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Seismic Observations of Structure and Physical Properties of the Subcrustal Lithosphere as Evidence for Dynamical Processes in the Upper Mantle

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Observations of body waves from explosions and earthquakes have revealed recently some unexpected properties of the lower lithosphere: *P*-wave velocities definitely larger than 8.2 km/s and anisotropy with velocities dependent on the azimuth of propagation both under oceans and continents. A model of the subcrustal lithosphere with pieces of laminas of high velocities is proposed to explain the transmission of high-frequency P_n and S_n to teleseismic distances and the tunneling of low-frequency body waves through the subcrustal lithosphere. The preferred orientation of these laminas is probably achieved by the same mechanism which produces the anisotropy.

The observations of high velocities in the lower lithosphere is evidence in itself that anisotropy is present there. Since the direction of maximum velocity correlates in the ocean and on the continent with a number of tectonic features, a causal connection between anisotropy and dynamical processes related to plate motion must be suspected.

References

Fuchs, K., Schulz, K.: Tunneling of low-frequency waves through the subcrustal lithosphere. J. Geophysics **42**, 175–190, 1976

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Seismic Anisotropy – a Summary

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The matrix formulation of Crampin (1970), and the decomposition of the elastic tensor into three-by-three sub-matrices (Taylor and Crampin, 1977; Crampin, 1977), permit numerical calculation of both body and surface wave propagation in simple layered anisotropic structures (Keith and Crampin, 1977a, 1977b, 1977c; Crampin and Taylor, 1971; Crampin and King, 1977). The general principles of propagation in anisotropic structures are well understood from these studies, but the effects of the anisotropy on the behaviour of the waves are often subtly different from the corresponding isotropic propagation.

The best known of these differences is that, in the presence of anisotropy, there are azimuthal variations in the velocity of body waves and the dispersion of surface waves. These are difficult to observe in the earth except in particular uniform structures. Such velocity anisotropy in the upper mantle has now been observed many times in refraction experiments at sea, in West Germany (Bamford, 1977), and velocity anisotropy of the dispersion of the Fundamental Rayleigh mode has been observed in the NAZCA plate in the Pacific Ocean (Forsyth, 1975).