

High heat flow anomaly seaward of the Japan Trench associated with deformation of the subducting Pacific plate

Makoto Yamano^{1*}, Yoshifumi Kawada¹, Hideki Hamamoto², Shusaku Goto³

¹Earthq. Res. Inst., Univ. Tokyo, ²Center Environ. Sci. Saitama, ³Geol. Surv. Japan, AIST

The Pacific plate subducting along the Japan Trench is very old, over 130 m.y., and thus supposed to be cold. Heat flow values measured on the seaward slope of the Japan Trench along a parallel of 38°45'N were, however, significantly higher than that expected from the seafloor age (Yamano et al., 2008). It indicates that the temperature structure of the incoming Pacific plate may be anomalous, which has an influence on the temperature distribution along the subduction plate interface. Aiming to investigate the extent and cause of the high heat flow anomaly, we conducted heat flow measurements along three E-W lines across the Japan Trench at latitudes of about 38 to 40°N. We obtained 136 new heat flow data mainly on the trench seaward slope and outer rise.

Combined with the existing data, our new results revealed the following features of heat flow distribution on the seaward side of the Japan Trench.

1) Heat flow distributions along the three lines are similar to each other. Heat flow is variable and anomalously high, higher than 70 mW/m², at many stations, while values normal for the seafloor age (about 50 mW/m²) are observed at some stations. No anomalously low values were obtained. It suggests high heat flow anomaly seaward of the trench is not a local phenomenon but extends at least over the northern half of the trench.

2) Significantly high heat flow (over 70 mW/m²) was observed within 150 km of the trench axis, though we need more data to examine if there is a distinct boundary. The limited extent indicates that the anomaly is closely related to deformation of the Pacific plate associated with subduction.

3) Closely-spaced measurements on the trench outer rise at around 40°15'N and 145°40'E revealed that rather uniform high heat flow spreads over 2 km in the N-S direction, parallel to the trench. In the E-N direction, a steep variation (50 % decrease in 2 km) was observed in the same area.

These results confirmed the existence of thermal anomaly in the uppermost part of the subducting Pacific plate and provide important information on the temperature distribution along the plate interface, including the rupture area of the 2011 Tohoku-Oki earthquake. High average heat flow within 150 km of the trench axis probably results from pore fluid circulation in the upper part of the oceanic crust, which has been highly fractured by deformation of the Pacific plate. Plausible heat transfer mechanism by pore fluid circulation is discussed in another paper in this session (Kawada et al.). Magma intrusion due to petit-spot volcanism in the last several million years cannot be a major source of the observed extensive heat flow anomaly because petit-spot volcanoes are rather sparsely distributed and the amount of melt produced in the mantle is also thought to be small. Local, kilometer-scale variations in the observed heat flow may be attributed to localized fluid flow along faults or high permeability zones developed in the surface part of the Pacific plate.

Keywords: heat flow, Japan Trench, Pacific plate, thermal structure, subduction zone, pore fluid circulation