Precise Positioning Technique with Error Estimation for Long-term Seafloor Geodetic Observation

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We have been devoting ourselves to develop and construct the seafloor geodetic network for the purpose of monitoring the seafloor movement of the upper crust related to the oceanic plate subduction for ten years. Fourteen seafloor geodetic observation stations have already been deployed on the landward slope of the major trenches around Japan. The station sites are mostly 100km away from the shore and about 2000m deep in depth. In this network observation, a combination technique of long base line kinematic GPS positioning and precise acoustic ranging is used in precisely positioning seafloor stations. To this day, we have improved the observation system repeatedly, so that the result reaches a high level. However, some of the observation components in themselves err occasionally by 20 cm and above in ranging or positioning. Although the error estimation method based on the GPS positioning has been applied to some observations, it has brought about unsatisfactory results occasionally. It is inevitable to establish the error estimation technique under the present conditions of the observation accuracy. In the field of multibeam bathymetry surveying, communication delay and axis biases of a motion sensor are essentially estimated. In the GPS positioning also, modeling of the spatial error is usually carried out. In respect of the underwater geodetic observation, it is desirable that the amount of errors will be estimated in the same way as those. Naturally enough, the GPS/Acoustic underwater positioning is affected by the GPS's error and the acoustic ranging error. To make matters worse, the relative positioning error between the GPS antenna and acoustic transducer sometimes aggravates the result. On the other hand, the GPS and acoustic positioning may be useful to estimate the error of each other. From this point of view, we have been researching on the error modeling in the seafloor geodetic analysis. So far some error biases, such as in the sound speed profile and in the height values from the GPS, proved to be measurable to some extent by means of estimations on the basis of the reliable seafloor station's positions. In addition, the precise acoustic ranging and positioning technique with the error estimation is effective to find out the inaccurate portions out of the GPS positions.