Inner Core Anisotropy From PKP Travel Times at Near Antipodal Distances

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The central region of the inner core is difficult to study because of poor sampling of seismic data. Previous studies from PKP(AB-DF) differential travel times at large distances suggest that the central part of the inner core is very anisotropic (Vinnik et al., 1994; Song, 1996). These differential times, however, can be affected greatly by strong heterogeneity in the lowermost mantle (e.g., Breger et al., 2000). We’ve examined a unique data set of PKP travel times from global digital and analog stations at near antipodal distances (Sun and Song, 2002). Most of the digital data are obtained from the IRIS DMC.

We obtained 638 AB-DF differential travel-time measurements and absolute travel-time measurements (470 for DF, 466 for AB) at distances greater than 168 degrees (Figure 1). The observed AB-DF residuals for the polar paths are consistently larger than those of the equatorial paths by over 3-4 standard deviations (Figure 1). Assuming a uniform cylindrical anisotropy model, the average inner core anisotropy amplitude is about 2.5%. We conclude that most of the AB-DF anomalies for the polar paths are likely from the inner core anisotropy and not from mantle heterogeneity.

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(1) Although often sparse and not uniform, the ray coverage of the AB rays at the CMB is quite good, with data at all latitudes and longitudes, thus they are affected by both slow and fast mantle anomalies (Figure 2). The regions sampled by the AB rays of the polar paths are well sampled by the AB rays of the equatorial paths.

(2) The DF residuals are negatively correlated with the AB-DF residuals while the AB residuals have a much weaker correlation with the AB-DF residuals (Figure 1B, C).

(3) We compare several mantle models with the data. Our results suggest that the mantle structure can explain part of the residuals of the equatorial paths, but cannot explain the polar path anomalies.