Seismic Study Guide

- Formulas are given at the bottom. Are there any that you think should be included? Email me: sarah.gr.devriese@gmail.com
- What is the physical property for seismic? What properties does acoustic impedance depend on?
    - https://gpg.geosci.xyz/content/physical_properties/seismic_velocity_duplicate.html
- What types of waves are there in seismology?
    - https://gpg.geosci.xyz/content/seismic/wave_basics.html
    - https://gpg.geosci.xyz/content/physical_properties/seismic_velocity_duplicate.html#seismic-wave-velocities
- Can you calculate arrival times for reflection and refraction seismic surveys?
    - https://gpg.geosci.xyz/content/seismic/traveltimes.html
    - What does "zero offset" mean? It means that the shot and receiver are in the same location.
- In the seismic app, can you identify which ray is which by just looking at the time vs offset plot?
    - https://www.3ptscience.com/app/SeismicRefraction
    - For the default parameters in the app, what is the crossover distance for the direct arrival (red) and first refraction (blue)? About 15 m.
    - For the default parameters, what is the intercept time for the direct arrival (red) and first refraction (blue)? About 0.03 s
    - For the default parameters, what is the crossover distance for the first refraction (blue) and the second refraction (green)?
    - Why does the second refraction arrive first at late times?
    - Answers: about 15 m; about 0.04 s; about 48 m; the 2nd refraction travels faster because it travels through the lower layer, so at long offsets, it arrives first.
- What is a required for a refraction survey to give us information from the deeper layers?
    - Velocity must increase with depth in order to get critically refracted rays. Try this in the seismic app! Do you get a refraction if the second layer has a lower velocity?
    - https://www.3ptscience.com/app/SeismicRefraction
- Given an incident angle and a velocity for the top layer, can you calculate the velocity for the layer just below?
    - https://gpg.geosci.xyz/content/seismic/waves_at_interfaces.html#angles-of-reflection-and-refraction
    - https://gpg.geosci.xyz/content/seismic/waves_at_interfaces.html#critical-angle
- Do you understand Snell's law for three layers?
    - https://gpg.geosci.xyz/content/seismic/traveltimes.html#two-horizontal-layers-over-a-halfspace
    - Take a look at Q27 in the seismic midterm review: https://github.com/ubcgif/eosc350website/raw/master/assets/2017/3_Seismic/Midterm2017_SeismicReview.pdf

- How are acoustic impedance, density, velocity, reflection coefficient, and transmission coefficient related? Can you calculate reflection and transmission coefficients if given the velocity and density of two layers?
    - https://gpg.geosci.xyz/content/seismic/waves_at_interfaces.html
    - https://gpg.geosci.xyz/content/seismic/seismic_reflection_seismogram.html
    - Take a look at Q18 in the seismic midterm review: https://github.com/ubcgif/eosc350website/raw/master/assets/2017/3_Seismic/Midterm2017_SeismicReview.pdf
- What is the minimum number of shots that are required to find the two depths that define a dipping layer?
    - 2!
    - https://gpg.geosci.xyz/content/seismic/seismic_refraction_dipping_layers.html
- Can you explain the basics of Normal Moveout (NMO) correction?
    - Can you draw Common Shot Gathers (CSG) for a single shot and 7 receivers?
    - Can you draw Common Midpoint (CMP) gathers for 5 shots and receivers?
    - If there is 1 interface, can you draw what the seismic traces would look like for the CMP gathers?
    - What do the traces look like after NMO correction?
    - The velocity of the top layer is 500 m/s and the velocity of the layer below is 1000 m/s. The thickness of the first layer is 25 m. What is the arrival time for a source and receiver in the same location? Time = 0.1 seconds
    - What is the arrival time when the source and receiver are separated by 50 m? Time = 0.14 seconds
    - What is the NMO correction needed for the trace with a 50 m separation? 0.04 seconds
    - https://github.com/ubcgif/eosc350website/raw/master/assets/2017/3_Seismic/NMO.pdf
    - https://gpg.geosci.xyz/content/seismic/seismic_reflection_stacking.html
- Look at the Midterm Review Questions for seismic
    - https://github.com/ubcgif/eosc350website/raw/master/assets/2017/Midterm_Review_Questions.pdf

Formulas

Are there seismic equations you think should be included here?

Email me! sarah.gr.devriese@gmail.com

Velocities	$v_p = \sqrt{\frac{K+\frac{4}{3}\mu}{\rho}}$	$v_s = \sqrt{\frac{\mu}{\rho}}$
Acoustic impedance	$Z = \rho v$	$R = \frac{Z_2 - Z_1}{Z_2 + Z_1}$ $T = \frac{2Z_1}{Z_2 + Z_1}$
General	$d = vt$	$\lambda = vT = \frac{v}{f}$
Vertical resolution	$L = \frac{\lambda}{4}$	
Refraction arrivals	$t = \frac{x}{v_2} + 2z\frac{\sqrt{v_2^2 - v_1^2}}{v_1 v_2} = \frac{x}{v_2} + t_i =$	
Cross-over distance	$x_{cross} = \left(\frac{v_1 v_2}{v_2 - v_1}\right) t_i = 2z\sqrt{\frac{v_2 + v_1}{v_2 - v_1}}$	
Refraction angles	$\frac{sin\theta_1}{v_1} = \frac{sin\theta_2}{v_2} = \frac{\sin\theta_3}{v_3}$	
Reflection hyperbola	$t_0 = \frac{2z}{v}$	$t(x)^2 = t_0^2 + \frac{x^2}{v^2}$
	x = distance from Tx to Rx	
Normal Moveout	$\Delta t = t(x) - t_0 \approx \frac{x^2}{2v^2 t_0}$	