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Structure of the D" layer beneath Hawaii inferred from analyses of anomalous Sdiff waveforms

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Global shear velocity tomographic models show two large-scale low velocity structures (LLSVPs) in the lower mantle beneath the Pacific Ocean and Africa. Their locations correspond to the regions where mantle upwelling flows are expected. Revealing the detail structures inside the LLSVPs and their surrounding regions should hold the key to understanding the generation of upwelling mantle plumes.
Here, we report that prominent postcursors to S/Sdiff waves are observed in Northern America for Papua New Guinea events. These waves sample the northern side of the Pacific LLSVP beneath Hawaii. First, we use ray theory to search for a range of models, which generate the postcursor and also provide the observed travel time difference between the postcursor and the main Sdiff phase. Then, for some of the models, we created waveforms down to 5 seconds using the Spectral element method installed in Earth Simulator. We obtained several models that provide synthetic waveforms in a fair agreement with the observations.
The result shows that two types of low Vs regions are required to explain the data. One is a broad and weak anomaly region with a Vs reduction of 5% or so. The other is a laterally localized strong anomaly region with a more than 30% reduction of Vs. The newly found strong anomaly region is located several hundred kilometers southwest of Hawaii on the CMB. The waveform modeling shows that the region should be thicker than 80km. This is 2 to 10 times thicker than the so-called ultra low velocity zones, which were previously detected in some other regions on the CMB. The thick ULVZ we have found is likely to be caused by the existence of chemical heterogeneities rather than partial melting.

Keywords: Seismology, Core-mantle boundary, Diffracted wave, S wave