

Tracing magma head in the volcano with continuous gravity monitoring (2)

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We observed continuous absolute gravity at Mt. Asama (2,500m above the sea) during the eruption of 2004, and calculated gravity change originating from rise of magma. We found the signs of eruptions; gravity attained its maximum (about 5 microgal) two or three days before eruptions.

Generally, raw gravity data suffer from two principal disturbances: ocean loading and rainfall effect. In order to recover gravity changes by magma movement, these effects need to be removed effectively. We present a new filtering technique to eliminate these disturbances. It enables us to detect minute gravity changes from volcanic origins.

In principle, this filter can be used at any volcano, paving a way to predict volcanic eruptions.

Introduction

Mt. Asama, an andesitic volcano in the central part of Japan, erupted on September 1st, 2004. Earthquake Research Institute had observed continuous absolute gravity to research magma movement in the volcano, for about 3 months at Asama Volcanic Observatory (AVO), 4km from the summit.

As is mentioned in the previous presentation by Okubo et al, we got a rough estimate of gravity changes caused by magma movement. To our regret, however, heavy rainfall in October and November (more than 300mm) disturbed gravity signals (by 10 microgal), which made it difficult to extract gravity variations from volcanic origins.

To overcome these problems, we carried out further corrections and discussed how to recover gravity changes by magma movement.

Methods

Observed gravity values suffered from disturbances of earth tide and ocean loading. To eliminate these effects, we used famous programs, such as GOTIC2. We could eliminate the former with sub-microgal accuracy, but on the latter, periodic residuals still remained (about 2 microgal). Then we filtered out diurnal and semi-diurnal variations from the residual gravity to estimate tide-free gravity change.

We also considered rainfall's effects on data empirically. We calculated gravity response to 1mm rainfall, using records around October 20th, when typhoon No.23 struck Japan. We calculated a response function, consistent with the theoretical value, 0.04 microgal/mm (in the infinite plane). In adopting this function, we could eliminate rainfall effects from gravity data.

Through these processes, we could estimate submicro gravity changes, mostly from volcanic origins.

Results and Conclusion

We found that gravity changes between 0 and 5 microgal, and that the dates of the maximum correspond with 2 or 3 days before eruptions. This is probably because gravity becomes greater as magma comes up in the volcano until its head approaches to the height of the gravimeter. When it rises farther, gravity value becomes smaller. We also inverted gravity changes for the position of magma head by using a simplified line mass model. We found that magma head rose higher than 2,000m when eruptions occur.

Thus we could estimate magma movement by applying proper corrections to "continuous" gravity data.