Modeling geomechanical deformation in reactive fractures

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Understanding processes that alter subsurface fractures is critical to identifying important leakage pathways and predicting the potential for migration of environmentally-relevant fluids. Many studies have highlighted the effects of mineral dissolution that occur from reactive fluid flow. However, these studies often ignore geomechanical forcings present in subsurface fractures. To investigate these effects, this study couples a two-dimensional reactive transport model [1] with a mechanical deformation model [2] to simulate reaction, flow and deformation in fractured rock. This study investigates the effect of different confining pressures on the evolution fracture aperture and permeability. Normal mechanical loads of 10, 30 and 50 MPa are simulated, using a fracture with 2.5cm by 5cm dimensions.

Results indicate that subsurface confining stress can lead to fracture wall closure when reactive flow results in mineral dissolution. Therefore, failure to account for geomechanical forcings in reactive flow simulations would overestimate permeability increase in subsurface fractures. In fractures where dissolution results in channelization, the amount of normal stress applied to the fracture effects the progression of the reaction front and the breakthrough time needed for the channel to penetrate the length of the fracture. Therefore, normal stresses dictate the time required for the rapid increase in permeability resulting from channelization.

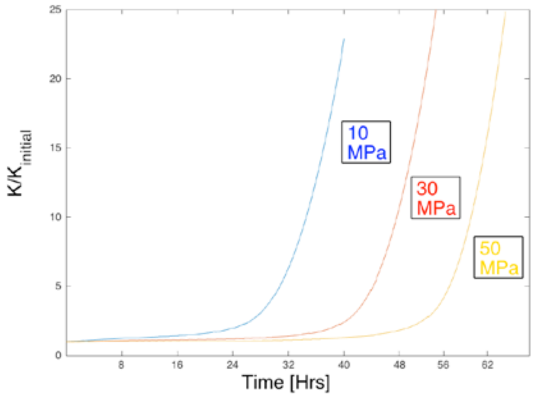

Figure 1: Permeability increase in a limestone fracture exposed to CO_2-acidified fluid, with normal stress effects.

[1] Deng, H. (2015) *Doctoral Dissertation, Princeton University*. [2] Pyrak-Nolte, L.J., Morris, J.P. (2000). *Int. J. Rock. Mech. Min. Sci.*, **37(1-2)**, 245-262.