TEAM NUMBER: ___________________

TEAM TBL 3: NEAR-SURFACE, SH-WAVE SURVEYS IN UNCONSOLIDATED, ALLUVIAL SEDIMENTS (YOUNG & HOYOS, 2001)

Instructor: Seogi Kang (skang@eos.ubc.ca)
Due: End of class on Friday October 12th, 2018

Overview

This case history consolidates many of the basic concepts related to refraction and reflection seismology, using an environmental problem. In your individual TBL, you summarized the case history using the 7-step process. Here, you will address some additional questions regarding the case history.

Instructions

Discuss the case history within your team. Together, answer the following questions. Please provide BRIEF but insightful answers to the following questions. Hand this in at the end of class.

Resources

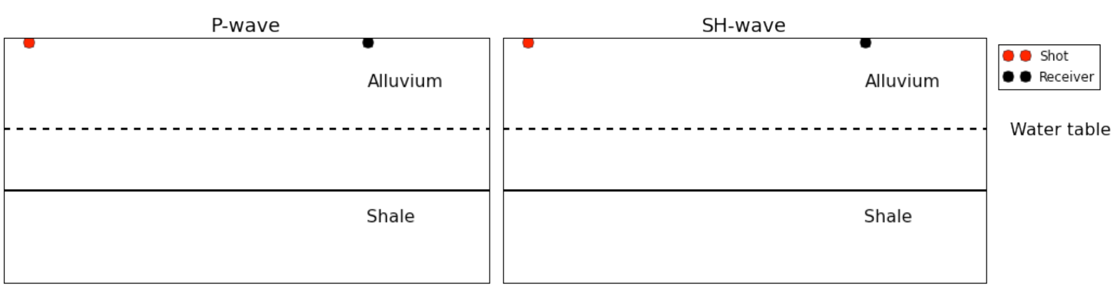
- GPG: https://gpg.geosci.xyz/content/seismic/index.html
- Seis_VerticalResolution notebook from gpgLabs
- SeismicApplet notebook from gpgLabs

Data processing & Interpretation

In the case history article, the authors make these two observations:

- "P-wave reflections may be difficult to obtain because the top of the saturated zone often prevents a very large P-wave impedance contrast that masks reflections from deeper horizons."
- "The water table is transparent to the SH-refraction."

Q1. Based on these observations, draw the reflected and refracted waves for both P- and SH-waves between a shot and a receiver in the figure below.



Now, consider the text:
"Soil borings are the Norman landfill commonly encounter a gravelly interval several feet thick at the base of the alluvium, and this zone is associated with high hydraulic

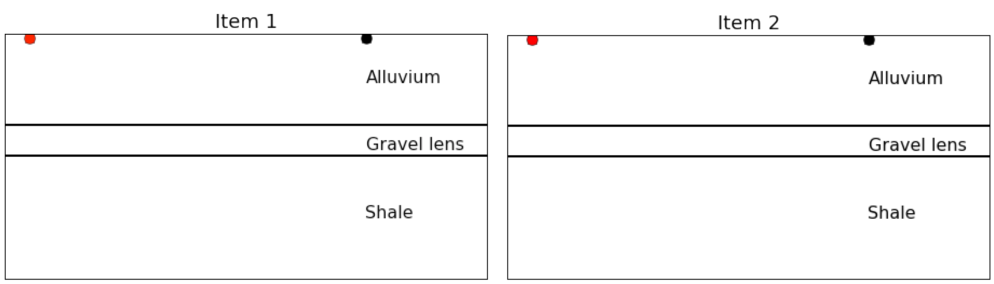
conductivity (Scholl and Christenson, 1998). Our SH-refraction survey is unlikely to have seen this interval for two reasons:

1. If velocity decreases in the gravel, then a refraction will not exist, or
2. If the gravel velocity exceeds that of the shale, a refraction can exist but it may never be a first arrival because it follows a path that is slower than the path along the shale.

If the gravel layer exists, therefore, it would be a blind zone (Burger, 1992), to SH refractions."

NOTE that the refraction they are referring to is the critical refraction along the top of the gravel lens.

Q2. For item 1 in the above quote, draw a refraction ray path for in the interface between the gravel lens and the shale in the figure (left) below.



Q3. For item 2 in the above quote, there appears to be a typo in the authors' comment. If they are referring to a critical refraction along the top of the gravel, which two layer velocities are important to consider?

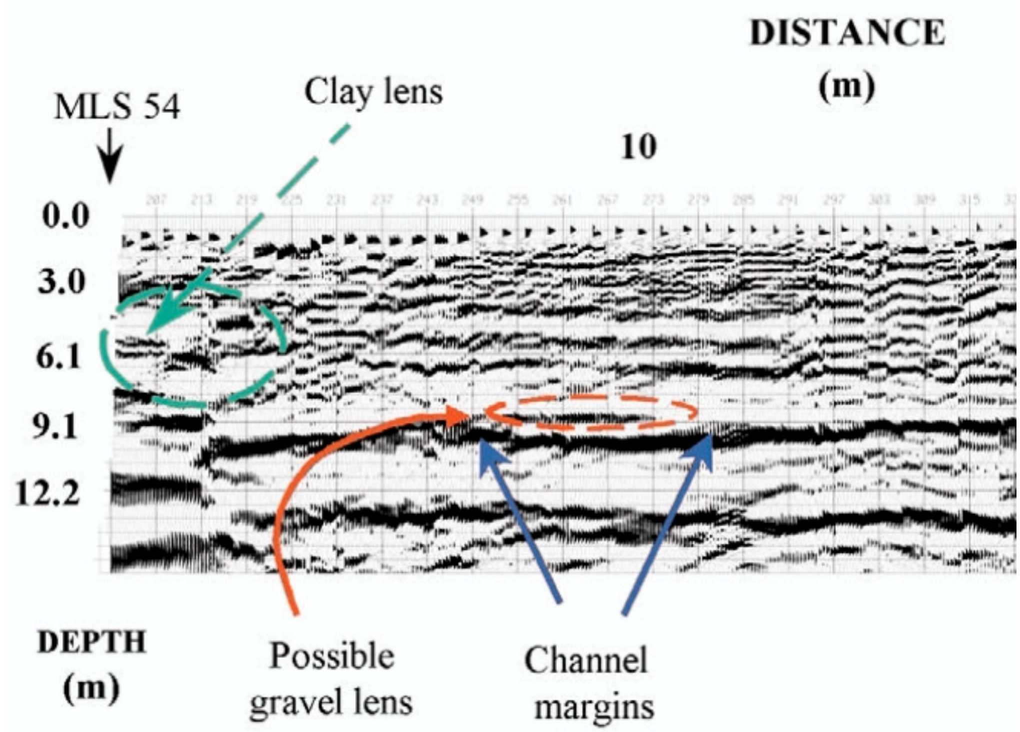
Q4. For item 2, assume that the author meant to say the following:

- "If the gravel velocity exceeds that of the **alluvium**, a refraction can exist, but it may never be a first arrival because it follows a path that is slower than the path along the shale."

Explain why it would never be a first arrival and support your explanation by sketching ray paths for the refracted waves in the figure below. Tip: try using the SeismicApplet too!

Synthesis

Let's dig a bit deeper about this gravel lens. According to the case history, gravel lenses might be expected to exist above the shale and the thickness of these might be about a meter. These are zones of high permeability and sought after if ground water is to be extracted.



The seismic reflection survey indicates a reflector about 9 meters away from the origin (see figure above). To an untrained eye, this feature might not even be noticed when looking at the seismic image. However, closer scrutiny shows it is distinctive. The question is whether we can expect to see separate reflections from the top and bottom of the gravel lens. The frequency of seismic wavelet is 67 Hz.

Q5. What is the minimum layer thickness that you can reasonably detect?

- Use the equations $L = \lambda/4$ and $\lambda = v/f$, where L is the thickness, λ is the wavelength, v is the velocity, and f is the frequency.
- Assume the velocity for the gravel lens is 200 m/s.
- See [GPG: Seismic Vertical Resolution] for more details

Q6. Now look at the seismic section in the above figure. What are the units of the vertical axis? Seismic data are recorded in time. How could they have made this switch?

Q7. What is the distance between the two reflections in the seismic section? How does this compare with your minimum layer thickness? What confidence does this give you that you might be able to see the top and bottom of the gravel layer?

Use the notebook: Seis_VerticalResolution to answer the following questions. Default parameters of the notebook are set so d2 = 9 m and d3 = 9.5 m, which means the gravel lens has a thickness of 0.5 m. The frequency is set to wavf = 67 Hz.

Q8. First adjust the velocities: v1 = 125 m/s (alluvium), v2 = 200 m/s (gravel), and v3 = 800 m/s (shale). Can you recognize the top and bottom of the gravel lens?

Q9. Slowly increase d3 from 9.5 m to 11.5 m. When you recognize two distinctive wavelets from the top and bottom of the gravel lens? How does it compare with the signature see on the seismic section?

Q10. What are possible reasons to explain any difference in character between your synthetic results and the observed seismogram?