The Influence of underwater temperature structure on seafloor positioning

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We have been developing a system for precise seafloor geodetic observation with the GPS/Acoustic combination technique and deploying several seafloor reference points on the land-ward slope of the major trenches around Japan, such as Japan Trench and Nankai Trough. The primary purpose of our observation is to detect and monitor the crustal deformation caused by the subduction of the oceanic plate near the plate boundary. At each point, we carry out a campaign observation with several days using a survey vessel. In this presentation, we present the study of relationship between underwater temperature structure and precision of seafloor positioning.

In this analysis, underwater sound velocity structure must be given to convert travel times of acoustic wave into travel ranges. The underwater sound velocity is calculated from observed temperature, salinity and pressure using the empirical equation of Del Grosso. However, it is difficult to get the sound velocity structure with accuracy sufficient to our purpose from observations such as CTD, XCTD and XBT measurements. Therefore, we are trying to estimate the sound velocity errors from the travel time residuals in the positioning analysis. By taking a proper strategy, the correction of sound velocity errors based on this estimation improves the final positioning result significantly. However in spite of taking this strategy, the precision of positioning results will decrease when a water temperature changes rapidly.

Sea area off Miyagi Prefecture shows unstable underwater temperature structure especially in spring and autumn. This instability deteriorates the precision of measurement results. On the other hand, in summer, underwater temperature structure is stable and measurement results have enough precision.

The underwater temperature structure in sea area along the Nankai Trough is more stable than that off Miyagi area. This measurement results of the stations situated along the Nankai Trough show higher precision.

These results show that a good undersea condition leads to the good precision of a result. However, even when the under sea condition is bad, an enough number of data lead an enough precision of result.