Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SVC50-16 Room:104 Time:May 24 09:45-10:00

Evolution of magma plumbing system of Sakurajima volcano in the last 50 years

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Sakurajimna volcano, a post-caldera volcano of Aira Caldera in South Kyushu, has repeated three plinian eruptions since 1471 and effused lava in 1946. Vulcanian eruptions have continued since 1955. Volcanic activity reduced in 2000, but increased its number since 2006. So researchers try to predict what will happen in the future. Yanagi et al.(1991) suggested that magma mixing of two end-member magmas(dacitic and basaltic) occurred during 1471-1946, judging from a linear trend of whole-rock compositions, compositionally bimodal distributions of plagioclase and coexistence of normally and reversely zoned pyroxenes. However, Nakagawa et al. (2011) concluded that three end-member magma mixing should hane occurred since the 20th centuty; basaltic magma (B) inject into mixed magma of silisic (S) and andesitic (A) just before eruption. We carried out the petrological study of the vulcanian eruptions in the last 50 years and discussed temporal change of magma plumbing system.

Whole-rock SiO_2 content of erupted materials in the last 50 years are 58-64% (andesitic). Compositional trend of these ejecta is consistent with that of 1914 and 1946, and change to more mafic with time since 1914. All the ejecta contain plagioclase, orthopyroxene, clinopyroxene and magnetite as phenocrysts, and sometimes accompanying olivine. Phenocryst contents tend to increase with time. Most of the plagioclase phenocrysts show melted structure, compositionally bimodal distributions (An60 and An80), and sometimes there exist compositional peaks of An90. Orthopyroxene phenocrysts show unimodal or bimodal distribution in the range of Mg#65-75, and clinopyroxene phenocrysts similarly in Mg#70-80. Furthermore, normally and reversely zoned phenocrysts of plagioclase and pyroxene usually coexist in a single sample. Olivine phenocrysts are mainly divided into two types, one is Fo70 (surrounded by thick pyroxenes), and another is Fo80 (surrounded by microlites, have no reaction rims). Core compositions of magnetite phenocrysts are in the range of Mg/Mn=8-12, but sometimes show Mg-rich composition.

Bimodal distribution of plagioclase phenocrysts, coexistence of normally and reversely zoned phenocrysts and presence of Mg-rich olivines that compositionally disequilibrium with pyroxenes suggested that magma mixing also occurred in the last 50 years. S-magma: plagioclase (An=46-64), orthopyroxene (Mg#=60-68), clinopyroxene (Mg#=66-72) and magnetite, and A-magma: plagioclase (An=64-86), orthopyroxene (Mg#=68-76), clinopyroxene (Mg#=72-79) and magnetite, and B-magma: plagioclase (An=86-94) and olivine (Fo=75-82). The end-member magmas of these vulcanian eruptions are similar to those of Nakagawa et al.(2011); focusing on plagioclase phenocrysts, low-An (An$<$64) phenocrysts is considered as being derived from S-magma and high-An (An$>$64) ones from A and B-magma. Examining relationships between ratios of these phenocrysts and whole-rock SiO_2, high-An phenocrysts increase with decreasing whole-rock SiO_2. This suggests that increasing of B-magma resulted in increasing ratios of high-An plagioclase and decreasing of whole-rock SiO_2, considering that compositional trend since 20th century should be formed by instrusion of B-magma to the mixed magma of S and A (Nakagawa et al., 2011). Furthermore, SiO_2-poor ejecta observed when eruptions are frequent in the late 1970s and 1980s. This fact suggests that intrusion of B-magma promotes vulcanian eruptions. However, phenocryst contents of olivine in these eruptions are different and no relationship with whole-rock SiO_2. We consider that volume of olivine phenocrysts is variable in B-magma; olivine-rich in the late 1970s, whereas olivine-poor in the late 1980s.

Keywords: Sakurajima volcano, magma plumbing system, magma mixing, vulcanian eruption