Seismic imaging using ocean bottom nodes in the Ishikari Basin, Japan Sea

*Tetsuo No[1], Takeshi Sato[1], Shuichi Kodaira[1], Satoshi Shimizu[2], Tetsuya Yokota[2], Karl Hosgood[3], Masako Robb[3], Tetsuro Tsuru[4]

1. JAMSTEC, 2. Nippon Marine Enterprises, 3. Emerson E&P Software, 4. Tokyo University of Marine Science and Technology

In the Japan Sea, damaging earthquakes caused by faults distributed in land–marine transition zones and coastal areas (such as the 2007 Niigata-ken Chuetsu-oki Earthquake and the 1964 Niigata earthquake) have occurred in the past (e.g. Usami et al., 2013). Moreover, according to recent reports, source faults which may cause large earthquakes became apparent in many coastal areas of the Japan Sea (e.g. Committee for Technical Investigation on Large-scale Earthquake in Sea of Japan, 2014). Therefore, data acquisition regarding crustal structures in land–marine transition zones and coastal areas is an important task for increasing the accuracy of the source fault model in the Japan Sea. In previous studies, seismic surveys using ocean bottom cables and two-ship seismic surveys have effectively obtained deep structure imaging in land–marine transition zones and coastal areas of the Japan Sea (e.g. Abe et al., 2010; Sato, 2013). However, owing to budget constraints, such methods and systems may not always be feasible. Therefore, to facilitate future seismic exploration in coastal areas, we attempted a seismic survey using ocean bottom nodes (OBNs), an approach that employs easy-to-handle equipment.

For our seismic survey, we used the JAMSTEC R/V *KAIMEI* to study crustal structures off of the northwestern coast of Hokkaido, Japan (Sato et al., 2018). The OBN system was constructed by Nippon Marine Enterprises, Ltd, comprising 10 nodes at approximately 100-m intervals in the Ishikari Basin. The OBN system was installed at a water depth of 800 m. Each node had a natural frequency of 15 Hz and recorded data for three component omnidirectional geophones and one hydrophone component (Shimizu et al., 2012). The data acquisition specifications were as follows: shot spacing was 25 m; tuned air gun array had a maximum capacity of 2,650 cu in (approximately 43.5 L) and comprised 11 air guns; standard air pressure was approximately 2,000 psi (approximately 14 MPa); and the air gun array was kept 6 m below sea surface throughout the experiment. In this survey line, a normal multi-channel seismic reflection (MCS) survey and a seismic refraction survey using ocean bottom seismographs were also separately performed.

Our data analysis used a method based on mirror imaging. Wave field separation using geophone and hydrophone polarity characteristics and multiple reflection waves was performed together with prestack migration (Dash et al., 2009). Normal reflection imaging was performed using the upgoing wavefield, which reflected on the reflector once. However, mirror imaging was performed using the downgoing wavefield. Using this approach, the imaging range could be extended to several times that of the developed OBN system. Based on a preliminary analysis of the OBN data, we obtained imaging of the sedimentary layer and the basement below the seafloor; the obtained results are consistent with those of the normal MCS profile.

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