The observation of GPS/ acoustic system on Japan trench

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GPS / Acoustic Observation around the Japan Trench

It is difficult to directly observe the deformation around plate boundaries because most part of those exist under seawater. In order to monitor horizontal seafloor crustal movements, we developed a GPS/ Acoustic system. The essence of this approach is to determine acoustic ranges between seafloor transponders and a sea surface point above the center of the transponder array, together with the location of the sea surface point using GPS. This system is composed of a kinematic GPS (Global Positioning System) component, an underwater component, and a surface interface between these two components. Precision acoustic transponders are used for the underwater component. We collaborated with SIO (Scripps Institution of Oceanography), UCSD on the precision acoustic transponder system capable for precise ranging up to10km, enough to locate the positions of PXP on the Pacific plate at about 6 km water depth. We could confirm the precision of about a few centimeter in ranging up to 14 km with this system. The interface between the GPS and the underwater acoustic system component is provided by a buoy equipped with three GPS receivers/antennae and a hydrophone connected rigid.

We carried out a GPS /Acoustic experiment on KT01-11 cruise of the R/V Tansei-maru, Ocean Research Institute (ORI), University of Tokyo, around the Japan Trench in late July, 2001. We deployed three transponders on the seaward slope of the trench (280km from the coast, about 5600m water depth). We used the data at Sanriku (about 280km away for this observation area) and Sendai (about 350km away) as reference stations.

We analyzed the GPS data using the GIPSY / OASIS-II developed and delivered by JPL (Jet Propulsion Laboratory) to estimate the position of the buoy. We derived 3 cm r.m.s (root mean square) of baseline length (2km) between Sendai on the buoy. We calculated the hydrophone positions by means of the locations of three GPS antennae every second. We estimated the transponder locations using the hydrophone position data since one transponder out of three got some trouble, because we can not estimate the center of transponder array. We derived equal to 0.14m the repeatability from two-way travel time residuals for each transponder.

Miura et al.,(2001) carried out the test for the accuracy of the long baseline. They installed two GPS antenna both Sendai and Tokyo about 310km distance. They estimated 2 cm for the repeatability of Tokyo site with Senadai site fixed. We estimated the good buoy positioning. Because they estimate the position fixed site. But we need to consider to the repeatability of buoy positioning for another reference station (ex. Sanriku).

We estimated 0.14m of the repeatability of two-way travel time residual on one transponder location because of good GPS results. But we aim to achieve the cm order to improve the model

Reference

Miura, S., H. Fujimoto, E. Murakami, Y. Osada, and C. D. Chadwell, Observation system for ocean-bottom geodesy: Evaluation of accuracy in ship positioning by kinematic GPS analyses, The Seismological Society of Japan, 2001 Fall Meeting, 2001