Simulation of the impact of SO_2 co-injected with CO_2 on the reservoir-rock reactivity

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An important aspect in CO_2 storage in geological media is the quality requirements put on the gases to be stored in terms of risk management. This study investigates and compares, through reactive transport modelling, the potential short-term (5y) reactivity of CO_2 gas streams - pure or containing ancillary gaseous compounds (SO_2: 0-1.5% Wt) - with the reservoir-rock of a limestone aquifer at 75°C. The modelling approach simulates the co-injection of CO_2-(SO_2) gases, through injection of CO_2 (under supercritical form) and simultaneous injection of a SO_2 (as a dissolved species solution) rich brine with TOUGHREACT [1].

The numerical simulation results indicate the development of an acidification front ($pH < 5$) following the progression of the gas migration in the reservoir. After an injection period of 5 years, the acidified zone extends up to 500 m from the injection well, independently of the impurity percentage of the CO_2 gas stream. In close proximity of the injection well (0-10m), substantial calcite dissolution, together with albite and K-feldspar dissolution, result in a drastic increase of the permeability (1 order of magnitude) and porosity (x2). When CO_2 is injected alone, anhydrite also precipitates in this reservoir zone. Significant calcite dissolution is also predicted in the zone 50-100m - a highly reactive zone - resulting in a local permeability and porosity increase. Because of its high solubility, SO_2 mainly remains in the brine (SO_2 content lower in the CO_2-rich phase than in the injected gas stream), decreasing its pH/Eh (relatively to pure CO_2). Dissolved SO_2 is lowly reactive with reservoir minerals.

[1] Xu et al. (2011). *Comput. Geosci.*, **37**, 763-774