Evidence of an S velocity reflector inside the Pacific Superplume at the base of the mantle

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Global shear velocity tomographic models show two large-scale low velocity structures, so called superplumes, in the lower mantle, under Africa and under the mid-Pacific. While existences of sharp lateral velocity changes have been reported at the borders of the superplumes, velocity structures within the superplumes are not well documented. Here, we report that there is a strong S velocity scatterer or reflector in the middle of the Pacific superplume at the base of the mantle, which laterally deflects S waves incident to it. The evidence comes from the prominent postcursors to the Sdiff waves. The events and stations are located in Papua New Guinia and in southern U.S, respectively. The postcursors show the following features: 1) they arrive 20 ~40 seconds after the Sdiff waves 2) the arrival times strongly depend on station azimuths, rather than epicentral distances, indicating that the waves are caused by an off great-circle structure. The later phase arrives systematically earlier as the azimuth to a station increases clockwise in southern US. The travel time differences between the first and second arrivals among nearby stations are beamformed to search for the incident angle and azimuth of the second arrivals. The beam-stacked incident angle is almost the same between the first and second arrivals but the beam-stacked incident azimuth departs southward by about 7 degrees relative to the azimuth of the first arrival. The departure is slightly larger to the northern stations and slightly smaller to the southern stations. We made a grid search for the location of the scatterer or reflector that can explain the travel time differences and off-great circle incident azimuths. The scattering points are concentrated in a depth range of 2891 ~2532km just above the CMB and in an area of -5 ~5 degrees N and 165 ~170 degrees E, corresponding to the middle of the Pacific superplume.

There are similar and dissimilar points between this postcursor, which sample the middle of the Pacific superplume and the previously reported Sdiff splitting which sample the borders of the Pacific and African superplumes (Wen, 2001, To et al 2005). The newly observed postcursor is well separated from the main Sdiff phase and their amplitudes are as large as the main Sdiff phase, whereas the postcursor from either southern Pacific or Africa is of smaller amplitude and overlaps in time with the main phase.

By conducting waveform modeling for several simple structures, we discuss the origin of the later phase.