Heat flow measurement on the seaward side of the Kuril Trench off Hokkaido

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To understand thermal structure of subduction zone, heat flow on the surface of incoming oceanic plate serves as an important boundary condition. On the surface of oceanic plate, observed value of heat flow is generally consistent with prediction of the plate cooling model (e.g., Stein and Stein, 1992). Yamano et al. (2014) revealed extensive high heat flow anomaly on the seaward side of the Japan Trench, where the very old Pacific plate (~135 Myr) subducts beneath northeast Japan, and some possible causes of the anomaly have been examined. Fujie et al. (2013, 2015) pointed out seismic velocity structure anomalies in the crust and the uppermost mantle seaward of the Japan and Kuril trenches and attributed them to increase in water content as a result of bending of the incoming oceanic plate. Kawada et al. (2014) examined influence of hydrothermal circulation in a permeable layer in the oceanic crust as a possible source of the high heat flow anomaly. They showed that hydrothermal circulation in the permeable layer thickening toward the trench axis in concordance with the seismic velocity anomaly pumps up heat efficiently and raises heat flow on the seafloor.

Infiltration of water into the crust is inferred seaward of the Kuril Trench as well based on the seismic velocity anomaly. Nakanishi (2011) argued that the direction of bending-related faults on the oceanward slope of the Kuril and Japan trenches is well correlated with the angle between the trench axis and the ancient spreading ridge axis, which varies along the trenches. It is also speculated that the trench-ridge angle is a major controlling factor of incoming plate hydration (Fujie et al., 2018). These studies suggest that it is indispensable to examine heat flow distribution seaward of the Kuril Trench, where few data have been obtained, for investigation of water and heat transport processes associated with plate bending.

In this study, we conducted heat flow measurement on the seaward of the Kuril trench off Hokkaido on KH-18-5 cruise of R/V Hakuho-maru. We measured geothermal gradient with a 3 m long temperature probe at eight sites and with a piston corer at four sites within about 120 km of the trench axis. We attempted penetration of the temperature probe several times at each site at intervals of 300 to 500 m. Few penetrations were successful within 60 km of the trench axis probably because thick layers of volcanic ash prevented the probe from penetrating into the sediment. Thermal conductivity was measured on piston core samples.

Most of the obtained 25 new heat flow values are roughly consistent with typical values for ocean basins older than 100 Myr (~50 mW/m^2), while high heat flow, 90 to 100 mW/m^2, was observed at one station about 70 km from the trench axis. This result indicates that the degree of heat flow anomaly on the seaward side of the Kuril Trench is lower than that in the counterpart of the Japan Trench.

Keywords: heat flow, Kuril Trench, oceanic crust, hydrothermal circulation, Japan Trench, Pacific plate

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