Imaging the effects of CO_2 injection on fluid transport properties in sandstone using Positron Emission Tomography

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During geologic carbon storage, the desequilibrium induced by continous CO_2 injection at deph leads to geochemical alteration of the heterogeneous rock matrix. This alteration leads in turn to the evolution of fluid transport properties and ultimately structural changes in the reservoir. This linkage has direct implications for the integrity of primary reservoirs and thus the success of geologic carbon storage during CO_2-rich brine injections.

This study focuses on the geochemical reactivity and associated structural alteration of a Mt. Simon sandstone reservoir sample due to CO_2 injection dissolved within a synthetic brine (ionic strength and total dissolved solids of 3.73 mol Kgw^{-1} and 196.3 g L^{-1}, respectively). The experimental procedure involves acquisition of a 3D permeability map of the initial sample by direct observation using non-invasive, real-time radiotracer imaging technique, Positron Emission Tomography (PET). The PET imaging study consists of a pulse injection at a flow rate of 1.4 mL min^{-1}, containing inert fluouride-18 radiotracer, performed at the beginning and at the end of the CO_2-saturated brine flow-through experiment. Geochemical alteration is induced between the pre and post PET-imaged injection pulses by injecting CO_2-rich brine under supercritical CO_2 conditions (P_{Total} = 100 bar, pCO_2 = 86.2 bar and T = 53 °C) at flow rate of 0.15 mL min^{-1} for over 8 pore volumes. The acidic CO_2 rich brine solution promoted the dissolution of K-feldspar, chloride and calcite, and the precipitation of some Ca and Si-bearing minerals, resulting in a net opening of pore space. However, peridic increases in differential pressure across the core suggest episodic clogging or displacemnte of fines, which results in a complex permeability evolution, thus altering local resistance to fluid phase pressure gradients.