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On long-term drift of pressure sensors used for vertical seafloor crustal movement

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Owing to the GPS networks that have revolutionized land geodesy, importance of geodesy has been well recognized. GPS is not accessible on the seafloor, where the GPS-Acoustic seafloor positioning plays an important role in the observation of horizontal crustal movements. However, the observation has not been reliable in the observation of vertical crustal movements, because the observation points are always in one side in the vertical positioning. That is way bottom pressure observation has been utilized as the most probable way to observe vertical crustal movements on the seafloor. Long-term and continuous pressure observation is not so difficult on the deep seafloor by using high precision and low-powered quartz pressure sensors. The system is basically suitable for real-time observation as a part of a cabled observatory.

We have carried out ocean bottom pressure observation in the offshore of Northeastern Japan by using pressure sensors manufactured by the Paroscientific Inc. The maximum depth rate of the sensors is 7000 m, and the resolution of the measured pressure is about 1 mm in water column. The ocean bottom pressure recorder is similar to the ocean bottom seismometers developed in the Earthquake Research Institute, University of Tokyo; it is dropped from a ship to be deployed on the seafloor, and is recovered with an acoustic command to release the weight. The sequence of observation is somewhat tricky to save the power for one-year observation; the sampling interval is one minute, in which DC power is supplied for 10 s for a measurement, and is off for the following 50 s. We have started pressure observation off Miyagi Prefecture in 2008 with higher sampling interval than 1Hz. Because the pressure sensors are the same with the previous observations, we briefly report here some results of previous observations.

Most of the signals in the variations of ocean bottom pressure are associated with ocean dynamics. The largest signals are those of ocean tides, and are easily decomposed ?? owing to the fixed period of each tidal component. The pressure variations observed off the Sanriku Coast agreed within 1.3 cm of water column to the sum of 8 principal tidal components synthesized from each of several global ocean tide models [1]. This result indicates that the tricky pressure observation mentioned above, as well as the global ocean tide models, is accurate to about 1cm of water column. None-tidal components of ocean dynamics is an important problem, and will be discussed in the future.

Another important problem is long-term stability of the measured pressure. We previously examined the observed data in 1990s with several pressure sensors, and found that each sensor had its own long-term drift, and that the value of the drift was almost constant around a value of about 1cm/month [2]. We have examined the data observed in these several years to confirm that most of the sensors show linear long-term drifts around 1cm/month. We have also found that two sensors show exponential drifts and that the drift of one sensor is larger than 1 m per year. The quality control of the manufacturer may have been degraded, and we have to check the pressure sensors not to use such bad sensors on the seafloor.

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References: [1] Matsumoto et al., GRL, 33, L16602, 2006. [2] Fujimoto et al., GRL, 30, 1456, 2003.