Seismic and geodetic precursors of small vulcanian eruptions at Suwanose-jima volcano, Japan

Takeshi Nishimura[1], Masato Iguchi[2], Hiroshi Yakiwara[3], Jun Okiawa[4], Yu'ichi Hirai[1], Hiroshi Aoyama[5], Haruhisa Nakamichi[6], Ryohei Kawaguchi[1], Yusaku Ohta[1], Takeshi Tamaguri[2]

[1]Science, Tohoku Univ., Japan, [2]DPRI, Kyoto Univ., Japan, [3]Science and Engineering, Kagoshima Univ., Japan, [4]ERI, Univ. of Tokyo, Japan, [5]Science, Hokkaido Univ., Japan, [6]Environmental Studies, Nagoya Univ., Japan

E-mail: nishi@zisin.gp.tohoku.ac.jp

Suwanosejima is a small volcano island south of Kyushu on the Pacific Ocean. The volcanic eruption of the island is characterized by small vulcanian explosions that repeatedly occur within a short interval of a few tens of minutes every a few months. We deploy 4 broad-band seismometers, 3 short-period seismometers and 5 borehole tilt meters at distances of 0.4-1.5 km. In the present study, we summarize precursor signals that are caused by magma behavior beneath active crater before explosions to understand the mechanism of vulcanian eruptions at Suwanosejima volcano for the period from September 2009 to 2011. Vulcanian explosions often occur during successive ash emissions for a few hours to days that generate continuous tremor. The explosions follow a sudden stop for about one or two minutes of continuous tremor. Uplift toward the crater also start at the same time when continuous tremor amplitude stop. Such coincidence suggests that the pressurization in the shallow magma is caused by accumulation of volcanic gas or ash due to a formation of a cap just beneath the active crater. It is noted that the inflations and explosions are also observed during a quiet period when no ash emission is observed. The cap is considered to be formed in a short time because the continuous tremor amplitude generally decreases for a few tens of seconds. Amplitude and duration of the inflation signals tend to become larger and longer, respectively, for explosion earthquakes with large maximum amplitude. The tilt signals are about a few tens of nano radian, which are detected at only station located close the active crater. The inflation amplitude is attributed to the pressurization at a depth of a few hundred kilometers beneath the active crater, and the maximum amplitude of explosion earthquakes are also explained by a release of the pressure stored before explosion. About 0.5 to 1 s before the onset of explosions, a tiny deflation with duration of about 0.6 s is observed in the seismogram of explosion earthquake. Our seismic waveform inversion shows that the tiny deflations are explained by contraction of volcanic conduit at a few hundred meter depth beneath the active crater. Pressure decreases are estimated to be about 0.03-1 MPa for a cylindrical source with a length of 500 m and a radius of 10 m. The pressure decrease may be a small leakage of gas, but no significant signal is detected by the acoustic sensors at stations: acoustic signal gradually and slightly sometimes increase its amplitude just before an onset of explosion, but the duration is not matched with that of the contraction seismic source. Although the mechanism of the contraction is still under investigation, it is noteworthy to mention that the maximum amplitude of explosion increases with the amplitude of contraction source.