

Absolute Gravity Variation at Sakurajima Volcano from April 2009 through January 2011 and its Relevance to the Eruptive Activity of Showa Crater

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We describe absolute gravity measurements performed from April 2009 through January 2011, and present technical suggestions for carrying out continuous observations in a volcanic area. The results clearly show significant gravity variations of as large as 30 μgal during the observation period. Hydrological simulations reveal that about half of the gravity change is attributable to groundwater disturbance. After correcting for this disturbance, the observed variations in gravity can be divided into 5 separate phases. Phase I is a period with few eruptions, which extends from April to late June 2009 when an abrupt 10 μgal gravity decrease was observed. During the succeeding phase II, from July 2009 to May 2010, gravity oscillated about a mean value with an amplitude of 5 μgal , while the monthly number of explosions at Showa crater dramatically increased from 50 to about 150. In phase III, which was a transient quiescent period, gravity increased by as much as 10 μgal in a single month. This was followed by phase IV, during which there was a steady gravity decrease until November 2010. During the final phase V, gravity remained almost constant until at least January 2011. These five phases are closely linked to the eruptive activity at Showa crater. In fact, excellent correlations are found among the records of absolute gravity, ejected weight of volcanic ash, ground tilt, and infrasound air shock amplitude. The gravity data are transformed into changes in magma head height using a simplified line mass model.

Key words: absolute gravity, magma head, open conduit, Sakurajima volcano, Showa crater

1. Introduction

Sakurajima volcano woke from a decade-long period of dormancy in 2006. Many Vulcanian eruptions and pyroclastic flows from Showa crater have been recorded (Iguchi *et al.*, 2010). The volcanic activity since 2006, and in particular since 2009, exhibited the following features:

(1) Most of the eruptions occurred at Showa crater with only a few exceptions at Minamidake crater, which had been the major vent for a 50 year period since 1955.

(2) The annual number of explosive eruptions in 2010 marked the highest ever recorded in Sakurajima volcano since 1955. Roughly 500 eruptions in 2009, 900 in 2010, 600 in 2011 as of September 1, 2011, are classified as explosions with distinct infrasound pressure pulses. Previously, only in 1960, 1974, 1983 and 1985 did the number exceed 400 although it never reached 500.

(3) Several parameters characterizing the intensity of volcanic activity since 2008 were smaller by a factor of 3 to 10 than those during the last active period from 1974 to 1985 (Iguchi *et al.*, 2010). For example, the total weight of ejected volcanic ash in 2009 is estimated to be only 3.2 million tons while in the 1980's it was 10 to 30 million tons every year. In addition, the volumetric changes of the inflation/deflation sources for individual explosions since 2008 were only 10^2 to 10^4 m^3 while those in the 1980's were 10^3 to 10^5 m^3 . Furthermore, the overall seismicity since 2008 was lower than that before 2007; it was not unusual to count more than 2,000 earthquakes per month before 2007 whereas this decreased to less than 800 since 2008.

To summarize, although there have been more frequent explosions since 2008, both the degree of seismicity and

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