Isoptoic tracers of crustal alteration in low temperature hydrothermal settings

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The chemical composition of seawater is a function of the riverine and the hydrothermal fluxes of various elements to and from the oceans. In particular, the alteration of oceanic crust during high-temperature (axial) and low-temperature (off-axis) hydothermal circulation plays a critical role in moderating the concentration and isotopic composition of many elements in the ocean, including lithium, boron, and magnesium. High-temperature (>200ºC) alteration of oceanic crust is a source of lithium and boron to seawater. On the other hand, off-axis low-temperature (<150ºC) alteration of oceanic crust is a major sink for seawater dissolved Li, B and Mg. This off-axis circulation is likely to contribute significantly to both global heat budget and geochemical fluxes of elements. However, the low-temperature oceanic crust alteration is poorly constrained both in terms of total flux as well as the isotope fractionation associated with this flux.

A detailed examination of Li, B and Mg flux into altered oceanic crust and the isotopic fractionation associated with the relevent chemical reactions is essential to better constrain the mass and isotope budget of these elements in seawater. The concentration and isotopic composition study of pore fluids from off-axis hydrothermal sites can yield information as to the extent of removal of these elements during chemical reactions with the oceanic crust, and the isotopic fractionation associated with these chemical reactions.

The North Pond, an axial basin on the Western flank of the Mid-Altantic Ridge, is an ideal site for investigating low-temperature crustal alteration. The relatively young (8 Myrs) crust is porous and fluid flow is vigorous but at low temperature (10-15ºC). There is a 2% decrease in Mg concentrations at the basement-sediment interface, indicating low-temperature crustal alteration. We will examine the effect of low temperature crustal alteration on the isotopic composition of the pore fluids at the sediment-basement interface through tandem determination of the three isotope systems (δ^{7}Li, δ^{11}B and δ^{26}Mg), and how that signal propagates into the sediment colum above. We will then use estimates of fluid flux in the basement to further constrain the impact of low temperature hydrothermal circulation on the marine isotopic composition of these elements.