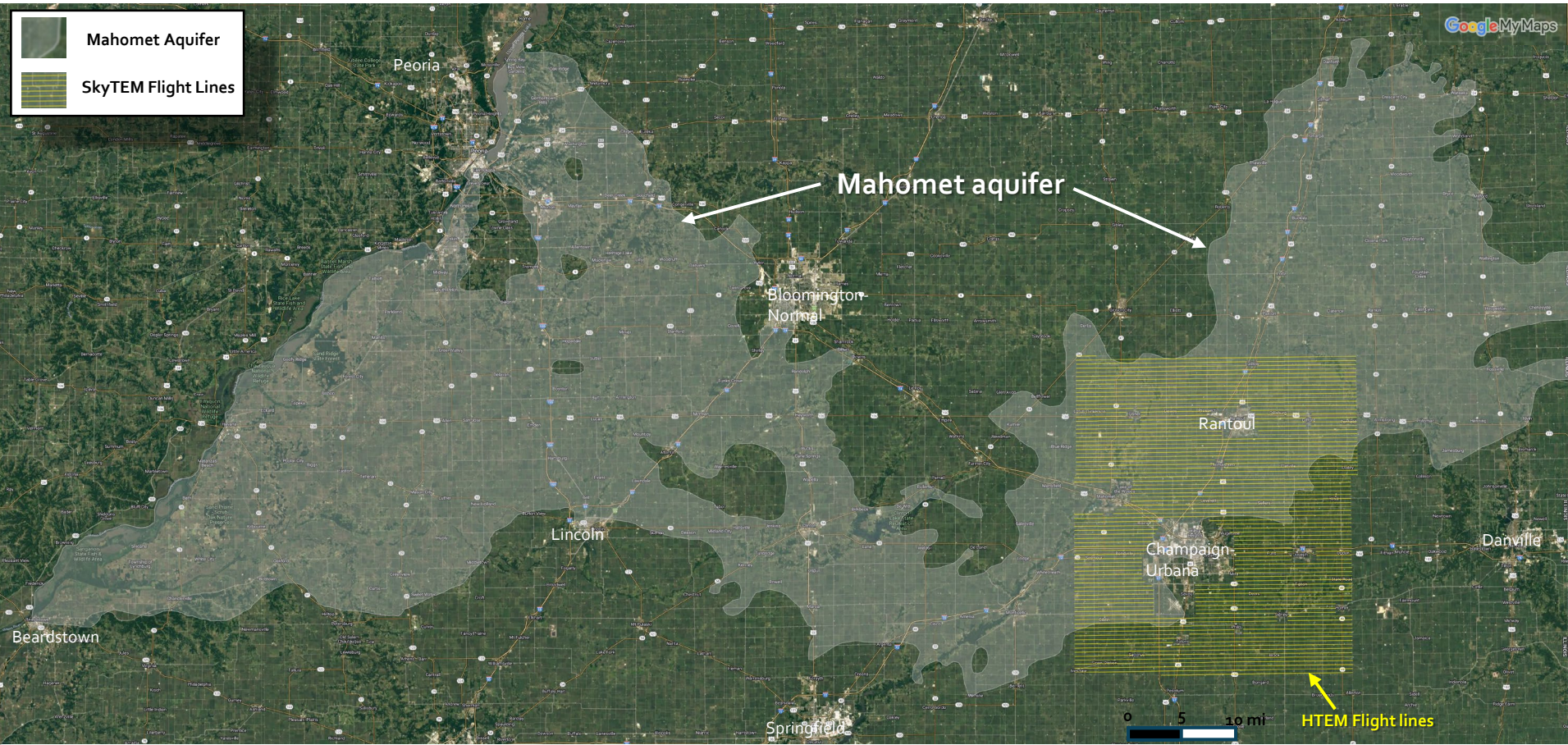




# Geophysical Mapping of the Mahomet Aquifer using Airborne Electromagnetic Method



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Steven Young, and Andrew J. Stumpf





# Acknowledgements

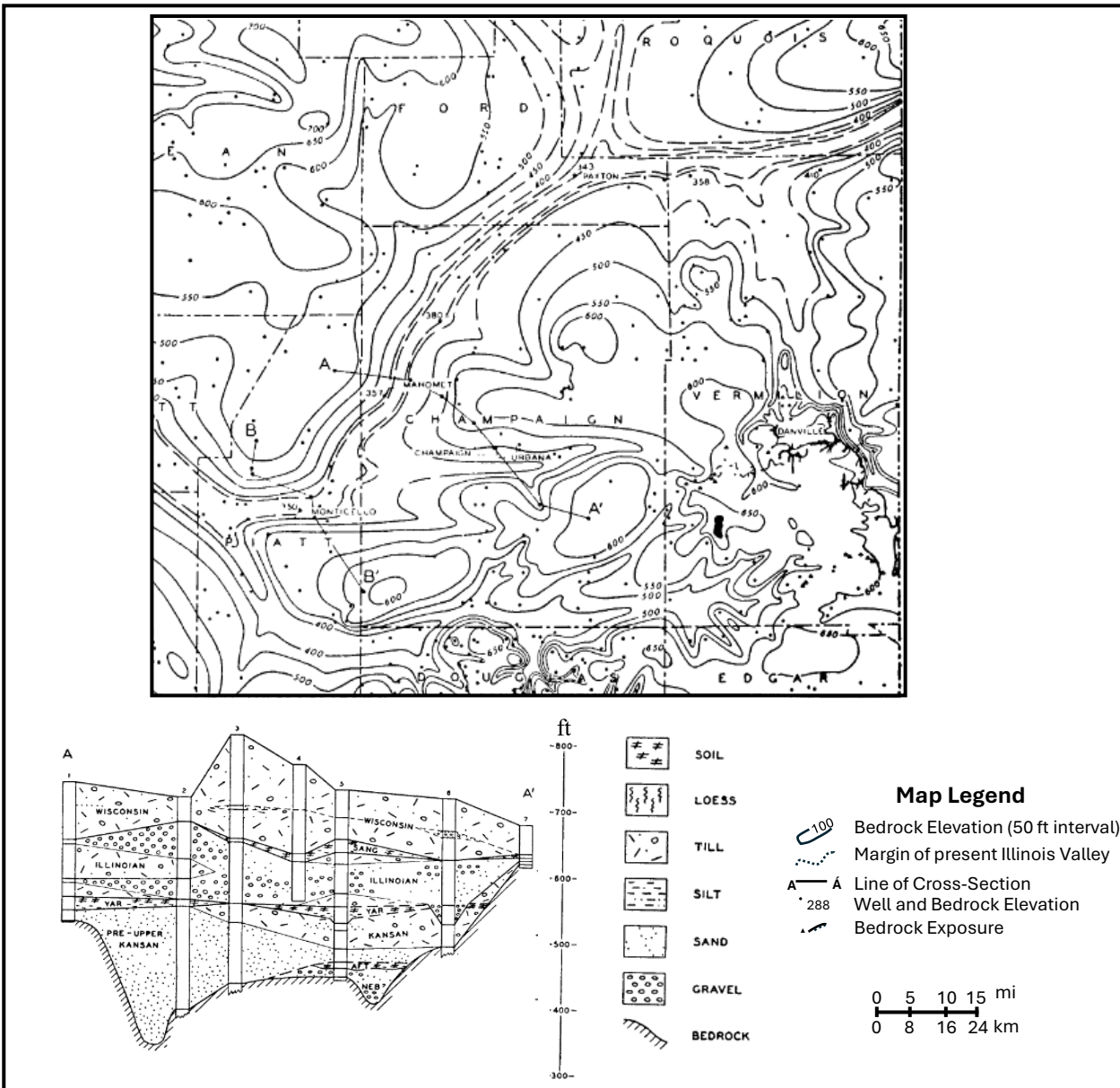


- Champaign County Board
- Champaign County 1st
- Local Leaders
- Local Advocacy groups
- State and Federal legislators
- Scientists across PRI
- Students! UIUC and ISU!
- Many motivated citizens



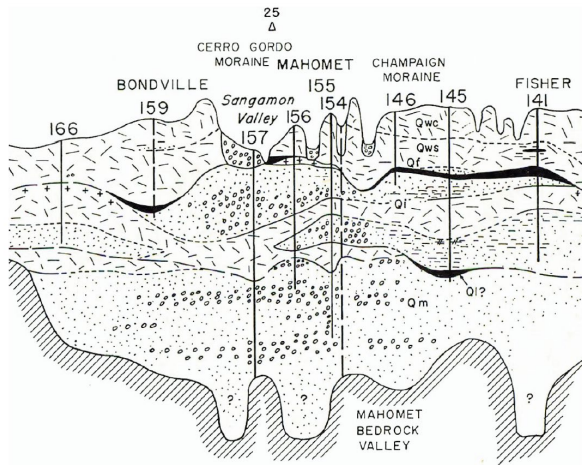


# Mahomet Bedrock Valley (MBV)

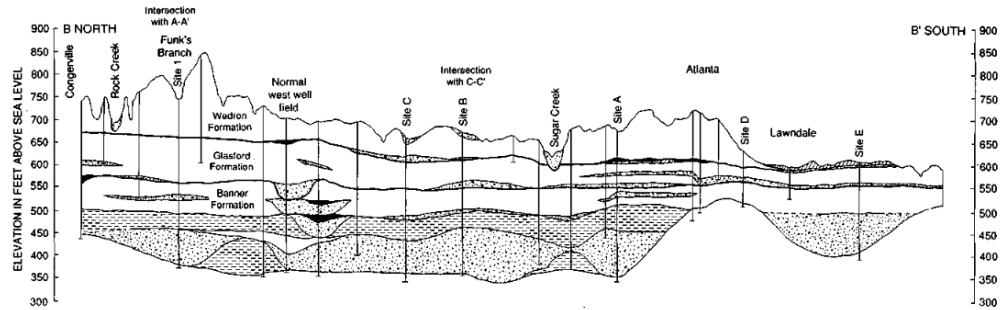




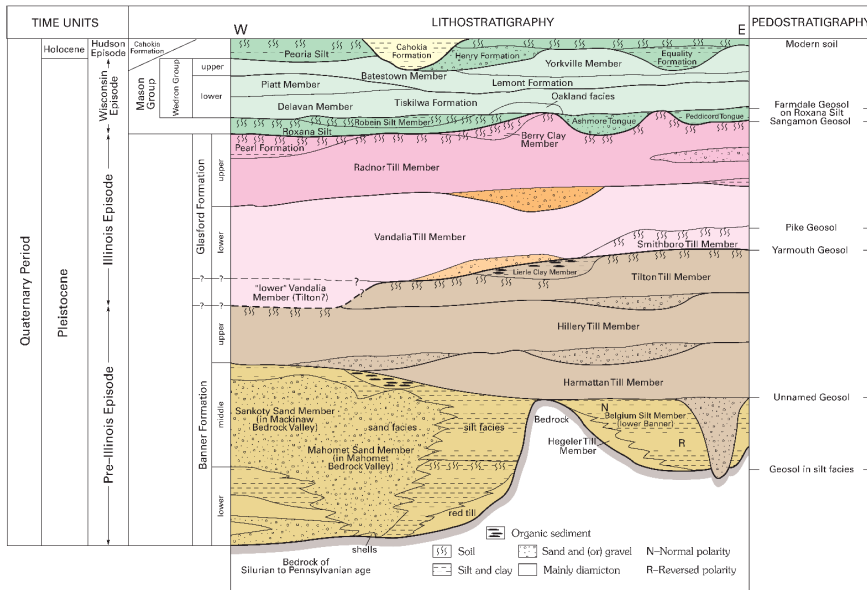
# Geological Framework



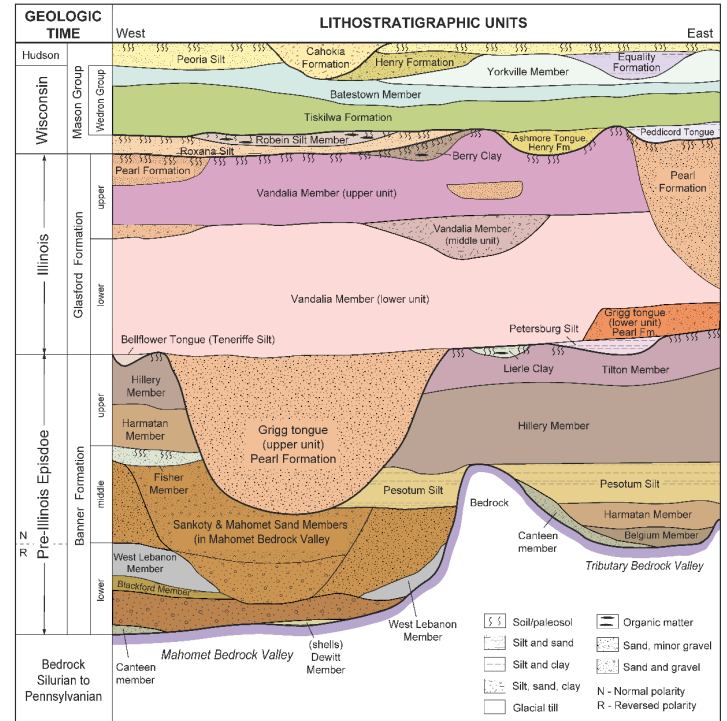
Mahomet Bedrock Valley (Horberg, 1953)



Sankoty-Mahomet (Wilson et al., 1994)



Mahomet Bedrock Valley (Soller et al., 1999); 5 boreholes

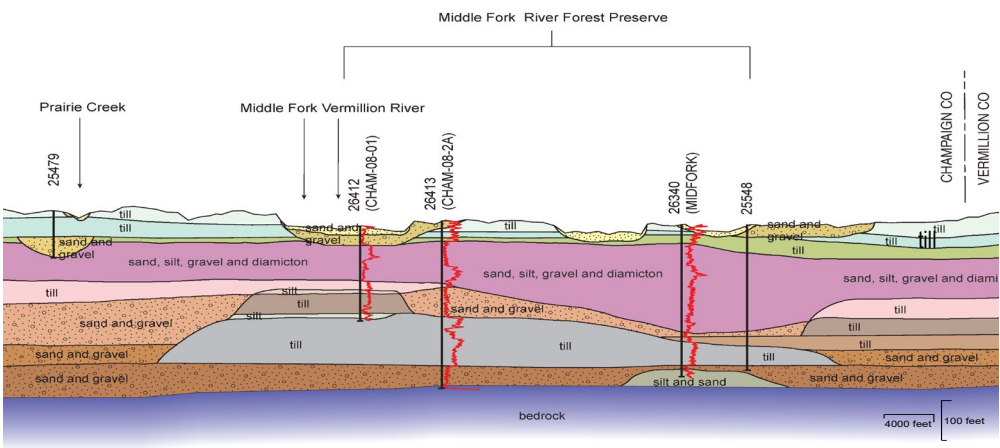
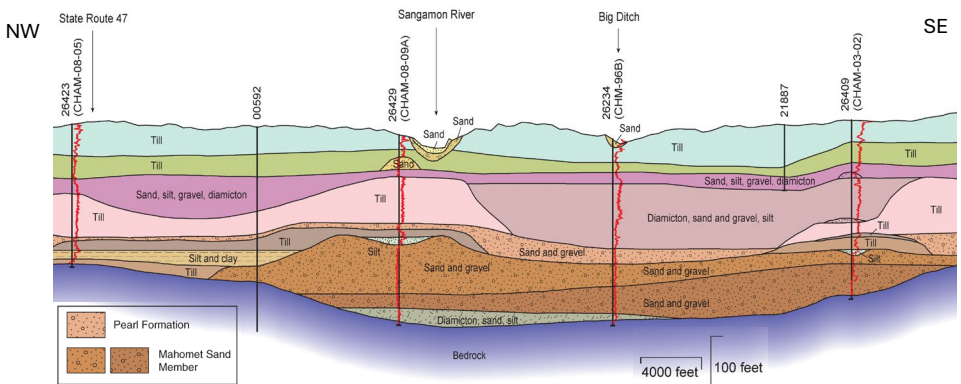
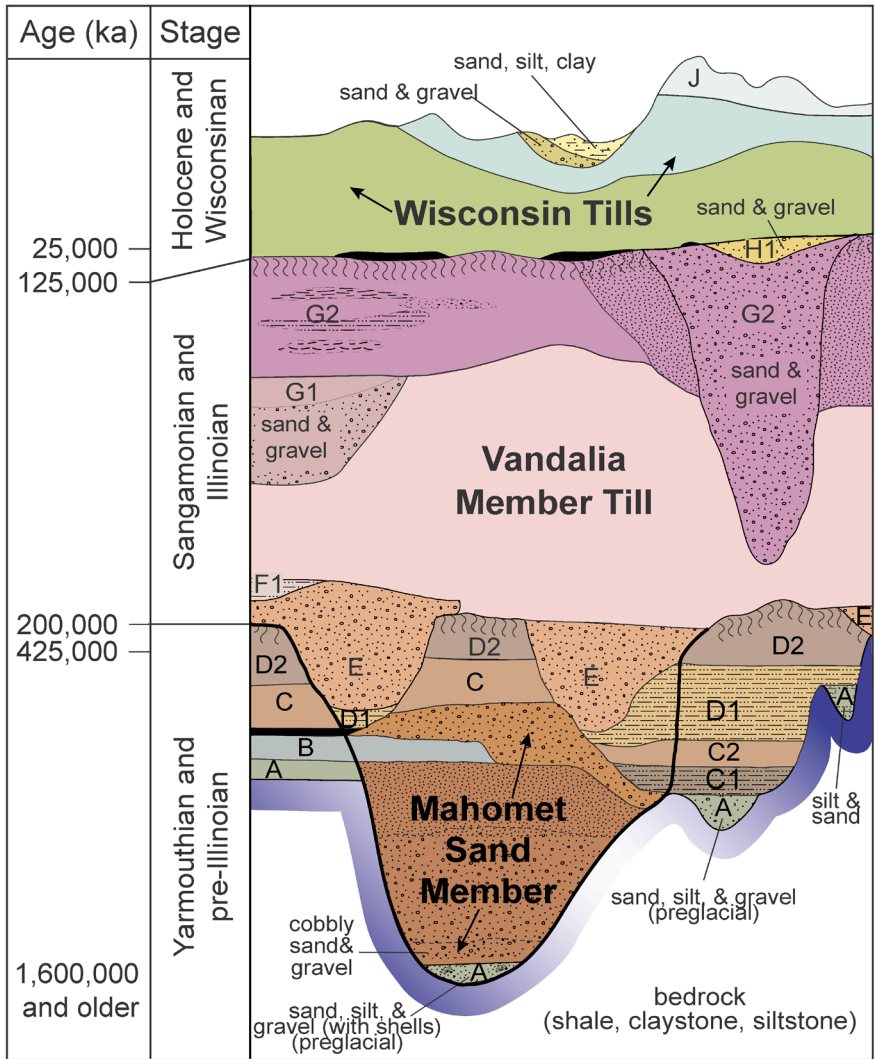


Champaign County and adjacent area (Stumpf et al., in review) 40 boreholes

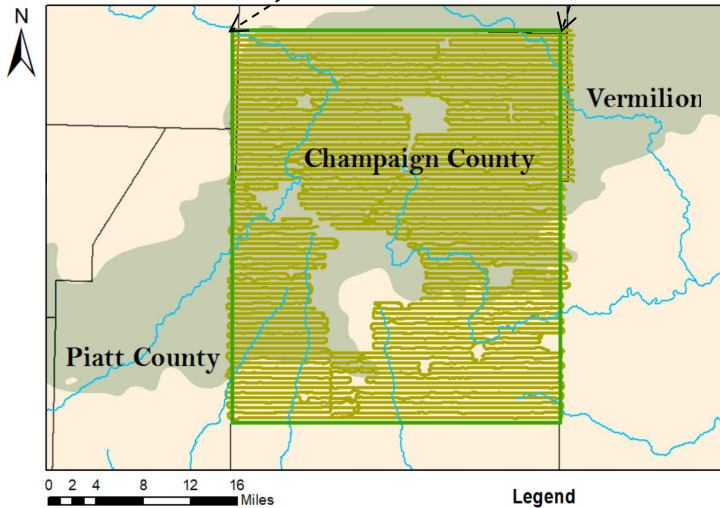
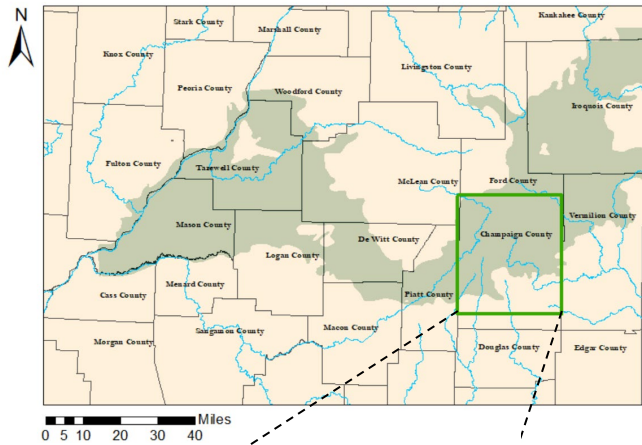




# Problem



# Project Goals

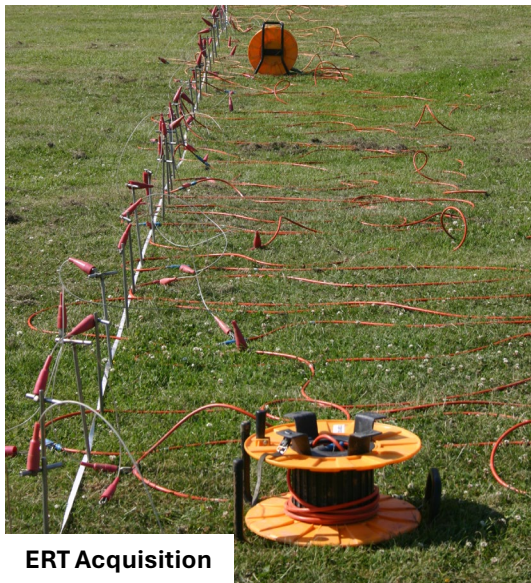


- 1. Improve delineation of the Mahomet aquifer boundary**
  - Aquifer boundary
  - Aquifer characteristics
- 2. Better define extent of aquifer and non-aquifer units**
  - Define characteristics of the aquifer and non-aquifer materials
  - Bedrock lithology (shale, carbonate, both?)
  - Bedrock structures (folds, faults, etc)
  - Bedrock surface topography
- 3. Develop a 3-D geological model of the Champaign County and create an updated geological framework**
- 4. Provide the Illinois State Water Survey with geologic information for use in developing a groundwater flow model.**

# Integrated Approach - Methods



HTEM Acquisition



ERT Acquisition



ISGS drilling rig system



HVSR Acquisition



Describing core



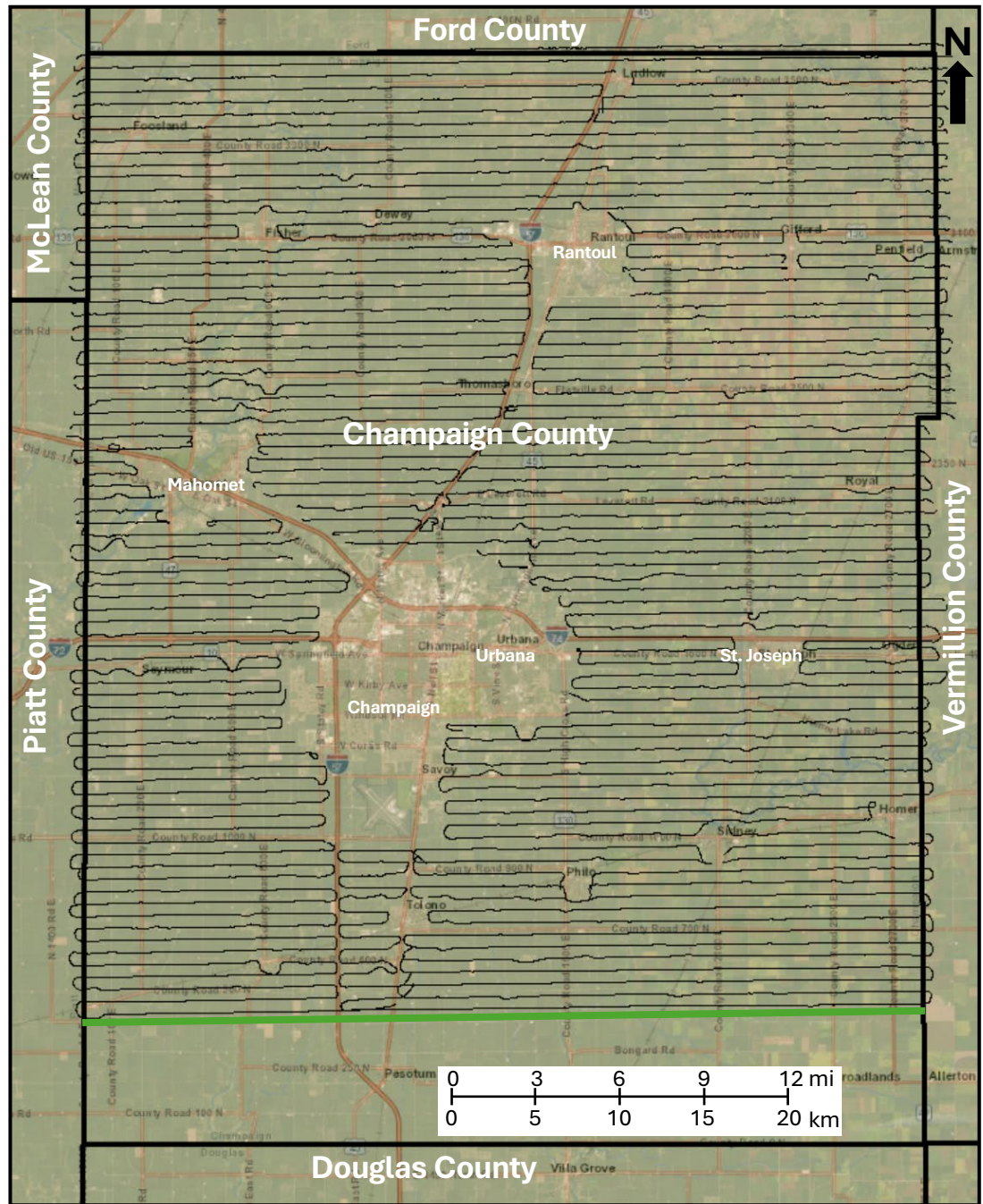
Partial Core



# Acquired HTEM Data

Acquired highest resolution HTEM data

- E-W transects
- ~ 3,145 km (1,954 miles) of HTEM
- 650 m (2132 ft) flight line spacing
- DOI ~300 meters (1000 feet)





# Other Acquired Data

## 1. ERT Data

- 6.9 km (4.3 miles) of ERT data

## 2. Seismic Data

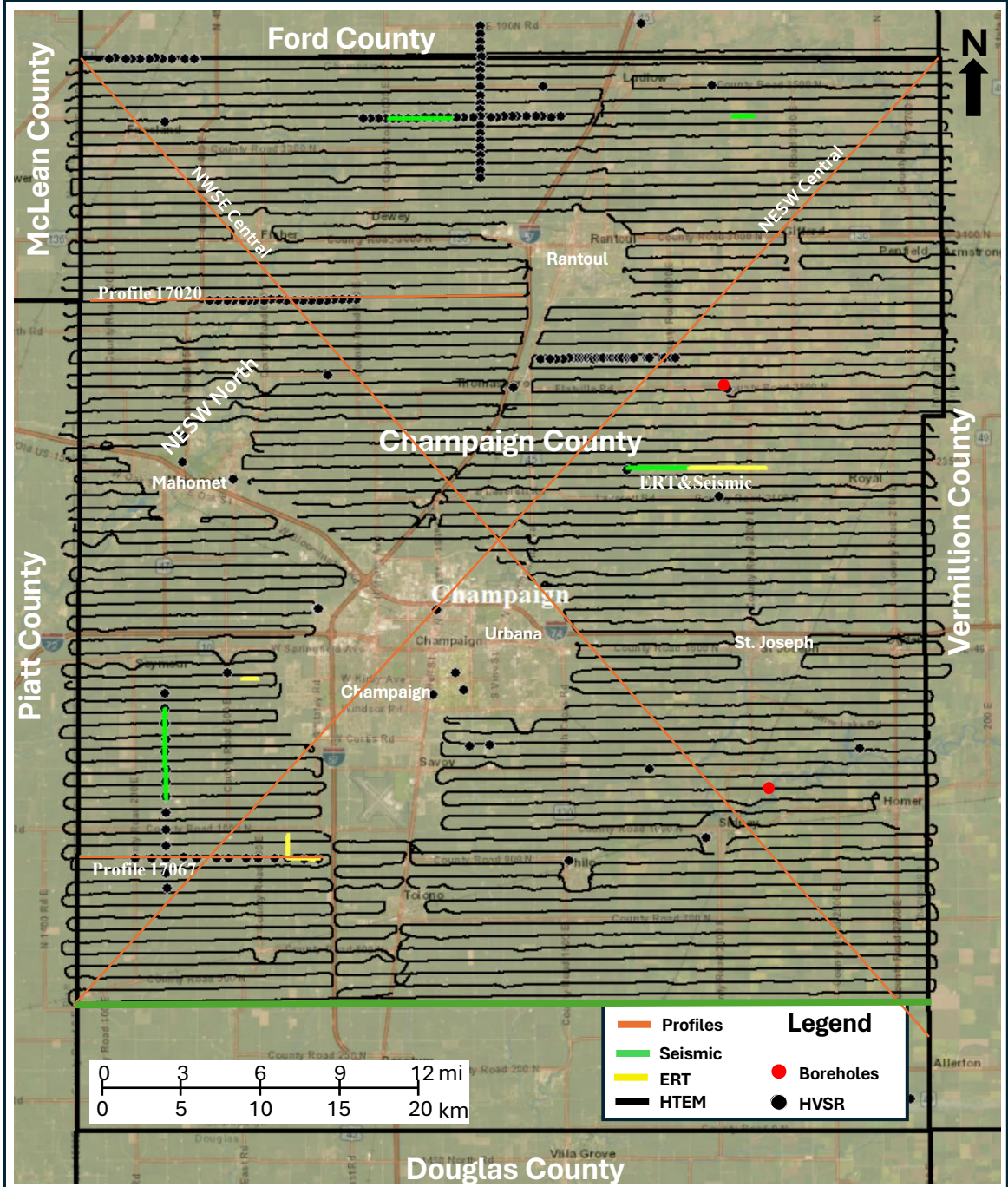
- 15.66 km (9.72 miles) of seismic reflection data

## 3. HVSr Data

- 180 HVSr points

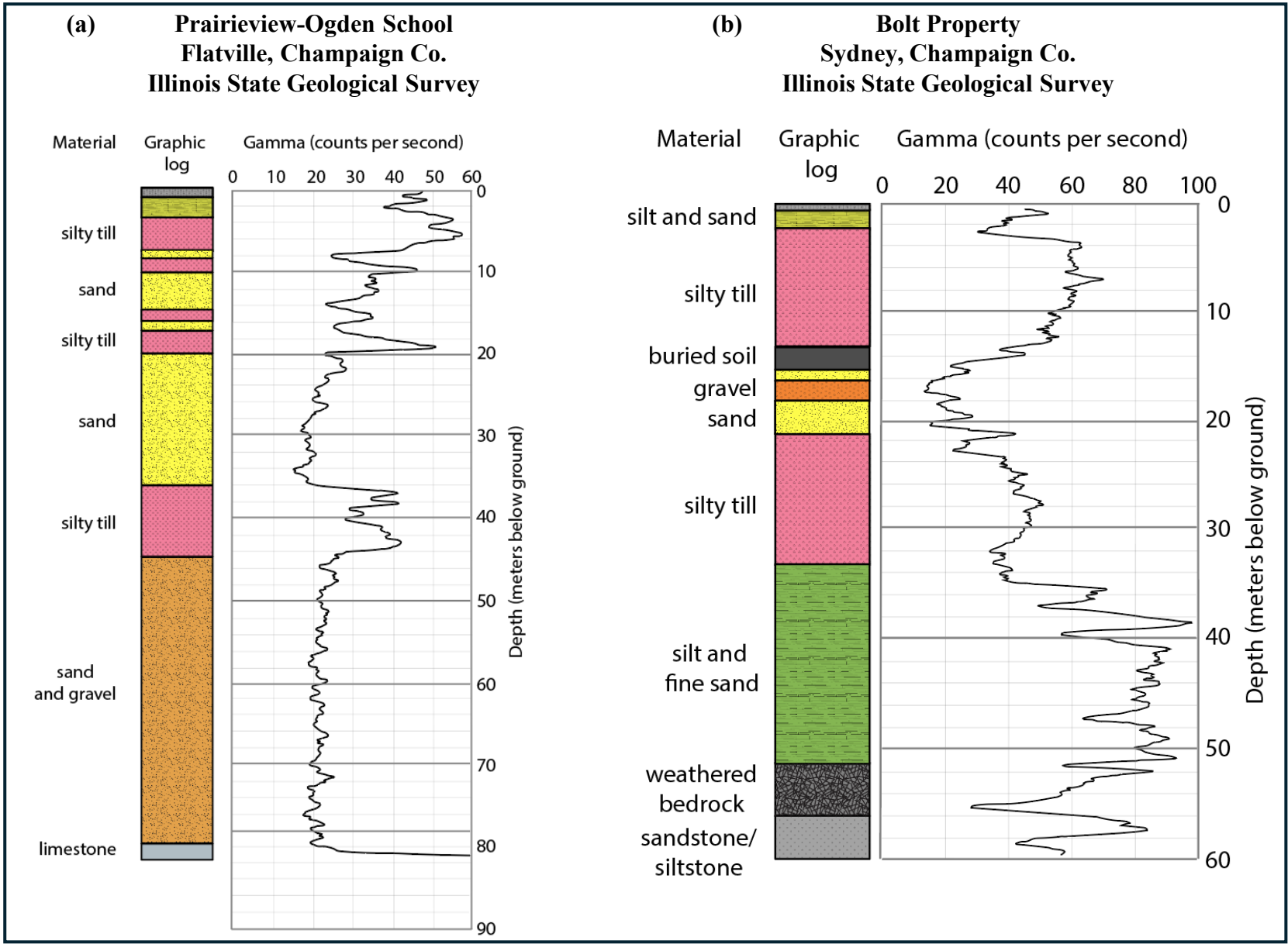
## 4. Boreholes

- 2 Boreholes



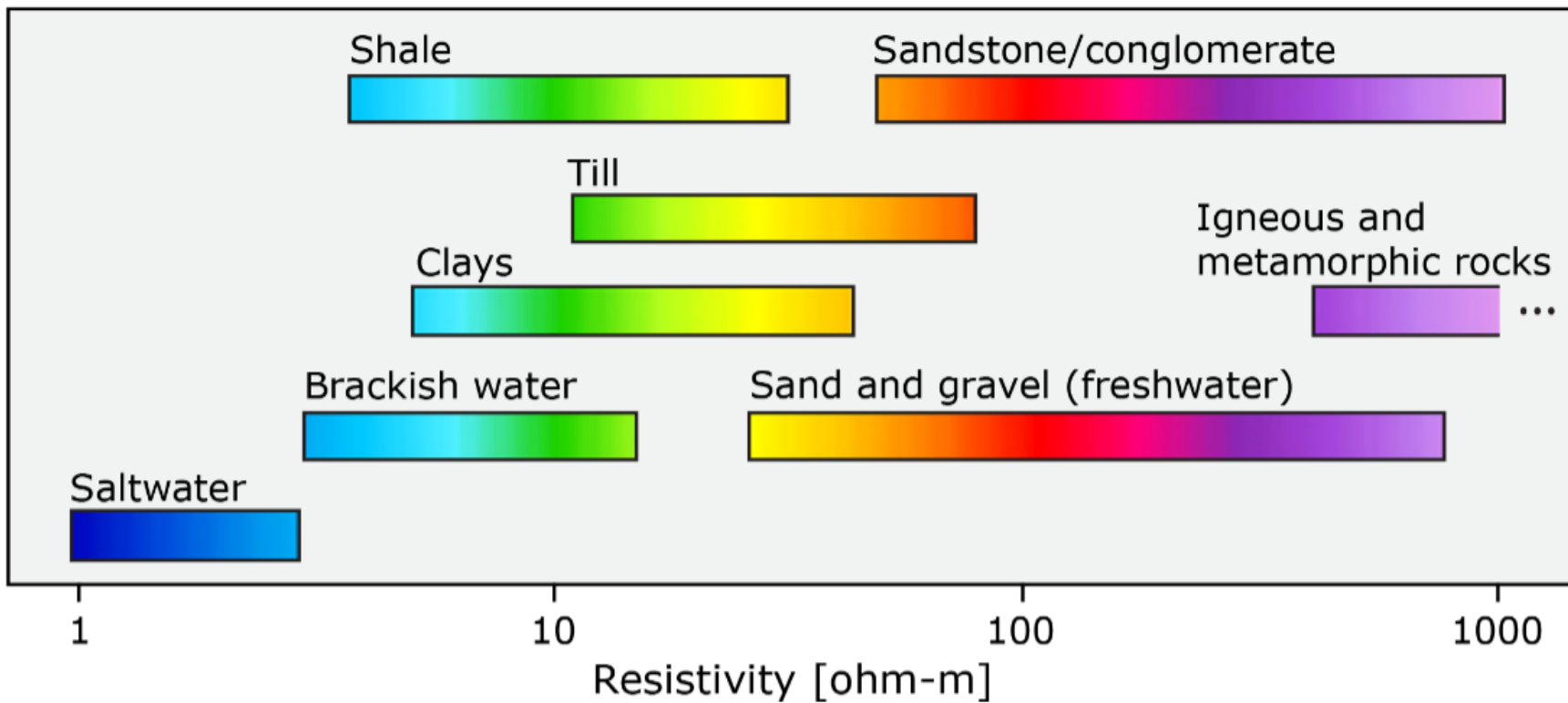


# Drilling Results



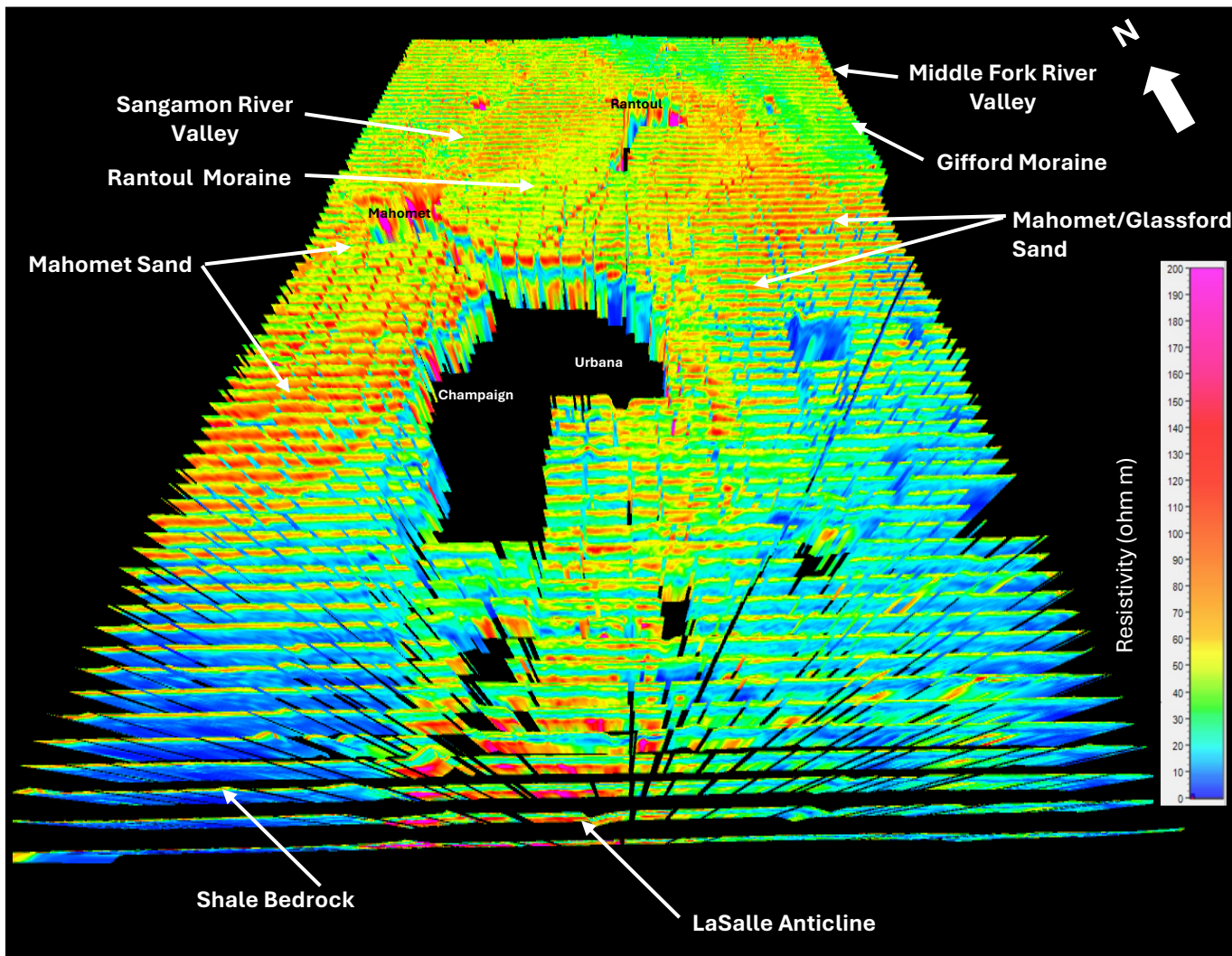


# Resistivity of Geologic Materials



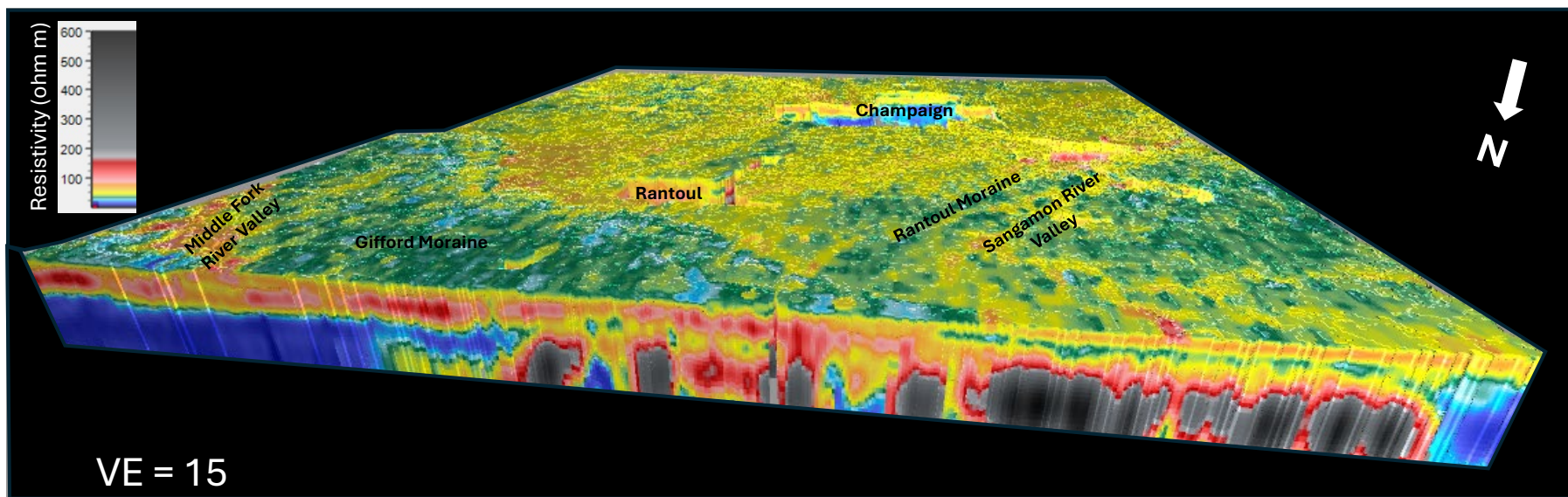


# HTEM Results – Fence Diagram



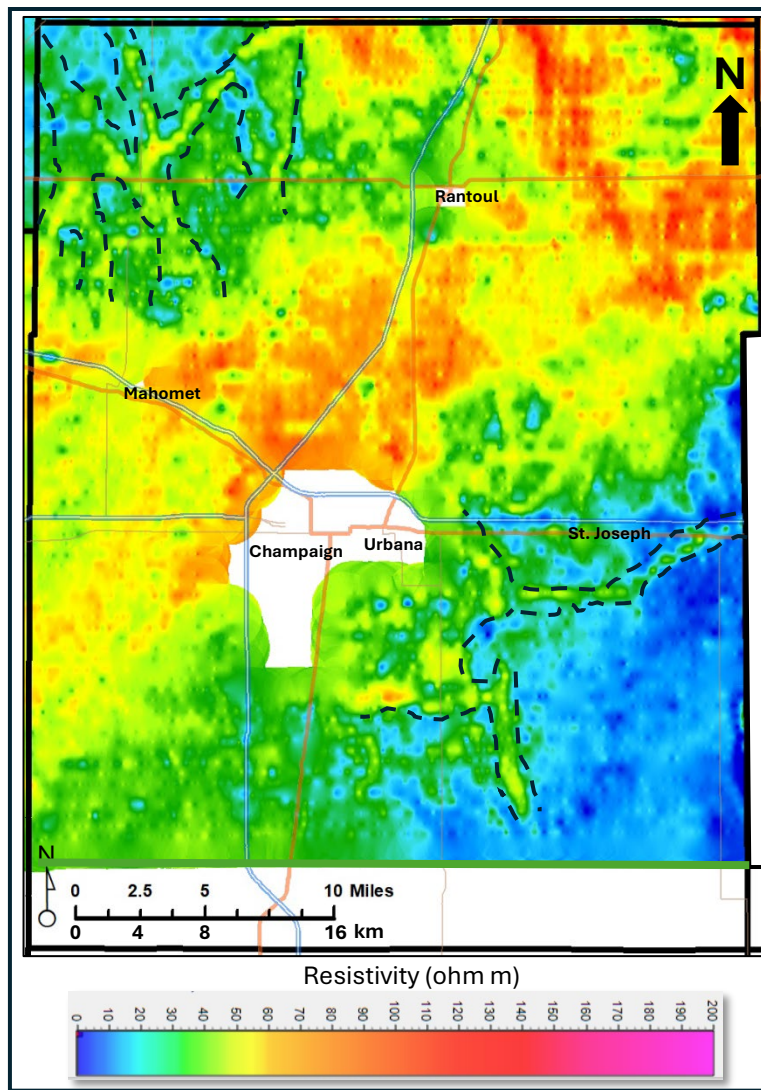


# HTEM Results - 3-D Cube

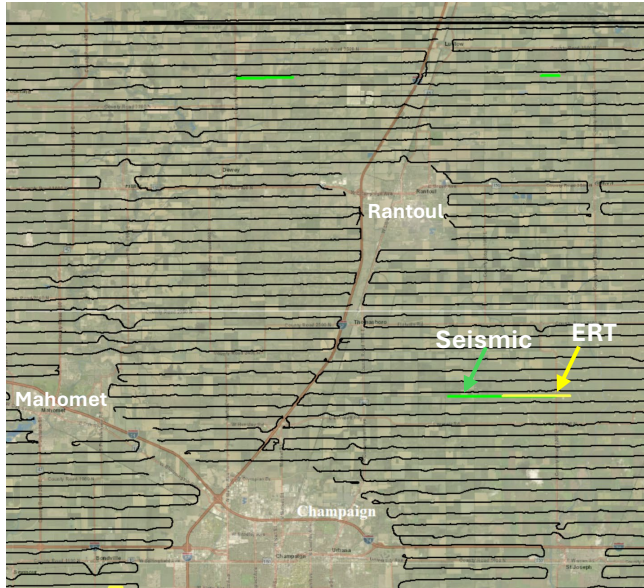




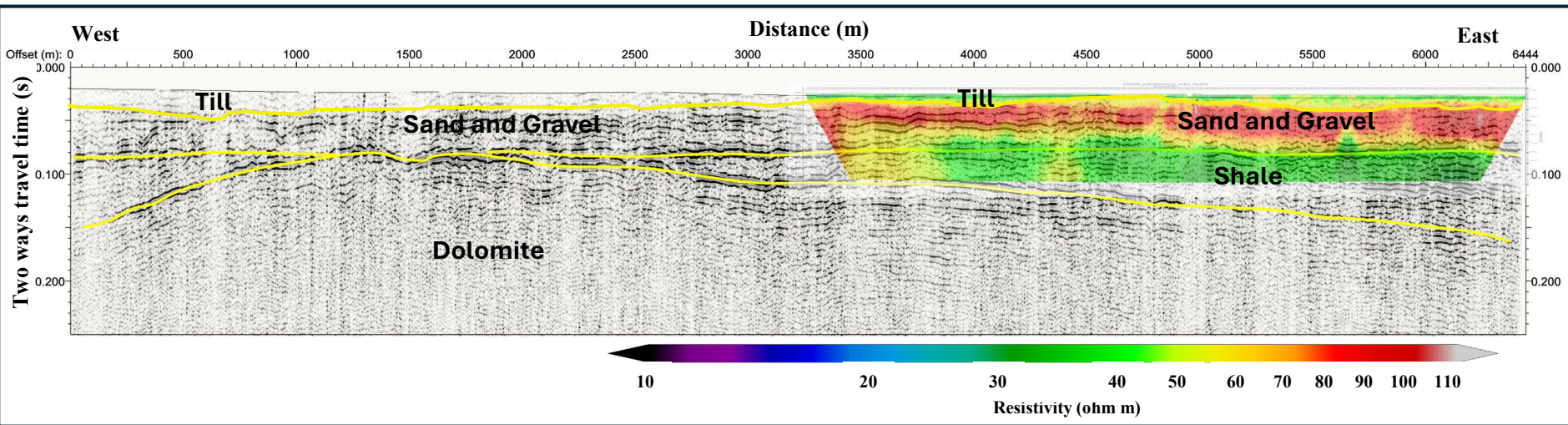
# HTEM Results – Horizontal Slice



# HTEM Results on Seismic Cross Section

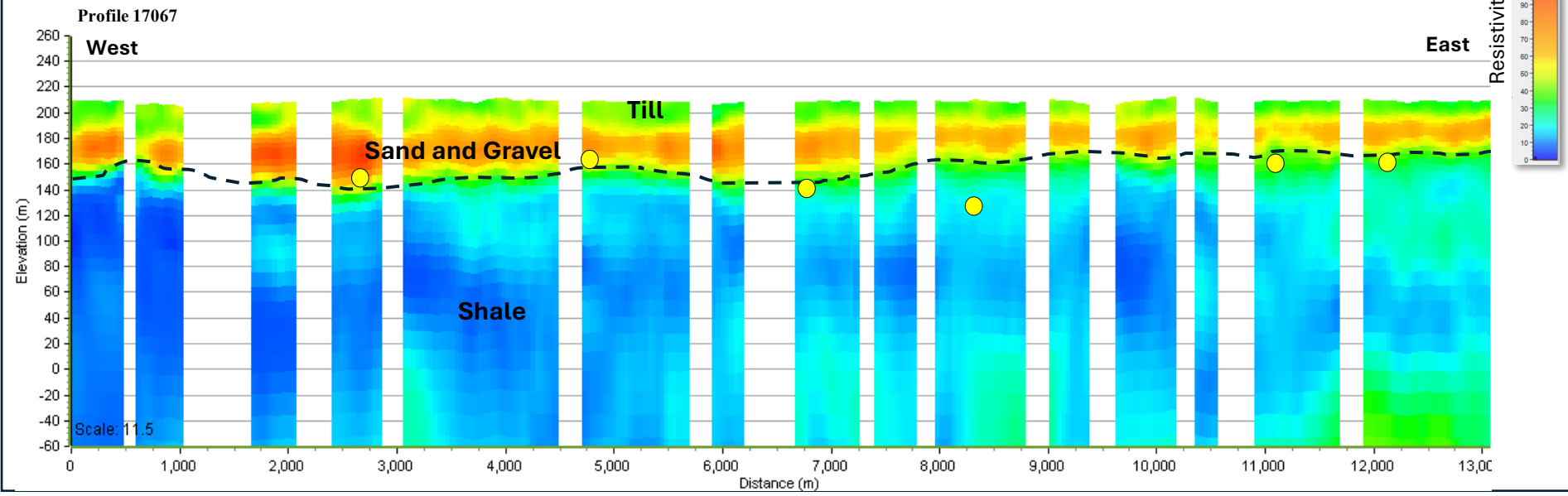
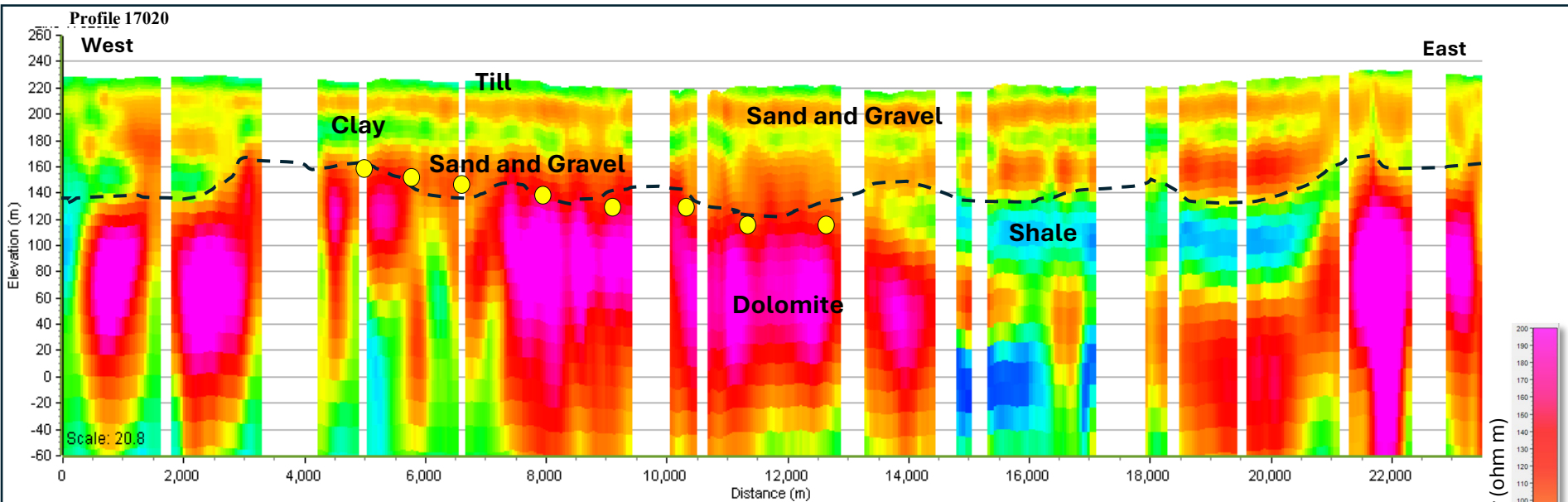


- ERT is limited in the depth of investigation compared to Seismic surveys
- Imaged four seismic units and three ERT units
- Folded strata associated with the LaSalle Anticlinorium





# HTEM and HVSR Results





# Electro Units to Material Type

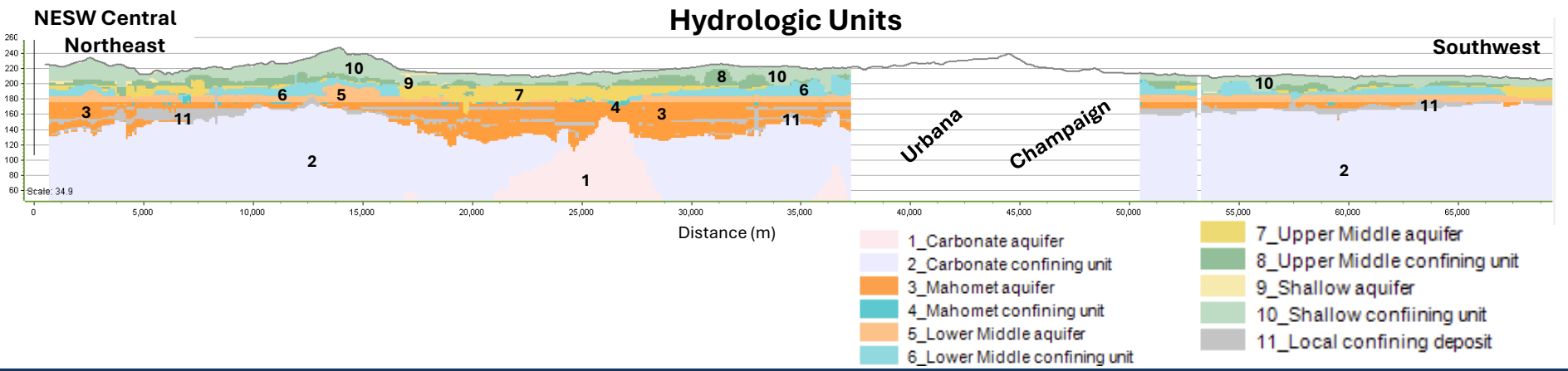
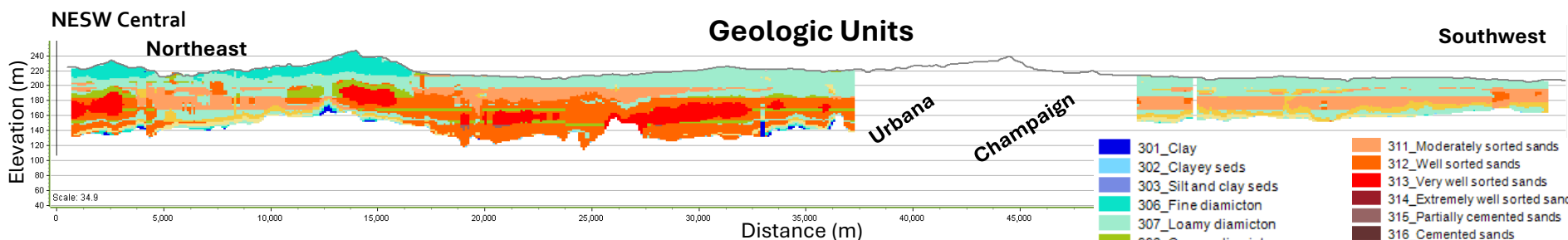
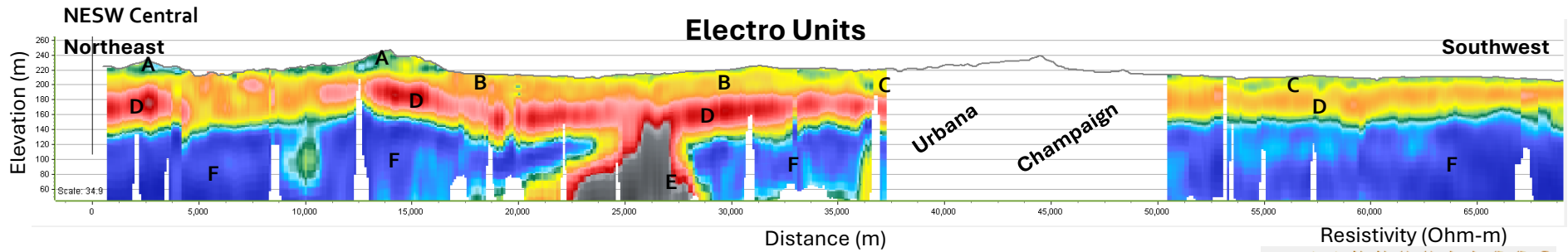


Resistivity Range (ohm m)	Lithologic Material Type	Hydrologic Material Type
1 - 15	Shale	Shale Confining Unit
15 - 20	Clay; Shale; Weathered Shale	Clayey Confining Unit; Shale Confining Unit
20 - 35	Clay; Clayey Sediments; Silt and Clay Sediments; Fine Diamicton; Loamy Diamicton; Weathered Shale	Clayey Confining Unit; Shale Confining Unit
35 - 45	Silt and Clay Sediments; Fine Diamicton; Loamy Diamicton; Very Poorly Sorted Sands; Weathered Shale	Clayey Confining Unit; Leaky Clayey Confining Unit; Shale Confining Unit
45 - 55	Silty Sediments; Loamy Diamicton; Poorly Sorted Sands; Coarse Diamicton; Weathered Shale	Clayey Confining Unit; Leaky Clayey Confining Unit; Shale Confining Unit
55 - 120	Silty Sediments; Silt; Loamy Diamicton; Coarse Diamicton; Moderately Sorted Sands; Well Sorted Sands; Weathered Carbonate	Clayey Confining Unit; Leaky Clayey Confining Unit; Sandy Aquifer; Carbonate Aquifer
120 - 600	Silt; Very Well Sorted Sands; Extremely Well Sorted Sands; Partially Cemented Sands; Cemented Sands; Weathered Carbonate; Carbonate	Clayey Confining Unit; Sandy Aquifer; Carbonate Aquifer
>600	Cemented Sands; Carbonate	Carbonate Aquifer





# Material Type Conversion



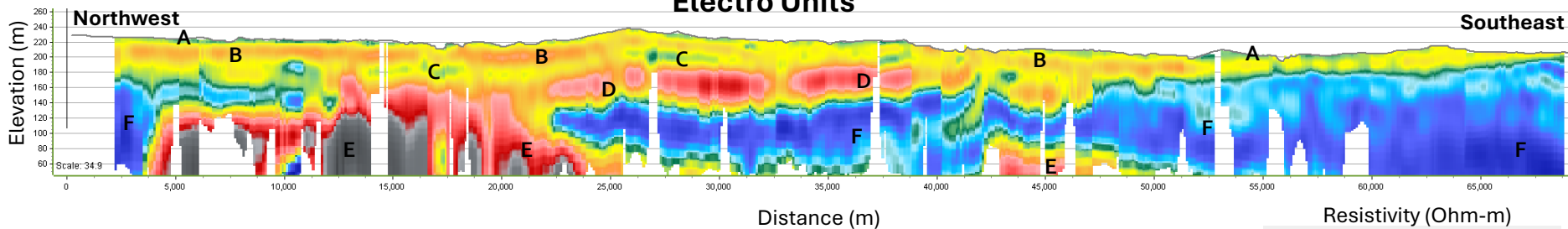


# Material Type Conversion



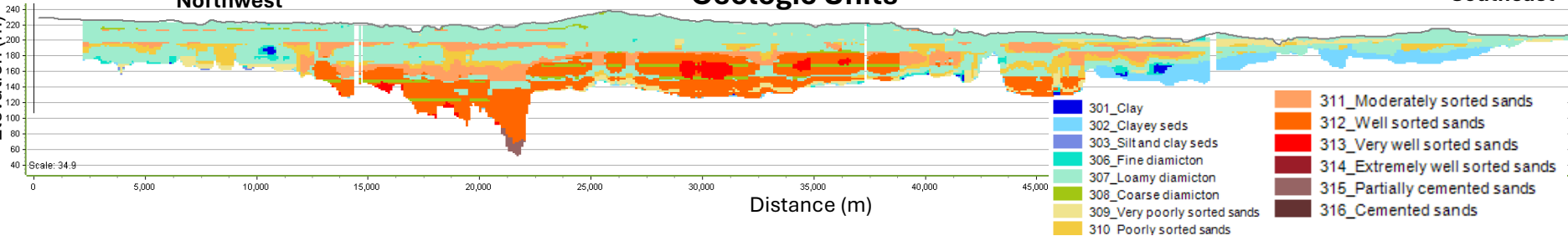
NWSE Central

## Electro Units

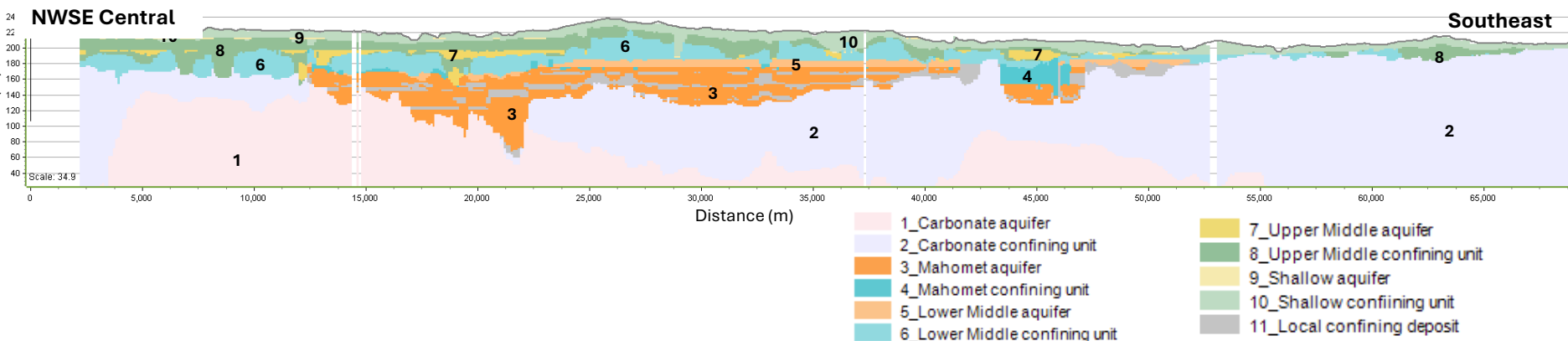


NWSE Central

## Geologic Units

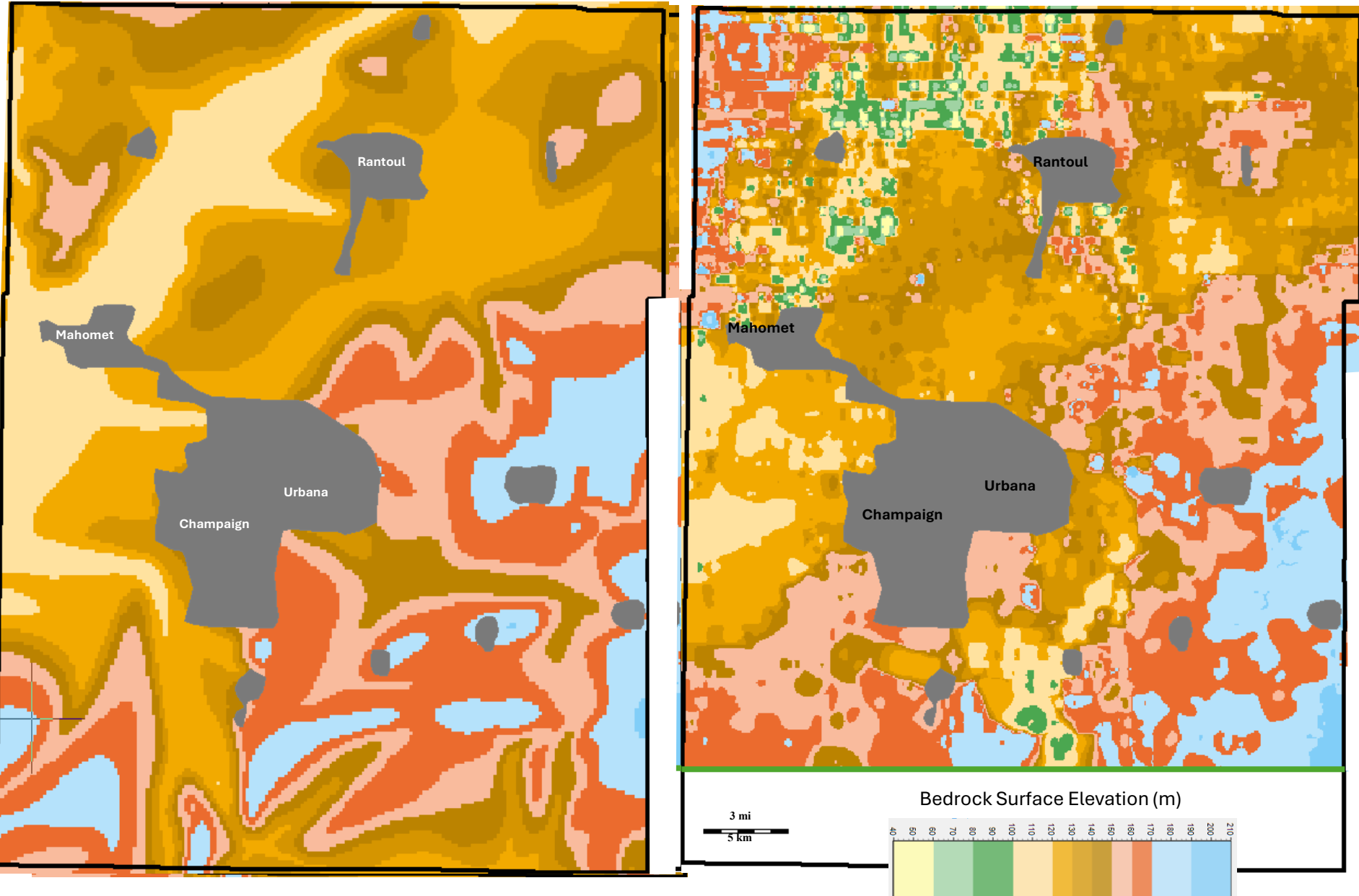


## Hydrologic Units



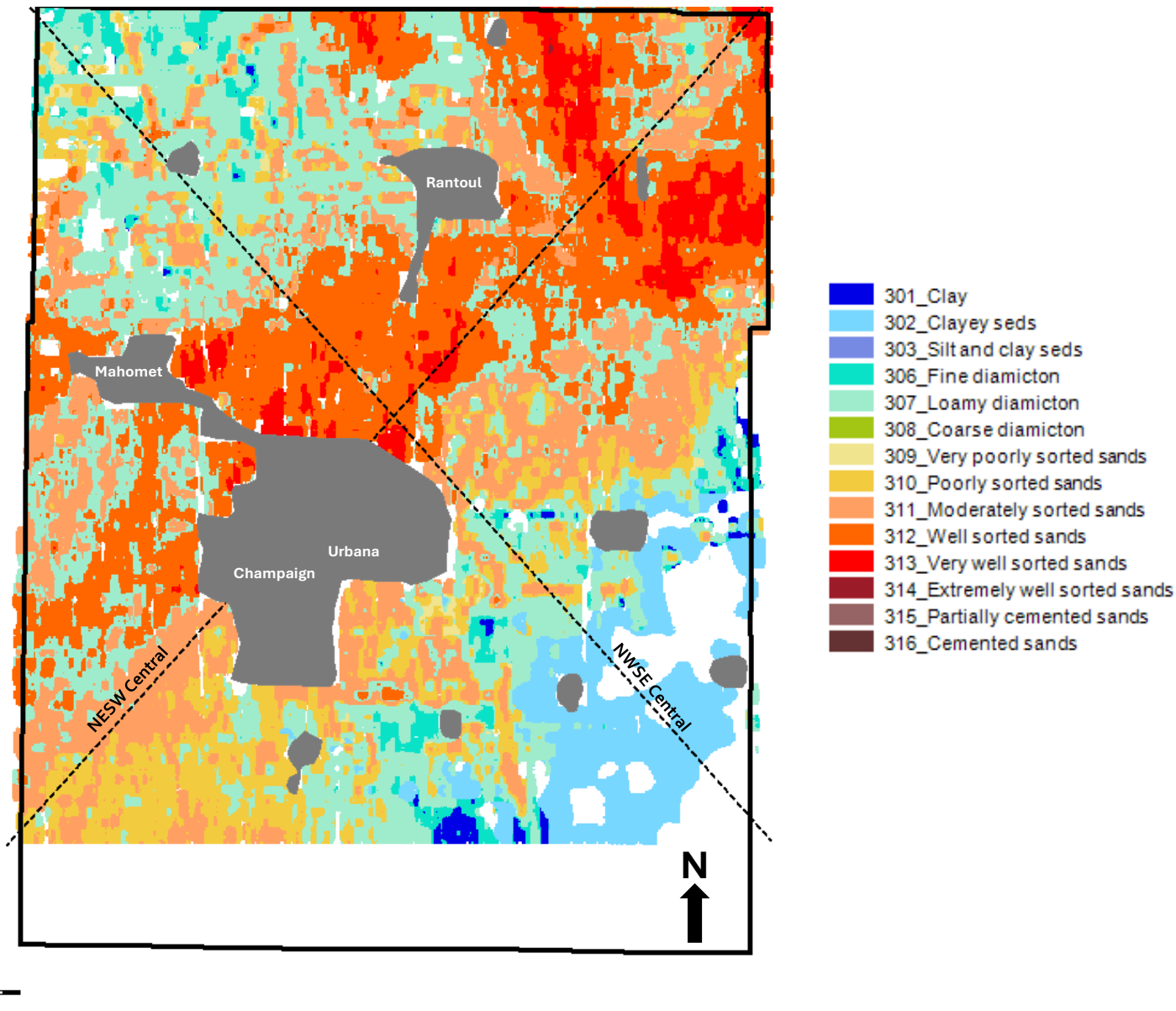


# Bedrock Topography



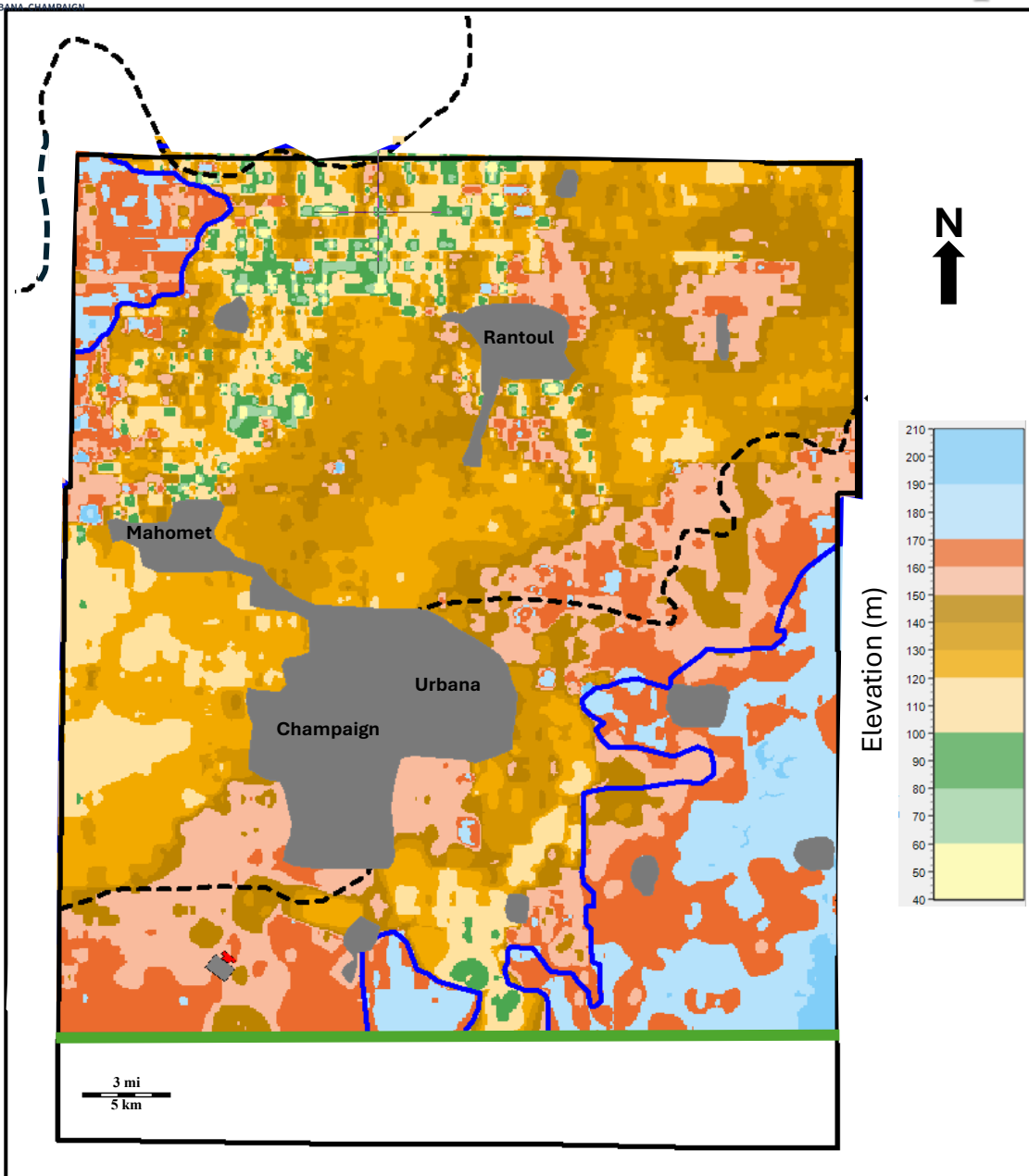


# Extent of the Mahomet Aquifer





# Extent of the Mahomet Aquifer



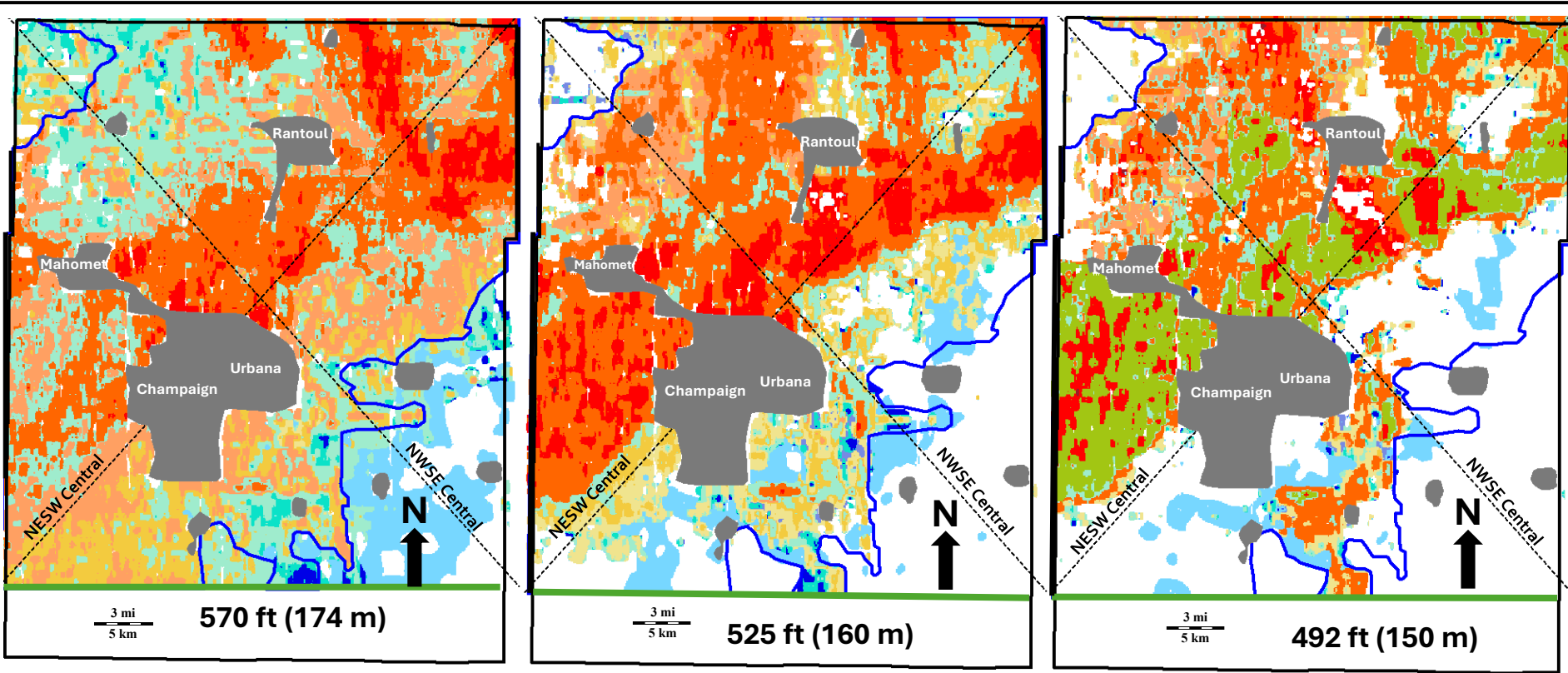
Roadcap, 2011 Boundary

HTEM Boundary





# Distribution of Geologic Material

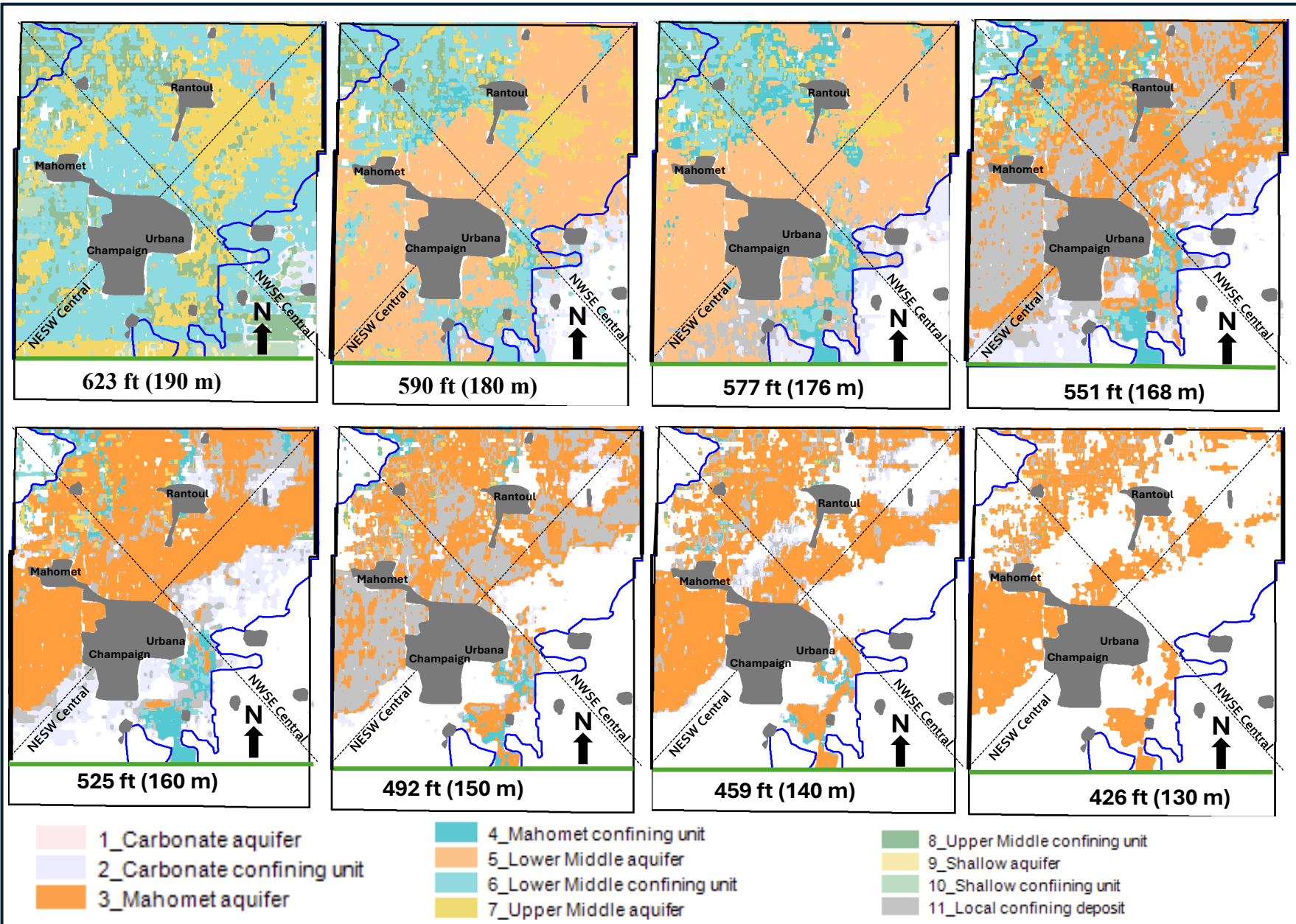


- |                        |                              |                             |                                 |
|------------------------|------------------------------|-----------------------------|---------------------------------|
| 301_Clay               | 307_Loamy diamicton          | 310_Poorly sorted sands     | 314_Extremely well sorted sands |
| 302_Clayey seds        | 308_Coarse diamicton         | 311_Moderately sorted sands | 315_Partially cemented sands    |
| 303_Silt and clay seds | 309_Very poorly sorted sands | 312_Well sorted sands       | 316_Cemented sands              |
| 306_Fine diamicton     |                              | 313_Very well sorted sands  |                                 |





# Distribution of Aquifer and Non-Aquifer Units



623 ft (190 m)

590 ft (180 m)

577 ft (176 m)

551 ft (168 m)

525 ft (160 m)

492 ft (150 m)

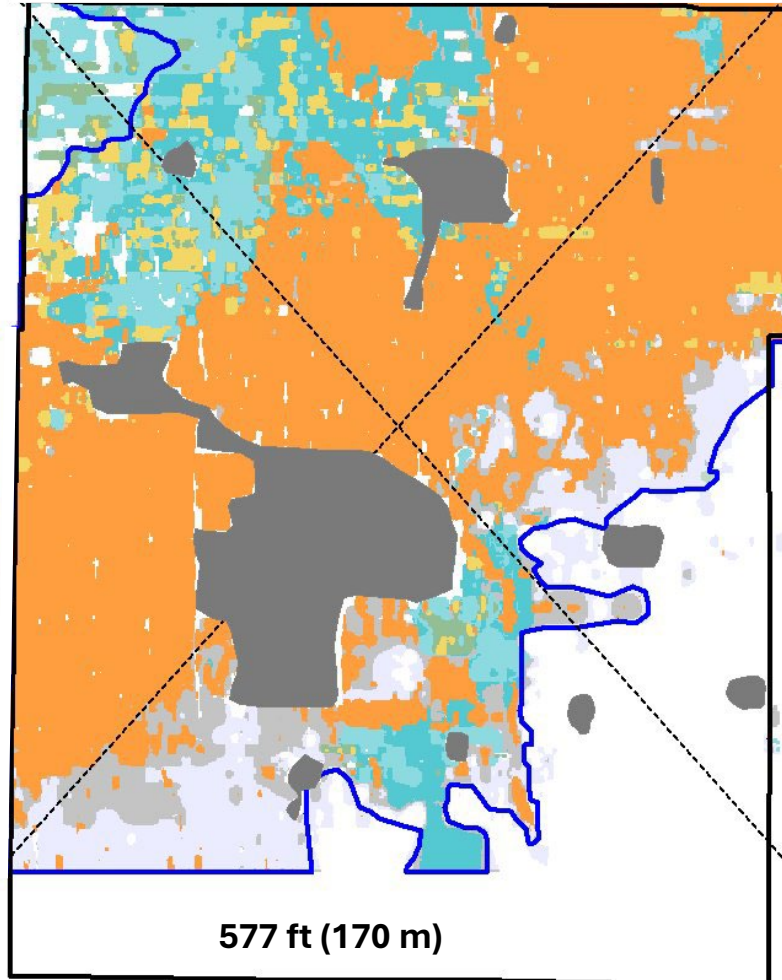
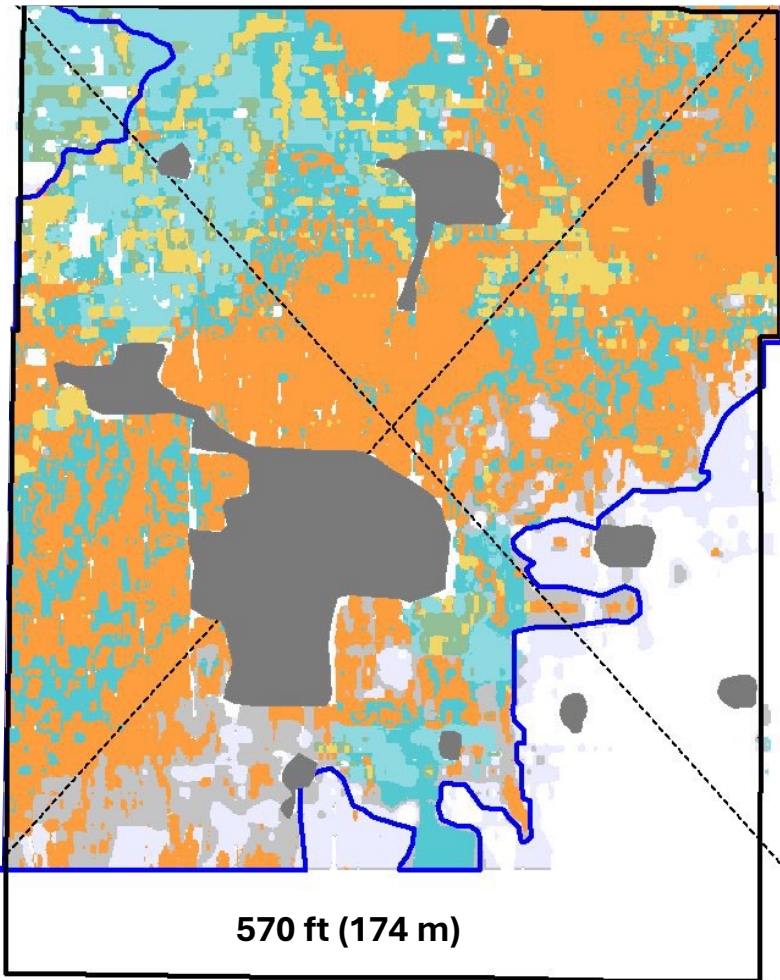
459 ft (140 m)

426 ft (130 m)





# Distribution of Aquifer and Non-Aquifer Units



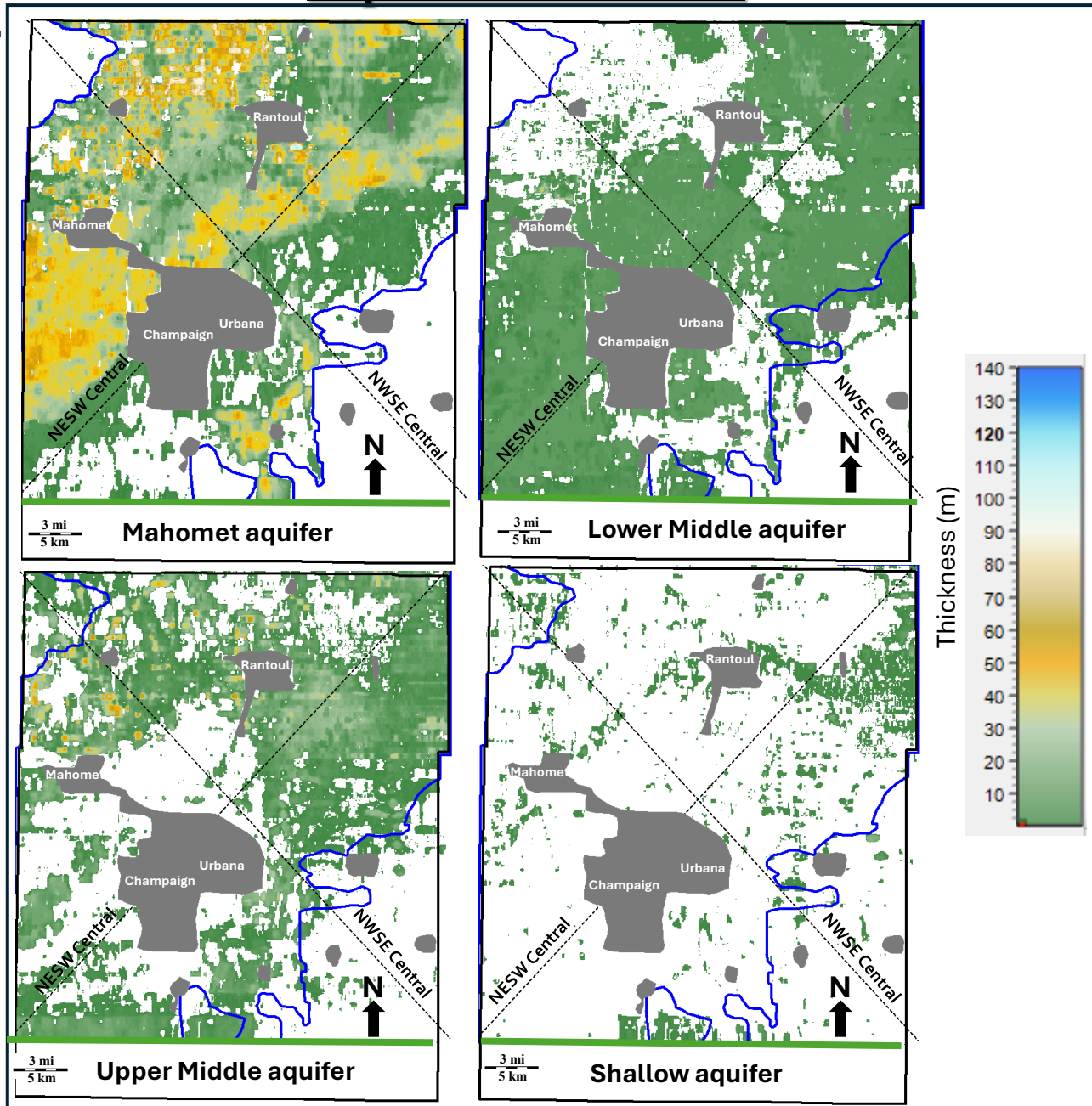
- 1\_Carbonate aquifer
- 2\_Carbonate confining unit
- 3\_Mahomet aquifer
- 4\_Mahomet confining unit
- 5\_Lower Middle aquifer

- 6\_Lower Middle confining unit
- 7\_Upper Middle aquifer
- 8\_Upper Middle confining unit
- 9\_Shallow aquifer
- 10\_Shallow confining unit
- 11\_Local confining deposit



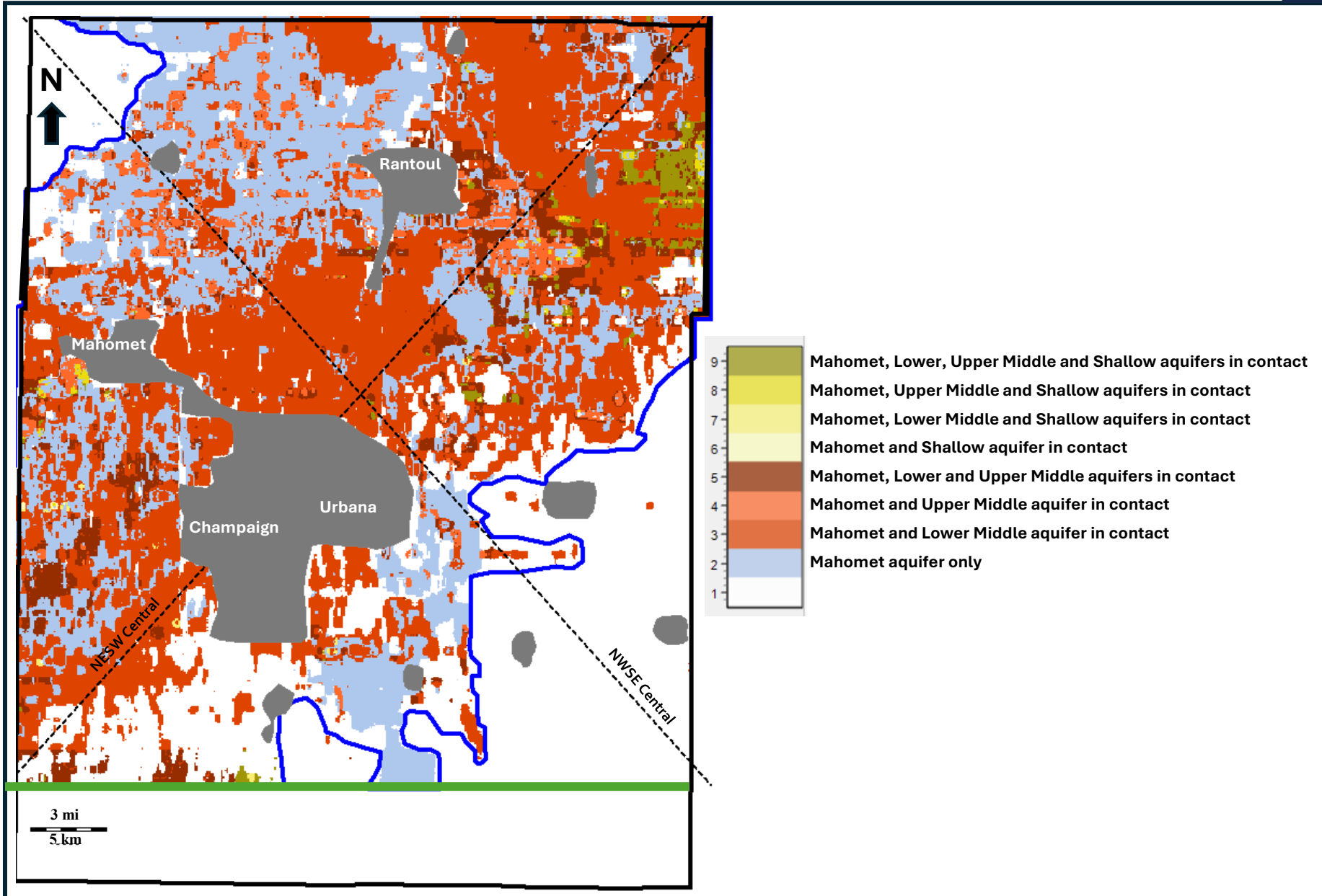


# Aquifer Thickness



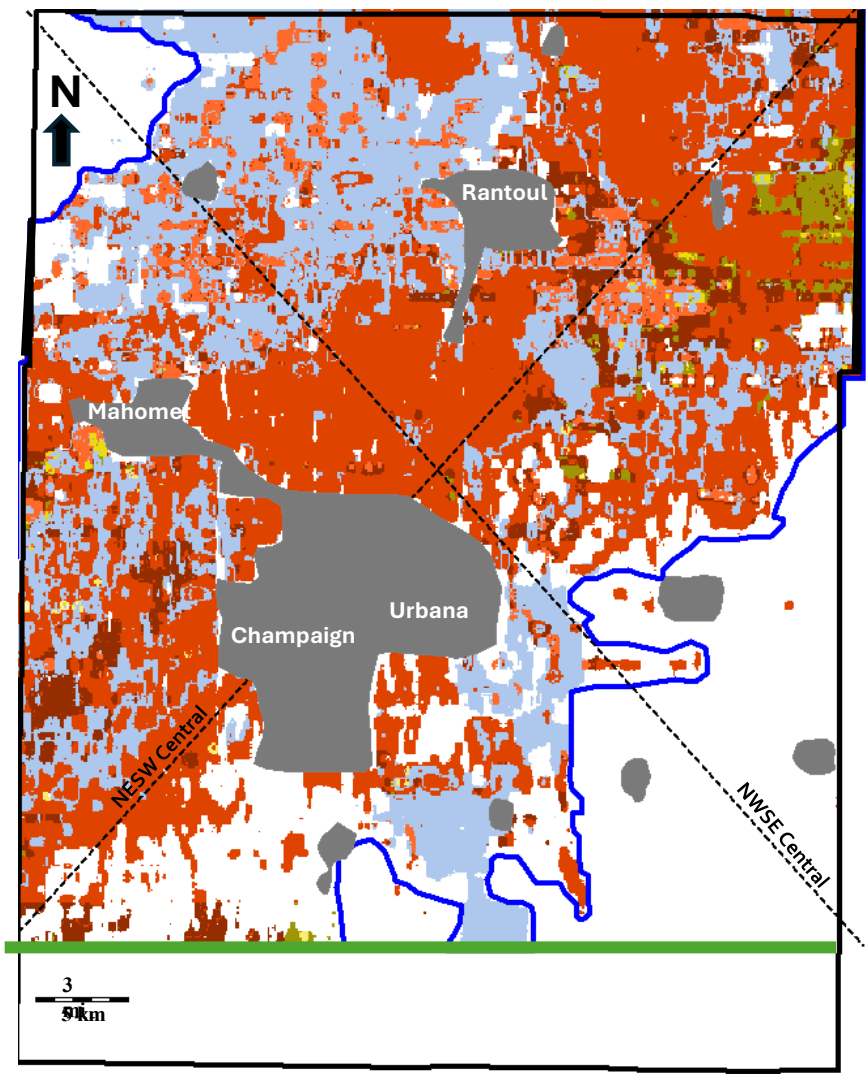
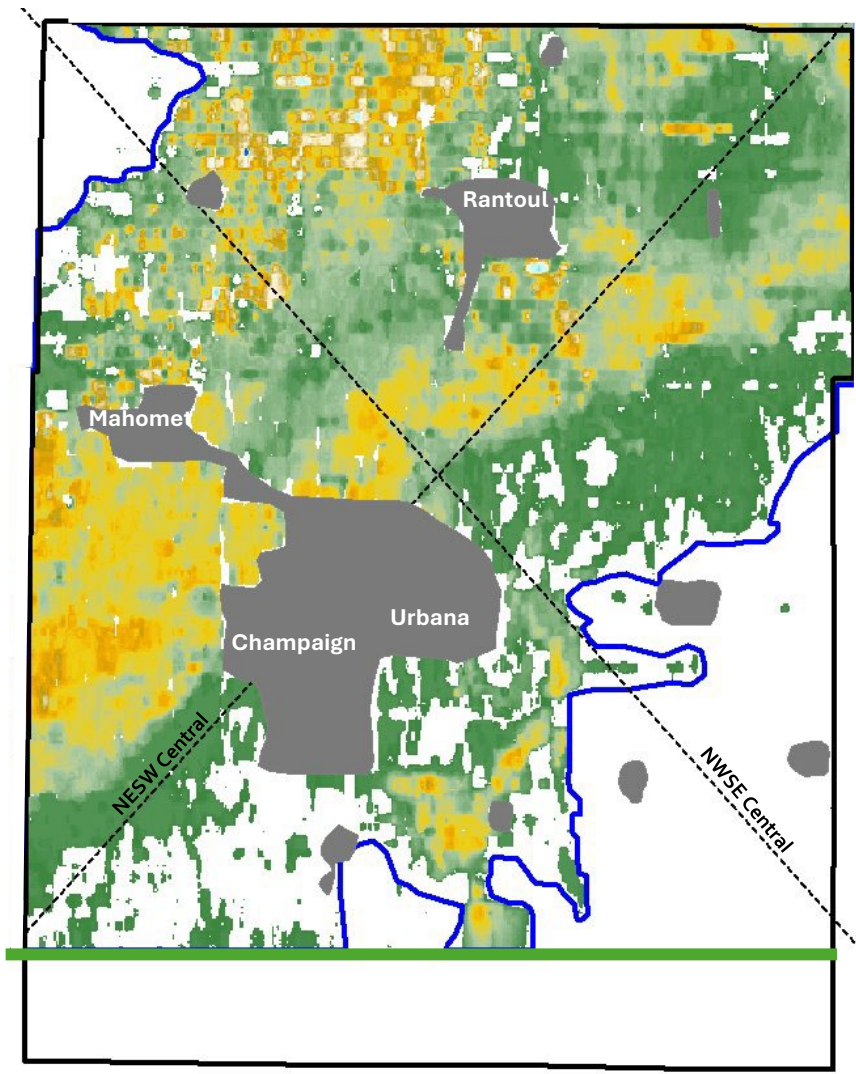


# Aquifer Connectivity

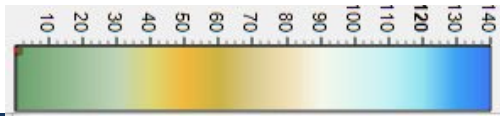




# Mahomet Thickness and Connectivity



Thickness (m)

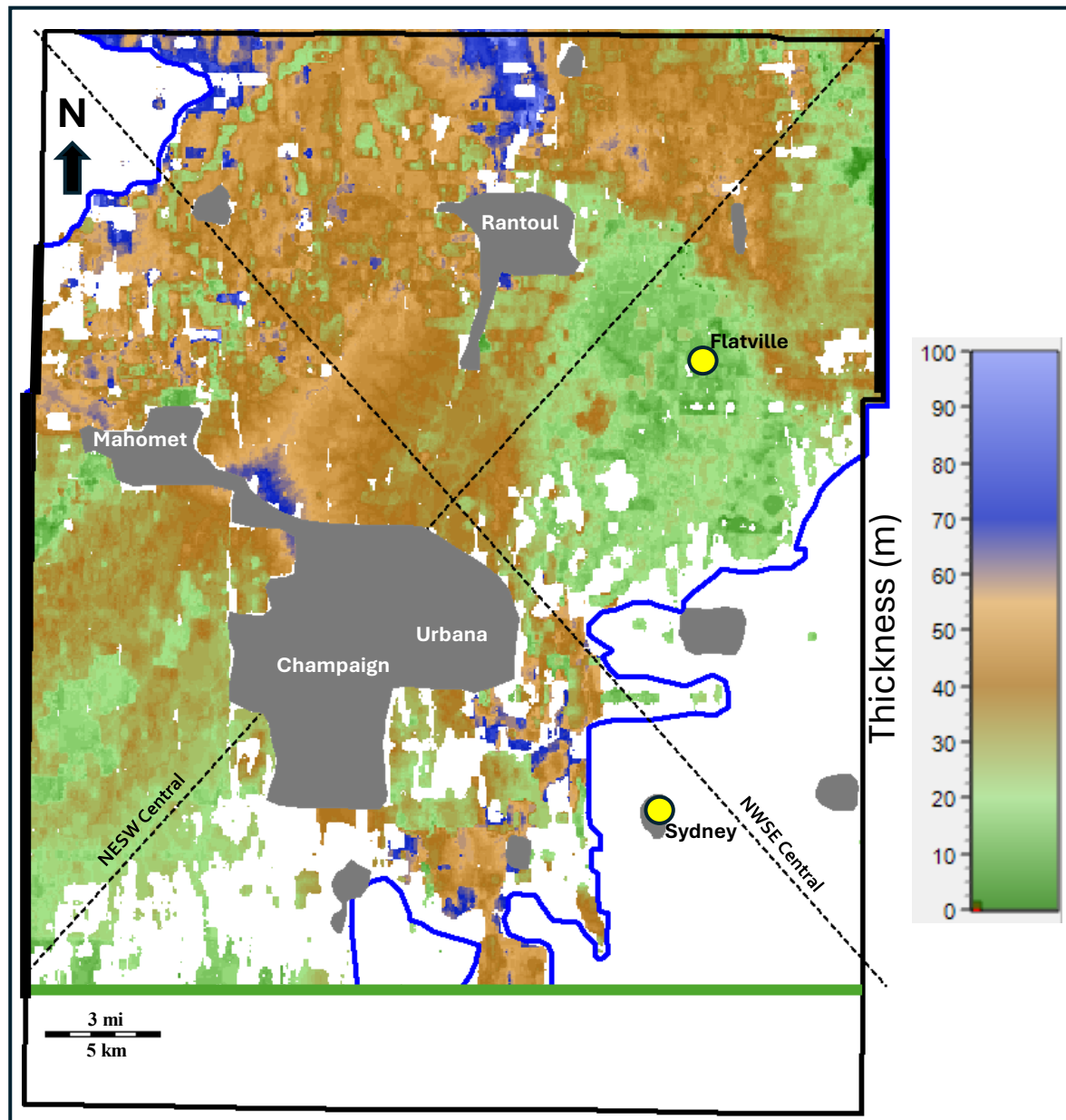


- Mahomet aquifer only
- Mahomet and Lower Middle aquifer in contact

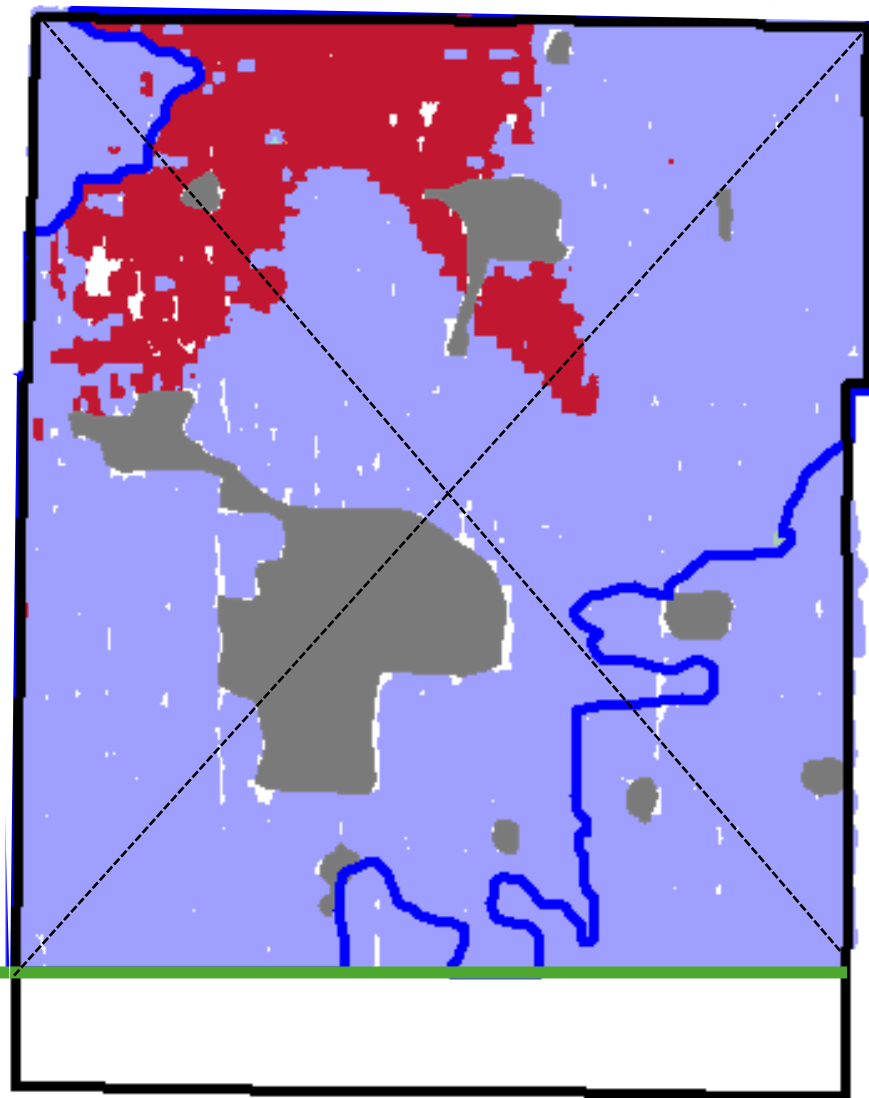















# Thickness of Confining Unit



# Distribution of Bedrock Units

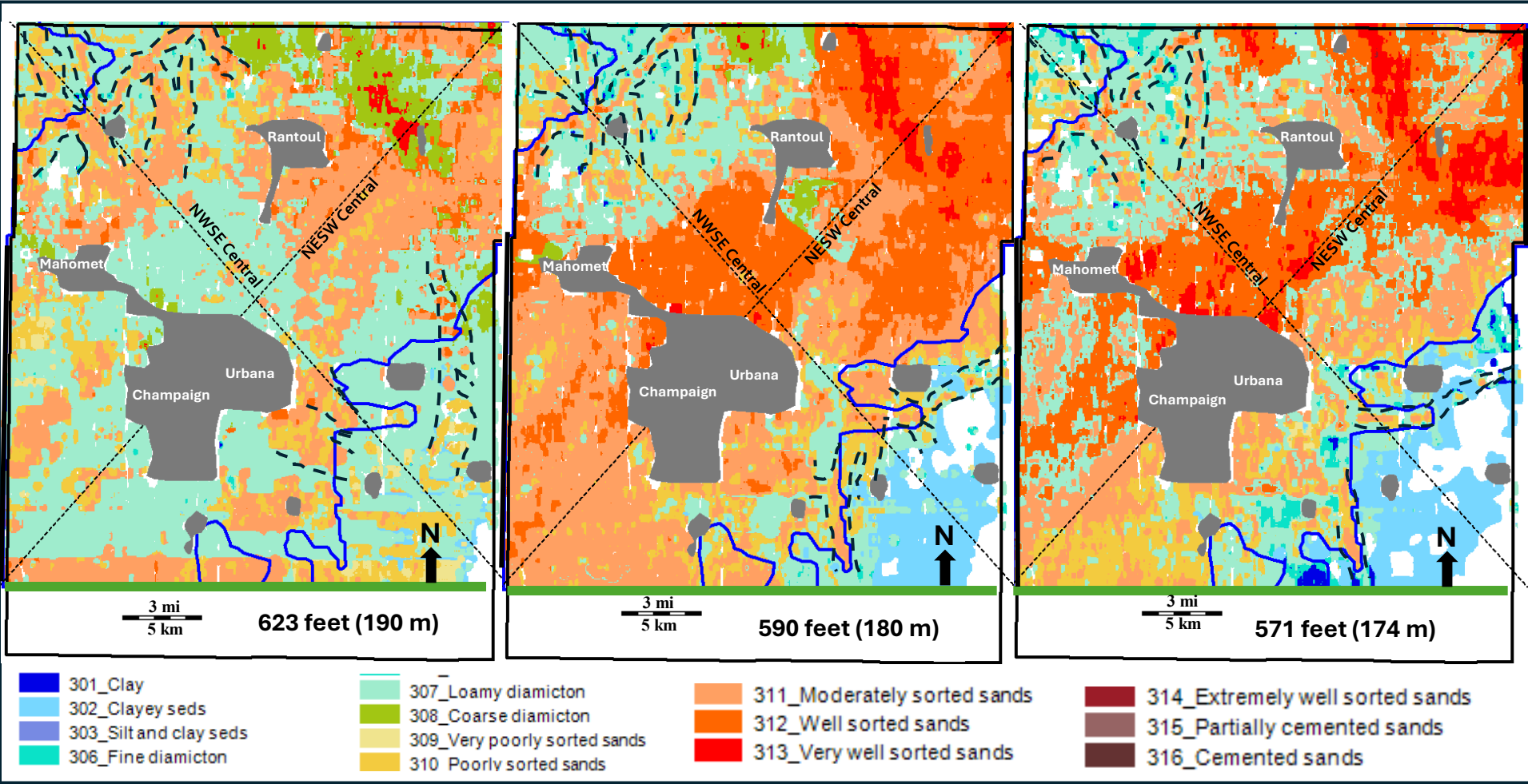


-  1\_Carbonate aquifer
-  2\_Carbonate confining unit
-  3\_Mahomet aquifer
-  4\_Mahomet confining unit
-  5\_Lower Middle aquifer
-  6\_Lower Middle confining unit
-  7\_Upper Middle aquifer
-  8\_Upper Middle confining unit
-  9\_Shallow aquifer
-  10\_Shallow confining unit
-  11\_Local confining deposit

5000

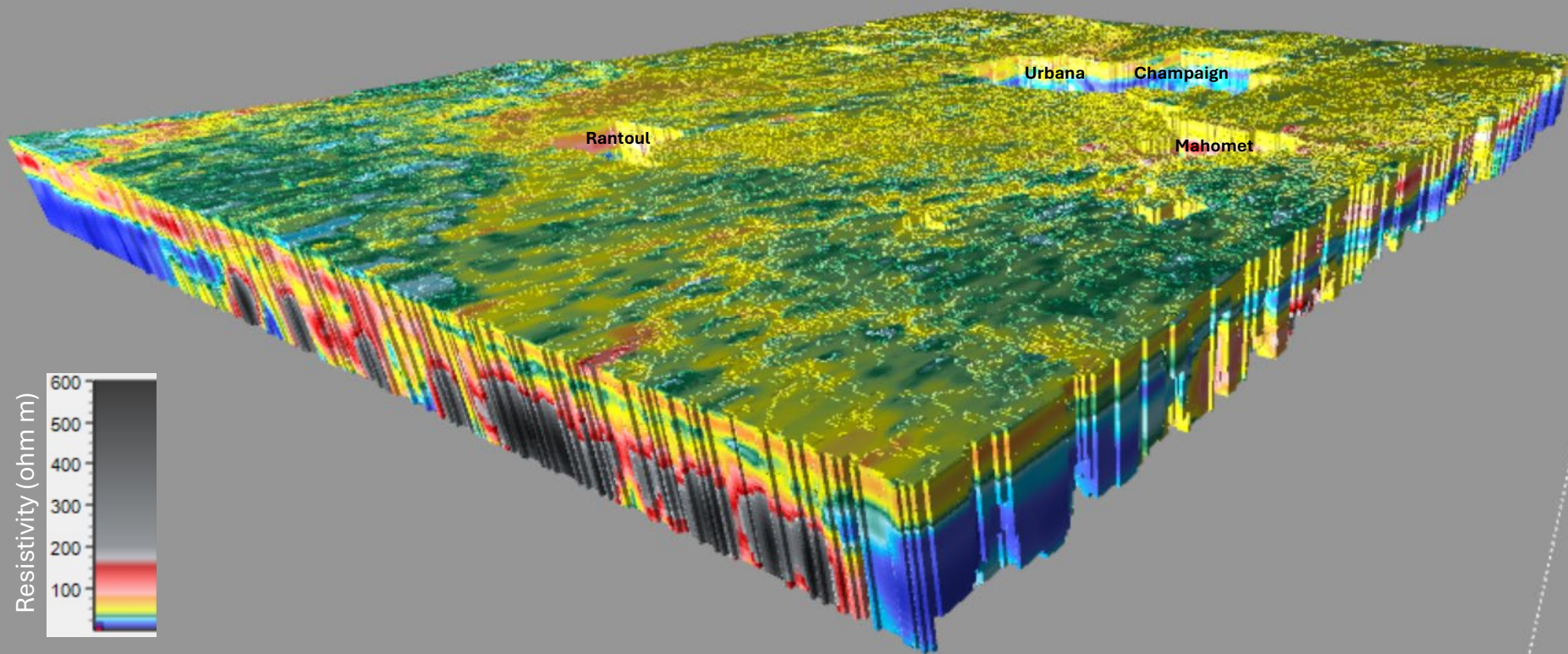


# Buried Channels



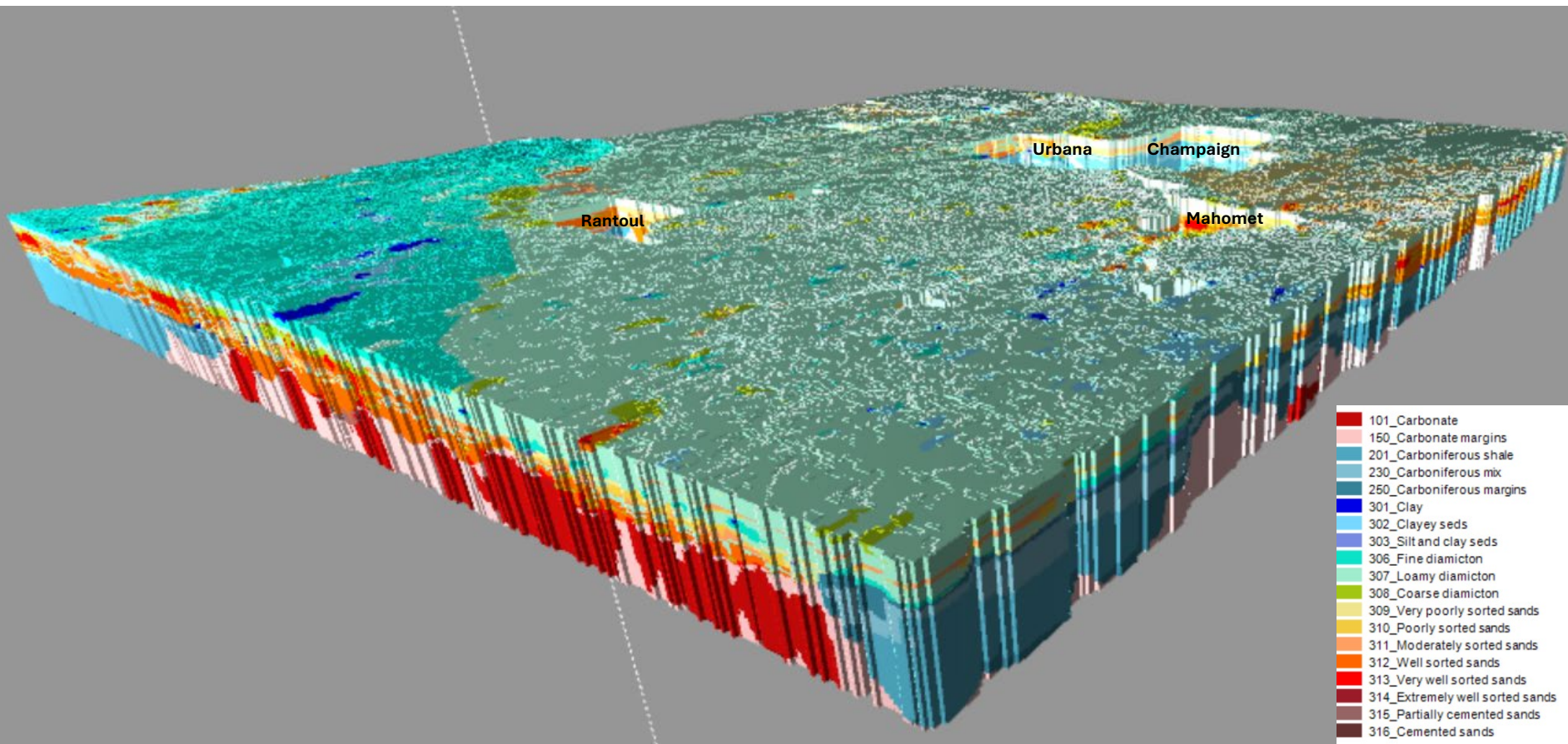


# 3D – Resistivity Model



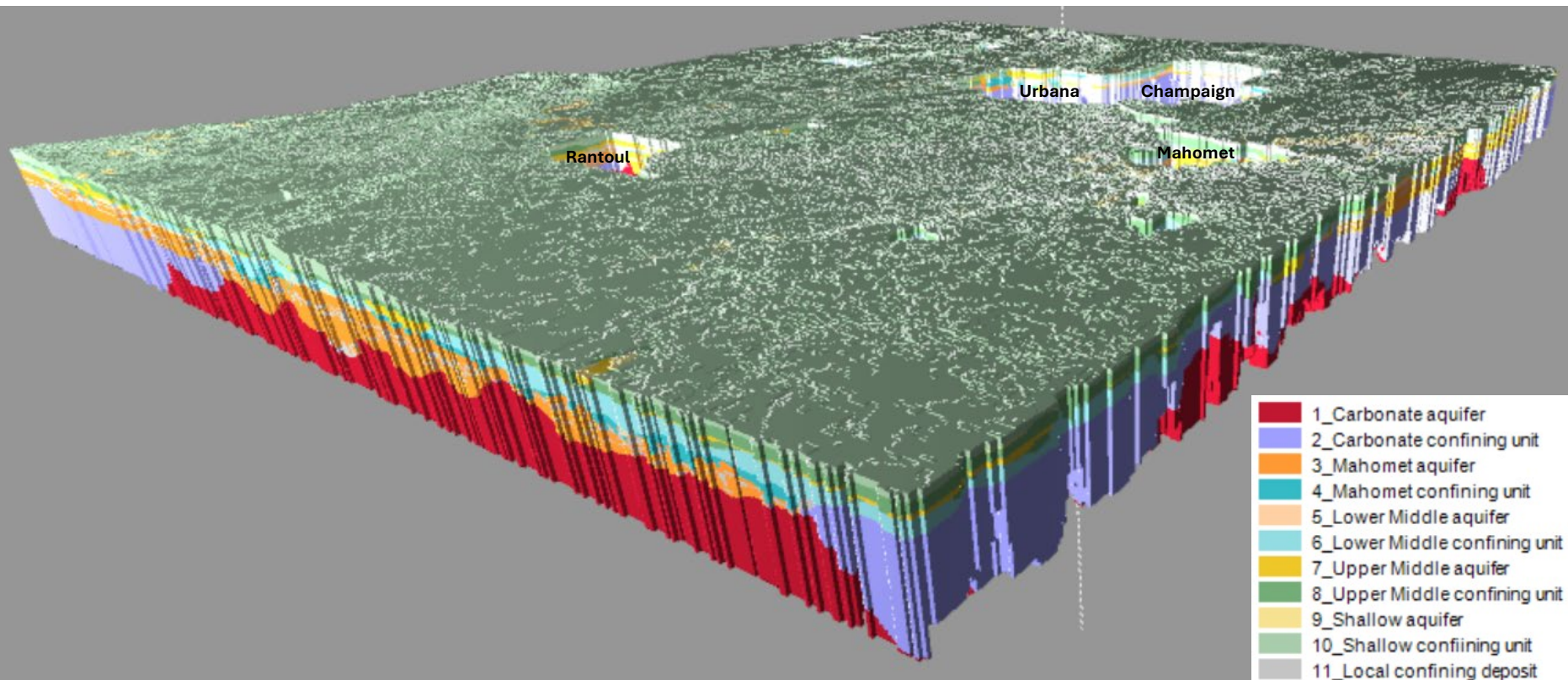


# 3D – Geological Model



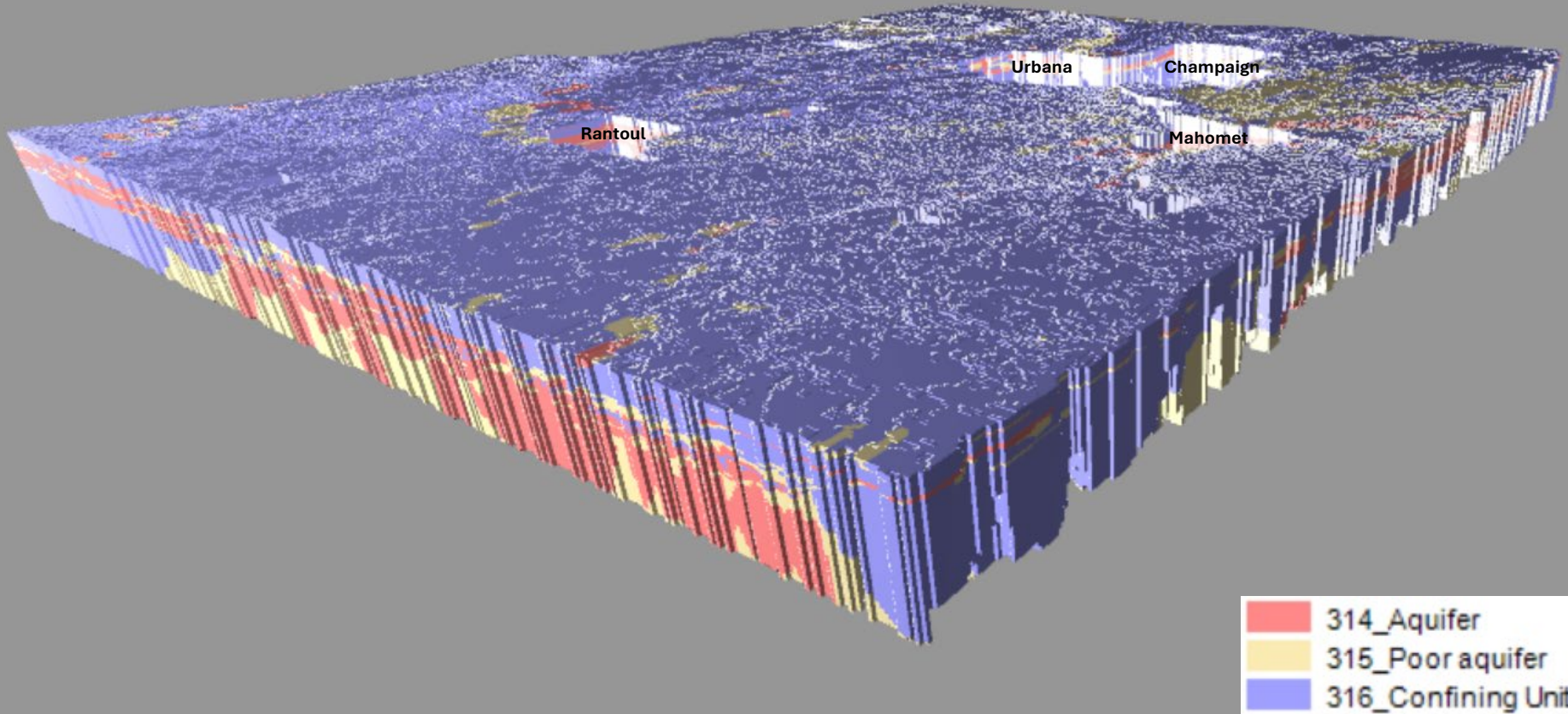


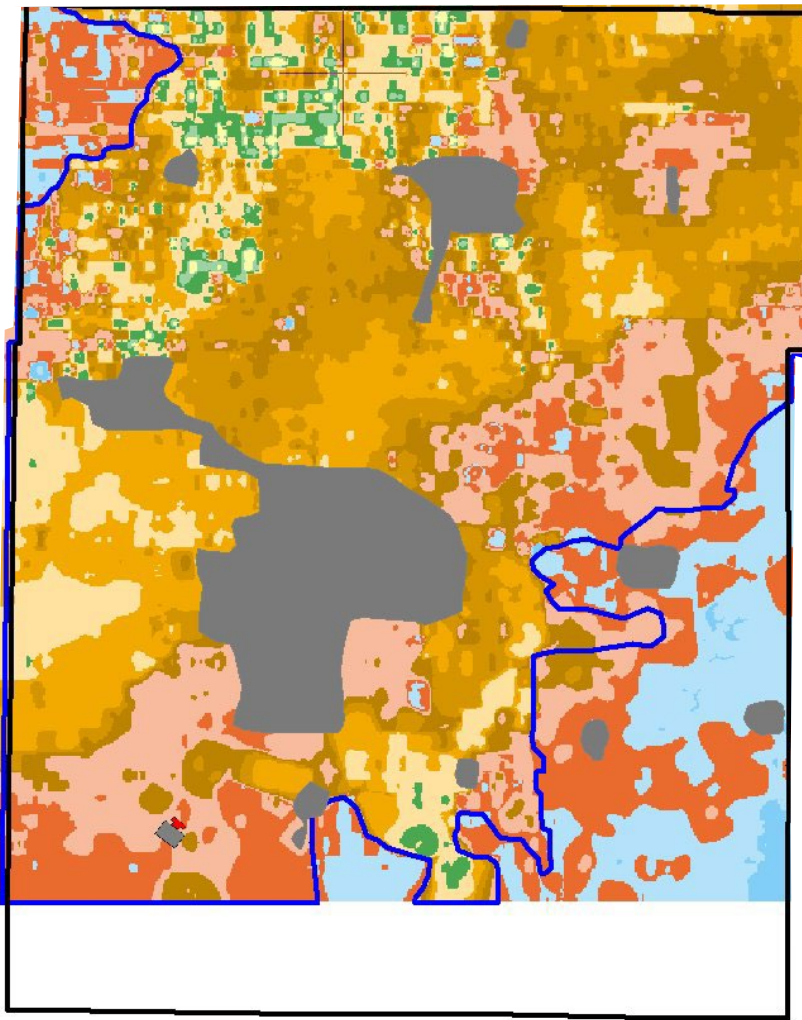
# 3D – Hydrological Model





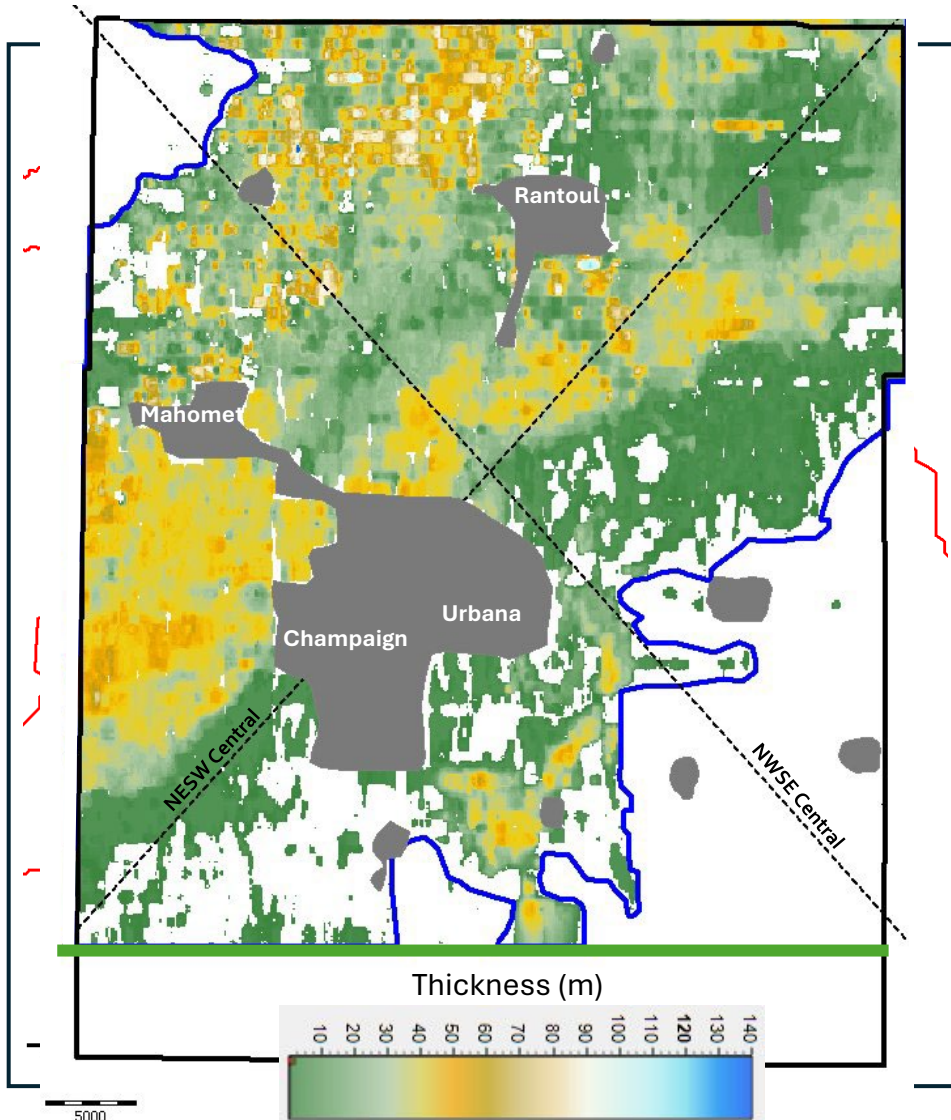
# 3D – Hydrological Model





- 1. First-ever high-resolution mapping of the distribution of;**
  - Aquifer/Non-Aquifer boundaries
  - Aquifer character/materials
  - Aquifer variability
- 2. Identification of additional water resources**
  - Sand and gravel filled buried channels as possible additional water resources.
  - Hydrological connectivity of aquifers provide a significant source of groundwater for domestic and agricultural wells
  - Possible recharge zones through buried channels
- 3. The high-resolution information from this project will contribute further to the sustainable management of groundwater resources in Champaign County**

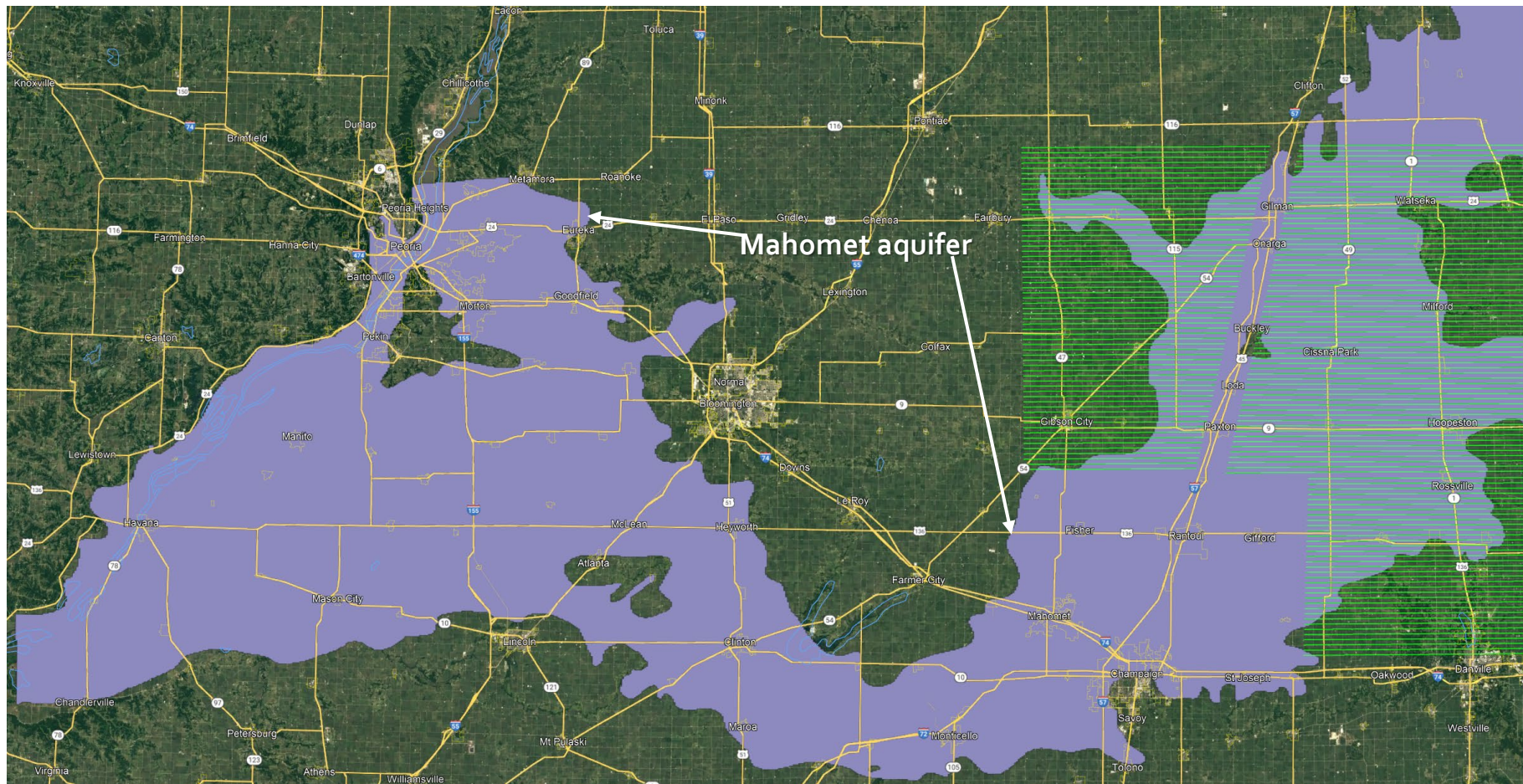
## 1. Redefining aquifer boundaries



- 1. USEPA (SSA) Boundary VS HTEM Boundary**
  - SSA boundary significantly underestimates the extent of the Mahomet aquifer
  - Potential changes to the estimates of saturated thickness of the Mahomet aquifer
- 2. Integrate results from this project with groundwater flow models**
  - Improved predictions of long-term water quantity and quality
  - Improved understanding of economic development potential
  - Reduce uncertainty of model results

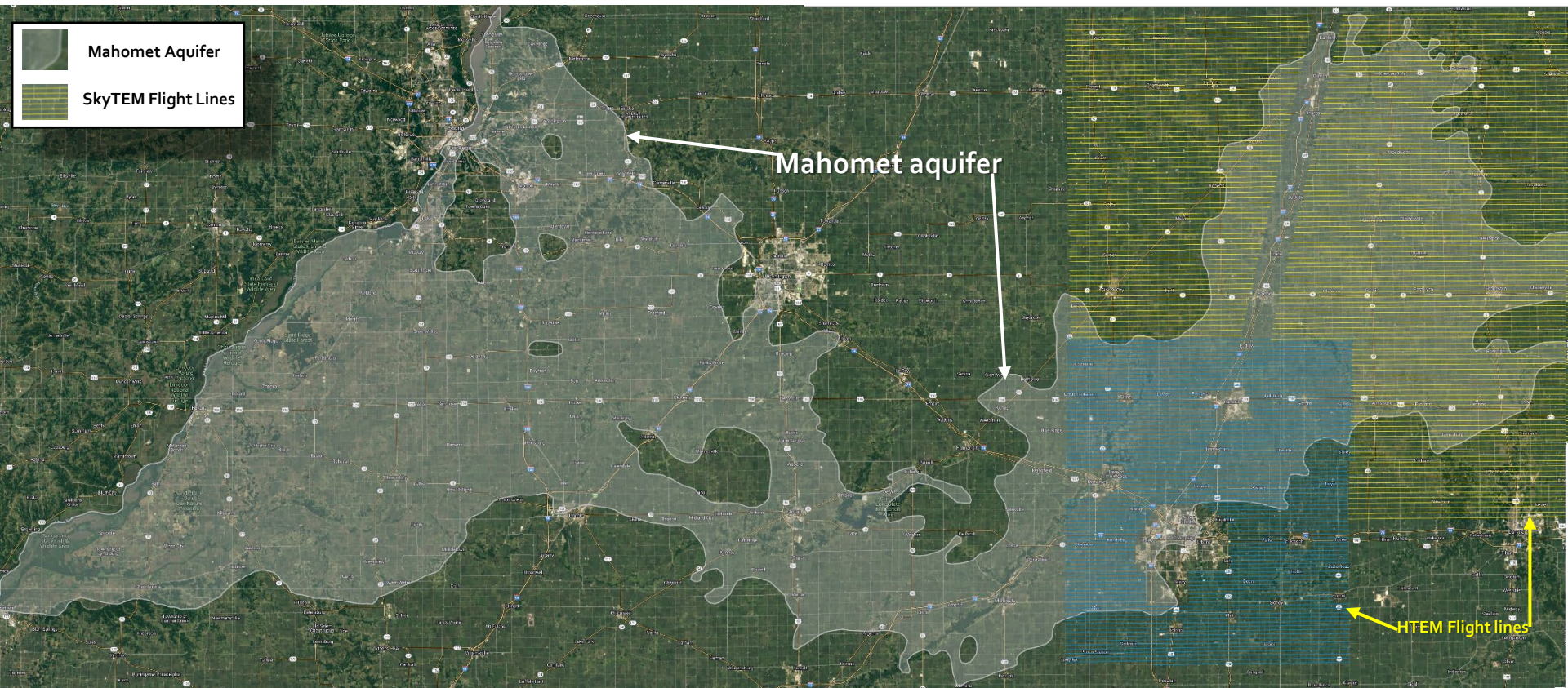


## 2. Continue with HTEM characterization of the MBV north and east of Champaign County





3. Continue to seek funds to complete the HTEM-based characterization and map the extent of the MBV in the entire east central Illinois.





## 4. For more details;

1. [Energizing Insight: New Maps for the Mahomet Aquifer \(arcgis.com\)](https://arcgis.com)
2. [Mahomet Aquifer Airborne Mapping Program – HTEM Geologic Mapping Project \(illinois.edu\)](https://illinois.edu)





# Thank you!!





