Analysis of GNSS/Acoustic geodetic data including the period of the transponder replacement at the northeastern off Yilan in Taiwan II

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In this study, we analyzed GNSS/Acoustic geodetic data acquired 60km off Yilan, north eastern coast of Taiwan from May 2009 to May 2016. The site is located just south to the rifting valley of the western end of the Okinawa Trough back-arc basin. The GNSS/Acoustic measurements were conducted for four times from May 2009 to August 2011 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 have not been fully analyzed. This is because the seafloor transponders were extinct due to the battery depletion between the former four epochs and the latter eight epochs. Although the last epoch of the former four (August 2011) observed three transponders, two of them did not reply to the acoustic ranging in the next July 2012 epoch and then three transponders were newly installed instead. Therefore, only one transponder is common between the former and the latter epochs. In addition, the common transponder was measured only two times before the extinction. Generally in GNSS/Acoustic measurement, the centroid of the transponder array is regarded as a benchmark position which represents the seafloor motion. Because the centroids of the transponder array differ greatly between the former and the latter epochs due to the replacement, these centroids are not recognized as continuous series of the measurement. However, if the position of the common transponder is determined well in both the former and the latter epochs, the epochs can be connected via its positions across the extinction. Although the common transponder was measured two times before the extinction, one of them has been unsolved because of a poor accuracy of the kinematic GNSS analysis. In this study, we improved GNSS analysis to deal with the unsolved epoch of June 2010 to improve the continuity of the measurement before and after the extinction. The poor accuracy of the kinematic GNSS analysis comes from poor quality of the signal due to frequent interruption by the hoisting of the observation buoy onto the deck of the vessel. In order to improve the accuracy with bad data, we solved the position of the GNSS antenna on the buoy with reference to that on the vessel which have not been used for our analysis. The accuracy of the position was improved and we newly added the epoch including the common transponder to the former sequence. As a result of the seafloor positioning including the new epoch, the average velocity of the benchmark within the period from May 2009 through May 2016 is 71.0±5.8 mm/yr southward, 43.7±10.3 mm/yr eastward and 62.6±9.6 mm/yr downward. Adding the new epoch of June 2010, the offset between the former four- and the latter eight-epoch sequences is deduced from 14.8cm southward, 35.5cm westward and 18.7 cm upward of the previous study (Mizuno 2019MS) without the epoch to 13.0 cm southward, 14.6 cm westward and 15.0 cm upward. Especially, the offset in the east-west component significantly reduced. However, the benchmark positions of the former four epochs still show large variance from the linear trend. This large variance should come from the lower number of the acoustic ranging in each epoch within the former sequence than that in the latter one. The variance of the benchmark position is twice as large in the east-west component as in the north-south component. This may be due to a large spatial variation in the sound velocity structure due to Kuroshio-current which has a large temperature gradient in east west direction around the site.

Keywords: seafloor crustal movement, GNSS/Acoustic measurement, Acoustic transponder, Okinawa Trough

