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Heterogeneous Velocity Structure at the Base of the Mantle

1. Model

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Using a ray-theory approach, we have modeled regions at the base of the mantle to determine the characteristics of the velocity structure which give rise to observed amplitude variations in PKP arrivals at epicentral distances greater than 158°. Consistent results for the amplitude anomalies over the period range 0.5–10 s were obtained by modeling the lowermost 150 km of the mantle at either the core-entry or core-departure point of the ray as consisting of cells which are 150 km high and 150 km in lateral extent with lateral velocity variations of up to 1.5%. The PKPAB is near-grazing at the mantle-core interface so that a ray traverses a number of cells. Our deterministic model contrasts with Chernov random scattering in allowing for more than a single scattering in the heterogeneous region. Also, the observed frequency dependence of the amplitude anomaly is inconsistent with that predicted by Chernov scattering.

Reference

Snoke, J.A., Sacks, I.S.: A model for laterally heterogeneous velocity structure at the base of the mantle. Carnegie Inst. Wash. Year Book **75**, 233–240, 1976

Heterogeneous Velocity Structure at the Base of the Mantle

2. Observations and Interpretations

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For epicentral distances greater than 158° the core phase PKPAB has near-grazing incidence at the mantle-core boundary and hence is highly sensitive to velocity structure at the base of the mantle, while PKPDF has near-normal incidence and is less sensitive. The amplitude ratio, PKPAB/PKPDF for given earthquake-seismograph pairs is insensitive to source or near station effects. The interpretation ambiguity caused by the two core boundary crossings for each arrival was removed by studying numerous earthquake-seismograph groups which had only one coincident core-mantle crossing region in their paths. Amplitude ratios for regions beneath the East Pacific and West Atlantic, where abundant data are available, show good coherence and indicate large well defined contiguous zones with different local structures. A model (see accompanying paper) which is consistent with the data suggests that in some regions there are small-scale ($\sim$150 km) convection cells while other regions may be involved in whole-mantle processes (convection, plumes). Correlations with isostatic anomalies of the gravity field are consistent with this suggestion.

Reference

Sacks, I.S., Beach, L.: Lateral heterogeneities at the base of the mantle—an indication of whole mantle convection. Carnegie Inst. Wash. Year Book **73**, 1020–1032, 1974