Introduction to Refraction Tomography

Geop402-*Senior Project*

- ❑Introduction
- ❑Refraction Design
- ❑Geophone Setup
- ❑Software
- ❑Results

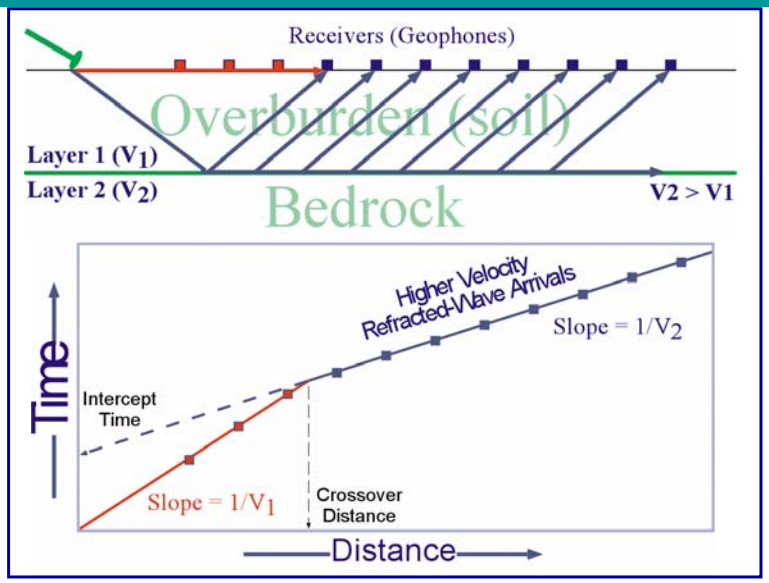
Refraction: Solutions

- **Brute Force**
  - High-energy Source

- **Survey Design**
  - Source Location
  - Receiver-Ground Coupling
  - Target Parameters
  - Modify Instrumentation
  - Work Off Hours

source: aec.army.mil/usaec/cleanup/geophysics03.ppt

Refraction Method



source: aec.army.mil/usaec/cleanup/geophysics03.ppt

Refraction Targets

- **Bedrock Surface**
  - **Changes in Topography**
  - **Pinnacles, Depressions**
- **Velocity Changes**
  - **Fractured Intervals**
  - **Weak/Competent Zones**
- **Foundation Studies***
  - **Dams**
  - **Major buildings**

source: aec.army.mil/usaec/cleanup/geophysics03.ppt
*pp 277 of John Reynold's book, 2002

Refraction: Road Blocks

- **Noisy Environment**
  - **Sumps, Fans, Traffic**
- **Difficult Medium**
  - **Road/Foundation Design**
  - **Low Signal Levels**
- **Complex Geology**

source: aec.army.mil/usaec/cleanup/geophysics03.ppt

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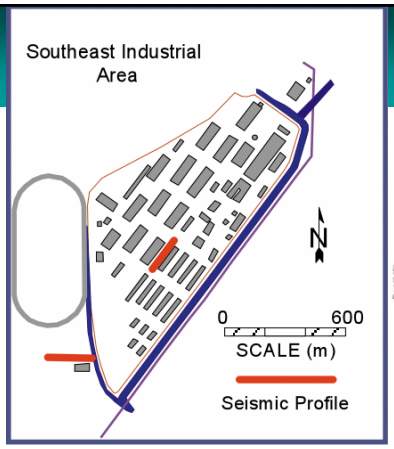
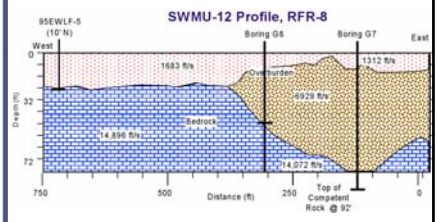
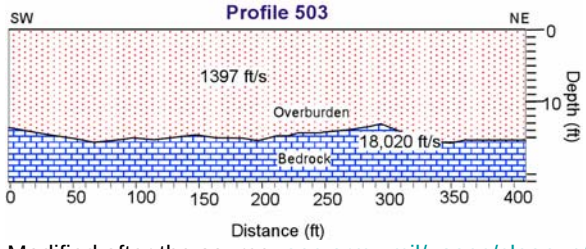
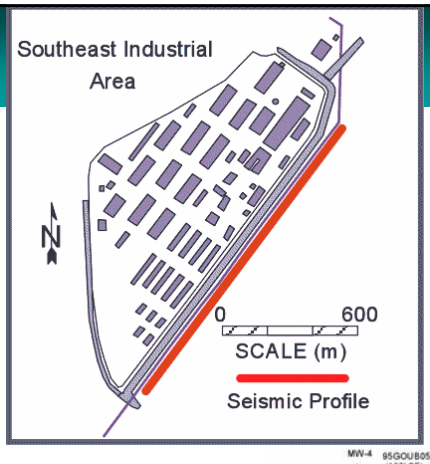


Short Profile





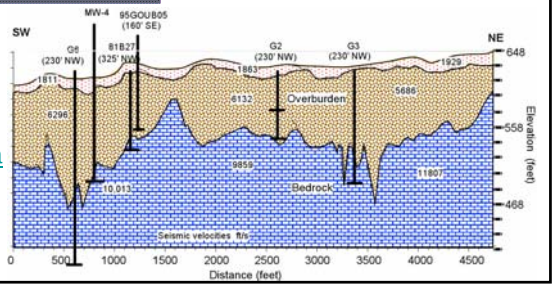
Modified after the source: aec.army.mil/usaec/cleanup/geophysics03.ppt



Long Profile

Borehole: horizontal bar indicates top of bedrock. For hole G2, upper horizontal bar indicates top of 15-20 ft thick dolomite layer.

Modified after the source: aec.army.mil/usaec/cleanup/geophysics03.ppt



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Geophone Setup

4.5 Hz geophone with spikes connected to 4 ft takeout, 60-pair seismic cables.

Source:http://www.kgs.ku.edu/Geophysics2/Equip/Geo%20Phones/Geo6.htm

Geophone Setup

Stretching as far as the eye can see, ***this line of geophones*** was laid after the snow and ice **were dug from each of the designed locations**.

Field crews were tireless in their efforts to get this done quickly, ***since the risk of bear attacks was very real.***

Source:http://www.kgs.ku.edu/Geophysics2/Equip/Geo%20Phones/Geo3.htm

Geophone Setup

Geophone have to work in all kinds of environments.

Here a ***field specialist*** checks the "*plant*" of a group of geophones in Alaska.

He has **a drill** to break through the permafrost.

Source:http://www.kgs.ku.edu/Geophysics2/Equip/Geo%20Phones/Geo5.htm

Geophone Setup

In Florida a string of geophones snakes though **the house** looking for ***voids*** under it.

Source:http://www.kgs.ku.edu/Geophysics2/Equip/Geo%20Phones/Geo8.htm

Geophone Setup

A typical Surface-Wave geophone setup.

Notice **the tape** measured is used to accurately position the geophones with **proper spacing.**

Source:http://www.kgs.ku.edu/Geophysics2/Equip/Geo%20Phones/Geo6.htm

Geophone Setup

Combined ReMi and seismic refraction setup in Sandia Mountains, NM. Equipment is set up on the back of the truck. ***Geophone spacing is 10 feet and the array length is 120 feet.*** ***The author*** *is* ***beginning to jog to generate surface waves*** *for a ReMi data set;* ***the sledge hammer seismic refraction energy source is in the foreground.*** *(Figure 1, Michael Rucker's paper).*

Geophone Setup

Small scale **ReMi** **geophone array setup** to evaluate **fill conditions** under concrete slab. Binder clips were set on spikes and then taped to the geophone bodies for mounting on the floor (Picture from the paper of Michael Rucker).

Geophone Setup

Typical field setup for ReMi data collection along loading and unloading curbs at airport terminals. Note cinder blocks used to assist with geophone placement on pavement. ***Geophones were placed on hollow cinder blocks set on the pavement in a 12-geophone array with 10-foot spacing.*** *Each ReMi data set was 12 seconds long at 1 millisecond sample intervals.* ***Twenty-eight Hz geophones*** *are set up on the cinder blocks, and* ***4.5 Hz geophones*** *are collected on the sidewalk next to the seismograph. The ReMi test is being performed on a street section consisting of a minimum of 5-inches of asphaltic concrete pavement over an aggregate base course.* ***Although the site was hopelessly noisy for seismic refraction****, as well as being paved, the ambient noise served well as a source for the ReMi method.*

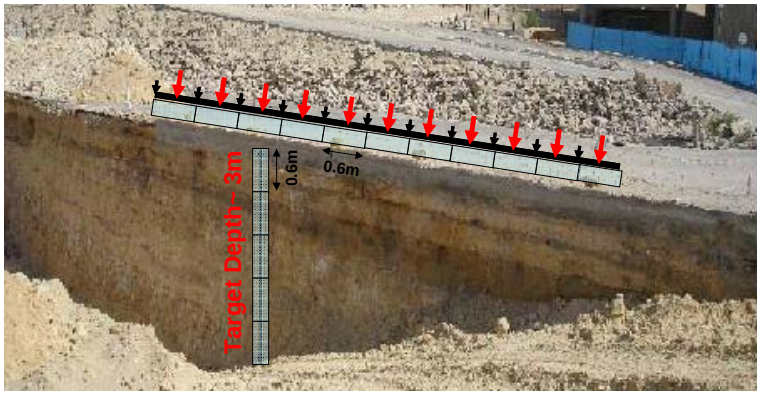
Figure 2 of Michael Rucker's paper.

Profile Design

Shot Point

Geophone

Example-1: Design on Receiver Distance



Then, what is the receiver distance regarding the target depth or vice versa? Refraction Design is over.

Receiver spacing (dx) is about 1/5 the max depth of target depth (z)

What is the resolution? 0.3 m

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Instrument Design

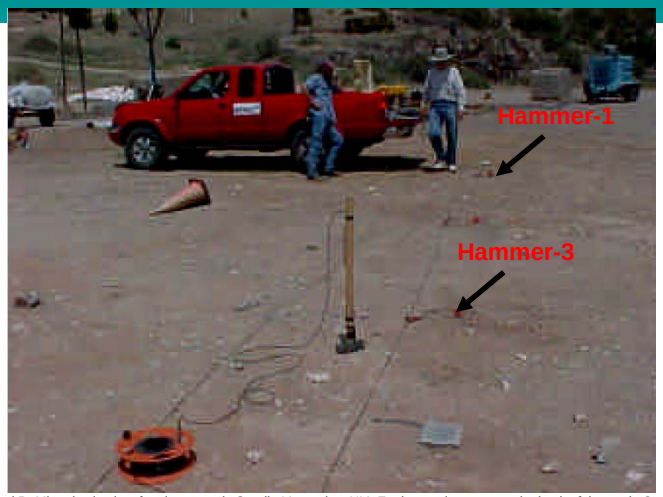
Objective	Tool	Total Time	Sampling
2D-Pwave	SEIS-OPT	250 milliseconds	0.25 milliseconds
1D-Swave	SEIS-REMI	30 seconds	2 milliseconds

2D-Pwave: Field Area should be quiet. Thus, avoid from the noise due to human activity. **FILTER can be ON and STACKING is OK.** Total time of recording should be 250 sec at 0.25 millisecond.

1D-Swave: FILTER can be OFF. No STACKING. Any noise through the field are due to walking, jogging and traffic can be use as an ambient use for REMI work. At least, 15 records are suggested due to best-fitting in statistical study.

One record means 12 traces resulted from one hammer hit. In practice, you can record 15 after each hitting near the individual source of geophone or include different activities such as walking (5 records), jogging (5 records), ambient noise (4 records) and striking (2 records) to generate different noise frequencies.

Instrument Design



Combined ReMi and seismic refraction setup in Sandia Mountains, NM. Equipment is set up on the back of the truck. ***Geophone spacing is 10 feet and the array length is 120 feet.*** ***The author*** *is* ***beginning to jog to generate surface waves*** *for a ReMi data set;* ***the sledge hammer seismic refraction energy source is in the foreground.*** *(Figure 1, Michael Rucker's paper).*

You don't have to finish walking across the trace when recording. That is person can be half-way or quarter-way down the line when 30 seconds is one. Just start the next recording. Once again all we are doing is generating noise coming along the array. No rules for how to do it.

Working Design

IMPORTANT NOTE

Following the 2D P-wave work, You run FILTER OFF AND also reset sample interval to 2milliseconds and recording time to 30seconds for REMI (very important). Also, you are collecting noise. So the hammer hit you are doing is "noise" for ReMi, *which is different than the ambient noise due excavation or walking*. Make sure you collect 15 noise records! 15 records each 30 seconds long.

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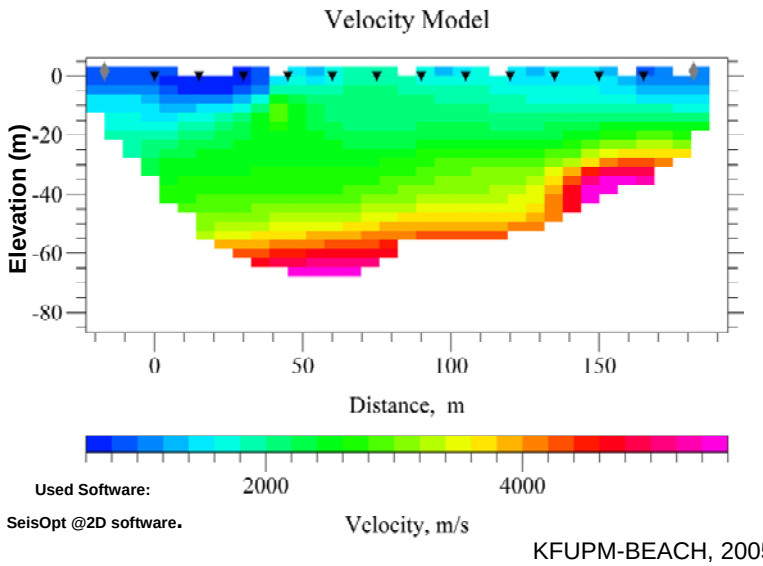
Expected Outcome

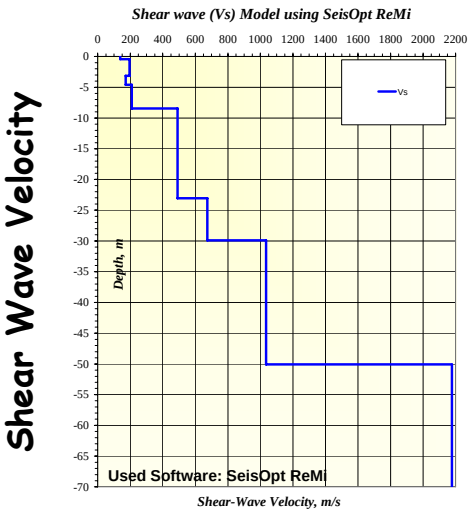


Used Software:

SeisOpt @2D software.

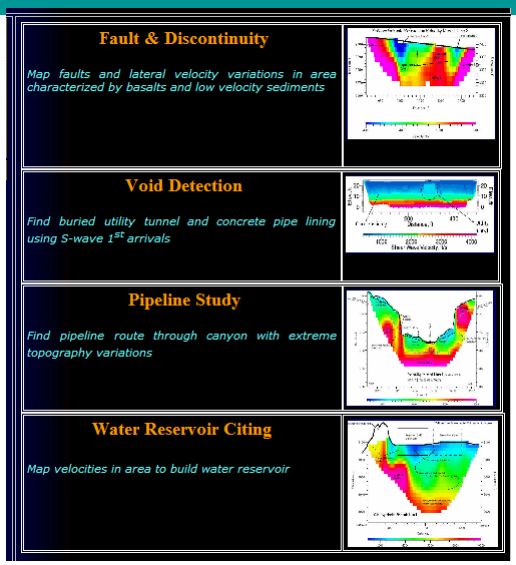
KFUPM-BEACH, 2005

Expected Outcome



KFUPM-BEACH, 2005

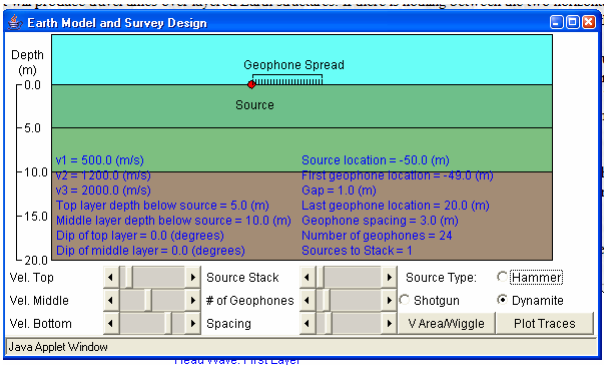
Case Works



http://faculty.kfupm.edu.sa/ES/oncel/geop402caseworks.html

Courtesy of Dr.Satish Pullammanappallil and *Copyright Optim, Inc.*

Make Your Model



Make your seismic Refraction Model

http://www.earthsci.unimelb.edu.au/ES304/MODULES/SEIS/DESIGN/SeisForwardJava.html

E-mail your mail to me, due to October 24

KFUPM-BEACH, 2005

Steps for clean field work

http://faculty.kfupm.edu.sa/ES/oncel/geop402refraction.html

Steps for clean field work

Control Source

Refraction seismology needs man-power. Thus, some of you should enroll in generating power. it might be better to encourage one to contribute continuously source-provider in order decrease the noisy effect.

Field Dressing

In order to protect one from one any possible unexpected effect, any coverage for our knee or head are suggested. The type of dress can be change region to region. Most important thing is to have one dressed, which might be flexible in working.

Data Transferring

Data in good quality is what we need to have following several steps noted above. But, more important to check we transferred data from exploration refraction seismograph to our Laptop. Additionally, field information and profile extensions should be noted successfully.

http://faculty.kfupm.edu.sa/ES/oncel/geop402refraction.html