# Significance of magnesium on water-rock interaction within oceanic lithosphere revealed by hydrothermal experiment

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Hydrothermal circulation within the oceanic lithosphere produces a variety of hydrothermal vent fluids, and affects the surface environments in various ways, including compositions of seawater, mineralization as well as the microbial activities. However, as hydrothermal alteration proceeds in multicomponent systems passing through various lithologies and temperatures, it is not easy to predict or evaluate the evolution of fluid chemistry within the hydrothermal system. In this study, we conducted the systematic hydrothermal experiments of basalt/harzburgite and saline fluids to understand the controlling factors on reaction pathways and fluid compositions and to establish the methodology to extract information from the hydrothermal fluids.
We conducted the flow-through experiments to dissolution/alteration of the rock powder at the conditions from 50 to 400 degreeC at 25 MPa. We used the two types of rocks powers; basalt (Island) and harzburgite (Horoman, Japan), and two types of solutions, NaCl 3wt percent solution and NaCl 3wt percent + $MgCl_2$ 0.3 wt percent, the latter is an analogue of seawater after the precipitation of gypsum $CaSO_4$ at elevated temperatures.
The major elements concentration generally higher in basalt-dissolved experiments than harzburgite-dissolved experiments, and the concentration of Si, Al, K and Ca in basalt increase with temperature and has a maximum at 350 degreeC, and then slightly decreases at 400 dergeeC, which is similar to the change of solubility of quartz (Si type), which is a function of water density, whereas the concentration of Mn increases monotonicly with temperature up to 400 dergeeC. In runs with $MgCl_2$, the concentrations of Si, Al, Fe, Mn, Ca, K drastically increases both in basalt and harzburgite systems. After the experiments, dissolution of glass was domiant in the basalt-$NaCl_{aq}$ experiments, whereas dissolution of glass, plagioclase and clinopyroxene to produce chlorite significantly occur in NaCl+$MgCl_{2,}$aq experiments. Principal component analyses of major elements of the solutions reveal that PC1 represent the pH decreases due to Mg addition, whereas the PC2 represent the formation of Mg mineral (chlorite) as a strong function of rock type (basalt vs. harzburgite). In contrast, the principal component analyses of trace elements represent that the dissolution of specific minerals such as plagioclase (PC1, Sr, Eu, Li) and Cpx/Ol (PC2, Ni, Zn, Co). Our results suggest that magnesium in seawater provides the primary controls on the reaction pathways of the oceanic lithosphere, by lowering pH to enhance the kinetics of mineral dissolution and by the formation of magnesium minerals, and that temperature dependency of trance element concentration could be controlled by the reaction pathways.

Keywords: Water-rock interaction, hydrothermal experiments, magnesium

 