Repeated seafloor geodetic measurements off Fukushima Prefecture using the GPS/Acoustic positioning system

Tomoko Mizukami[1]; Hiromi Fujimoto[1]; Yukihito Osada[1]; Motoyuki Kido[1]; Satoshi Miura[1]

[1] RCPEV, Graduate School of Sci., Tohoku Univ.

Our group in Tohoku University has been trying to measure horizontal seafloor displacement in the subduction zone along the Japan trench using a GPS/Acoustic (GPS/A) positioning system. Sanriku region is the area where the Pacific plate is subducted under the North American plate. The backslip distribution model (Suwa et al., 2006) estimated by land-based GPS network data demonstrates that the plate coupling is weak off Iwate Prefecture, and is strong off Fukushima and Miyagi prefectures. On the other hand, seismicity off Miyagi and off Fukushima are different. Large earthquakes with magnitudes around 7.5- have repeatedly occurred off Miyagi. On the other hand, such large earthquakes have not occurred repeatedly off Fukushima.

There has been no report on seafloor geodetic measurement off Fukushima Prefecture. So it is important to directly measure the crustal movements in this region for understanding the mechanism of earthquake occurrence in the subduction zone.

The GPS/A positioning system consists of kinematic GPS analysis between reference stations on land and GPS receivers at sea surface, and precise acoustic measurements between the sea surface and the seafloor. In this study, we deployed three precise acoustic transponders (PXPs) to form an equilateral triangle array. A buoy towed from a vessel is used as a surface platform for the GPS/A observation. The buoy is equipped with four GPS antennas on the top and an acoustic transducer at the bottom. We keep the buoy near the center of the PXP array during GPS/A observation. Precise travel time is obtained from correlation analysis between the transmitted signal from the buoy and the reply signals from the PXPs. The distance between the buoy and the PXPs is then estimated with sound velocity data, which are calculated from XBT/XCTD observations, and corrected by using the method of Kido et al.(2006). Finally, we get position of the center of the PXPs using thus obtained ranging data.

We started GPS/A observation in 2005 in the offshore of Fukushima Prefecture (GFK) and conducted four campaign observations. In July 2005, three PXPs were newly deployed and each position was determined during the Tansei-maru cruise KT-05-13. We then carried out an observation keeping the buoy near the center of the PXPs. In August 2005, we conducted the second observation after the off Miyagi earthquake on Aug 16 (Mj 7.2).In November 2005 (Hakuho-maru cruise KH-05-3), we conducted the third observation. In July 2006, we determined each PXPs position again and the fourth observation for 3 days during Tansei-maru cruise KT-06-15.

After the analysis, the observed displacement from June 2005 to August 2005 is 2.2 +/- 2.5 cm eastward and 1.8 +/- 5.5 cm southward.The result is much the same as the coseismic displacement calculated from the land-based GPS network (Miura et al., 2007).This observed displacement has the same degree of error with coseismic displacement, and we have to reduce the error before interpreting the result.The observed displacement from August 2005 to July 2006 is 7.1 +/- 2.6 cm/yr westward and 4.6 +/- 4.9 cm/yr northward. The displacement at GFK calculated from the backslip distribution (Suwa et al., 2006) is 4.1 cm/yr westward and 1.3 cm/yr northward.The direction of the observed displacement is almost same as the calculated one and the displacement is a little bigger value than the calculated one. This result suggests that the interplate coupling off Fukushima Prefecture is as strong now as off Miyagi Prefecture.