Basalt-water interactions at supercritical conditions (400˚C – 500 bar)

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This study concentrates on fluid-rock interactions in mid-ocean ridge basaltic (MORB) rocks under supercritical conditions. The experiment was conducted to investigate the reaction-path chemistry of supercritical fluid in terms of the nature and timing of chemical and mineralogical exchange. In previous experimental studies, some insight was gained into the fluid-rock exchanges that gave rise to the fluid chemical signature; however, many questions involving the equilibrium and kinetics of water-rock interaction remain. The reactive environments of mid-ocean ridge and seafloor spreading centres are of enormous global importance but surprisingly, there are few modern experimental studies aimed at understanding the associated hydrothermal activity. In order to study fluid-rock of these systems, computer modelling is less accessible due to a lack of thermodynamic data. The experimental approach offers the only alternative to directly access the fluid-mineral interactions occurring in these environments.

We used fresh basalt from the Reykjanes Peninsula, Iceland and distilled water. Using a flow-through apparatus, basalt was reacted with fluid at a temperature and pressure up of 400°C and 500 bars for a total period of 37 days. Effluent solutions were analysed using standard methods for aqueous samples and run products were analysed by a combination of XRD, SEM, and petrography.

Unaltered basalt is composed of predominantly plagioclase and clinopyroxene, with a lesser amount of opaque minerals and a minor quantity of olivine. Effluent samples from the experiment contained high concentrations of silica (2000 mg kg^{-1}), Na and Al, and minor amounts of Ca and K, and no detectable Fe, Mg, Mn. The pH increases to 9.2 by the end of experiment, indicating measurable hydrolysis of silicate phases. Activity-activity diagrams for Na-K-Ca show that compositions lie within the stability of albite and diopside whose presence was also confirmed by XRD analysis.