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Subsurface structure and slip pattern of the Median Tectonic Line, SW Japan inferred from GPS displacement rate field

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The Median Tectonic Line (MTL) is the longest arc-parallel fault system in southwest Japan. Its right-lateral strike-slip motion is originated from oblique subduction of the Philippine Sea plate at the Nankai Trough, separating the Nankai forearc sliver (the outer zone) from the inner zone of southwest Japan. The deformation of the forearc sliver is characterized by interseismic contraction in the direction of the plate convergence (NW-SE) and long-term westward block movement along the MTL. In addition the MTL itself has a potential to generate a large inland earthquake in the future. Therefore it is important to understand subsurface structure and current slip/locking pattern of the MTL fault plane.

From dense GPS campaign measurements along a traverse line across the MTL, we have made it clear that a transition zone of the relative motion between the outer and inner zones is located 20-30 km north of the surface trace of the MTL (Tabei et al., 2002). To interpret the transition zone, we used a northward-dipping MTL fault plane which was revealed by seismic reflection survey (Ito et al., 1996) and assumed that its upper part was locked and a stationary right-lateral slip was occurring at depth. However, the concept of a pure strike-slip on an inclined fault plane seems somewhat unrealistic. In addition linear distribution of earthquakes aligned 20-30 km north and parallel to the MTL seems inconsistent to the hypothesis of the dipping MTL fault plane because most of them show a right-lateral slip on a nearly vertical fault plane. Unfortunately station distribution of the nationwide continuous GPS network is rather sparse in the north of the MTL because of the existence of the Seto Inland Sea. In this area we have deployed supplementary three GPS stations and collected continuous data since November 2010.

We propose a kinematic model of the transition zone. The model consists of several vertical right-lateral faults in a hanging wall above the northward-dipping MTL fault plane, which are close and parallel to each other. Distributed slip deficits on this parallel fault system may block the relative motion between the outer and inner zones and act as s broad shear zone as a whole. In this study we assume four parallel faults with different widths and depths from surface. Integrated displacement field from relative block motion and slip deficits on these faults is consistent with that derived from a strike-slip on an inclined fault.

We check the effect of the 2011 Tohoku-Oki earthquake on the deformation field of southwest Japan. We compare two displacement rate fields before (Jan. 2006 - Dec. 2009) and after (Mar. 2011 - July 2013) the earthquake. After the earthquake, additional wide-area displacements of 1-4 cm/yr trending to the source region (extension) have been superposed on the original compressional deformation field due to the subduction of the Philippine Sea plate. No significant change has been recognized in the latter.

Keywords: Median Tectonic Line, Nankai Trough, GPS, Deformation