Feasibility study on long-term monitoring of seafloor deformation with ocean bottom pressure recorders of pop-up type

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Precise pressure observation at the seafloor is an effective mean to detect vertical crustal deformation in offshore areas. A small sensor of high precision and low power consumption enables to build an ocean bottom observation system to make continuous observations for one to two years. The ocean bottom pressure observation networks deployed to monitor tsunami are expected to allow monitor vertical deformation of the seafloor in the seismogenic regions. Several studies have demonstrated that the bottom pressure data can detect transient signals associated with activities of submarine faults or volcanos. Time constants of the detected events were mostly shorter than a month but it would be difficult to detect tectonic events of much slower deformation rates by the seafloor pressure motoring. Since many plate boundary zones on the earth are located beneath oceans, observations of longterm deformation at the seafloor are invaluable to understand dynamics of plate interaction, formation and development. The most significant reason of the difficulties in detecting slow crustal deformations by the pressure observation is lack of the knowledges about longterm fluctuations appearing in the pressure records obtained at the seafloor. In this paper, we discuss about characteristics of ocean bottom pressure records in long, more than a couple of months, period based on the actual data obtained by the repeating deployment of free-fall/pop-up type bottom pressure recording systems in the Japan Trench area for about 10 years and also by recent laboratory experiments. Most of the obtained pressure time series show evident longterm temporal variations irrelevant to the actual motion of the seafloor but could be attributed to the instrumental instabilities. The pattern of the temporal variation on the record seems similar to one another when we compare the records obtained by the identical pressure sensor, suggesting that the observed pressure records contain a characteristic response specific to the sensor. Previous laboratory experiments on the response of pressure sensors of the same kind showed a transient behavior after applying high pressure has several similarity to those we see on the seafloor observation records. This suggest that the sensor specific characteristics can be known through laboratory tests and can be removed from the records of the seafloor monitoring to extract pressure changes associated with actual seafloor motions. Motivated by this idea, we are carrying out a long-term laboratory experiment in which the pressure sensor previously used in the field observations are exposed to well-controlled high pressure to know longterm behavior of the sensor under the pressure equivalent to the deep sea. We are making another experiment to know longterm stability of a clock install in our pressure recorders. Since the clock supplies a time base to measure oscillation frequency of the pressure sensor, its stability can also account for longterm drift in the pressure data obtained by the instruments.

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