Closely-spaced heat flow measurements around a 'petit-spot' volcano

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Recent heat flow measurements on the seaward slope and outer rise of the Japan Trench revealed the existence of high heat flow (70 to 120 mW/m^2). The values are anomalous high for the age of the Pacific plate in this area, considering that reliable heat flow values obtained in old ocean basins with ages over 100 m.y. are about 50 mW/m^2. It indicates that the thermal structure of the topmost part of the plate is anomalous in this area. A possible cause of this anomaly is the thermal effect of intra-plate volcanism called 'petit spot', which produced young volcanic rocks sampled on the seaward slope of the Japan Trench and on the Pacific plate 600km away from the trench (Hirano et al., 2006).

We made heat flow measurements in the area surrounding the sites where the young volcanic rocks were sampled on three research cruises (KR04-08, KR05-10, KR07-06), aiming to investigate the extent of thermal effect of the petit spot. The measured heat flow values range from 50 to 70 mW/m^2 at most stations, comparable to or slightly higher than the typical value for ocean basins older than 100 m.y. In contrast, an extremely low value, 20 mW/m^2, was measured in the vicinity of the Yukawa Knoll, which was formed by the petit-spot volcanism.

To investigate the anomalous low heat flow in detail, we conducted closely-spaced heat flow measurements around the Yukawa knoll on YK08-09 cruise in July and August, 2008. The measurements were made along two lines where subsurface structure had been investigated by seismic reflection survey. Heat flow is 20 to 30 mW/m^2 within about 1 km of the center of the Yukawa knoll, while it is around 50 mW/m^2 beyond about 2 km from the knoll. This local low heat flow anomaly can be interpreted as a result of advective heat transfer by pore fluid flow in the basement. The obtained heat flow data are, however, not enough for discussing the regime and the driving force of the fluid flow. More detailed measurements around the Yukawa Knoll and other knolls and numerical simulation of pore fluid flow will allow us to infer the flow pattern and to evaluate the effect of the petit-spot volcanism on the thermal structure of the upper part of the Pacific plate.