COLLIER GEOPHYSICS

Society of SAME American Military Engineers

Sustaining Member

Service Disabled Veteran Owned Small Business SDVOSB cVE

Geophysical Investigations in Support of Military Missions

Presented by: Jorgen Bergstrom, P.Gp. Collier Geophysics

Who We Are

Collier Consulting

- Est. 1998, Gail & Hughbert Collier
- Stephenville, TX

Certified WBE Women's Business Enterprise

HUBZone CERTIFIED

Texas Department of Transportation

Collier Geophysics

- Est. 2018, Nathan Collier
- Stephenville, TX

Service Disabled Veteran Owned Small Business SDVOSB cVE

Markets We Support

Engineering

Environmental

Construction

PROVEN GEOPHYSICAL EXPERT SOLUTIONS FOR

Airfields
Archeological (Cultural Resource) Studies
Buried Object and Utility Detection
Contaminant Mapping
Dam & Levee Assessments
Engineering Design & Construction
Energy – Renewables
Environmental Studies
Geotechnical Parameters
Groundwater Characterization
Karst & Void Detection
Litigation
Master Planning
Non-Invasive Site Characterization
Roads & Bridges
Water Resource Studies

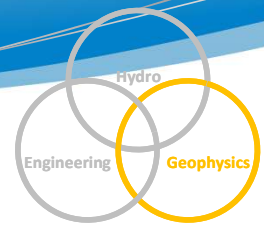
Geophysical Services

Surface
Borehole
Airborne (including drone)
Marine
2D & 3D Modeling & Imaging

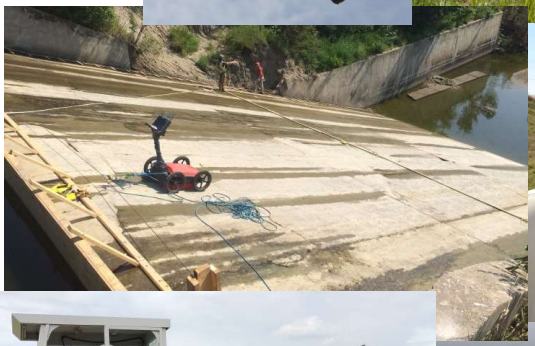
Geophysical Methods

Seismic Reflection/Refraction
Multi-channel Analysis of Surface Waves
Electrical Resistivity
Ground Penetrating Radar
Electromagnetic
Magnetic
Borehole Logging
Gravity

What We Do - Geophysics



- Seismic Refraction / Reflection
- Surface Resistivity
- Ground Penetrating Radar
- Electromagnetic Surveys
- Gravity
- Borehole Geophysics
- Downhole Video Surveys
- Marine Geophysics
- Drone Enabled Geophysics



Where We Are

- Texas
- Colorado
- Georgia
- North Carolina
- Massachusetts
- Tennessee
- Wisconsin

Collier Geophysics Offices

Austin, TX
Doug Laymon, MS

Houston, TX
Finn Michelsen, MS

Denver, CO
Phil Sirles, MS

- ✓ 10+ Geologists
- ✓ 15+ Geophysicists
- ✓ 3 California Professional Geophysicists
- ✓ 9 Industry Leaders, each 30+ years exp.

Atlanta, GA
Jorgen Bergstrom, MS

Oak Ridge, TN
William Doll, PhD

Raleigh, NC
Nick Rebman

West Bend, WI
John Jansen, PhD

Federal Clients

- Department of Agriculture (Forest Service)
- Department of Defense (US Army Corps of Engineers, US Air Force)
- Department of Energy
- Department of Interior (National Parks Service, Fish and Wildlife Service, Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation)
- Department of Transportation (Various State DOTs)
- Federal Highway Administration
- Department of Veterans Affairs
- Environmental Protection Agency
- National Aeronautics and Space Administration (NASA)

USACE – Current Contract Vehicles

US Army Corps of Engineers®

- **Jacksonville – W912EP21R0029 – Individual Project**
  - Sole Source at EAA A-2 Reservoir in Palm Beach County Florida. Geophysical TEM survey
  - Prime: Collier Geophysics

- **Huntington – W9123720D0010 - IDIQ**
  - National IDC for geotechnical services for dam and levee safety projects with the USACE
  - Prime: Stantec Consulting Services, Inc.

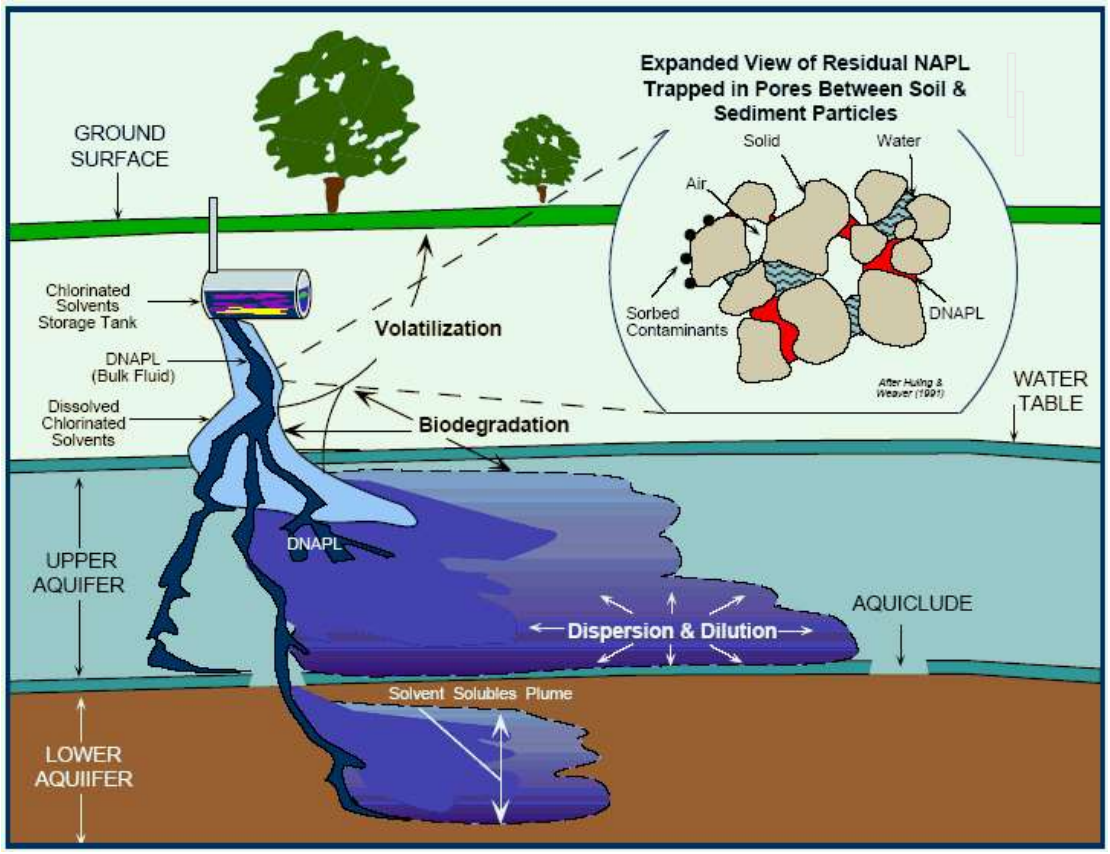
- **Louisville / RMC W912QR20R0034- IDIQ**
  - A/E Services for the Risk Management Center which includes projects within the United States and its territories for dame and levee safety and other work as assigned to USACE
  - Prime: RJH Consultants, Inc.

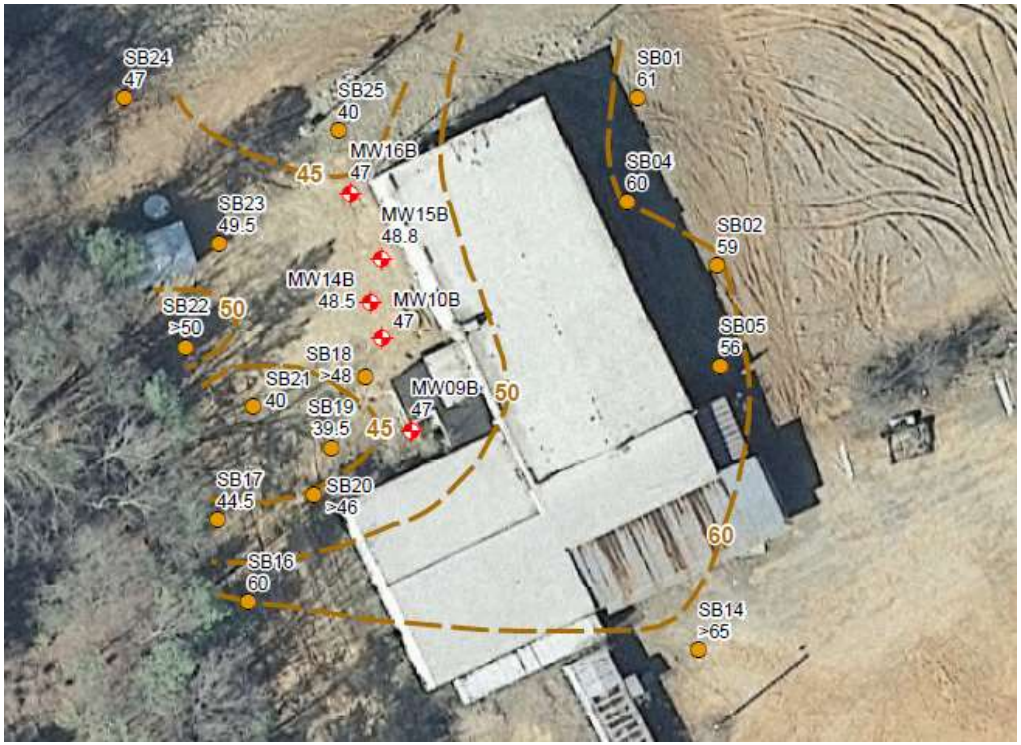
Why Use Geophysics?

- **Large areas** can be scanned quickly and at a low cost
- Geophysics can provide **continuous information** (borings and test pits provide discrete data points)
- Geophysical data can be used to **optimize drilling** activities
- Geophysics can be used to **mitigate risk** (i.e.,damage prevention) of subsurface hazards
- Geophysics uses **non-invasive techniques** thereby minimizing workers' exposure to contaminants
- Geophysics can be used in **rugged / inaccessible terrain** and in **wetland areas** not accessible by drill rigs or backhoes

Reduced Uncertainty = Lower Risk to Project Scope, Cost, and Time

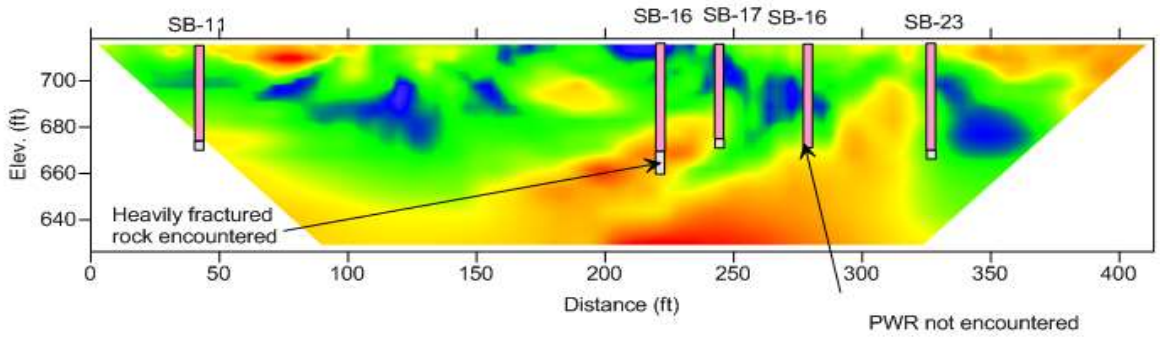
Site with Dense Non-Aqueous Phase Liquid (DNAPL) contamination (chlorinated solvents)

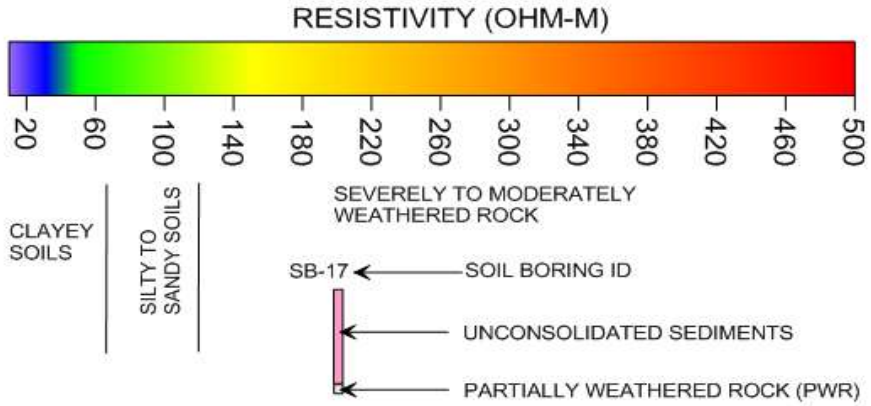

Expanded View of Residual NAPL Trapped in Pores Between Soil & Sediment Particles
Solid
Water
Air
Sorbed Contaminants
DNAPL
After Huling & Weaver (1991)
GROUND SURFACE
Chlorinated Solvents Storage Tank
DNAPL (Bulk Fluid)
Dissolved Chlorinated Solvents
Volatilization
Biodegradation
WATER TABLE
UPPER AQUIFER
DNAPL
AQUICLUDE
Dispersion & Dilution
Solvent Solubles Plume
LOWER AQUIIFER

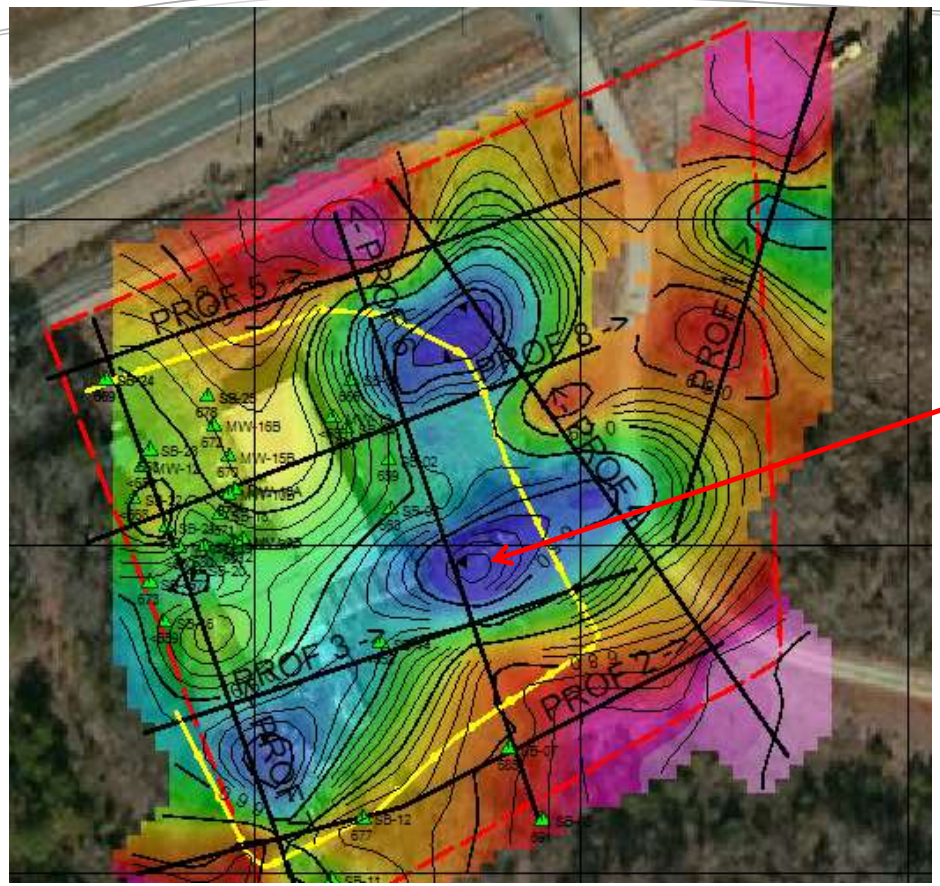


Bedrock contours based on monitoring wells and soil borings

Bedrock mapping with ERI





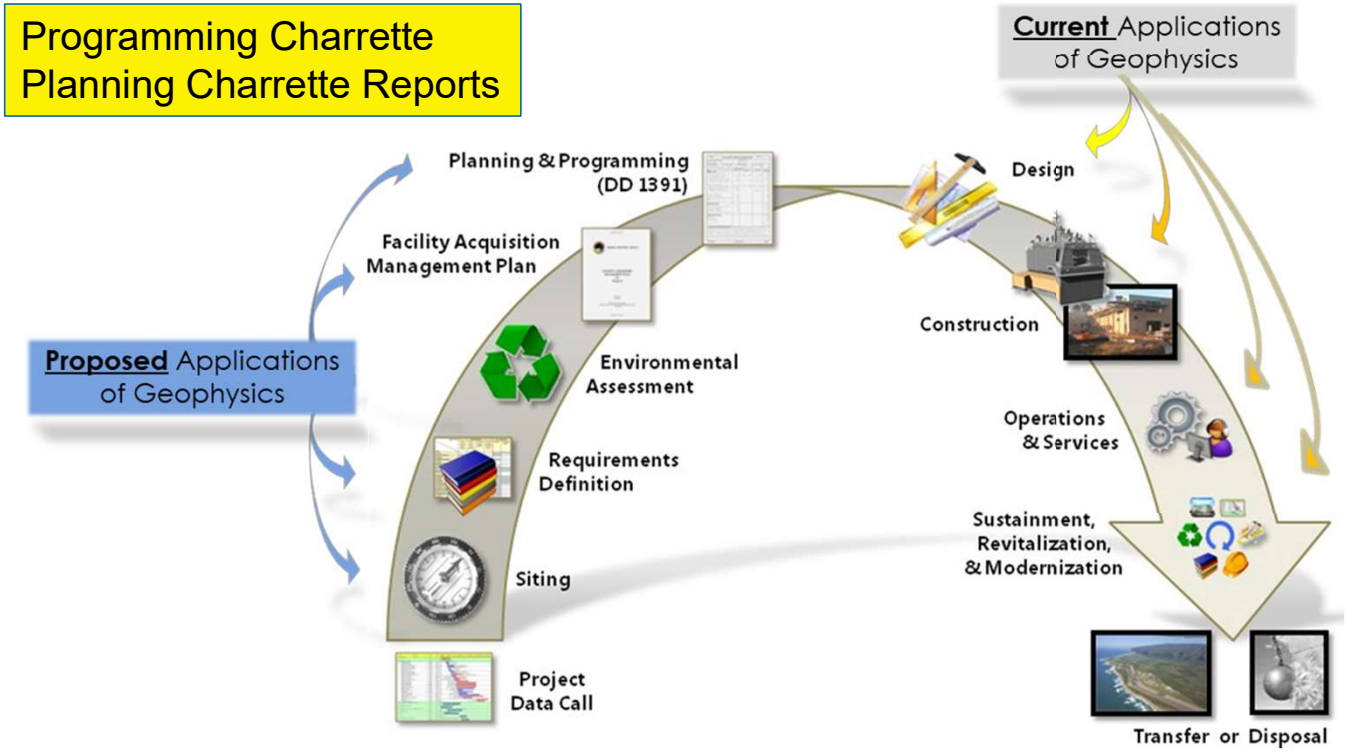


Bedrock valley targeted for additional monitoring wells

Bedrock contours based on geophysics (electrical resistivity imaging). Contour maps are typically developed by interpolating data from multiple profiles.

Use of Geophysics for Improving Site Selection

Programming Charrette
Planning Charrette Reports



USACE Project Lifecycle

Selecting sites with better understanding of subsurface conditions reduces risk and cost.

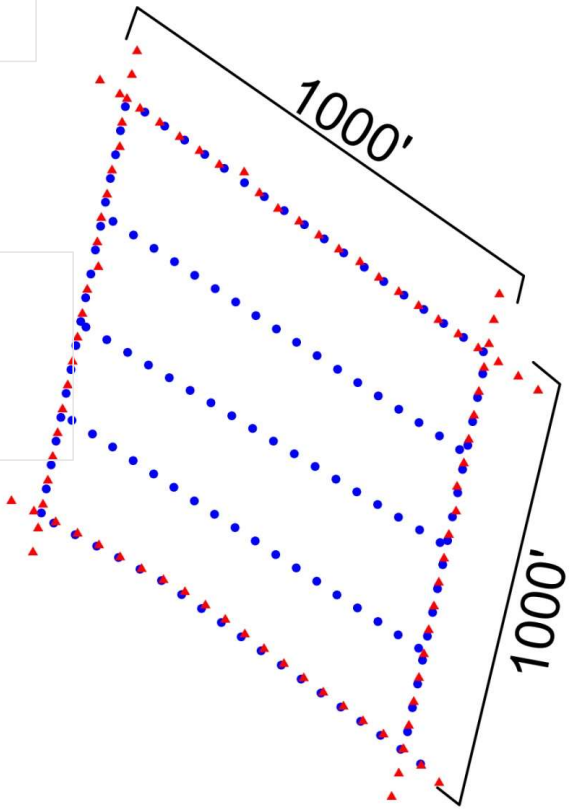
Use of Geophysics for Site Selection - Case Study

- Five 22-acre candidate sites were evaluated for missile test launch facilities.
- Client decided to conduct geophysics (3D seismic) over all five sites to better define subsurface conditions
- One preferred site was selected based on geophysics
- A comprehensive geotechnical study was conducted on the selected site only

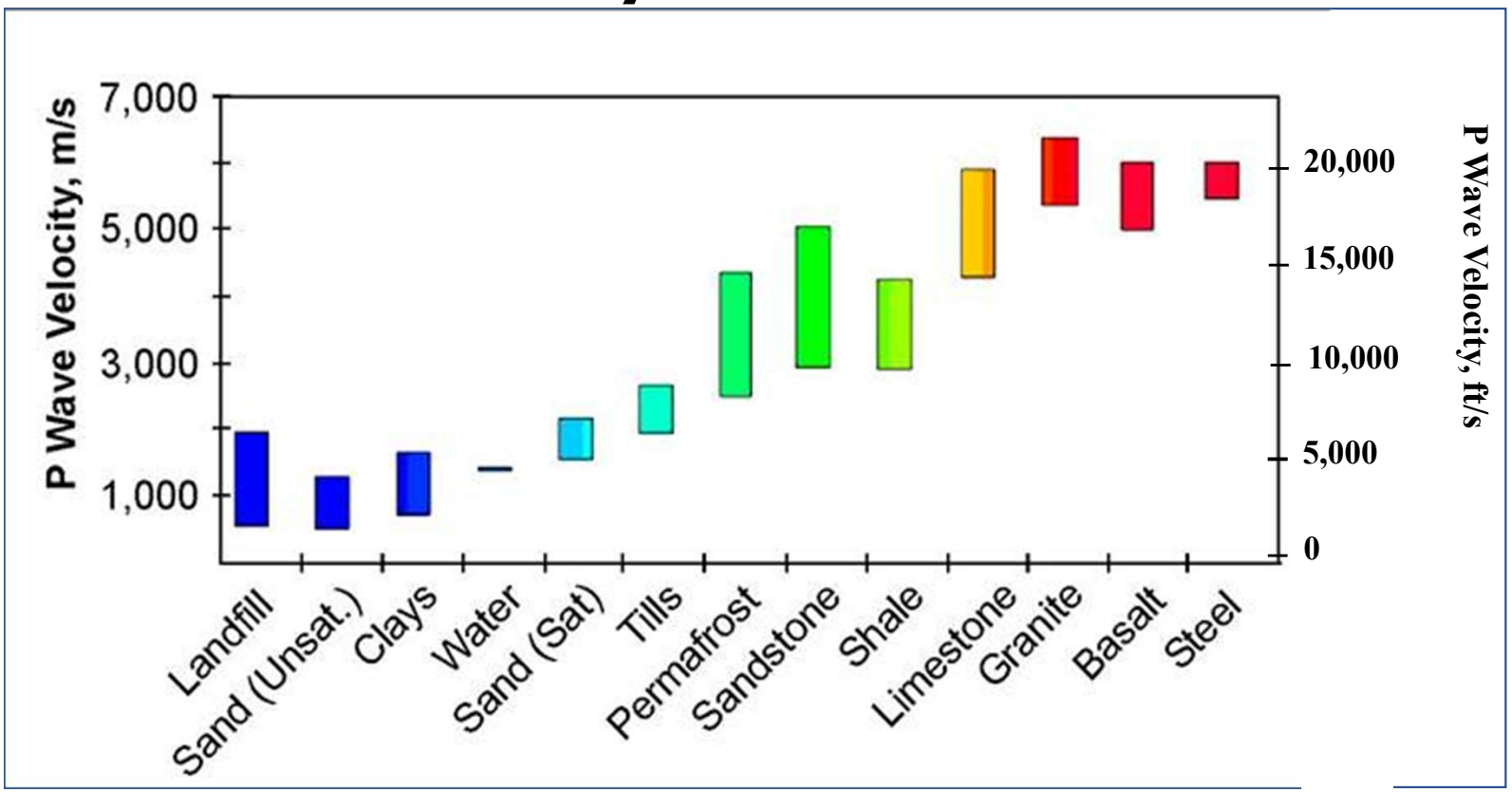
3D Seismic investigations conducted across five 22-acre sites

Tracked Weight Drop Source

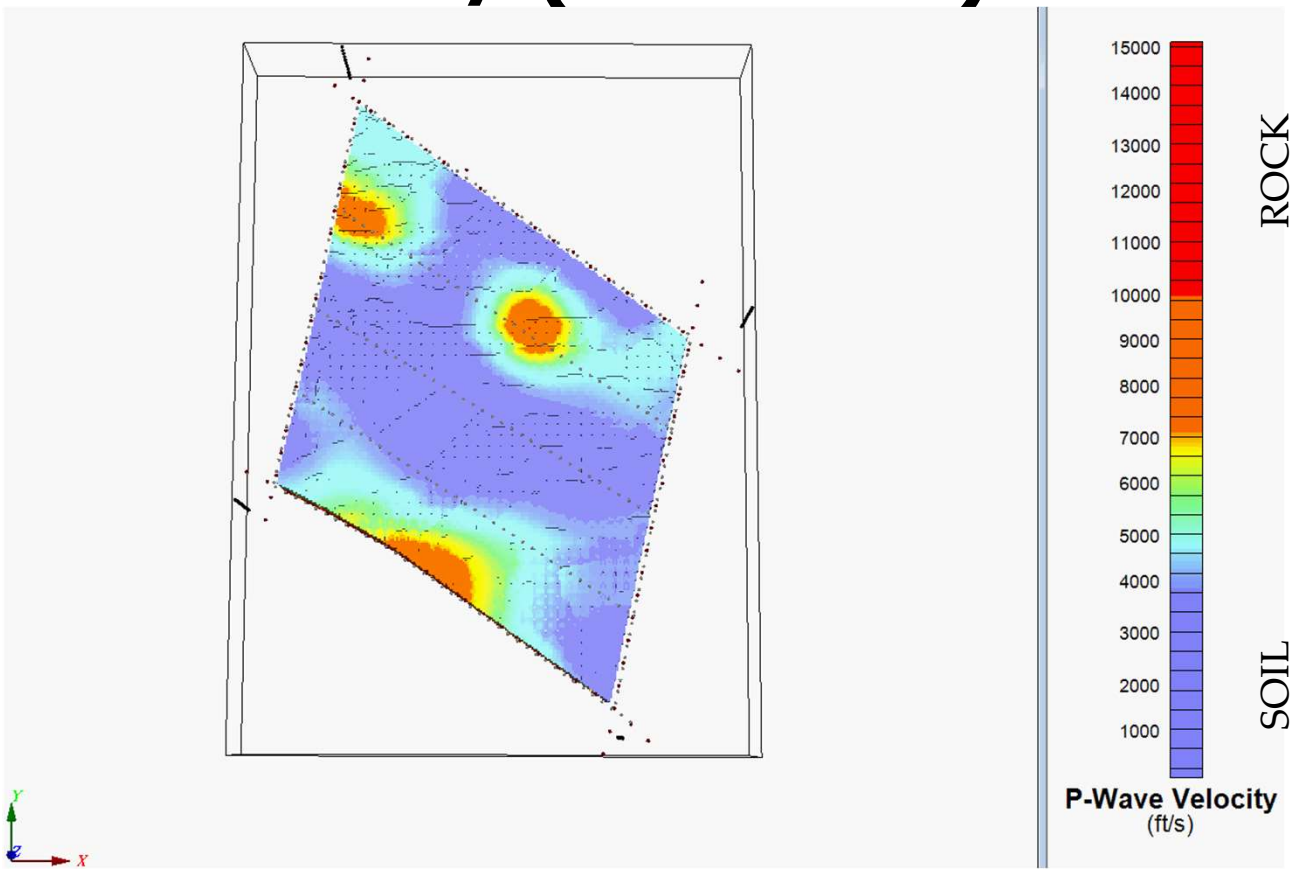
Wireless seismic acquisition



P-Wave Velocity for Different Materials



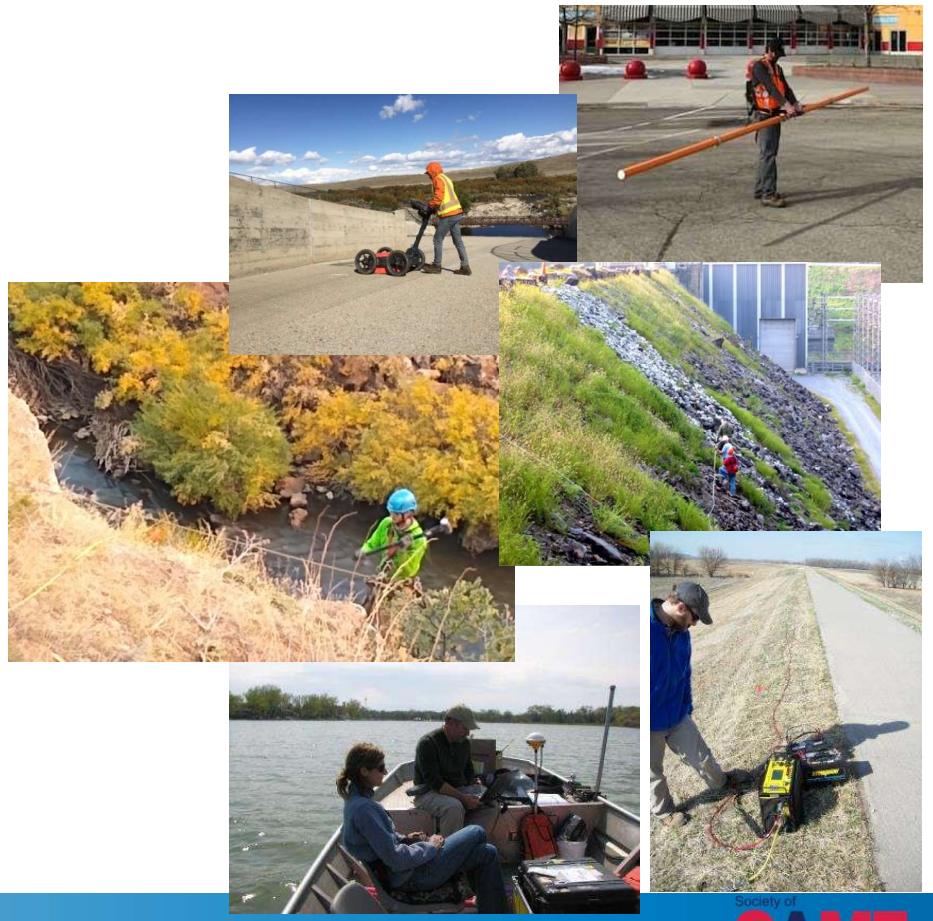
Seismic Velocity (Hardness) Data Cube



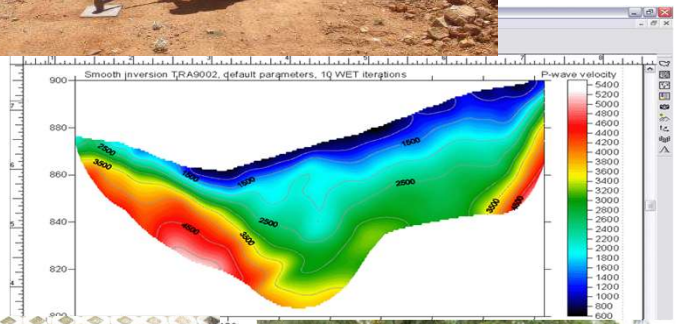
Geophysical Methods

Used for Environmental and Geotechnical Investigations

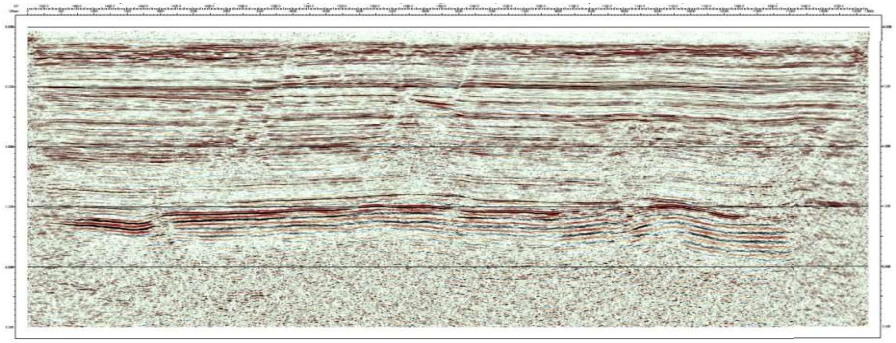
- Seismic – Refraction Tomography SRT/MASW/Reflection
- Electrical Resistivity Tomography ERT
- Ground Penetrating Radar
- Electromagnetics (EM)
- Magnetics



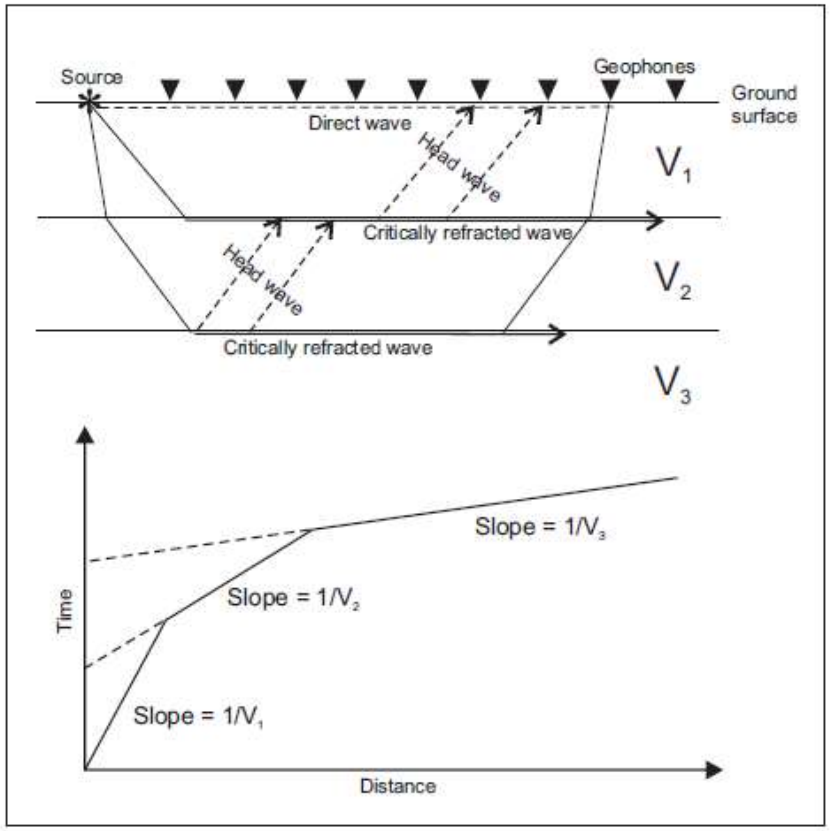
Seismic Methods



- *Refraction Tomography (SRT)*, MASW, Reflection, Cross & Downhole
- Generation of Sound Wave Into Subsurface
- Geophones & Seismograph to Measure the Travel Time of the Wave
- Measures Seismic Velocity - P&S Wave
- Map Lithology & Structure



Seismic Refraction Survey



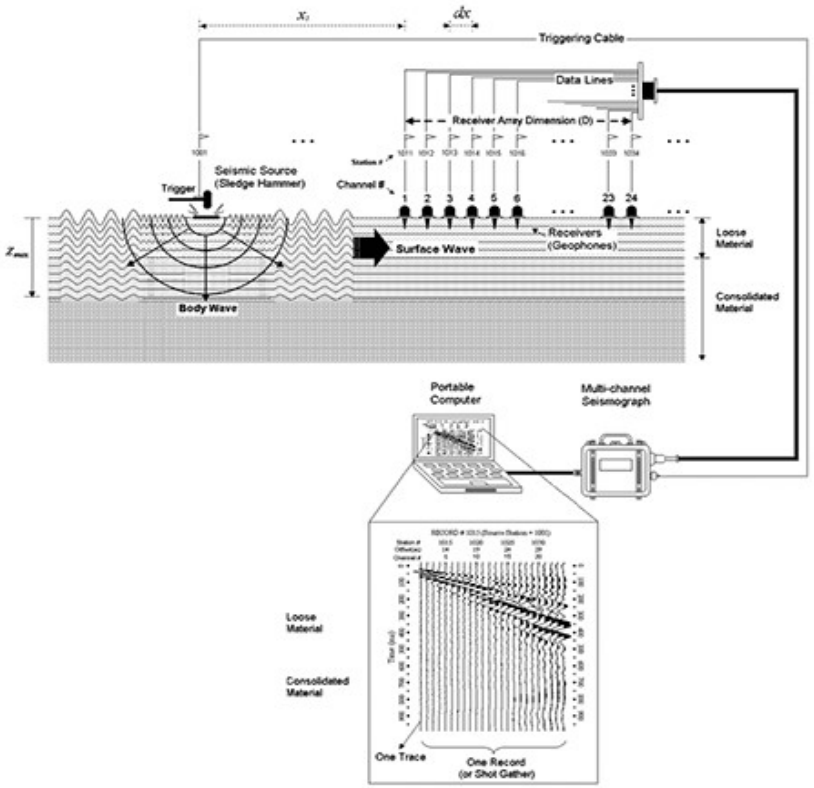
- In a seismic refraction survey, only the travel time for the wave arriving first is recorded
- For the method to work, seismic velocity needs to increase with depth
- For complex geology, refraction tomography and forward modeling can be used to contour and distinguish gradual changes in lateral and vertical velocity

Multi-Channel Analysis of Surface Waves (MASW)

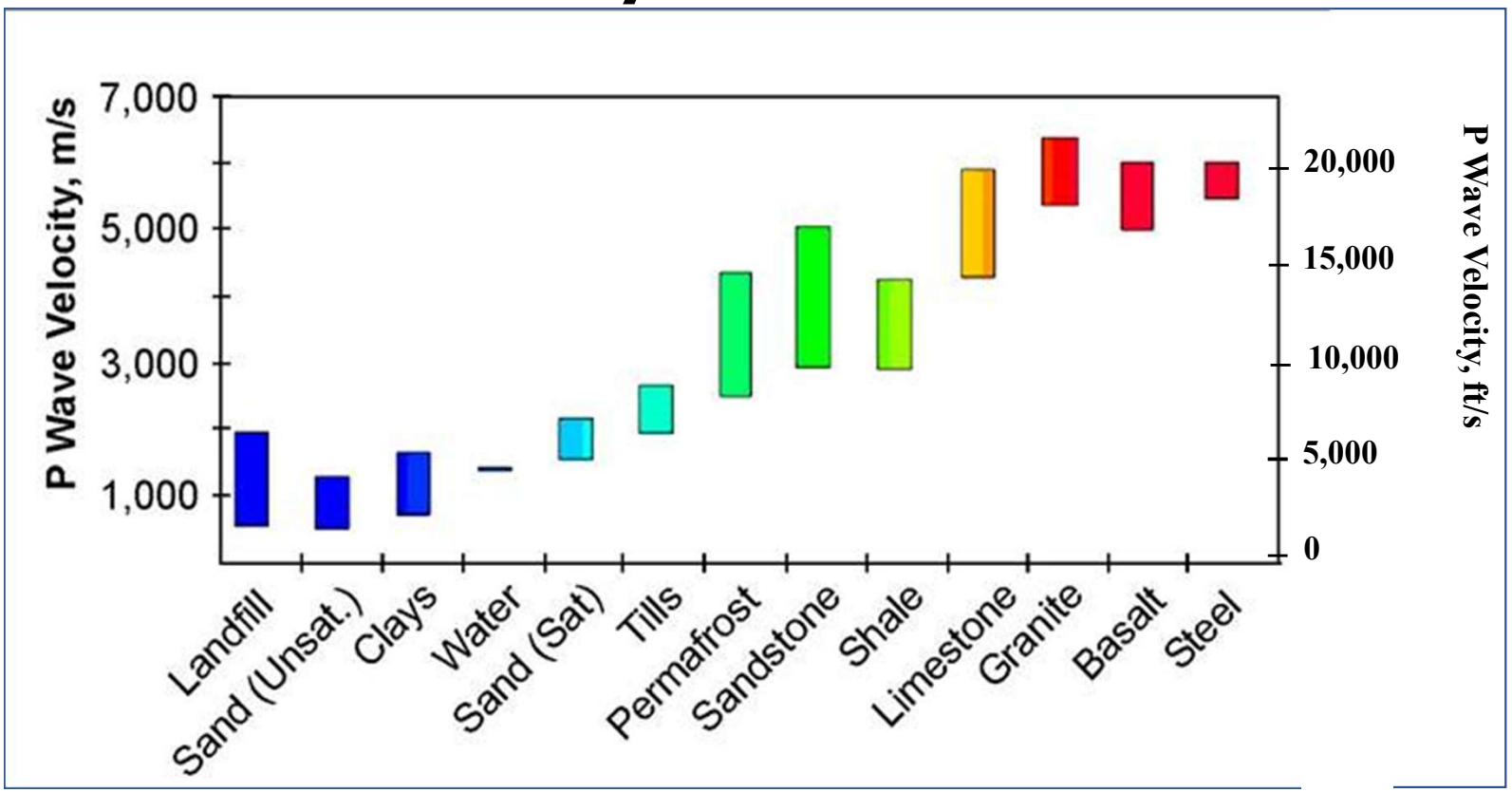
- In a MASW survey, shear wave velocity variations with depths are deduced by analyzing the relationship between surface wave velocities and wavelength.

- MASW can be used to locate low velocity zones and layers.

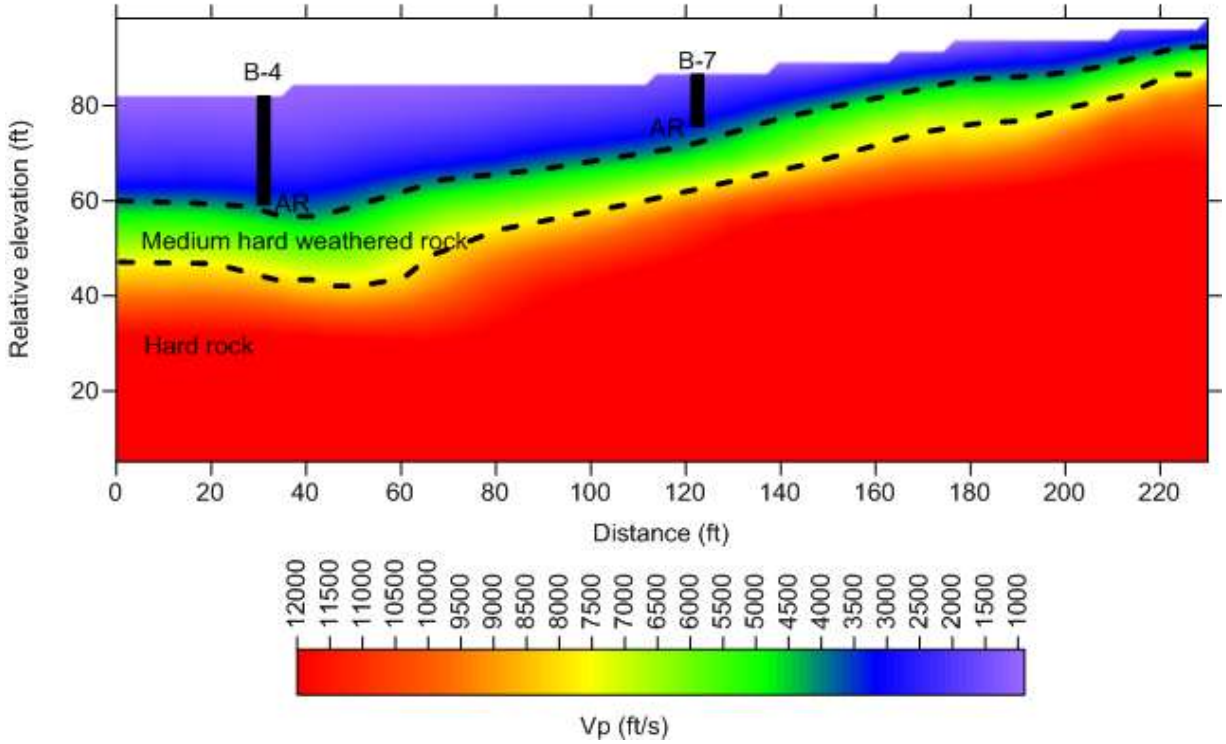
- For complex geology, forward modeling can be used to contour and distinguish gradual changes in lateral and vertical velocity



P-Wave Velocity for Different Materials

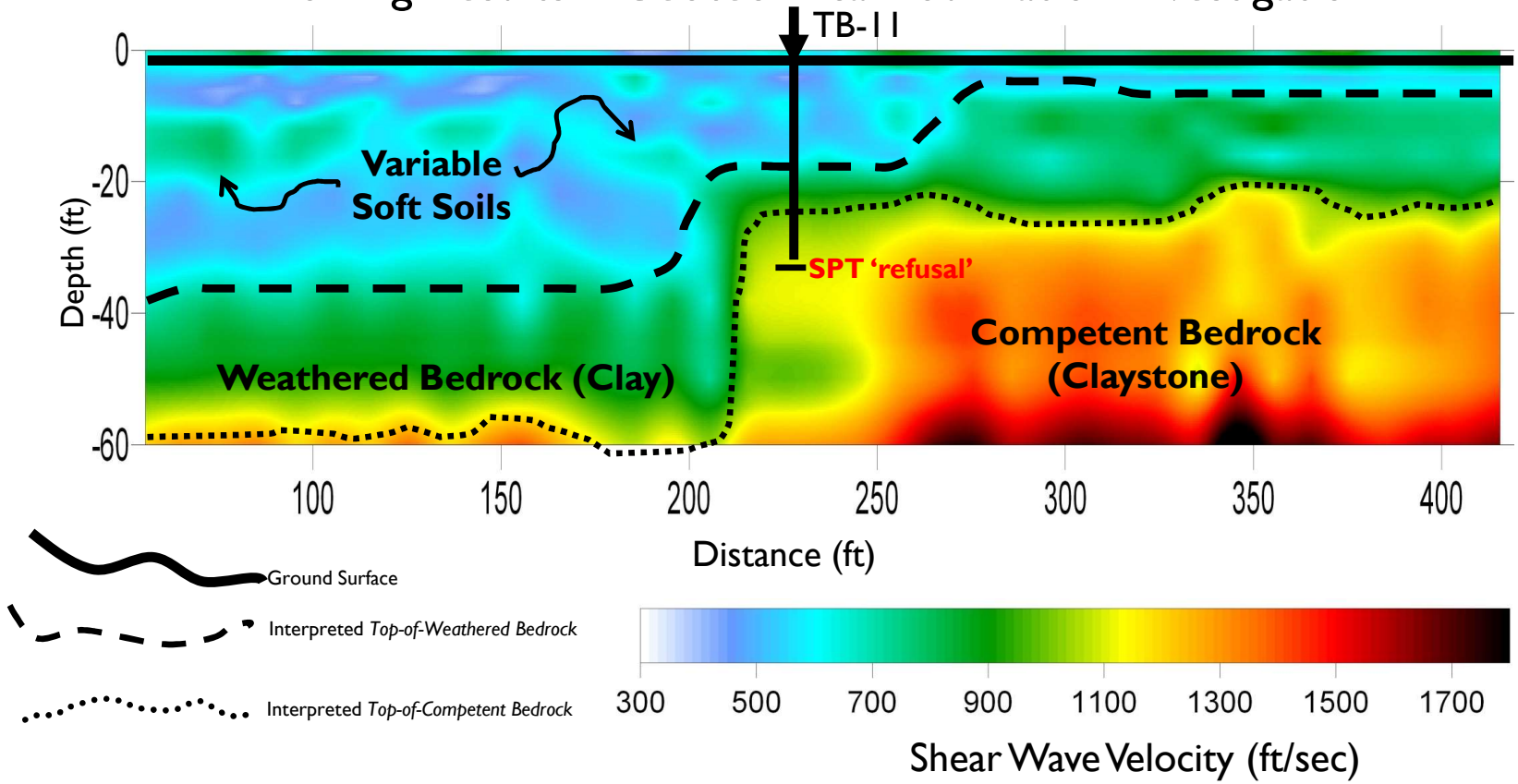


Refraction seismic - correlation with borings



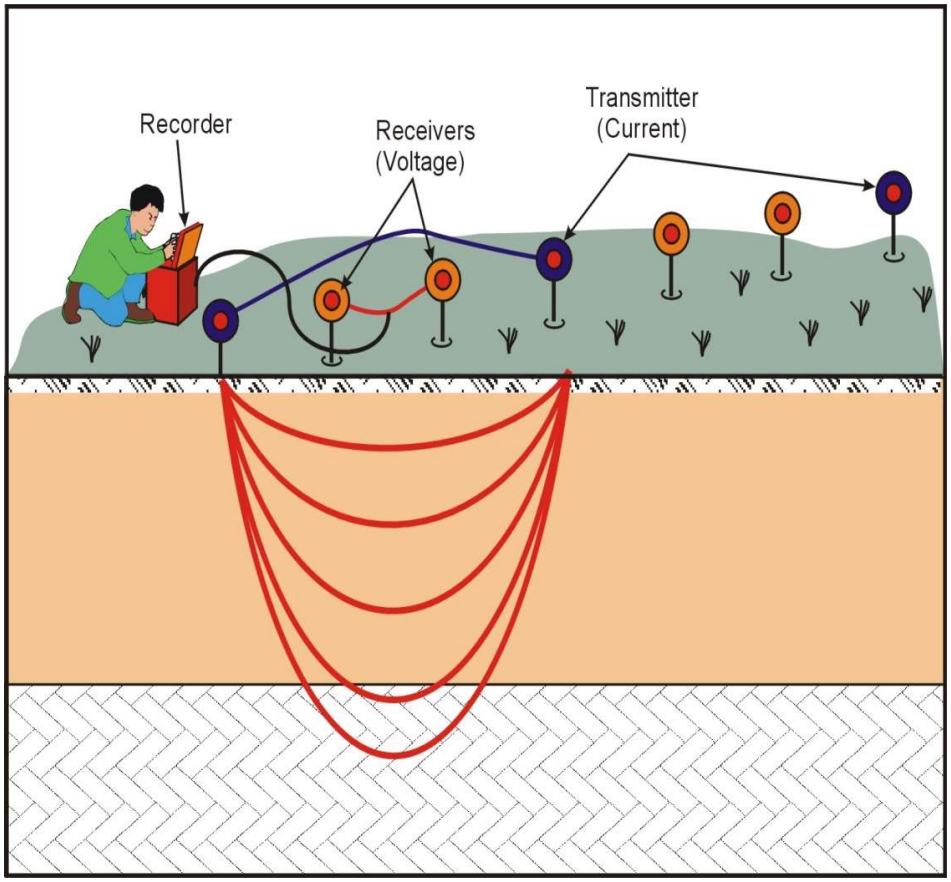
MASW Method Example

2D Profiling Results – Geotechnical Foundation Investigation

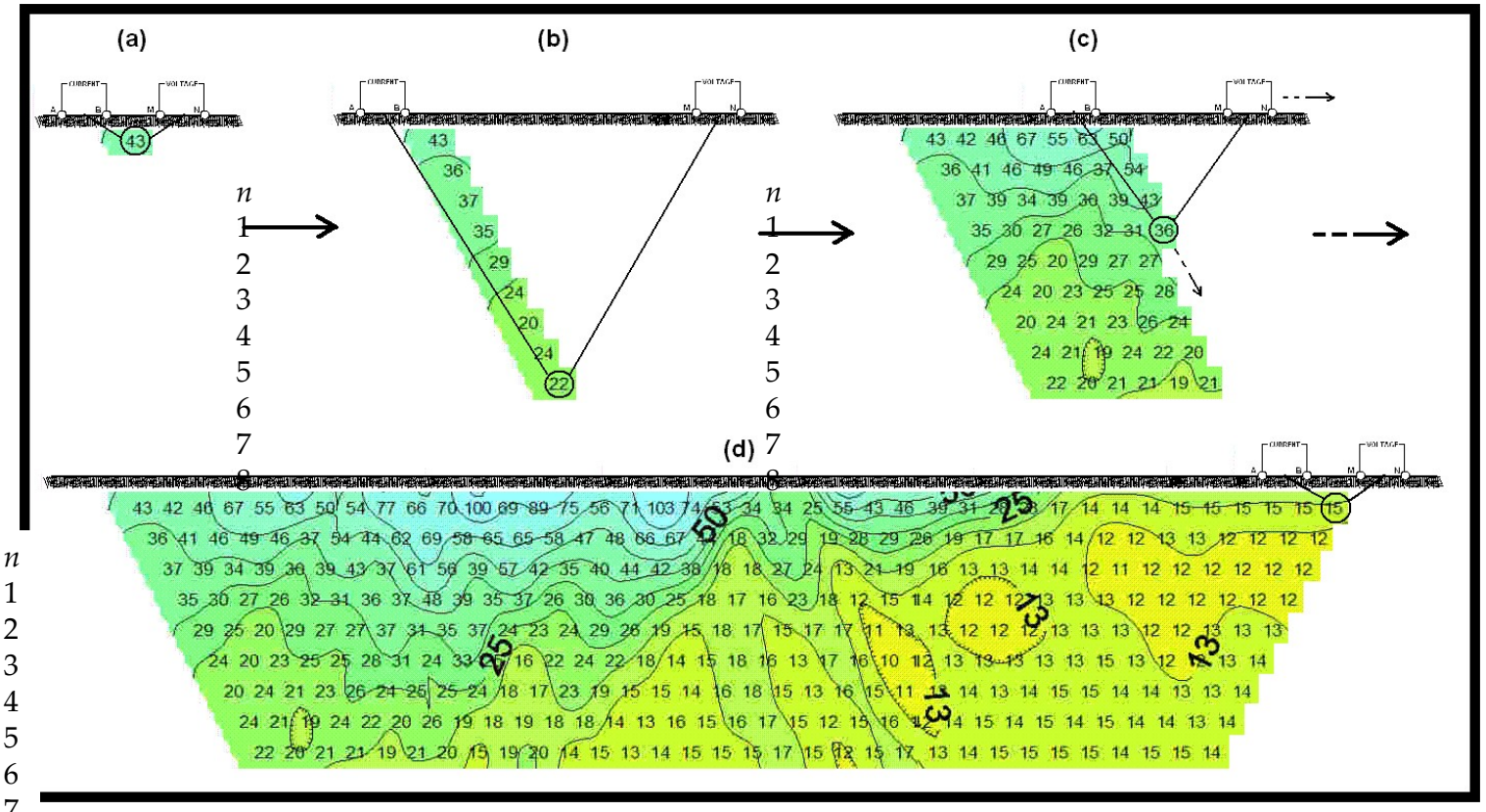


Electrical Resistivity Imaging (ERI)

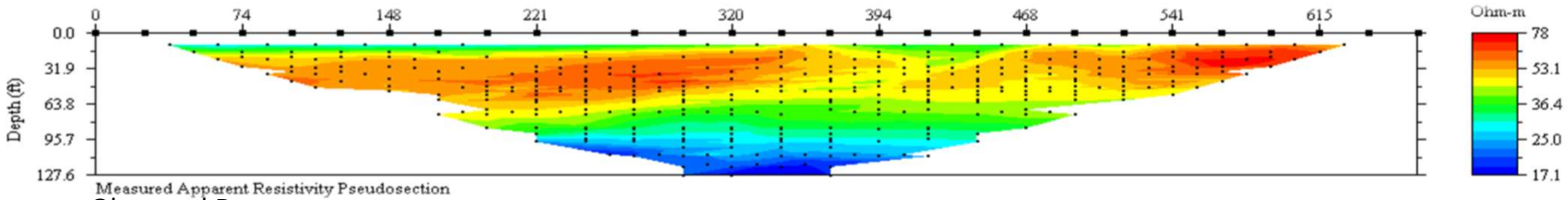
Electrical Resistivity Imaging (ERI)



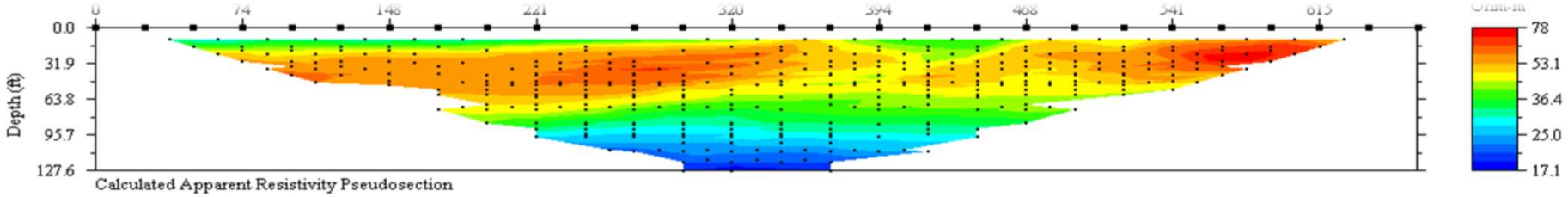
Apparent Resistivity "Pseudosection"



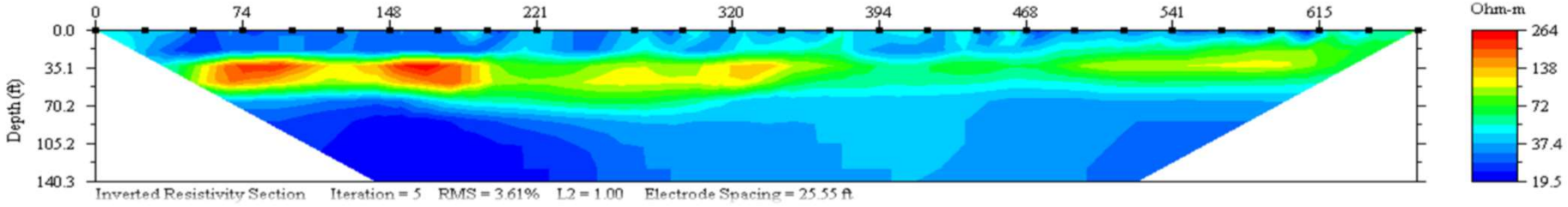
ERI Data Modeling



Observed Data

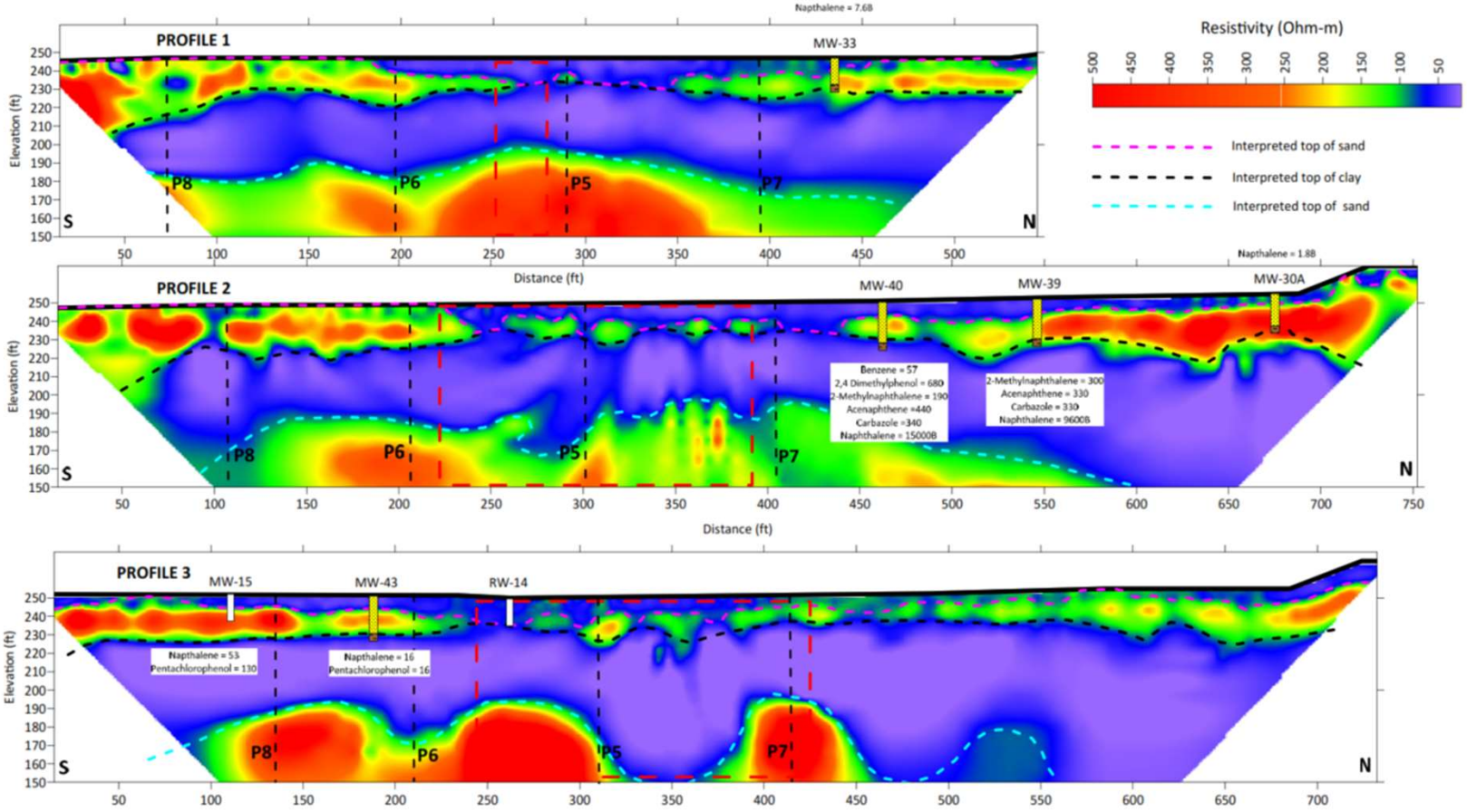


Back-calculated data from inverted model

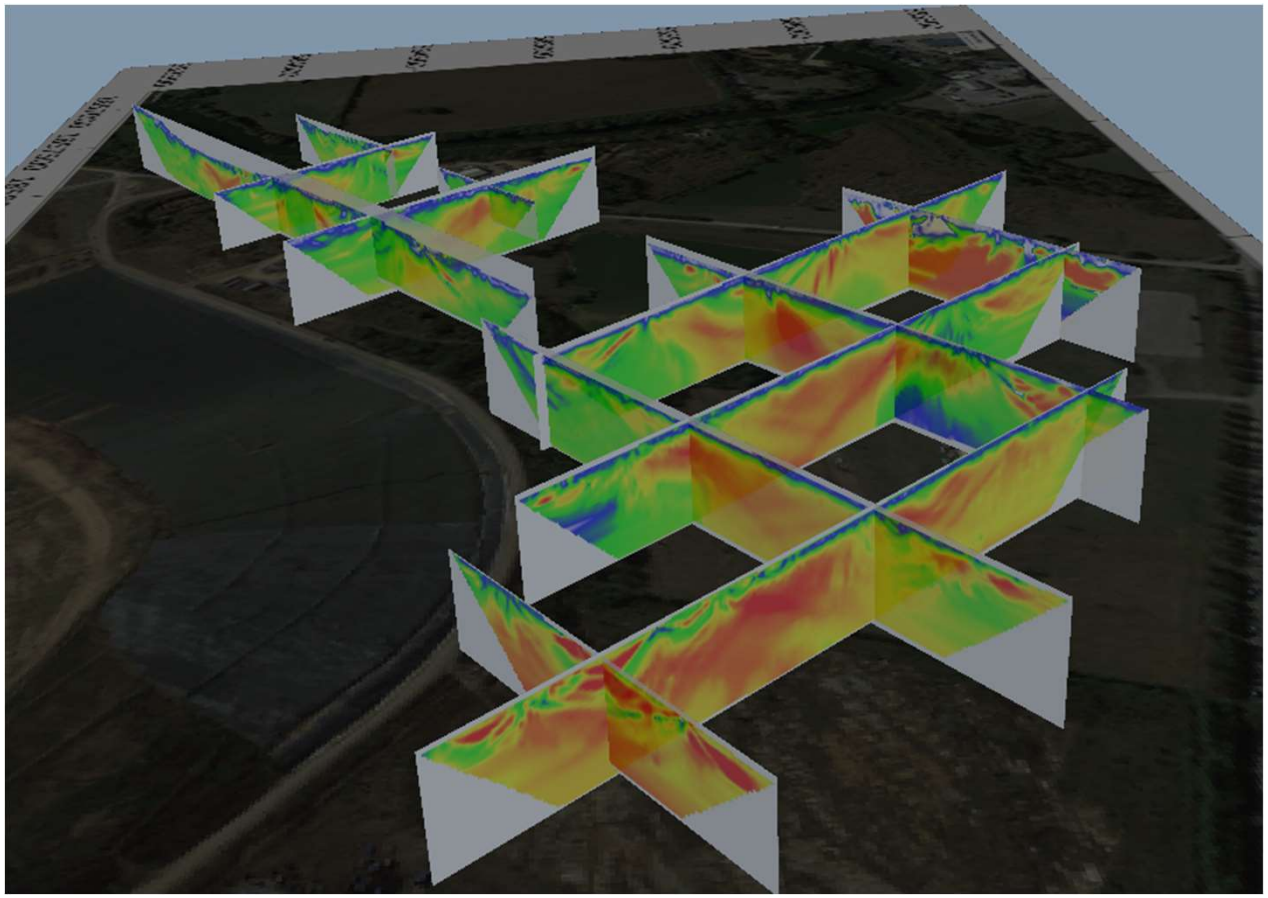


Inverted Model

ERI For Detailed Site Characterization



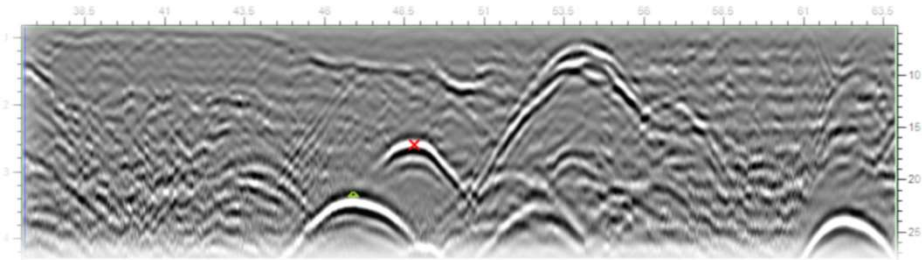
ERI Data as Fence Diagrams for 3D Visualization



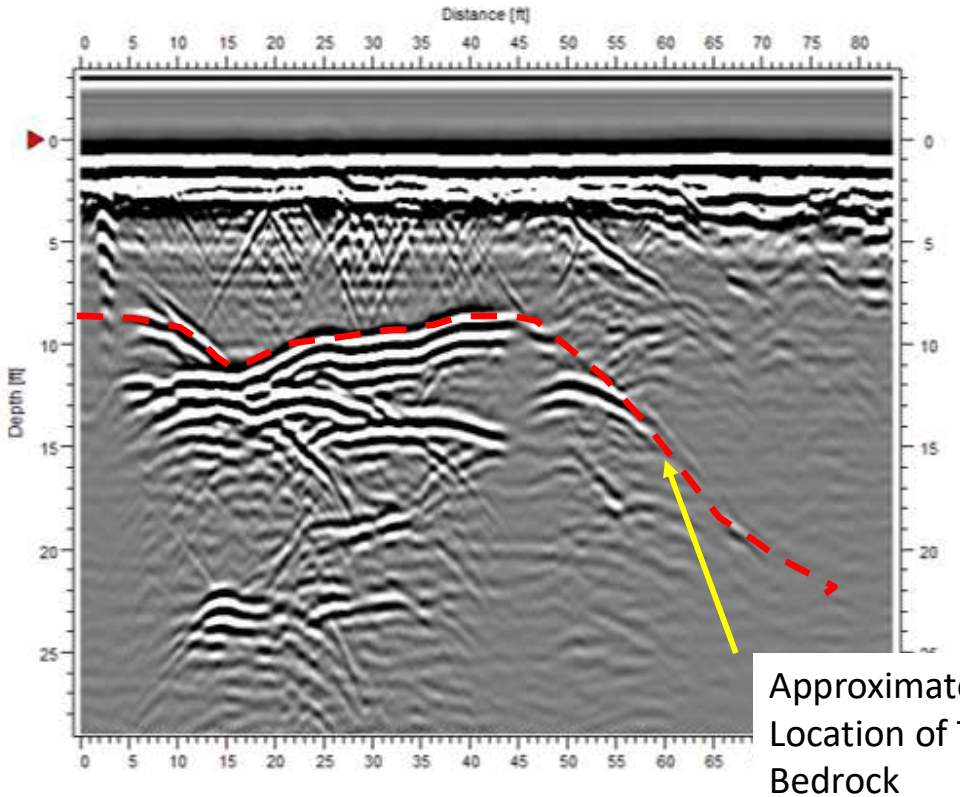
Ground Penetrating Radar

APPLICATIONS:

- ❑Underground Utilities
- ❑Underground Storage Tanks
- ❑Voids, Sinkholes and Ground Settling Issues
- ❑Non-Destructive Testing
- ❑Burials
- ❑Lithology
- ❑Fracture and Weak Zones
- ❑Depth to Shallow Bedrock
- ❑Archaeological Investigations

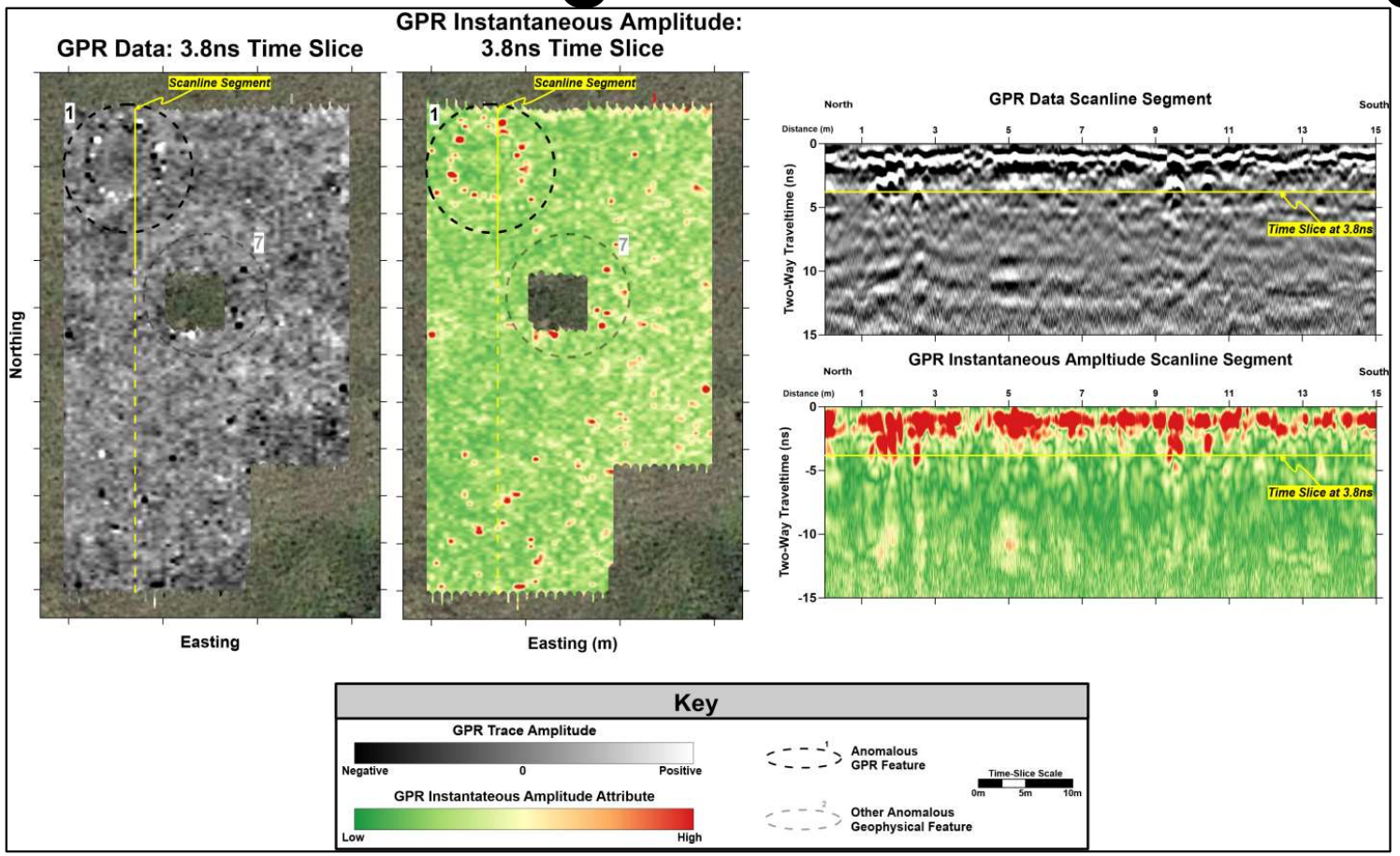


Ground Penetrating Radar - Bedrock



Approximate Location of Top of Bedrock

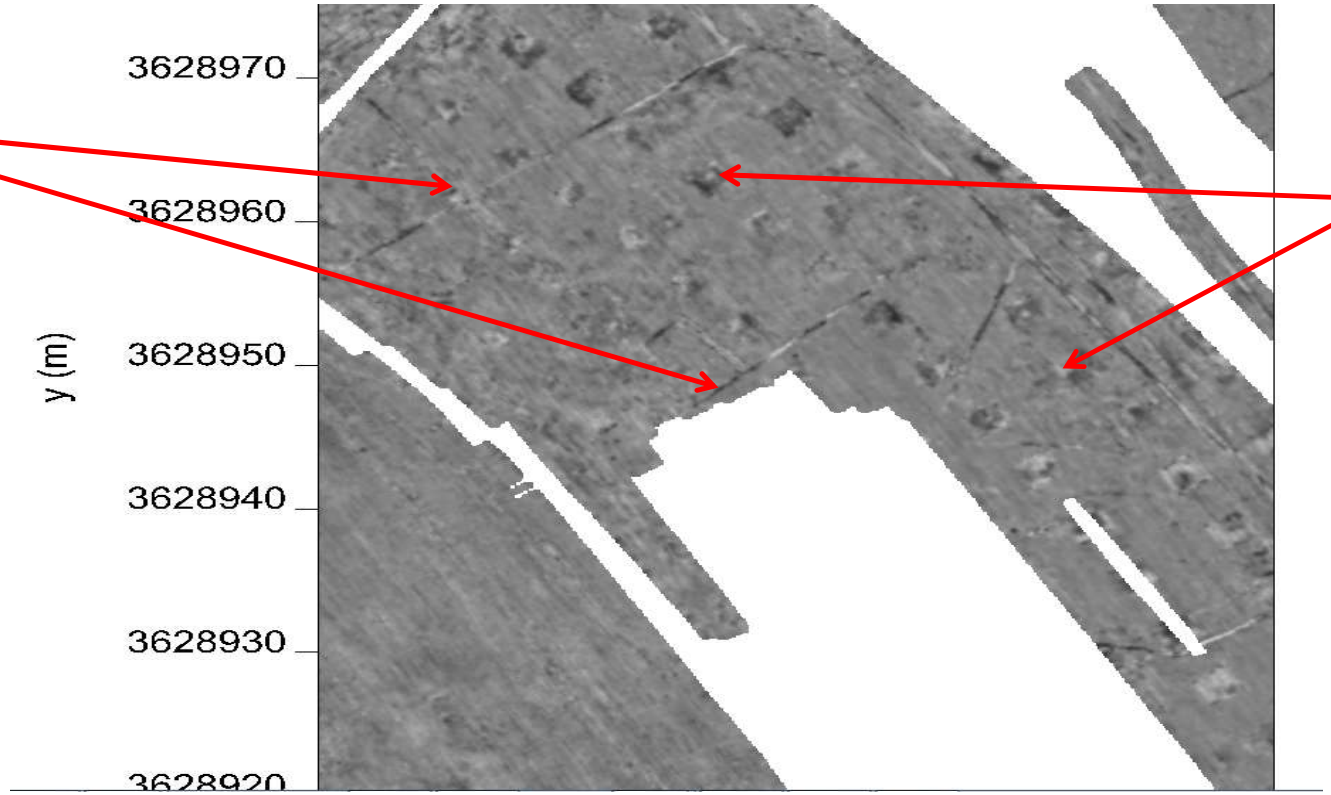
Ground Penetrating Radar – Archaeology



3D Multichannel GPR Array Systems

3D Multichannel GPR Array Systems

Buried Utilities



Buried Concrete Structures

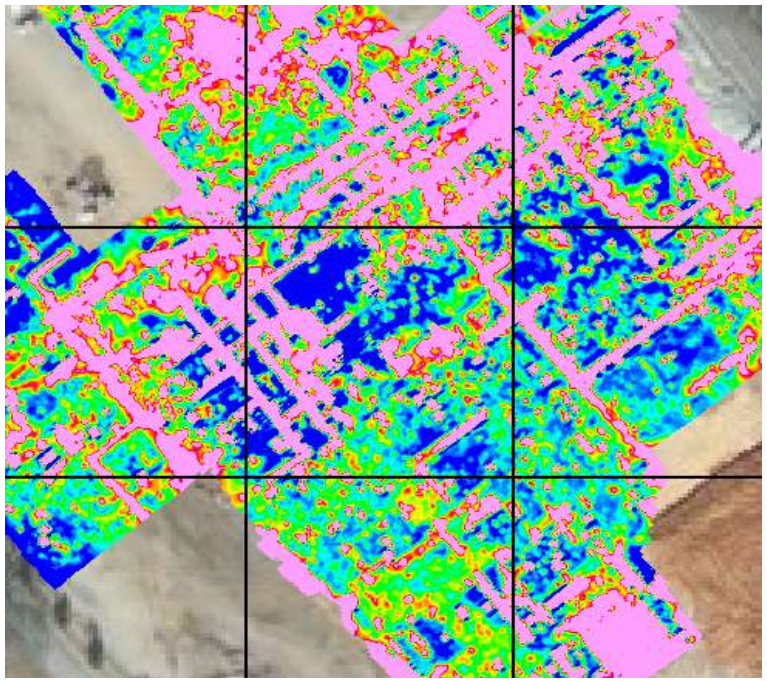
GPR Slice at 2.5 feet below ground surface

Electromagnetics (EM)

- Frequency Domain & Time Domain (FDEM & TDEM)
- Induction of EM Field
- Imaging of subsurface soil conductivity and magnetic properties
- Ferrous and Non-Ferrous Metals
- Instruments utilize a transmitter and receiver coil
- GPS data streamed into logger

TDEM – EM 61

Linear features showing extensive network of subsurface piping



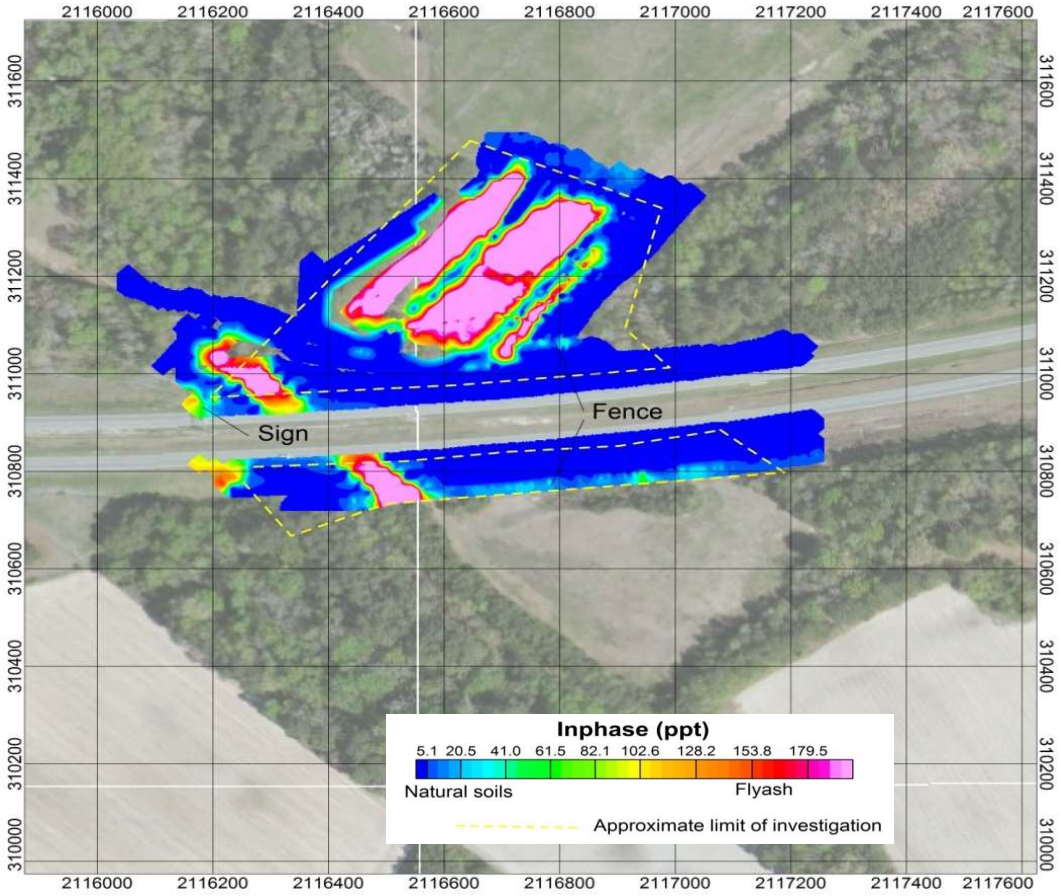
UST

GPS data streamed into TDEM logger for accurate positioning of buried objects.

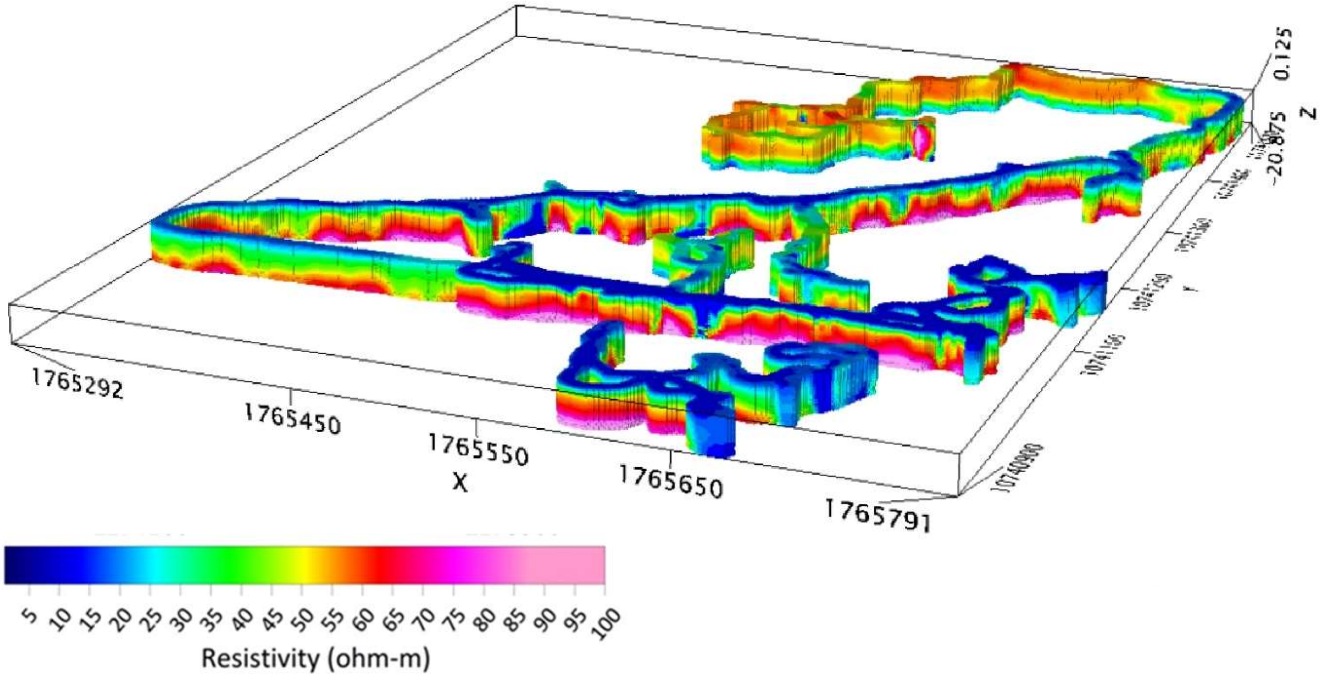
Former Gas Station

FDEM Electromagnetic Mapping of Landfill Extents

In-phase Data
(*metal detecting component*)

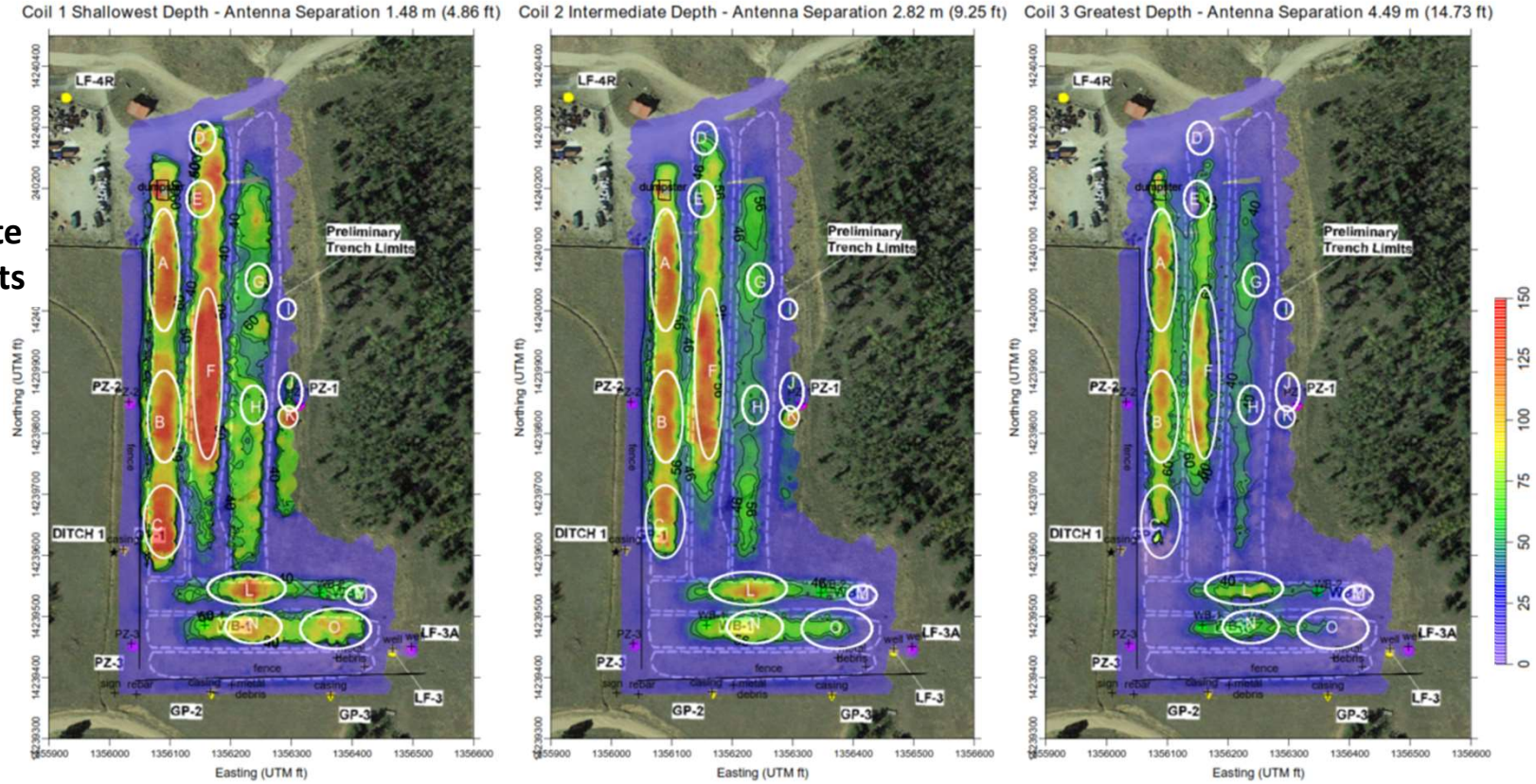


Site-Wide Mapping 3D Conductivity Using FDEM



FDEM depth slices – Bulk conductivity

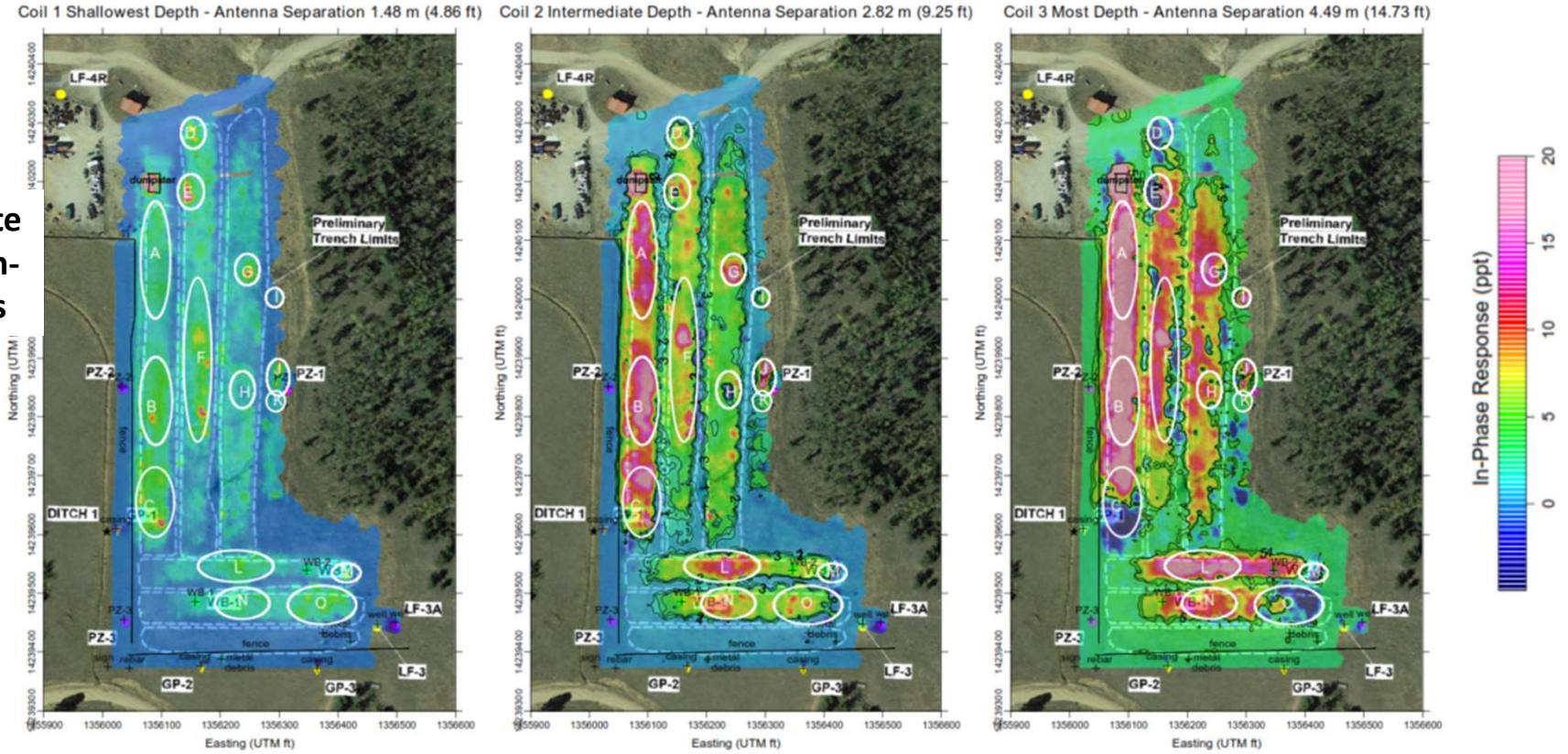
Municipal Waste >metallic objects



Approx. 0 – 5 feet ***Approx. 0 – 10 feet*** ***Approx. 0 – 15 feet***

FDEM depth slices – In-phase response

Municipal Waste >metallic & non-metallic objects

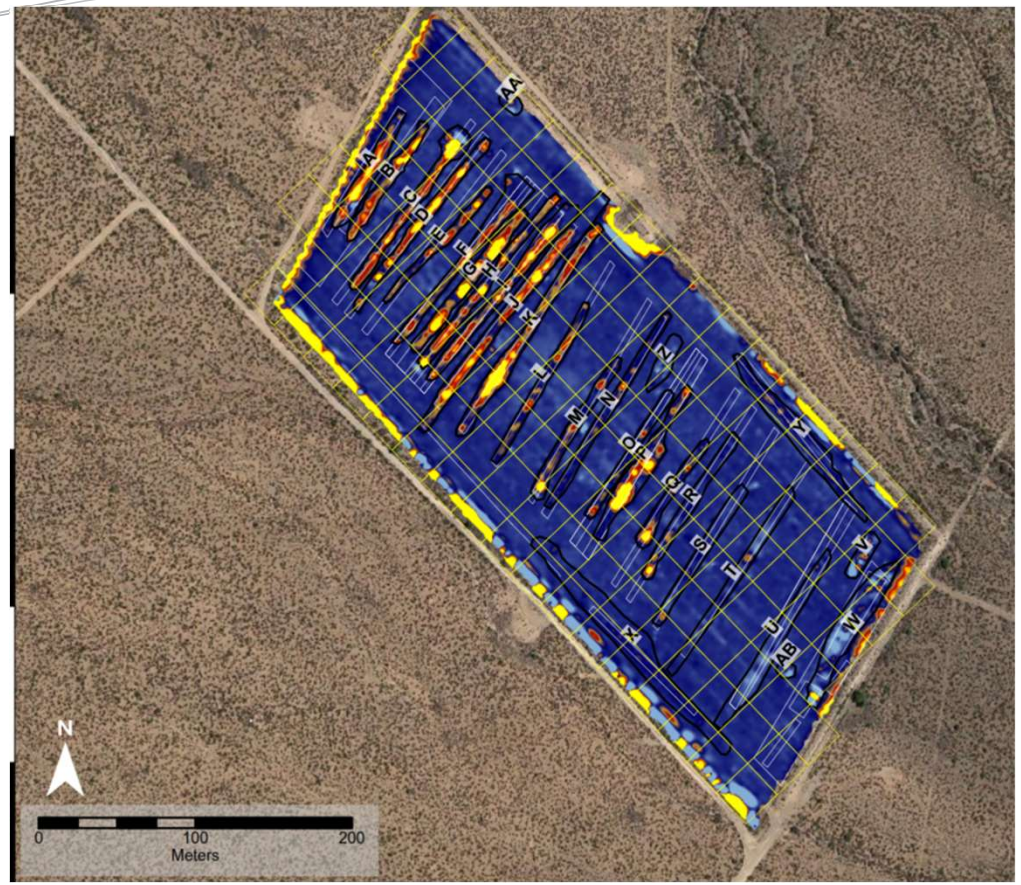


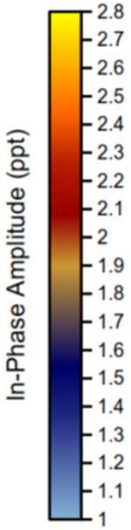
Approx. 0 – 5 feet

Approx. 0 – 10 feet

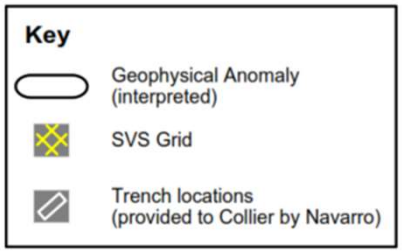
Approx. 0 – 15 feet

FDEM– In-phase response



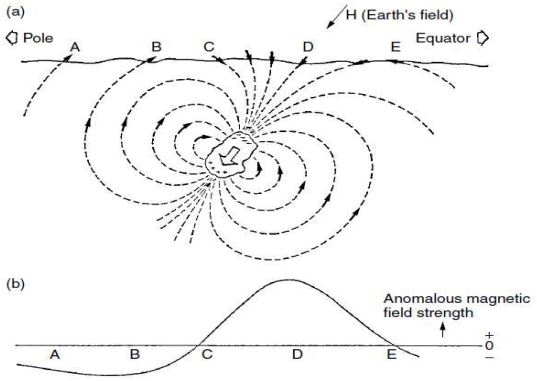


Radioactive waste site improved trench locations, extents and definition of both ferrous and non-ferrous metallic buried objects using geophysics.



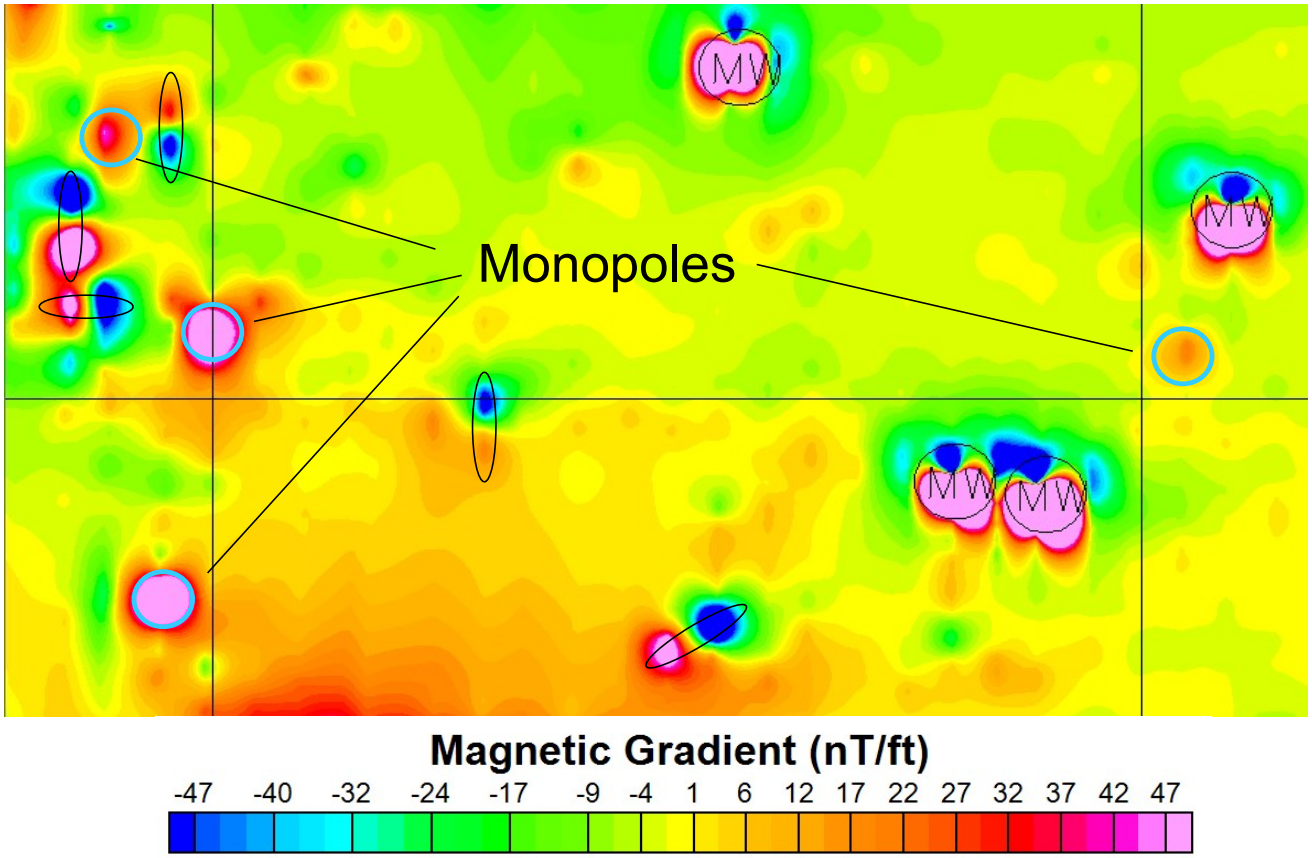
Magnetic Surveys

- Measure changes in earth's magnetic field
- Anomalies caused by
  - Buried ferrous materials
  - Lithological changes
- Total Field Instruments and Gradiometers
- Depth related to target size
- Data is presented as profiles and in the form of magnetic intensity contour maps (nT)



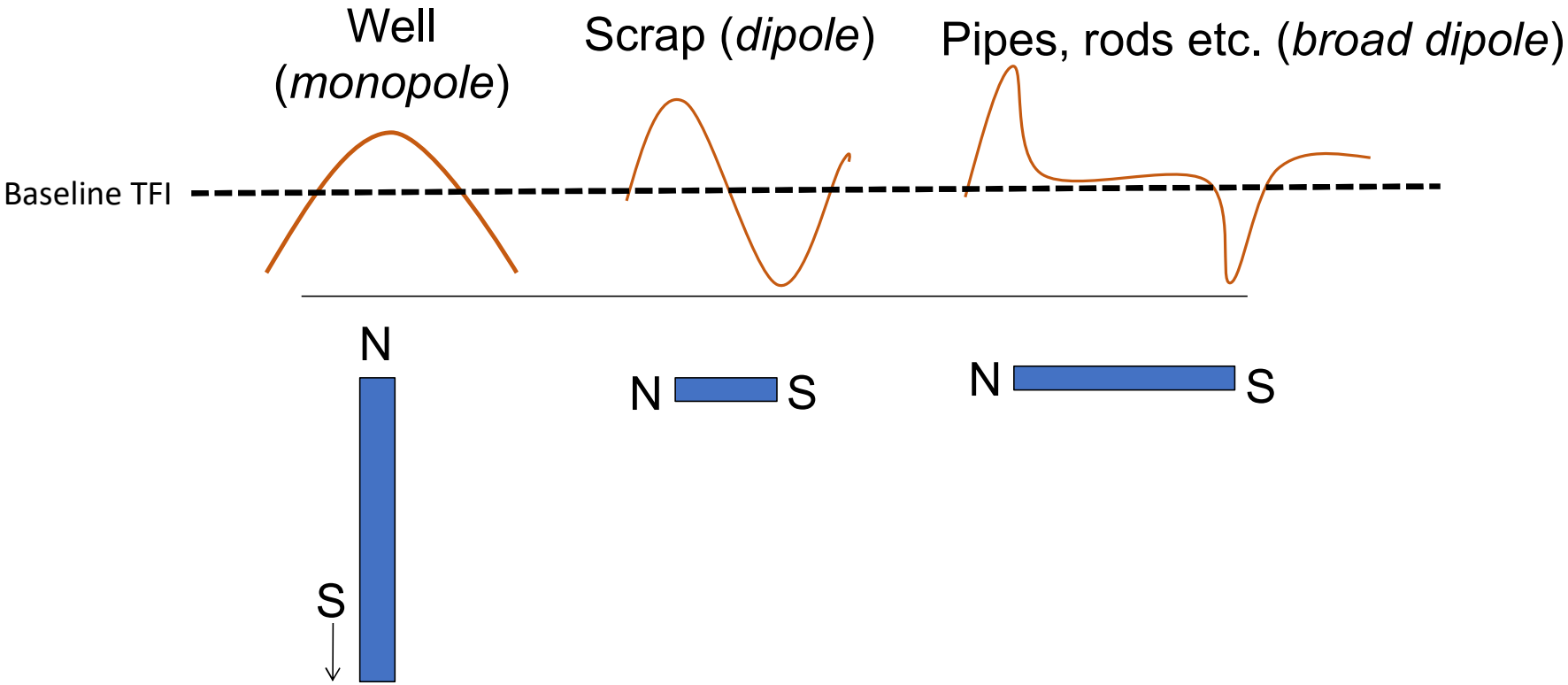
Combination of Magnetic and GPR Surveys

Missing monitoring well - Magnetometer data



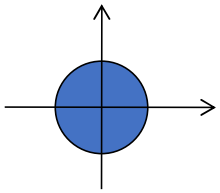
Magnetic Target Anomaly Responses

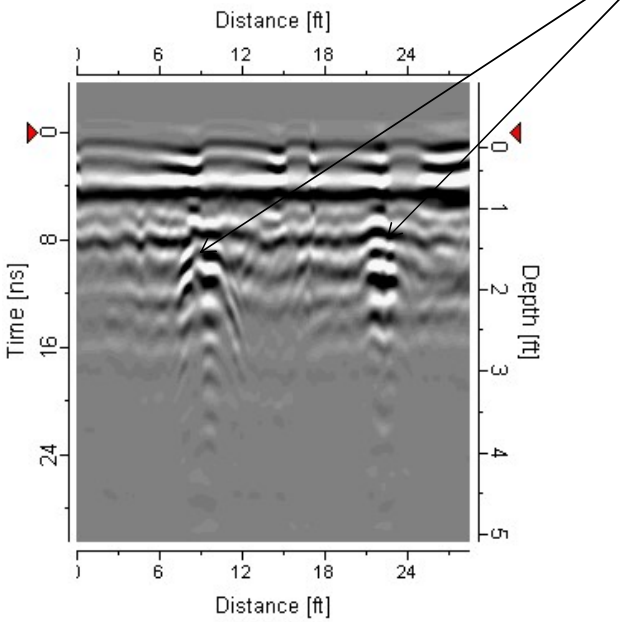
Locating a missing monitoring well
Anticipated response with magnetometer



Combination of Magnetic and GPR Surveys

Missing monitoring well - Anticipated response with GPR





Object has equal dimensions in two directions

GPR passes over target at perpendicular direction

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Thank you!!!

Geophysical Investigations in Support of Military Missions

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