

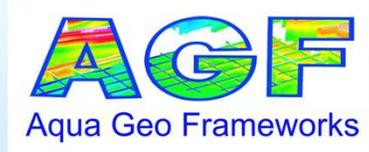
Airborne Electromagnetic (AEM) Surveys for Groundwater Studies in KS GMD-1

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AGF

- We have worked in the following States:
 - AK, AZ, CA, CO, FL, IA, ID, IN, KS, LA, ME, MI, MN, MT, ND, NE, NH, NM, NV, OK, SC, SD, TX, UT, WA, and WY.
 - Northern Marianas Islands
- We have worked in the following Countries:
 - Afghanistan, Antarctica, Australia, Botswana, Brazil, Canada, China, Columbia, Costa Rica, Denmark, Ecuador, Egypt, Ethiopia, Germany, Guyana, Honduras, India, Iraq, Ireland, Israel, Japan, Kenya, Malaysia, Mexico, Panama, Saudi Arabia, Singapore, South Korea, Sumatra, Thailand, Turkey, UAE, and UK.
- Licenses
 - Professional Geologist
 - AR, AZ, FL, IN, KS, MO, NE, TX, UT, and WY
 - Professional Geophysicist
 - CA
 - Geology Firm licenses
 - AZ, FL, KS, and NE (Previously TX)

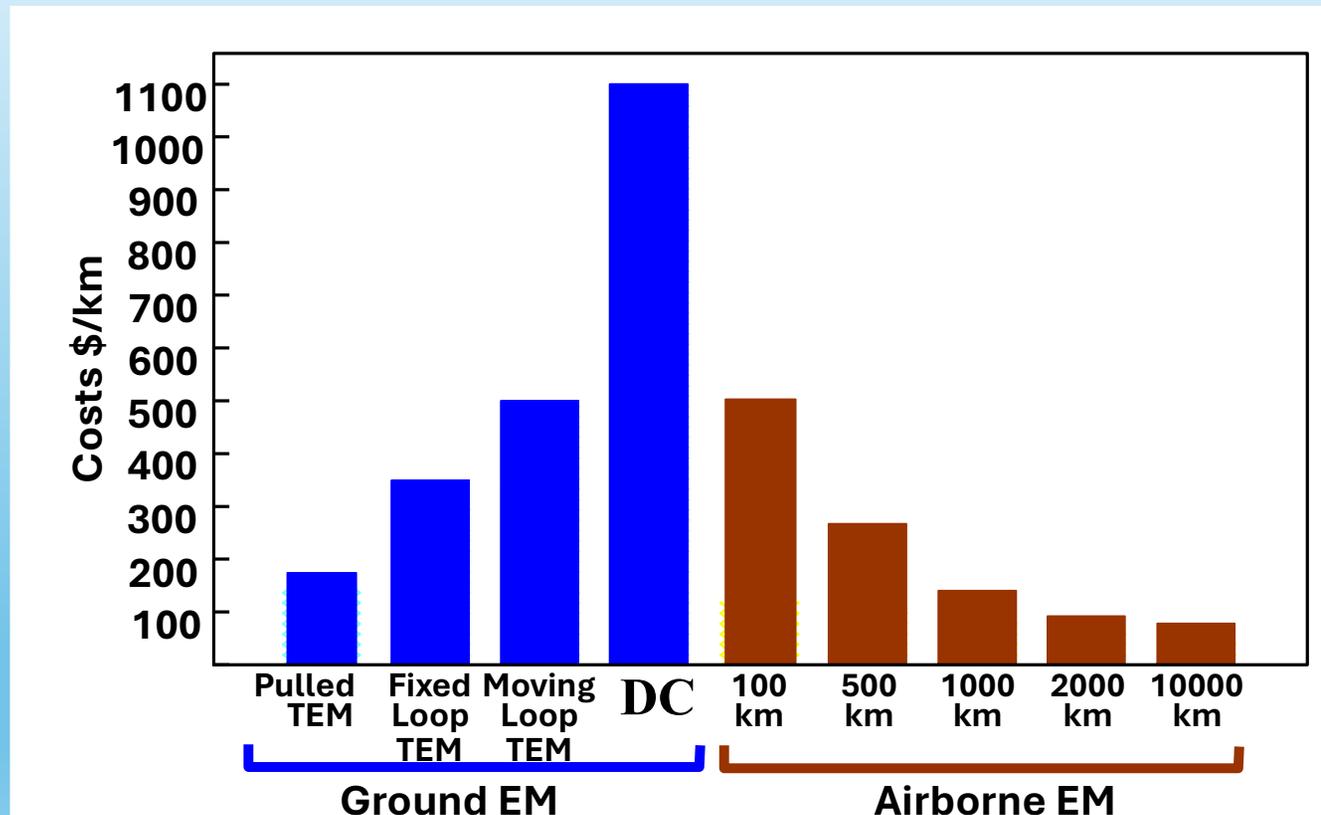
Airborne Electromagnetic (AEM)

Background

- Airborne Geophysics began following WWII
- Airborne magnetic surveys were the first airborne geophysics
- Mining exploration stimulated development of methods to map ore bodies including magnetic, radiometric, and EM techniques
- Gravity and magnetic methods have traditionally been used in petroleum exploration
- 1990's airborne geophysical methods have been used for groundwater, environmental, engineering and agricultural purposes.
- 2004 Calibrated systems customized for groundwater mapping developed
- 2010's Beginnings of mapping programs in Nebraska, Europe, Australia
- 2020's Many large-scale projects through USA, Australia, Europe

Why airborne geophysics?

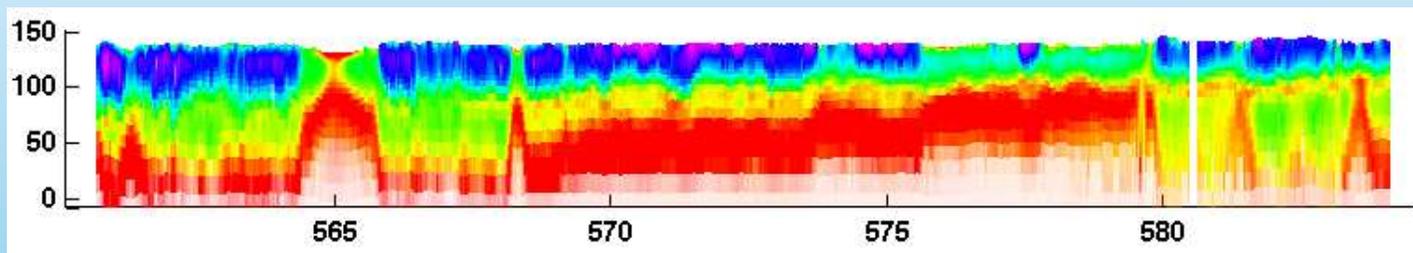
COST - Ground vs. Airborne \$



* Costs are representative only, and do not constitute a contract!

Why airborne geophysics?

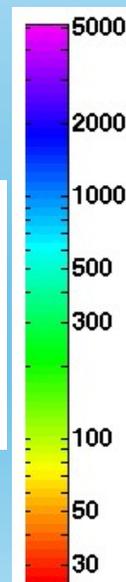
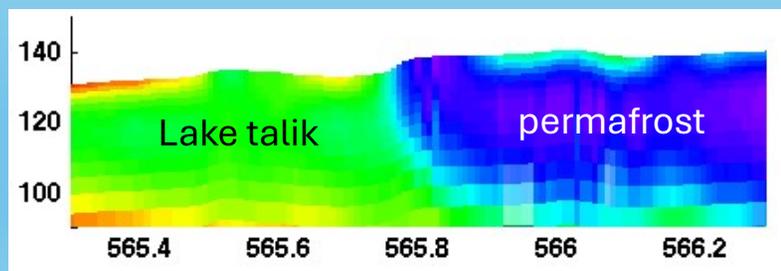
Airborne resistivity
~ 100 km / hour



Abraham, 2012
Minsley et. al., 2012



Ground-based resistivity
~ 1 km / day



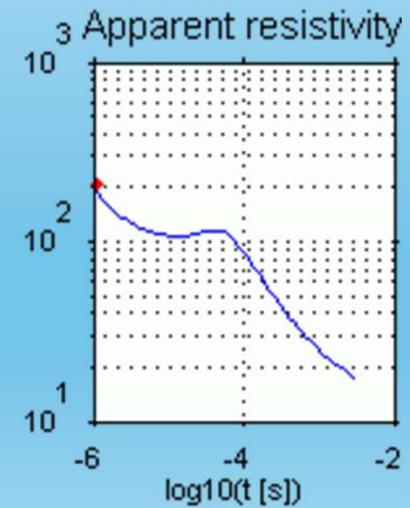
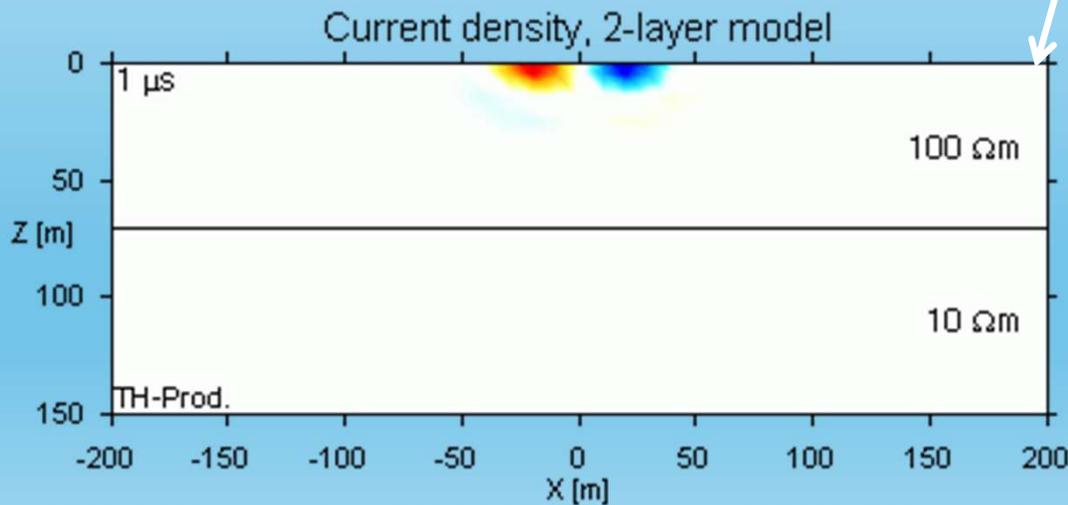
In a Nutshell - Physics of EM Induction Methods

- **Current in Tx loop produces a magnetic field**
- **Turning off or varying the current (dB/dt) induces a current system in the earth**
- **Induced current system diffuses outward and downward with time**
- **Interaction of current system and ground controlled by earth *resistivity***
- **We measure a secondary magnetic field generated from the induced currents in the earth on one or more receivers**

What's happening in the earth



The current induced in the earth diffuses downward and outward
What we measure in the receiver coil



E. Auken from Aarhus University of

Helicopter AEM Platform



Developed in Denmark for
Groundwater Mapping

Dual Plus System
High Frequency
Low Frequency

High Bandwidth

Calibrated to Earth Model

Drift Mitigation in
Electronics/Processing

Platform Attitude Control

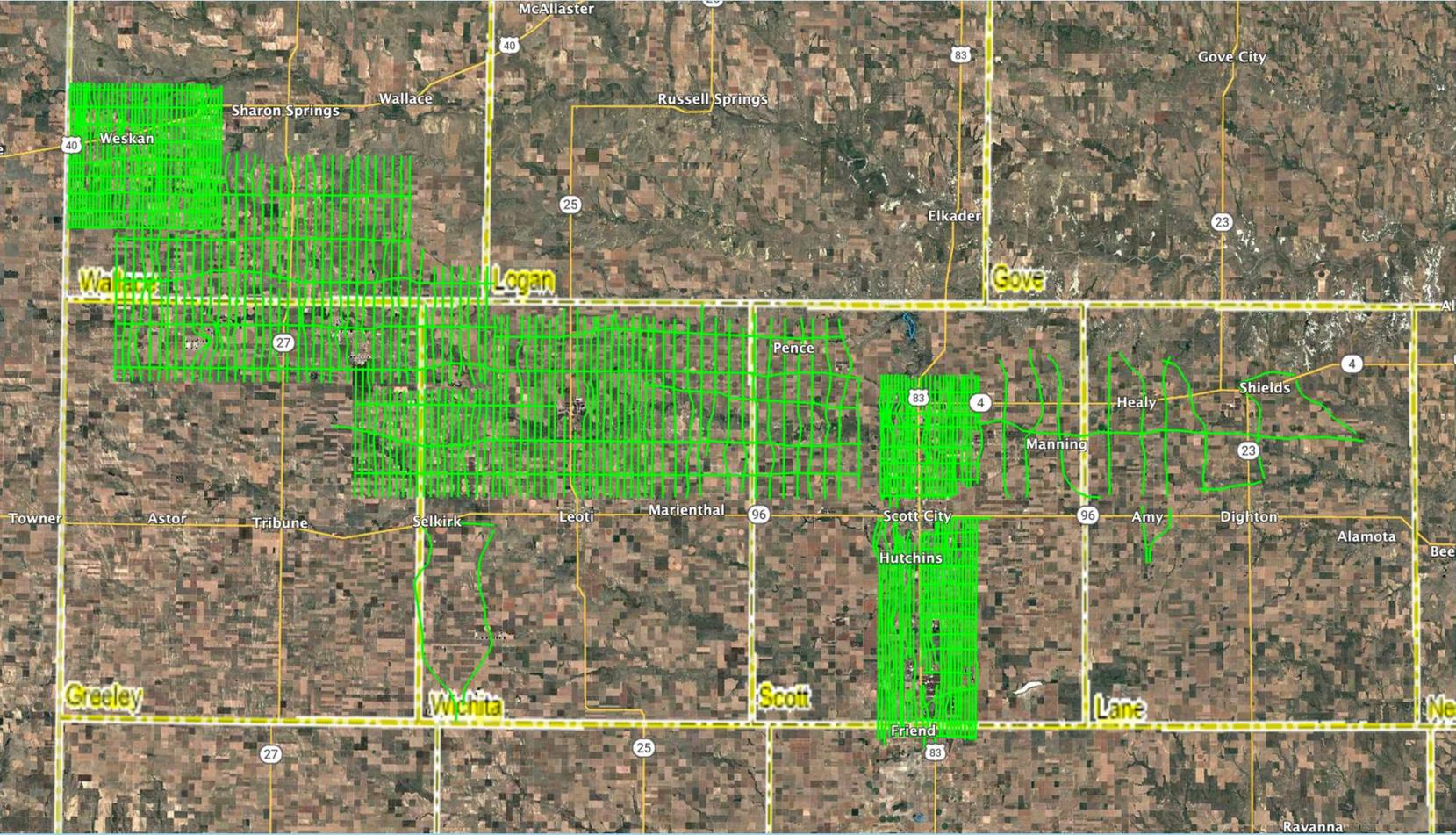
Integrated Processing in Aarhus
Workbench

Additional Considerations when using Airborne EM

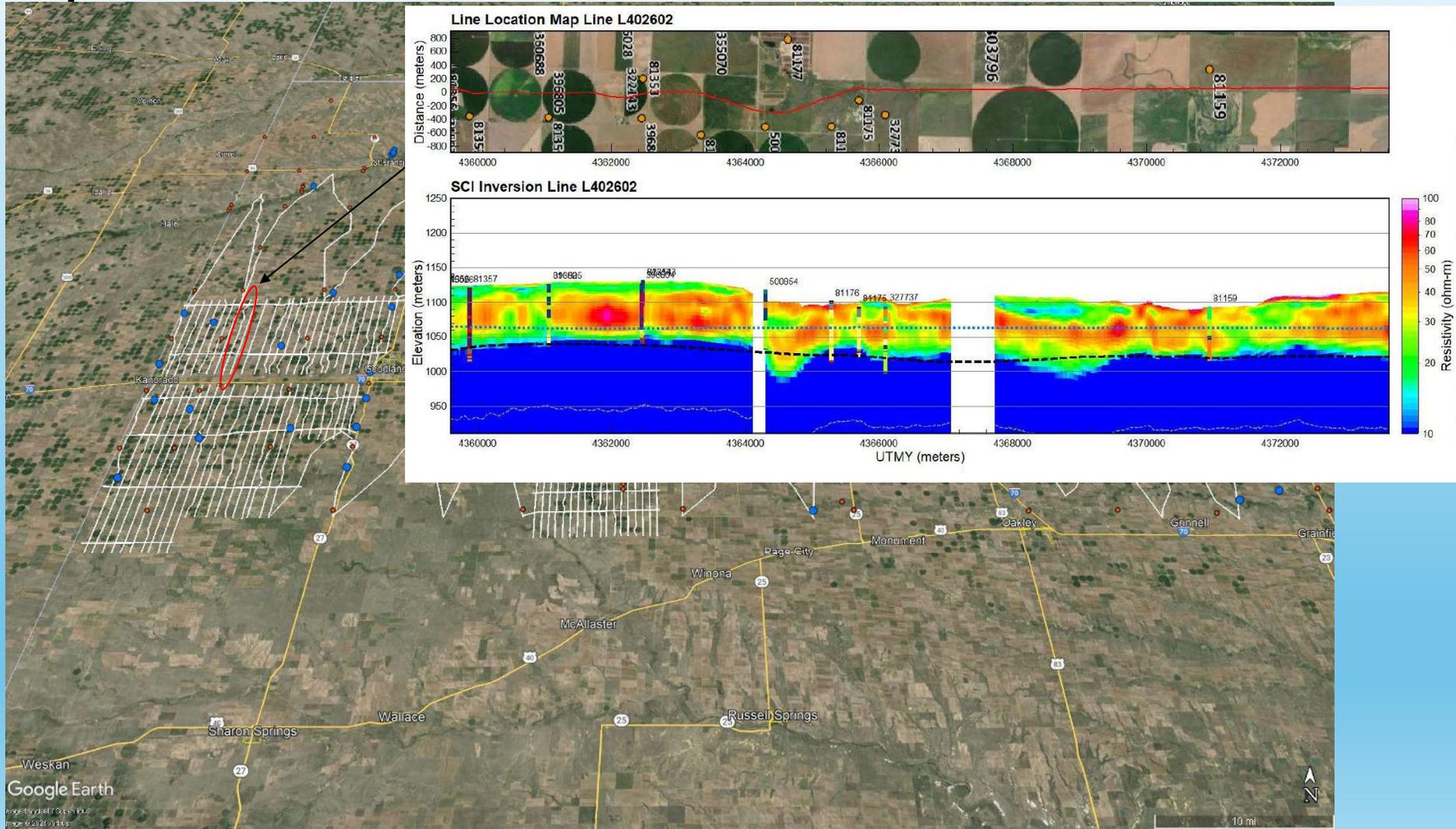
- Contractors fly surveys
- Elevation control, attitude control
- System calibration
- Infrastructure
- Public awareness



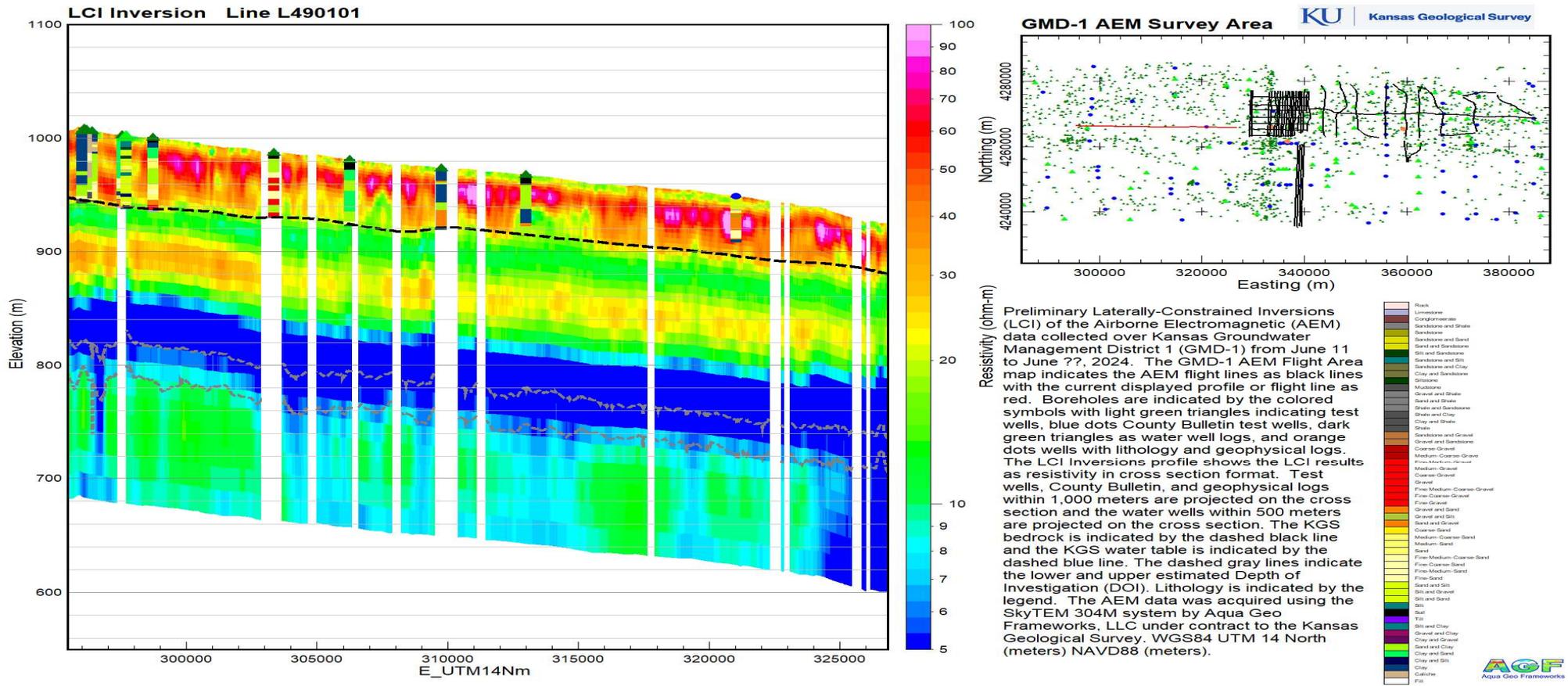
GMD-1 AEM Flight Area



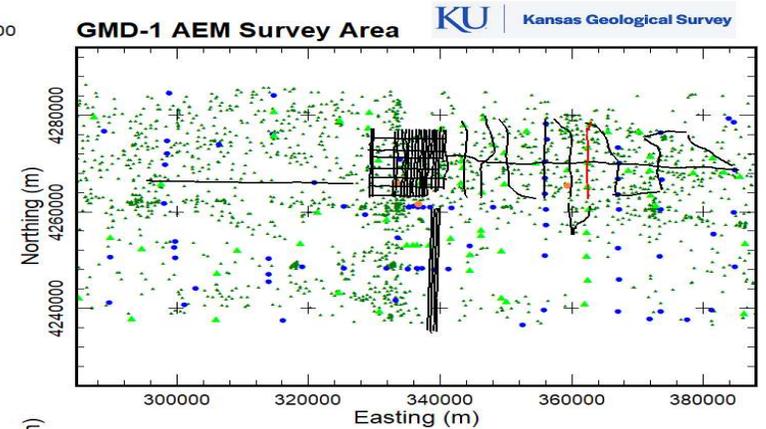
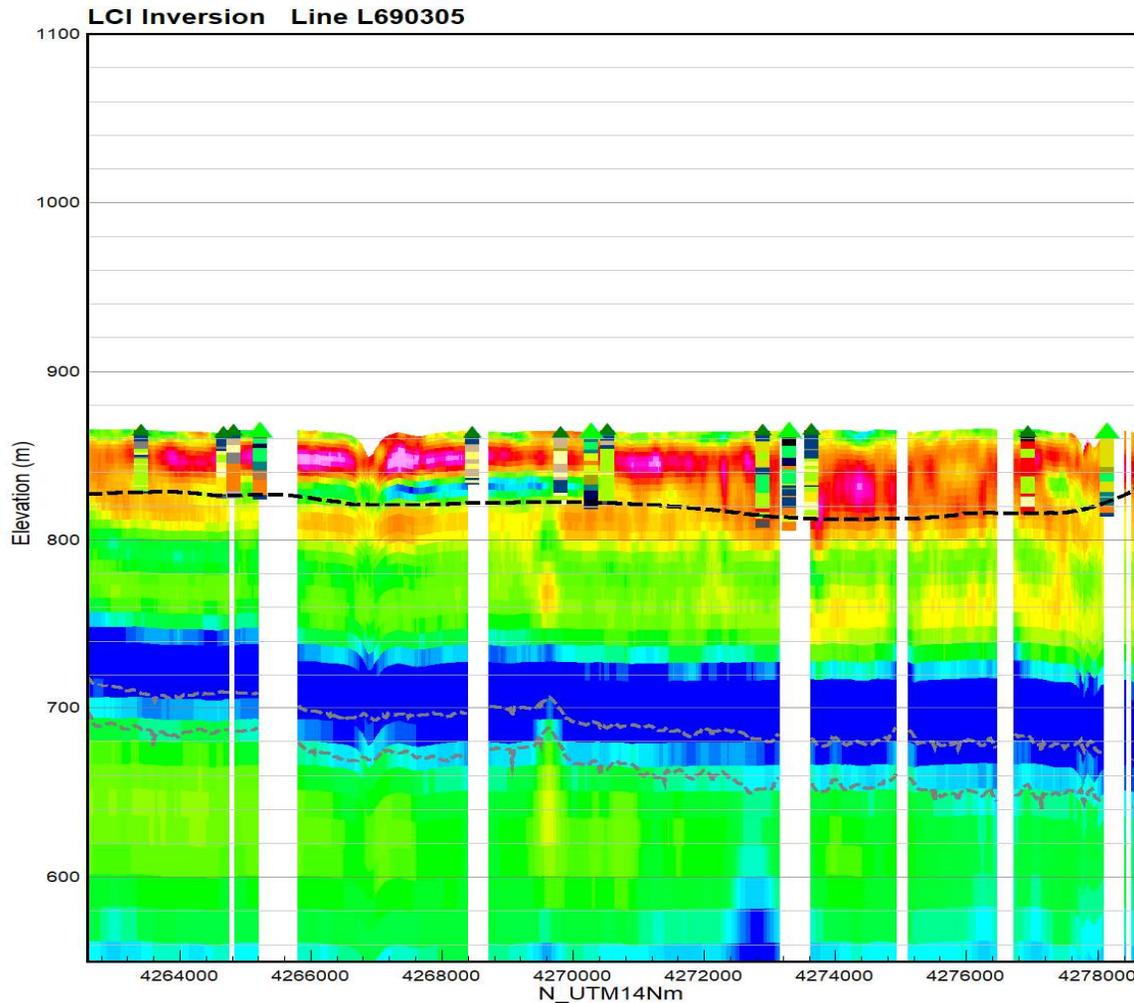
Example from GMD-4



“Preliminary” Example GMD-1



“Preliminary” Example GMD-1



Preliminary Laterally-Constrained Inversions (LCI) of the Airborne Electromagnetic (AEM) data collected over Kansas Groundwater Management District 1 (GMD-1) from June 11 to June ??, 2024. The GMD-1 AEM Flight Area map indicates the AEM flight lines as black lines with the current displayed profile or flight line as red. Boreholes are indicated by the colored symbols with light green triangles indicating test wells, blue dots County Bulletin test wells, dark green triangles as water well logs, and orange dots wells with lithology and geophysical logs. The LCI Inversions profile shows the LCI results as resistivity in cross section format. Test wells, County Bulletin, and geophysical logs within 1,000 meters are projected on the cross section and the water wells within 500 meters are projected on the cross section. The KGS bedrock is indicated by the dashed black line and the KGS water table is indicated by the dashed blue line. The dashed gray lines indicate the lower and upper estimated Depth of Investigation (DOI). Lithology is indicated by the legend. The AEM data was acquired using the SkyTEM 304M system by Aqua Geo Frameworks, LLC under contract to the Kansas Geological Survey. WGS84 UTM 14 North (meters) NAVD88 (meters).

