Assessing the potential impacts of CO2 leakage on fresh groundwater: from experiments to predictive models

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Geological storage of CO2 in deep saline aquifers is one of the options considered for the mitigation of CO2 emissions into the atmosphere. A deep geological CO2 storage is not expected to leak, however, potential impacts of CO2 leakage into aquifers overlying deep storage site have to be addressed. . A better understanding on how it could affect groundwater quality, aquifer minerals and trace elements mobilization is necessary to fully characterize a future storage site. Moreover, this characterization is required to evaluate monitoring and remediation plans. As part of the collaborative project CIPRES co-funded by the ANR, we present reactive transport works dedicated to the impact assessment of CCS on fresh groundwaters.

In a 3D model using ToughReact v.3, we perform different CO2 leakage scenarios in a confined aquifer. This study focuses on theAlbian aquifer that is a strategic water resource in the Paris Basin. The model is based on groundwater and rock chemistry of the Albian green sand layer (i.e. Quartz, Glauconite, Kaolinite) at 700 m deep. The geochemical model was elaborated from experimental data (Barsotti et al. 2016 and Humez et al. 2014) taking into account kinetics for mineral dissolution, ion exchange and surface complexation processes. The numerical mesh consists of 200 m× 500 m × 60 m. A grid refinement near the leakage point is considered to focus on local phenomena e.g. secondary precipitation, surface processes. The total mesh comprises 21600 cells.

The results highlight the importance of sorption processes on trace element mobilization and transport (As, Zn and Ni) in fresh groundwater. Moreover, we distinguish different geochemical behavior (CO2 plume shape, secondary precipitation, desorption...) occurring at different depth and length scale according to the horizontal flow rates and density effects that are influenced by hydrodynamic properties (regional gradient). Coupling geochemical processes and regional flows influence on water chemistry evolution allows to strengthen monitoring and verification plan as well remediation perspectives.