Convective mixing fingers and chemistry interaction in CCS

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Supercritical CO_2 injected into geological formations tends to accumulate at the top of target aquifers. Once dissolved, a denser CO_2-rich fluid is generated on top of the lighter native brine. This unstable configuration promotes convective mixing of liquids, having a major impact on CO_2 dissolution and, thus, on carbon mineralization.

A reactive transport model that couples convective mixing with geochemical reactions has been developed with iCP [1] to assess the interaction between chemistry and fluid flow. The chemistry of a carbonate-hosted aquifer was simulated considering gypsum (equilibrium) and calcite (kinetics). The two end members are the native fluid and the boundary fluid resulting from equilibrating the native fluid with 50 atm of CO2 (Table 1).

	pH	ρ (kg/m3)	TIC (mol/kgw)
Initial fluid	6.98	1.024	2.63 e-4
Boundary fluid	3.35	1.035	0.652

Table 1. pH, density and total inorganic carbon concentration of the initial fluids .

Results predict the intrincate relation between flow and chemistry. Convective fingers affect the distribution of the chemical species, while mineral content and the reaction rate drive porosity and permeability changes. The simulations are categorized as a function of the Rayleigh and Damkhöler numbers.

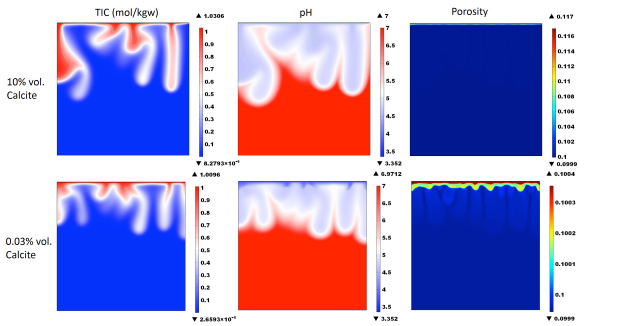

Figure 1. TIC, pH and porosity after 10 years simulation for aquifers with 10% (up) and 0.03% (down) calcite content**.**

[1] Nardi, et al. (2014) *Computers & Geosciences* **69**, 10-21.