

The Ice Box Calorimetry: A handy method for estimation of heat and water discharge rates through a steaming ground

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Thermal activities such as fumaroles and steaming grounds are seen at many volcanoes during non-eruption periods. Precise estimations of these heat discharge phenomena provide us constraints to reveal a mechanism of growth of hydrothermal system, cooling process of intruded magma and degassing in magma reservoir and/or conduit. Energy fluxes from fumaroles are estimated by some methods such as image analysis and an UV spectrometer, and have been discussed quantitatively. On the other hand, the estimation method of steaming grounds has large uncertainties.

We have developed a new technique, Ice Box Calorimetry, for estimation of heat discharge rates through steaming ground. Ice in an aluminum box is a powerful tool for measuring the total heat transfer including conductive, convective and latent heat in vapor, from the ground surface.

To check the applicability of the IBC, we carried out a laboratory experiment using a hotplate on which wet sand of 25 mm depth was put. Applying the IBC, we measured m , t , m_0 and t_0 and calculated Q of 0.6 - 2.6 kW/m² for the surface hotplate temperature of 100 degree Celsius. The experiments show that Q_s estimated by the IBC correspond to heat flows that are calculated from the power consumptions of the hotplate. The convective heat fluxes by vapor are estimated approximately to be 60 % of each total heat fluxes Q . This result is corresponding to careful measurements of steaming ground by the water calorimeter (Hochstein and Bromley, 2005).

Using this method, we can rapidly measure heat discharge rates without any special apparatus. Applying the Ice Box Calorimetry to the Nishiyama steaming ground at Usu volcano, Japan, we obtained the local differences of heat discharge rates. The total heat and water discharge rate from the Nishiyama steaming ground are estimated to be 16 MW and 280 ton/day in September 2006, respectively. They represent just 1% of the rate immediately following the 2000 eruption.