APPENDIX II

(B) Transit Time of a Ray in Layers

The radius of the \(n\)th seismic ray penetrating a depth \(Z_n\), emerging at an epicentral distance \(\Delta_n\) is given by (A.7), Fig A3

\[
A_n = \frac{1}{2} \left[ 2r_0 \left( r_0 - Z_n \right) \left\{ 1 - \cos \left( \frac{\Delta_n}{2} \right) \right\}^2 + Z_n^2 \right] \tag{A.8}
\]

The distance of the centre of curvature \(O_1\) and centre of the earth \(O\), is given by

\[
A_n = \alpha_n + r_0 - Z_n \tag{A.9}
\]

where, \(B_0 B_n = Z_n\)

\(B_0 B_{n-1} = Z_{n-1}\) etc.

The angle between line \(OO_1\) and \(OQ_{n-1}\) (the point of intersection of the ray on top of \(n\)th layer) is given by,

\[
\cos \theta_n = \frac{A_n^2 + A_{n-1}^2 - (r_0 - Z_{n-1})^2}{2 A_n A_{n-1}} \quad ; \quad OQ_{n-1} = \rho - Z_{n-1}
\]

\[
\cos \theta_n = 1 - \left( \frac{Z_n - Z_{n-1}}{2 \alpha_n \left( \alpha_0 + r_0 - Z_n \right)} \right) \left[ 2r_0 - \left( Z_n + Z_{n-1} \right) \right]
\]
The length of the arc confined in the nth layer is therefore,

\[ L_n^n \equiv L_{n,n} = 2 \alpha_n \theta^n_n \quad (A.11) \]

The transit time of the nth ray in the nth layer

\[ \Delta t_n^n = \frac{L_n^n}{V_n} \quad (A.12) \]

\[ V_0 = \text{average velocity of seismic wave in the nth layer.} \]

The corresponding angle subtended by the intersection on the top of the (n-1)th layer, similarly is

\[ \theta^n_{n-1} = \frac{\pi}{180} \cos^{-1} \left[ 1 - \frac{(Z_n - Z_{n-1}) \left( 2r_0 - (Z_n + Z_{n-1}) \right)}{2 \Delta_n A_n} \right] \quad (A.13) \]

The angle subtended by the ray in the (n-1)th layer, on one side

\[ \theta^n_{n-1} = \theta^n_{n-1} - \theta^n_n \quad (A.14) \]

The path length confined in the (n-1)th layers and the transit times are calculated as in (A.11)

\[ \Delta t^n_{n-1} = \frac{L^n_{n-1}}{V^n_{n-1}} \quad (A.15) \]

The average velocities in the layers \( \bar{V}_n, \bar{V}_{n-1} \) can be found as follows.
(6) Average Velocity in the Layers

Starting from the first layer, the travel time $\tau_1$ (or $T_1$) is known from ($T - \Delta$) data. The average velocity $\bar{v}_1$ is calculated from Eqn. (A.12) or (A.4). For the next layer, the angle subtended on top of the earth

$$\Theta^2_2 = \frac{\pi}{180} \cos^{-1}\left[\frac{a_2^2 + a_1^2 - r_0^2}{2a_1 a_2}\right]$$

Consequently, $\Theta^2_2$ and $\Theta^2_1$ are known from (A.11) and (A.5). The total path length $L_2 = 1$, and $L_1^2$, $L_2^2$, length traversed by 2nd ray in first layer, 2nd layer are known.

$$L_2^2 = L_{2,1} - L_1^2$$

$L_2^2$ is calculated using (A.11)

The time of transit in 2nd layer $\Delta t_2^2$, is given by

$$\Delta t_2^2 = T_2 \text{ (total travel time)} - 4t_1^2$$

$$= T_2 - \frac{t_1^2}{\bar{v}_1}$$

The velocity in the 2nd layer is then calculated as

$$\bar{v}_2 = \frac{L_2^2}{\Delta t_2^2}$$

This is carried on for them, and we can get a layered depth-velocity profile also.