Molybdenum isotopic compositions in volcanic rocks from the Izu islands

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Magmas in the subduction zone volcanos are generated by the flux melting of the mantle wedge, due to the addition of fluids derived from the subducted plate. The chemical composition of the fluid changes as the subduction progresses, which causes the compositional diversity of the island arc volcanoes. Among the geochemical tracers to understand these processes, Mo isotopes are emerging as a new and important tracer of the subduction related processes. This is because, Mo isotopes undergo mass-dependent fractionation during the dehydration process on the subducted plate (e.g., [1-2]). Mo isotopic studies of the northern Izu Islands have been conducted by some researchers [2]. However, the behavior of Mo isotopes via dehydration in the subduction depths below Niijima has been unclear because there are no volcanic islands with basaltic lavas beyond Niijima in northern Izu Islands. Geochemical studies of the deep subduction back arc basalt samples including seamounts and back arc basin basalts (BABB) from the Smith Rift (e.g., [3]) are available, however, the eruption ages for the most of the seamount and BABB samples are unknouw and they were erupted during the Shikoku Basin expansion (before 15 Ma). Therefore, the Mo isotopic compositions for these samples cannot be compared directly with those in Quaternary basalts on the volcanic front.
We have focused on basaltic xenoliths in rhyolite on Kozushima, which is located on the rear arc side than Niijima, and showed that the major and trace element characteristics of the volcanic rocks would originate from a deeper subduction site than Niijima [4]. In this study, we determined the Mo isotopic composition of volcanic rocks in the Izu Islands (Izu Oshima, Niijima, and Kozushima) using thermal ionization mass spectrometry (TIMS) coupled with a double-spike method. The $\delta^{98/95}$Mo (10^3 times relative deviation from standard NIST 3134) values were −0.24 ±0.19‰ (N = 13, 2SD) at Izu Oshima, −0.39 ±0.01‰ at Niijima, and −0.58 ±0.15‰ (N = 4, 2SD) at Kozushima. Previous studies revealed that the $\delta^{98/95}$Mo values decrease from the volcanic front (Izu Oshima) to the rear-arc (Niijima) [2]. In this study, we found that the basaltic xenoliths from Kozushima, which has a more rear-arc-like geochemical feature than Niijima, have a mean $\delta^{98/95}$Mo value lower than that of Niijima. Also, the $\delta^{98/95}$Mo values in rhyolites from Kozushima (−0.33 to −0.14 ‰) and seawater (2.3 ±0.1 ‰[5]) are higher than that of the basaltic xenolith. Therefore, it is conceivable that fluids dehydrated from the subducting slab is responsible for the low $\delta^{98/95}$Mo value observed in the basaltic xenoliths. Our results suggest that continuous dehydration occurs in the subducting slab beneath Niijima and Kozushima, and that heavy Mo isotopes are selectively partitioned into dehydrating fluids in the rear arc region beyond Niijima. Such continuous dehydration and the associated Mo isotope fractionation indicate that dehydrated slab material with light Mo isotopic composition is supplied to the deep mantle in the Izu arc region.

Reference
[1] Freymuth, Heye, et al. "Molybdenum mobility and isotopic fractionation during subduction at the Mariana arc." Earth and Planetary Science Letters 432 (2015): 176-186.
[2] Villalobos-Orchard, Javiera, et al. "Molybdenum isotope ratios in Izu arc basalts: The control of subduction zone fluids on compositional variations in arc volcanic systems." Geochimica et Cosmochimica Acta 288 (2020): 68-82.
[3] Tollstrup, Darren, et al. "Across arc geochemical trends in the Izu Bonin arc: Contributions from the subducting slab, revisited." Geochemistry, Geophysics, Geosystems 11.1 (2010).

[4] Tatsuya Tamura, Tetsuya Yokoyama, Akira Ishikawa JpGU - AGU Joint Meeting 2020 SGC49-06 "Geochemical study of Kozushima rhyolites and basaltic xenoliths"
[5] Siebert, Christopher, et al. "Molybdenum isotope records as a potential new proxy for paleoceanography." Earth and Planetary Science Letters 211.1-2 (2003): 159-171.

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