

Serpentinaized wedge mantle derived from seismic tomography

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1. Introduction

Fine-scale three-dimensional seismic velocity structure is revealed with arrival time data obtained by the high-sensitivity seismograph network of Japan (Hi-net) operated by National Research Institute for Earth Science and Disaster Prevention (NIED) which densely covers Japan Islands (Matsubara et al. 2008). We can obtain both P- and S-wave velocity (V_P and V_S) structure and estimate Poisson's ratio. Materials or physical properties are discussed with these P- and S-wave velocities and Poisson's ratio.

2. Serpentinized wedge mantle or materials in the lower crust ?

We have to distinguish that the low-velocity zone at depths of 30-40 km is in the wedge mantle, lower-crust of thick crust, or those with fluid. We can distinguish it with consideration of seismic velocity of olivine and serpentine mainly in the wedge mantle and amphiborite mainly in the lower crust.

For example, we can estimate the existence of 20% serpentinized wedge mantle in the region with 7.5km/s V_P and 4.1km/s V_S (Christensen, 1972). We cannot consider the existence of the amphiborite there since amphiborite has V_P within the range of 6.87-7.05 km/s (Christensen, 1996).

Serpentinized wedge mantle with V_P as 6.8 km/s has V_S as 3.6km/s and V_P/V_S as 1.89 (Christensen, 1972). However, we cannot consider the existence of serpentine if V_S is not so low. The existence of amphiborite in the lower crust with fluid is consistent with the V_P , V_S , and V_P/V_S .

3. Existence of serpentine estimated with seismic tomographic analysis.

Existence of the serpentinized wedge mantle is first proposed by Kamiya and Kobayashi (2000) at depths of approximately 30 km beneath the Kanto region, central Japan. Matsubara et al. (2005) obtained the fine-scale velocity structure beneath Kanto region with data of NIED Hi-net and estimated the volume ratio of serpentine. Beneath the Tokyo, 20 % serpentinized wedge mantle is estimated in the high- V_P/V_S region at depths of 30-40 km.

Deep low-frequency tremors and short-term slow-slip event are observed beneath the southwestern Japan (Obara, 2002; Obara et al., 2004). From tomographic analysis, this tremor zone is consistent with high- V_P/V_S region (e. g. Honda and Nakanishi, 2003). Matsubara et al. (2008) clarified that the high- V_P/V_S region is elongated southward at depths of 20-35 km beneath Tokai region and Bungo channel where the long-term slow-slip events are observed.

Matsubara et al. (2008) concluded that the region with long-term slow-slip event is consisted with amphiborite and fluid and that the region with tremor zone consisted of approximately 20 % serpentinized wedge mantle.

4. Estimation of ratio of serpentine and fluid.

We can estimate the distribution of ratio of serpentinization in the wedge mantle and distribution of ratio of fluid with the result of laboratory experiment (Christensen, 1996; Watanabe et al., 2007) and relationship between the decrease of velocity and fluid (Takei, 2002) if we obtain more accurate velocity structure in more fine-scale.