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Seismic observations of deep eclogitic ponds beneath Hawaii and other Pacific hotspots

Sanne Cottaar (1), Matthew Kemp (2), Stephen Pugh (1), John Maclennan (1), and Jennifer Jenkins (1)
(1) University of Cambridge, Cambridge, United Kingdom , (2) University of Oxford, Oxford, United Kingdom

P-to-s converted phases or receiver functions are used to map the mantle transition zone and discontinuities in the upper mantle beneath Hawaii (> 5000 RFs) and other hotspot locations (max. ∼200 RFs).The receiver functions are analysed with a variety of stacking methods.

Beneath Hawaii there is a deep 410 km discontinuity across the region. To the southwest of the Big Island the 660 is shallow by 30 km and a deeper, weaker arrival arrives at around 700 km. This is interpreted to be the location of the upwelling plume, where the thinned mantle transition zone is due to the olivine transitions and the deeper 660 is due to the garnet phase transition. The splitting of the 660 could be an indication of purely high temperatures or an eclogitic component in the plume.

In the upper mantle, the so-called X-discontinuity is observed between 300 and 350 km depth. To the east of the Big Island the amplitudes of this conversion are particularly strong and come from ∼360 km depth. Strikingly energy from the 410 km conversion is barely observed here. The X-discontinuity could be due to the silica phase transition from coestite to stishovite, suggesting widespread ponding of silica enriched material fed by recycled or primordial material in the underlying plume at these depths as proposed by Ballmer et al. 2013. The widespread ponding could also explain the suppression and decreased amplitudes seen in the 410 discontinuity signals.

In comparison to the results beneath Hawaii, the X-discontinuity is observed beneath Samoa and Society Islands. Beneath Samoa, a significant 410 arrival is observed, while the 410 is also weak beneath the Society Islands. The X-discontinuity beneath the hotspots could suggest the presence of an eclogitic component, and potential for a deep eclogitic pond. Due the lower number of data here, it is difficult to asses the lateral variability in MTZ thickness and 410 visibility around these hotspots.

These observations of the X-discontinuity provide additional evidence that Pacific mantle plumes carry an anomalous eclogitic component. We hypothesise that the eclogite leads to widespread ponding in the upper mantle