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Re–Os geochemistry of altered dacitic rock at Site U1527, IODP Expedition 376: Implications for the Re cycle in intraoceanic arcs

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The Re–Os isotopic system is a powerful tool for both geochronology and tracing various geochemical processes. Because the Os isotopic ratio ($^{187}\text{Os}/^{188}\text{Os}$) distinctly differs between modern seawater (≈ 1.06) and hydrothermal fluid (≈ 0.13), the Re–Os isotopic system is potentially a sensitive tracer of subseafloor fluid flow and the release or uptake of hydrogenous/magmatic Re and Os. The effect of alteration on the Re–Os budget in oceanic crust has been examined for mid-ocean ridge basalt (MORB) and lower oceanic crustal gabbro. In contrast, applications of the Re–Os system in intraoceanic arc settings are limited mainly to fresh igneous rocks; the role of hydrothermal alteration has not yet been examined.

Here, we provide a depth profile of Re–Os geochemistry at Site U1527, located on the NW caldera rim of the Brothers volcano hydrothermal field in the Kermadec arc, which was drilled during International Ocean Discovery Program (IODP) Expedition 376 in 2018. Volcaniclastic rocks from Hole U1527C that had experienced various degrees of high- and low-temperature hydrothermal alteration were analyzed for bulk chemical composition as well as Re–Os concentrations and isotopes. The concentration of Re varied from 0.172 to 18.7 ppb, and that of Os ranges from 9.7 to 147.1 ppt. Hydrothermal alteration usually resulted in the Re uptake by rocks, but a part of Re was released into the ocean by later oxidative weathering. Compared with Re, Os mobility resulting from hydrothermal alteration was limited. Before alteration, our samples likely had homogenous $^{187}\text{Os}/^{188}\text{Os}$ of between 0.13 and 0.14, whereas alteration added hydrogenous Os to some drill core sections in two different ways. Elevated $^{187}\text{Os}/^{188}\text{Os}$ with Ba enrichment and abundant pyrite occurrence suggests Os precipitation induced by subseafloor mixing of seawater and high-temperature hydrothermal fluid. The highest Re and Os concentrations at Hole U1527C, found in the same interval, were associated with high concentrations of Bi, Sb, and Tl. In contrast, elevated

$^{187}\text{Os}/^{188}\text{Os}$ without Ba and Os enrichment can be explained by adsorption of seawater-derived radiogenic Os onto Fe hydroxide during seawater ingress into volcanoclastic rocks with a high matrix volume.

Intense Re enrichment at Hole U1527 relative to the high-temperature alteration zone in altered MORB may be related to abundant pyrite precipitation and high Re content in primary arc magmas. We propose that degassed Re from shallow intraoceanic arc magmas may be sequestered by seafloor high-temperature alteration. Part of the stored Re might also be released into the ocean by later oxidative seawater circulation and seafloor weathering, raising a question about the role of alteration zones in the Re cycle in subduction zones. This study is one of the first attempts to apply the Re–Os system to altered rocks in arc settings, and future research should provide more information about the fate of Re in intraoceanic arcs and the detailed role of hydrothermal alteration in the Re cycle on the Earth.