Exercise 7 a)

- Assume a boundary between two beds, which dips at an angle of 5^0. The seismic velocity above the interface is 1 km/s and that below it is 2.5 km/s. The perpendicular distance from the shot to the interface at the end of the profile at which shooting made downdip is 0.25 km.
- Calculate the arrival times for direct wave, reflected wave, and refracted wave if the recording is conducted at an interval of 0.1 km in the range of 1.5 km from the shot point.
- Plot a few ray-path trajectories and show the time-distance relations for the waves.
- Find out the critical distance (X_{crit}) and the crossover distance (X_{cross}) from the diagram.

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- **Solution**
- The travel time for direct wave is given by $t=x/v_0$.

 where X = Horizontal offset from the shot point (0 – 1.5 km) and V_0 = Velocity above the interface (1 km/s).

- The arrival time for reflected wave is given by

$$t = \frac{1}{v_0}\sqrt{x^2 + 4h^2 + 4hx\sin\phi}$$

Where h = Perpendicular distance from the shot to the interface (0.25 km) and ϕ=Dip angle of the interface (5°).

- The arrival time for refracted wave is given by

$$t = \frac{2h\cos i_c}{v_0} + \frac{x\sin(i_c + \phi)}{v_0}$$

Where i_c = Critical angle (i_c = $\sin^{-}\frac{v_0}{v_1}$).

- For instance, at 1.5 km t_{dir}=1.5 s, t_{rfl}=1.62 s and t_{rfr}=1.17 s.
- From the plot, X_{crit} = km and X_{cross} = km.
- (Hints: X_{crit}=0.3-0.4 km and X_{cross}=0.8-0.9 km)

b)

- The travel time data for a reflected wave are given in the following table.

X (meter)	t (s)	X (meter)	t (s)
00	0.5		
200	0.53	-200	0.53
400	0.60	-400	0.60
600	0.70	-600	0.70
800	0.83	-800	0.83
1000	0.97	-1000	0.97

- Find out the angle of dip (ϕ) of the reflecting interface and determine the velocity of the medium above the interface (v_0) (assumed to be constant) and the perpendicular distance (h) from the shot to the interface.
- From the velocity value found above, what rock type you would expect to encounter in a drill hole for the top layer?

Solution

- The form of the time–distance curve is hyperbolic and the axis of symmetry of the hyperbola is the line $X=0$. This indicates that the reflecting surface is horizontal.
- The velocity of the medium above the interface (v_0) has readily been determined from the slope of the linear relationship between t^2 and x^2: slope$=1/v_0^2$.
- The depth to the reflecting surface has been determined as $h=v_0 \times t_0/2$.

- Because of overlap of velocity values, it is difficult to identify lithology from velocity alone. The low value, in the present case, may be interpreted as highly unconsolidated sedimentary materials.
- (Hints: v_0=1.0-1.5 km/s and h=0.25-0.4 km)