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Compact long-term ocean bottom seismometer equipped with small broadband seismic sensor

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It is important to understand coupling between plates in a subduction zone for studies of earthquake generation. Recently low frequency tremor and very low frequency earthquake (VLFE) were discovered in plate boundary near a trench. These events (slow earthquakes) in shallow plate boundary should be related to slow slip on a plate boundary. A Broad Band Ocean Bottom Seismometer (BBOBS) is useful for observation of slow earthquakes, however a number of BBOBSs are limited due to cost. On the other hand, plenty of Long-term OBSs (LT-OBSs) with recording period of one year are available. However, the LT-OBS has seismometer with a natural period of 1 second. Therefore frequency band of observation is slightly narrow for slow earthquakes. Therefore we developed a compact long-term broad-band OBS by replacement of the seismic sensor of the LT-OBSs to broadband seismometer.

We adopted seismic sensor with natural period of 20 seconds (Trillium Compact Broadband Seismometer, Nanometrics). Because tilt of OBS on seafloor can not be controlled due to free-fall, levelling system for seismic sensor is necessary. The broadband seismic senor has cylinder shape with diameter of 90 mm and height of 100 mm, and the developed levelling system can mount the seismic sensor with no modification of shape. The levelling system has diameter of 160 mm and height of 110 mm, which is the same size as existing levelling system of the LT-OBS. The levelling system has two horizontal axes and each axis is driven by motor. Levelling can be performed up to 20 degrees by using micro-processor (Arduino). Resolution of levelling is less than one degree. The levelling system immediately starts by the power-on of controller. After levelling, the the seismic senor is powered and the controller records angles of levelling to SD-RAM. Then the controller is shut down to consume no power.

We made a field evaluation of the developed Compact Broad Band Ocean Bottom Seismometer (C-BBOBS) in Hyuga-nada where slow earthquakes often occur. The first C-BBOBS was deployed in February and recovered in July 2017. We have obtained records from the deployment to the recovery continuously and many local and teleseismic events were recorded. Ambient seismic noises were calculated, and it is found that intrinsic noise levels of the sensor seem to be lower than ambient seismic noise on seafloor at observation band (period shorter than about 10 s).

C-BBOBS is useful for observation of slow earthquakes on seafloor. In addition, seafloor observations of teleseismic events and deep earthquakes to estimate seismic structure of deep regions and observations of submarine volcanoes are expected.