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A Member of The GEL GROUP, Inc.

The Use and Limitations of Common Geophysical Methods in Determining Bedrock Depth

Kelly Plummer

Geo^{3}T^2 Conference 2015

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Bedrock Depth: Engineering Challenges

- Building and Construction Concerns: Is blasting needed?
- Environmental Concerns
- Utility Installation
- Complications in Karst Areas

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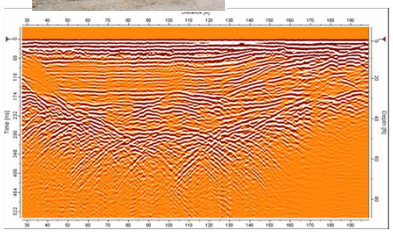
Methods of Finding Bedrock





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Geophysical Equipment and Methods





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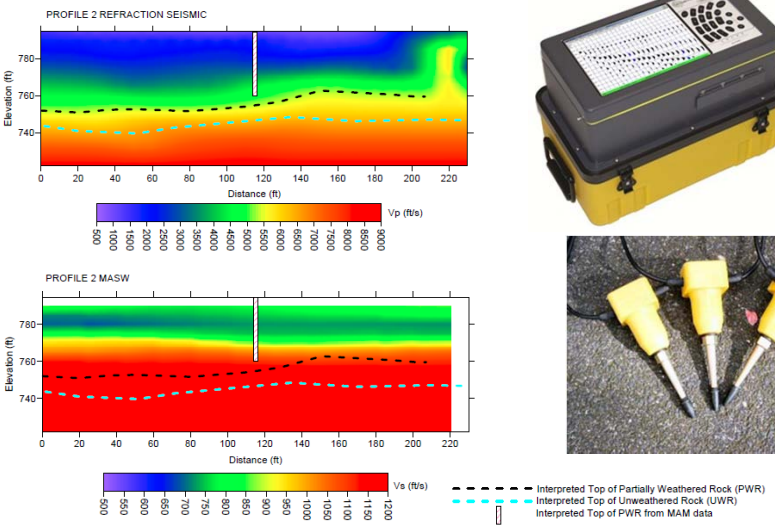
Seismic Methods



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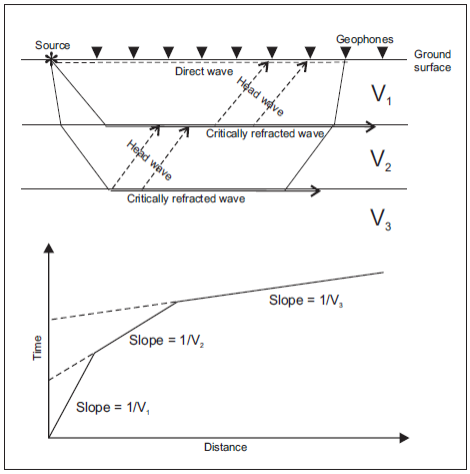
Seismic Refraction Survey



- Seismic velocity needs to increase with depth for this method to be effective.
- Only the travel time for the wave arriving first is recorded.
- Nearby concrete structures can cause interference by refracting waves.
- For complex geology: refraction tomography and forward modeling can be used to contour and distinguish gradual changes in lateral and vertical velocity.

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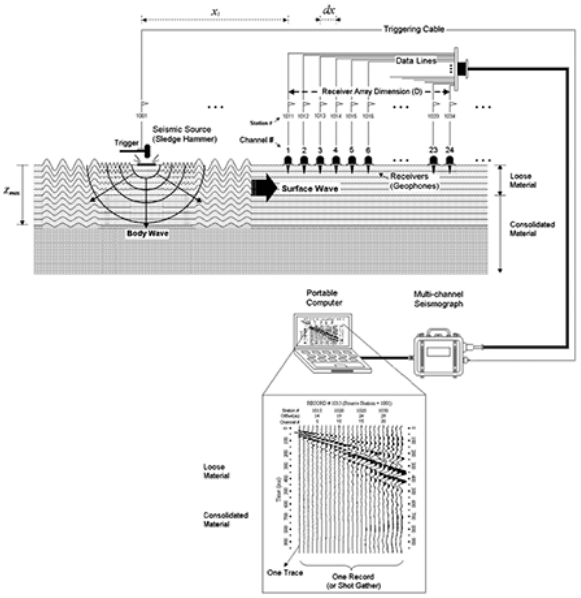
MASW Survey

- 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.



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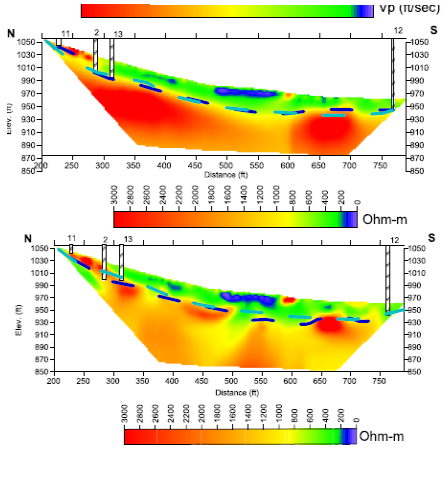
Resistivity Methods



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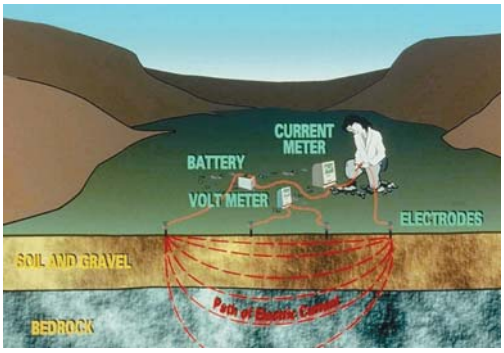
Electrical Resistivity Imaging Survey

- In an ERI survey, the apparent resistivity of the subsurface is measured using a large number of potential and current electrode combinations
- The end result is a cross section of resistivity variations with depth along a profile.
- Some materials have the ability of holding a charge after the current has been turned off. These materials can be detected by measuring this effect (induced polarization).
- ERI is superior to Seismic refraction and MASW at sites with large variations in bedrock topography



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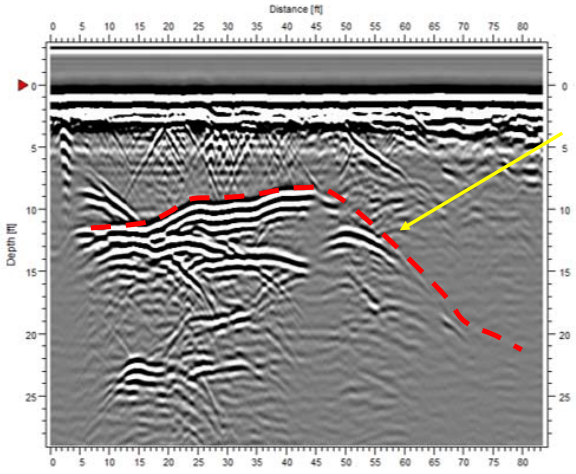
Ground Penetrating Radar



Approximate Location of Top of Bedrock

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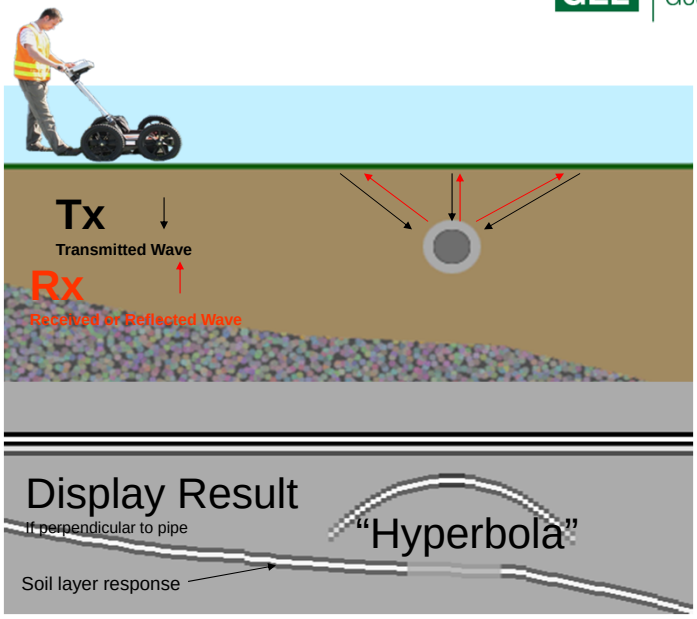

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The Advantage of Using Geophysics

- Provides information in areas conventional testing methods (SPT, CPT, test pits etc.) cannot be used, such as areas with limited access and clearance and areas with environmental concerns.
- Most intrusive methods provide information for a relatively small area, this method can be used to:
  - Cover larger areas, faster, and cheaper
  - Provide continuous information
  - Determine detached bedrock and locating boulders
  - Differentiate between unweathered and weathered rock.

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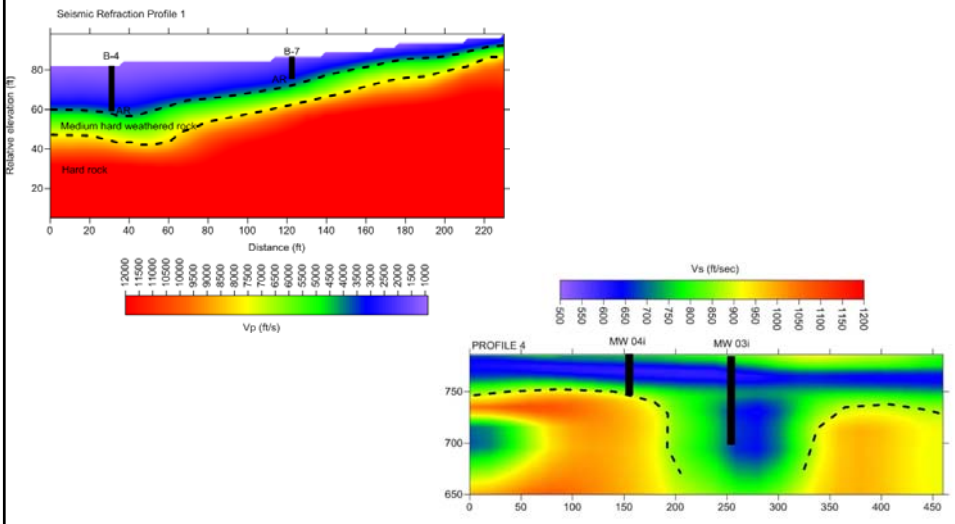
Continuous Measurement Surveys



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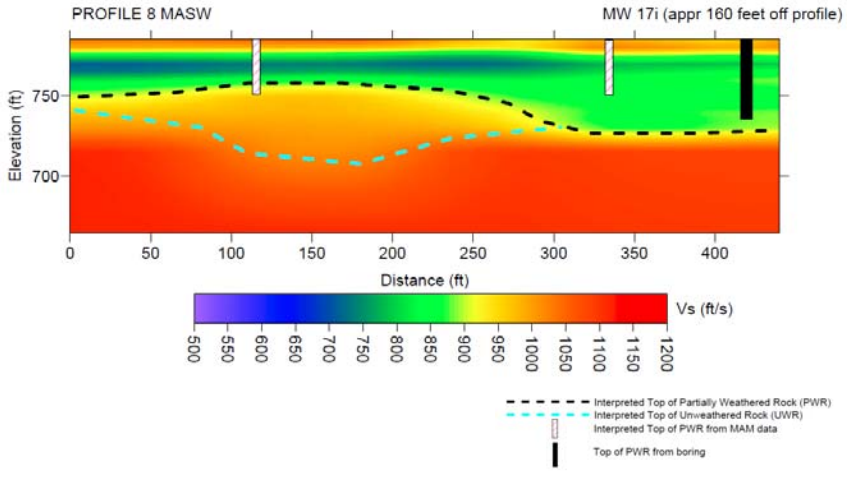
Weathered vs. Unweathered Rock



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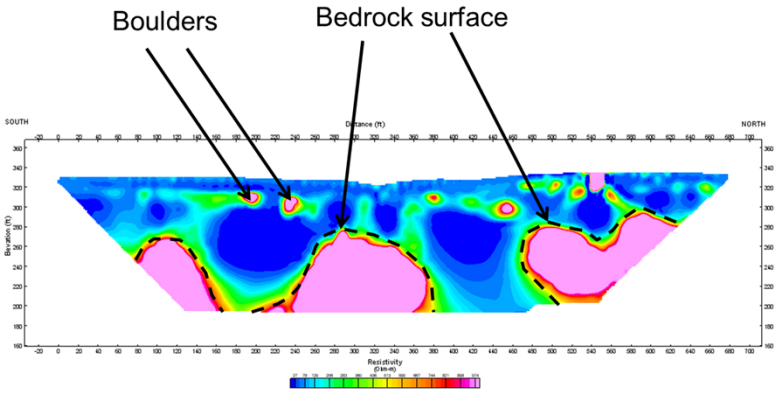
Irregular Features



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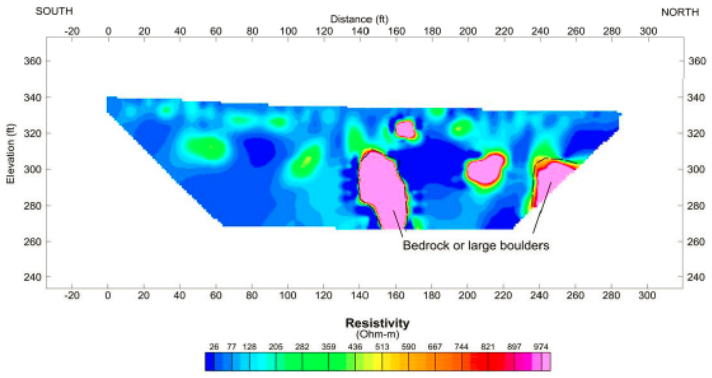

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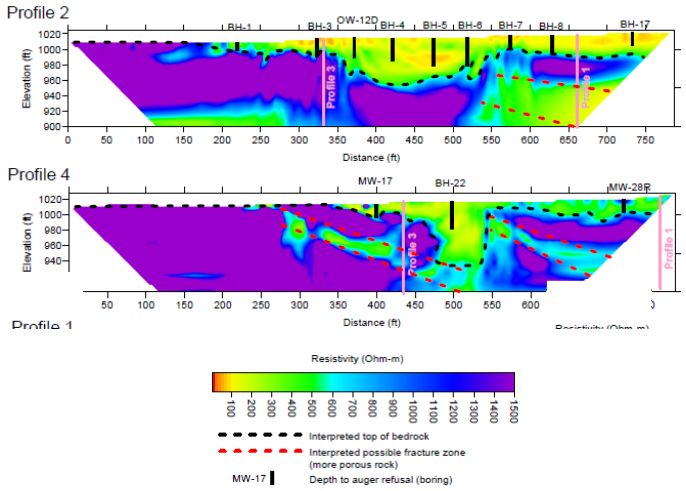
Bedrock Fractures



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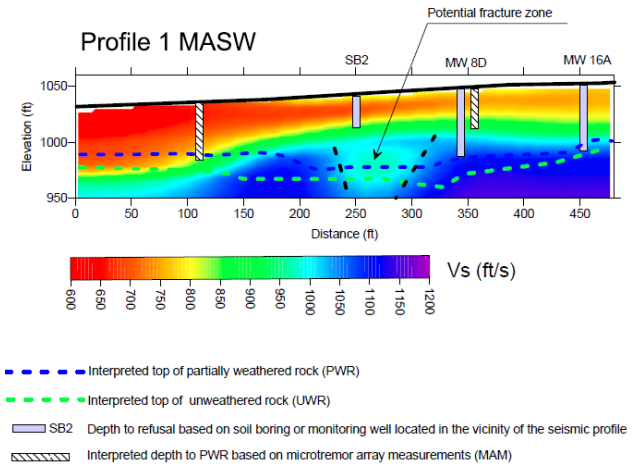

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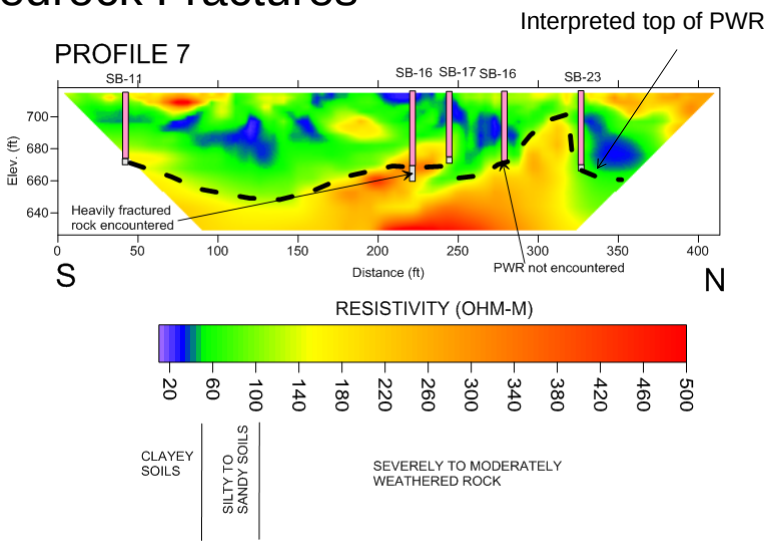

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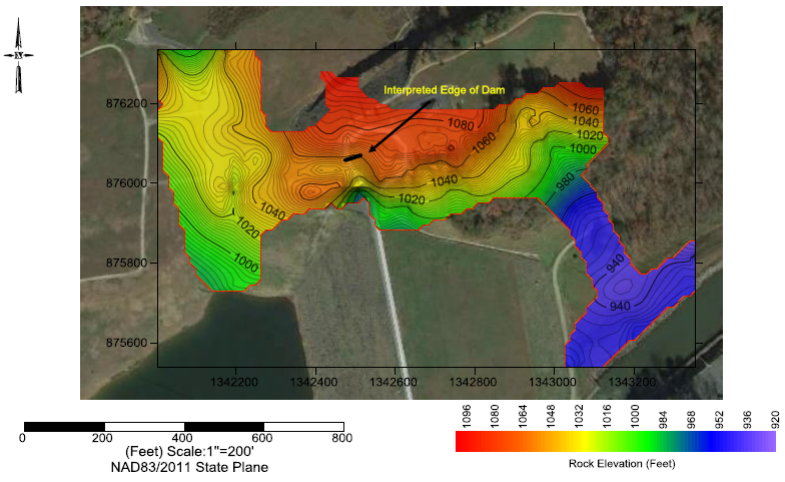
Bedrock Maps – Elevation



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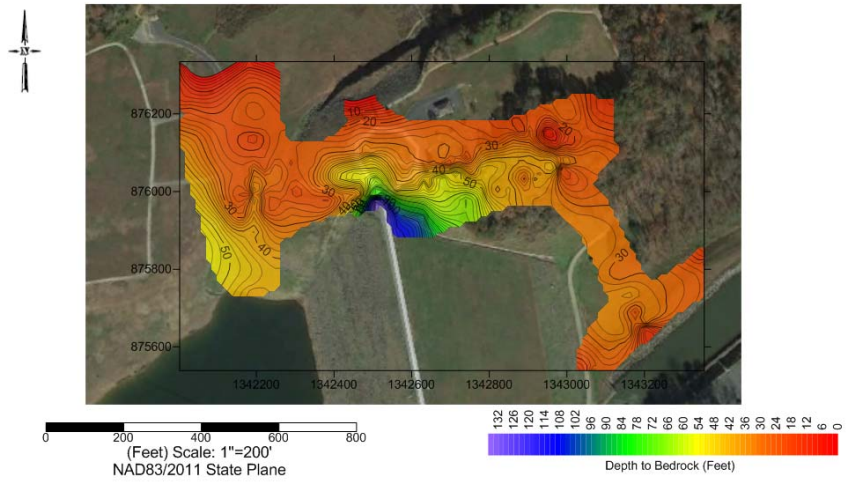
Bedrock Maps – Depth to Rock



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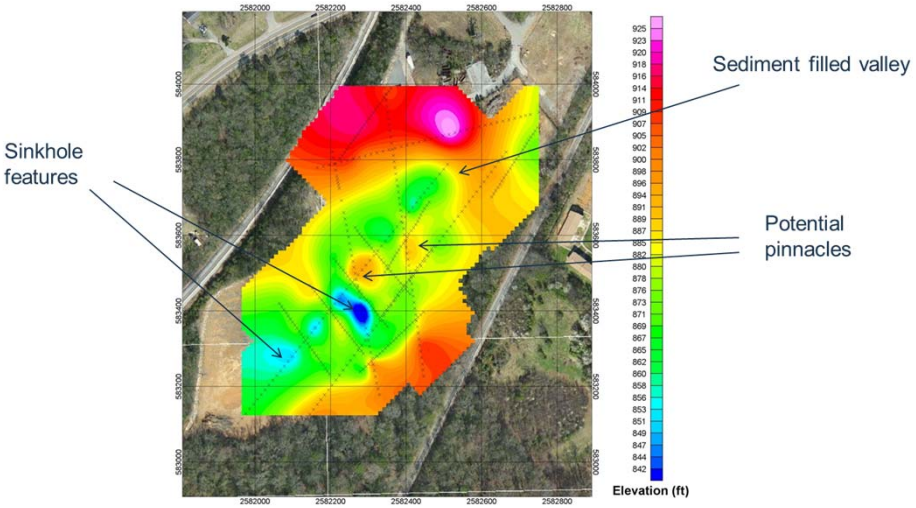
Bedrock Maps



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Site Variability

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Site Variability

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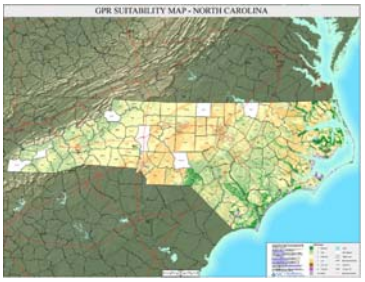
Site Complications



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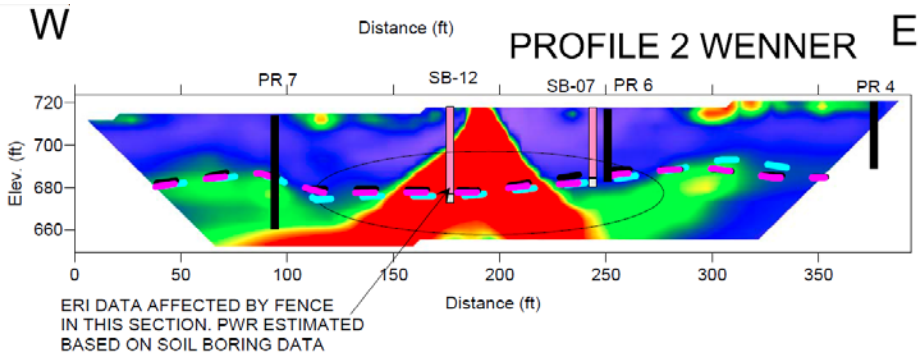
Site Complications



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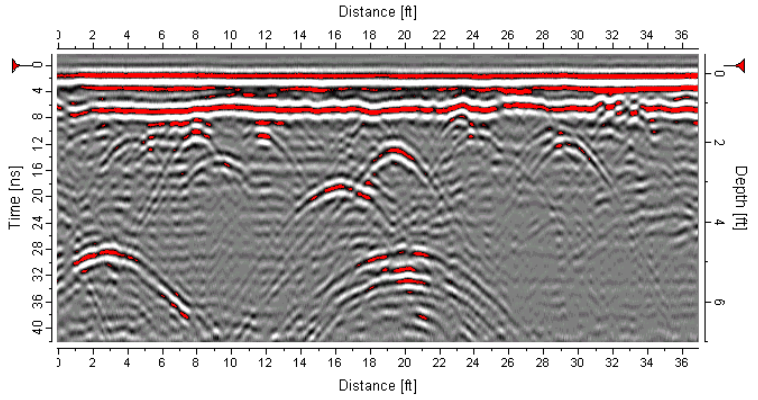
Site Complications

GPR Scan in Relatively “Good” Soil Conditions



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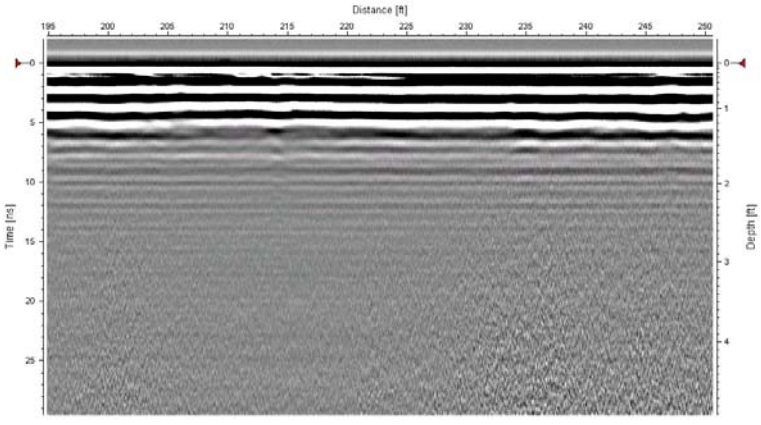
Site Complications

GPR Scan in Relatively “Poor” Soil Conditions



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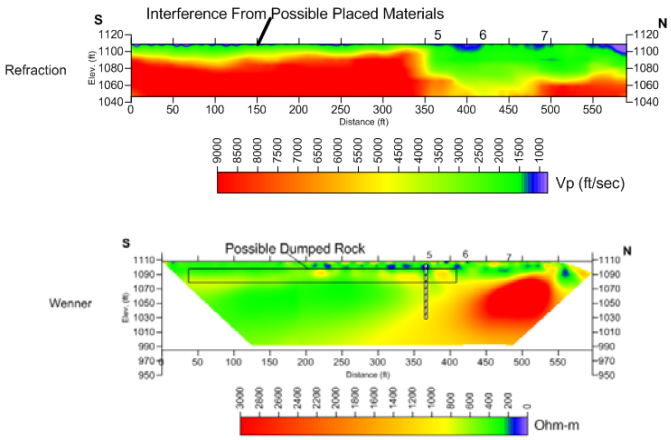

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Conclusions

- Geophysics has become a valuable tool for engineers and scientist in locating bedrock

- There are different geophysical techniques that can be used including GPR, Resistivity, and Seismic Methods

- These techniques can be used to provide continuous subsurface information including the location of boulders, fractures, etc.

- The use of geophysical methods can be used to provide bedrock maps for relatively large areas and much lower cost than conventional intrusive methods.

- The limitations of these methods along with site conditions must be evaluated when performing these projects to achieve the best results.

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Questions?

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