論　説

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噴気地における地表面温度と放熱率の経験的関係
—赤外カメラと氷箱熱流計測による同時観測実験—

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An Empirical Relationship between Ground-surface Temperature and Heat-discharge Rate on Steaming Ground: Field Experiments Using IR Thermometer and Ice Box Calorimetry

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The heat balance model can be used to readily calculate the total heat-discharge rate through steaming ground based on the distribution of surface temperature obtained by an infrared radiation (IR) thermometer. This method is convenient; however, the model involves some critical assumptions and large uncertainties. With the aim of developing a simple method for reliable measurements of the total heat-discharge rate, we carried out field experiments at the geothermal field of Yoshioka hot springs, Aso volcano, Japan. To directly measure the heat-discharge rate at each measurement site, we used Ice Box Calorimetry (IBC), which can be used to measure the combined conductive and convective heat-discharge rate, Q (W/m^2), from the ground surface, based on the time required to melt ice housed within an aluminum box placed on the ground. At the same time, we used an IR thermometer to measure the ground-surface temperature, T (℃), at each site. Our observations revealed the relationship between the heat-discharge rate anomaly ΔQ ($=Q-\overline{Q}_0$) and the temperature anomaly ΔT ($=T-\overline{T}_0$), where $\overline{Q}_0$ and $\overline{T}_0$ were the average ground-surface temperature and the average heat-discharge rate outside the geothermal area, respectively. Although the obtained data show a degree of scatter, the value of ΔQ increases almost linearly with ΔT, consistent with the heat balance model: $\Delta Q = C\Delta T$, where C is the proportional coefficient, which is estimated to be 51±2 (W/m^2/℃) from the least squares method. We consider that this empirical relationship is applicable in obtaining accurate estimates of the total heat-discharge rate from steaming ground. To assess the reliability of the linear relation and determine appropriate values of C, it would be necessary to conduct additional accurate, simultaneous observations of Q and T at sites on many different volcanoes and under various meteorological conditions. Furthermore, we carried out measurements when the ground surface was wet due to rainfall. As a result, we obtained Q_0 of 220 W/m^2, larger than the value obtained with a dry ground surface. This experiment suggests that the presence of rainwater enhances heat convection, including latent heat, near the ground surface.

Key words: steaming ground, Ice Box Calorimetry, IR thermometer, heat-discharge rate, ground surface temperature

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