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Terrestrial heat flow and thermal structure in Southwest Japan

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Introduction

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 South West Japan Area, we constructed about 200 boreholes, the deepest borehole station is N.KNHH at the depth of 2000m.

Estimation Method for thermal structure

We researched a thermal structure of the lithosphere in the South West Japan area based on NIED Hi-net 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 as follows,

$A(z) = A(0)\exp(-z/D)$: $D = 25$km, $A(0) = 3.0 \times 10^{-6}$

A(z) is vertical distribution of heat production, where z = 0 represents the present surface and A(0) is the measured heat generation.

Summary

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: The evaluated temperature of seismogenic zone in the upper crust range between 200 degree and 400 degree.
Geographical distributions of terrestrial heat flow show that high heat flow stations are observed along the region where non-volcanic long-period tremors occur about 30km deep.Mantle helium has been observed in Shikoku area (Notsu et al., 2006) and the Kii Peninsula region (Matsumoto et al.,2003). In SW Japan, the slab-derived fluids, which cause fracturing within the crust, result in easier transfer of fluids, mixed with mantle helium, to the surface (Notsu et al., 2006). This movement of the slab-derived fluids also transports the heat of mantle wedge, which cause the terrestrial high heat flow anomaly.

Keywords: heat flow, thermal structure, Hi-net