Analysis of GNSS/Acoustic geodetic data including the period of the transponder replacement

*Ikuta Ryoya[1], Koto Mizuno[1], Horng-Yue Chen[3], Masataka Ando[2], Takeru Komi[1]

1. Faculty of Science, Shizuoka University, 2. Center for Integrated Research and Education of Natural Hazards, Shizuoka University, 3. Institute of Earth Science, Academia Sinica

In this study, we analyzed GNSS/Acoustic geodetic data including the period of the transponder replacement. The data were obtained 60km off Yilan, north eastern coast of Taiwan from May 2009 to May 2016. The site is located just south to the rifting valley in the western end of the Okinawa Trough back-arc basin. The GNSS/Acoustic measurements were conducted for four times from May 2009 to August 2012 and eight times from July 2012 to May 2016. Although the seafloor crustal deformation of the latter eight epochs has been already reported by Chen et al. [2018, GRL], the geodetic data of the former four epochs haven not been analyzed. This is because of a replacement of the seafloor transponders due to the battery depletion between former four epochs and latter eight epochs. Although the last observation of the former four epochs (August 2011) used three transponders, two of them did not reply to the acoustic ranging in July 2012 and then three transponders were newly installed instead. Therefore, the common transponder is only one between the former and the latter epochs. Generally in GNSS/Acoustic measurement, the centroid of the transponder arrays is regarded as a benchmark position which represents the seafloor motion. Because the centroids of the transponder arrays differ greatly between the former and the latter epochs due to the replacement, we cannot recognize these epochs as a continuous series of the observation. Thus We developed a new solution method to deal with the epochs with only a few common transponders as a continuous observation series. The new method solves not the centroid but the motion of the common transponders between different epochs directly. Solving only one configuration of the transponder array from the whole measurement data, the relative motion can be solved more robustly than solving the centroid independently for each epoch. We applied this method to the data and verified the continuity of the estimated benchmark motion comparing with a simulation. The simulation was conducted given an artificial transponder replacement based on the real data. As a result, when enough data are provided in each epochs, we can consider the former and the latter epochs as a continuous series of the observation with an error within 10cm in horizontal component. However, the result of the real data analysis generated about 40cm discrepancy between the former and the latter epochs. From the additional simulation, it was suggested that significantly small number of the acoustic ranging in the observation just before the battery depletion would affect the continuity of the benchmark position as well as the small number of transponders in the former epochs which was three instead of the four in the latter epochs. However, simulation also suggested that the motion of the benchmark within each epoch group before and after the replacement can be solved well. The solved benchmark velocity which is assumed to be same between the former and the latter is identical to the velocity reported in Chen et al. [2018, GRL]. This result suggests that there was no back-arc opening evet during the former epochs.

Keywords: Seafloor crustal deformation, GNSS/Acoustic measurement, Okinawa Trough