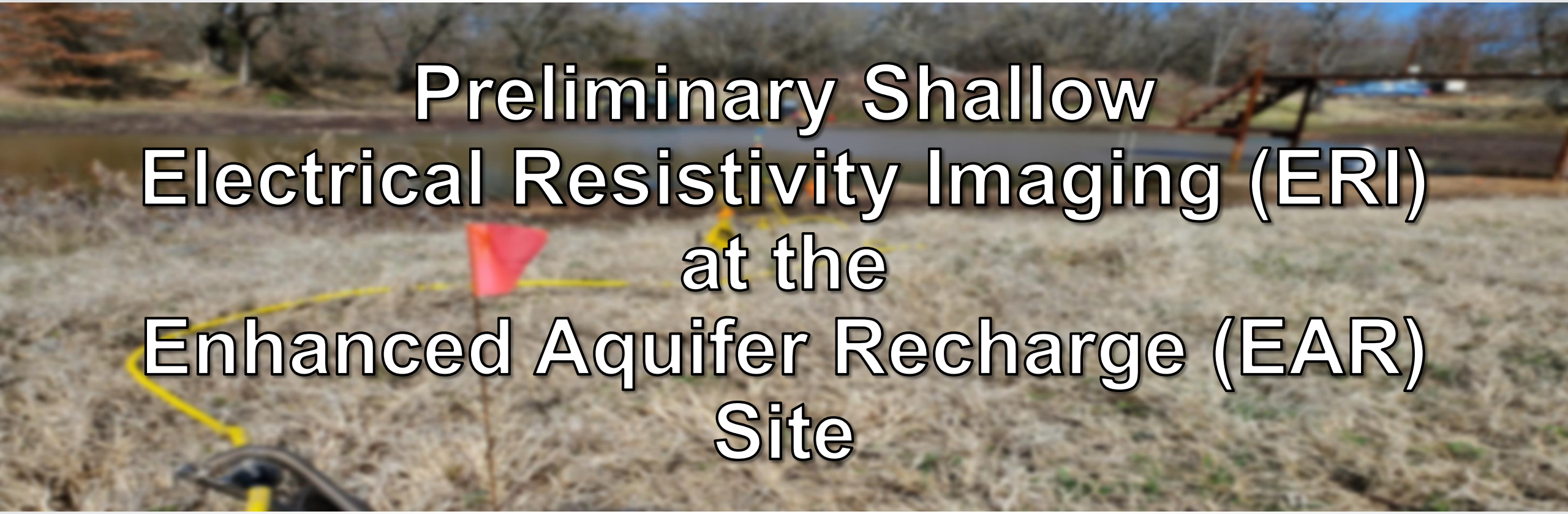

Preliminary Shallow Electrical Resistivity Imaging (ERI) at the Enhanced Aquifer Recharge (EAR) Site

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Outline

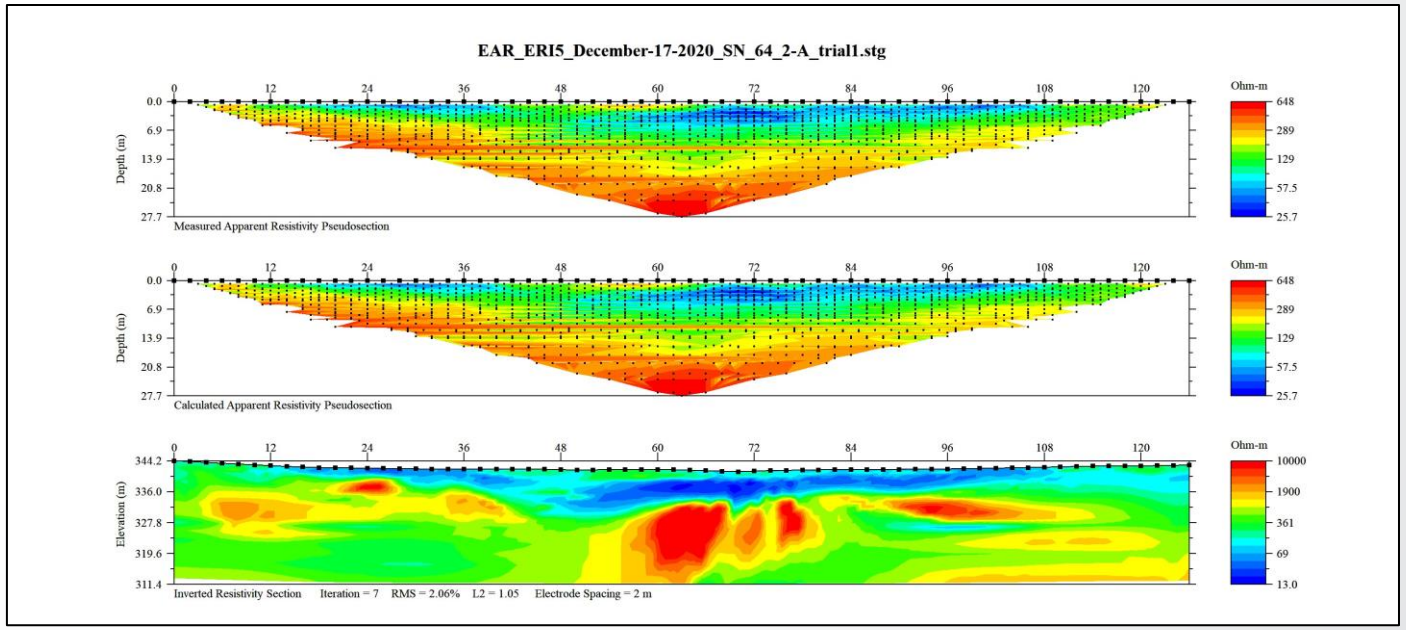
- ERI, what is it?
- Shallow Karst and Epikarst
  - Importance for EAR site
  - ERI findings and impact
- Well Siting
  - Conceptual Site Modeling
  - Confirmation drilling
- What's Next
  - Limitations and Data Gaps
  - Next steps

Photo at EAR site

Electrical Resistivity Imaging (ERI)

- Geophysical technique which measures the apparent electrical resistivity of the subsurface in order to create a 2D image of these measurements.

- ERI is regularly used for high resolution site characterization of:
  - contaminated sites,
  - groundwater presence,
  - flow and transport, and
  - geologic structures.



Screenshot of data processing

ERI signatures and effects

- Electrical resistivity signatures are affected by pore space; specific gravity
  - Water is typically less resistive than rock
  - Air is typically more resistive than rock

- Other signatures
  - Microbes
  - Groundwater chemistry
  - Water
  - Lithology

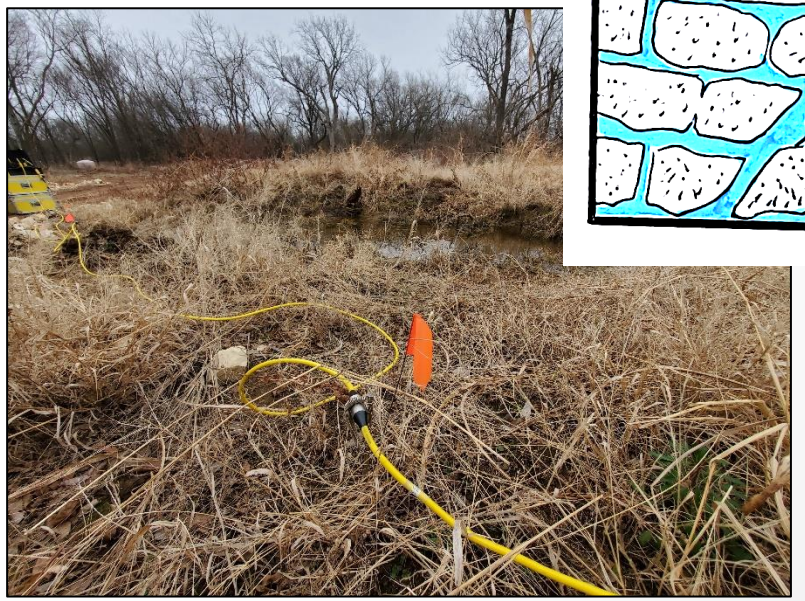
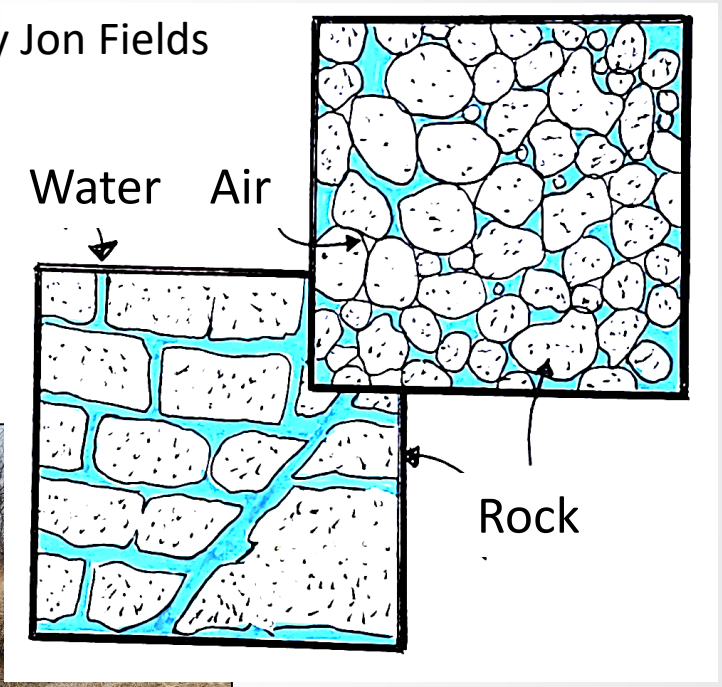


Photo at EAR site



Karst or Epikarst?

- What is it?
  - Epikarst (highly fractured bedrock)
  - Karst (dissolved bedrock; sinkholes and caves)
- How do you find it in the subsurface?
  - Poke and hope (less science)
  - Geophysics (more science)

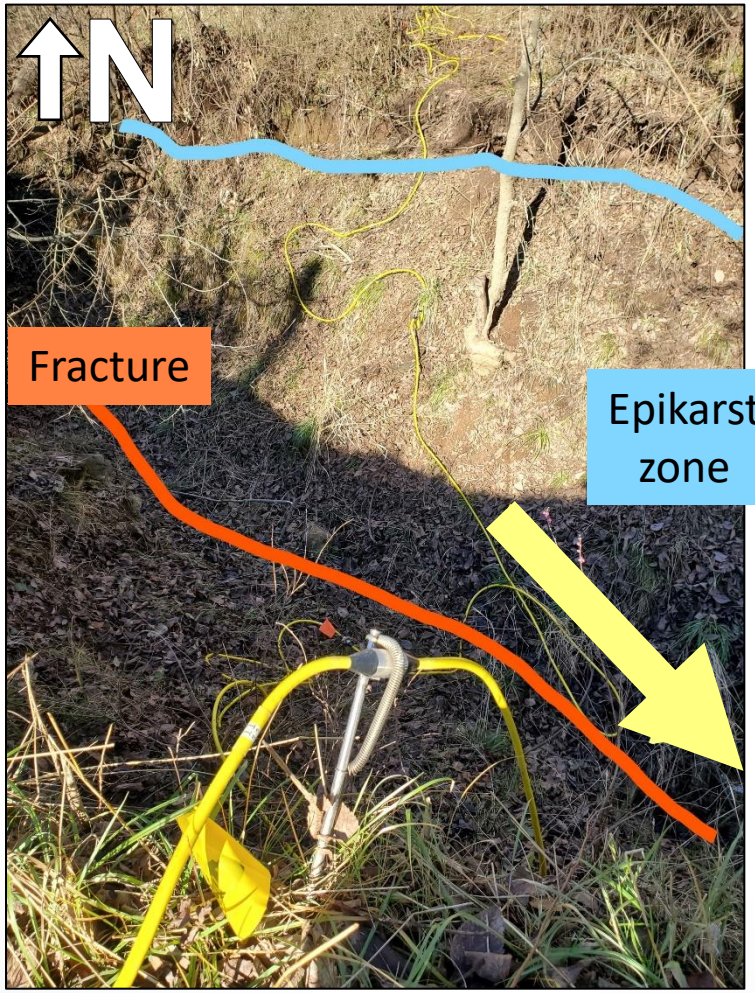


Photo at EAR site

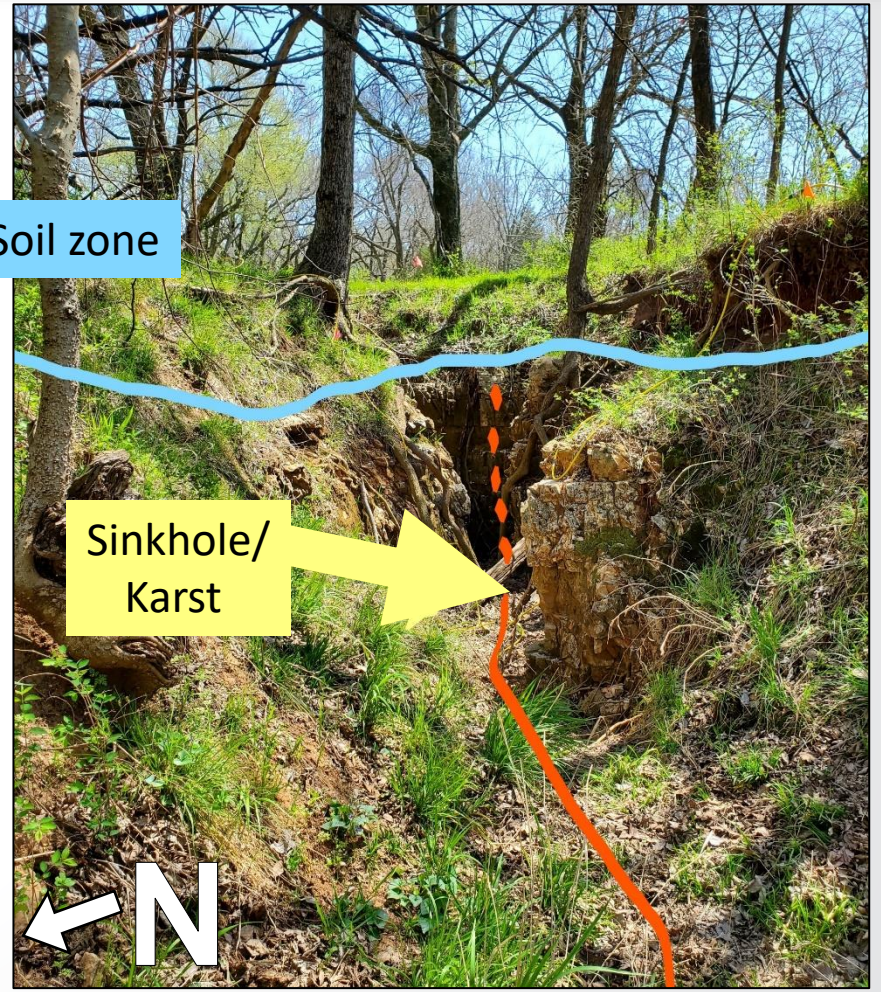
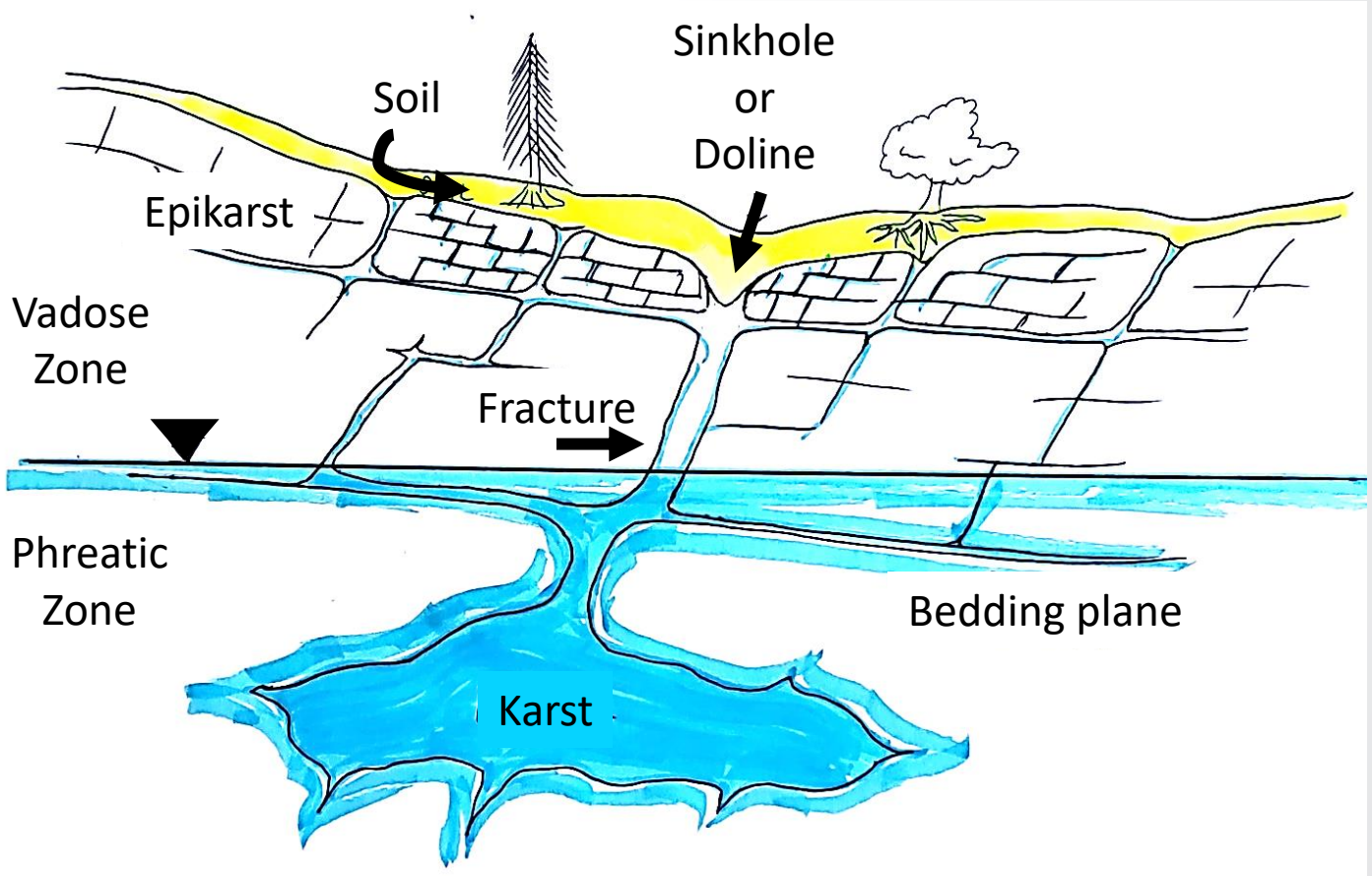


Photo at EAR site

Fractures and conduits

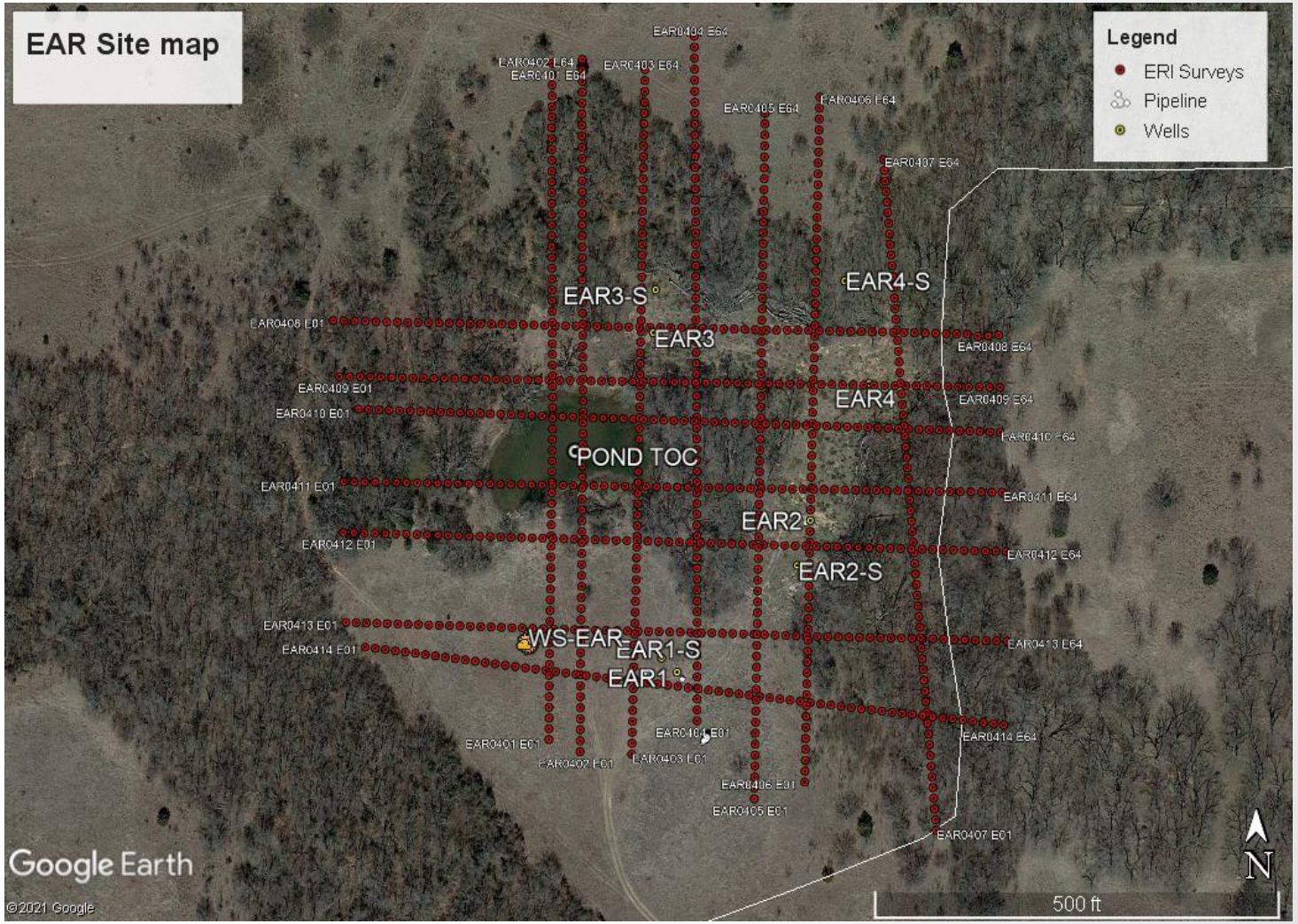
- Preferential flowpaths
- Fracture zones
  - Higher porosity and permeability
  - Relatively linear signatures
- Karst / epikarst
  - Microbial and geochemical influences
  - Large potential for conduits



Illustrated by Jon Fields

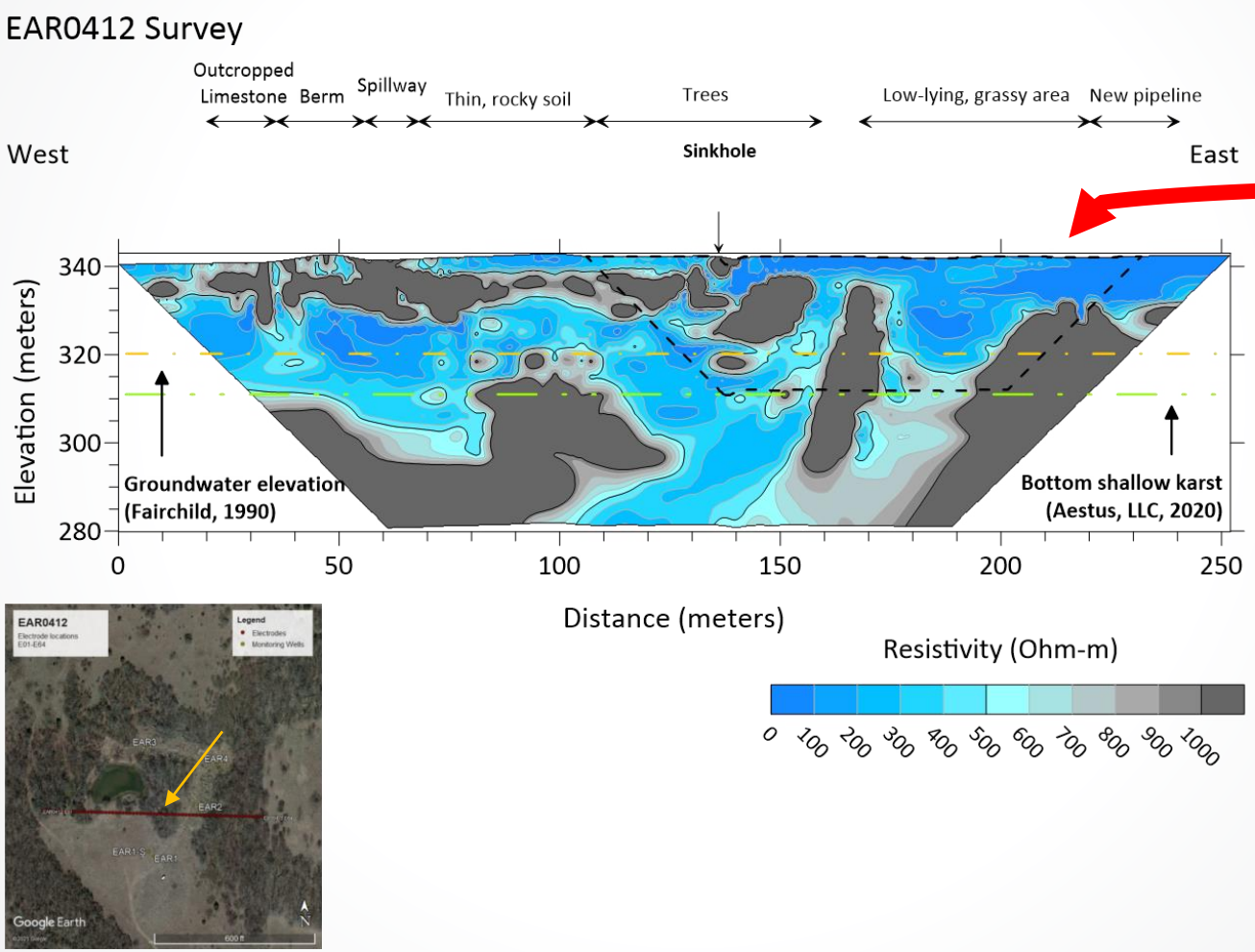
Study area

- Data density
  - 5:1 ratio (Length:Depth)
  - 28 surveys
  - ~2,600 data points / survey
  - >72,000 total data points
- Effort
  - Data collection
  - Processing (ongoing)
  - Interpretation (ongoing)

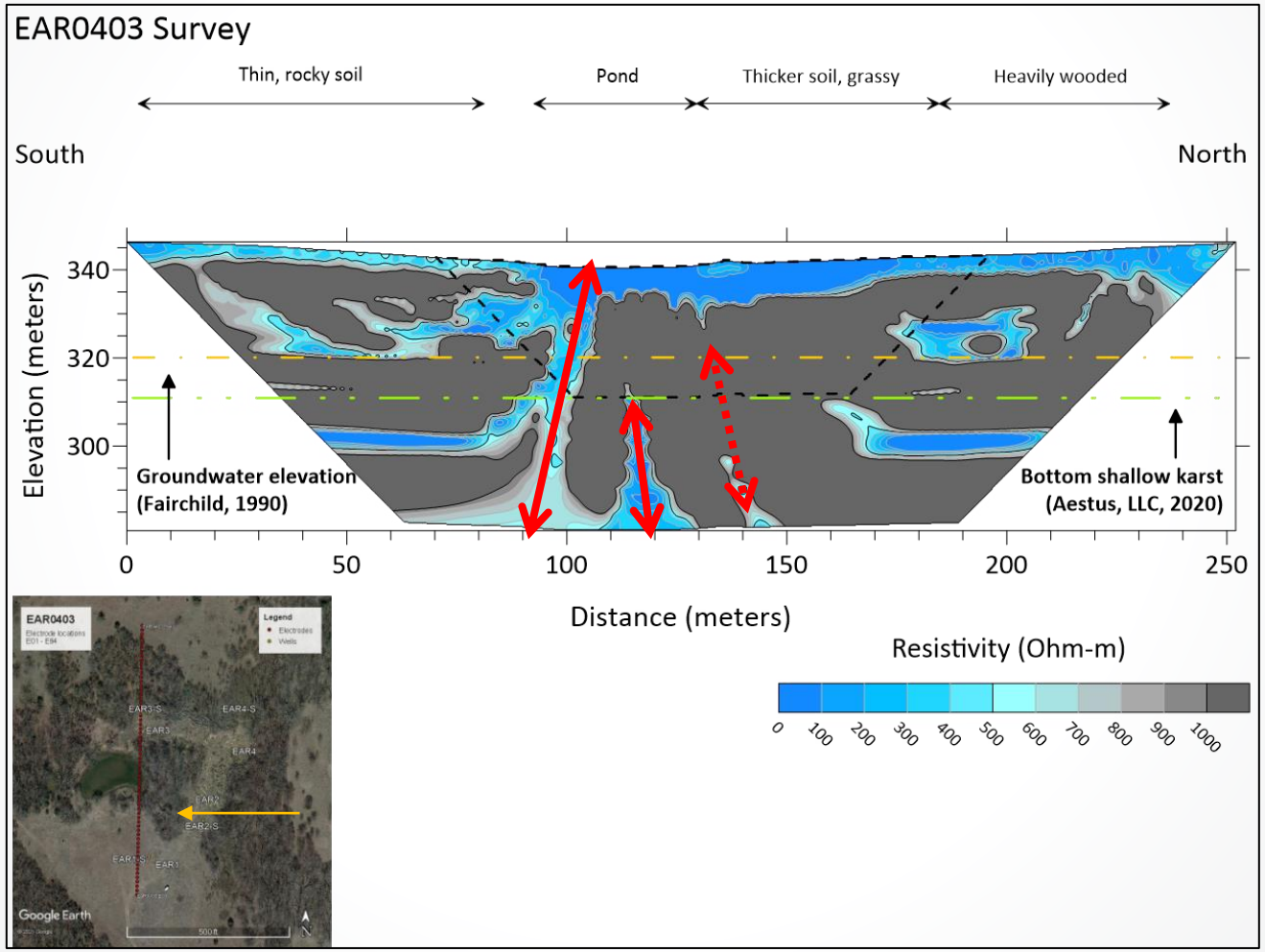


Google Earth Map by Jon Fields

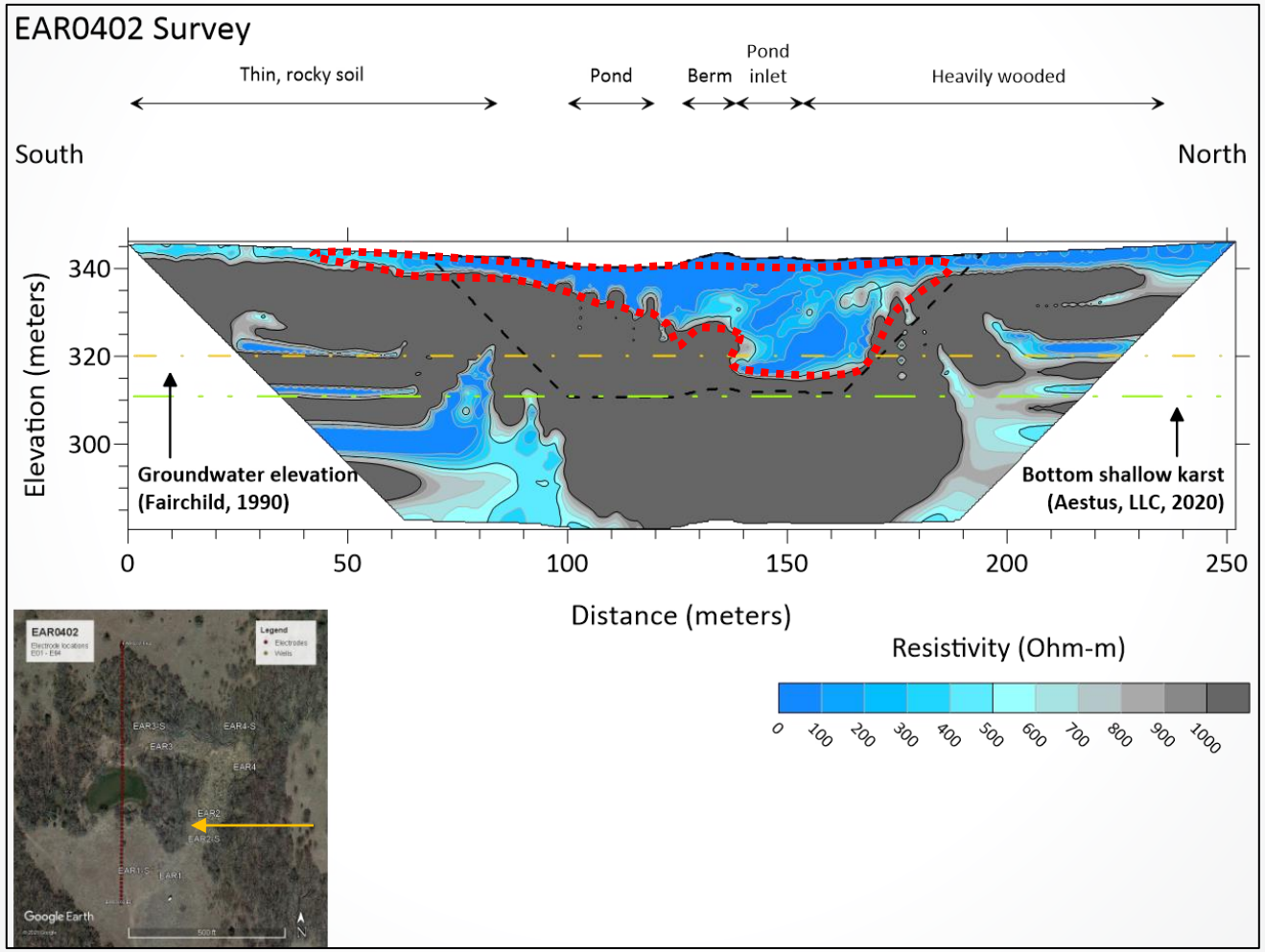
Post-processed ERI results (example)



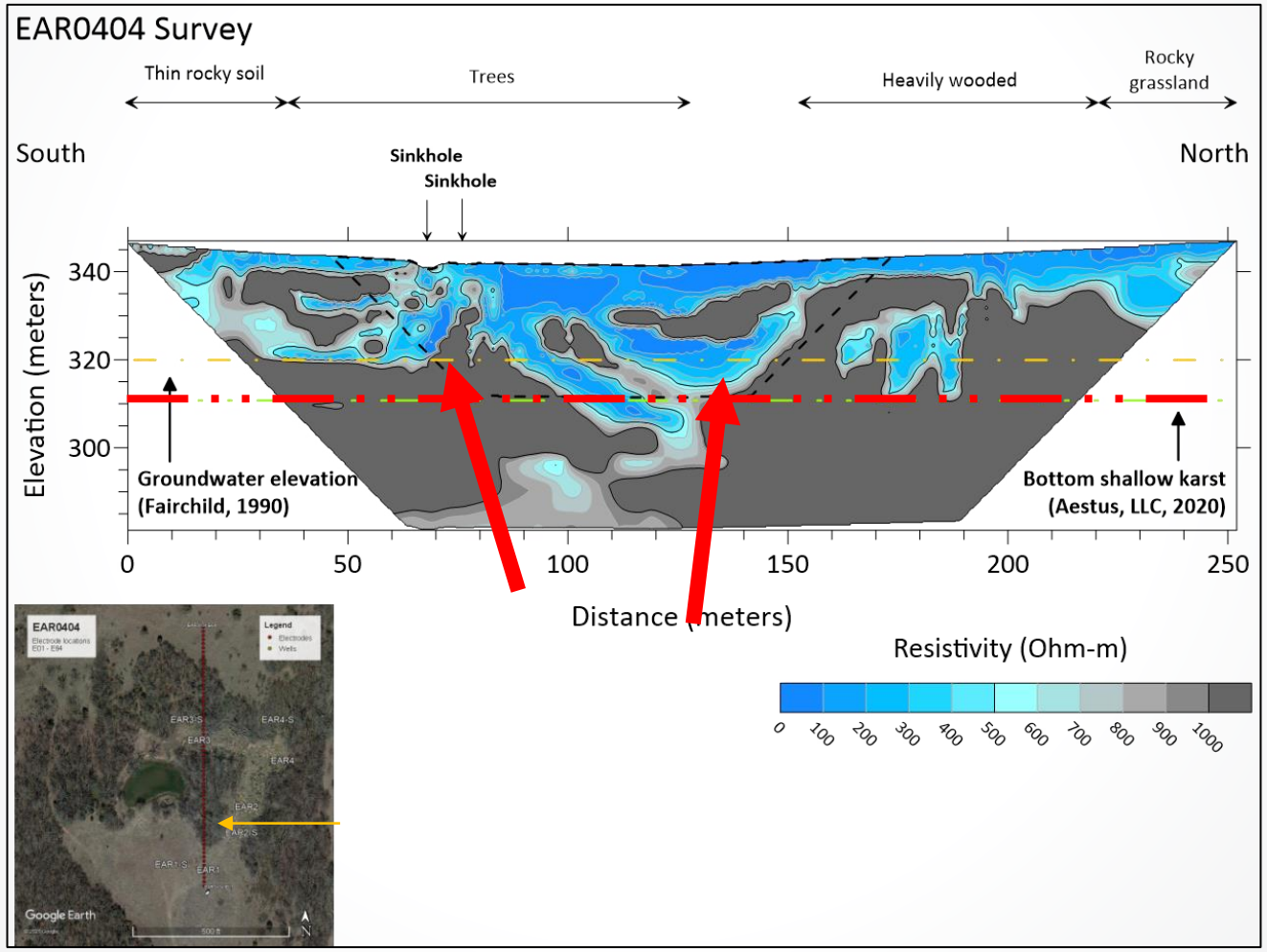
Fracture signatures



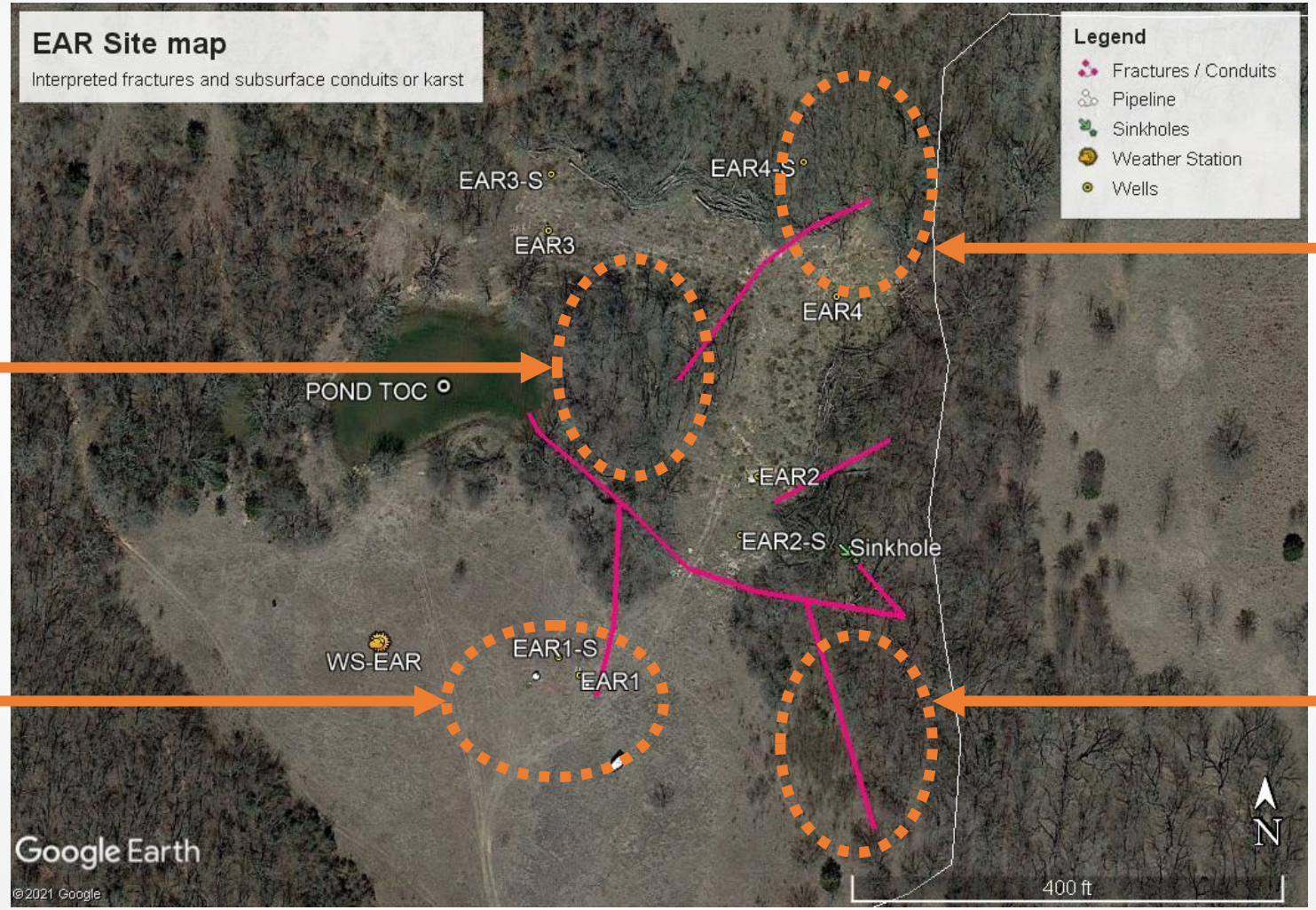
Epikarst signatures



Karst signatures



Preliminary interpretations



Prominent epikarst and karst

Thick epikarst

Prominent karst

Thick epikarst

Google Earth Map by Jon Fields

Model calibration

- Doctors don’t operate without prior knowledge (scan)

Photo at EAR site

Photo at EAR site

- ERI surveys at the EAR site can indicate potential targets for high flow (drill)

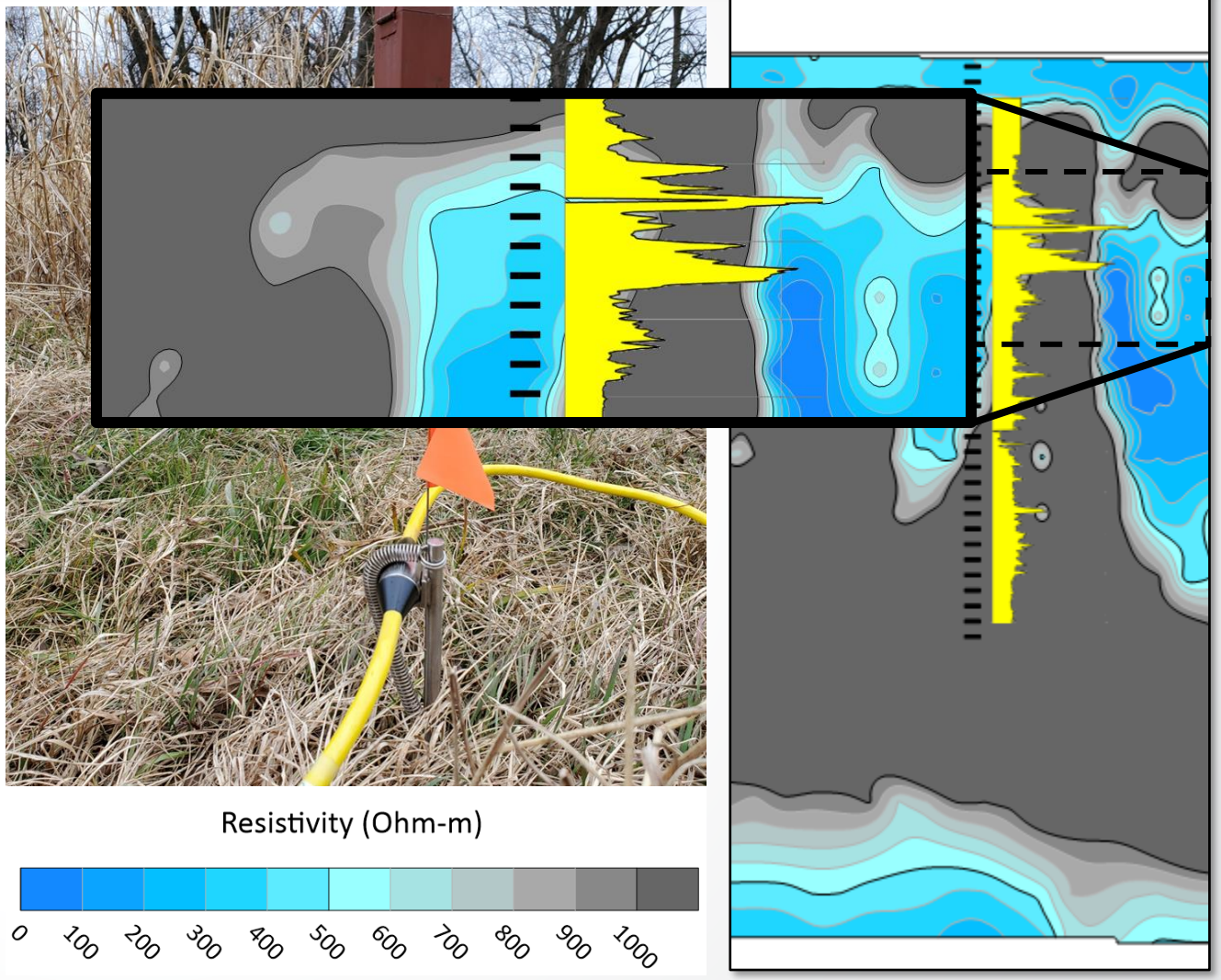
Well siting

- Lithologic logs and geophysical logs complement electrical resistivity imaging (ERI) surveys

- 1D data vs 2D data

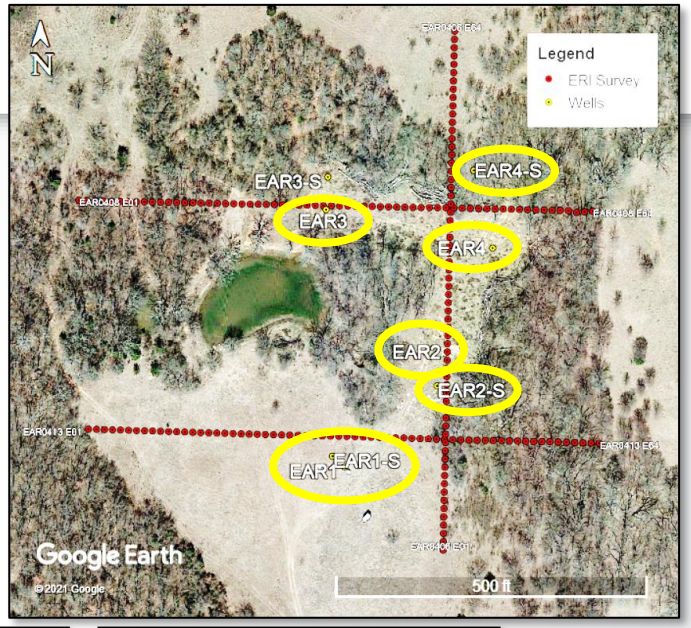
Caliper log overlain →

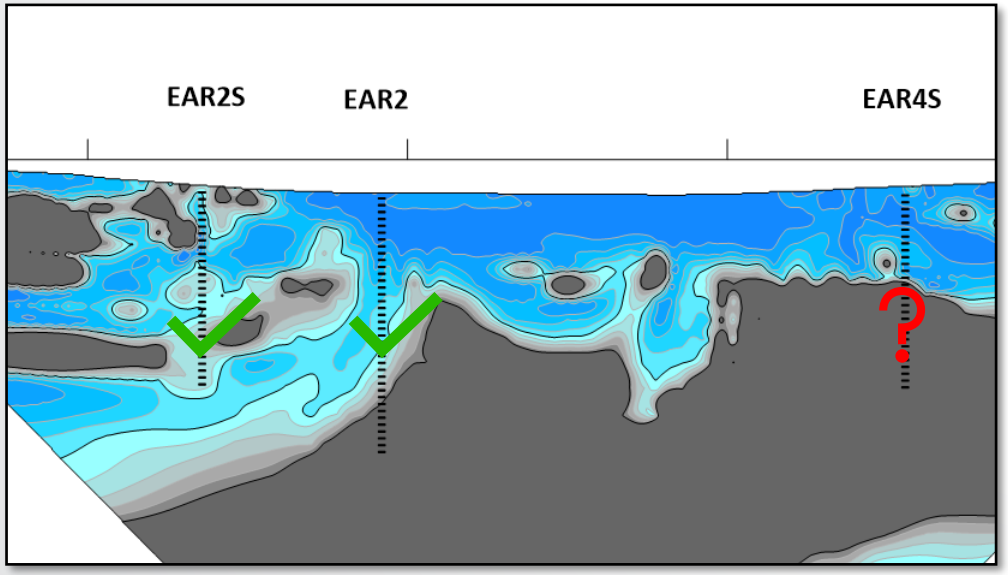
Signature depicts potential karst, bedding, or washout in the wellbore in the lower resistivity portion (blue) of the ERI survey

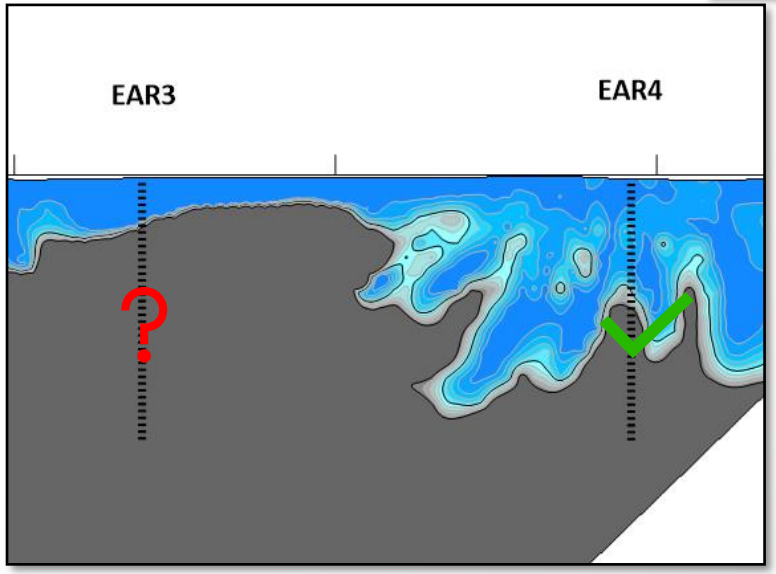


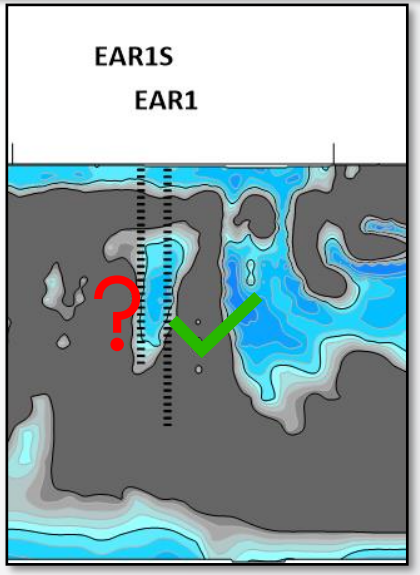
Well siting

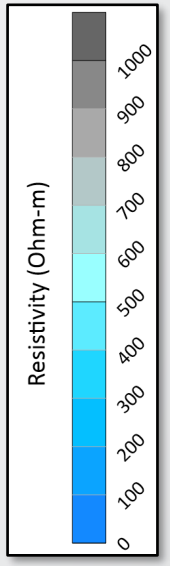
- Installed without prior use of electrical resistivity imaging to site wells: mixed bag of results
- Low-flow and high-flow wells
- Pre-drilling plan can more efficiently place wells











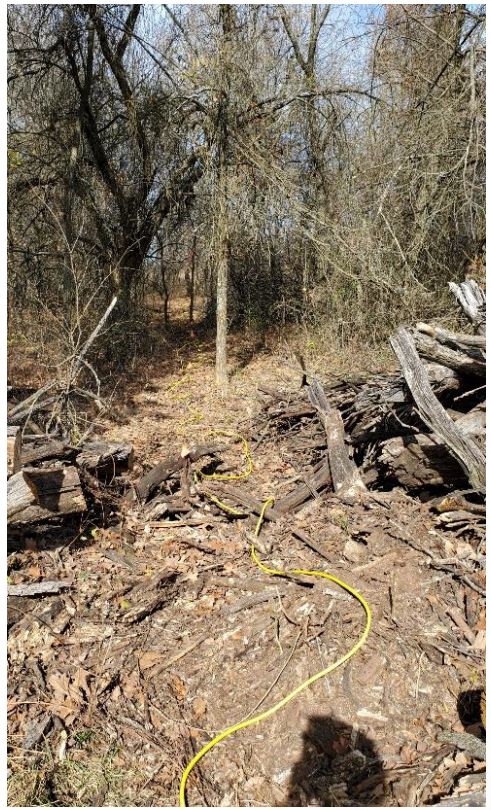
What's next

Limitations

- Time, time, time
- Confirmation drilling required
- One time data collection event

Before

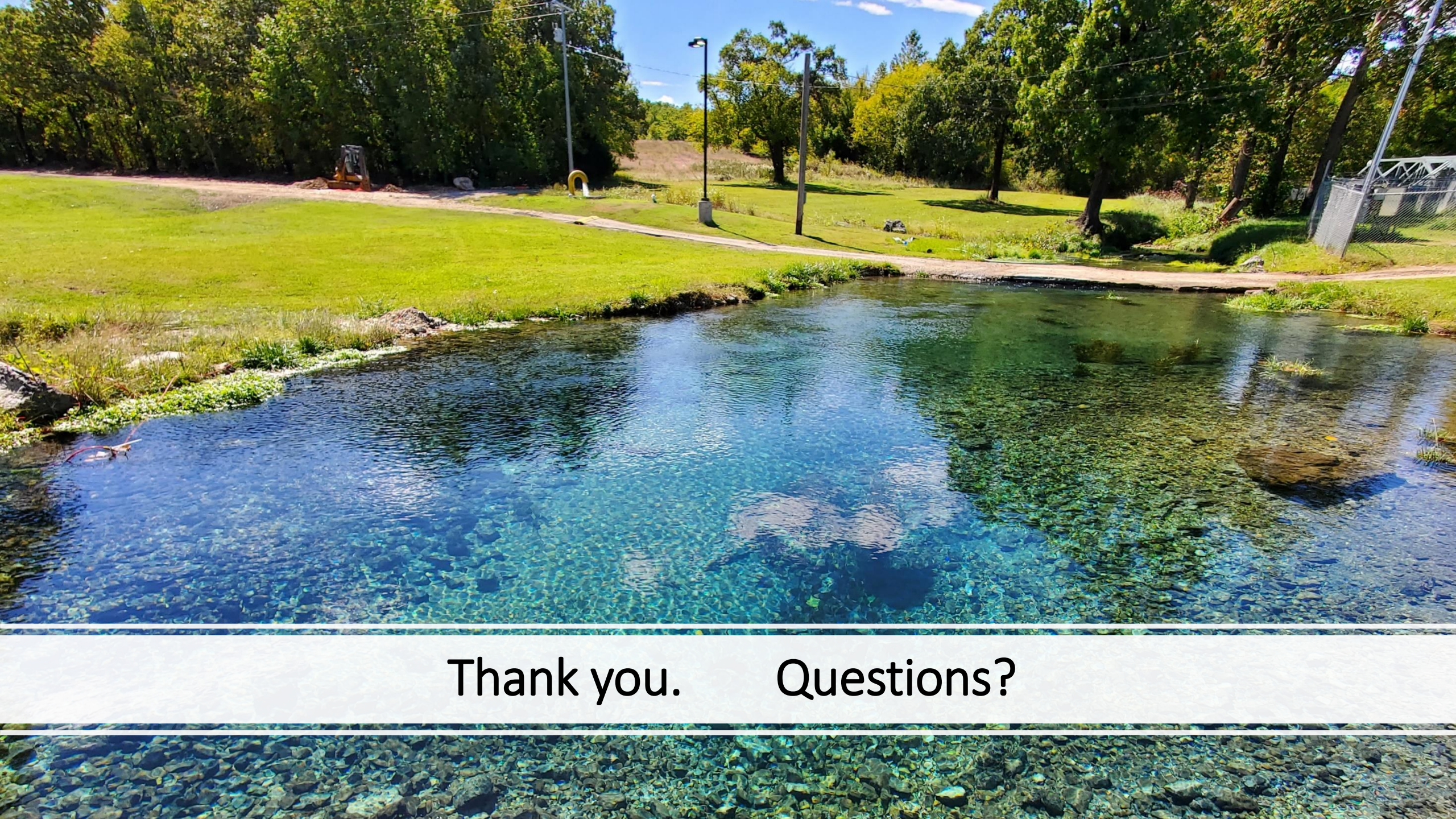
After



Photos at EAR site

Next Steps

- 3D modeling for better understanding
- Transient ERI for rain events
- Target selection and confirmation drilling



Thank you. Questions?