TRAVEL-TIME CURVES FROM VELOCITY DISTRIBUTIONS WITH APPLICATIONS TO THE EARTH'S UPPER MANTLE

by

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A Digest of a Dissertation Presented to the Faculty
of the Graduate School of Saint Louis University
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

1964

DIGEST

Velocities within the earth can be determined from body wave time-distance data provided the velocity does not decrease too rapidly with depth. Until the present time, the properties of time-distance curves in the presence of such a low-velocity zone have been considered only qualitatively.

In this dissertation, a technique was developed for calculating a travel-time-distance (T-D) curve for any velocity distribution including continuous and discontinuous increases and decreases of velocity with depth. By fitting a calculated curve to observed data, we were able to determine velocity as a function of depth even when a large decrease of velocity exists. This velocity function, of course, was not unique.

Some properties of T-D curves were quantitatively studied by systematically varying the characteristics of a single model and noting the corresponding variations in the calculated T-D curves. It was concluded that a significant low-velocity channel (LVC) may not be evidenced by a shadow zone but rather by an overlapping of two distinct branches of the T-D curve. It was further concluded that the presence of a shadow zone implies a very gentle velocity gradient below the LVC.

Observed travel-times and distances for two underground nuclear explosions measured in four different azimuths were fitted with T-D curves by assuming a velocity distribution and evaluating the time and distance equations. It was concluded that the data can be satisfied by an LVC for P waves in the upper mantle. The character of the channel was determined for different azimuths. The depth to the top of this LVC was found to vary from shallow (70 km) in the western U. S. to deep (125 km) in the eastern U. S. The velocity gradient below the LVC is sharp enough to produce no prominent shadow zones. It was further concluded that there are significant lateral variations in the upper mantle velocities in the southwestern U. S.