Comparative petrology of the historical large eruptions of the Sakurajima Volcano: constraints from magnetite chemistry

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In order to understand the triggering mechanism of volcanic eruption, it is inevitable to examine whether magma mixing occurred just prior to the eruption. In the Sakurajima volcano, Kyushu Japan, it has been reported that the erupted magmas were formed via magma mixing and that the mixing ratio of the mafic end-member has been increased. In this study, we investigated mineralogical characteristics of magnetite in the erupted materials of the three large historical eruptions (Bunmei, Anei and Taisho eruptions) to clarify the role of magma mixing on the evolution of magma reservoir and eruption trigger mechanism.

When a magma mixing occurs, phenocrystic solid solution in the lower temperature magma experiences simple or partial dissolution. The partial dissolution is composed of three steps, dissolution of the original phenocryst, growth of a rim enriched with a high temperature component (formation of reverse zonings), and chemical homogenization through diffusion. These disequilibrium textures record various magma mixing events occurred in various ages, according to their rates of dissolution and diffusion. Diffusion coefficient of ulvospinel component in magnetite solid solution is much faster than the other diffusion in silicate minerals, and chemical zoning in the magnetite homogenizes in a few years at a temperature of the Sakurajima andesites.

Based on the chemical compositions of magnetite phenocrysts and inclusions in plagioclase, we obtained the following results: (1) Most of the magma was replenished after the Bunmei eruption. (2) Before the Bunmei eruption, mafic magma was repeatedly injected as reported for the present magma chamber, and the magma temperature in the chamber increased gradually. (3) There was no sign of magma mixing a few years before of the eruptions of Bunmei East and West pumices. (4) Before the Anei eruption, heterogeneous magma chamber could exist and erupt within a few years after the magma homogenization through a magma chamber overturn or a mixing in the conduit. (5) A mixing with a higher temperature magma occurred just prior the Taisho eruption. These results show that no common magmatic process is found before the eruptions of the three historical large eruptions.