

Crustal structure in the margin of the northern Japan Sea back-arc basin off NW Hokkaido deduced from the seismic survey

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The Japan Sea is a back-arc basin in the northwestern Pacific. From geophysical, geological, and petrological data, the back-arc opening of the Japan Sea was initiated by crustal rifting in the Asian continental margin in the Early Oligocene, with subsequent ocean floor spreading (e.g., Tamaki et al., 1992; Kano et al., 2007). After 3.5 Ma, in the eastern and southwestern margin of the sea, the crustal shortening occurred by a strong compression (e.g., Sato, 1994, Itoh et al., 1997). Along the eastern margin, fault-fold belts developed as a result of deformation caused by extension associated with the opening of the Japan Sea and by the later compression (e.g., Okamura et al., 1995; Sato, 1994). Moreover, results of seismic surveys from the Japan Basin to the eastern margin of this sea indicated that structures related back-arc opening might play a role in the location of large earthquakes and the distribution of the deformation zone including active faults and folds along the margin of the Japan Sea (e.g., No et al., 2014). This result demonstrates that the elucidation of the back-arc opening process is important for understanding not only back-arc extension along the Asian continental margin, but also the mechanism of large earthquakes and the distribution of subsequent deformation in the Japan Sea back-arc basin. Even though the margin of the northern Japan Sea off Hokkaido is the region of deformation zone including active faults and folds and includes the source area of the 1940 Shakotan-Hanto-oki earthquake (M 7.5), we have little information of the detailed opening and deformation processes. This might be due to the lack of detailed crustal structure obtained by sufficiently dense OBS spacing in seismic surveys.

To obtain the crustal structure, we conducted the active-source seismic survey using ocean bottom seismographs (OBSs) and multi-channel streamer (MCS) in the margin of the northern Japan Sea ranging from the Japan Basin to the coastal area off the northwestern Hokkaido and in the Ishikari Bay in 2017. The seismic survey has 2 lines; one was conducted from the Japan Basin, the Okushiri Ridge, the Kamui Trough to the Ishikari Basin off Rumoi in the northwestern Hokkaido using 39 OBSs, 1 OBN set, and an air-gun array system (max., 10,000 cu. inch) and MCS system, and the other was conducted from the Ishikari Basin to Ishikari Bay using 19 OBSs and an air-gun array system (max., 5,300 cu. inch).

In record sections of several OBSs, not only the first arrived phases but also later phases reflected from interfaces in the crust and uppermost mantle are visible. Also, the MCS profile clearly images the sedimentary layer and the undulations of the basement. The crustal structure in the Japan Basin is similar to the typical oceanic crust (e.g., White et al., 1992). From the basin, the Okushiri Ridge, Kamui Trough to Ishikari Basin, the crustal thickness and the P-wave velocity distribution have a variation. Particularly, these variations are large between the Okushiri Ridge and Kamui Trough. On the other hand, from the Kamui Trough to the coastal area and in the Ishikari Basin, the upper crust has a P-wave velocity of 5.4-6.2 km/s corresponding to the continental upper crust.

Keywords: Crustal structure, Japan Sea, arc-back-arc basin