Relative observation of ocean bottom pressure: Application to seafloor movement accompanied with the 2000 Miyake volcanic activity

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Vertical movement of the seafloor can be detected by ocean bottom pressure (OBP) observations. This method is not restricted by distance from land and can be applied anywhere under the sea. However, OBPs are greatly affected by ocean dynamics, which affects mass distribution of seawater above the sensors. Therefore, we must remove ocean dynamical effects, as well as instrument drift, in order to detect ocean bottom crustal movement by the OBP observations.

An effective approach is to measure pressure differences between two sensors deployed separately. The spatial scales of ocean dynamics can often be larger than that of ocean bottom crustal movement and if this assumption is hold, the ocean dynamics component may be removed from OBP data by taking the pressure difference between the two OBPs. In this study, we tried to detect ocean bottom crustal movement associated with the 2000 volcanic activity of Miyake Island by taking the pressure difference; i.e. relative pressure observations.

We inspected characteristics of the data obtained by the relativity pressure observations using several OBP data sets, which do not contain crustal deformation signals. In all the cases we inspected, tide components and most of the irregular pressure changes, possibly due to ocean dynamic events, can be removed by taking pressure difference. The residuals can be approximated as linear functions of time with rates of less than 1hPa/month and with standard deviations of about 1 hPa. The linear variations of the pressure residuals are due to difference in drift rates of the two instruments used in the observations.

Evident crustal movement accompanied with the 2000 volcanic activities of Miyake Island was observed by the GPS network deployed at Miyake and its nearby islands. The source of the crustal deformation was estimated to be located beneath the seafloor between the Kouzu and Miyake Islands, where we deployed one of our OBP sensors (My2). Another OBP (My1) was deployed about 10 km away from this site and these OBP recording systems observed for about 40 days. The two OBP records roughly conformed to sea level changes observed at coastal tide stations around this area. By taking difference of the two OBP records, we found gradual pressure increase at the My2, relative to My1. This pressure change corresponds to depression of the seafloor at My2, near the Kouzu, by about 6 cm within two weeks. This result agrees well with the vertical crustal movement pattern expected from the source model obtained by the GPS data modeling.