# Heat budget of hydrothermal ponds and its relation to geothermal flux in a neighboring deep lake: Kuttara Volcano, Hokkaido, Japan

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In order to know the geothermal activity of Kuttara Volcano, Hokkaido, Japan, heat budget of internal hydrothermal ponds is estimated and its geothermal influence on the neighboring deep Lake Kuttara (148 m depth in maximum) is explored. The major hydrothermal area in the geothermal region of Noboribetsu town consists of three hydrothermal ponds, Oh-yunuma (water surface area, $1.61\times10^4$ $m^2$), Okunoyu ($9.0\times10^2$ $m^2$) and Taisho-Jigoku ($2.6\times10^2$ $m^2$), and a small bubbling pond (4.1 $m^2$), where the bubbling of hot water continuously occurs. Heat budget of Oh-yunuma, Okunoyu and the small bubbling pond in 2013 –2015 showed mean geothermal flux at 2.8, 22.0 and 32.0 kW $m^{-2}$, respectively. It was found out that the neighboring Lake Kuttara increases both water temperature, $T$ (℃), and electric conductivity, $EC_{25}$ (mS/m), at 25 ℃ near the bottom at the deepest point (148 m) in thermally stratified periods of 2013 - 2015. The linear relationship between $T$ and $EC_{25}$ suggests that geothermal water leaks to the bottom. The geothermal flux at the bottom was calculated at a range of 0.50 - 9.3 W $m^{-2}$ with mean of 2.9 W $m^{-2}$. With respect to the interannual geothermal-flux variations, a comparison between Okunoyu and Kuttara indicates that Kuttara responses to the geothermal variation of Okunoyu with a time lag of 5 months on average. Supposing a hydrothermal reservoir at ca. 100 m below the lake bottom, the time lag is explained by the Darcy law between the reservoir and lake bottom.

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