Impact of Coating Development on the Hydraulic and Transport Properties in Argillaceous Limestone Fracture.

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Abstract

Results are reported for an acidic water flow-through experiment conducted in a fractured argillaceous limestone sample (73% carbonates). The change in fracture geometry and related parameters is reported for six data sets obtained from synchrotron X-ray microtomography experiments. High-resolution 3D images of the sample allowed to quantify the changes in fracture morphology at a spatial resolution of 6 μm. Mineral mass loss and permeability changes in the sample were also determined. Several physico-chemical phenomena were identified during the experiment. Initial smooth fracture surfaces evolved rapidly toward rough surfaces with uneven clay coverage due to the preferential dissolution of carbonate minerals compared to clay minerals whose dissolution kinetics is about 10^6 slower. A micro-porous clay coating progressively developed at the fluid-rock interface during heterogeneous dissolution of the fracture, while the global dissolution kinetics of the fracture walls exponentially decreased. The increase in surface roughness and the presumed reorganization of clays caused a progressive reduction in permeability. During the last flow-through stage, a large decrease in sample permeability was attributed to the large removal of clay particles; this process was responsible for a dramatic collapse of the fracture walls near the sample inlet and led to the development of preferential flow pathways. The development of the clay coating also acted as a barrier to flow and mass transfer between calcite grains and bulk solution and affected transport processes within the fracture.