

Evolution of permeability and fluid chemistry during serpentinization of ultramafic rocks: An experimental study

FAROUGH, A.^{1*}, MOORE, D.E.², LOCKNER, D. A.²
AND LOWELL, R. P.¹

¹Virginia Tech, Blacksburg, VA

(*correspondence: afarough@vt.edu)

²USGS, Menlo Park, CA

Serpentinization plays a key role in hydrothermal processes and structural deformation at slow and ultraslow mid-ocean ridges. The links between the serpentinization reactions and changes in permeability and stresses are poorly understood. To advance our understanding of the evolution of permeability and fluid chemistry accompanying serpentinization reactions, we performed a series of high-temperature permeability experiments on fractured solid ultramafic rock samples. Experimental conditions were 260°C, 50 MPa confining pressure, and 20±2 MPa pore pressure. Multiple peridotites and pyroxenites were tested, to investigate the effect of mineral assemblage on fluid-rock interaction and permeability. Samples were cylindrical cores of 18 mm diameter and 23 mm length that were split axially to form a well-mated tensile fracture. A 7.5 mm thick layer of the same rock, crushed and sieved (0.18-1.0 mm size range) was placed on the inlet end of the sample to produce a heated fluid reservoir with which the deionized water, used as pore fluid, could react before entering the fracture.

About 1 cm³ water was pumped through the sample each day and collected for chemical analysis. Pore-fluid flow was in one direction and the pore-pressure change and flow rate were recorded to determine permeability. In most samples, the initial effective permeability was 10⁻¹⁵-10⁻¹⁸ m², and decreased by about 3 orders of magnitude in approximately 2 weeks, suggesting that serpentinization reactions have a rapid effect on permeability. The behavior of Mg, Fe, and Si in solution varied with the composition of the host rock and with time. Thin section analysis of the samples from before and after the experiments shows that the experiments reasonably simulate the natural setting observed in IODP samples that show pervasive, small-scale fracturing.