Title:

Compositional heterogeneity near the base of the mantle transition zone beneath Hawaii

Abstract

Establishing the existence or absence of compositional heterogeneity near the base of the upper mantle transition zone (~660 km depth) is central in the quest to understand convection in Earth's mantle. While mantle temperature can be inferred from lateral variations in discontinuity depth, expressions of variations in bulk composition have so far remained elusive. In the Central Pacific, we infer the latter from reflection coefficients of so-called *SS* precursors, which can now be determined because wave-packet array analysis allows us to observe underside reflections at upper mantle discontinuities over larger source-receiver distances than was previously possible. Hitherto concealed amplitude-distance trends reveal lateral variations in radial contrasts in wavespeed and density at the 660 km discontinuity ($\Delta\beta_{660}, \Delta\rho_{660}$), but not at the *410*. Thermodynamic models suggest that these differences have a compositional rather than thermal origin, with the mantle beneath Hawaii close to pyrolitic (60% olivine) and the base of the transition zone SE of the hotspot enriched in olivine (up to 90% harzburgite). This evidence for compositional heterogeneity corroborates numerical convection models with compositional segregation near the *660* in high temperature, low viscosity environments expected near lower mantle upwellings.