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Anisotropy as cause for polarity reversals of D'' reflections

Christine Thomas (1) and James Wookey (2)

(1) Universität Münster, Institut für Geophysik, Münster, Germany (tine@earth.uni-muenster.de), (2) University of Bristol, Dept of Geology, UK

Seismic reflections from structures in the D'' region – the lowest 200-400 km of the Earth's mantle – can provide information on the velocity contrast of this region. Using the waveforms and polarities of the D'' reflections in P and S-waves we can distinguish between different possibilities that may cause the observed structures, such as phase transitions, aligned material or thermal anomalies. Here we use recordings of seismic events that reflect beneath the Caribbean and Eurasia. Both P and S reflected waves are used where possible. The source-receiver combinations provide reflections off D'' in two fast velocity regions. Under Eurasia three crossing paths are used. The polarities of reflections in both regions differ and can therefore help to further discriminate the cause for the observed reflections. In one region, we find apparent positive S-velocity contrasts but negative P-wave velocity contrasts for the D'' reflector. In the second fast velocity region we detect positive P- and S-wave velocity contrasts in two orthogonal paths crossing in the lowermost mantle indicating a different scenario for the structures in D''. A third intersecting path shows negative polarities of the reflected P wave. One possible explanation to reconcile observations in both regions is a phase transition from perovskite to post-perovskite with 12 percent of alignment in the post-perovskite phase. Depending on the travel direction of the waves with respect to the flow direction in the lower mantle, apparent positive or negative velocity jumps (reflectivity) can be expected. Other isotropic and anisotropic models are tested but cannot fully explain the range of observations we find in the data.