Effects of CO_2 injections on calcite precipitation in brine aquifers: an overall kinetic rate law.

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CO_2 injections in brine aquifers would modify strongly the physic and the chemistry of the host aquifer (i.e Temperature, Chemical composition, Partial pressure of CO_2…) affecting mainly the calcite precipitation kinetics. Although many geological system can be described using thermodynamic concepts and principles, the factor governing their fate and evolution can only be understood if the kinetics and mechanisms of reactions are well known. One of the most crucial problems in the application of carbonate fluid-rock interactions remains the function describing the variations of the precipitation rate. From previously published and new kinetic data set, we developped an inversion model to establish an overall rate law allowing to describe the calcite precipitation rate as a function of temperature ($5<T$°C<70), partial pressure of CO_2 ($30<P_{CO_2}$(Pa)$<30.10^4$), salinity ($5<S<55$) and specific constituents activity (a_i (µmol.kg^{-1})). Experiments were carried out using the constant addition technique to maintain constant [Ca^{2+}] and chemical affinity, while [CO_3^{2-}] was varied to isolate its role on the rate of calcite precipitation.

Results of the experimental data inversion predict variations of calcite precipitation rate and reaction mechanisms in response to a CO_2 injection in brine aquifers.Despite both temperature and ionic strength control the kinetic reaction mechanisms(i.e. partial reaction order with respect to [CO_3^{2-}]), the variations of CO_2 partial pressure enhances by three orders of magnitude the rate of calcite precipitation in completely buffered fluids. Our study highlight the main catalytic role played by PCO_2 in present day sedimentary basins independently from the desequilibrium conditions. Salinity and temperature have on the other hand a catalytic influence only under far from equlibrium conditions.