Simultaneous Geophysical Observations at Kuju Volcano, Central Kyshu, Japan

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The authors have been accumulated several geophysical observation data at Kuju volcano, central part in Kyushu Island, Japan since early 80's. Although these data were interpreted independently, the integrated interpretation was difficult because of the difficulties of making simultaneous measurements of different observations. To detect the correlations between the temporal variations of different physical quantities, and to find the physical processes beneath the central part of Kuju volcano, we conducted the simultaneous and continuous geophysical observations such as gravity, spontaneous potentials, ground tilt, and surface temperatures at Kuju volcano.

To interpret the correlations between different data sets quantitatively, we utilized the standard Pearson's analysis and calculated correlation coefficients between different observation data. Also, we utilized so called non-parametric correlation analysis, such as Spearman's order statistical tests, and Kendall's statistical tests. Besides, we have evaluated the confident probabilities of the calculated correlation coefficients. That is, the probability of the occurrence of measured data completely accidentally, under the null hypothesis that the two observations are mutually uncorrelated. If the probability is small enough to reject the null hypothesis, we can conclude that there are some correlations between two observations. If the data are noisy, correlations coefficients may become small. A parametric statistical analysis is non-robust against the noise in the data. A non-parametric statistical test loses some portions of the information contained in the data, and results in smaller correlation coefficients comparing to parametric one. On the other hand, it is more robust against noise. And if the null hypothesis is rejected by non-parametric test, there certainly exits a correlation.

The analysis result of the simultaneous measurement data showed that, the temporal variations of ground tilt at several hundreds of meters apart have strong consistency. The relation between different fumarole temperatures showed a weak, but statistically significant correlations. Specifically, the correlation coefficient between the temperature variations in the fumarolic area and the new crater created after 1995 phreatic eruption was 0.2, but its confident probability was 0. This suggests that the source of the steam at several hundred meters apart is same reservoir. Ground tilt and fumarolic temperature also showed good correlations. These results show the close correlations between the fumarolic activities and the near surface deformations.