Imaging the 410 and 660-km Discontinuity Structure Beneath Hawaii using the SS-precursors

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Using precursory energy to the seismic phase SS, we map the local topography of the 410 and 660-km discontinuities in the vicinity of Hawaii and use a 3-D axi-symmetric wave propagation code to model the observations. A focused investigation of transition zone structure beneath Hawaii using the SS-precursors off the underside of the 410 and 660-km phase-boundary discontinuities, S410S and S660S, respectively, provides a powerful probe for understanding the mantle dynamics, elastic structure, and composition beneath the Hawaiian hotspot. To achieve this, we geometrically stack approximately 2000 broadband seismograms obtained from various data centers, such as IRIS, ORFEUS, and the CNSN. The stacking method uses the predicted move-outs for the precursory phases, and corrects for models of upper mantle heterogeneity. Transition zone thickness and discontinuity depth are estimated using the differential delays between SS and its precursors. Stacking results for an extended 4500 x 4500 km region centered on Hawaii will be shown. Our initial results directly beneath Hawaii image a depressed 410 (~10-15 km) from large S410S-SS times, but have no evidence for a precursor off the 660-km discontinuity. To the north of the islands, S660S is clearly present with the 660 strongly elevated (15-20 km) and S410S appears unperturbed from standard reference model predictions (e.g. PREM). Synthetic modeling of topography on the discontinuities suggests that the absence of S660S directly beneath Hawaii could be due to defocusing and scattering by topographical variations on the 660-km discontinuity. We will compare our data to waveforms generated by the 3-D SH axi-symmetric code to investigate the effects of heterogeneity on the order of several kilometers or less. Initial analyses of our data indicate variations in the SS-precursor amplitudes over laterally regional scales (~500 km). This may be consistent with a lower mantle plume source that locally produces short scale topographic or volumetric heterogeneity at the 660-km discontinuity. Other possibilities to explain this observation will also be presented, such as complex compositional heterogeneity from the pooling of plume material beneath the 660, or a complex origin for the plume at the 660-km discontinuity.