Geophysical Research Abstracts, Vol. 8, 06078, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06078

Mantle transition structures beneath western United States derived by P and S receiver functions

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The Oblique subduction of the Farallon plate and consequently the Pacific plate under the North American plate has resulted complicated modes of plate interaction, leaving imprints in the upper mantle and the transition zone beneath western North America. The Farallon plate is currently separated by the Pacific plate into the Juan de Fuca and Gorda plate in the north and the Cocos plate in the south, resulting in formation of the Mendocino and Rivera triple junctions, respectively. Between the two triple junctions, subduction is replaced by transform motion of the Pacific plate relative to the North American plate along the western margin of North America. Here we jointly use P and S receiver function methods to study mantle transition zone discontinuities in the area and compare the results of the two methods. The mantle discontinuities are generally attributed to the phase transformation of mantle minerals and are therefore subjected to temperature dependent depth variation. The thickness of the transition zone changes according to the ambient mantle temperature. Teleseismic data of 67 permanent broadband seismic stations of different seismic networks located in western North America were analyzed to generate P and S receiver functions. In our data both the 410 and 660 km discontinuities are clearly observed by P and S receiver functions. The arrival times of the two discontinuity phases are simultaneously delayed by 2-3 s. The constant separation of the two discontinuities indicates that there is no much temperature variation in the mantle transition zone. The time delay of the 410 and 660 phases can be explained by a low upper mantle velocity and a thin lithosphere thickness, consistent with earlier tomography results and a recent S receiver function study. Significant negative amplitudes in front of the 410 phase are observed in the S receiver functions. This indicates a low velocity zone at top of the 410 km discontinuity, which can be interpreted as a partial melt layer, possibly linked to earlier sucduction of the Farallon plate.