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Study of magma accumulation and supply processes based on ground deformation at Sakurajima volcano from 1998 to 2005

Kohei Hotta[1*], Takahiro Ohkura[1], Masato Iguchi[2], Keigo Yamamoto[2]

[1]Graduate school of Science, Kyoto Univ., [2]DPRI, Kyoto Univ.

Sakurajima is an active volcano located at the southern edge of Aira caldera. Vertical ground deformation of Sakurajima and Aira caldera during summit eruption activity from 1955 has been mainly detected by precious leveling. The vertical ground deformation has been related to the eruptive activity. The ground has been uplifting since 1946. The uplifting of ground stopped and had showed subsidence since 1974 when number of volcanic eruption began to increase. The subsidence pattern has been modeled with the 2 spherical pressure sources at the center of the Aira caldera (about 10km depth) and at beneath the summit crater (about 5km depth) (e.g. Eto and Nakamura, 1986; Eto, 1989). In contrast, the ground around the Aira caldera turned to uplift since 1993 and eruptive activity decreased except temporal increase in eruptions in 1999. Eruptive activity was shifted to Showa crater in June 2006. In this study, we analyzed GPS data to make clear process of magma accumulation and movement prior to eruptive activity at the summit crater in December 1999 and eruptive activity at Showa crater in June 2006.

GPS data observed by SVO (Sakurajima Volcano Observatory) and GEONET data during 1998-2005 were analyzed. The stations are distributed within about 30 km from Sakurajima. Variable deformation rates are found by the continuous GPS observation. In the periods of small deformation rate from January to December 1998 (phase A) and from September 1999 to November 2004 (phase C), we obtained pressure source at depths 9.6-9.7 km near the center of Aira caldera by assuming a spherical source. By contrast, in the periods of large deformation rate from December 1998 to September 1999 (phase B) and from November 2004 to March 2005 (phase D), we obtained the depths of pressure sources at depths 6-7 km, which were shallower than sources in the periods of small deformation rate. In the periods of small deformation rate (phases A and C), magma was thought to be accumulated to the magma reservoir at the center of Aira caldera. On the other hand, the periods of large deformation rate (phases B and D), pressure source migrated to shallower place. Those periods preceded the eruptive activities at the summit crater in 1999 and beginning of the eruption of the Showa crater from 2006. It is suggested that magma moved to relatively shallow place in those periods.

Volume change rates of the sources in phases A, B, and D were estimated to be $0.95*10^7$ m^3/year, which was close to average magma supply rate at Sakurajima ($1*10^7$ m^3/year). On the other hand, in phase C when the eruptive activity declined after eruptive activity in 1999, volume change rates of the source was estimated to be $0.5*10^7$ m^3/year which was about half of other phases. Increase in eruptive activity may be related to accumulate rate of magma.

Keywords: Sakurajima volcano, Aira caldera, ground deformation, GPS, precious leveling, Mogi's model