Detection of P-wave reflection from the D” layer and an examination of the Double-crossing model

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The D” layer in the lowermost mantle with a thickness of 100 - 300 km is known as a strong lateral heterogeneous structure, implying complicated interactions between rocky mantle and molten outer core. The phase transition from Pv to pPv (Tsuchiya et al. [2004], Murakami et al. [2004]) is a newest and probable cause of the origin of the D” layer. If a seismic reflector in the D” layer corresponds to the phase transition, seismological detection of the D” reflector has a powerful tool to investigate compositional and thermal structures in the lowermost mantle. Consideration of the clapeyron slope of the phase transition and the geotherm around the CMB region leads to the possibility of the ”double-crossing model” (Hernlund et al. [2005]), which predicts two seismic discontinuities in the D” layer in a case of sharp thermal gradient in the D” layer; hot core temperature and/or cold mantle temperature. Previous studies observed two D” discontinuities by using ScS precursor (Thomas et al. [2004], Hernlund et al. [2005]) and PcP precursor (Kito et al. [2007]).

In this study, we attempt to examine the double-crossing model by using P-wave reflection from the D” layer (PcP precursors) and discuss the thermal structure in the CMB region. We use waveforms recorded by the IMS (International Monitoring System) array from January, 1996 to December, 2000. The vertical-component waveforms are filtered between 0.5 and 1.5 Hz. We obtain the stacked waveforms using linear stacking and phase-weighted stacking (Schimmel and Paulssen [1997]).

Our preliminary analyses indicate a difference in the number of the PcP precursors in the stacked waveforms among three regions; two precursors beneath Siberia and Central America, one precursor beneath northern part of the Gulf of Mexico. No precursor is detected beneath Western Pacific.

According to the ”double-crossing model”, thermal structure beneath Siberia and Central America may be inferred as a sharp temperature gradient in the lowermost mantle, possible by a cold lowermost mantle suggested by the previous studies on the D” layer in these region. No precursor beneath Western Pacific may be caused by a hot mantle temperature, which is consistent with the ”super plume” suggested in this region. One precursor beneath northern part of the Gulf of Mexico indicates a single crossing between the geotherm and the clapeyron slope in the lowermost mantle implying a lower CMB temperature compared with other two regions. However, lateral variation in temperature may be very small at the CMB because of a viscous flow in the outer core. It is difficult to explain the D” discontinuity observed in this study in terms of only the phase transition. Thus another origin of the D” reflector should be considered.