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Crustal deformation across the Median Tectonic Line in western Shikoku, southwest Japan

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Crustal deformation field in southwest Japan is characterized mainly by two factors resulting from oblique subduction of the Philippine Sea plate: The first one is the short-term (roughly 100-year) crustal shortening in the direction of plate convergence, and the second is the permanent lateral movement of the Nankai forearc along the Median Tectonic Line (MTL). While the interseismic rate of the former is about ten times as large as that of the latter, the former is reset to zero whenever an interplate great earthquake occurs at the Nankai Trough. To clarify these two different modes of deformation, we conducted dense GPS array observations across the MTL in eastern Shikoku in 1998-2003. We decomposed observed deformation field into the above two modes by evaluating elastic loading of the overriding plate due to the drag of the subducting plate. The results showed that the crustal deformation field in the vicinity of the MTL can be explained by the locking of the upper portion of the MTL fault plane and the stationary aseismic slip at the lower portion, driving the Nankai forearc laterally to the west at a rate of about 5 mm/yr (Tabei et al., 2002).

We constructed a second dense GPS array network across the MTL in western Shikoku and conducted observations in 2002-2007. The biggest problem may be a modeling of plate interface that changes abruptly its strike and dip-angle off the western Shikoku. Instead of conventional rectangular faults, we use 756 triangular elements that reproduce plate interface in a region of 13 1-138E in longitude and 30-35N in latitude without any gap or overlap. Then we explicitly give a plate convergent vector to each element and calculate overall surface deformation by Poly3D (Maerten et al., 2005). Plate locking ratio is assumed as 100% on the elements located at the depth of 4-24 km, 25-75% at 24-36 km, and 0-10% below 36km (Ichitani et al., 2010). Finally we derive permanent deformation along the MTL by retrieving the forward calculated elastic loading from the observed deformation field.

The results show that the southern block of the MTL is moving to the west-southwest at a rate of 2-10 mm/yr relative to the northern block. It is notable that the MTL in eastern Shikoku has not only a right-lateral component but a small tensile one. The deformation field may be related to a counter-clockwise block rotation of the southwest Japan crust that has been derived from nation-wide GPS velocity data (Nishimura and Hashimoto, 2006). However, the results obtained in this study are never explained by a simple right-lateral motion on a single fault plane. It is strongly suggested that there exists a shear deformation zone north of the MTL.

Keywords: Shikoku, Median Tectonic Line, GPS, Philippine Sea plate