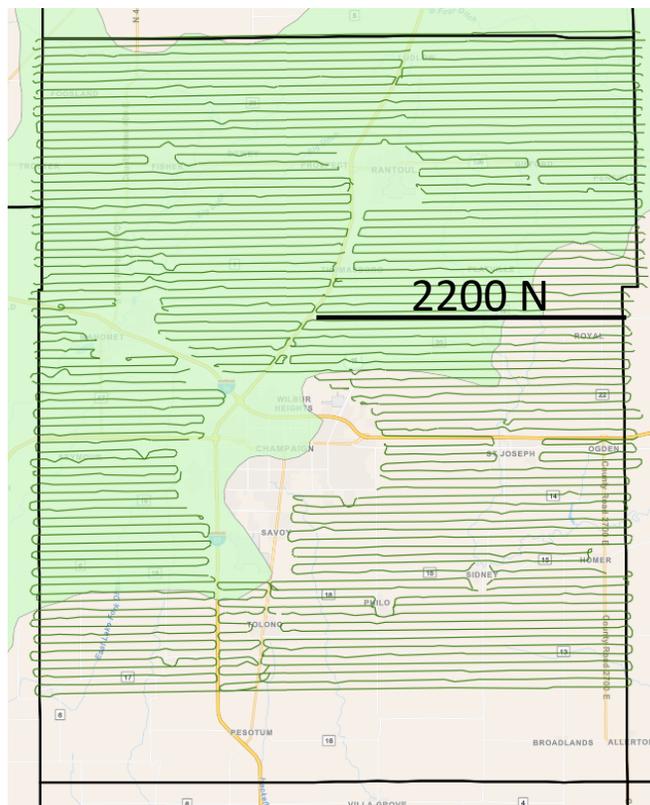
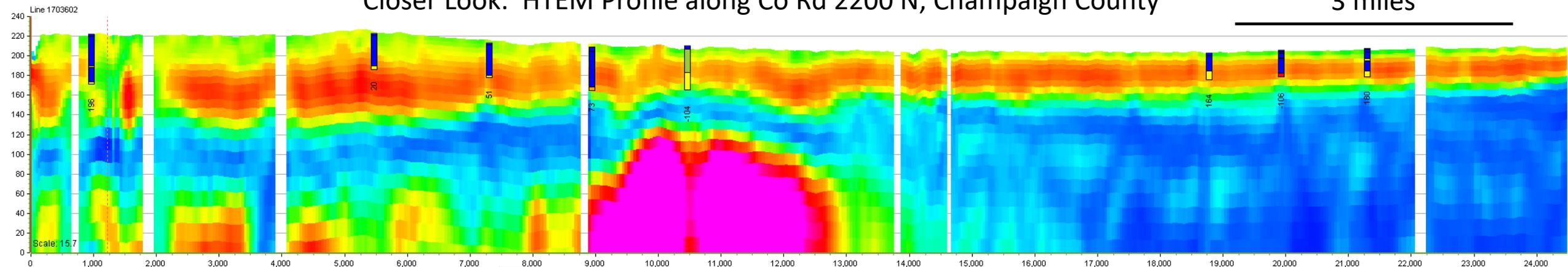


Preliminary HTEM Data



Closer Look: HTEM Profile along Co Rd 2200 N, Champaign County

3 miles



HTEM profile details

- Measurements of electrical properties to 300 meters depth
- Mathematical inversion of data from time to distance to produce profile
- Colors show electrical properties (**resistive** vs **conductive**)

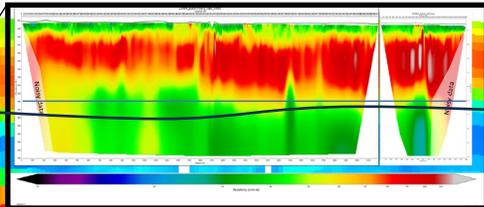
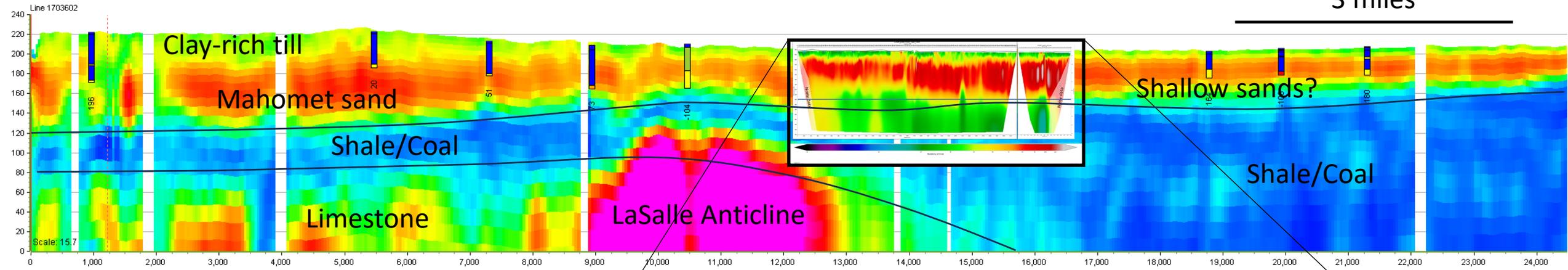
What to look for?

- Bedrock Types and Features
- Glacial Materials, Thicknesses, Changes
- Bedrock Topography Surface/Changes



Closer Look: HTEM Profile along Co Rd 2200 N, Champaign County

3 miles

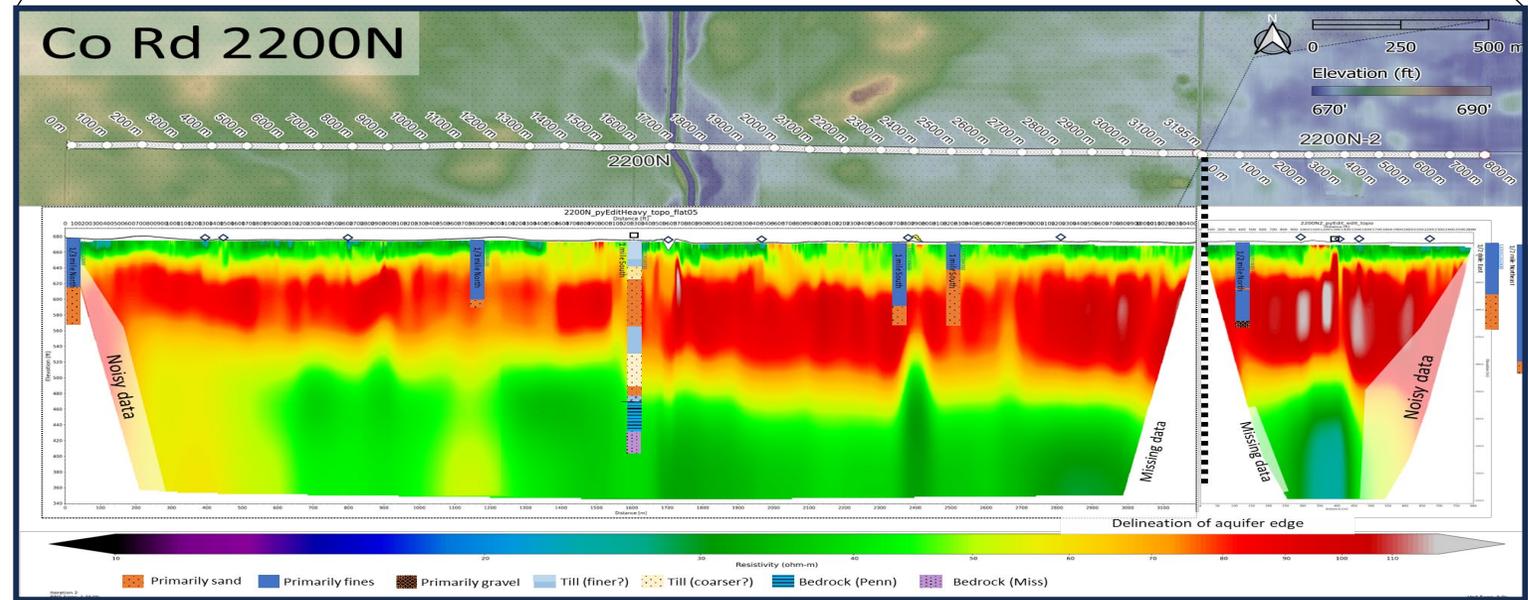
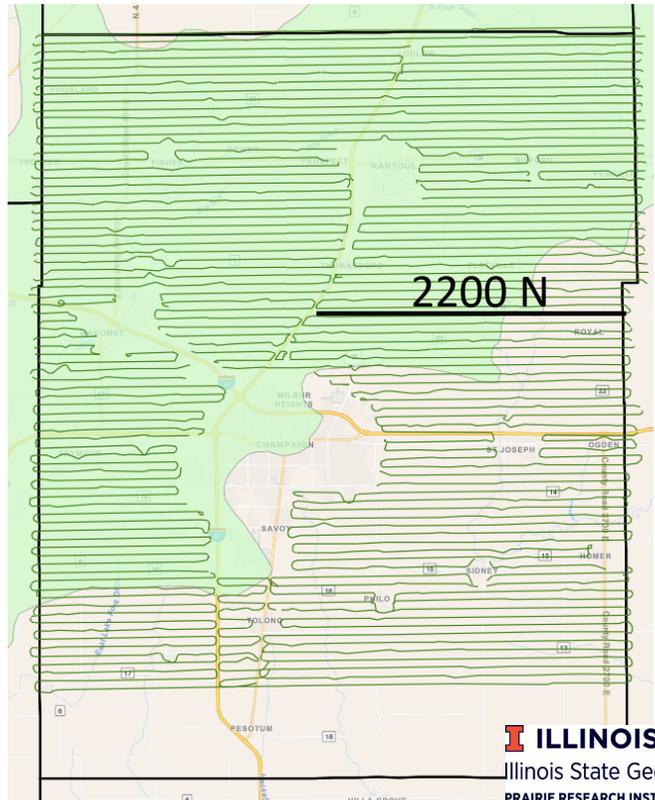


Shallow sands?

Shale/Coal

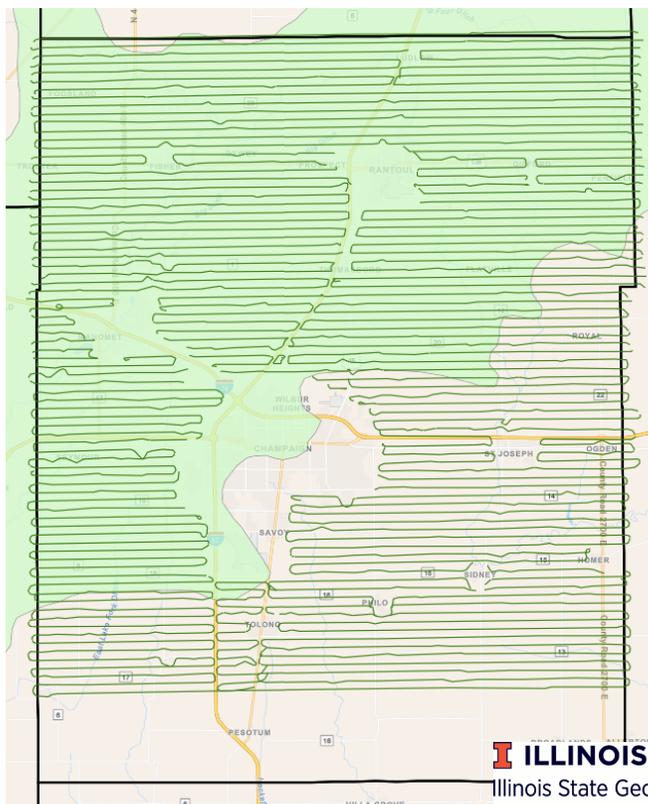
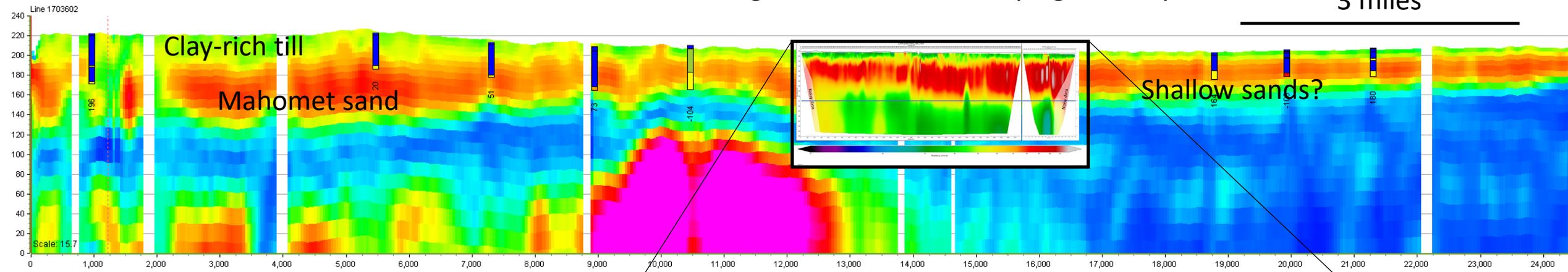
3 miles

Ground-Based Electrical Resistivity



Closer Look: HTEM Profile along Co Rd 2200 N, Champaign County

3 miles



Ground-based VS Airborne Geophysics

Collecting **3087** kilometers of data

Airborne

- ~500 km/day
- \$ Helicopter and Mobilization
 - **\$385,000**
- 7 days

Ground based EM

- 3 km/week.....no vacation
- \$ Travel/Students.....
 - **\$3.5 million**
- 12.3 years



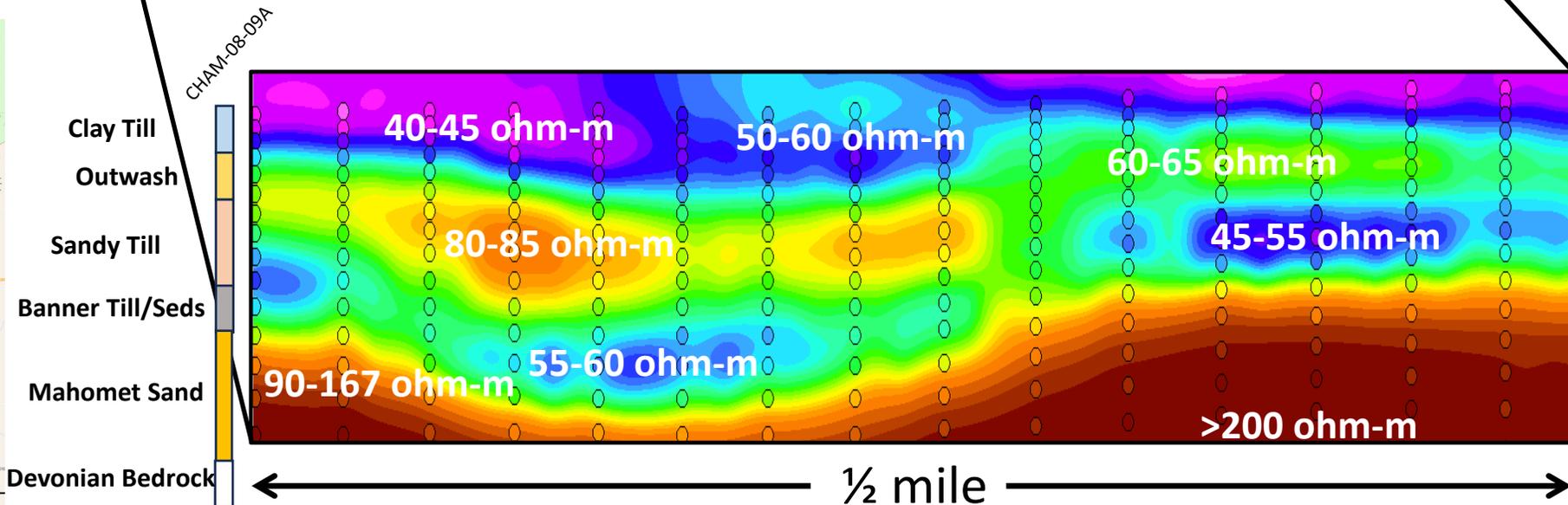
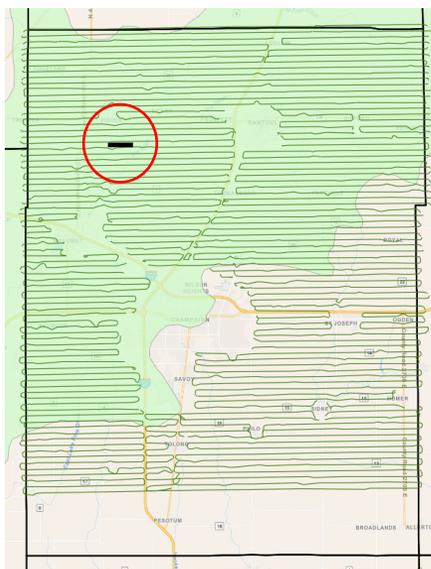
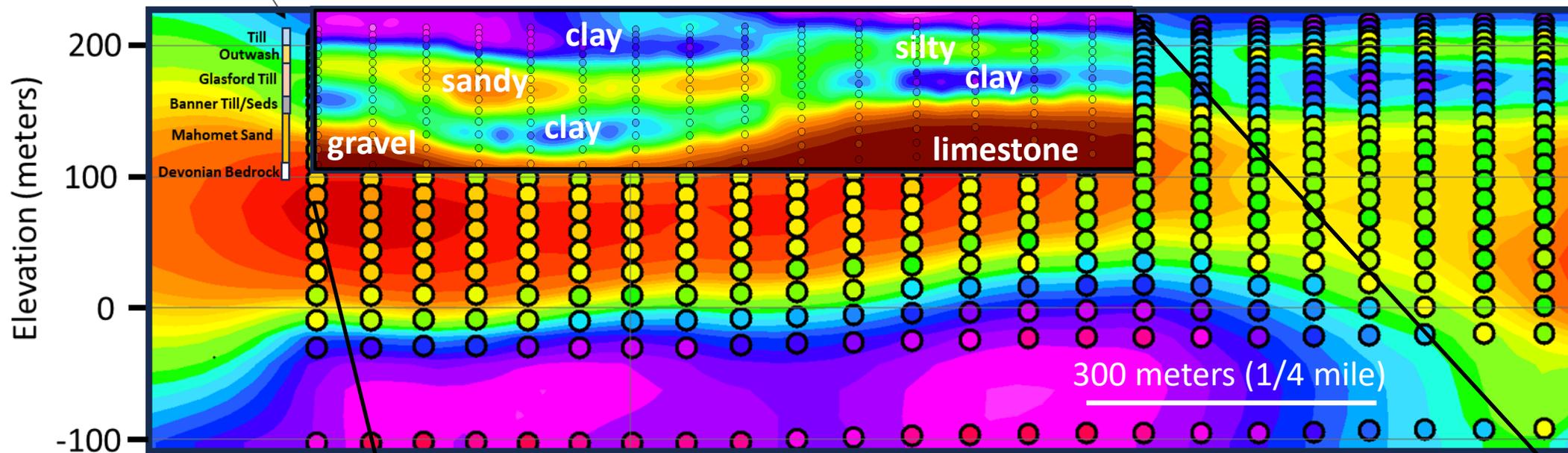
ISGS boring

CHAM-08-09A

50 meters

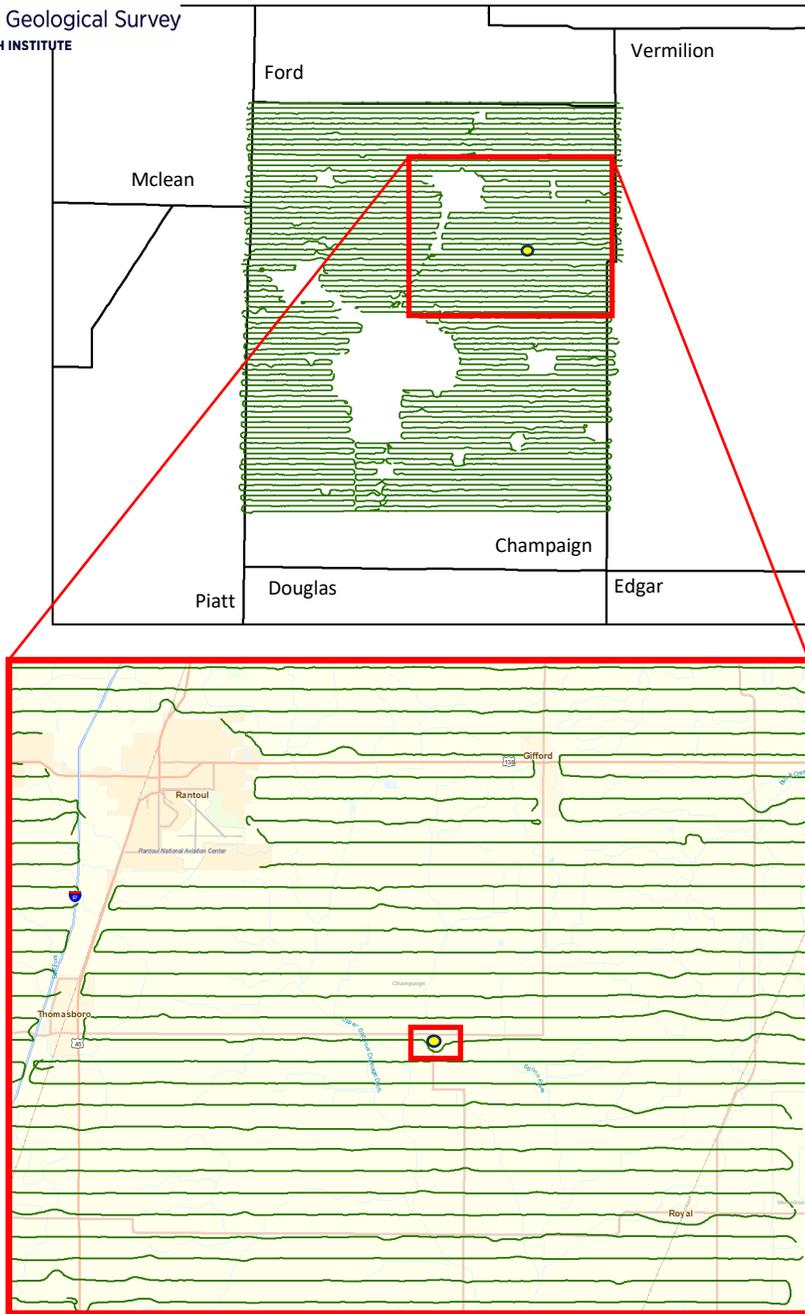


Even CLOSER Look!! HTEM Profile East of Rantoul



Drilling at Prairie-Ogden School District #197 July 2023

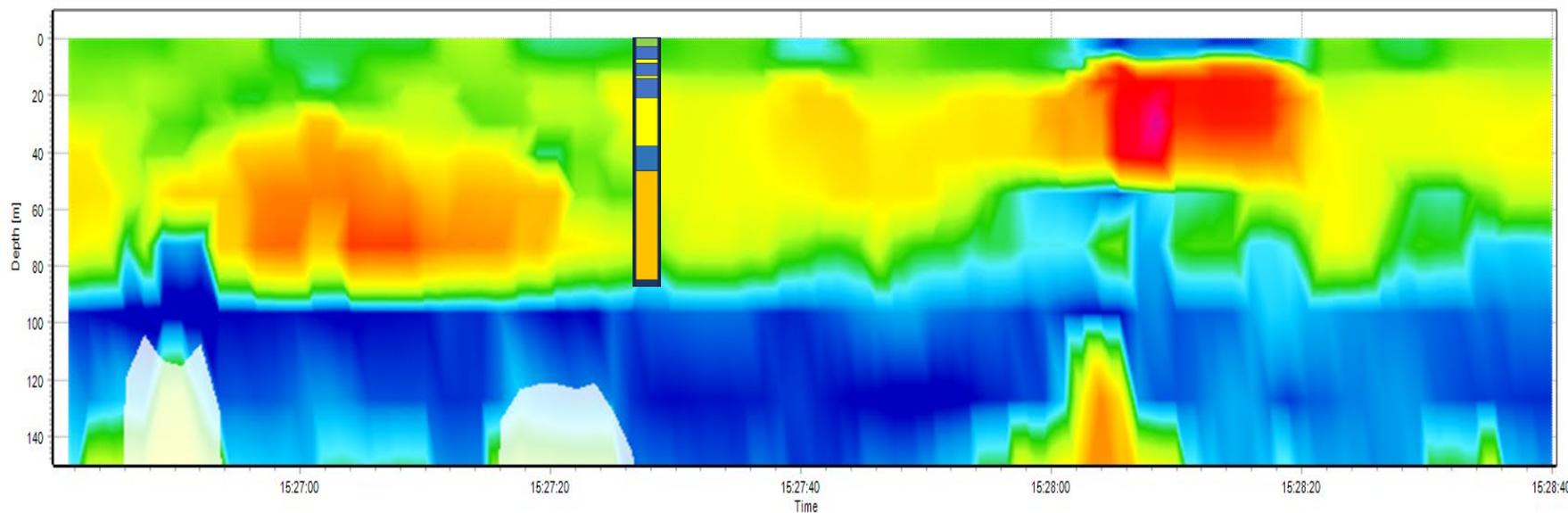
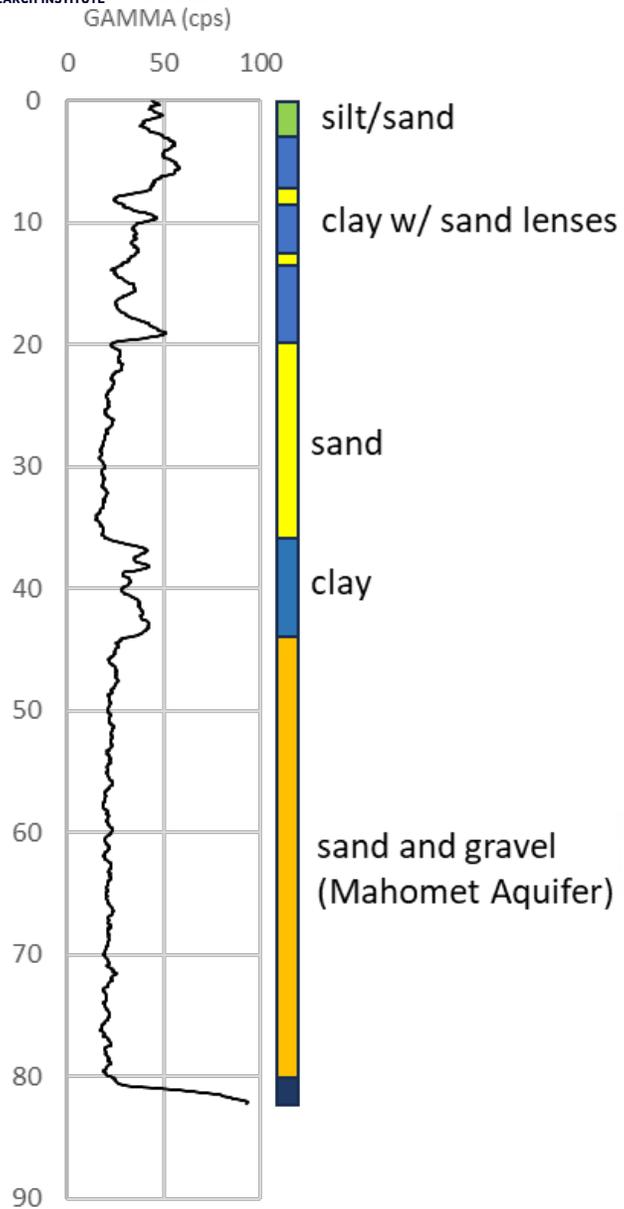


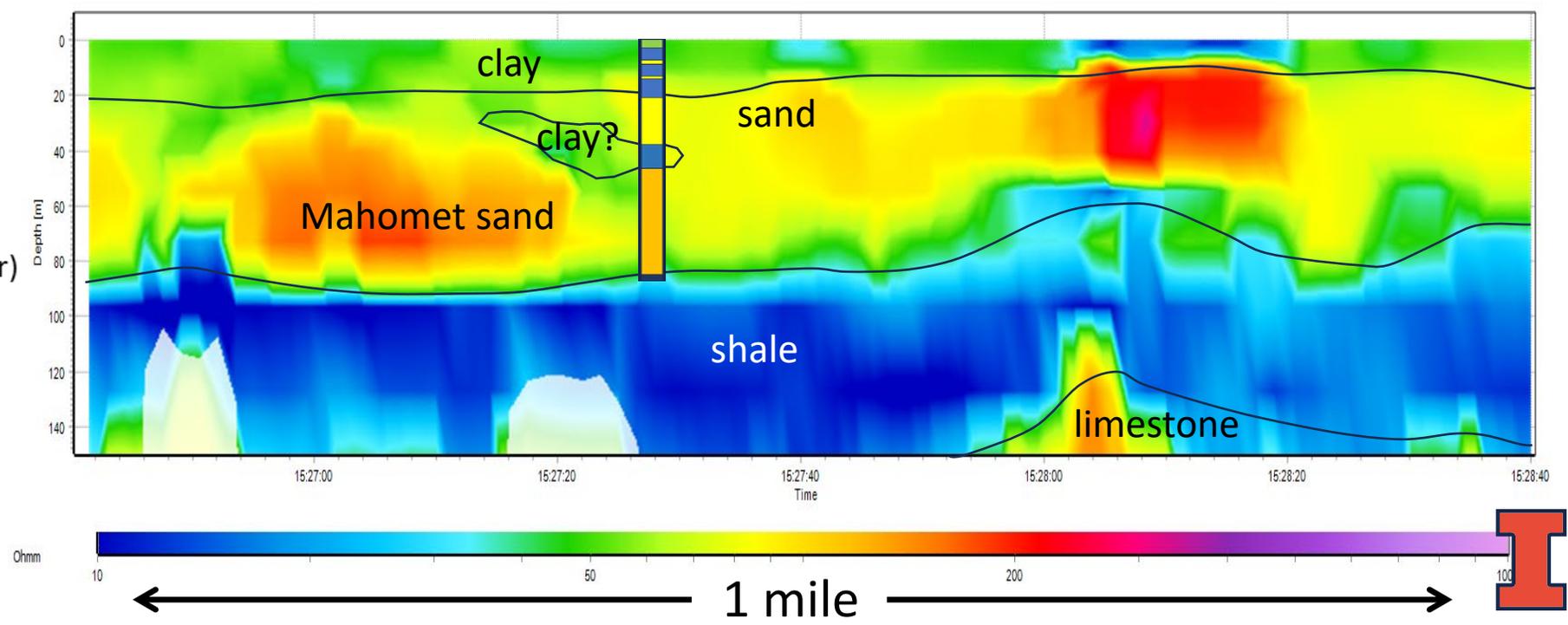
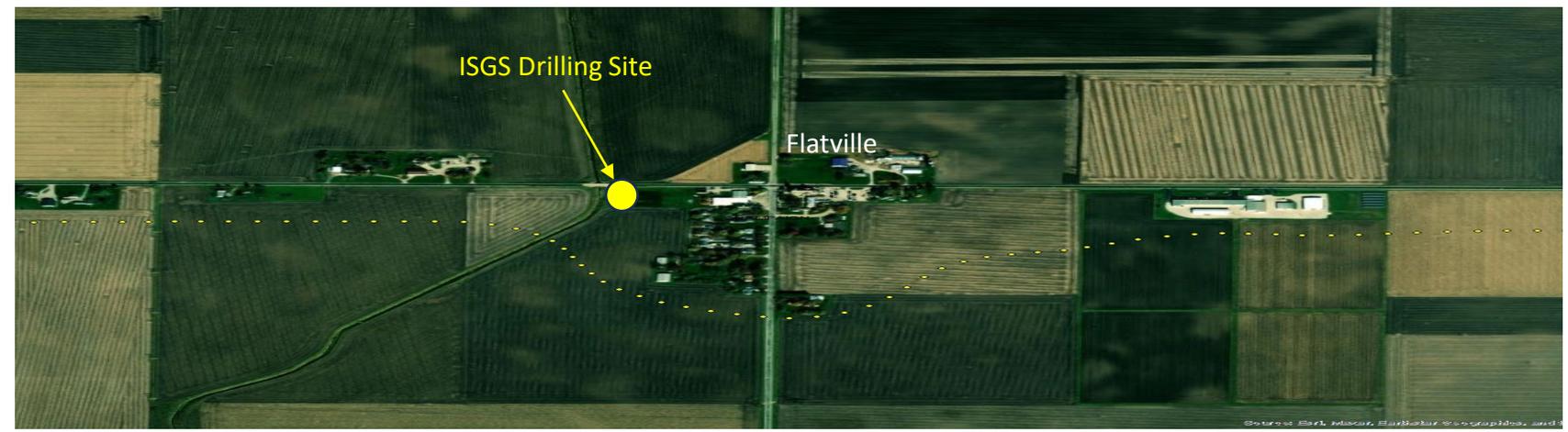
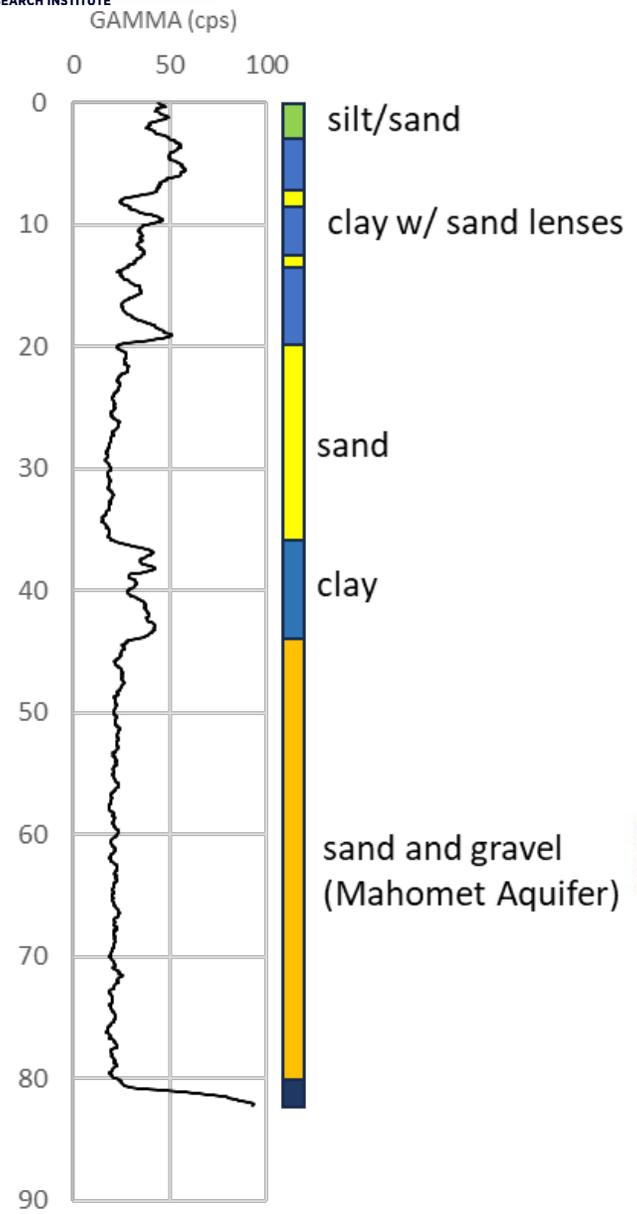


Drilling in Flatville July 2023



Source: Esri, Maxar, Earthstar, GeoEye, and the GIS User Community

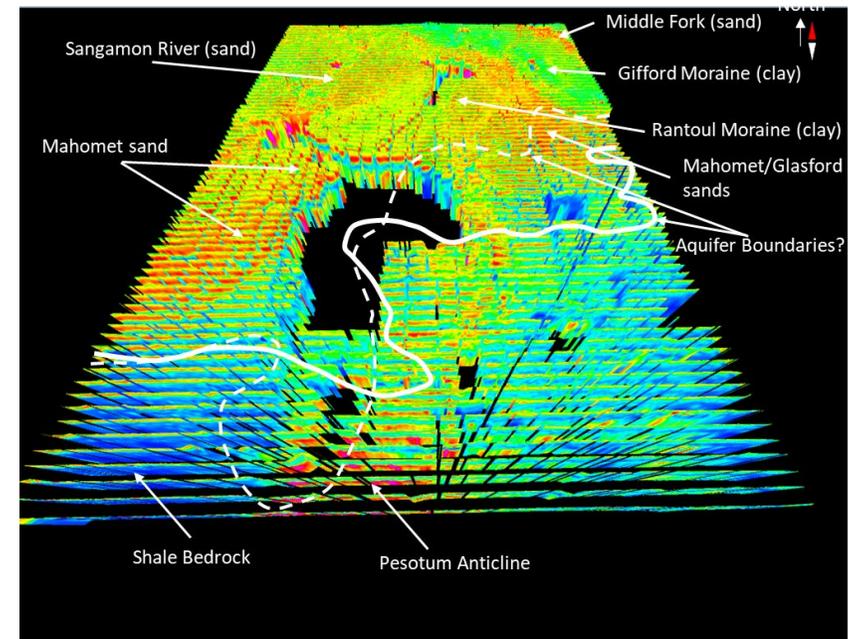




Where from here?until 2024-2025

- **2023-2024**
 - **Finish data processing**
 - **Data visualization**
 - **Data interpretation**
 - **2024-2025**
 - **3D modeling and construction**
 - **Reporting and deliverables**
 - **Public workshops and review**
- ↓
- **2025-2026**
 - **Integration with ISWS groundwater flow models**

	Budget	Expenditures	Balance
Personnel (student/staff)	\$ 7,680	\$ -	\$ 7,680
Fringe	\$ 588	\$ -	\$ 588
Supplies (safety/batteries)	\$ 680	\$ -	\$ 680
Travel (vehicles/students)	\$ 10,997	\$ 3,000	\$ 7,997
Contractual	\$ 434,600		\$ 6,600
SkyTEM		\$ 385,000	
Mobilization		\$ 30,000	
Drilling		\$ 13,000	
Facilities and Administration	\$ 45,455	\$ 40,700	\$ 4,755
Totals	\$ 500,000	\$ 471,700	\$ 28,300



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Thank you!!

