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Terrestrial heat flow and thermal structure in Hokkaido area of North Japan

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Introduction

In the Hokkaido district of North Japan, there is a very complicated crustal structure such as Hidaka collision zone, which is the major collision boundary. Furthermore the Pacific (PAC) plate subducts westward from the Japan trench and Kuril trench. In this subduction area, M8-class inter-plate earthquakes occur repeatedly. Research on thermal structure and plate structure would help to clarify the seismotectonics of the Hokkaido district and to assessing earthquake hazard and seismic risk.

Heat Flow Data

We measured thermal gradients and heat flow all over Japanese Islands by using the National Research Institute for Earth Science and Disaster Prevention's (NIED) high-sensitivity seismograph network (Hi-net) boreholes. NIED Hi-net is composed of about 800 borehole stations installed almost homogeneously over the Japanese Islands with an average spacing of 20km. Because these Hi-net boreholes are designed for a long-term observation, these are structurally stable with using casing pipe. Although majority of the Hi-net stations have the boreholes of 100-200m in depth, deep observation wells were made at some specific sites if necessary. In Hokkaido District, we constructed 112 boreholes, the deepest borehole station is N.MRRH at the depth of 535m. Comprehensive heat flow distribution in Hokkaido district is as follows: extremely low heat flow under 40mW/m2 in Hidaka region, the central axis zone of Hokkaido shows low heat flow, high heat flow is observed in the backarc side of the volcanic front.

Estimation of Thermal Structure

We researched a thermal structure of the lithosphere in Hokkaido District based on NIED Hi-net deep borehole heat flow data. In this analysis, we used one-dimensional heat conduction model on steady state. Geological and crustal model for thermal structure estimation as follows;
Layer 1: sediment (0km ? 4km)
Layer 2: Pre-Neogene Layer (metamorphic rock, etc., - 10km)
Layer 3: Grants (10km ? 30km)
We adopted a typical thermal conductivity on various rock respectively, with a temperature dependency. In this study, we considered an exponential model of radioactive heat production in lithosphere.

Conclusion

We estimated thermal structure by using one-dimensional heat conduction equation, with the variables based on published or measured values for our heat flow data, heat generation, and thermal conductivity. Estimated thermal structure in this study is as follows: Low temperature region under 150 degrees Celsius at 30 km depth is along Hidaka collision zone, high temperature region is estimated in the backarc side of the volcanic front.

Keywords: heat flow, thermal structure, Hi-net, Hokkaido