Article

Bull. Volcanol. Soc. Japan
Vol. 58 (2013) No. 1, pp. 183−189

Separate Quantification of Volcanic Gas Fluxes from Showa and Minamidake Craters at Sakurajima Volcano, Japan

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(Received October 11, 2011; Accepted December 26, 2012)

We conducted SO_2 flux measurements at Sakurajima volcano, Japan during 2007−2010 to ascertain differences in the degassing activity at two craters of the volcano: Minamidake and Showa craters. Recent developments in SO_2 visualization techniques using a UV camera observation system enabled us to quantify the SO_2 flux from each crater. SO_2 flux reflects conditions of the volcanic conduit. Therefore, a separate estimate of the gas fluxes from different vents is useful to gain insight into conditions within the volcano. Sulfur dioxide flux from Showa crater ranged from a few hundred to several thousand ton/day. In contrast, sulfur dioxide flux of 100−500 ton/day from Minamidake crater remained at a lower level. These results suggest that degassing conditions (i.e. permeability of the conduit or the amount of degassing magma) of Minamidake crater have remained stable. In contrast, the degassing activity of Showa crater is probably variable and sensitive to volcanic activities in the crater. The difference implies that drastic variations of Sakurajima volcano's SO_2 flux data, observed using a conventional traverse method with a UV spectrometer, resulted from the Showa crater's SO_2 flux, not the Minamidake crater's SO_2 flux.

Key words: volcanic gas, UV camera, SO_2 flux, remote sensing

1. Introduction

Volatile components are dissolved in magma under pressure. As magma ascends to the shallow region of a volcanic edifice, the magma begins to decompress, thereby causing exsolution of volatiles, which provides a driving force for explosive eruptions. Therefore, measurements of volcanic gas emissions provide reliable information related to the state of the magma and contribute to the monitoring of volcanic activity.

Sulfur dioxide (SO_2), a major volcanic gas constituent emitted from active volcanoes, can be detected using ultraviolet (UV) light absorption. Sulfur dioxide flux observations are used to monitor the variation of volcanic activity. The instrument used most widely to measure SO_2 flux is a correlation spectrometer (COSPEC; Stoiber *et al*., 1983). At the beginning of the 21st century, cheaper and more compact UV spectrometer systems (*e. g.*, mini-DOAS; Galle *et al.*, 2002; COMPUSS; Mori *et al.*, 2007) were developed to replace COSPEC. These advancements have facilitated data collection and have increased the number of observations. Although these developments have been innovative, the production of high temporal resolution SO_2 flux measurements remains challenging as UV spectrometers scan volcanic plumes. Recently developed UV camera observation systems (Bluth *et al.*, 2007; Mori and Burton, 2006) can provide images of the SO_2 column amount and measure SO_2 flux at high frequencies (up to 2 Hz). Recent studies using this new tool have revealed links between volcanic gas emissions and seismic signals (*e.g.*, Kazahaya *et al.*, 2011; Nadeau *et al.*, 2011).

Sakurajima volcano is an active volcano in southern Kyushu, Japan. This stratovolcano consists of two adjoining edifices: Kitadake and Minamidake. Previously, the main active crater had been Minamidake crater, which generated numerous eruptions since 1955. After the 1990s, the volcanic activity subsided to moderate levels. Showa crater, located east of Minamidake crater, awakened from about 60 year dormancy in June 2006. The main volcanic activity shifted from Minamidake crater to Showa crater. In contrast to the now active Showa crater, few explosions have occurred at Minamidake crater since 2006 (JMA, 2007, 2008, 2009, 2010).

The two craters are the major degassing source of Sakurajima volcano since June 2006. Sulfur dioxide flux is controlled by the several degassing parameters. One candidate is permeability of a volcanic conduit (*e.g.* Edmonds *et al.*, 2003). Because these two craters have different eruptive behaviors, as described above (*e.g.* number of erup-

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