Exercise 14

- The travel times of waves at first arrival are given in the table below.

X (km)	t (s)	X (km)	t (s)
0.0	0.00	1.6	1.65
0.2	0.25	1.8	1.75
0.4	0.50	2.0	1.84
0.6	0.75	2.2	1.93
0.8	1.00	2.4	2.01
1.0	1.25	2.6	2.07
1.2	1.47	2.8	2.13
1.4	1.56	3.0	2.18

- Determine the number of layers from the time-distance curve and find out the wave velocity in each layer and thickness of the layers, if the layering is horizontal and there is no low speed layer or blind zone in the section.
- From the velocities found above, what rock types you would expect to encounter in a drill hole?

Solution

- The t-d curve drawn can be divided into three segments each of which represents first arrivals from the top of one of the layers.
- Since the layering is horizontal and there is no low-speed layer or blind zone in the section, the velocity of each layer (v_0, v_1, v_2) can be obtained from the slope of the respective segment of the graph.
- $1/v_0=\Delta t_0/\Delta x_0$ $\therefore v_0=$ km/s
- $1/v_1=\Delta t_1/\Delta x_1$ $\therefore v_1=$ km/s
- $1/v_2=\Delta t_2/\Delta x_2$ $\therefore v_2=$ km/s

- The thickness of the first layer h_0 can be obtained from the intercept time $t_{i1.}$
- $t_{i1} = \frac{2h_0\sqrt{v_1^2 - v_0^2}}{v_1 v_0}$ $\therefore h_0=$ km.
- The thickness of the second layer h_1 can be obtained from the intercept time $t_{i2.}$
- $t_{i2} = \frac{2h_0\sqrt{v_2^2 - v_0^2}}{v_2 v_0} + \frac{2h_1\sqrt{v_2^2 - v_1^2}}{v_2 v_1}$ $\therefore h_1 =$ km.

- The velocity values found above indicate that the study area consists of sedimentary rocks. Because of overlap of velocity values, it is difficult to identify lithology from velocity alone. In the present case, it may be assumed that the first layer (V_0= km/s) consists of weathered (unconsolidated) rocks, the second layer (V_1 = km/s) consists of shale, and the third layer (V_2 = km/s) consists of sandstone.

- (Hints: v_0=0.7-1.0 km/s, h_0=0.25-0.5 km; v_1=2-2.3 km/s, h_1=0.4-0.55 km; v_2=3.3-3.6 km/s)