GPS/Acoustic seafloor positioning off the northeastern Japan

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Large earthquakes occurred around northeastern Japan associated with subduction of oceanic plates such as the Pacific plate. Seismic coupling on the subduction plate boundaries is a key in the study of the large earthquakes, and important progresses have resulted from geodetic and seismological networks on Japanese islands. Spatial distribution of the seismic coupling in the subduction zone of the Japan Trench has been estimated based on GPS observation(Nishimura et al., 2000)or seismological observation(Igarashi et al., 2001). However, there have been few data of seafloor observation of crustal movement near the seismogenic zones. It is important to extend the geodetic observation into the seafloor. GPS/Acoustic (GPS/A) seafloor positioning can be the most probable method for monitoring seafloor crustal movement.

We have developed a seafloor positioning system combining kinematic GPS (KGPS) and precise underwater acoustic ranging to investigate dynamics of the plate boundary. We use a small towed buoy for the positioning, and successfully reduce the effect of underwater acoustic noises generated from a survey vessel. We present a results of experiments carried out off northeastern Japan in the Japan Trench subduction among 2003 and 2005.

We carry out GPS/Acoustic observation in two steps; the first step is to deploy PXPs and to estimate the location of each PXP. The second step is GPS/A observation to get a precise horizontal position of the PXP array center. We deployed an array of three PXPs at GJT4 in Fig. 1 in August 2003 during KT-03-12 cruise of the R/V Tansei-maru. We then estimated the position of each PXP using data collected while the buoy shifted around the PXP. We had little time during the cruise to precisely locate the center of the PXP array.

We revisited this site in August 2004, June 2005, August 2005 and November 2005 for precise positioning of the PXP array center using the data collected with the buoy above the array center . Throughout the observation epochs, shore stations at SNR and AOB were maintained as the GPS reference stations. Sampling interval was 1second for logging both on land and at sea. The baseline length for KGPS positioning was about 110km.

We estimate the slip vector associated with the plate motion to be 9cm in the East direction. The deformation caused by the earthquake roughly agrees with that estimated from GPS observation on land. But we need to monitor the PXP array to estimate the vector in this area. We can’t estimate the crustal movement occurred the 2005 Miyagi-oki earthquake. But we continue to monitor the crustal movement on GJT4. Therefore we need to analysis the repeatability of crustal movement occurred the earthquake on the next observation (November 2005).