Phase transformation depth and upper-plane seismic belt in the crust of the Philippine Sea slab

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The genesis of intermediate-depth earthquakes remains enigmatic, because lithostatic pressure at such depths becomes too high to allow brittle faultings. Some special weakening mechanism is required for their occurrence. Dehydration embrittlement has been proposed as a possible mechanism for decreasing effective normal stress and so triggering intermediate-depth earthquakes [e.g., Kirby et al., 1996; Seno and Yamanaka, 1996]. Precise relocation of intermediate-depth earthquakes has demonstrated a characteristic fine-structure of the hypocenter distribution in the Pacific slab that supports the dehydration embrittlement hypothesis. Kita et al. [2006] have found a clear belt of higher-than-normal seismicity in the upper plane of the double seismic zone, located at depths of 70-90 km in the subducting crust of the PAC slab and trends parallel to iso-depth contours of the plate interface in the forearc side of the volcanic front over a length of about 1000 km from Hokkaido to Tohoku. Its deeper end coincides well with the location of metamorphic facies boundary in mafic oceeanic crust from jadite lawsonite blueschist to lawsonite amphibole eclogite estimated from a thermomineralogical model by Hacker et al. [2003]. The seismic belt beneath Kanto does not run parallel to but obliquely to the iso-depth contours, deepening toward the north from ˜100 km to ˜140 km depth. This deepening of the seismic belt beneath Kanto is caused by the contact with the overlying cold Philippine Sea slab, which farther supports the dehydration embrittlement hypothesis (Hasegawa et al., 2007).

We have investigated whether or not a similar seismic belt is formed in the crust of the Philippine Sea slab subducting beneath southwestern Japan. We used seismic velocity structure in and around the Philippine Sea slab, hypocenters of intraslab earthquakes, and the configuration of the upper surface of the Philippine Sea slab estimated by Hirose et al. (2007) by double difference tomographic inversions and focal mechanism determinations. The results show that a similar seismic belt trending parallel to iso-depth contours of the plate interface has been found in the crust of the Philippine Sea slab at depths of 50-70km beneath Kyushu and at depths of 40-70km beneath Kanto. A similar seismic belt has not been found beneath the area from Tokai to Shikoku, but some hypocenter concentrations in the subducted crust are seen right below the transition zone of the interplate coupling, suggesting the relation with the occurrence of deep low-frequency tremors/earthquakes (Obara, 2002).