Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC12-01 会場:304 時間:5 月 26 日 14:15-14:30

A new method to monitor water vapor cycles in active volcanoes
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The monitoring of multiple gas species from volcanic plumes in real time is crucial to understand the mechanisms involved in persistent degassing, and can be used anticipate volcanic unrest and magma ascent towards the surface. Progress in gas remote-sensing techniques during the last decades has led to the development of ultraviolet absorption spectrometers and UV cameras, which enable to monitor SO2 emission cycles in real time, at very high-frequency (about 1Hz), and from several kilometers away from the volcanic plume. However, monitoring of the more abundant gases, i.e., H2O and CO2, is limited to volcanoes where infrared spectrometers and infrared lamps can be installed at both sides of the crater rims. In this study, we present a new and simple methodology to register H2O emission cycles from long distances (several kilometers), which is based on the light scattered by the micrometric water droplets of condensed plumes. The method only requires a commercial digital camera and a laptop for image processing, since, as we demonstrate, there is a linear correlation between the digital brightness of the plume and its volcanogenic water content. We have validated the method experimentally by generating controlled condensed plumes with an ultrasonic humidifier, and applied it to the plume of Erebus volcano using a 30 minutes-long movie [1]. The wavelet transforms of the plume brightness and SO2 time series (measured with DOAS [1]) show two common periodic components in the bands about 100-250 s and about 500-650 s. However, there is a third periodic component in the band of about 300-450 s in the SO2 time series that is absent in the brightness time series. We propose that the common periodic components are induced by magmatic foams collapsing intermittently beneath shallow geometrical barriers composed by bubbles with high content of both H2O and SO2, whereas the third periodic component could be induced by foams collapsing beneath a deeper geometrical barrier composed by bubbles with high content of SO2 but low content of H2O. This is consistent with the fact that most of the water exsolves at very low pressures. Our new methodology should lead to new insights into magma degassing process and anticipation of volcanic eruptions, in particular when combined with other monitoring methods. [1] Boichu et al. (2010), J. Volcanol. Geotherm. Res. 195:325.

キーワード: volcano, monitoring, phreatic, camera, Mayon, degassing
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