Monte Carlo Simulation of Gravity Gradient for Observing Volcanic Activity

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Attempts to detect mass distribution changes, associated with volcanic activity, by measuring gravitational fields have been done since the 1920s in Japan. Measurement was done by using the gravity-variometer, such as the torsion balance on the Sakurajima volcano. In the early 1990s, Absolute Gravimeter (FG 5) of Micro-g LaCoste Company, which is simple to use and lightweight, became popular in field measurements. The absolute gravimeter has a resolution of 10^{-8} m/s^2 level when used at a quite observation station. When observing volcanic activity with an absolute gravimeter, it is possible to estimate the height of the magma head from gravity change. However, the absolute gravimeter is sensitive to environmental disturbances, and the error is thought to mislead the height of magma head by several hundred meters.
The instrument we are developing is a new gravity gradiometer. The gravity gradiometer can measure vertical gravity gradients with a resolution of 10^{-9} $1/s^2$ level at an observation station with seismic vibration. In this gravity gradiometer, two test bodies are thrown upward at different heights in a vacuum tank at the same time, and the difference between the free fall acceleration of the two test bodies is obtained by a Michelson interferometer. Gravity is proportional to $1/r^2$ and the gravity gradient in the vertical direction is proportional to $1/r^3$, where r is the distance between the gravitational source and the instrument. Therefore, the gravity gradiometer has a better sensitivity to nearby gravity sources, and is suitable for observation of the environmental disturbances, such as rainfall and groundwater fluctuation. Simultaneous observation of the absolute gravimeter and gravity gradiometer at the same observation station could allow us to estimate the displacement of the magma head more accurately.
Assuming a simple volcano model, we have calculated the gravity change by Monte Carlo simulation for Mt. Asama and Sakurajima volcanos, and examined the usefulness of the simultaneous observation of the absolute gravimeter and gravity gradiometer. In this presentation, I will report the results of the simulation and discuss the optimum observation station for the absolute gravimeter and gravity gradiometer.

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