Noble gas isotope compositions of mafic phenocrysts in the Stage 3 lavas of Kusatsu-Shirane Volcano

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Kusatsu-Shirane Volcano is an active volcano, composed of two composite pyroclastic cones (Mt. Shirane and Mt. Motoshirane). Typical eruptions at Kusatsu-Shirane during the last 140 years were phreatic eruptions, and the first historic phreatic eruption at Mt. Motoshirane occurred on 23 January, 2018. The chemical and isotopic compositions of volcanic gases can be useful indicator of volcanic activity because it can be a geochemical tracer for the contributions of various components such as magma, crust and atmosphere, and the degree of magma degassing. The air-corrected $^{3}He/^{4}He$ ratio of Sessho-gawara fumarole, located on 2 km east of the 2018 phreatic vent, had been constant at 7.0-7.5 Ra during 2014 and 24 January 2018, and dropped to 6.5 Ra on 13 February 2018 [1]. Therefore, Toyama et al. [1] expected that the low $^{3}He/^{4}He$ ratios observed after the 2018 eruption may reflect relative increase of the contribution of gas supplied from the Mt. Motoshirane hydrothermal reservoir which may have low $^{3}He/^{4}$ He ratio. However, the relationship of noble gas isotopic compositions between possible end-member components such as volcanic gas and evolved crustal magma and mantle-derived mafic magma, which is the possible source of hydrothermal fluid, is poorly understood. In order to obtain information on the noble gas isotopic ratios of mafic and evolved crustal magmas, we analyzed mafic phenocrysts in lavas erupted during the Stage 3 (after 16 ka [2]).

We report the noble gas (He, Ne, Ar) isotopic ratios of mafic phenocrysts (ol, opx, cpx) in the andesitic lavas of Kusatsu-Shirane Volcano. The lavas analyzed in this study were Kagusa Lava erupted from Mt. Shirane, and Sessho Lava and Furikozawa Lava both erupted from Mt. Motoshirane. After fragmentation of these lavas using SELFRAG Lab (High-voltage pulsed power selective fragmentation system) installed at JAMSTEC, about 100 mg each phenocryst was separated by hand picking. Noble gas (He, Ne, Ar) isotope analysis was conducted using a mass spectrometer installed at the University of Tokyo. In-vacuo crushing method was used for extraction of noble gases [3].

The preliminary $^{3}He/^{4}He$ ratios were as follows: cpx in Furikozawa Lava was 6.0 ±0.9 Ra; ol in Furikozawa Lava was 11.0 ±2.6 Ra; and ol in Sessho Lava was 8.3 ±0.5 Ra. These values are similar to the $^{3}He/^{4}He$ ratio of volcanic gases such as Kitagawa fumaroles on the northern flank of Mt Shirane (average 7.6 Ra) and Sessho-gawara fumaroles (average 7.2 Ra) [1]. The $^{4}He/^{40}Ar^{*}$ ratios (Ar* denotes non-atmospheric ^{40} Ar) were as follows: ol and cpx in Furikozawa Lava were 0.14 and 0.62, respectively; opx in Kagusa Lava was 0.22; and ol in Sessho Lava was 0.65. In contrast, Kitagawa fumaroles were 9.4 and Sessho-gawara fumaroles were 3.9. Because He is more soluble than Ar within silicate melt, $^{4}He/^{40}Ar^{*}$ ratio of magma would increase as it degasses. Using $^{4}He/^{40}Ar^{*}$ ratios as the index for the degree of magma degassing, Sessho Lava was slightly more degassed than Furikozawa Lava and Kagusa Lava. In contrast, the values observed in current fumaroles suggest that volcanic gas is derived from magma that is significantly degassed compared to magmas that have crystallized mafic minerals. These results suggest that $^{4}He/^{40}$ Ar* ratio of volcanic gas has a potential to be a good indicator to monitor degassing stage of magma and/or replenishment of undegassed primitive magma to a shallow magma chamber. As the

above-mentioned data are preliminary, we will discuss more in details by analyzing more samples.

References: [1] Toyama et al., JpGU2019, SVC38-P07, 2019. [2] Takahashi et al., *Proc. Inst. Nat. Sci. Nihon Univ.* 2010. [3] Sumino *et al.*, *J. Mass Spectrom. Soc. Jpn.* 2001.

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