

## Brief review of on-land heat flow data in Japan: Reconstruction of ground surface temperature history from borehole temperature profiles

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Terrestrial heat flow (or simply termed 'heat flow') is the amount of conductive heat loss through the earth's surface per unit time and per unit area, which is determined as the product of the vertical temperature gradient near the surface and the thermal conductivity of the formations. It is the most fundamental geophysical data for estimation of subsurface temperature structure. Heat flow measurements in and around Japan were started around 1960 and have been conducted to give key information for investigation of thermal structure and tectonics of subduction zones. The obtained heat flow distribution across the Japanese island arcs has significantly different features between NE Japan and SW Japan, mainly attributable to the difference in age of the subducting oceanic plate. We have been compiling heat flow data in the northwest Pacific area (0 to 60 °N, 120 to 160 °E), which includes the whole Philippine Sea, Japan Sea, and Sea of Okhotsk. The most recent version of the data set (Hamamoto and Yamano, 2019) contains 3670 data.

It should be noted that heat flow data on land in Japan had been rather sparse and not evenly distributed, for temperature gradient needs to be measured in relatively deep boreholes to avoid near-surface disturbances and there were not many holes suitable for measurement. This situation has been improved by temperature profile data obtained in observation wells for the Hi-net (High-sensitivity Seismograph Network), which are densely and evenly distributed over the Japanese islands. A flaw in Hi-net temperature data is that most of the wells are shallow, about 100 m deep, and thus subject to influences of groundwater flow and temporal variation in ground surface temperature (GST). Taking account of such disturbances, Matsumoto et al. (2022) derived new heat flow data in NE Japan arc from Hi-net borehole temperature profiles. They carefully removed profiles affected by groundwater flow and applied corrections for GST variation based on an existing model of surface air temperature rise in Japan over the past 100 years due to climate change.

While disturbance in subsurface temperature distribution by downward propagation of GST variation is noise for heat flow measurements, it provides information on the past thermal environment around the surface. Analyzing borehole temperature profiles, we can estimate the long-term trend (century-scale) of GST variation, which is closely related to surface air temperature variation. Studies of the past climate change based on this principle have been extensively conducted since the 1980s mainly in North America and Europe and contributed to investigation of recent global warming. Similar GST history reconstruction analyses were made at various sites in Japan and other east Asian countries as well and produced stimulative results, including the following examples. Goto and Yamano (2010) compared the reconstructed GST histories on northern Awaji Island and in Ulsan (SE Republic of Korea) and discussed possible relationship between GST and nearby sea surface temperature. Hamamoto et al. (2009) found significant differences in recent surface warming among sites in Bangkok and the surrounding area, probably reflecting the heat island effect.

### References:

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