High temperature and hydrus melt oceanward of subducting slabs at the 410-km discontinuity

Masayuki Obayashi[1]; Hiroko Sugioka[2]; Junko Yoshimitsu[3]; Yoshio Fukao[4]

[1] IFREE, JAMSTEC; [2] JAMSTEC; [3] JAMSTEC,IFREE; [4] Earthq. Res. Inst., Univ. of Tokyo
IFREE/JAMSTEC

Our P-wave whole mantle tomography revealed a low velocity region oceanward of the Northern Honshu slab of the Pacific plate at depths around the 410-km seismic discontinuity. The existence of the slow anomalies is also supported by the analysis of the P wave records from the J-array (a large-aperture seismic array in Japan) for a Bonin earthquake. The P arrivals to Northern Honshu (at epicentral distances of 13-20o) are strongly triplicated because of the 410-km discontinuity. The later arrivals along the retrograde branch, where ray paths pass through the low velocity region, are anomalously slow. Comparison of the observed and synthetic waveforms indicates not only slow anomalies but also depression of the 410-km discontinuity. This depression represents the direct evidence for the low velocity zone of primarily thermal origin. An excess temperature of 200 K and the associated fractional melt of less than 1 % can explain both the results of the tomographic and waveform analyses, suggesting hydrous melt atop the 410-km according to the following scenario. The excess temperature of 200 K is high enough for the olivine-dominant upper mantle to exceed its wet solidus. Although water can be little stored in the olivine-dominant upper mantle, a mechanism of supplying water from below has been suggested (Ohtani et al., 2004; Bercovici & Karato, 2003). Because of a large sustainability of water in wadsleyite, the wadsleyite-dominant transition zone is likely to contain a large amount of water. When hot upwelling rises through the hydrated transition zone, it can absorb water by reaction with wet wadsleyite. The consequent hydrated hot upwelling would release water by phase transition from wet wadsleyite to olivine at the 410-km discontinuity and hence partial melting would occur atop the discontinuity. This hydrous melt is heavier than the ambient mantle (Matsukage et al., 2005; Sakamaki et al., 2006) and is able to exist stably to form a low velocity zone in some depth range above the discontinuity.