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Transition zone anisotropy near regions of subduction

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Seismic anisotropy should be more concentrated near the boundary layers of the mantle, as these are regions of enhanced deformation. Anisotropy in the uppermost and lowermost boundary layers - the lithosphere and D" region - is now well documented. To what degree the region of the 660∼km discontinuity acts as a boundary layer is less established, but has important implications for the style of mantle convection and the nature of mass exchange between the upper and lower mantle. Any evidence of seismic anisotropy in this region is an important sign of strain-induced rock fabric at this boundary. Here we present a systematic search of mid-mantle anisotropy using deep subduction-zone earthquakes recorded at teleseismic distances.

With any study of source-side anisotropy, it is important to carefully account for anisotropy in the upper-mantle beneath recording stations. We use 44 stations in North America and Ethiopia where SKS splitting measurements show little variation with station-to-source backazimuth, suggesting a simple homogeneous form of upper-mantle anisotropy. We use events between 55 and 82 degrees from the source to ensure near-vertical paths in the shallow mantle and to avoid interference with the D" region. The anisotropy estimates are based on results with high quality measurements of both source-side and receiver-side anisotropy. Furthermore, we only use measurements were estimates of source-side S-wave polarizations agree with those predicted from global CMT solutions.

We have analyzed all events since 1979 that are >M5.7 and deeper than 200∼km. In general, the magnitude of our >1000 splitting measurements show little variation with depth, thus ruling out intra-slab anisotropy due to metastable olivine or a high-pressure low-temperature pyroxene-to-illmentite phase transition. The splitting varies from very small in some regions to very large (>3secs) in others. Without more detailed modeling is difficult to distinguish between a transversely isotropic fabric in the uppermost lower mantle from a more variable subduction related supra-slab anisotropy. However, the fact that ringwoodite, the dominant mineral phase at the base of the transition zone, is essentially isotropic, whilst perovskite is highly anisotropic, suggests that the anisotropy is concentrated in the region beneath the 660∼km discontinuity.