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Change in the water-soluble components of the ash from Sakurajima in the sequence of its eruptive activity

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Sakurajima, located on the south edge of Aira caldera, is a stratovolcano and one of the most active volcanoes in the world. Recent eruptive phase has been sustained at the summit crater, Minamidake, since October 1955. In 1970s and 1980s, its activity was extremely heightened with numerous powerful explosions, and huge amounts of tephra were discharged from the summit crater.

Strombolian eruptions with swarm of BL-type earthquakes forerun vulcanian explosions with explosion earthquakes, and vulcanian explosions are often followed by continuous ash eruptions with tremor, which is the ordinary sequence of the eruptive activity of Sakurajima volcano (Kamo, 1978). Geophysical observation revealed that hypocenters of BH-type, BL-type and explosion earthquakes are concentrated inside a cylindrical chamber with a radius of 200m, at depths from 1 to 3 km beneath the crater. The cylindrical chamber was a magma conduit, which connected the summit crater and a shallow magma reservoir (Ishihara, 1990; Iguchi, 1994). BH-type earthquake swarm is associated with slow inflation of the summit without significant eruptive activity, whereas BL-type earthquakes swarms during rapid deflation of the summit with strombolian eruptions (Ishihara and Iguchi, 1989). Dominant frequencies of BH-type, BL-type and explosion earthquakes are different from each other although hypocenters of these earthquakes distribute inside the cylindrical chamber beneath the crater, which attributed to difference in source processes affected by the state of the magma conduit (Iguchi, 1994).

Volatile components such as water (H2O), fluorine (F), chlorine (Cl), sulfur (S) and carbon (C) are chemical substances dissolved in magma under high pressure. Ascent of magma causes exsolution of volatiles, mostly H2O, which provides the driving force for explosions. Further, release of volatiles highly changes viscosity and density of magma, and thus influences the violence of explosions. Examination of the behavior of volatiles can provide a better understanding of eruptive activity and degassing processes from magma. Pristine ash particles react with HF, HCl and SO2 in eruption plumes, and certain proportions of HF, HCl and SO2 in gas phase are fixed onto the surface of the particles in water-soluble forms. The HCl/SO2 value of smoke is equal to the Cl/S04 values of the water leachate of ash (Ossaka and Ozawa, 1975; Nogami et al., 2008). Change in the mode of the eruptive activity at Sakurajima is drastic and release of volatiles from magma corresponding to its activity is examined by analysis of water-soluble Cl and SO4 in volcanic ash.

The Cl/S04 values of the ash issued by strombolian eruptions with BL-type earthquake swarm are significantly higher than those of the ash ejected by vulcanian explosions and continuous ash emission. In the sequence of strombolian eruption to continuous ash emission, the Cl/S04 values of the ash decline steeply. And re-ascent of magma with BL-type earthquake swarm after continuous ash emission synchronized with return increase of the Cl/S04 values of the ash. These results demonstrate that magma intrusion to the shallow zone of the volcanic edifice is detectable through geochemical observation if the swarm of BL-type earthquake is not significant.