Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36920

Helium isotope record of magma injection: Comparison of phenocryst and fumarole gases from the Kirishima volcano group

RAI YONEDA[1], HIROCHIKA SUMINO[2], MASATAKA KAWAGUCHI[1], YASUHISA TAJIMA[3] AND TOSHIAKI HASENAKA[4]

[1]The University of Tokyo
[2]University of Tokyo
[3]Nippon Koei Co.,LTD.
[4]Kumamoto University

Noble gases are useful geochemical tracers for the origin of materials on and in the Earth. For example, since helium isotopic ratio, $^3He/^4He$, is $1.4\times10^{-6}\equiv1$ R_A in the atmosphere, while $^3He/^4He = 8(\pm1)$ R_A in the convecting mantle and $^3He/^4He<0.02$ R_A in the crust, helium in fumarole gases or hot springs is attracting attention as a monitoring tool for volcanic activity (*e.g.*,[1]). However, the $^3He/^4He$ of melt inclusions in mafic phenocrysts, expected to reflect magma itself, is necessary for understanding the maximum $^3He/^4He$.

In this study, $^3He/^4He$ of olivine and pyroxene phenocrysts from the Kirishima volcano group in Japan were measured. The $^3He/^4He$ of olivine in the pumice of the Shinmoe-dake 2011 eruption was $7.43(\pm0.06)$ R_A, while that of pyroxene in the same pumice was $7.98(\pm0.17)$ R_A. Since the olivines and pyroxenes are considered to have crystallized in deep and shallow magma chambers, respectively[2,3], the observation that $^3He/^4He$ of pyroxene exhibits more mantle-like properties seems contradictory. This could be attributed to crystallizing at different times in the magma chambers, the $^3He/^4He$ in which changes over time. In other words, the olivine crystallized when the $^3He/^4He$ in the chambers waslow, and the pyroxene when it was high. Olivines in three lavas from Ohachi, erupted in 788, 1235, and 1350, respectively, had a high $^3He/^4He$ of around 8 R_A ($8.6(\pm0.4)$, $7.93(\pm0.12)$, and $8.6(\pm0.2)$ R_A, respectively) to reinforce that Ohachi lavas have a deeper origin[4]. The $^3He/^4He$ in fumarole gases in Iwo-yama, which is thought to share the magma conduit with Shinmoe-dake, was around 7.0 R_A in 2016, but has increased over the past 8 years to around 7.8 R_A[5]. This suggests that magma supply from a deeper part containing helium with a $^3He/^4He$ of around 8 R_A, represented by pyroxene from Shinmoe-dake and olivines from Ohachi, triggers the rise in the $^3He/^4He$ of fumarole gases.

[1] Padrón, E. *et al.* (2013) *Geology*. [2] Suzuki, Y. *et al.* (2013) *JVGR*. [3] Aizawa, K. *et al.* (2014) *JGR Solid Earth*. [4] Kagiyama, T. *et al.* (1997) *Bull. Volcanol. Soc. Jpn*. [5] Fukushima, N. *et al*. (2025) *JpGU meeting*.