

Vp/Vs structure of the shallower part of the subducting Pacific lithosphere around the Japan Trench axial region

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We have revealed that the Vp of the oceanic crust and upper mantle of the Pacific lithosphere is significantly reduced near the axial part of the Japan Trench, from airgun-OBS seismic experiments made at the outer rise and the inner trench regions of the trench (Azuma et al., 2009). From the spatial correlation between the Vp reduction and the development of the horst-graben structure, it is suggested that the Vp reduction is possibly caused by the fracturing and water infiltration accompanying the lithospheric bending. However, in order to thoroughly understand the mechanism of the structural change, we must clarify the Vs structure of the subducting oceanic lithosphere.

This study uses two different datasets. One is the data obtained by the seismic experiments described by Azuma et al. (2009). We analyzed converted S waves from the airgun source recorded on the horizontal components of OBS by a 2D ray tracing method (Zelt and Smith, 1992) and determined the Vp/Vs ratio in the Pacific lithosphere before it subducts. Another is the earthquake arrival time data. We observed inter- and intra-plate earthquakes beneath the inner trench slope by OBS array deployed at the outer rise region and analyzed the P and S wave travel times by using a 3D ray tracing method (Zhao et al., 1992). The latter is the first attempt of estimation of seismic velocity of the slab mantle around trench axis.

The results of seismic experiments show that the Vp/Vs ratio of the oceanic layer 2 and 3 and upper mantle at the outer rise are 2.08-2.11, 1.84-1.87 and 1.71-1.72, respectively. In comparison with the ratio of a normal oceanic lithosphere (Shinohara et al., 2008), Vp/Vs of the layer 2 at the outer rise significantly increases whereas the Vp/Vs does not show significant change either in the layer 3 or in the upper mantle. The travel time analysis of the earthquake data shows that the Vp/Vs ratio of the slab mantle beneath the trench is 1.73-1.74, which is slightly larger than that beneath the outer rise. This increase of mantle Vp/Vs ratio from the outer rise toward the inner trench correlates with the Vp reduction observed at the outer slope region where the horst-graben structure is developed. It is concluded that the deep normal faulting reaching to the upper mantle accounts for the observed Vp reduction and increase of Vp/Vs in the Japan Trench.

Keywords: ocean lithosphere, subduction zone, Japan Trench, outer rise, plate bending