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Alteration and auto-sealing of fractured shales induced by CO2-rich fluid percolation

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We investigate the sealing reliability of fissured shale caprocks submitted to highly CO_2-enriched water fluxes. Results are reported for water flow-through experiments conducted in a 20% carbonate shale sampled in the Tournemire tunnel (France). Different percolating fluids - either equilibrated or undersaturated with respect to the rock forming minerals – are variably enriched in CO_2up to 0.1 MPa partial pressure, and then injected at constant flow rate in fractures of known initial aperture. The change in fracture permeability is recorded as well as the composition of the effluent fluid. We observed a decrease of the fracture permeability up to a complete sealing in certain cases, whereas the net balance of the rock mass decreases due to the dissolution of the carbonate fraction. The rate of decrease of the fracture permeability depends on the initial composition of the fluid (pH, ions content). X-ray microtomography and electron microscopy imaging allow enlightening the possible processes that end up to the auto-sealing of the fracture. As carbonate fraction dissolves, clays-fluid interface area increases and swelling of the illite-smectite fraction seem to occur, possibly enhanced by local chemical exchanges.