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Element mobility and oxygen isotope systematics during submarine alteration of basaltic glass

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Abstract

Studies of the submarine alteration of basaltic glass may improve the understanding of crust-seawater interactions and the oceanic elemental cycle. Natural alteration processes such as the palagonitization of basaltic glass are complex, and their elucidation is crucial to the understanding of fluid-rock interactions. This study involves major and trace element and isotope mapping of a submarine-altered basaltic glass grain and reveals sequential development of alteration textures toward the grain core through the transition between unaltered glass and palagonite. The conversion from basaltic glass to palagonite in a low-temperature submarine environment results in enrichment in B, Rb, K, Li, H_2O, U, Nb, Th, Ti, Cu, Ta, Zr, Hf, Ni, Sc, Fe, Cr, Pb, and Zn; and depletion in Si, Mg, Al, Sr, Na, Co, rare-earth elements, Ca, P, and V (in order of decreasing distribution coefficient). The glass-palagonite interface region has the highest high field strength element (HFSE) and Fe-Ti contents but the lowest Mg content, indicating that the Fe-Ti phases that host HFSE were precipitated first during initial palagonitization. At the same time, an inferred exchange of oxygen occurred, based on variation in $\delta^{18}O$, with values increasing from basaltic glass to palagonite. However, initial palagonite compositions were affected by subsequent precipitation and/or incorporation/adsorption of additional compounds such as $Mg(OH)_2$ scavenged from pore water.

Keywords: Basaltic glass, palagonite, alteration, elemental imaging, oxygen isotope