54. Velocity Anisotropy of Seismic Waves in the Northwestern Pacific Ocean Lithosphere

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The present authors and their colleagues¹⁻⁴) carried out seismometrical observations by means of ocean bottom seismometers (OBS) at 10 sites in the Northwestern Pacific in 1974, 1977 and 1978. The sites are shown in Fig. 1. At least two OBS's were deployed at each site. They were set up with mutual separations of tens of kilometers in various directions.

During the observations, OBS's recorded many natural earthquakes which occurred in the neighborhood of Japanese Islands. The epicentres of these earthquakes were located by the seismological network of Japan Meteorological Agency, Tohoku University and the Earthquake Research Institute of the University of Tokyo. The epicentral distance of these earthquakes at the OBS sites ranged from 450 km to 1350 km. In addition to these, five series of long range artificial explosion experiments (140–800 km) were also made and their records obtained.

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Using the records with clear first arrival obtained by these OBS observations, the apparent velocities of P waves could be calculated. The velocities are 8.15 km/sec on the average but they were found not to be the same and show a remarkable anisotropy according to the azimuthal direction of approach of the waves as shown in Fig. 2.

\[ v = 8.15 + 0.55 \cos 2(\alpha - 155^\circ), \text{ km/sec}, \]

where \( \alpha \) is measured clockwise from the north. The maximum velocity is 8.70 km/sec in the azimuth \( \alpha = 155^\circ \) (335°) and the minimum is 7.60 km/sec in the azimuth 155°−90°=65°. The difference of the two velocities is as large as 8.70−7.60=1.10 km/sec (245°) which amounts to 13.5% of the mean value of the two.

The velocities of P waves measured are the apparent ones along the ocean bottom but they can be considered to be the same as the real velocities at the deepest points of the respective ray paths, because the ocean bottom structure is nearly horizontal here.

Since the deepest points of the ray paths of the recorded distant natural earthquakes are well below the low-velocity layer, the above results mean that the anisotropy of the wave velocity extends down to the whole thickness of the lithosphere.

The azimuth of maximum velocity is perpendicular to that of
magnetic lineation which was found by T. W. Hilde and others in this part of the Northwestern Pacific. In other words, the azimuth of minimum velocity is parallel to that of magnetic lineation as shown in Fig. 3.

All these facts suggest that the velocity anisotropy which was found is fundamentally related to the developmental history of the lithosphere in this part of the Pacific Ocean.

References

3) ———: Velocity anisotropy extending over the entire depth of the oceanic lithosphere. Final Reports of the International Geodynamics Program, Geodynamic Series (in press).