

Hydrothermal flow-through experiments of basalt alteration: Exploring feedbacks between reactive transport processes

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Flow-through alteration experiments can be used to explore feedbacks between chemical reactions and flow fields, and thus, provide insight for reactive transport modeling. In this contribution, we assess basalt alteration by performing hydrothermal flow-through experiments on solid cores at 150°C and 150 bars. Experimental fluid (0.94 mol NaCl/kg and 0.6 mol CO₂/kg) was pumped into basalt cores (~1.3 cm diameter and ~2.6 cm length) that were cut from a borehole sample of Snake River Plain Basalt. Two experiments used a flow rate, Q , of 0.01 ml/min for 20 and 33 days, and two others used a Q of 0.1 ml/min for 0.5 and 2.7 days. In contrast to little permeability change at the lower Q , permeability increased at the higher Q , although there was an order of magnitude difference in the increase between the two experiments. Trends of dissolved species also depended on experimental Q . At the lower Q , dissolved Fe initially increased to a peak concentration of 2.5 mmol/kg and then decreased with reaction progress, while aqueous Si initially decreased before increasing to concentrations of 6-7 mmol/kg. During these experiments, Mg continually increased and ultimately attained concentrations of 5-6 mmol/kg. Concentrations of Fe, Mg, and Si were more stable during the experiments at the higher Q . Alkali metals (Li, K, Rb, and Cs) were preferentially dissolved from basalt cores, to the extent that all of the Cs was dissolved over the relatively short experimental time scales. Even though experiments were conducted on solid cores, high elemental recoveries in outlet fluids indicate a dense flow path network that facilitates fluid-rock reaction at all Cs-bearing sites within each core. Finally, cores were scanned using X-ray computed tomography (XRCT) both before and after experiments to document changes in pore geometries. Alignment of pre- and post-experimental XRCT scans illustrates both dissolution and precipitation, and ongoing work is quantitatively analyzing these pore-scale changes.