

Interaction of volcanic gases with crater lake deduced from volcanic plume composition of Aso volcano

Hiroshi Shinohara[1]

[1] GSJ, AIST

No. 1 crater of Nakadake, Aso volcano is an active crater, which repeated Strombolian eruptions with several years intervals, and it hosts an acid and hot crater lake during its calm stage. The activity of Nakadake is characterized by an activity cycle of 1) Calm stage (characterized by acid crater lake activity), 2) Activating stage (characterized by crater lake volume decrease, incandescence and mud eruptions), and 3) Eruption stage (characterized by Strombolian eruptions) (Sudo et al., 2006). Change of the crater lake volume is controlled by changes of material and energy balance of the crater lake. Therefore, understanding of the material and energy budget of the crater lake and interactions of deep supplied volcanic gases with a shallow hydrothermal system is a key to understand not only hydrothermal processes of the volcano but also changes of volcanic activity. The input to the crater lake is mainly volcanic gas and meteoric water and the output is through evaporation and seepage. Volcanic plume is continuously emitted from the crater, mainly by evaporation from the crater lake and from high-temperature fumaroles located at southern rim of the crater lake. The purpose of this study is to estimate chemical composition of these volcanic gases based on plume chemistry measurement and evaluate volcanic supply rate, interaction between the volcanic gases and hydrothermal system and their contribution to the material and energy balance of the crater lake.

We measured composition of plumes at the rim of the crater by application of Multi-GAS (a portable multiple gas sensor system for volcanic plume composition measurement) and estimated composition of the source gases. Volcanic gases are mainly derived from evaporation of crater lakes (named evaporation gas) and from high-temperature volcanic gas. Contribution of these sources is variable depending on the wind condition and location of the measurement, and we tried to distinguish these contribution.

We repeated the plume measurement several times since October, 2003. During this period, crater lake volume changes between 100% and 20% of the full volume. The estimated volcanic gas composition (daily average at each observation point) has large ranges as $\text{CO}_2/\text{SO}_2=1-5$, $\text{H}_2\text{O}/\text{SO}_2=34-190$, $\text{H}_2/\text{SO}_2=0.01-0.28$, $\text{SO}_2/\text{H}_2\text{S}=6-140$, $\text{SO}_2/\text{Cl}=3-200$. Variation is large, in particular for $\text{SO}_2/\text{H}_2\text{S}$ and SO_2/Cl . These ratios are low in high-temperature volcanic gases and high in the evaporation gases, which is also characterized by rapid and large changes in $\text{SO}_2/\text{H}_2\text{S}$ ratio. These features might be caused by dissolution of volcanic gas components in the lake water. HCl has much larger solubility to water than SO_2 . Reaction of SO_2 and H_2S with 1:2 proportion forms elemental sulfur in water; therefore precipitation of sulfur will increase the $\text{SO}_2/\text{H}_2\text{S}$ ratio. In contrast, variations of CO_2/SO_2 ratio and $\text{H}_2\text{O}/\text{SO}_2$ ratio depend not only on the sources but likely due to temporal changes of their compositions, and we need further detailed evaluation to estimate end-member compositions.

We conducted the plume measurement at vicinity of the high-temperature fumaroles in September, 2007 and estimated the following composition; $\text{CO}_2/\text{SO}_2=5$, $\text{H}_2\text{O}/\text{SO}_2=43$, $\text{H}_2/\text{SO}_2=0.28$, $\text{SO}_2/\text{H}_2\text{S}=13$. We can calculate an apparent equilibrium temperature from this composition as about 900 degree C, which is consistent with the observation of incandescence in this period. During this period, SO_2 emission rate was about 300 (t/d) (Takehiko MORI, pers. com.). Assuming the high-T volcanic gas is supplied to the crater lake, we can estimate the amount of volcanic gas supplied to the crater (including the crater lake and high-T fumaroles) as 4400 (t/d) with water supply of 3600 (t/d).