Baseline Electromagnetic Survey Results at the Kemper County CarbonSAFE Site (FWP-1022403)

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Legal Statement

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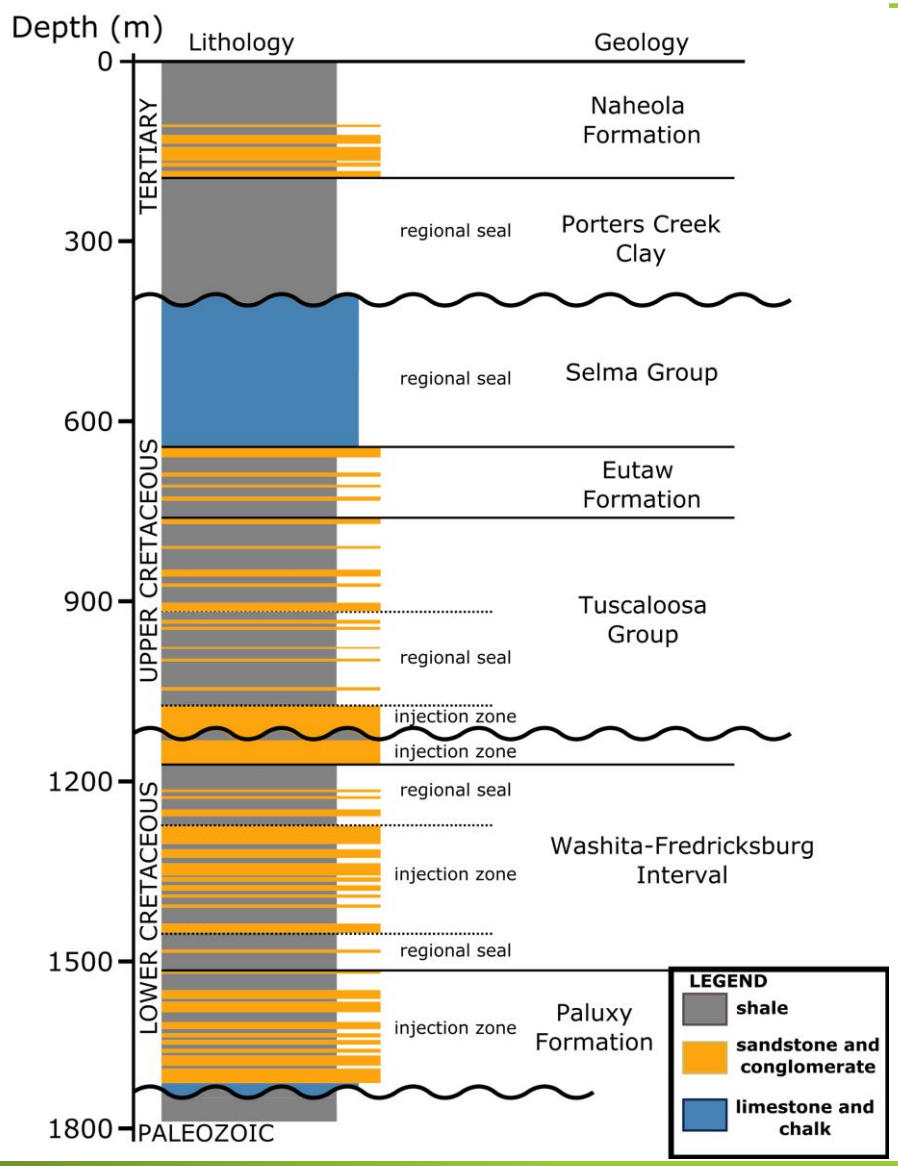
Project Overview

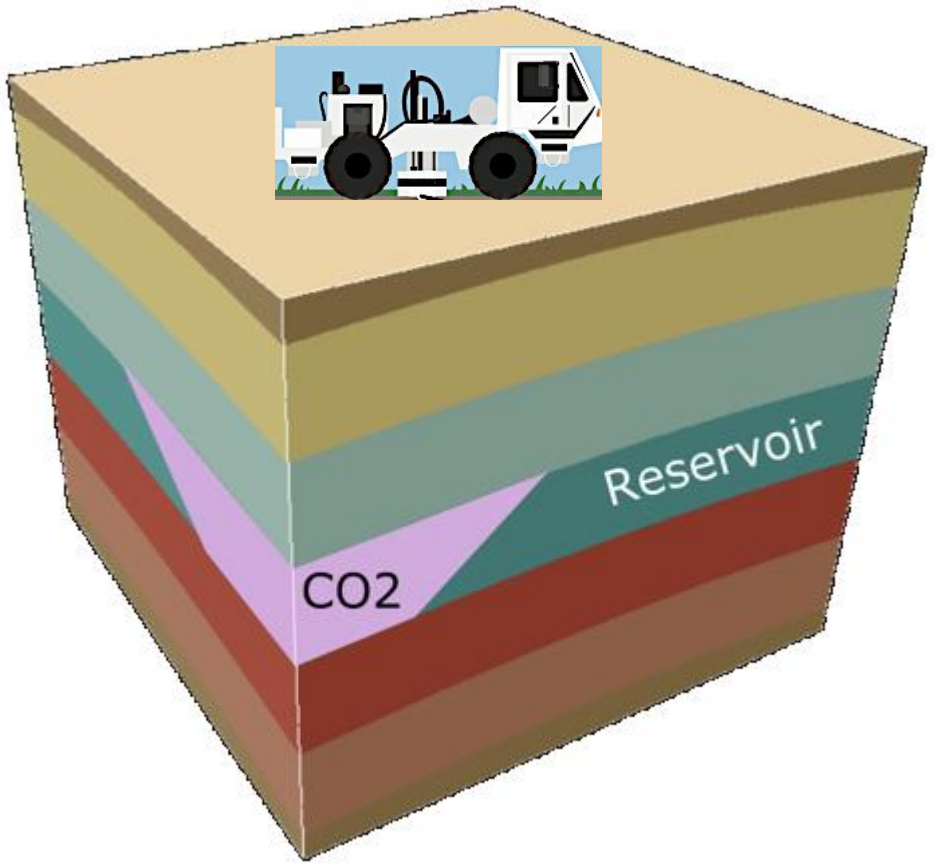
- Key Project participants
  - NETL Researchers & Colorado School of Mines
  - Site access provided by Mississippi Power Company
- Project Objectives
  - Assess electromagnetics as a low-cost tool to monitor CO_2 at storage sites
  - Conduct an airborne survey over the Kemper CarbonSAFE site, Mississippi
  - Recover a baseline conductivity model of Kemper
  - Assess cultural electromagnetic noise
  - Simulate injection scenarios and predict monitoring success
  - Repeat a monitoring survey post-injection
- Project Performance Dates
  - EY 2020 – EY 2025
  - Sunsetting with option to continue post-injection at Kemper for monitoring survey(s)

Geology at Kemper CarbonSAFE



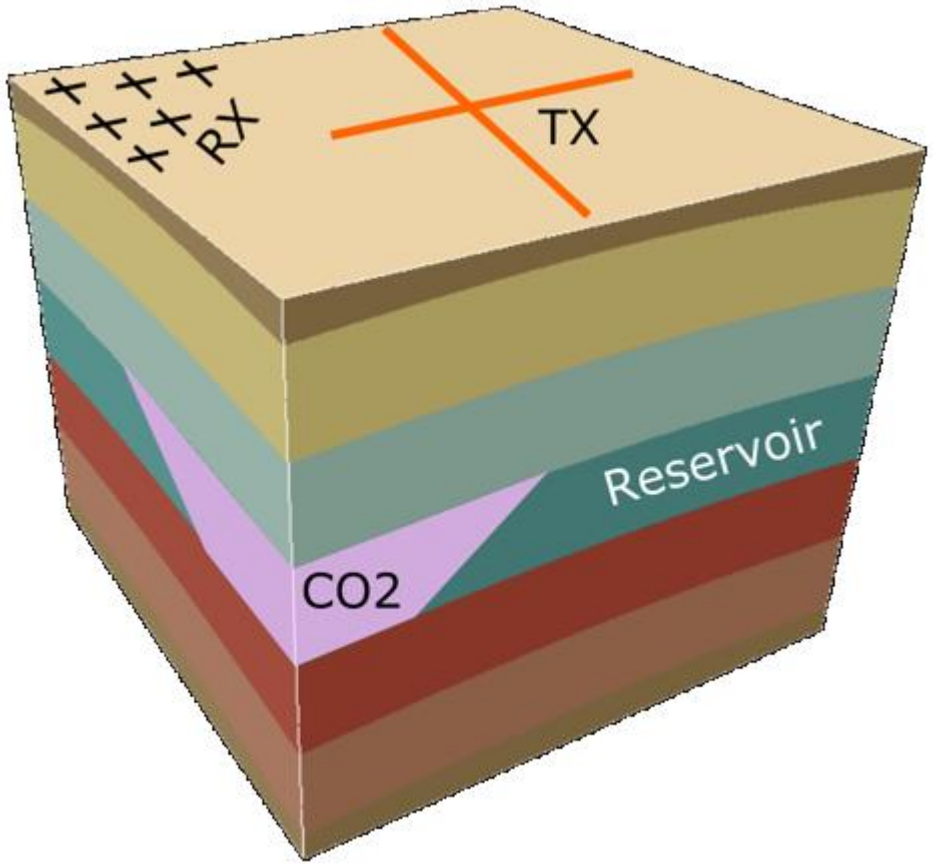
- 1D layer cake geology
- Sandstone injection zones ~900-1200m depth at the site
- ~300m saline aquifer injection zones
- 30%+ average porosity
- 16 Darcy permeability
- Brine saturated
- Regionally continuous seals

Seismic



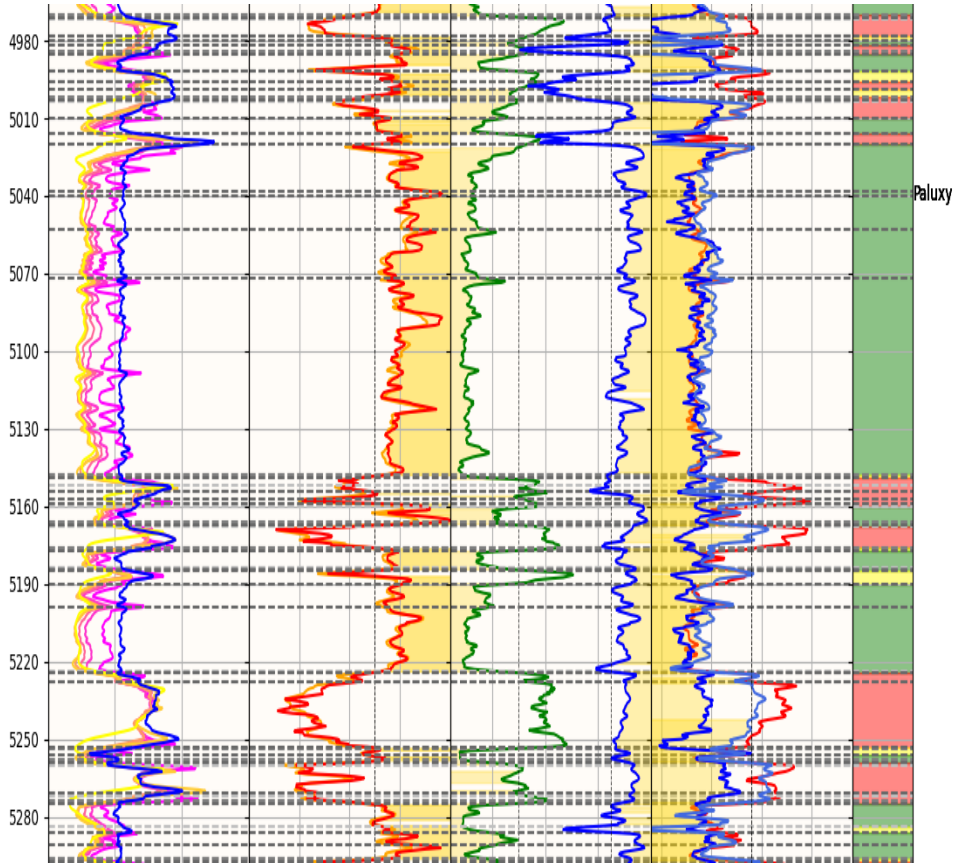
- Velocity contrast
- High resolution
- Expensive (1 survey every ~5 years)
  - ~3 million USD per survey for most sites
- Sensitivity issues
  - CO_2 presence, not saturation
- Access issues

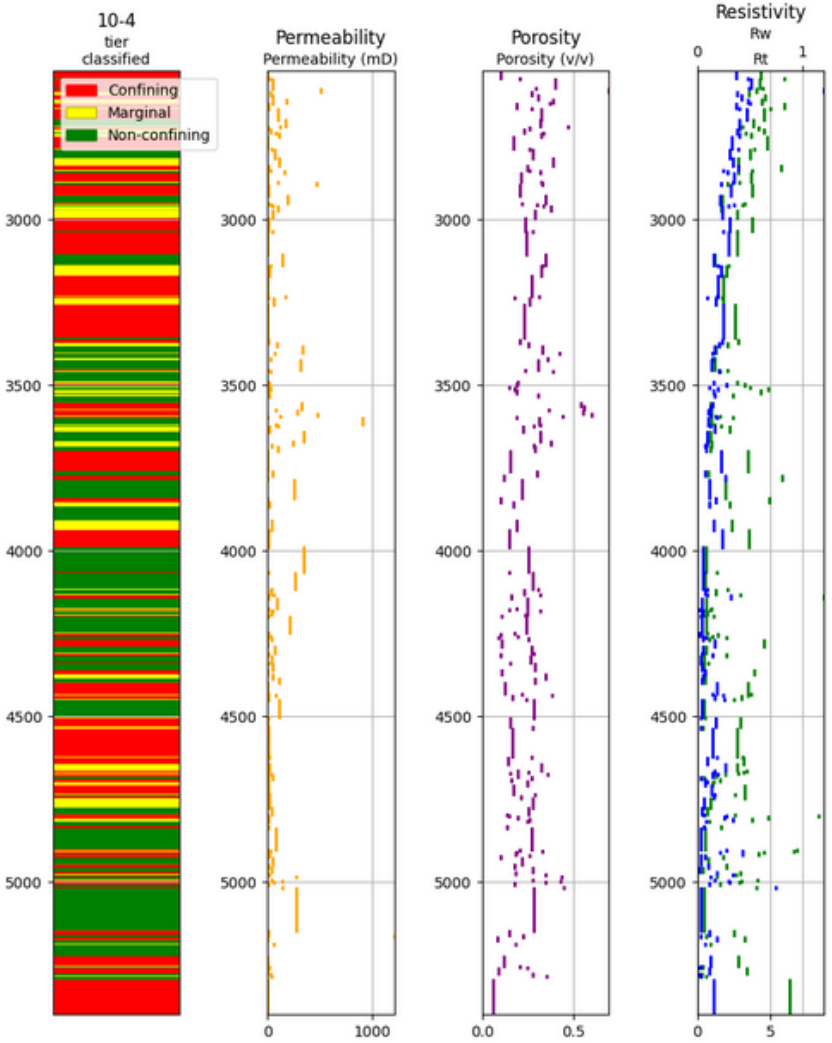
Electromagnetics

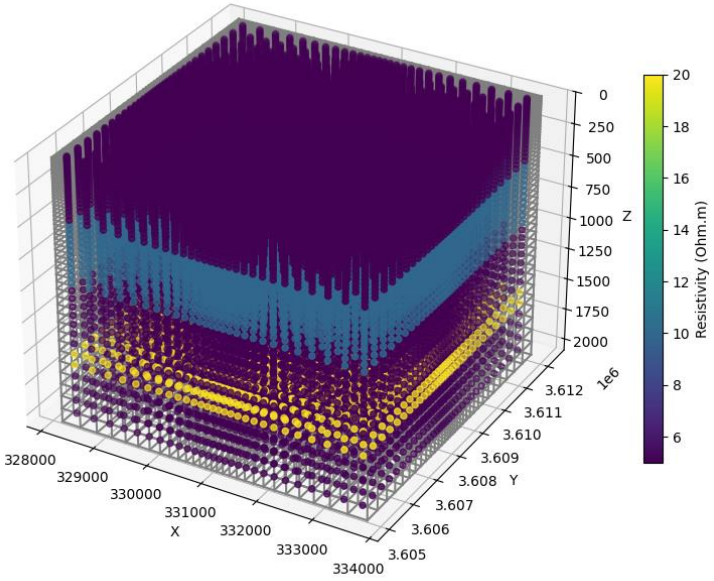


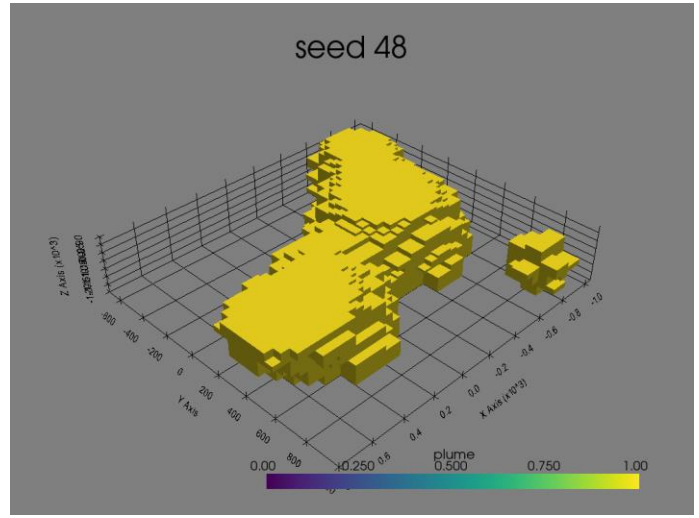
- Conductivity contrast
- Sensitive to CO_2 saturation
- Cost efficient
  - ~100k USD per survey for most sites
- Small surface footprint (antennae)
- Survey large area with helicopter and drone-based surveys (magnetic field)

Building Test Simulations

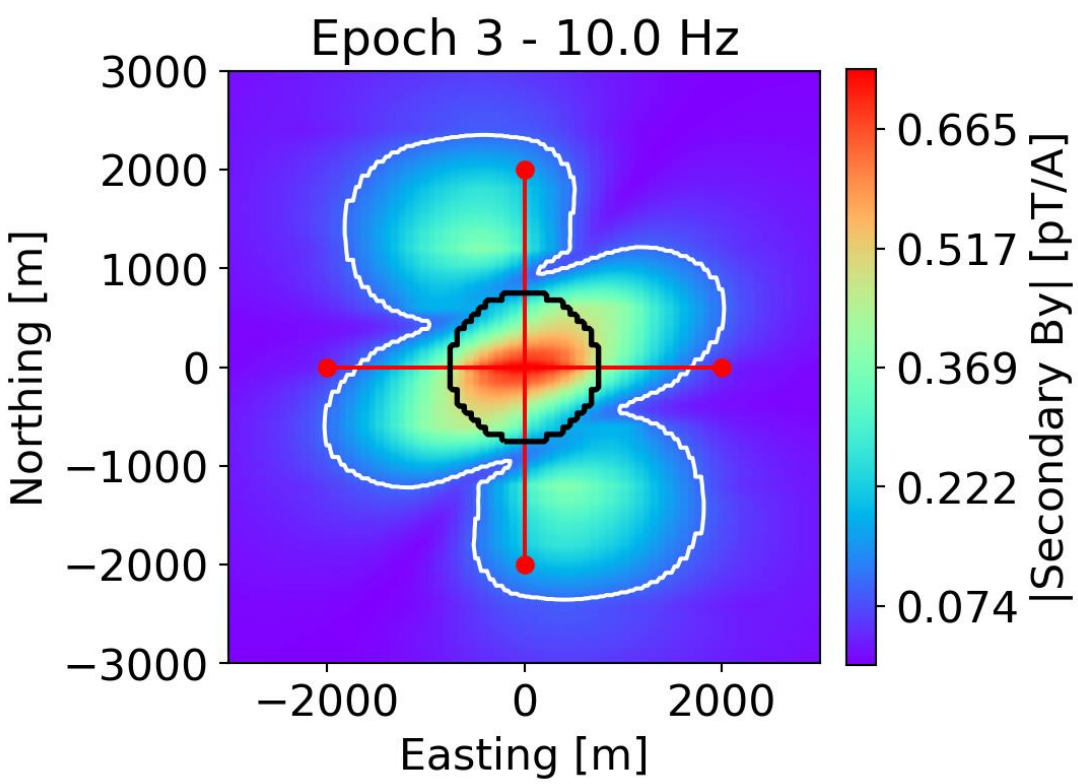


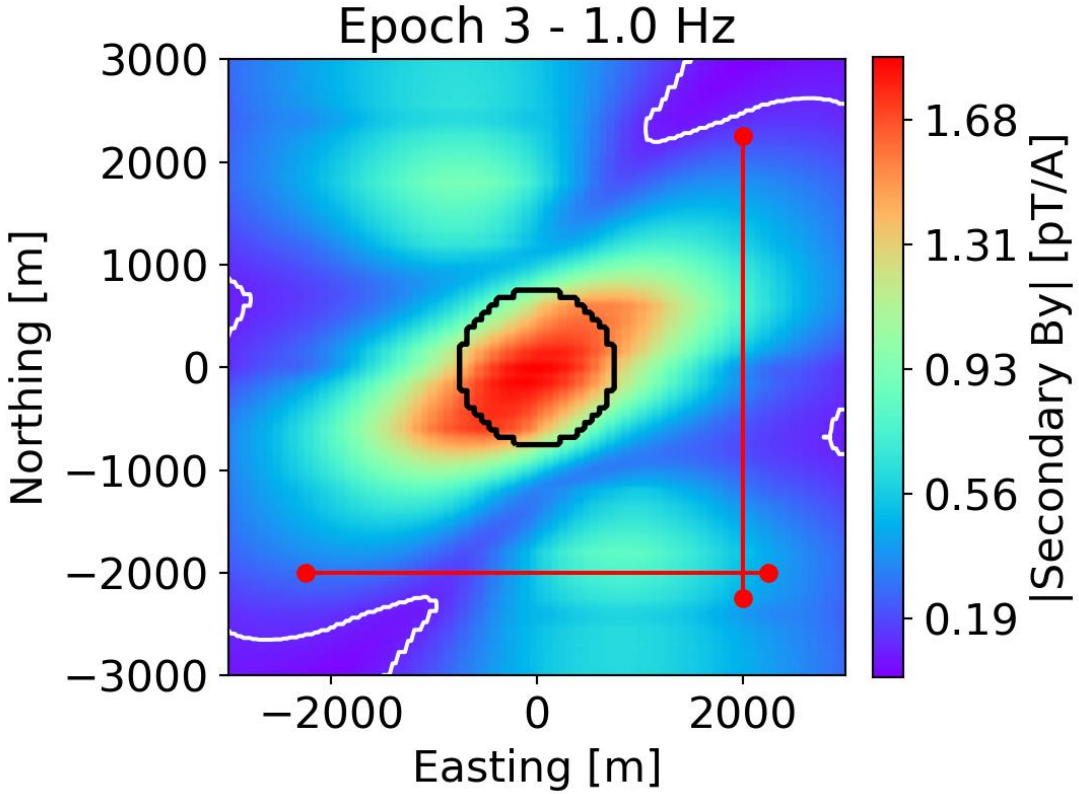




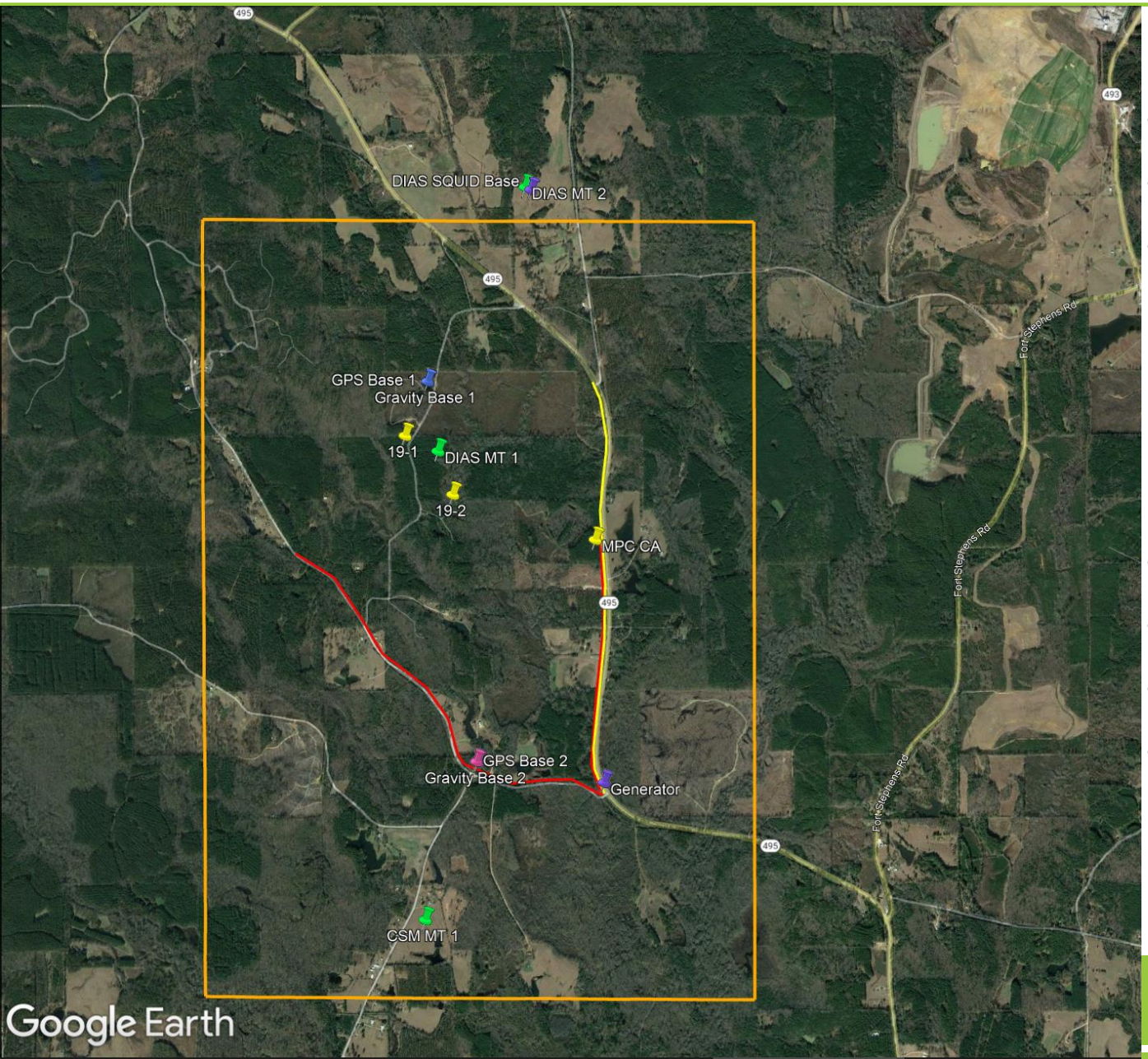


Modeling Results



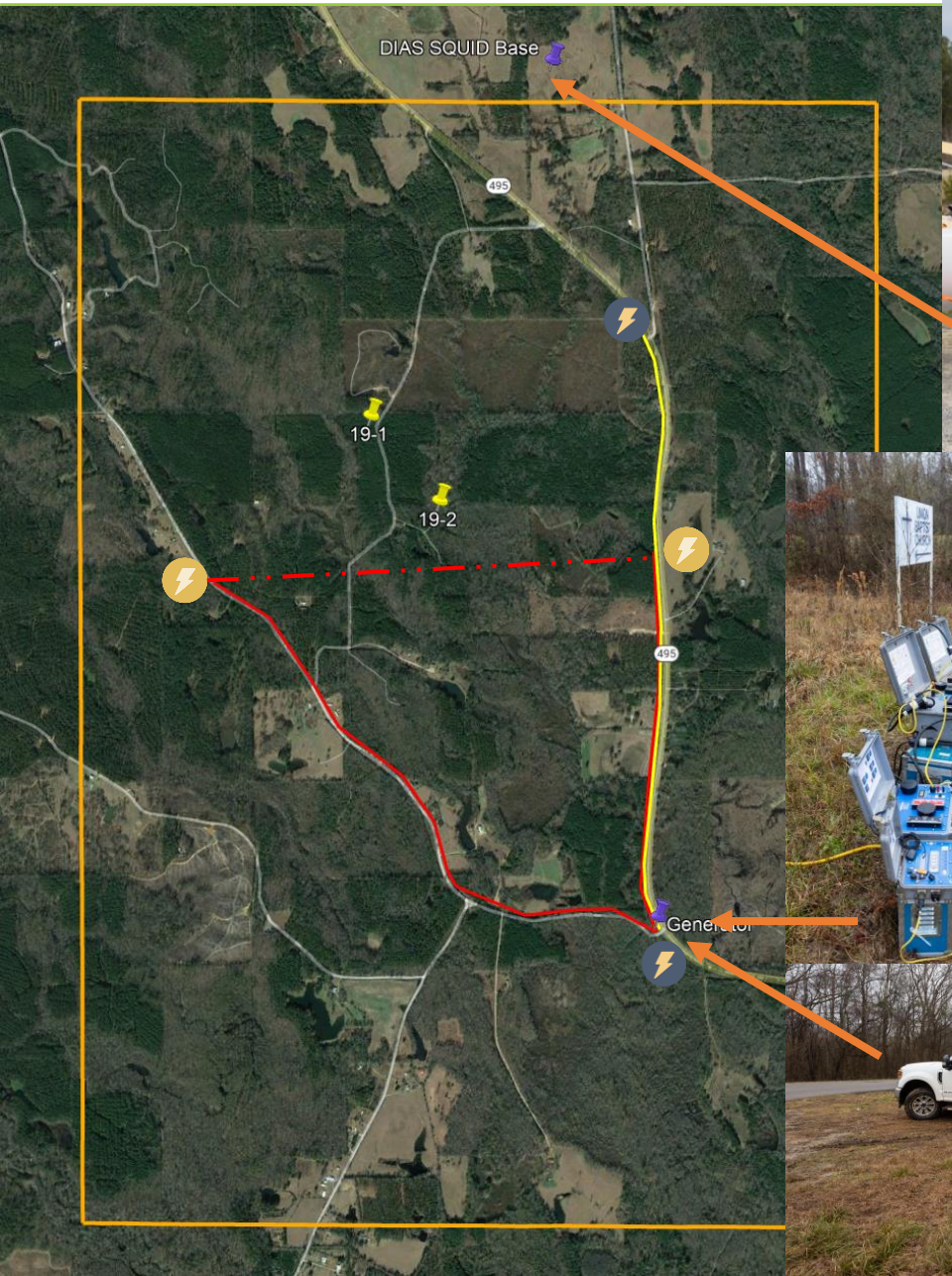


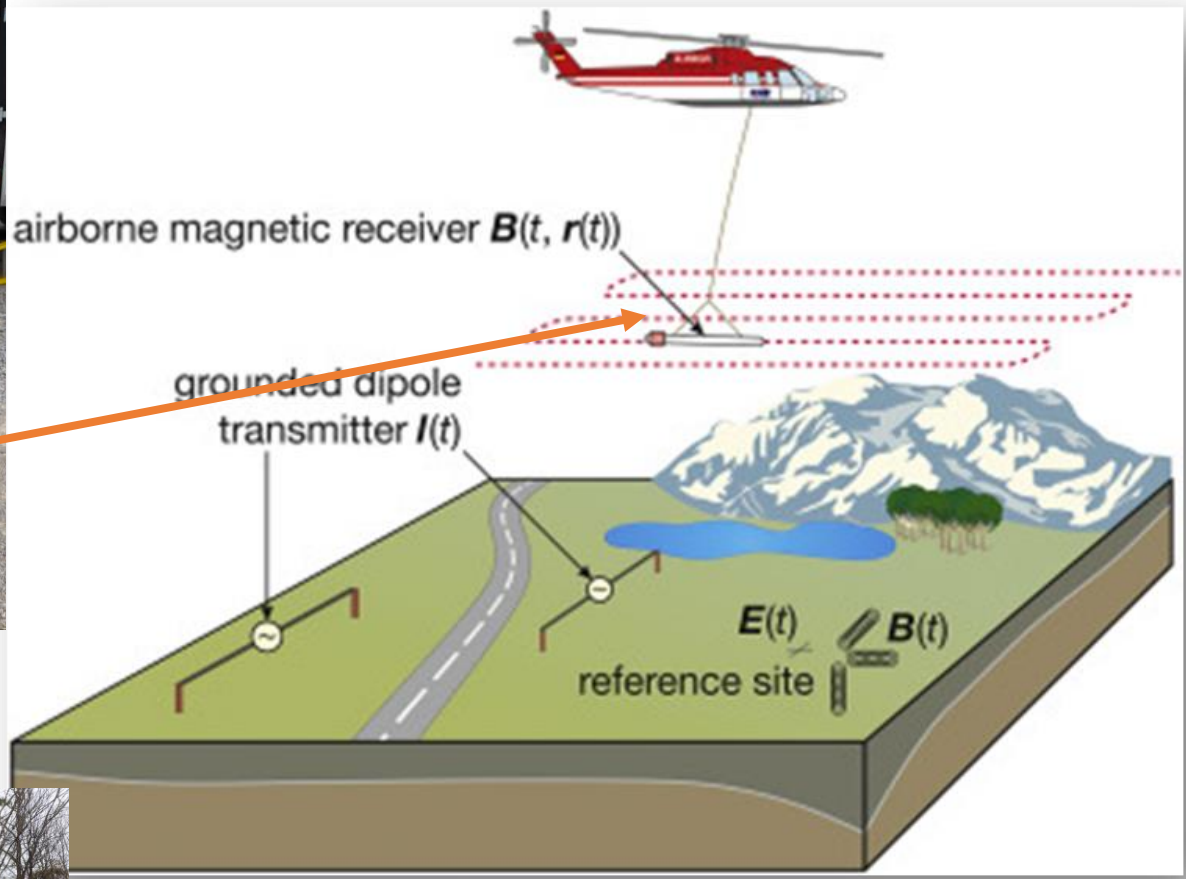
Survey Overview

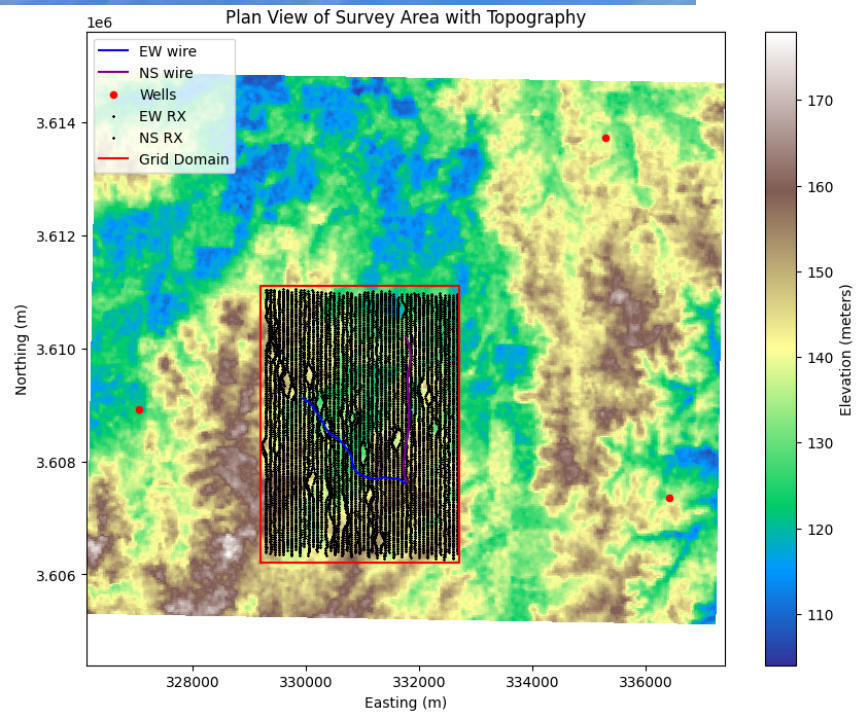


- CO_2 captured at Plant Ratcliffe
- Pipeline to 19-2 well for injection
- Monitor plume from surface
  - Seismic (expensive)
  - **Semi-airborne electromagnetics**
  - Magnetotellurics
  - Gravity
- Recover baseline conductivity
- Understand cultural noise
- Repeat after injection
- **First of a kind survey!**

Controlled-Source Electromagnetics (CSEM)







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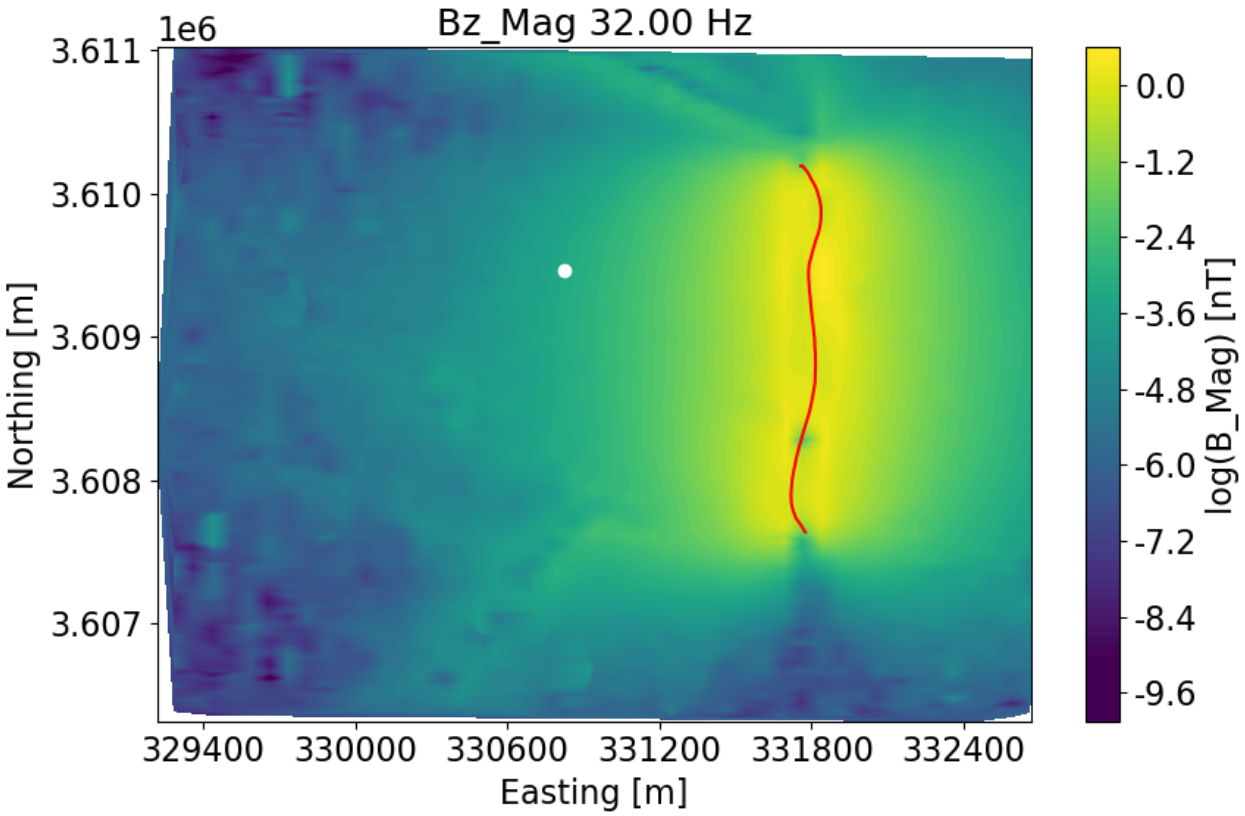
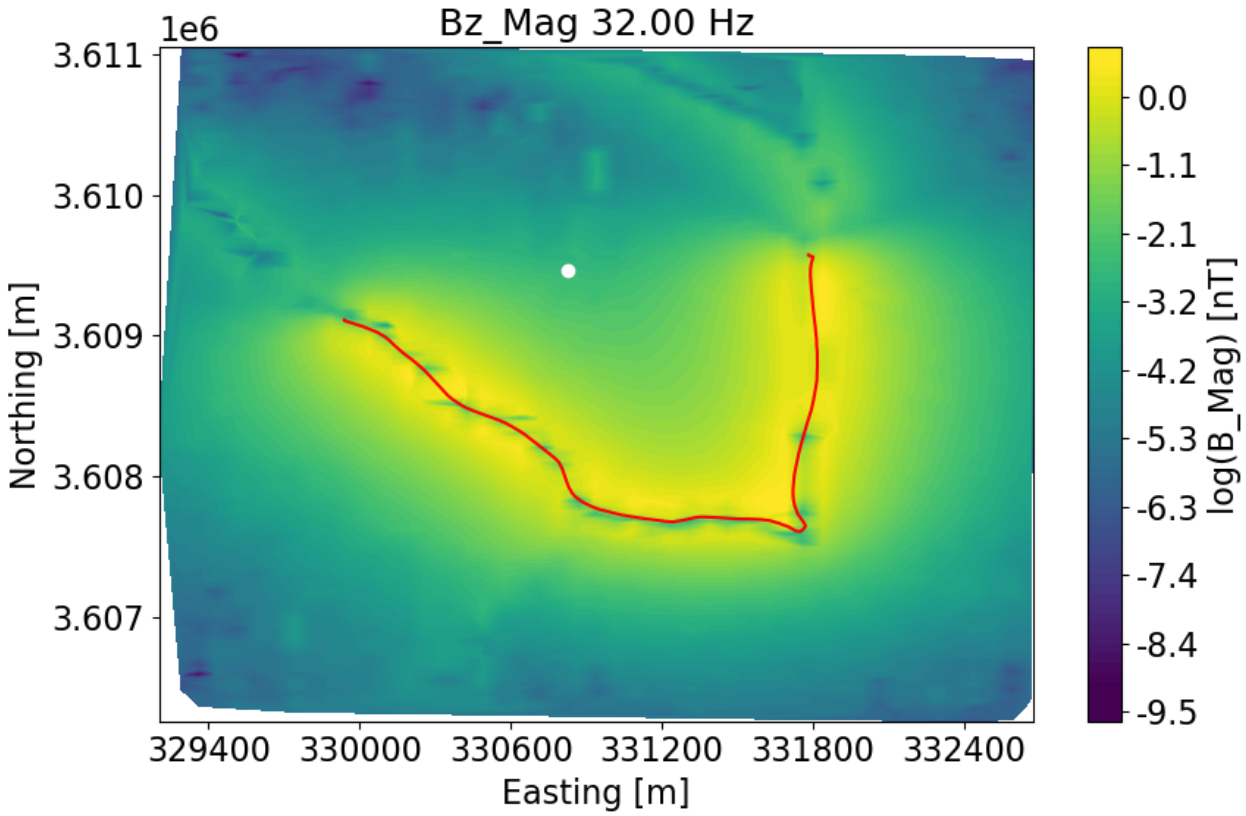
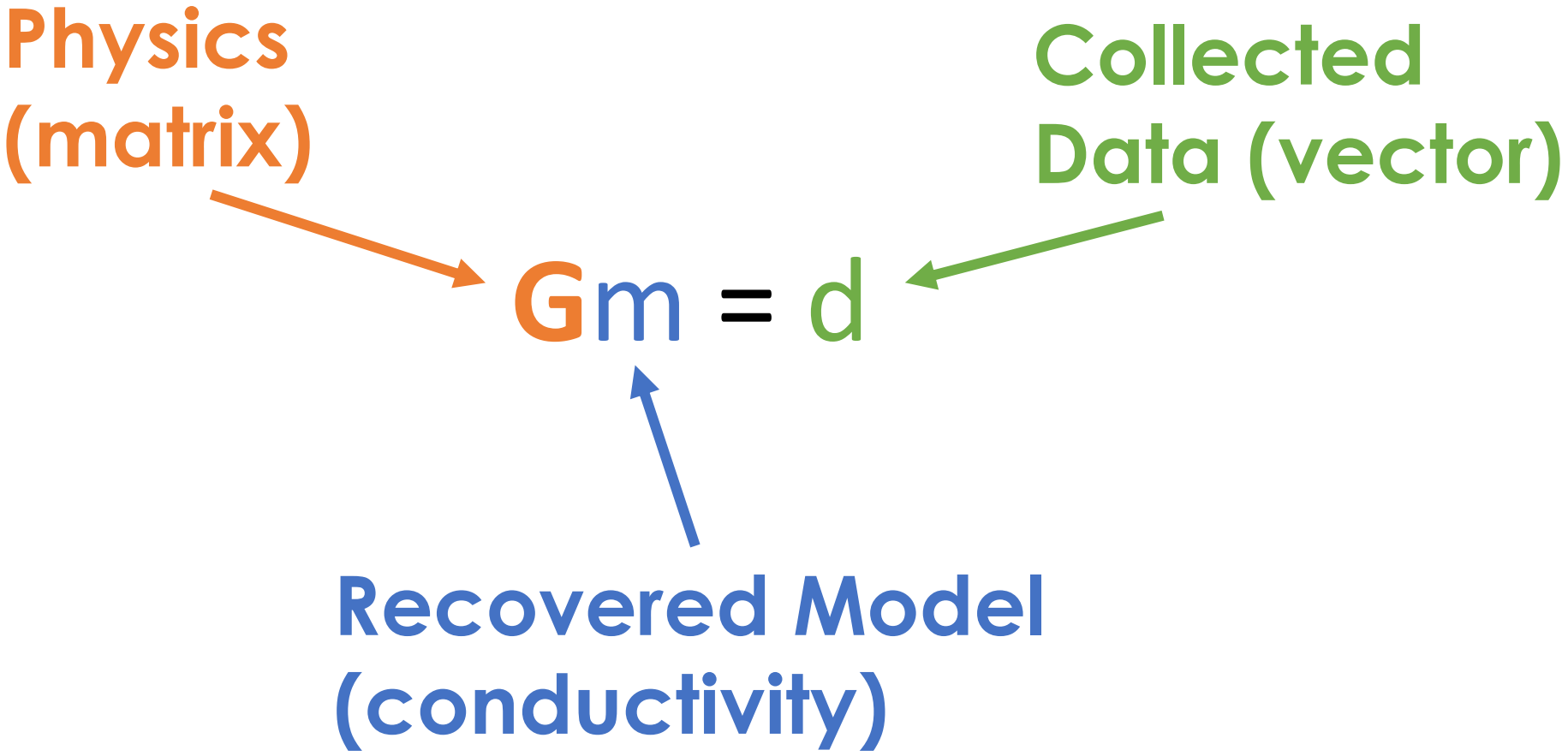
Collected Data

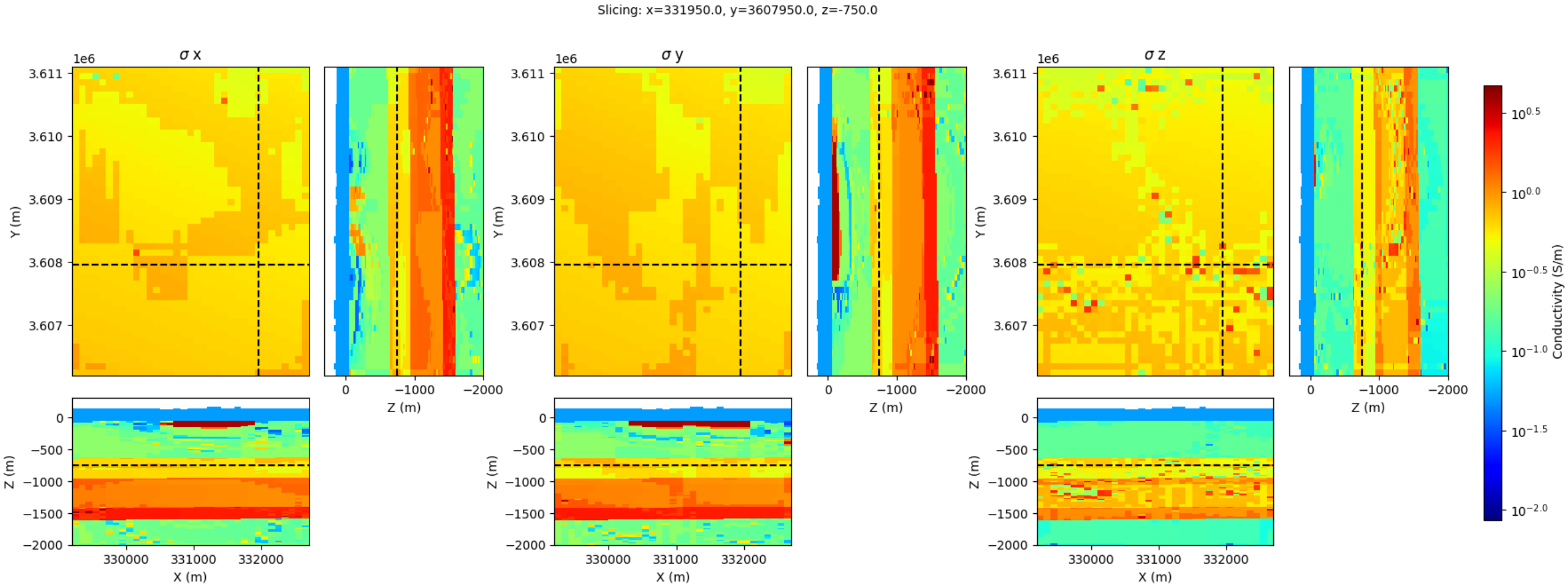




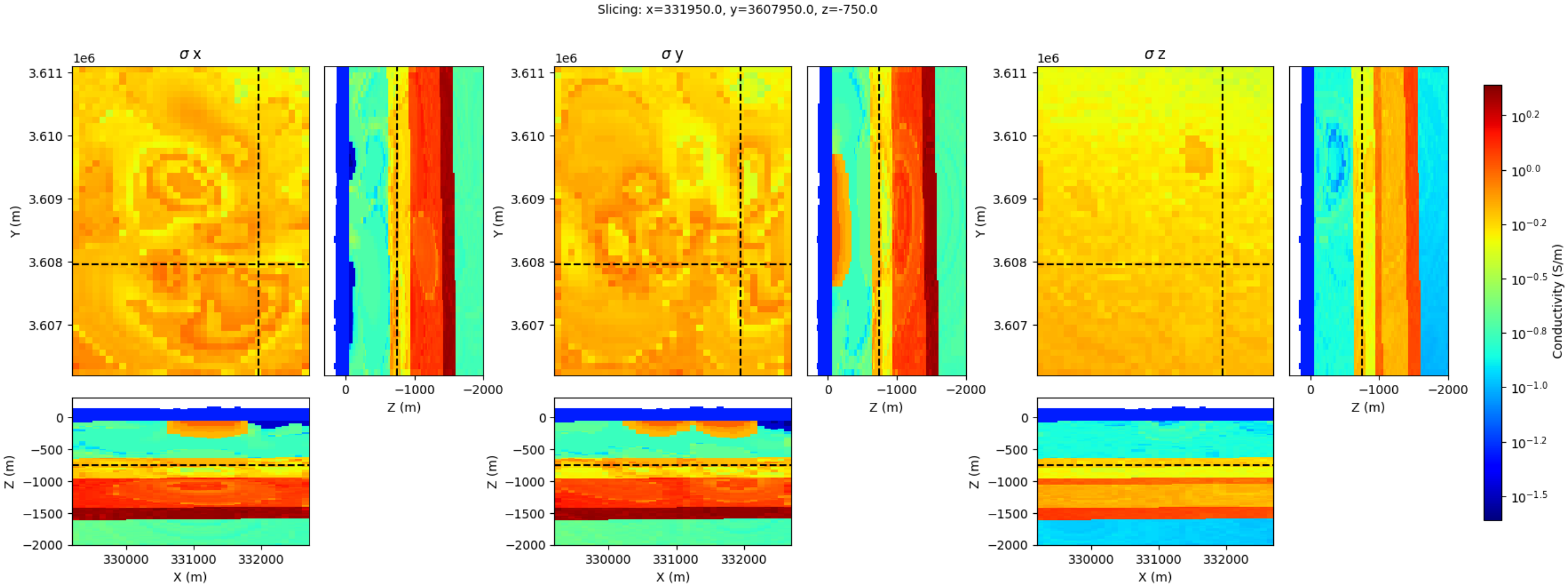
Model Recovery



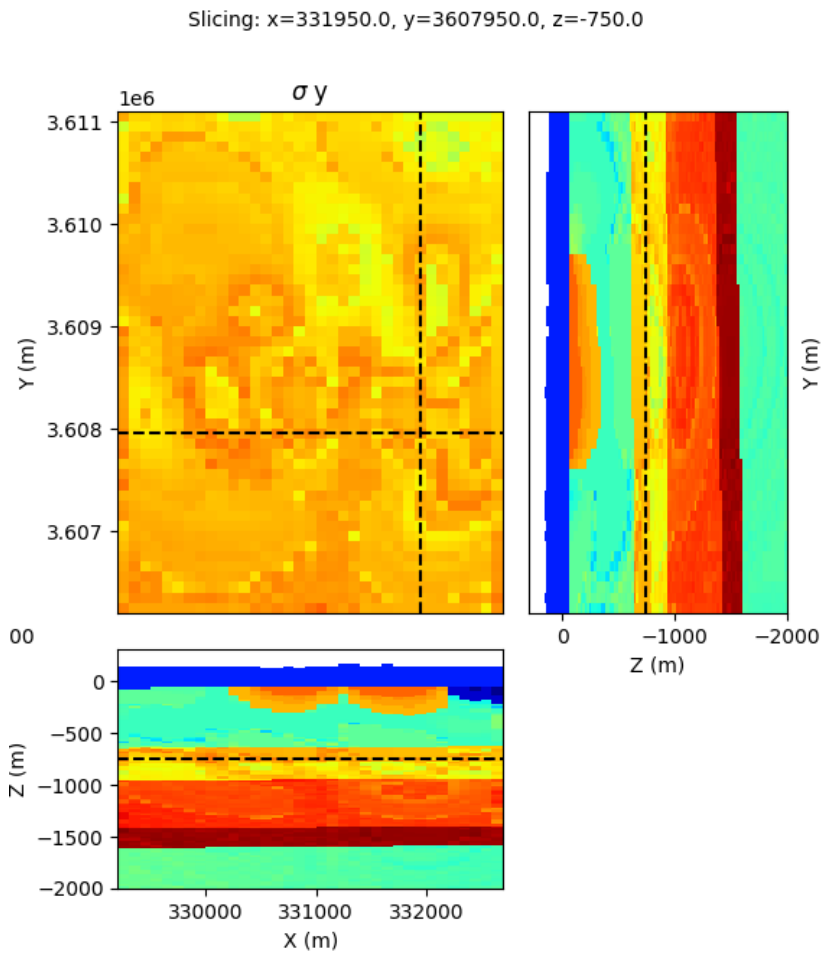
North-South Transmitter



East-West Transmitter



Inversion Results



- 1D conductivity structure at the Kemper site recovered
  - Expectation matches reality
- Baseline conductivity at site is VTI
  - Horizontal components are similar
  - Vertical component is different
- Cultural noise is present in data, but can be overcome
- Strong baseline conductivity model to compare monitoring surveys

Summary

- Successful project concept, validation, data collection, and interpretation
- Recovered 3D baseline conductivity structure of region
- Local EM noise level is manageable
- Points to ability to use electromagnetics to monitor site
  - Incorporate into monitoring strategy
- CSEM is not suitable everywhere, but can be beneficial
  - Relatively shallow injection (~< 2 km)
  - Conductive brine reservoir
  - Other EM methods suitable elsewhere

Next Steps

- No known plans to inject at Kemper in next 2 years
- Simulate injection/leak scenarios into baseline model and simulate data
- Publishing findings
- Explore other EM methods (magnetotellurics, cross-well, drone-based, etc.)
- Real-time CSEM monitoring
  - Lot of practical limitations
- Extensions to other storage sites
  - Can incorporate into monitoring plans
  - Potential to reduce number of costly seismic monitoring surveys
  - "Best time to do a baseline survey is pre-injection. Second best time is now."

- Willing to collaborate with storage sites if appropriate and able

Questions?

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