Anomalous deepening of Upper-plane seismic belt of double seismic zone beneath Hokkaido corner:Shielding effect of sliver material

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1. Introduction

Kita et al. [2006] found the ’upper-plane seismic belt’ , a belt-like concentration of intraslab seismicity parallel to iso-depth contours of the plate interface at depths of 70-90 km in the upper plane of the double-planed deep seismic zone in the Pacific slab, and interpreted it to be associated with dehydration reactions near a facies boundary modeled by Hacker et al. [2003]. Hasegawa et al. [2007] further found that this upper-plane seismic belt in the Pacific slab does not run parallel but obliquely to the iso-depth contours beneath Kanto, deepening toward the north to ˜140 km depth. They showed that this local deepening is caused by delay of eclogite-forming phase transformations due to the contact with the overlying Philippine Sea slab. Kita et al. [2008, JPGU meeting, SSJ meeting] found that the upper-plane seismic belt beneath the Hokkaido corner is located at depths of 80-120 km, while it is located at depths of 70-90 km in the surrounding areas. In other words, the seismic belt in the Hokkaido corner is also deepened locally there. Beneath this area, the Kuril fore-arc sliver is colliding with the NE Japan arc and lower-crust material of the sliver is estimated to be dragged into the mantle wedge below [e.g. Ito and Iwasaki, 2002]. In the present study, we investigated the seismic velocity structure beneath the Hokkaido corner in order to understand the relationship between the fore-arc sliver crustal material and the upper-plane seismic belt in the Pacific slab beneath this area.

2. Data and method

We applied double-difference tomography method [Zhang and Thurber, 2003, 2006] to a large number of arrival-time data of 88,030 for P waves and 66,712 for S waves from 5847 earthquakes that occurred in the period from 2002 to 2006 beneath the arc-arc junction area. The 1D velocity structure of JMA 2001 [Ueno et al. 2002] was adopted as an initial P-wave velocity model. An initial S-wave velocity model was calculated by assuming a constant Vp/Vs value of 1.73. In the initial model, we assigned P- and S-wave velocities within the subducted Pacific slab to be 5% faster than those in the mantle on the basis of the plate model of Kita et al. [2008, SSJ meeting], which is determined from the upper envelope of the intermediated-depth earthquakes and the hypocenter locations of repeating small earthquakes [Uchida et al., 2007] and low-angle thrust type events.

3. Results and discussion

The inversion results clearly show the existence of a low-velocity zone having P-wave and S-wave velocities of crustal materials in the mantle wedge beneath the arc-arc junction area. This low-velocity zone is continuously distributed from the bottom of the crust to the upper surface of the subducting Pacific slab beneath the collision zone. In other words, the low-V zone contacts with the upper surface of the Pacific plate. This low-V zone is interpreted to be the crustal material of the subducted fore-arc sliver. Comparison of the deepened ’upper-plane seismic belt’ with this low-V zone shows that the distributed area of the low-V zone is located at the shallower extension of the seismic belt. This implies that the contact with the overlying sliver crustal material hinders the heating of the Pacific slab crust by hot mantle wedge, causing delay of eclogite-forming phase transformation and hence deepening of the seismic belt there, similarly to the case of Kanto.