VIBROSEIS FOR PHASE II OF THE SOURCE PHYSICS EXPERIMENT

Emily Sexton
3 MAIN OBJECTIVES

- Understanding the Earth layers just below our feet
- Better detection of nuclear testing in foreign countries
- Finding multiple mediums for measurement
• We can use a source that has a certain frequency that inputs an impulse into the ground, also known as seismic waves, which are also generated during an earthquake.
  • Some examples of these sources are hammers, weight drops, gun shots, ext.
  • In this case we are using a vibroseis truck
VIBROSEIS TRUCK

- Lowers a plate onto the ground, lifting up the truck slightly.
- Uses hydraulics to vibrate, sending seismic waves into the ground.
• Geophones: contain a coil that moves up and down as a seismic wave propagates by it.
• On the left is a picture of someone installing a geophone into the ground.
• We can use the delay times between when the truck vibrated and when the geophones picked up the shaking to determine how fast the seismic waves were traveling.
• Seismic waves travel through different types of rock and soil at different velocities. We can use the arrival times of the different seismic waves to determine how fast the waves were traveling (telling us what type of rock is under our feet), and if it changed velocities (i.e., there is a change in rock type, a fault, or a water table present.)
• The geophone line is connected to a computer, where we can observe the live movement along the line and record the vibrating of the truck.
- It is possible to set off nuclear explosions that are small enough they can be mistaken for small earthquakes, mine blasts, etc. The purpose of this experiment is to measure the behavior of seismic waves originating from a controlled explosive source. These results can be used to determine how seismic waves originating from a nuclear explosion would differ from those coming from an earthquake, thus determining the source.
- Since the United States does not have the authority to enter other countries to see if they have been conducting nuclear tests, we need a way to monitor the other countries from afar.
- This will allow us to determine if there has been nuclear testing, and where the testing occurred.

<table>
<thead>
<tr>
<th>SOURCE PHYSICS EXPERIMENT (SPE)</th>
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<tbody>
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<td>▪ Distinguish between small seismic events</td>
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<td>▪ Measure the seismic activity from a distance</td>
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<td>▪ Determine if countries have been nuclear testing</td>
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• They encountered multiple problems during the experiment due to the granite they were working in.
  • Granite is a dense rock formed by volcanic activity.
  • There were many fractures/faults in the rock that made it difficult to drill a straight hole
  • The water table was much higher than they expected and their equipment wasn’t waterproof.
• Seismic waves travel differently through different types of rock, so in order to acquire a wider range of data, they want to conduct Phase II of the experiment in Alluvium, which is much less dense than Granite.
  • Alluvium consists of clay, silt, sand, and gravel.
  • They want an existing borehole (where they have done testing previously) because it saves money and time if they don’t have to drill a new hole.
  • If they can find a site that doesn’t have as many fractures as Phase I, it would make the analysis easier.

**MULTIPLE MEDIUMS FOR MEASUREMENT**

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<thead>
<tr>
<th>Phase I: Granite</th>
<th>Phase II: Alluvium</th>
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<tbody>
<tr>
<td>Complex geology caused problems for the experiment</td>
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<tr>
<td>Fractures</td>
<td>Existing borehole</td>
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<td>Perched water table</td>
<td>Diameter 36-64 inches</td>
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<td></td>
<td>Depths &lt;1000 ft (ideally 550 ft)</td>
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<td></td>
<td>Alluvium thickness of 550 feet</td>
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<td></td>
<td>Water table below 550 feet</td>
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<td>Few fractures/faults</td>
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• This is a map of the line we used. The orange dots represent locations where the truck vibrated (shot points) and the purple dots represent the locations of the geophones.
• The truck vibrated for 8 seconds, and it would vibrate 4 times at each shot point. Therefore, it vibrated for a total of 32 seconds at each location.
• These are some images of vibroseis shots at three separate locations.
• The first shot was before the first geophone, which is why the peak is off the record.
• The next two shots are making their way down the line. (These are only 3 files out of 191, how many shots there were).
• The lines represent the arrival of different seismic waves at each geophone. The geophones closest to the shot experience the least delay between when the shot goes off and when the seismic waves reach them.
• These files will be processed so that we end up with a cross section of the land with faults, the water table, and different layers of rock/soil. This will be determined based off of the changes in velocity in which the seismic waves travel through the ground.
THANKS

This vibroseis survey was made possible by Cathy Snelson\textsuperscript{1}, Veraun Chipman\textsuperscript{1}, Dudley Emer\textsuperscript{1}, Bob White\textsuperscript{1}, Ryan Emmitt\textsuperscript{1}, Al Wright\textsuperscript{1}, Chris Cothrun\textsuperscript{2}, Nedra Bonal\textsuperscript{3}, Heather Gang\textsuperscript{1}, Jennifer Mercadante\textsuperscript{1}, Michael Floyd\textsuperscript{1}, and Chris McGowin\textsuperscript{1}.

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