Heat flow measurement in Lake Biwa

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Active venting of water and gas has been observed in the vicinity of a fault on the bottom of Lake Biwa. Heat flow measurement is a useful tool for investigation of such fluid flow. Previous studies reported heat flow values at two stations in Lake Biwa: one is 50 mW/m^2 in a borehole on the bottom of the lake and the other is 44 mW/m^2 in a borehole located at the lakeshore. Taking account of values measured in the surrounding area, heat flow in the Lake Biwa area not disturbed by fluid flow is estimated to be about 50 mW/m^2.

We conducted heat flow measurement at five stations in a deep basin in the northwestern part of Lake Biwa in 2010 using a research vessel “Hakken-gou”, which was operated by Lake Biwa Environmental Research Institute at that time. We used a conventional heat flow probe for measurement on deep seafloor. The length of probe is 1.5 or 3.0 m and seven temperature sensors are mounted along the probe. The maximum water depth of Lake Biwa is about 100 m, and bottom water temperature (BWT) variation with a large amplitude has been observed. Subsurface temperature within a few meters of the lake bottom must be affected by BWT variation. The temperature profiles we measured with the heat flow probe were apparently disturbed by BWT variations. At one station in close vicinity to fluid vents, we obtained an extremely large temperature gradient (approximately 300 mK/m). It means that heat flow at this station is anomalously high, whatever disturbance by BWT variation the temperature profile suffered. The observed high heat flow is attributable to upward fluid flow through sediment, since advective heat transport by fluid flow is very efficient.

However, we cannot measure heat flow precisely with conventional heat flow probes in shallow water areas with significant BWT variations. For obtaining reliable heat flow values, we should conduct long-term temperature monitoring and analyze the data considering influence of BWT variations. Analysis of long-term temperature data may also provide information on fluid flow velocity. We need to conduct reliable and high-density heat flow measurements for investigation of fluid flow related to faults on the bottom of Lake Biwa.

Keywords: Heat flow, Lake Biwa, Bottom water temperature variation

