Midterm review – seismic part

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Q18. Assume a seismic wave that propagates downwards perpendicular to the surface. There are two horizontal layers underneath the surface. Which of the following statements is FALSE?

(a) If the acoustic impedance of the two layers is the same, then the reflection coefficient is zero.
(b) If the acoustic impedance of the two layers is the same, then the transmission coefficient is 1.
(c) If the acoustic impedance of the top layer is much greater than that of the layer below it, the reflection coefficient will be -1.
(d) If the acoustic impedance of the bottom layer is much greater than that of the layer above it, the transmission coefficient will be 2.

In order to answer this question, remember the equations for reflection and transmission as well as acoustic impedance, which were given on the equation sheet with the exam.

If Z1=Z2: R=0, T=1

If Z1>>Z2: R=−1, T=2. The value R=−1 means that the pulse will be reflected with a polarity change, for example at the rock-air interface, with an upward traveling wave.

If Z2>>Z1: R=1, T=0 (wave travelling down through the air and hitting the air earth interface).

See the GPG: https://gpg.geosci.xyz/content/seismic/waves_at_interfaces.html

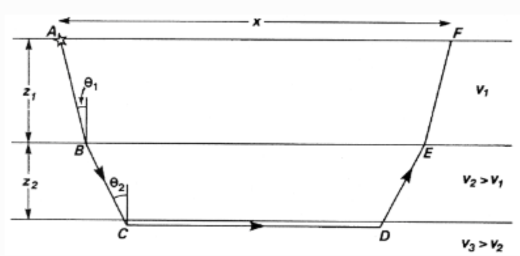
Q27. Suppose you have three horizontal layers. For the critically refracted ray path traveling along the second interface (ie, between the middle and lower layers), what is the incident angle at the first interface (ie, between the top and middle layer).

(a) $\sin^{-1}(v2/v3)$
(b) $\sin^{-1}(v1/v3)$
(c) $\sin^{-1}(v2/v2)$
(d) $\sin^{-1}(v3/v1)$

The extension to more layers is in principle straight forward. Snell's law holds for waves at all interfaces, so for a multi-layered medium

$$\frac{\sin\theta_1}{v_1} = \frac{\sin\theta_2}{v_2} = \frac{\sin\theta_3}{v_3} = \ldots$$

For a three layer case, the algebra is slightly more involved compared to a two layer example because we need to compute the times due to the ray path segments in the two top layers. Consider the diagrams below:



See the GPG: https://gpg.geosci.xyz/content/seismic/traveltimes.html#two-horizontal-layers-over-a-halfspace

Q29. What is the moveup rate and the fold for a survey with 8 geophones that are 3 meters apart and shots are every 4 meters?

- **(a) Moveup rate = 1.33; fold = 3**
- (b) Moveup rate = 1.33; fold = 6
- (c) Moveup rate = 0.75; fold = 3
- (d) Moveup rate = 0.75; fold = 6

Moveup rate = shot spacing/geophone spacing = 4/3 = 1.33

Fold = Number of geophones/2*moveup rate = 8/2*1.33 = 3

See the GPG: https://gpg.geosci.xyz/content/seismic/seismic_survey_geometry.html?#fold