Uplift and subsidence of the new mountain formed by the 2000 eruption of Mt.Usu

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1 Introduction

The eruption of Mt.Usu is characterized by a migration of active magmatic regions, precursory seismicity that included many felt earthquakes, the formation of shinzan(lava dome or cryptodome) and the following slow subsidence. It is widely known that precursory seismicity indicates the beginning of eruptive activity and the shift from uplift to subsidence indicates the end of eruptive activity. However, the dynamics of these phenomena have yet to be well understood.

We focus on the formation of shinzan and the following slow subsidence. As a first step to understand dynamics of this phenomenon, leveling data have been summarized for the 2000shinzan to investigate spatial and temporal elevation change. By fitting the data to the analytical expression of vertical displacement formulated in the Mogi model, the depth and volume change of the sources were estimated.

2 The feature of elevation change at the shinzan revealed by leveling

The air-born laser scanner survey in April 2000 revealed that the shinzan show semi-ellipsoidal shape extending from northeast to southwest(CERI,2000). The centeral part of the shinzan was monitored by continuous GPS measurement that recorded the shift from uplift to subsidence in early August 2000(Mori,2004).

The leveling route run through the central part of the 2000 shinzan in the direction of north and south. Leveling survey was carried out in March 1993,Nevember 2000,November 2003,December 2004.

Remarkable uplift was recorded within a 1-km distance both to the north and south from the benchmark ID61 90m northwest of NB-crater. The elevation change reached its highest point at the benchmark RTK nearby GPS observation point which is now a viewdeck. However, when elevation change data is checked in detail, another lower peak can be observed.

Comparison of elevation change datasets for the periods 2000-2003 and 2003-2004 with those for 1993-2000 reveals that uplift and subsidence had occurred in virtually the same area. In order to examine the relation between patterns of uplift and subsidence, we calculated the ratio of uplift(subsidence) to maximum uplift(subsidence) in each period and the ratio of the amount of subsidence to that of uplift at each benchmark. Results show that patterns of uplift and subsidence are approximately symmetric, that is, the amount of subsidence is proportional to the amount of uplift.

In order to examine how much the velocity of subsidence changes, the elevation change obtained by the continuous GPS observation was compared with that of benchmarks located nearby. The secular change of subsidence observed by leveling has nearly the same trend as that of GPS observation.

3 Data analysis using the Mogi model

The locations and volume changes of the inflation and deflation sources were estimated using the Mogi model. Results show that the inflation and deflation sources are located within 90-300m of NB-crater and the inflation source is located 300m north away from the deflation source. The depths of the inflation and deflation sources are 500m and 530-820m,respectively. The volume change of the inflation source is about ten percent of that of deflation.

The difference in location between the sources of the inflation and deflation is thought to arise from an assumption of a spherical source in an isotropic, homogeneous elastic medium. Observational limitations such as the lack of a comparable benchmark and single leveling route may also cause differences in the results.

4 Future tasks

More complicated source shapes such as a spheroid and an inhomogeneous medium will be considered in future modeling. Determination of the focal point of subsidence is also planned using networks of GPS observation and dry tilt installed in the previous year.