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Relationship between the coefficient of geothermal flux for the heat balance technique and micrometeorological data

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The coefficient of geothermal flux is essential for the heat balance technique (Sekioka and Yuhara, 1974), which is one of the methods for measurement of heat discharge rate from geothermal fields, and is determined by micrometeorological data of a target area. In order to comprehend the temporal change of the micrometeorological conditions and the coefficient of geothermal flux, we have manufactured an automated continuous micrometeorological measurement system and measured micrometeorological data at the Kyu-Hachiman-Jigoku geothermal unit in the Unzen geothermal area in Nagasaki Prefecture, the Komatsu-Jigoku geothermal unit in Oita Prefecture, Aso Volcano in Kumamoto Prefecture and Hakozaki Campus in Fukuoka Prefecture. As a result, the values of the coefficient of geothermal flux showed turbulent changes in a wide range and in a short time (Fujimitsu et al., 2009).

We conducted the continuous micrometeorological measurements in Aso in 2005 and in Komatsu-Jigoku in 2005 and 2006 with 1-minute, 10-minute and 5-second intervals, respectively. And we obtained 5596, 534 and 4621 sets of the observed micrometeorological data and the coefficient of geothermal flux values calculated by using the observed data, which were applicable for the statistical processing. The correlation coefficients (multiple correlation: R) between the 8 micrometeorological conditions (atmospheric temperatures at 10, 50, 55, 150 cm heights, relative humidity values at 10, 50, 150 cm heights and a wind velocity at 100 cm height) and the values of the coefficient of geothermal flux did not show very strong correlations (the maximum R is 0.45 with the atmospheric temperature at 55 cm height at Komatsu-Jigoku in 2005). The values of R between the 4 parameters (the vapor pressure, the density of the air, the transfer velocity, the reciprocal of the Bowen ratio) calculated by using the observed micrometeorological data and the values of the coefficient of geothermal flux indicated a weak negative correlation with the density of the air and no obvious correlation with the vapor pressure. And although the values of R with the transfer velocity and the reciprocal of the Bowen ratio showed some positive correlations but large variations, the values of R with the product of the transfer velocity and the reciprocal of the Bowen ratio indicated extremely strong positive correlations (R=0.97 to 0.99) in every case. Therefore, we obtained a regression equation for the relation between the coefficient of geothermal flux and the product of the transfer velocity and the reciprocal of the Bowen ratio. It means that we can estimate the value of the coefficient of geothermal flux with simpler process than before.

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Sekioka, M. and Yuhara, K. (1974) Heat flux estimation in geothermal areas based on the heat balance of the ground surface. J. Geophys. Res., Vol. 79, No. 14, 2053-2058.

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