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Convergence of the Philippine Sea Plate in Mindanao, the Philippines

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Tectonics of the Philippines Archipelago is characterized by westward subduction of the Philippine Sea plate at the Philippine Trench in the east (5.8 - 7.0 cm/yr), eastward subduction of the Sunda plate at the Manila Trench in the west (3.3 - 3.6 cm/yr), and left-lateral strike-slip movement of the Philippine fault inland. Under the SATREPS project ”Enhancement of earthquake and volcano monitoring and effective utilization of disaster mitigation information in the Philippines” we have conducted yearly GPS campaign measurements in the eastern part of Mindanao since March 2010. The main purpose of the observation is to make clear the plate locking distribution at the Philippine Trench and slip/locking pattern of the Philippine fault in order to estimate earthquake generation potential in Mindanao.

We occupied 15 sites in the eastern Mindanao and collected continuous data for successive three to six days on March 2010-2013. Collected data were processed with Bernese software ver.5.0 together with the data from global IGS station (PIMO near Manila) to obtain coordinates and displacement rates based on ITRF2008. The displacement rates were then converted to those with respect to the Sunda plate. Moreover we used previous displacement rate data obtained in the central and western Mindanao from the 1997-2003 campaign measurements to cover the whole of Mindanao.

The resulted displacement rate filed shows that west-northwest motions are dominant due to the convergence of the Philippine Sea plate from the east but their spatial decay with increasing distance from the trench is not significant. Even the full locking of the Philippine Trench plate interface down to the depth of 80 km can explain only 29 percent of the observed displacement rate at the maximum. Thus we need to introduce remarkable rigid block rotations to interpret the deformation pattern of Mindanao. As a result of the estimate of pole position and angular velocity of the block rotation, deformation field of Mindanao cannot be reproduced by a rotation of single block. Considering the Philippine fault as a block boundary, it is natural to introduce multiple blocks into Mindanao. Unfortunately current station coverage and density are not enough to resolve elastic deformation due to plate locking at the trench and rigid motions due to multiple block rotations.

Keywords: Philippine Trench, Philippine fault, GPS observation, Mindanao