Subsurface density structure and serpentinized rate of the mantle wedge beneath southwest Japan estimated from gravity anomaly

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In Shikoku region, metamorphic belts are distributed parallel to the trench axis of the Nankai trough and deep low-frequency tremors and slow slips occur on the transitional region of the subducting Philippine Sea plate. The tremor and short-term slow slip event (SSE) are distributed to the high Vp/Vs regions, suggesting that those occur at a boundary section of serpentinized mantle wedge and Philippine Sea slab (Matsubara et al., 2009). In this study, we estimate the subsurface density structure beneath southwest Japan (Shikoku and Chugoku regions) and discuss a serpentinized rate of the mantle wedge based on gravity anomaly analysis.
The gravity data we analyzed here are measured by Kabazawa University and other institutes (Sawada et al., 2009; Yamamoto et al., 2011; Geospatial Information Authority of Japan, 2006; Geological Survey of Japan, 2004: Gravity Research Group in Southwest Japan, 2001). We adopt the density of 2,670 kg/m^3 for Bouguer correction and terrain correction. We calculate the terrain correction using the method of Honda and Kono (2005). We also use the configuration data of the basement depth (National Research Institute for Earth Science and Disaster Prevention), Conrad and continental Moho (Katsumata, 2010) and oceanic Moho of Philippine Sea slab (Shiomi et al., 2008).
We set 7 profiles in the east-west direction and 5 ones in the north-south direction on the land area from Shikoku to Chugoku regions for the density structure analysis. The inital density structure model is constructed from the configuration data mentioned above. We modify the depths of Conrad and continental Moho to explain the observed gravity anomaly by applying sequential iteration with the two-dimensional Talwani's method. In the modification, changes of the depths are constrained within the two times of the error of Conrad and continental Moho reported by Katsumata (2010).
First, we estimate the density structure with no serpentinized region. For the profiles of north-south direction, we obtain the structure, which reproduce well the observed gravity anomaly except for the difference between the observed and synthetic gravity anomalies caused by the effect of the surface structure and the shallower slab except for the profile in the central part of southwest Japan. For the profiles of east-west direction, the difference is large in the eastern part of Shikoku region. This difference may be caused by intricate configuration of the Philippine Sea slab, which implies inadequacy of the two-dimensional analysis beneath the eastern part of Shikoku.
Second, to examine a serpentinized rate in the mantle wedge, we assume following three cases of serpentinized region: (i) on the surface of the slab, (ii) in the high Vp/Vs region, (iii) combination of (i) and (ii). Here we judge that an estimated density structure is possible if the misfit, which is defined by the sum of the square of residual, is less than that of the case of no serpentinized region. For the case (i), a possible serpentinized rate is up to 100 % in the serpentinized region with ~3 km of thickness on the surface of slab. For the case (ii), 20 % is the upper limit of serpentinized rate in the eastern part of Shikoku, whereas 40 % is maximum in the other parts. For the type (iii), 20 % and 40 % are the upper limit of serpentinized rate in the eastern and the western parts of Shikoku region, respectively. As a result, the serpentinized rate in the eastern part is lower than that in the western part for the type (ii) and (iii).
We suggest that the difference in the serpentinized rate between the eastern and the western parts is caused by the difference in the thermal structure and the degree of dehydration due to the

variation of the configuration of the subducting PHS slab. The number of the tremors decreasing from the west to the east is possible to be linked with the serpentinized rate in the mantle wedge beneath Shikoku region.

Keywords: Serpentinization, Mantle wedge, Gravity anomaly

