Detecting underground mine voids using geophysical techniques

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Objectives

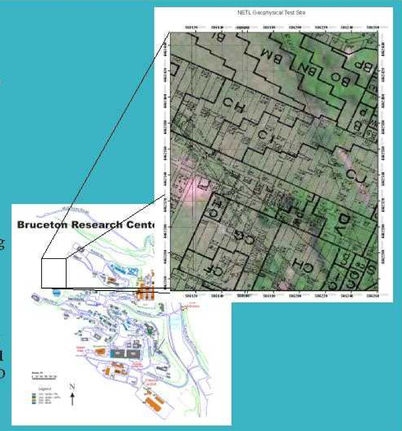
To create a comprehensive geophysical model of apparent resistivity distribution in a suspected near-surface air-filled ground voids.

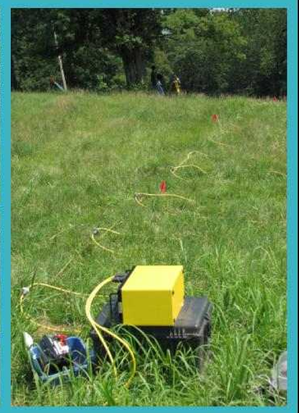
- To establish a geophysical equipment calibration site based at the NETL site near Pittsburgh.
- To research whether or not an air-filled ground void has a distinctive EM response, as opposed to DC induced field which is a standard method for this type of surveying.
- To test compatibility of various EM data inversion algorithms and compare them to electrical resistivity profiling.

Introduction

Area under study is known to contain underground mine voids

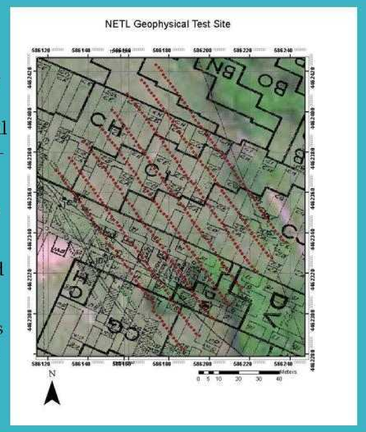
- Georeferencing of old mine maps was performed in order to rectify accurate positioning of mine workings
- Geophysical surveys were carried out including EM-34 sounding, Supersting resistivity profiling and EM 31 surveying
- Geophysical data were processed and interpreted resulting in a variety of 2D and 3D apparent conductivity imagery.

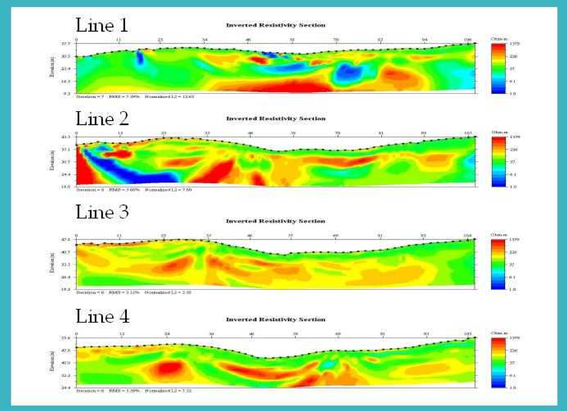


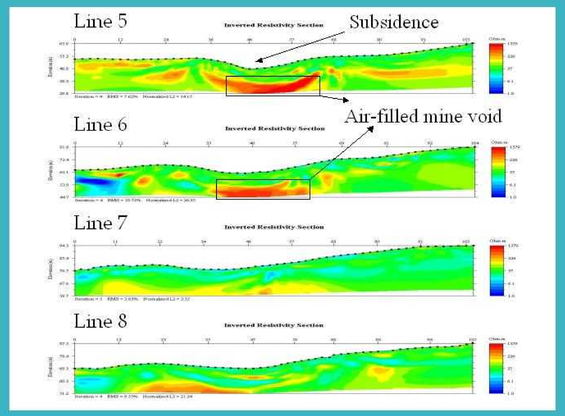


DC Resistivity surveying

- Dipole-dipole array was utilized, 4m electrode spacing, total number of electrodes - 56
- A data set of 8 lines was collected
- Data set was leveled and geo-rectified
- Supersting data was inverted and imaged as a set of apparent resistivity profiles

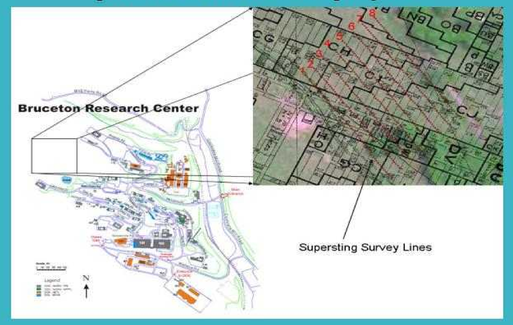






EM 34 Surveying

A total of 8 lines were collected repeating DC resistivity profiles, but with 10 m sampling rate

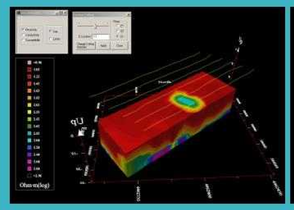


Inversions of EM 34 data

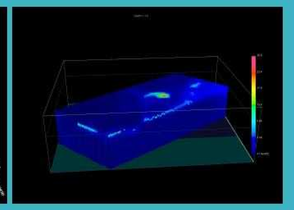
Here are two algorithms used to invert EM 34 data:

- EM1DFM developed by University of British Columbia
- 1D Emigma inversion developed by PetRos Eikon

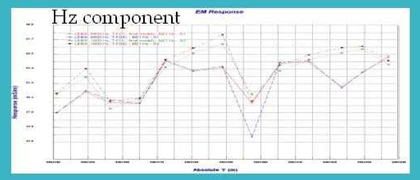
Emigma inversion

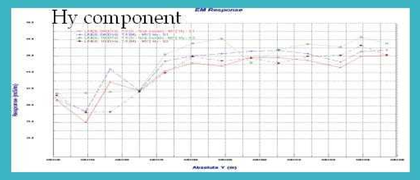


EM1DFM inversion

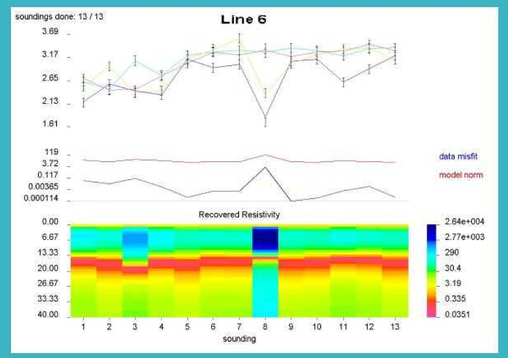


Convergence of Emigma inversion



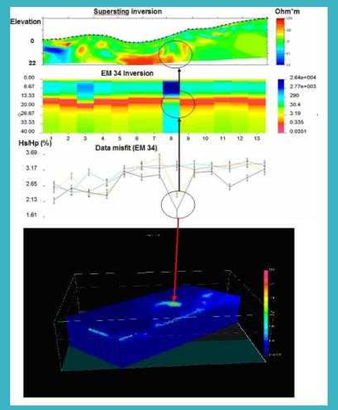


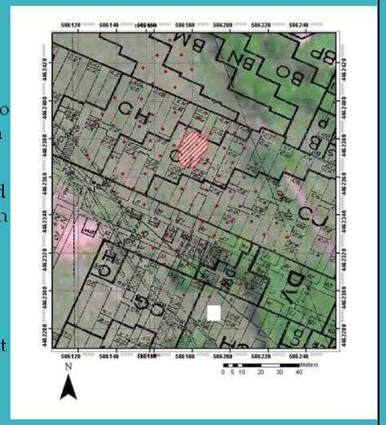
Convergence of EM1DFM inversion



Interpretation

- A zone of anomalous resistivity was discovered at an estimated depth of 7 to 14 meters.
- This zone was correlated with data collected by Supersting resistivity system.
- It is believed that the zone indicated an air-filled subsurface void.



Conclusions

- On planar map this anomaly corresponds to zone of coal extraction
- Electromagnetic methods demonstrated capabilities of detection air-filled voids
- A follow up is suggested with utilization of seismic methods to verify exact locations of voids.