Fluorine and chlorine contents of volcanic ash discharged from Minamidake, Sakurajima volcano in the sequence of its eruptive activity

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Decompression of magma by moving toward the surface causes exsolution of volatiles in magma, which provides the driving force for explosive eruptions. Degassing of volatiles from magma changes its viscosity and density drastically, and these can influence violence of a volcanic eruption.

Sarukajima is one of the most active volcanoes in the world and very close to the populated area. Its recent eruptive phase at the summit crater of Minamidake has been sustained since October 1955. At Sakurajima volcano, strombolian eruptions forerun vulcanian explosions, and vulcanian explosions are often followed by continuous ash emissions, which is the typical sequence of eruptive activity. HF and HCl are the major constituents of high temperature volcanic gas next to water. Further, F and Cl are the most abundant volatiles next to water in volcanic rocks. Hence, precise investigation on the behavior of halogens in volcanic ejecta will provide us reliable information on the change in the mode of eruption.

Volcanic ash particles react with HF and HCl in eruption plumes, which gives origin to the water-soluble F and Cl. Meanwhile, F and Cl that are not exsolved from magma are tightly sealed within the ash particles in water-insoluble forms. The F/Cl ratio in water-insoluble part of the ash samples was significantly larger than the F/Cl ratio in water-soluble part. This result demonstrates that F was fixed mainly in water-insoluble form, whereas Cl was fixed on the ash chiefly in water-soluble form. Thus, the difference in reactivity of F and Cl with silicates causes fractionation of these components through volcanic emanation. Cl contents of the ash particles ejected by strombolian eruption were sufficiently higher than those of the ash discharged by vulcanian explosion and continuous ash emission. Change in water-soluble and water-insoluble F and Cl contents of volcanic ash ejected by the eruption of Sakurajima in 1978 revealed that volatile-rich magma ascended to the top of the crater and caused strombolian eruption and the change in the mode of eruption to vulcanian explosion and continuous ash emission was due to degassing of volatile components. The F contents of the ash discharged by continuous ash emission were obviously higher that those of the others, which was probably caused by reaction of volcanic gases with silicates fragments.