Field Trip Assignment

Utkarsh Jaiswal

18EX20030

(1) We can observe that first reflecting surface is encountered by geophone placed at 40 metres.

Thus, using data for geophone at $x = 40m$ and $x' = 43m$, the traverse time $T = 80ms$ and $T' = 90ms$ respectively

From above given equations, $T'^2 - T^2 = (x'^2 - x^2)/V^2$

$$\Rightarrow V = \sqrt{((x'^2 - x^2)/(T'^2 - T^2))}$$

$$\Rightarrow V = \sqrt{\{(43)^2 - (40)^2\}/\{(90)^2 - (80)^2\}} \text{ m/s.}$$

$$\Rightarrow V = 3827.1476 \text{ m/s}$$

Formula for 'h' is ;

$$h = \sqrt{(V^2 \times T^2 - x^2)}/2$$

$$\Rightarrow h = (\sqrt{(3827.1476)^2 (80/1000)^2 - (40)^2})/2$$

$$\Rightarrow h = 151.77m$$

We are given with the shot offset $x = 34m$ and Geophone interval $= 48m$.

Three prominent reflections are indicated by arrows.

$T_1 = 450ms$,

$V_1 = (34/450/1000) m/s = 75 m/s$.

$T_2 = 500ms$,

$V_2 = (34/500/1000) ms = 68 m/s$.

$T_3 = 650ms$.

$V_3 = (34/650/1000) ms = 52 m/s$.

Assuming these are the only reflections present.

Velocity = Displacement / Time

Here distances are starting from 34, 82, 130, 178, 226, 274, 322, 370 and 418

VRMS → For multiple flat layers and assuming the offset is small compared with the depth, a hyperbolic moveout equation can be derived as a truncated power series in which VRMS is used as velocity. Root-mean-square velocity is calculated from interval velocities

$$V_{RMS} = \sqrt{V_1^2 \cdot t_1 + V_2^2 t_2 + \hat{\partial}\varepsilon \,\hat{a}\varepsilon) (t_1 + t_2 + \partial\varepsilon (\hat{\partial}\varepsilon))}$$

$$\Rightarrow V_{RMS} = \sqrt{(75^2 \times 0.45 + 68^2 \times 0.5 + 52^2 \times 0.65) / (450 + 500 + 650))}$$

$$\Rightarrow V_{RMS} = \sqrt{(2531 + 2312 + 1757)/1600} = 2$$

V_{int} → The constant velocity of a single layer (which can be very thin) calculated from

V_{int} can be approximately

VRMS using DIX equation.

$$V_{int} = \left[\sqrt{\left(t_2 V_{RMS2}^2 - t_1 V_{RMS1}^2\right) / \left(t_2 - t_1\right)}\right]$$

Where V_{int} = Internal velocity

t_1 = travel time to first reflector

t_2 = travel time to second reflector

V_{RMS1} = root - mean - square velocity to the first reflector

V_{RMS2} = root- mean- square velocity to the second reflector

Thickness,

$$z = 0.5 \times \sqrt{(t^2 v^2 - x^2)}$$

$$z_1 = 0.5 \times \sqrt{\cancel{(0.45)^2 - (34)^2}}\ \sqrt{(0.45) \times (75)^2 - (34)^2}$$

$$\Rightarrow z_1 = 2\text{kms}.$$

$$z_2 = 0.5 \times 5 = 2.5\text{kms}$$

$$z_3 = 0.5 \times 6 = 3\text{kms}.$$

From t-d curve,

$$t^2 = \frac{(x - 2j\sin\beta)^2}{V_t^2} + \frac{4j^2\cos^2\beta}{V^2}.$$

$$t_{min} = \frac{2j\cos\beta}{V}$$

$$t_0 = \frac{2j}{V}$$

$$\Rightarrow \cos\beta = \frac{t_{min}}{t_0}$$

$$x_{min} = 2j\sin\beta \Rightarrow j = \frac{x_{min}}{2\sin\beta}.$$

$$\therefore V = \frac{2j\cos\beta}{t_{min}}$$

Selected values and computed answers

t-zero (ms)	51.3	beta (°)	-9.1
t-min (ms)	50.6	Thickness (m)	44.8
x-min (m)	14.0	velocity (m/s)	1727.5

Actual input used to produce graph values

Velocity (m/s)	1725
Thickness (m)	45
Dip (°)	-9

(5) We take S at $x=0$ as the source and the geophone at $x=12km$ as R. Four wavetrains are observed. The slowest has an apparent velocity of about 1.4km/s, the arrival time at R is off-scale. This is the direct water wave, but its velocity is low for water perhaps because of interference with a dispersive channel is not exact.

Measured data are:-

L: $V_L = 1.71km/s$, $t_{RL} = 6.84s$, $t_{iL} = ?$

M: $V_M = 2.67km/s$, $t_{RM} = 5.38s$, $t_{iM} = 0.95s$.

N: $V_N = 5.45km/s$, $t_{RN} = 3.97s$, $t_{iN} = 1.77s$

if L is a head wave, the intercept time should be $(6.84 - 12/1.70) = 0.22s$. Thus we conclude that L is not a head wave as from a planar refractor. it may be a wave or part of a dispersive water reflection but we have insufficient data to identify it. Disregarding L, we are left with only water layer and two refractors M and N.

(i) Assuming no-dip

Refraction M

We have following data

$V_I = 1.5$ km/s, $V_M = 2.67$ km/s, $t_{IM} = 0.95$ s.

Then,

$\sin\theta_c / 1.5 = 1/2.67$

$\Rightarrow \theta_c = 34.2°$.

$h_M = V_I t_{IM} / 2\cos\theta_c = 1.50 \times 0.95 / 2 \times \cos 34.2° = 0.82$ km

Refraction N:

$\sin\theta_1 / 1.50 = \sin\theta_c / 2.67 = 1/5.45 \Rightarrow \theta_1 = 16°,\ \theta_c = 29.3°$.

$1.77 = 2 \times 0.82 \cos 16° / 1.50 + 2h_2 \cos 29.3° / 2.67$

$\Rightarrow h_2 = (1.77 - 1.10) / 0.65 = 0.67/0.65 = 1.03$ km.

$Z_N = 0.83 + 1.03 = 1.86$ km

(ii) Assuming 5° dip to the right

In this case, the profile is in the downdip direction, the arrival times, velocities and intercept times are of unchanged except that the velocities are now apparent velocities and the intercept time give slant depths normal to the beds.

Refraction M

We have, $V_1 = 1.5$ km/s, $V_{am} = 2.67$ km/s, $\xi = 5°$.

$t_{IM} = 0.95$,

$\sin(\theta_c + 5°) = V_1 / V_{am} = 1.50/2.67$

$\Rightarrow \theta_c + 5° = 34.2° \Rightarrow \theta_c = 29.2°$.

$V_M = V_1/\sin\theta_c = 1.5/\sin 29.2° = 3.07$ km/s

$h_M = V_1 t_{IM} / 2\cos\theta_c = 1.5 \times 0.95 / 2\cos 29.2° = 0.82$ km.

Refractor N

Using Adachi's method, but given data are not in form suitable for it. The ~~s~~ Instead we shall strip off the surface layer after which we have 2 parallel ~~surface~~ horizon. and therefore slant depth of horizon M at. the source S is 0.82km. At R, slant depth is

$h_M = 0.82 + 12 \sin 5^\circ = 1.87km$.

Thus to locate horizon M we using radii 0.82 arcs at S and R with 1.87km respectively then draw horizon M tangent to arcs.

$\sin \alpha = V_1 (\Delta t / \Delta x) = V_1 / V_{aN} = 1.50 / 5.45$

$\Rightarrow \alpha = 16.0^\circ$.

$\theta + 5^\circ = 16.0^\circ$

$\theta - 5^\circ = \theta^\circ$

Total length $= SS' + RR' = (0.8 + 1.8)$ km

dividing by 1.5 gives 1.73s to be subtracted from t_N. leaving $t_{N'} = 3.97 - 1.73$ $= 2.24s$ for the travel time relative to M. for the distance $S'R' = x' = 11.5km$. The intercept Also the distance M and N are based on times for both M and The beds. since The the normal ~~on~~ to The beds are parallel we can subtract tim from tim to get $t_{N'}$, the intercept time of N for virtual source S'.

$t_{N'} = (1.77 - 0.95)\,s = 0.82s$.

We must correct apparent velocity $V_{aN} = 5.45 km/s$. We write this as $1/5.45 = \Delta t/\Delta x = 2.20/12.03 /km$. The event N is linear from $x=12$ to beyond $x=0km$ so we write $1/5.45 = 0.110/6$ s/km. The numerator is difference between t_N at $x=12$ and 6km correction is $RT = 0.50/1.50 = 0.33s$.

$\Delta t' = 1.10 - 0.33 = 0.77s$. Correction to Δx is negligible so we get $V_N \approx 6/0.77 = 7.79 km/s$

We can now get the depth of N below M, we have,

$\theta_c = \sin^{-1}(V_M - V_N) = 3.07/7.79 = 23.3°$

Because horizons M and N are parallel relative to we find intercept time of N in M by subtracting the intercept time in part (i) so

$t_{iN'} = 1.77 - 0.95 = 0.82s$

Thus,

$h_{N'} = 3.07 \times 0.82/2\cos 23.3° = 1.37km$

Since depth of M at S is 0.82km.

$Z_N = 0.82 + 1.37 = 2.19km$ (slant depth at S!)

(iii) Because of shallow depth of M we check to see where it outcrops - The horizon M passes through the point $(x,z) = (0, 0.82\cos 5°)$ $= (0, 0.817)$. Thus it will outcrop at

$x = 0.817/\tan 5° = 9.34km$ (in part (i) slope $= \tan 5°$)

Event M exists at offset of 12km hence assumption of 5° dip to the left is not consistent with given data.