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Porosity and permeability change of Lower Tuscaloosa and Marine Shale formations (Mississippi, USA) induced by CO2 injection: a numerical study

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A reservoir-scale numerical model was developed with the use of multi-phase reactive transport code TOUGHREACT to estimate porosity, permeability and mineral composition changes of Lower Tuscaloosa (LT) sandstone formation and Marine Shale (MS) caprock overlying LT formation when CO2 is injected into LT formation. The reservoir-scale numerical model was developed based on geological settings of LT and MS formations at Plant Daniel CO2 storage test site, Mississippi, USA. Another core-scale reactive transport model was developed with the use of reactive transport code CrunchFlow to predict permeability evolution of small LT and MS samples when exposed to CO2-saturated brine in the laboratory, and the permeability and solution chemistry results from the model were compared with experimental data to validate important modeling parameters (equilibrium constants (Keq), reaction rate constants (k) and n in the Verma-Pruess permeability-porosity relation) that were used in the reservoir-scale simulation. Both the reservoir-scale model and the core-scale model predict precipitation of amorphous silica (SiO2, am) and kaolinite in the pore space of LT rock when interacting with CO2-saturated brine. Dissolution of chlorite and feldspar is also predicted. However, mineral precipitation and dissolution are limited in both LT and MS formations after interacting with CO2-saturated brine for 130 years, and porosity and permeability changes of LT and MS formations caused by mineral precipitation/dissolution are minimal.

References

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