Getting a Clearer Picture with Geophysics

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Presentation Overview

This presentation will cover…

- What is geophysics?
- Why geophysics?
- Methodology and when to use
  - Seismic
  - Resistivity
  - Ground Penetrating Radar
  - Electromagnetics
- Marine Geophysics
- Drilled shaft testing options

This presentation will not cover…

- Specific details of how each method works
- All of the methods available

Because…
It’s Too Early To Do This!
Geophysics Defined

Merriam-Webster
A branch of earth science dealing with the physical processes and phenomena occurring especially in the earth and in its vicinity.

Wikipedia
A subject of natural science concerned with the physical processes and physical properties of the Earth and its surrounding space environment, and the use of quantitative methods for their analysis.

For today’s purposes
Derive subsurface information with surface methods or minimally intrusive methods. Better summarized as “really cool stuff!”
Traditional Geotechnical Site Characterization

- Visual observations of the existing surface conditions
- Obtain borings for soil and rock samples
- Install monitoring wells to observe groundwater conditions
- Perform laboratory testing on discrete sampling intervals
- Interpolate/extrapolate data from the very limited data points
Found it!!!

Congratulations, it only took you 65298 seconds.
Seismic Applications

- Determining Seismic Site Classification
- Map bedrock topography
- Rippability of soil/rock
- Locate potential sinkhole/karst conditions
Seismic
AASHTO Site Classification

- Least conservative method
- Estimates the shear wave velocity
- Required to assign a Site Class A, often needed to verify a Site Class B, C, or D
- Relatively inexpensive with huge potential cost savings

<table>
<thead>
<tr>
<th>SITE CLASS</th>
<th>SOIL PROFILE NAME</th>
<th>Soil shear wave velocity, $\bar{v}_s$, ft/s</th>
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<tbody>
<tr>
<td>A</td>
<td>Hard rock</td>
<td>$\bar{v}_s &gt; 5,000$</td>
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<tr>
<td>B</td>
<td>Rock</td>
<td>$2,500 &lt; \bar{v}_s \leq 5,000$</td>
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<td>C</td>
<td>Very dense soil and soft rock</td>
<td>$1,200 &lt; \bar{v}_s \leq 2,500$</td>
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<td>D</td>
<td>Stiff soil profile</td>
<td>$600 \leq \bar{v}_s \leq 1,200$</td>
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<tr>
<td>E</td>
<td>Soft soil profile</td>
<td>$\bar{v}_s &lt; 600$</td>
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Seismic Mapping Bedrock Topography
Seismic Mapping The Subsurface
Seismic Rippability Studies

- Ripppable to depths of about 25' to 45'
- Marginally Ripppable between depths of about 25' to 50'
- Non Ripppable below depths of about 25' to 50'

Elevation, ft

Velocity, ft/sec
Seismic Rippability Studies

D10R
- Multi or Single Shank No. 10 Ripper
- Estimated by Seismic Wave Velocities

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<th>Seismic Velocity</th>
<th>0</th>
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<td>Meters Per Second × 1000</td>
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- TOPSOIL
- CLAY
- GLACIAL TILL
- IGNEOUS ROCKS
- GRANITE
- BASALT
- TRAP ROCK
- SEDIMENTARY ROCKS
- SHALE
- SANDSTONE
- SILTSTONE
- CLAYSTONE
- CONGLOMERATE
- BRECCIA
- CALICHE
- LIMESTONE
- METAMORPHIC ROCKS
- SCHIST
- SLATE
- MINERALS & ORES
- COAL
- IRON ORE
Seismic
Locating Weak Zones/Karst
Electrical Resistivity Applications

- Map bedrock topography
- Detecting buried debris
- Locate potential sinkhole/karst conditions
Electrical Resistivity Imaging
Mapping Bedrock Topography
Electrical Resistivity Imaging

Detecting Buried Debris

Anomalies likely to be fill

Anomaly could be consistent with an underground buried objects
Electrical Resistivity Imaging
Locating Weak Zones/Karst

Anomalous areas (green) indicative of weathered bedrock or gravelly residual soils

Anomalous areas (red) indicative of intact bedrock

Anomalous area (light green, orange, and yellow) indicative of possible incipient sinkhole formation

Anomalous areas (green) indicative of weathered bedrock or gravelly residual soils
Ground Penetrating Radar Applications

- Detect shallow voids
- Locate buried debris/tanks/utilities
- Map shallow bedrock
- Determine reinforcement placement and pavement thickness
Ground Penetrating Radar
Void Detection
Ground Penetrating Radar
Void Detection

TUNNEL 1 - WEST HAUNCH

GPR ANOMALY

DISTANCE (Feet North of South Portal)

DEPTH (feet)
Ground Penetrating Radar
Locating Buried Debris

Large Metallic Anomaly
Ground Penetrating Radar
Mapping Shallow Bedrock
Ground Penetrating Radar
Evaluating Pavements
Electromagnetic Applications

- Locate buried debris/tanks/utilities
- Locate saturated/soft subsurface areas
Electromagnetic Locating Debris
Electromagnetic
Locating Saturated/Soft Zones
Just so the “Bridge Guys” Don’t Feel Left Out...
Marine Geophysics

Echo Sounding
Marine Geophysics

Sub-bottom Profiling
Drilled Shaft Testing Evaluation

Cross-Hole Sonic Logging
Drilled Shaft Testing Evaluation

Thermal Integrity Profiling

Neck

Bulge
Think Geophysics