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Seafloor movements on the northern part of the Philippine Sea plate detected by GPS-acoustic observation

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Along the Sagami Trough, where the Philippine Sea plate subducts beneath the North American plate, the megathrust earthquakes such as the 1923 Taisho Kanto earthquake (M7.9) and the 1703 Genroku earthquake (M7.9-8.2) had occurred repeatedly. On the west side, the west edge of Sagami Bay is considered as a boundary of the Izu Micro plate (IM) and the Philippine Sea plate [e.g. Sagiya, 1999]. Moreover, Taylor et al. [1991] suggested the back-arc rift zone along Izu-Ogasawara trench where the Pacific plate subducts beneath the Philippine Sea plate. Nishimura [2011] quantitatively estimated the motion of the Philippine Sea plate as the rigid rotations of several blocks and the slip deficits on the boundary faults. Because the most part of the Philippine Sea plate is covered with the ocean, however, few geodetic observations have been performed near the boundary faults. Thus, we, the group of Japan Coast Guard, have repeatedly performed seafloor geodetic observation with the GPS-acoustic technique (GPS-A) in order to detect the motion of the northern part of the Philippine Sea plate, especially near the boundaries.

We installed the GPS-A sites BOSS and SAGA on the seafloor southeastern off the Boso Peninsula and in the west part of the Sagami Bay, respectively. We set BOSS on the Izu-Arc block (IA) near the Sagami Trough, to detect the speed of the subducting Philippine Sea plate. On the other hand, we set SAGA on the IA near the northern part of the IM-IA boundary, where the Izu-Hanto-Toho-Oki earthquake (M6.7) had occurred in 1980. SAGA should be affected by the coupling of the IM-IA boundary faults.

We obtained the displacements relative to the rigid IA [Nishimura, 2011] on which the sites are located. Before the 2011 Tohoku-Oki earthquake (M9.0), no significant displacement was detected at BOSS (Sep. 2007 - Oct. 2010), which suggests that the seafloor around BOSS was considered to be rigid. Displacements detected at BOSS after the Tohoku-Oki earthquake (Apr. 2011 - Nov. 2013) were not significant either, though eastward coseismic displacement of 4-5 cm was detected. On the other hand, displacements at a rate of 1-2 cm/y toward south-southeast were detected at SAGA before the Tohoku-Oki earthquake (Jan. 2003 - Mar. 2011). We also detected eastward coseismic displacement of about 10 cm due to the Tohoku-Oki earthquake at SAGA. After the earthquake, eastward component of the displacement rate at SAGA was increased (May 2011 - Jun. 2014), which is considered to be caused by the postseismic deformation. Our results at SAGA obtained before the Tohoku-Oki earthquake are consistent with the quantitative model estimated by Nishimura [2011], which indicated the coupling on the IM-IA boundary faults. Therefore, the results at both BOSS and SAGA support the validity of the block-motion model by Nishimura [2011] on the seafloor near the boundary.

In this presentation, we report and discuss the results at BOSS and SAGA as well as other sites on and around the northern part of the Philippine Sea plate.

Keywords: GPS-acoustic seafloor geodetic observation, Philippine Sea plate, Sagami Trough, Block motion