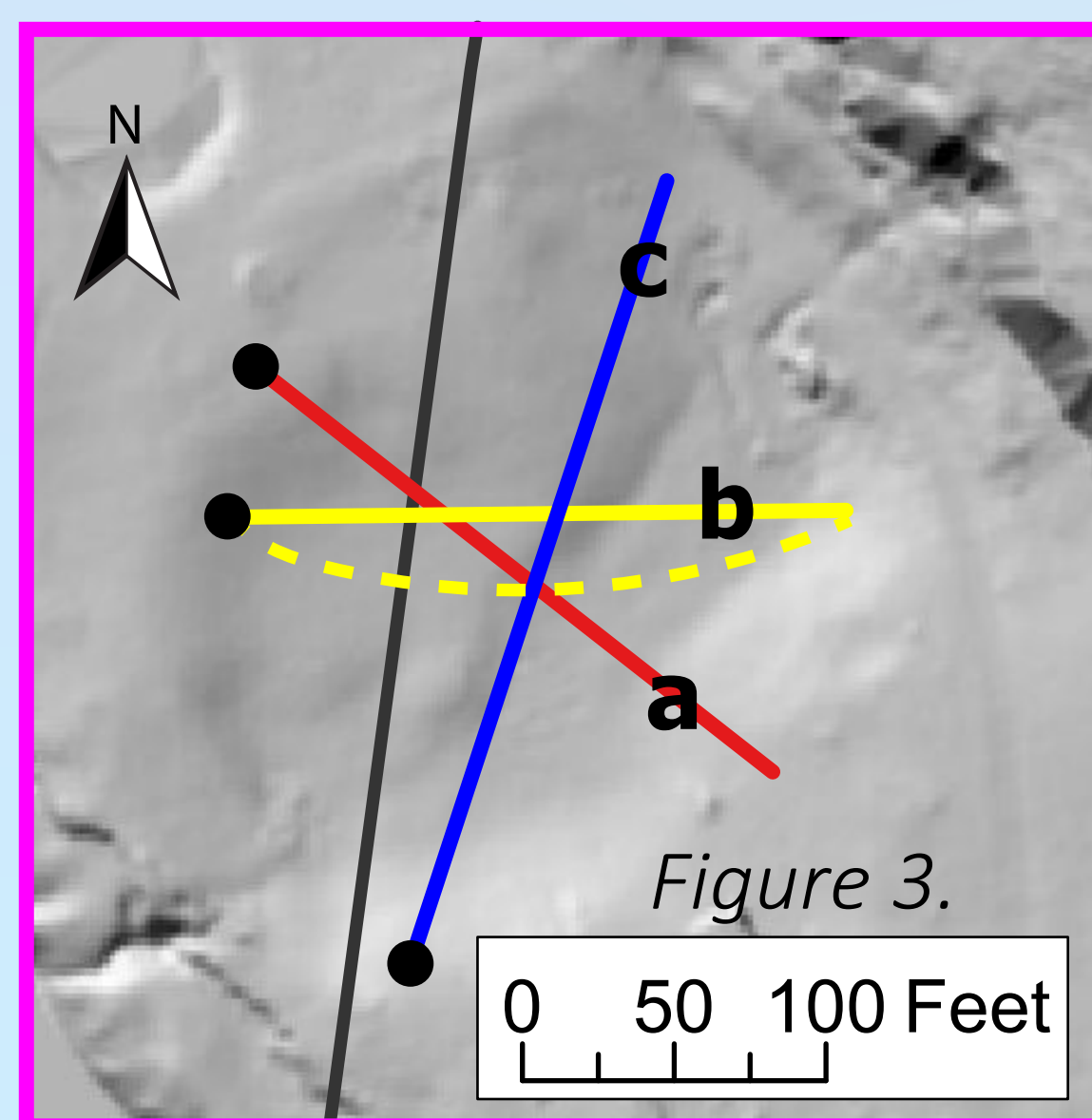
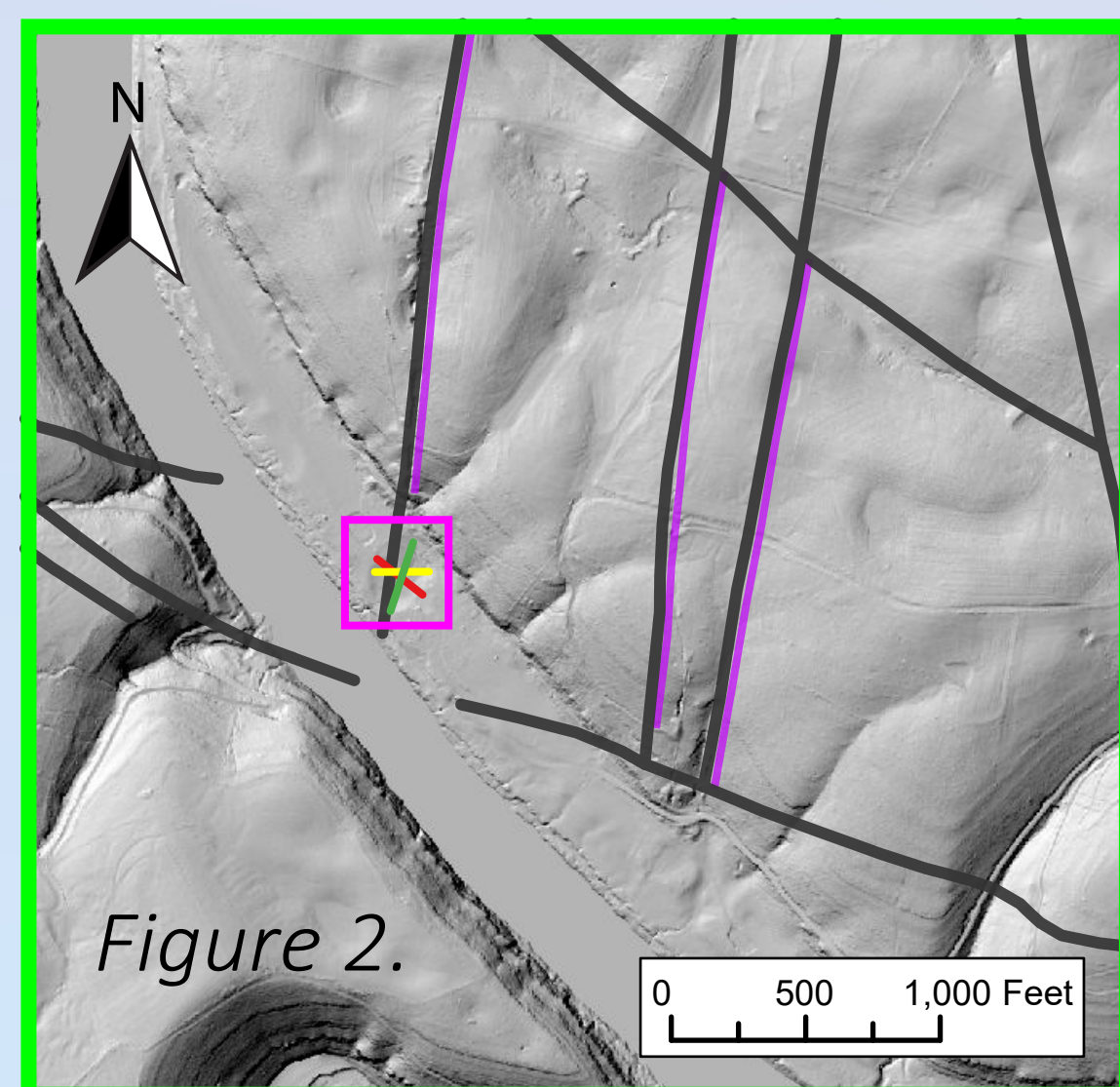
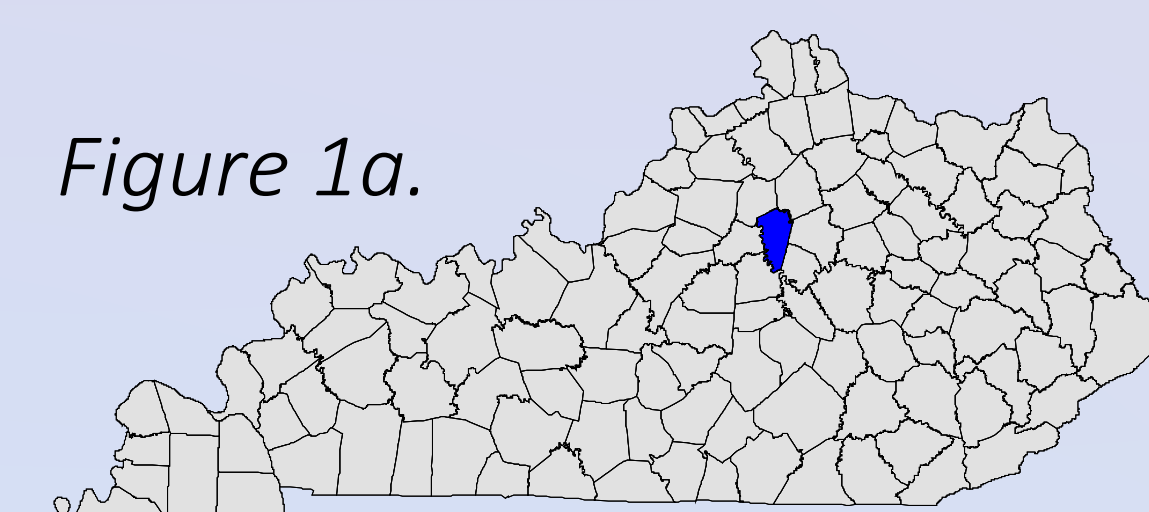


Using Electrical Resistivity Tomography to Investigate Subsurface Faulting in Mundy's Landing

Background

Electrical Resistivity Tomography (ERT) is an effective geophysical technique for noninvasive subsurface exploration, especially for hydrological investigations. ERT has also become a valuable tool in locating subsurface features like faults (Arjwech et al. 2021) as well as karst conduits (Zhu, Currens, and Dinger 2011). The purpose of this study is to explore the relationship between subsurface structural features and hydrological processes within Mundy's Landing. Specifically, this study is utilizing ERT to determine if a subsurface fault is behaving as a fluid conduit--promoting the formation of a large and unusually shaped depression. These findings may provide useful insight into land subsidence processes and overall landscape evolution of Mundy's Landing and surrounding areas.

Study Area



*dotted yellow line is closer to true location

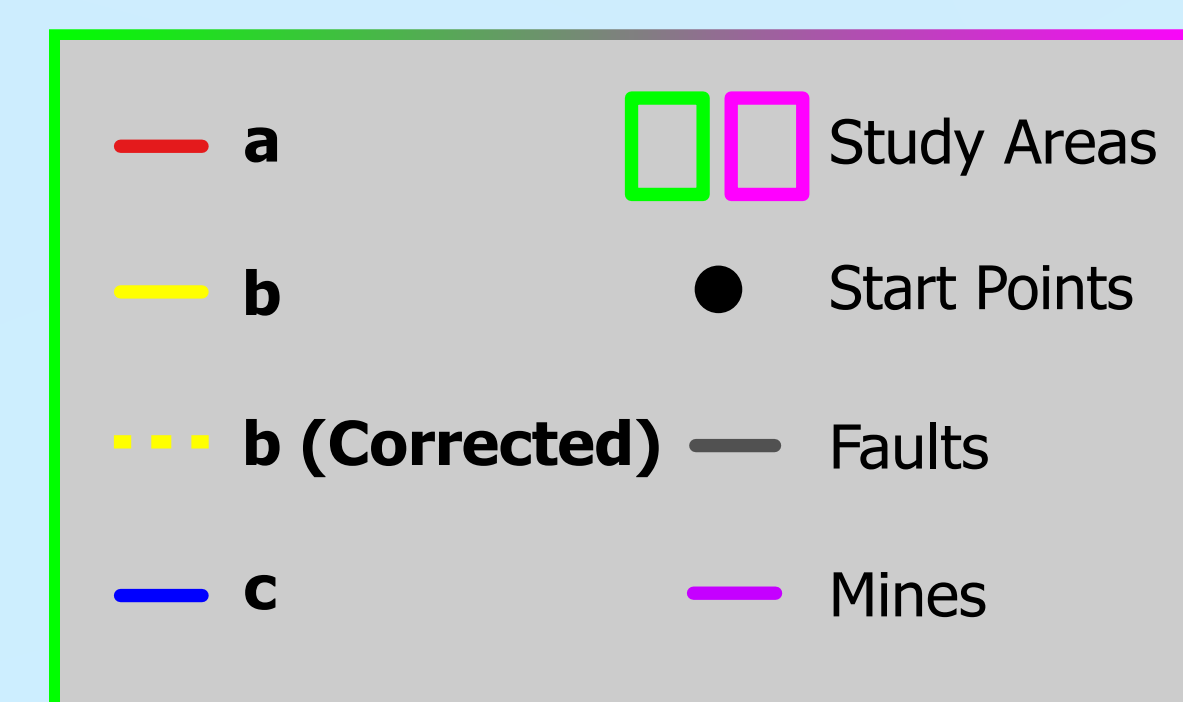


Figure 1b.

- Located in Woodford County, Kentucky
- Encompasses an inner meander bend of the Kentucky River
- Alluvial deposits overlay Camp Nelson Limestone
- Kentucky River interacts with limestone producing fluviokarst landscape (Phillips et al. 2004)

- Several Normal faults containing fluorspar veins were mined out from the early 1900's until WWII (Anderson et. al 1982) and operated as a bustling hub for travellers during and prior to that time
- The mines have been inactive and the landing has been privately owned since WWII
- Recent extreme flooding has raised concerns for land subsidence
- **Could subsurface structural features be contributing to flooding and land subsidence problems?**

Figure 1a. Inset maps of Kentucky. Figure 1b. Inset map of Woodford County. Figure 2. Larger Study area of mundy's landing with fault trace and mines. Figure 3. Closeup of ERT profile lines and intersection with fault-zone. Black circles indicate starting points.

Methods

- ArcGIS analysis of high-resolution (2ft resolution) DEM Models
- Analysis of 24k Harrodsburg Geologic Quadrangle (GQ)
- Traditional field observations
- Electrical Resistivity Tomography (ERT)
 - 84-electrode SuperSting Resistivity Meter
 - 5ft electrode spacing
 - Dipole-dipole electrode array
 - 3 recorded profiles totaling 740 feet
 - Terrain files created using ArcGIS Pro
 - Apparent resistivity values inverted with EarthImager 2D program

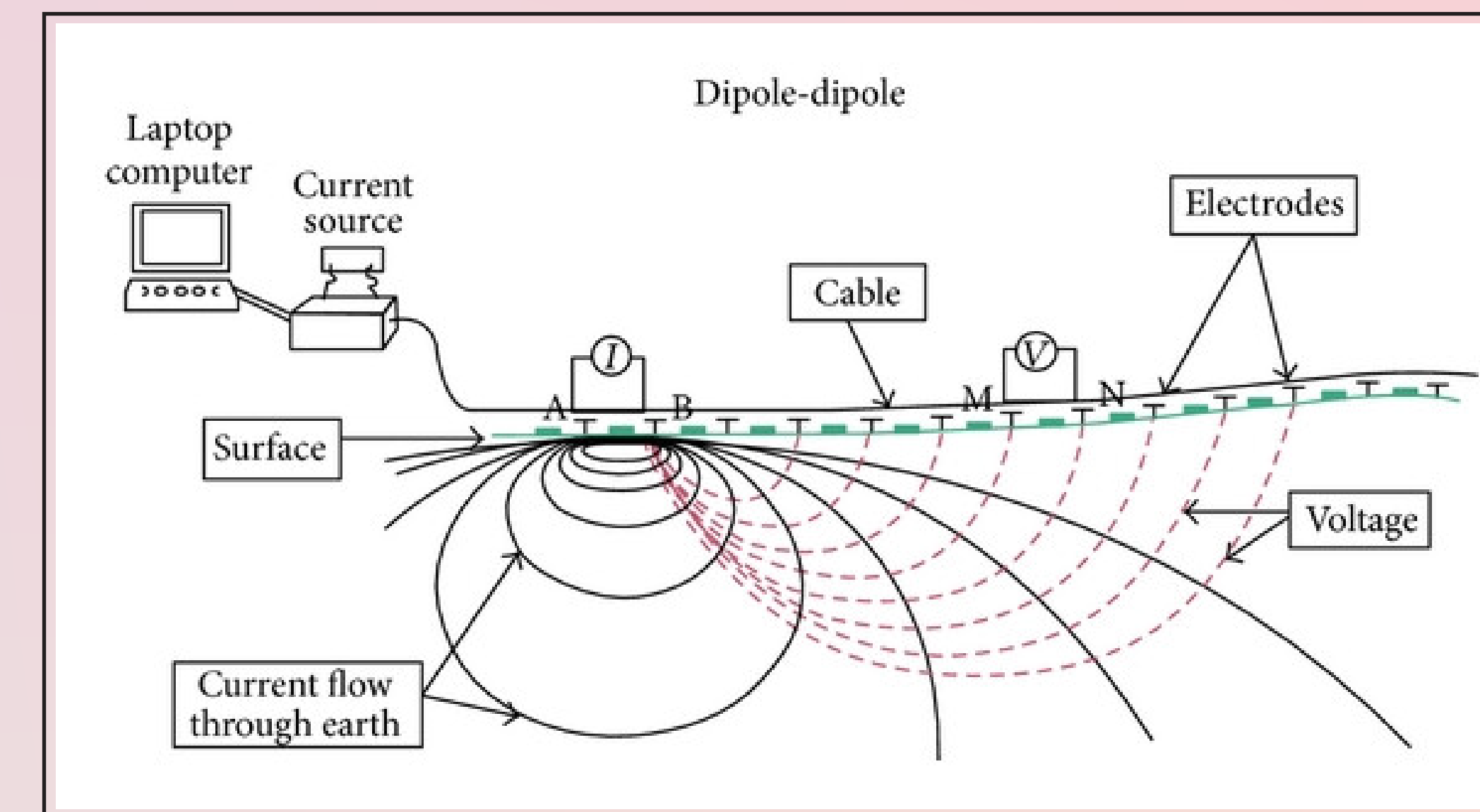


Figure 4. Diagram of dipole-dipole electrode array for ERT survey. From Application of 2D Electrical Resistivity Tomography in Landfill Site: A Case Study of Iku, Ikare Akoko, Southwestern Nigeria [Figure 5], by Chibueze Okpoli 2013.

Results

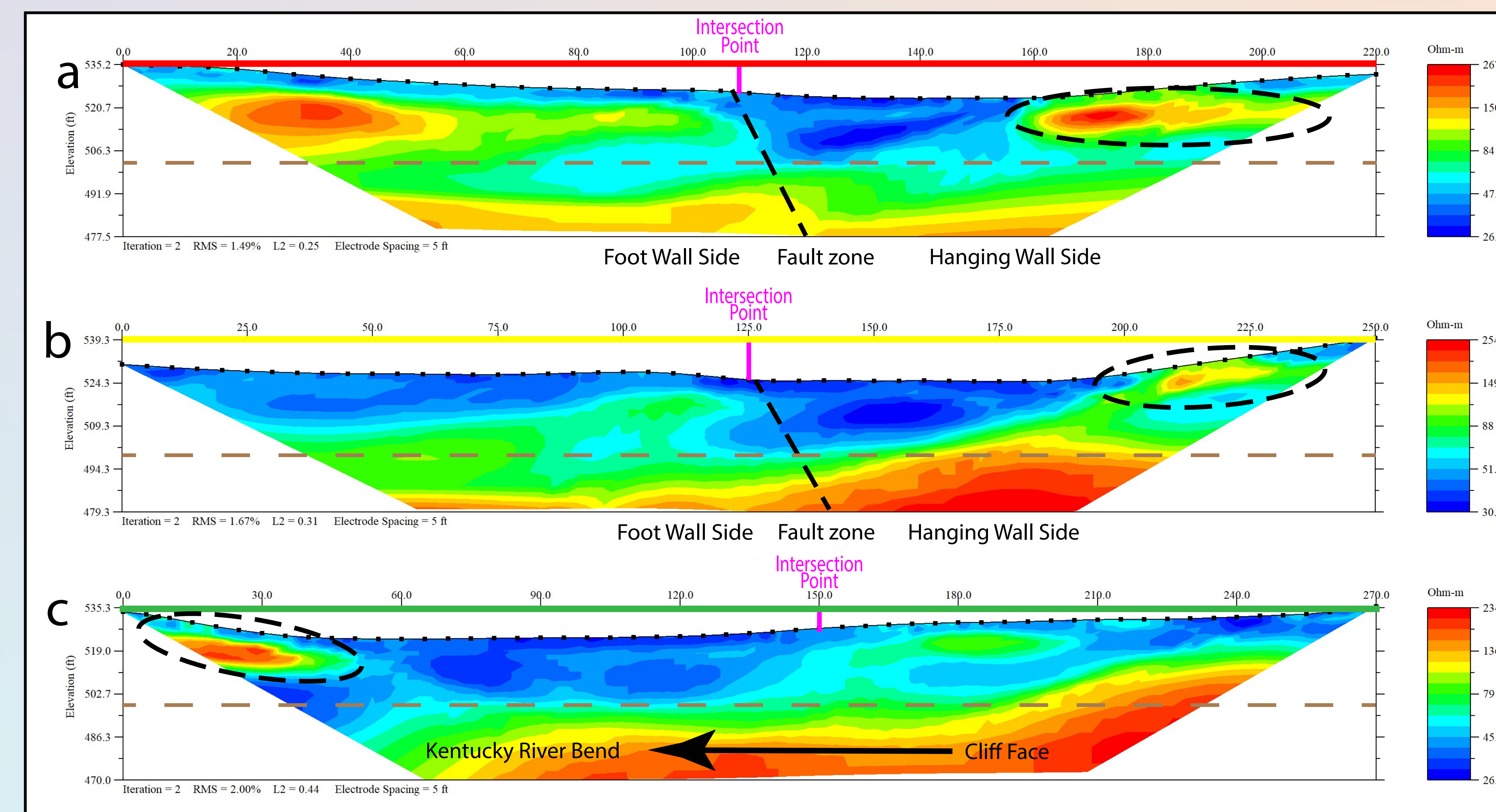


Figure 5. Inverted resistivity profiles. a) Line 1, b) Line 2, and c) Line 3. Black dotted circles are highlighting possible tree root interference. Brown dotted line represents the surface elevation of the Kentucky River (~500ft). Color interpretation: Red to yellow: interpreted as bedrock. Blue to teal: interpreted as alluvium. Green: Possibly fractured or highly weathered bedrock, or areas with higher clay content.

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Discussion

Profiles a and b present large areas of low resistivity congruent with expectations for fault zone expression. The appearance of a hanging wall and foot wall can be interpreted more easily in profile a than b. Profile b also lost roughly 45 feet from data collection to processing, so the exact location of the fault within this profile is not precise. Profiles a and c also lost some footage but no more than 5-10 feet each. Profile c does not intersect with the fault from the map view and intersection cannot be interpreted from the profile; it is possible the green block is an extension of the fault but this is not verified.

The appearance of the blue "bowl-shaped" areas on profiles a and b are interpreted as being a fluid pathway. Why the fault is channeling water, however, is still unknown. There are 3 possible explanations:

1. This area could have been mined out and poorly backfilled.
2. The fault could be deflecting water to the hanging wall side.
3. The fault could have karstified, creating a positive feedback loop with any channelized water.

Conclusions and Future Work

Regardless of why, there is a clear relationship between fault expression and this depression, indicating there is some fault related void space (natural or anthropogenic) behaving as a fluid conduit in this location.

This work could also suggest that the current mapping of the fault is off by about 30-40 feet in some places, though future work is needed to confirm this as well.

Suggestions for future work include drilling and logging cores and extending ERT lines for deeper subsurface penetration as to verify findings.

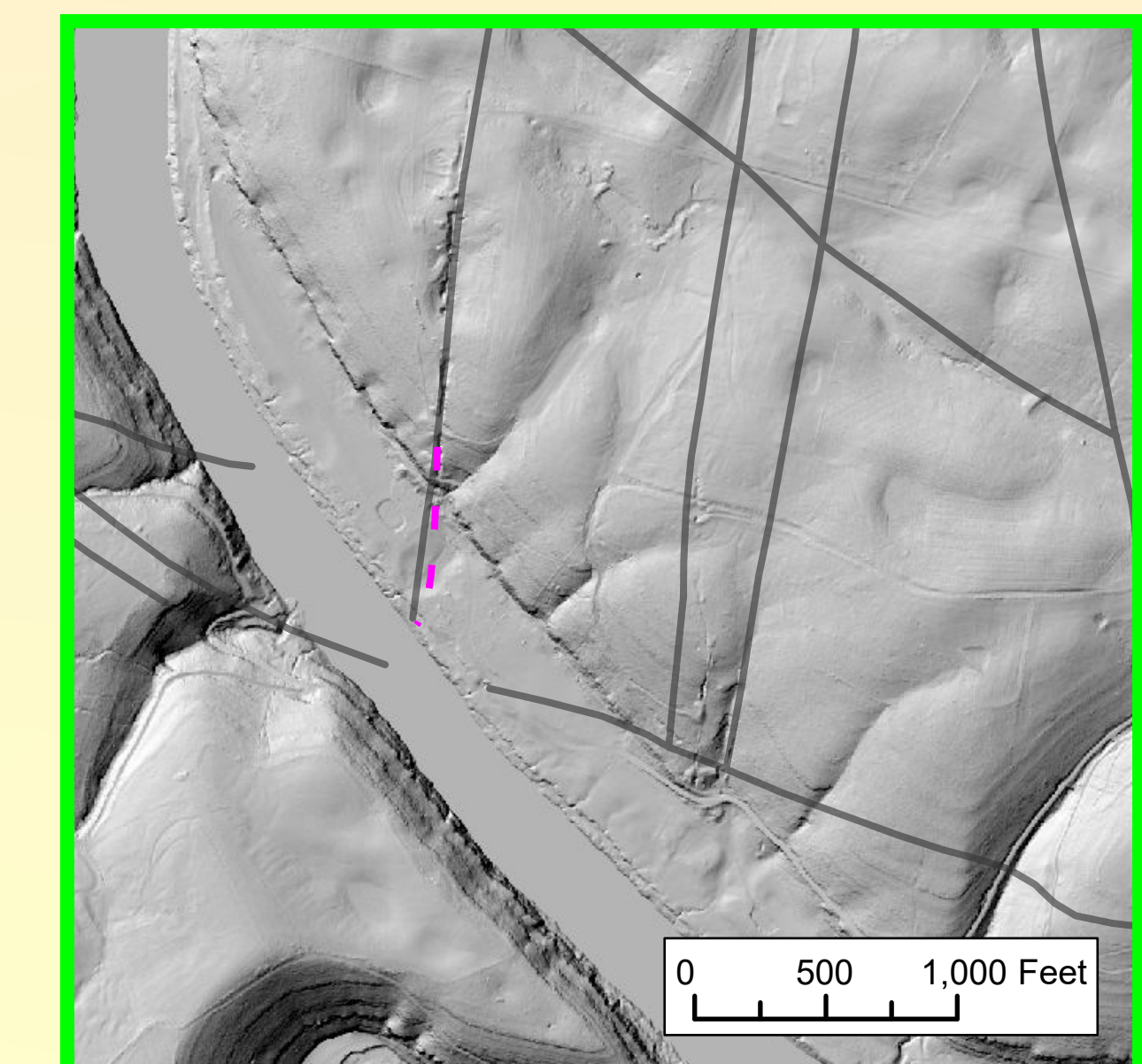


Figure 6. Map of Mundy's; pink dotted line represents possible new location for fault.

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