Syn-eruptive oxidation of sulfides in the recent eruption products of the Sakurajima volcano

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Sulfide mineral occurs as inclusions and as isolated crystals in the recent eruption products of the Sakurajima volcano, Kyushu, Japan. In the pumices of the 1914–15 Plinian eruption, Pyrrhotite (Po) crystals have partly reacted to form spongy Fe oxides. A similar texture has been reported in some previous studies (Hattori, 1993), but the mineral phases and formation processes of the spongy Fe oxides have not been clarified. Our quantitative and compositional map analyses with electron probe microanalysis (EPMA) revealed that the spongy Fe oxides are mostly Ti-free magnetite (Mt), with a thin rim (<3 μm) of hematite on rare occasions. The spongy texture includes unreacted regions of Po, mesh-like pores, and S-rich spots, showing that it was formed by desulfidation of Po. Ti was scarcely detected, even in the outermost rim; this indicates that the reaction occurred syn-eruptively in the 1914–15 activity, since Ti-enrichment in the rim via diffusion is expected if equilibration with the surrounding melt proceeded. Thermodynamic calculations showed that Po is stable at log fO_2 <ΔNNO + 2 at a pressure of 1 bar and magmatic temperature, which is 1–2 log units higher than the usual magmatic fO_2. These constraints on the timing and oxidation condition of desulfidation lead to the conclusion that the reaction was caused by oxidation of the magma in a shallow volcanic conduit, not in magma chamber processes. The pumice groundmass consists mostly of glass, indicating that the rate of the desulfidation reaction is faster than the decompression-induced crystallization of microlites in the andesitic magma. Therefore, the desulfidation reaction of Po has the potential to be used as a geospeedometer for very fast magma ascent in vigorous explosive eruptions.