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Modelling of diffusion-limited transport in an altered fracture during dissolution.

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Fractures are the principal pathway for water flow in low permeability rocks. Moreover rocks located near the earth surface are subject to alteration by the circulating fluids, so fracture geometry, fluid flow, and solute transport can be considered as parameters evolving with time. Prediction of reactive transport in fractures is challenging because of the complexity of interactions in natural environment. So the input of experimental data from laboratory or field scale is required to validate the results from models and to extrapolate them on the long term. Here, we present laboratory observations and modelling on the impact of a micro-porous coating development on fracture geometry, flow and reactive transport. This study examines the dissolution effects caused by acidic water within a natural fracture in an argillaceous limestone sample, specifically examining the evolution in the geometry and hydraulic properties in relation with the fluid chemistry. A micro-porous clay coating progressively develops at the fluid-rock interface, due to the preferential dissolution of carbonate minerals compared to clay minerals whose dissolution kinetics is about 10ˆ6 slower. The development of the clay coatings acts as a barrier to flow and mass transfer between calcite grains and bulk solution, and induces diffusion along a moving grain boundary. On the basis of experimental results, a conceptual model for mass transport is proposed. Multi-component reactive transport is solved with the HYTEC code (Ecole des Mines). Integrating constitutive laws in the code to relate permeability and effective diffusion coefficient to porosity variations enables to obtain good agreement between experimental results and numerical simulation.