Volcanic gas composition of Sakurajima volcano, Japan

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We conducted volcanic gas composition measurements applying Multi-GAS and alkaline-filter techniques at Sakurajima volcano, which continues persistent degassing and frequent small-scale Vulcanian eruptions for several decades. The Multi-GAS and alkaline-filter needs to be conducted in a dense plume for precise measurement. However, we cannot access to the summit area of the volcano because of the frequent eruption and we applied various techniques to approach the volcanic plume at Sakurajima, including 1) air-borne measurement with a Cessna aircraft, 2) air-borne measurement with an unmanned helicopter and 3) automatic measurement at a flank of the volcano. Accuracy of the estimated gas composition depends on measured volcanic gas concentration which is quite variable depending on wind speed, direction, volcanic activity and distance from the summit crater.
We started the measurement in 2012. Until the early 2015, Sakurajima volcano continues the intensive persistent degassing with SO2 flux larger than 1,000 t/d and with frequent explosions at Showa crater, but SO2 flux decreased to around 100 t/d in the late 2015 with quite limited number of explosions. The volcanic gas compositions are fairly well estimated during the high flux period. The estimated average composition is; CO2/SO2 = 0.5, H2O/SO2=110, SO2/H2S=8, H2/SO2=0.15 and SO2/Cl=10 (mol ratio). This composition is similar to composition of other high-temperature gases in Japan with an exception of larger H2O/SO2 than others (i.e., about 40 at Asama, Miyake and Aso volcanoes). The CO2/SO2 ratios vary between 0.5-1.5 but negatively correlate with the measured SO2 concentration. The similar correlations observed at Asama volcano were interpreted as the results of mixing of low-temperature gases with low SO2 and high CO2 concentrations. At Sakurajima volcano, however, distribution of low-temperature fumaroles are limited and the cause of the correlation is not clear. The SO2/Cl ratios vary 5-20, which is consistent with the SO2/HCl ratios measured in 2009-2013 by FT-IR for the gas plume from the Showa crater (Mori et al., 2004).
During the low flux period in the late 2015 and the early 2016, the estimated ratios are different from those during the high flux periods; SO2/H2S=0.6-2.5 and CO2/SO2 = 20-150. During the low flux period, the measured gas concentrations were quite low (with maximum SO2 concentration of 0.1-0.5 ppm) and the estimated ratios are likely associated with quite large uncertainty, in particular for CO2/SO2 ratios. We measured d13C of CO2 in the plume samples collected during the flight when CO2/SO2 ratios were estimated as 150 and estimated the large CO2/SO2 ratio was caused by CO2 with low d13C (about -25 per mil) which is quite different from a common volcanic gas CO2 and the large ratio is unlikely represent that of the gases from the summit vent. The SO2/H2S ratios during the low flux period are lower than those during the high flux period. The low values can be caused by various reasons, however, most likely cause might be pressure difference of magma degassing. Since SO2/H2S ratio at constant oxygen fugacity and temperature inversely proportional to pressure, 10 times increase of the degassing pressure can cause the ten times decrease of the SO2/H2S ratios.

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