The First Data of the Autonomous BBOBS-NX (NX-2G) for New Era of Ocean Bottom Broadband Seismology

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Abstract

The ocean floor broadband seismology has been established based on several practical observations by using broadband ocean bottom seismometer (BBOBS) and its new generation system (BBOBS-NX) in Japan since 1999. The data obtained by our BBOBS and BBOBS-NX is adequate for broadband seismic analyses, especially the BBOBS-NX enables the quality of the horizontal data comparable to land sites in longer periods (10 s –). And, the BBOBS-NX with tilt measurement function, BBOBST-NX, is in practical evaluation for the mobile tilt observation that may realize a dense seafloor geodetic monitoring with low cost. The weak point of the BBOBS-NX system lies in the intrinsic limitation of the submersible in its operation. If this system can be operated alone like as the BBOBS, it should be a true breakthrough of ocean bottom seismology. We call this new autonomous BBOBS-NX as the NX-2G in short. Several problems to realize the NX-2G have been almost cleared through test observations since 2012. The function of the NX-2G system is based on 3 stage operations as shown in the image. The glass float is added to obtain enough buoyancy to extract the sensor unit from the seafloor and also to suppress the oscillating tilt of the system in descending, not to exceed the tilt allowance of the broadband seismic sensor. In Oct. 2016, the first in-situ test of the NX-2G system was performed. The landing of the NX-2G looked well and the maximum tilt in descending was about ±2.5°, that ensured the effective suppression for the oscillating tilt by the glass float. As the final step test of the NX-2G, the one-year-long observation has been started in April 2017 with the BBOBS deployed nearby, to obtain simultaneous data for the noise level evaluation. The free-fall deployment and the transition from the landing stage to the observation stage were completed, those were monitored through the acoustic communication from the ship. This NX-2G was recovered in Oct. 2018 with the ROV, KAIKO Mk-IV, to watch the transition from the observation stage to the recovery stage at the seafloor. All function of the NX-2G at the seafloor was perfect with immediate extraction of the sensor unit. Noise level comparison with the BBOBS shows about 10 dB improvement that is not enough as expected, which may lie in a small tension of the cable between the sensor unit and the recording unit. And, scenes of the landing and the first transition were selfied by the Deep-Sea CAM.
The ocean floor has never been studied as thoroughly as the seabed surface. The ocean floor is home to a vast array of life, from the smallest plankton to the largest whales. Understanding the ocean floor is crucial for a variety of reasons, including environmental conservation, resource exploration, and climate research. However, studying the ocean floor is challenging due to its depth and the harsh environmental conditions. To overcome these challenges, researchers have developed various technologies and methodologies to explore the ocean floor.

One of the most significant contributions to ocean floor exploration is the development of the BBOBS-NX system. The BBOBS-NX system is a seafloor observation system that can monitor various environmental factors, such as water temperature, pressure, and seismic activity. It consists of a sensor unit and a recorder unit, connected by an underwater cable. The sensor unit is usually deployed on the seafloor, while the recorder unit is located on a ship or a submersible vehicle.

The BBOBS-NX system has been used in various oceanic projects, such as the Stagnant Slab Project and the TIARES project. These projects have provided valuable data on the ocean floor and have contributed to our understanding of the ocean's behavior and processes. The BBOBS-NX system has also been used in developmental tests, such as the NX-2G system, which was developed to improve the system's performance and reliability.

The NX-2G system was deployed in 2009 and 2010 in the NOMan project, which aimed to deploy 8 units of the NX-2G system in the Pacific Ocean. The NX-2G system had a new feature that allowed it to monitor the tilt of the sensor unit, which was important for understanding the ocean's behavior and processes. The NX-2G system also had a new design that allowed it to be deployed and recovered by a ROV (remotely operated vehicle).

In addition to its technical capabilities, the BBOBS-NX system has also been used to study the effects of various environmental factors on the ocean floor. For example, the BBOBS-NX system was used to study the effect of ocean currents on the ocean floor. The system was deployed in areas with strong ocean currents, and the data collected provided valuable insights into the behavior of these currents.

Overall, the BBOBS-NX system has been a valuable tool for ocean floor exploration, and its use continues to expand our knowledge of the ocean's behavior and processes. The system's capabilities and reliability will continue to improve, and we can expect to see even more exciting discoveries in the future.