

Volcanic activity of Mt Kusatsu-Shirane suggested by the variations in fumarolic gas composition and crater lake water chemistry

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Introduction

In the early of 2014, a swarm of volcanic earthquake has started at Mt Kusatsu-Shirane (Japan Meteorological Agency, JMA, 2015). The daily number of earthquake reached to 149 as maximum on 24th July 2014, followed by a sharp decrease until September of 2014. JMA also detected a change of geomagnetic force induced by the de-magnetization of crust beneath the summit crater on the mountain. We carried out a geochemical observation at the geothermal area and the crater lake.

Results and Discussions

After the swarm of volcanic earthquake on July, the concentration of some chemical components in the lake water of Yugama crater increased, for example, Cl⁻ and H⁺ concentration increased, respectively, 81 and 67%, in Oct 2015 relative to Aug 2014, suggesting the input of HCl. A similar change has been observed in 1990 at the same crater lake. The change is consistent to the invasion of ground water into the solidifying magma as proposed by Ohba et al (2008). The Cl in the solidifying magma could be extracted to fluid as HCl under the super critical condition of H₂O (Giggenbach, 1996).

The CO₂/H₂O ratio of fumarolic gases at the geothermal area on the mountain was 0.044 in July 2014, which decreased to 0.021 in Oct 2015. One possible explanation to the change of CO₂/H₂O ratio is the change of degassing pressure of magma. Even if the H₂O and CO₂ content in magma is constant, the pressure of degassing affects the CO₂/H₂O ratio of fluid degassed from magma. Due to the low solubility of CO₂ relative to H₂O, the high degassing pressure increases the fluid CO₂/H₂O ratio. The magma of Mt Kusatsu-Shirane might be pressurized by the sealing zone (Fournier, 1999) until the early of 2014. If the sealing zone breaks, the CO₂ enriched fluid can be liberated. The swarm of earthquakes is generated by the CO₂ enriched magmatic fluid injected to the shallow hydrothermal system beneath the crater lake. The HCl enriched fluid arrived at the lake with slight delay after the injection of CO₂ enriched fluid.

Keywords: Mt Kusatsu-Shirane, Hydrothermal system, Crater lake