Structure of the mantle transition zone beneath the Tonga region

Yoshiyuki Imato[1]; Akira Yamada[2]; Dapeng Zhao[1]

[1] GRC, Ehime Univ; [2] GRC, Ehime Univ.

Mineral physics studies suggest that the phase change at the 410 km discontinuity has a positive Clapeyron slope, while the 660 km discontinuity has a negative slope. Thus near the cold subducting slab the 410 may be uplifted to a shallower depth, while the 660 is depressed to a greater depth. Hence the mantle temperature has a great influence on the depth variations of the two mantle discontinuities.

In this study we have investigated the depth variations of the 410 and 660 km discontinuities and estimated the lateral variation in the thickness of the mantle transition zone beneath the Tonga region using S-to-P converted phases. We used waveform data recorded by the J-array and Hi-net seismic networks which cover the entire Japanese Islands densely and uniformly. There are over 300 J-array statons and about 500 Hi-net stations. We have analyzed short-period vertical component seismograms from 49 deep earthquakes with mb greater and equal to 5.5 and focal depths greater and equal to 100 km that occurred beneath the Tonga region from November 1996 to December 2003. A Phase Weighted Stacking method has been used in this study because these converted phases usually have small amplitudes which are not identifiable in each seismogram. We selected approximately 40 to 150 records with a good signal-to-noise ratio and applied a low-pass filter for each event. The seismograms are subsequently aligned on P onsets which are normalized to unity. The polarity of the seismogram is also reversed when necessary. After stacking, several S-to-P converted and reflected waves at the mantle discontinuities are clearly detected in the stacked waveforms. The depth variations of the mantle discontinuities are estimated by the relative travel time difference between the converted and/or reflected phase and first P waves by using the iasp91 Earth model (Kennett and Engdahl, 1991).

Our results show that in the vicinity of Vanuatu trench the mantle transition zone becomes thicker due to the subducting Australian plate. In the centeral parts of the Tonga region the 410 discontinuity becomes deeper due to the influence of hot materials as imaged by seismic tomography. In the vicinity of Tonga trench the mantle transition zone becomes thicker due to the subducting Pacific plate. Our results obtained from shallower events may contain a large error caused by long ray paths passing through the high-velocity subducting slab. Hence we are calculating the relative residuals between the converted and reflected phase and first P waves using a 3-D ray tracing method (Zhao and Lei, 2004), to estimate precise locations of the reflection and/or conversion points.