Booth #199
Abstract #197476
Session #104, T6. Combining Geology and Geophysics (Posters)
Monday, 10 October 2011
Presenting author will be at the booth from 2 to 4 PM, and 4:30 to 6 PM
Minneapolis Convention Center, Hall C

Refining Floodplain Stratigraphy at the Pine Lake Environmental Campus Archaeological Site Using GPR, EMI, and GPS

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ABSTRACT

The Pine Lake Environmental Campus (PLEC) of Hartwick College provides an excellent research locale to investigate floodplain stratigraphy. The Campus rests on a glacial moraine and Holocene floodplain next to Charlotte Creek in central upstate New York. Archaeological excavations on the floodplain have unearthed artifacts dating from the 20th Century to nearly 10,000 years BP. Further, archaeological test pits provide excellent ground truth for geophysical surveys. Previous ground penetrating radar (GPR) surveys of this floodplain revealed numerous channel and bar like features in the radar stratigraphy. Our work builds on that study, correcting problems with geolocation of profiles, increasing the data density, adding an electromagnetic induction (EMI) profile survey and characterizing surface topography with differential GPS.

For our surveys, we partitioned the floodplain into seven rectangular grids to take advantage of visualization software for three dimensional data. Each grid had 0.5 m spacing between each survey line. For each line we shot GPR at 1 cm spaced intervals, and followed the same path with EMI, collected at roughly 1 m spacing between shots. Grids varied widely in shape and size. For each day's survey, static GPS receivers provided georeference control, and roving GPS attached to the GPR captured local topography.

We find that rectangular grids greatly simplified correlation between lines, and facilitated both processing and visualization of GPR and EMI data. GPR stratigraphy portrays buried bars, channels and sandy units. These features are clearly recognizable and easily traceable between profiles. EMI was particularly successful in identifying a buried historic dump, which is marked by anomalously high conductivity. We will compare EMI and GPR signals to better understand the physical response of GPR to regions of high conductivity, and test the utility of EMI for archaeological investigation in floodplain settings.

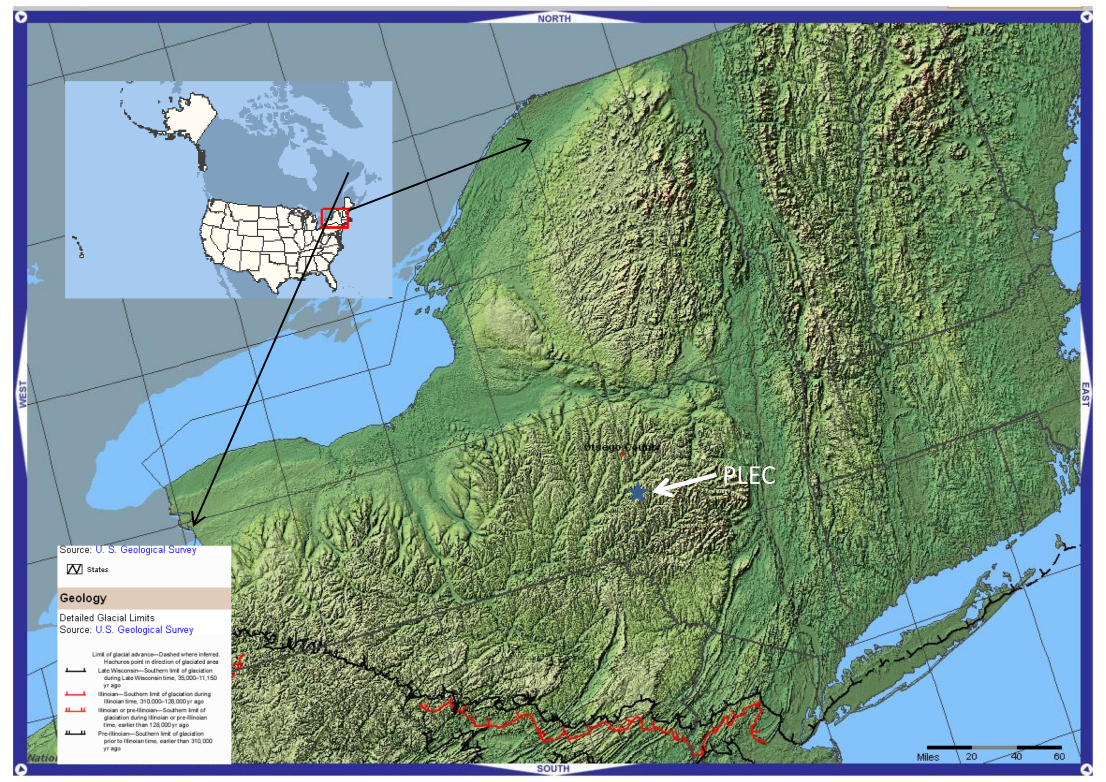

Figure 1. Index map of Pine Lake Environmental Campus in New York, USA. Lambert Azimuthal Equal-Area Projection, Map courtesy of National Atlas. http://www.nationalatlas.gov/mapmaker

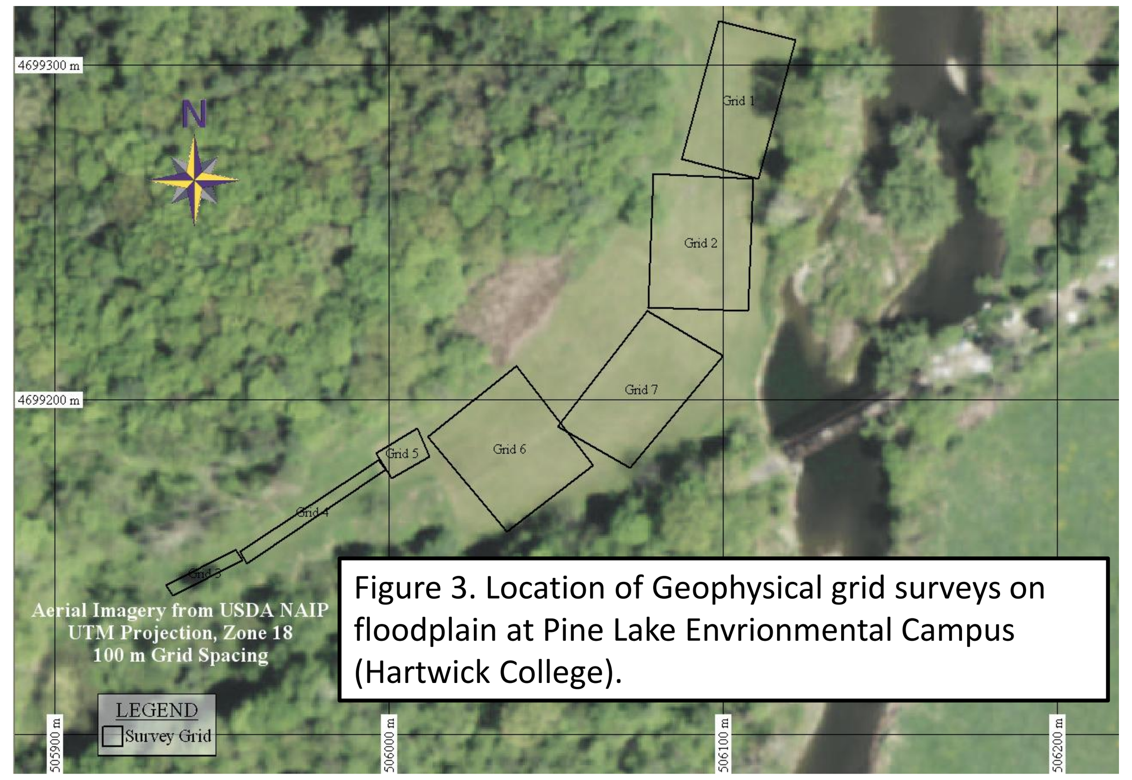

Figure 3. Location of Geophysical grid surveys on floodplain at Pine Lake Envrionmental Campus (Hartwick College).

Figure 2. Pine Lake Summer 2011 survey grids. Grid corners were surveyed with a total station. All points were transformed from a local total station reference frame to UTM (Zone 18) using static GPS receivers and a 2D conformal coordinate transformation. The locations for static receiver locations are averages of the 3 to 4 days of data, with minimal external control from regional reference stations.

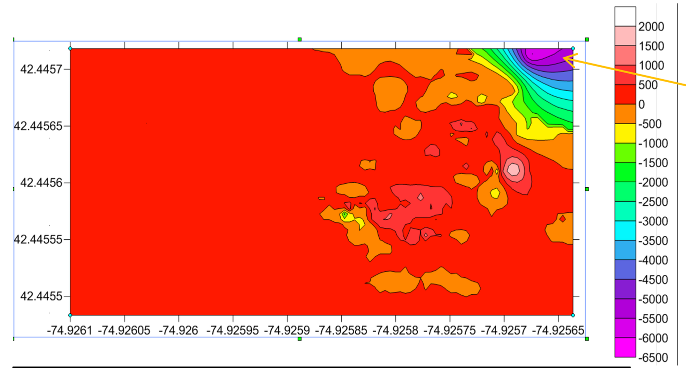

Figure . Contour map of conductivity in Grid 4. Arrow indicates anomalous peak in conductivity corresponding to an archeological dump.

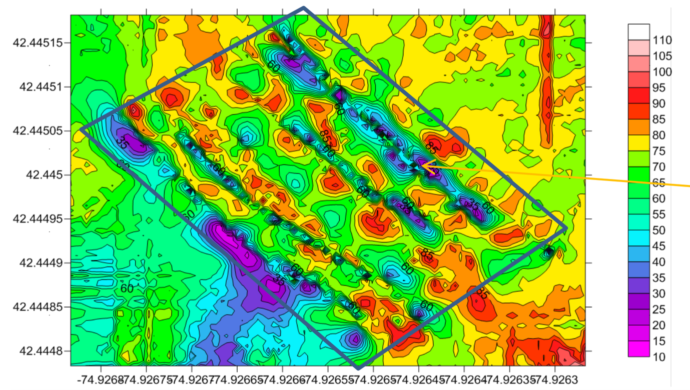

Figure 5. Contour map of conductivity Grid 6. Arrow is pointing to an set of sub parallel linear anomalies of conductivity. Note that Surfer generated fake data outside the bounding grid.

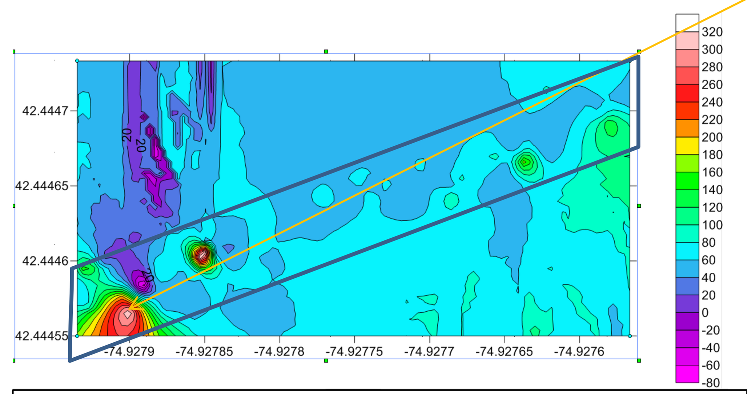

Figure 6. Contour map of conductivity Grid 3. Arrow shows an anomalous peak in Grid 3. Surfer generated fake data outside the bounding grid.

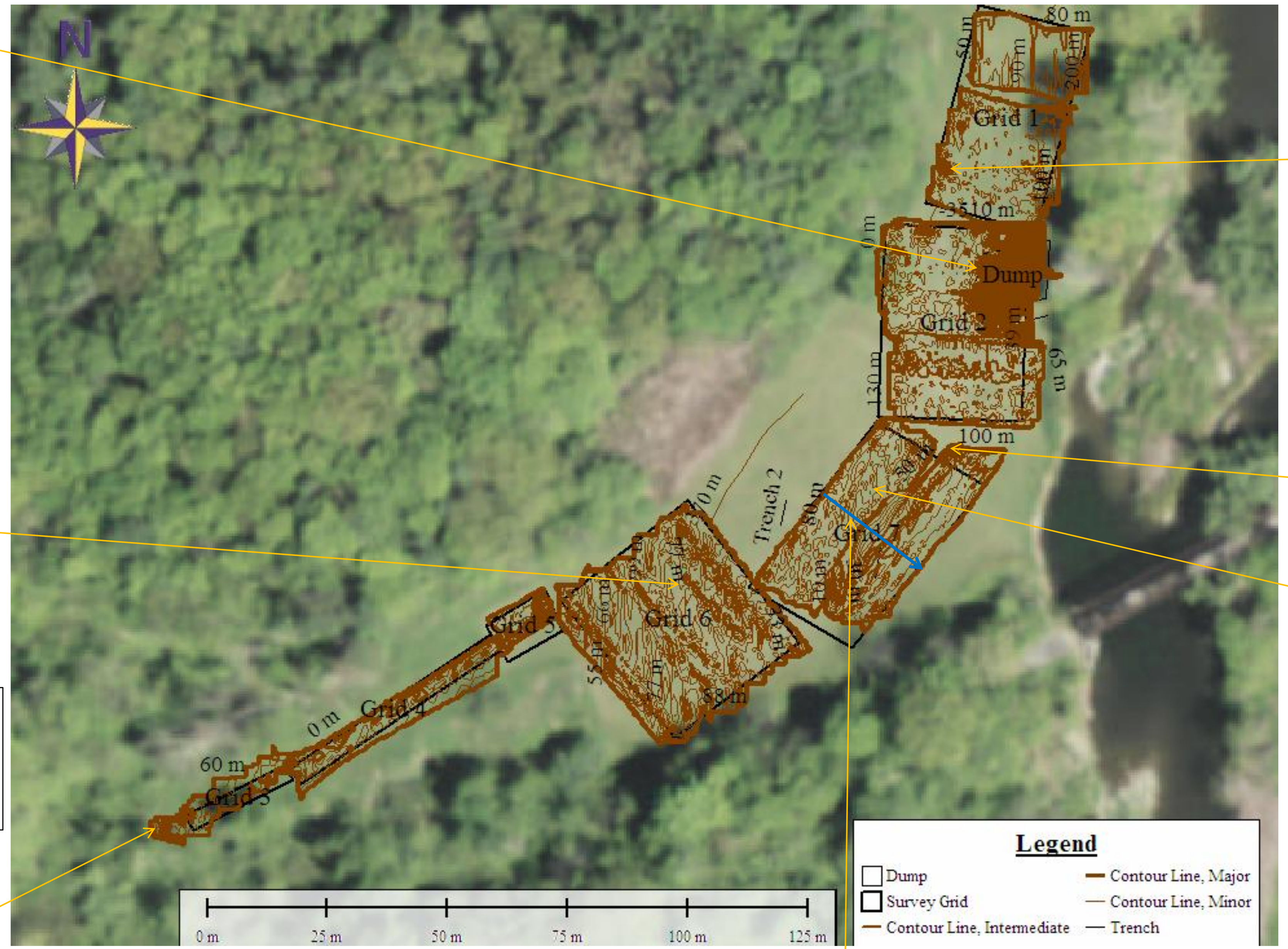

Figure 3. Pine Lake summer 2011 survey grids. Each grid has been properly fit with a correlating EMI survey allowing conductivity contours to be created. Note: EMIs non-corrected GPS showed error on location of grid.

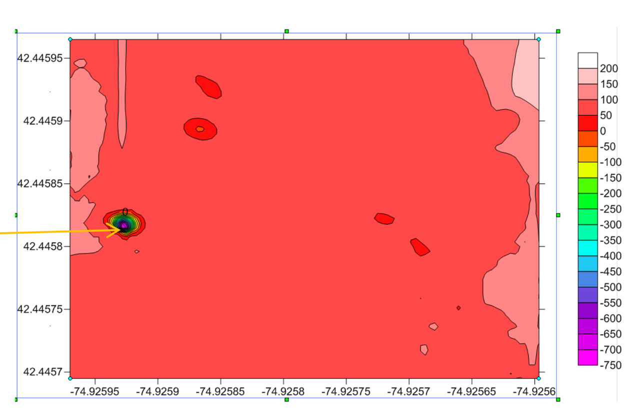

Figure 8. Contour map of conductivity in Grid 1. Arrow indicates bowl like anomaly. Possibly corresponding to a fire pit or buried metal object.

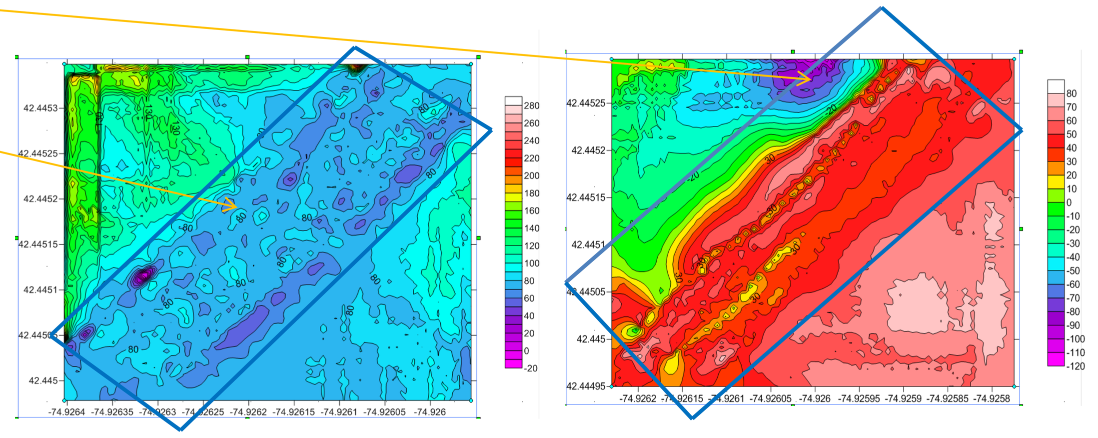

Figure 9a. Figure 9b.

Figure 9. Contour maps of conductivity in Grid 7. Figure 9a. Arrow indicates unknown conductivity structure in Grid 7, present in both 9a and 9b. Structure in 9a shows low conductivity. Figure 9b. Arrow indicates depression in conductivity, while the area below shows high conductivity. Note that Surfer generated fake data outside the bounding grid.

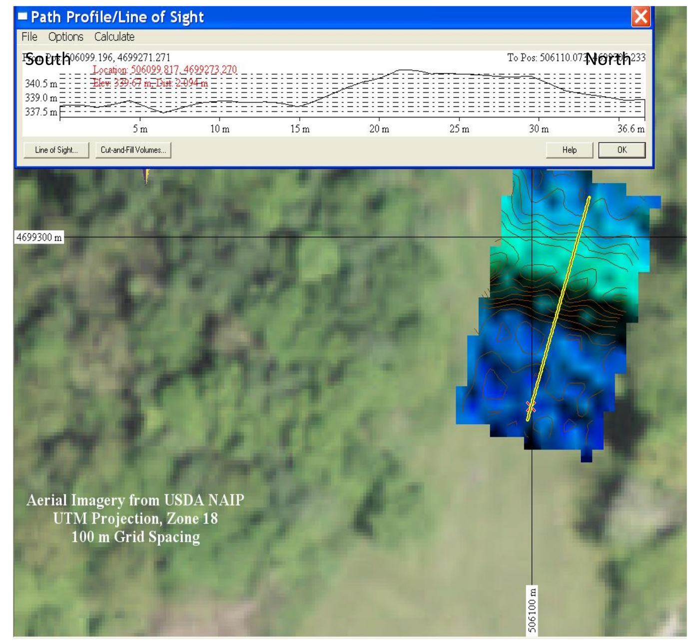

Figure 10. Grid 1 Topography derived from differential GPS attached to GPR cart. Contour interval = 0.5 m. Topographic profile displays a mound, which is in fact not there. The satellite configuration resulted in a 2-3 m mound in the solution for height.

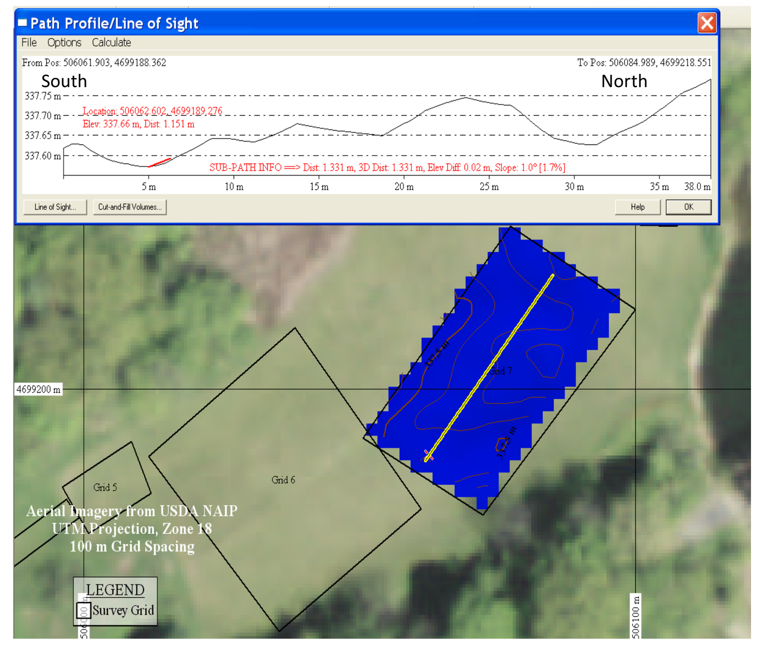

Figure 11. Grid 7 Topography derived from differential GPS attached to GPR cart. Contour interval = 0.1 m. Topographic profile displays gentle undulations in the floodplain, with a maximum height range of ~0.3 m. Satellite configurations resulted in better resolution of the ground surface on this date.

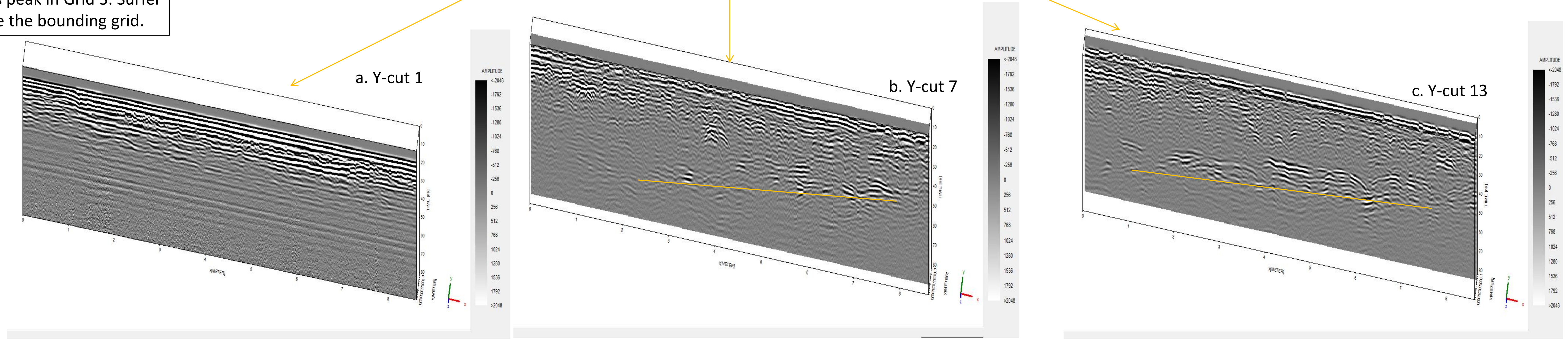

Figure 7. a,b, and c are Y-cuts(X-scans) of a 3-D cube created from Grid 7. These GPR profiles show a continuous feature. The line shown on b and c help illustrate the feature likely to be a bar or channel. Blue arrow indicates the direction of Y-cuts.

Summary of Discovery for 2011 Geophysics Survey

- **EMI Profiling reveals new features that have gone undetected by archaeological digs and GPR surveys.**
- **These features due to electrical conductivity variability include parallel linear anomalies, and localized highs and lows.**
- **A conductivity map clearly identified an historic (19th Century) dump.**
- **We interpret highly localized strong conductive anomalies as either buried metal objects, or possibly old fire pits.**
- **High conductivity areas do not necessarily disrupt or attenuate GPR signal returns.**

Challenges faced in weaving together the data sets

- EMI Profiler utilized non-corrected GPS signals for location.
- For differentially corrected GPS data, signal degradation occurred the same time each day, and is visible in Fig. 10, and in Grid 7 (Fig. 11) where our survey lines diverge from total station located boundaries to the grid.

Data Processing

- We used ReflexW as the data processor for GPR profiles. The software interface was challenging to master.
- We were unable to access the entire field due to ongoing archaeological excavations.
- Amount of data grew rapidly as processing continued. Data expanded from 4Gb to over 18Gb. This created a storage problem.

Miscellaneous issues

- Weather depleted time in the field.
- Over grown shrubs and bushes kept surveys from extending farther.
- Aucoin's path wandered during EMI collection due to excessive mosquito bites.

Acknowledgements

This research is supported by SUNY Oneonta's Student Grant Program for Research and Creative Activity. We thank The Pine Lake Environmental Campus and Hartwick College for providing access to the site. We express our deep gratitude to Cindy Klink and Renee Walker for assistance and guidance in the field, and for their unflagging enthusiasm.