INTERACTIONS BETWEEN CHEMICAL ALTERATION, FRACTURE MECHANICS, AND FLUID FLOW IN HYDROTHERMAL SYSTEMS

Owen Callahan
The Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas
owen.callahan@gmail.com

Abstract

Fault and fracture networks are important conduits for fluid transport in the upper crust. Extreme thermal and chemical gradients in fracture-controlled hydrothermal systems result in enhanced water-rock interaction and redistribution of minerals into distinct alteration assemblages. The effect of this mineral redistribution on fracture mechanical properties and fracture geometry, and the potential feedback between chemical alteration, fracture evolution, and fluid flow conduits, remain to be addressed.

This project aims to accomplish the following objectives: (1) quantify the impact of hydrothermal alteration on fracture mechanical properties; (2) establish feedback mechanisms linking chemical alteration, fracture mechanics, and fracture network geometry; and (3) validate conceptual feedback models through numerical simulations of fracture network evolution.

The project combines petrography and fracture mechanics testing of naturally altered samples with numerical simulation of fracture network evolution. Fracture mechanics tests will quantify the effects of chemical alteration on fracture toughness and subcritical fracture index. Field, petrographic, and laboratory observations will lead to numerical simulations of fracture network evolution that test the sensitivity of fracture network geometry to contrasting fracture mechanical properties in adjacent assemblages.

Project outcomes will contribute to our understanding of the evolution of hydrothermal systems. The results will also be relevant to coupled processes of fluid flow and mechanical behavior in a variety of chemically reactive environments, including the interaction between injected fluids and reservoir rocks during advanced recovery operations, subcritical crack growth in reservoir and seal rocks at CO_2 sequestration sites, the focusing of flow in epithermal ore deposits, and in seismically active fault zones.

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