Seismological investigation of the 410 km discontinuity in the mantle wedge beneath the Fiji-Tonga region

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The Fiji-Tonga region is characterized by the subducting Pacific slab beneath the Australian plate. The subduction of the world's oldest plate is related to the active tectonics of volcanic arcs and back-arc spreading in this region. The deep structure beneath this region down to the mantle transition zone may have a clue to connect the surface tectonics with the deep dynamics in the mantle wedge.

The depth variation of the 410 km discontinuity in the mantle wedge beneath the Fiji-Tonga region is determined by using two seismic probes with different frequency ranges. One is short-period teleseismic waveforms which include conversion and/or reflection waves at the 410 km discontinuity under the source-side. These phases (S410P, s410P and p410P) are detected in the filtered waveforms with a frequency range of 0.2 - 1.0 Hz. The obtained depths of the 410 km discontinuity are deeper than 410 km in the mantle wedge. A remarkable feature is that the 410 km discontinuity-associated phases are not visible in the region near the subducting Pacific slab. Another probe is near-source receiver functions obtained from combinations of earthquakes and broad-band seismograms in this area. The receiver functions are obtained with a rather low frequency range (0-0.5 Hz) compared with the former probe. The results also show a deeper 410 km discontinuity beneath the region.

The tomography image of this region is first reported by Zhao et al. (1997), which shows clear low-velocity anomaly down to 400 km depth just beneath the Lau back-arc spreading center. Recent joint inversion of P and S waves also imaged this low-velocity anomaly (Conder and Wiens, 2006). Although upwelling of hot material is expected in the mantle wedge in this region, its origin is not clear. The waveform analysis by Tibi and Wiens (2005) indicates no uplift of the 410 km discontinuity (rather depressed), which is interpreted as a hot flow across the 410 km by Helffrich (2005). Our observations are consistent with Tibi and Wiens (2005), supporting a depressed 410 km in the mantle wedge. Thus the low-velocity anomaly revealed by seismic tomography may have its root at a depth deeper than 410 km, suggesting deeper geodynamics caused by the subducting Pacific slab in the mantle transition zone.