High heat flow anomaly observed on the seaward slope of the Japan Trench

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The relationship between heat flow and seafloor age for oceanic lithosphere has been well studied since the 1970s. Reliable heat flow values measured in old ocean basin areas with ages over 100 m.y. are almost constant, about 50 mW/m^2. On the Pacific plate seaward of the Japan and Kuril trenches, where the seafloor age is 120 to 140 m.y., however, relatively high heat flow values, up to 80 mW/m^2, had been reported at several stations. To investigate the origin of such high heat flow, we carried out detailed measurements on the seaward slope of the Japan Trench along parallels of 38deg45min N and 40deg15min N, which confirmed the existence of high heat flow in this area.

33 new heat flow data at 12 stations were obtained along 38deg45min N, where the seafloor age is about 135 m.y. The most conspicuous heat flow anomaly was detected on a small mound located on the trench outer swell, about 130 km seaward of the trench axis. Heat flow is very high, 114 mW/m^2, on the mound and lower on the foot of the mound, about 70 mW/m^2, still higher than the value expected for the seafloor age. On the upper part of the seaward trench slope, between 40 km and 100 km from the trench axis, the heat flow distribution is complicated: heat flow is normal (around 50 mW/m^2) at some stations, while it is high (70 to 90 mW/m^2) at others. Most recent measurements were made at three stations on the seaward trench slope along 40deg15min N in October 2007. Heat flow observed at two of the stations range from about 70 to 85 mW/m^2, indicating that an anomalous heat flow zone might extend along the Japan Trench.

The heat flow anomalies were observed over the area where the Pacific plate is being bent associated with subduction. It suggests that they may be related to deformation of the uppermost part of the plate, e.g. development of normal faults and horst/graben structures. Fluid flow along normal faults may enhance vertical heat transfer and cause the spatial variation of surface heat flow, though no clear correlation between the heat flow distribution and the seafloor topography has not been found. The high average heat flow requires the existence of some heat source at relatively shallow depths. The heat source may be provided by the intra-plate (’petit spot’) volcanism, which has been active in the Pacific plate seaward of the Japan Trench in the last several million years. It is important to evaluate effects of the volcanism and fluid flows on the thermal structure of the topmost part of the Pacific plate, which has a direct influence on the temperature distribution of the subducting plate interface.