Waveform Search for the Innermost Inner Core
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Waveforms of the PKIKP seismic phase in the distance range 150° to 180° are analyzed for evidence of an inner-most inner core of the type proposed by Ishii and Dziewonski having an abrupt change in elastic anisotropy near radius 300 km. Seismograms synthesized in models having a discontinuity at 300 km radius in the inner core exhibit focused diffractions around the innermost sphere at antipodal range that are inconsistent with observed PKIKP waveforms. Successful models have either a transition in elastic properties spread over a depth interval greater than 100 km or an innermost sphere that exceeds 450 km radius. Evidence of a sharp discontinuity in the lower to mid-inner core is sparse in existing global seismic data. Some examples, however, can be found of PKIKP complexity near 161°, consistent with a triplication created by a 475 km radius discontinuity. An abrupt change in either viscoelastic or scattering attenuation at this radius is also observed in PKIKP waveforms, suggesting the existence of an innermost sphere with low, regionally uniform, seismic attenuation. In contrast to the relatively uniform inner-most inner core, a 0 to 100 km thick region at the top of the inner core exhibits strong lateral variations in attenuation and velocity structure, suggesting lateral variations in the processes of solidification, flow and re-crystallization at the inner core/outer core boundary. Analogous to the evidence for an abrupt fabric change in the upper-most inner core, the seismic evidence for an innermost inner core may represent another fabric change near 700 km depth from the inner core/outer core boundary. This last and deepest change may simply signify the end stage of solidification, flow and re-crystallization, resulting in the highest ordering and largest grain sizes of intrinsically anisotropic crystals.

Waveform profiles stacked in 0.5 distance intervals for different orientations of PKIKP rays with respect to the rotational axis (polar cos ξ < 0.3, intermediate 0.3 < cos ξ < 0.75 (middle panel), and equatorial cos ξ > 0.75).

Seismograms synthesized in inner core models having a +2% P-velocity discontinuity at radii 300 km (left), 400 km (middle), and 500 km (right).