Development of the autonomous BBOBS-NX (NX-2G) : preliminary test report

*Hajime Shiobara[1], Aki Ito[2], Hiroko Sugioka[3], Masanao Shinohara[1]

1. Earthquake Research Institute, University of Tokyo, 2. D-EARTH, Japan Agency for Marine-Earth Science and Technology, 3. Graduate School of Science, Kobe University

We have developed the broadband ocean bottom seismometer (BBOBS) and its new generation system (BBOBS-NX), and, with them, several practical observations have been performed to create and establish a new category of the ocean floor broadband seismology, since 1999. Now, our BBOBS and BBOBS-NX data is proved to be at acceptable level for broadband seismic analyses. Especially, the BBOBS-NX is able to obtain the low noise horizontal data comparable to the land station in periods longer than 10 s, which is adequate for modern analyses of the mantle structure. Moreover, the BBOBS(T)-NX is under practical evaluation for the mobile tilt observation at the seafloor, which will enable dense geodetic monitoring by its mobility and low cost.
The BBOBS-NX system is a powerful tool for ocean bottom seismic studies, although, the current system has intrinsic limitation in opportunity of observations due to the necessary use of the submersible vehicle for the deployment and recovery. If we can use this system at almost any kind of vessels, like as the BBOBS (self pop-up system), it should lead us a true breakthrough of ocean bottom observations in geodynamics. Hereafter, we call the new autonomous BBOBS-NX as NX-2G in short. There are two main problems to be cleared to realize the NX-2G system. The first one is a tilt of the sensor unit on landing, which is larger than the acceptable limit of the sensor (±8°) in about 50% after our 16 free-fall landings of the BBOBS-NX. As we had no evidence at which moment the tilt occurred, we tried to observe it during the BBOBS-NX landing in 2015 by attaching a video camera and an acceleration logger. This result shows that the tilt on landing would be determined by the final posture of the BBOBS-NX system just before the penetration into the sediment. The second problem is a required force to extract the sensor unit from the sticky sediment, which was about 80 kgf in maximum from several in-situ measurements. This value is not so large to realize the self pop-up recovery system. The function of the NX-2G system is based on 3 stage operations like as the current BBOBS-NX system as shown in the figure. The core mechanism to perform these operations has been developed for the ultra-deep OBS system in 2012, already. It was also examined that we can place any object close to the sensor unit as far as they were mechanically decoupled, in the sense of the seismic band noise induced by the bottom current in 2012, too. Additional glass floats are aimed not only for obtaining large buoyancy to extract of the sensor unit, but also for suppressing the rotation (oscillating tilt) of the main part of the NX-2G system in descending.
In Oct. 2016, we made the first in-situ test of the NX-2G system near the observation node (YOB3) of the new off Kamaishi ocean floor cable system by using a ROV, where the water depth is 1570 m. Same as the deployment of the BBOBS-NX in 2015, the video camera and the acceleration logger were equipped with the NX-2G system, and then, it was dropped from the sea surface. The ROV was used to watch the operation of the NX-2G system at the seafloor. The landing looked well with small tilt, and it was examined from the acceleration data in descending. The maximum tilts measured this time was about ± 2.5°, whereas that of the BBOBS-NX in 2015 was more than ±12°. So that, the additional glass float effectively worked to suppress the rotation of the main part of this system, which is almost same design as the BBOBS-NX. The extraction of the sensor unit, which had been penetrated well, was also succeeded with the total buoyancy of about 75 kgf, although it took more than 2 minutes to finish the extraction completely. As the final experiment, we will start one-year-long observation of this NX-2G system in this April, with the BBOBS-NX and the BBOBS, to obtain simultaneous data for comparison of the noise level.

Keywords: ocean bottom seismometer, broadband seismology, instrument development