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

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Geo³T² Conference 2015

Bedrock Depth: Engineering Challenges

• Building and Construction Concerns: Is blasting needed?
• Environmental Concerns
• Utility Installation
• Complications in Karst Areas
Methods of Finding Bedrock

Geophysical Equipment and Methods
Seismic Methods

• 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.

Seismic Refraction Survey

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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.

Resistivity Methods
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.

Ground Penetrating Radar

Approximate Location of Top of Bedrock
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.
Continuous Measurement Surveys

Weathered vs. Unweathered Rock
Bedrock Fractures

Profile 2

Profile 4

Profile 1

Reactivity (Om-m)

Interpreted top of bedrock
Interpreted possible fracture zone
More porous rock
MW-6 Depth to auger refusal (bores)

Bedrock Fractures

Profile 1 MASW

Potential fracture zone

Interpreted top of partially weathered rock (PWR)
Interpreted top of unweathered rock (UWR)
SR2 Depth to refusal based on soil boring or monitoring well located in the vicinity of the seismic profile
Interpreted depth to PWR based on microtremor array measurements (MAM)

Problem Solved www.gelgeophysics.com
Bedrock Fractures

PROFILE 7

Interpreted top of PWR

RESISTIVITY (OHM-M)

CLAYY SOILS
SILT TO SANDY SOILS
SEVERELY TO MODERATELY WEATHERED ROCK

Bedrock Maps – Elevation

Problem Solved

www.gelgeophysics.com
Bedrock Maps – Depth to Rock

Bedrock Maps

Sinkhole features

Sediment filled valley

Potential pinnacles
Site Variability

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Site Variability

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Site Complications

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GPR Scan in Relatively “Good” Soil Conditions

Site Complications

GPR Scan in Relatively “Poor” Soil Conditions
Site Complications

- Geophysics has become a valuable tool for engineers and scientists 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.

Conclusions
Questions?
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