Geochemical and structural alterations by CO_2-rich brine transport through Mt. Simon reservoir core under supercritical CO_2 conditions

GABRIELA DAVILA[1], CHRISTOPHER ZAHASKY[2], SALLY M. BENSON[2], DUSTIN M. CRANDALL[3], CHARLES L. WERTH[4], JENNIFER L. DRUHAN[1]

[1] University of Illinois Urbana Champaign, UIUC, Department of Geology, 605 W Springfield St. 61820 Champaign, IL 61820, USA.

[2] Stanford University, Department of Energy Resources Engineering, 367 Panama St Green Earth Sciences 065, Stanford, CA 94305, USA.

[3] National Energy Technology Laboratory, Morgantown, WV 26505, USA.

[4] University of Texas at Austin, Department of Civil, Architectural and Environmental Engineering, 301 E. Dean Keeton St., Stop C1786, Austin, TX 78712, USA.

Abstract

The Illinois Basin- Decatur Project (IBDP) is a large-scale CO_2 injection and storage demonstration site which has thus far injected 1-million metric tons of CO_2 over three years at 2206 m depth. Micro-seismic events were observed within the injected CO_2 plume well after the primary injection pressure wave, implying structural change associated with geochemical alteration. The present study evaluates the interaction between a Mt. Simon core sample and a CO_2-rich synthetic brine in a through-flowing experiment. Over 40 pore volumes were flushed through the sample at a flow rate of 0.15 mL min^{-1} under P_{Total} = 100 bar, pCO_2 = 86.2 bar and T = 53 °C. The experimental procedure involves collection of effluent samples to construct a time series of dissolved solutes, which are used to quantify mineral dissolution/precipitation processes and relate these observations to alteration of the structure and mechanical properties of the solid phase. 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 porosity increase ~2 mm from the inlet. Consequently, in this advection dominated regime (Pe >1), local heterogeneities result in decreased permeability ($k_{(f)}/k_{(i)}$ = 0.76), thus altering local resistance to fluid phase pressure gradients. The aqueous concentrations obtained from the experimental procedure were reproduced by a 2D reactive transport simulations using CrunchFlow software to evaluate kinetic parameters and evolution of mineral surface area.