Structure of Sakurajima volcano revealed by geophysical observation and significance of volcano exploration

Masato Iguchi[1]

[1] SVO

Sakurajima volcano is an andesitic volcano, at southern rim of Aira caldera. Magmatic explosions have been repeated at the summit crater and the number attained 7800 at the end of 2005. Internal structure of the volcano, especially magma supply system has been revealed by geophysical volcano observations. Total amount of 1.34 cubic km of lava and 0.52 cubic km tephra were ejected by gigantic eruption in 1914. As the result, ground around Aira caldera subsided, especially, subsidence of the ground at the western rim of the caldera attained 80cm. It was inferred that magma reservoir of Sakurajima is located at a depth of 10km beneath Aira caldera, not beneath the summit of Sakurajima (Mogi, 1958). The magma reservoir has stably existed during the period of the summit eruption since 1955. Inflation of Sakurajima was observed prior to increase in explosivity from 1974 and the center of inflation was located beneath the central part of Aira caldera. The inflation tuned deflation in 1985 and the deflation center was located at similar position (Eto et al., 1997). In addition, the ground around Aira caldera and Sakurajima restarted to inflate in 1993 and the inflation center occupies the similar location. This is confirmed by horizontal displacements detected by GPS observation. Horizontal displacement vectors are directed outward from the center of Aira caldera (Kriswati and Iguchi, 2003).

Detail of distribution of vertical displacement at Sakurajima volcano shows existence of minor magma reservoir at a depth of 5km beneath the currently active crater at the summit of Sakurajima, adding to the main magma reservoir beneath Aira caldera. The existence of minor magma reservoir beneath the summit is supported by the following facts; (1) Minor inflation of the ground of Sakurajima is detected by a tiltmeter and an extensometer immediately before summit explosions and the tilt vectors are oriented to the summit crater (Ishihara, 1990). (2)Anomalously attenuated zone of seismic waves is located beneath the summit crater (Kamo et al., 1980). (3) Hypocenters of A-type earthquakes, which are generated by shear fracture in rock, and B-type and explosion earthquakes, which are caused by expansion of volcanic gas of magma, are separated from each other. This implies that volcanic conduit filled with magma fluid clearly exists in rock of volcanic body (Iguchi, 1994). From above mentioned observation results, it is concluded that main magma reservoir beneath Aira caldera and sub magma reservoir beneath the summit crater exist and the sub magma reservoir is connected to the summit crater through the volcanic conduit.

Next, how to connect the main magma reservoir beneath the Aira caldera and the shallower magma reservoir beneath the summit? Kamo and Ishihara (1980) inferred additional magma path from the south off Sakurajima to the shallow magma reservoir beneath the summit from the fact that hypocenters of A-type earthquakes migrated from deep part of SSW of Sakurajima to shallower part beneath the summit crater prior to increase in eruptive activity in May 1976. A number of A-type earthquakes occurred in 2003 at the similar location during inflation stage starting from 1993. However, recent continuous GPS shows that inflation center is kept at the center of Aira caldera and no indication of inflation at the southern part of Sakurajima even in the increase in seismicity at the southern part. It is reasonable that A-type earthquakes were caused by migration of magma from the reservoir beneath Aira caldera to beneath and south of Sakurajima rather than direct intrusion of magma from south off. It is difficult to grasp magma path to the shallow sub reservoir beneath the summit from hypocenter distribution of volcanic earthquakes in low seismic zone at north of Sakurajima. Seismic exploration by using active sources may be possible to make clear such a magma path from seismic wave velocity, attenuation, reflection and scattering spatial distribution.