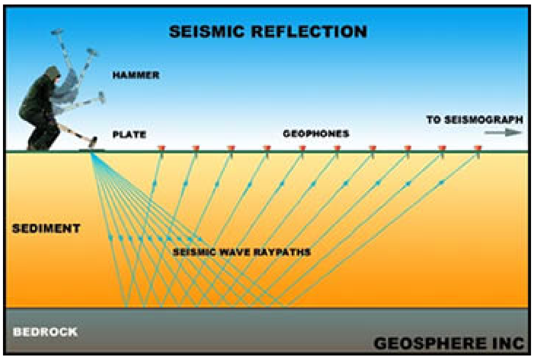
201 GPH
Unit 3 (Review)

Q. What is seismic reflection?

A. is a method of exploration geophysics that uses the principles of seismology to estimate the properties of the Earth's subsurface from reflected seismic waves.



Q. Which exploration techniques are used in seismic reflection?

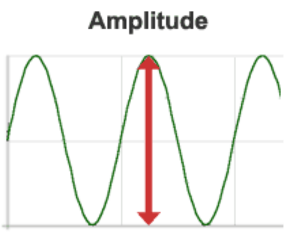
A. Active Methods (Induced Sources): a signal is injected into the earth and then measure how the earth respond to the signal

Q. What are the applications of seismic reflection?

A. They are:
1. Detection of subsurface cavities.
2. Shallow Stratigraphy
3. Site surveys for offshore installations
4. Hydrocarbon exploration
5. Crustal structure and tectonics

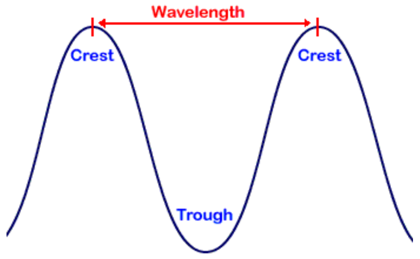
Q. What is wave amplitude?

A. Wave amplitude is the distance from level of crest to level of trough.



Q. What is a wavelength?

A. Wavelength is the distance from crest to crest.



Q. What is reflection coefficient (R)?

The **reflection coefficient** is the ratio of the amplitudes of the reflected and incident waves:

$$R = Ar/Ai$$

Q. What is transmission coefficient (T)?

The **transmission coefficient** is the ratio of the amplitudes of the transmitted and incident waves:

$$T = At/Ai$$

Q. What is acoustic impedance (Z)?

The amount of energy that is partitioned into transmission and reflection depend on **the angle** between the incident wave and interface and on the **acoustic impedance (Z)** of each layer:

$$Z1 = \rho 1v1 \quad \text{and} \quad Z2 = \rho 2v2$$

Q. What are the Zoeppritz equations?

$$R = \rho_2 v_2 - \rho_1 v_1 / \rho_2 v_2 + \rho_1 v_1 = Z_2 - Z_1 / Z_2 + Z_1$$

$$T = 2 \rho_1 v_1 / \rho_2 v_2 + \rho_1 v_1 = 2Z_1 / Z_2 + Z_1$$

These are the **Zoeppritz equations**. There are also more complicated forms of the Zoeppritz equations that can be used for any angle of incidence.

Q. What do the reflections and transmission coefficients depend on?

A. They depend on the difference in impedance between two layers.

Q. If Z1=Z2, what will happen?

- If Z1 = Z2, there is no reflection. All energy is transmitted into the second layer. This does not mean that ρ1=ρ2 and v1= v2! All that matters is that $\rho_1 v_1 = \rho_2 v_2$

Q. What is the value of R?

- **R** can have a value of +1 to -1. **R** will be negative when $Z_1 > Z_2$. A negative value means that there will be a phase change of 180° in the phase of the reflected wave (a peak becomes a trough). This is called a **negative polarity reflection**.

Q. What is the value of T?

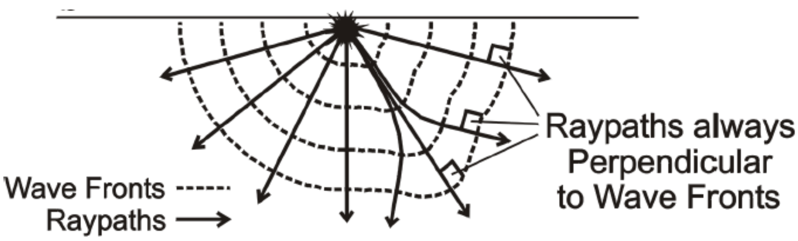
- **T** is always positive – transmitted waves have the same phase as the incident wave. **T** can be larger than 1.

Q. How much are the reflection coefficients for the earth?

- Reflection coefficients for the Earth are generally less than ±0.2, with maximum values of ±0.5. Most energy is transmitted, not reflected.

Q. What is the difference between wave front and ray path?

A. Wave front: is the continuous line or surface including all the points in space reached by a wave or vibration at the same instant as it travels through a medium. Ray path: raypath is always perpendicular to wave front.



Q. Calculation #1:

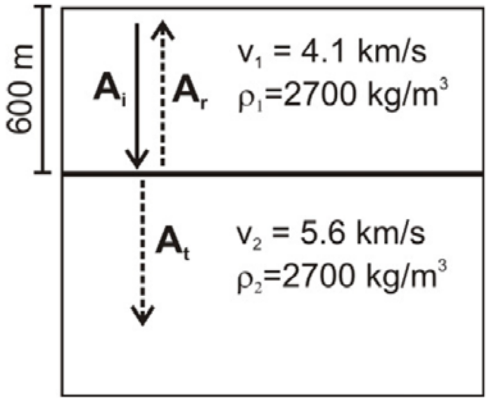
A 600 m thick layer of sandstone overlies a granite basement with a higher velocity. A seismic wave is generated at the surface and travels vertically downward. At the sandstone granite interface, the incident wave is split into a reflected wave and transmitted wave. The amplitude of the reflected and transmitted waves (Ar and At) can be calculated from the Zoeppritz equations. Assume that Ai = 1.0 and that there is no geometrical spreading, attenuation, or scattering. Velocity and density are constant within each layer. Calculate:

a) The acoustic impedance (Z) of each layer

b) R and T

c) The amplitude of the two waves Ar and At?

A. Answer:



a) The acoustic impedance (Z) of each layer:

$$\mathbf{Z1 = \rho_1 v_1 = 2700 \times 4.1 = 11{,}070\ (kg\ km\ s^{-1}\ m^{-3})}$$

$$\mathbf{Z2 = \rho 2 v2 = 2700 \times 5.6 = 15{,}120\ (kg\ km\ s^{-1}\ m^{-3})}$$

b) R and T:

The reflection and transmission coefficients are then:

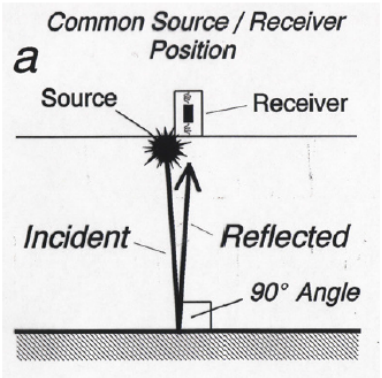
R = 0.17 , **T** = 0.95

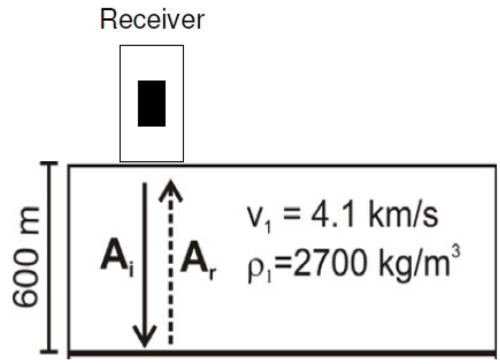
c) The amplitude of the two waves:

A_r = R x A_i = 0.17 A_t = T x A_i = 0.95

Q. Calculation #2:

Q. Calculate the arrival time for the wave?

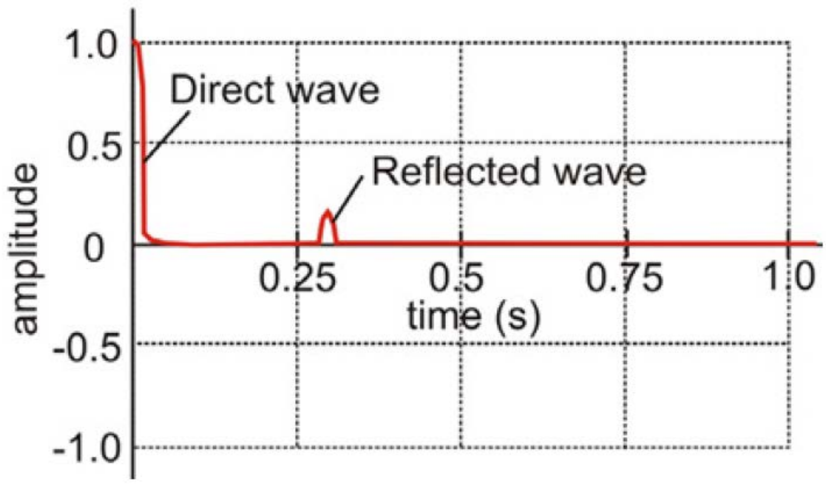




A. Answer:

Time = 2 x 600 / 4100 = 0.29s

The seismic record will look like this:



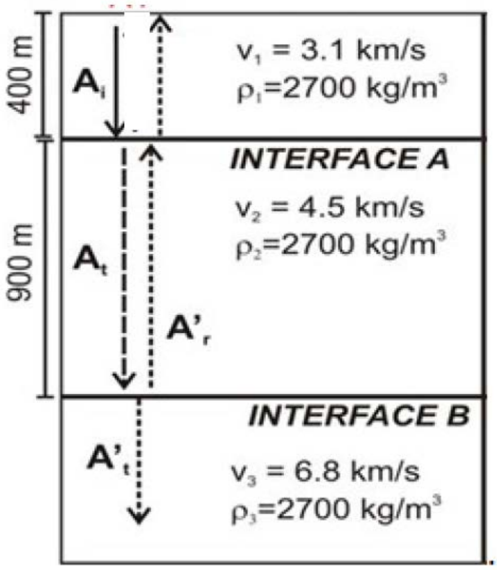
Q. Calculation #3:

Calculate:

a) R and T for interface A

b) R and T for interface B

c) Total arrival time



A. Answer:

a) Z_1= 8370 kg km s^{-1} m^{-3}

Z_2= 12150 kg km s^{-1} m^{-3}

R_A= 0.18 and T_A= 0.82

Arrival time for interface A= 0.26 sec

b) Z_2= 12150 kg km s^{-1} m^{-3}

Z_3= 18360 kg km s^{-1} m^{-3}

R_B= 0.20 and T_B= 0.80

Arrival time for interface B = 0.4 sec

c) Total arrival time = 0.26 + 0.4 = 0.66 sec