Title:	Broadband SPdKS waveforms reveal ULVZ ridge in the central Pacific
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Abstract

Over the past decade, the seismic phase SPdKS has been used to examine anomalous boundary layer structure at the core-mantle boundary (CMB), and revealed evidence for the presence of ultralow-velocity zones (ULVZ) right at the CMB. Studies have mapped ULVZs with thicknesses up to 40 km, S-wave velocity reductions from 5 to 45%, and P-wave velocity reductions from 5 to 15%. Some significant modeling uncertainties are present for ULVZ mapping. The nature of ULVZs may be intimately linked to overall mantle processes (e.g., the birth place of plumes), thus we desire better structural and geographical constraints. Here we investigate ULVZ structure in the central Pacific utilizing 37 southwest Pacific deep focus events with impulsive source mechanisms recorded in the Americas, focusing on the broadband (BB) SKS and SPdKS wavefields. SPdKS is an SKS wave that intersects the CMB at the critical angle for ScP, thus initiating short segments of diffracted P-waves (Pd) along the CMB at the core entry and exit locations. Analysis of these data show a cluster of highly anomalous SPdKS waveforms: SPdKS initiates at an epicentral distance of around 103°, roughly 7° earlier than in models lacking ULVZ structure (e.g., PREM). Also, the SPdKS amplitudes are larger than SKS. The anomalous waveforms are observed for multiple events recorded at stations across N. America, with the commonality that the source-side Pd CMB inception points are grouped together forming a ridge-like pattern (~200 km in length trending NW). SPdKS source-side inception points to the NE of this ridge display milder ULVZ characteristics, whereas inception points to the NW or SE of the ridge display PREM-like characteristics. We model these P/SV- waveforms using the 2.5D axi-symmetric finite difference algorithm PSVaxi. Although PSVaxi does not incorporate full 3D geometry, it is useful here as the geometry of the observed ridge is perpendicular to the station-receiver great circle path, and we are capable of computing synthetics with 6 sec dominant periods. We show that our observations are compatible with PSVaxi predictions for a ULVZ ridge shaped structure, trending to the NW, and sloping off to thinner ULVZ to the NE. The location of this ULVZ ridge is located in the center of the Pacific Large Low Shear Velocity Province (LLSVP). The nature of the LLSVP is uncertain, but appears consistent with a chemically distinct origin, e.g., a thermochemical pile. Geodynamic modeling suggests the existence of internal upwellings and downwellings within piles, resulting in hot ridges around the pile margins, as well as within the pile. For this possibility, if ULVZ material is significantly more-dense than pile material, ULVZs may accumulate beneath the upwelling

regions within the piles. The ridge-like ULVZ feature we observe is consistent with hot linear basal temperature anomalies in regional upwelling zones in geodynamic calculations. This ULVZ modeled here may be associated with upwellings giving rise to the Samoan hot spot.