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Time stamp experiment of MEMS-gyro for the observation of seafloor crustal deformation using multi-buoy system

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We are developing a new method for the observation of seafloor crustal deformation using multi-buoy system. The system measures seafloor crustal deformation by determining position of benchmarks on the seafloor using multi-buoy which link-up GPS and acoustic signals. Acoustic ranging is used to measure distance between the buoys and seafloor benchmarks. And kinematic GPS is used to locate the multi-buoy every 0.2 seconds. Now we have deployed 4 seafloor benchmark units at Suruga Bay and 4 units at Kumano Basin. At each survey site, three seafloor transponders are settled to define a benchmark unit. In November 2012, first observation of seafloor crustal deformation using the buoys was held in Suruga Bay. Analyzing observed data, errors of traveltime ' s residual were about 0.2ms(Mukaiyama et al 2012JPGU). These errors were too large. From approximate calculation, it is predicted that these errors of 0.16ms at maximum can be removed by introduction of a gyro compass. So, we introduced MEMS-gyro to multi-buoy observation to monitor the attitude of the buoys at Suruga Bay at November 2013. The MEMS-gyro was NAV440CA by Crossbow Co.. For the attitude monitoring of the observation of seafloor crustal deformation, time stamp is important. Although the gyro introduces time stamp provided by its GPS processor, its accuracy was not evaluated. In this study, we conducted rotation experiments to evaluate the accuracy of its time stamp. In the experiment, we used another GPS antenna system as a time reference. The GPS antenna and the gyro were deployed on a rotation table to synchronize their motions and the time stamp of the rotated gyro was checked with reference to the GPS time. Timing between their motions was evaluated by cross correlation between GPS circular trajectory and the rotation angle of the gyro. Specifically, we rotated the table for 3 min every 1 hour. This subset was repeated 3 times. As a result, delay times in first two sets were about -38ms. But third set was -58ms. The delay became lager. Offset of the average angle between GPS and gyro was also deferent from first two sets to third set. This deference might be caused by that of rotation speed between three subsets. We tried additional experiment with different parameter settings of MEMS-gyro under controlled rotation speed. We will also report the result of this additional experiment.

Keywords: Seafloor crustal deformation, buoy, GPS, MEMS-gyro, Time stamp, Rotation experiment