Reservoir characterization and complications for trapping mechanisms at Cranfield CO2 injection site

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Abstract:

Understanding and predicting physical and chemical trapping mechanisms are important for designing successful CO2 storage projects. The processes have been investigated extensively by numerical modeling and, to a lesser degree, by laboratory experiments. The results of modeling and laboratory studies need to be verified at field conditions and scales. A variety of field data sets have been collected at the Cranfield CO2 injection and monitoring site of the Southeast Regional Carbon Sequestration Partnership (SECARB) where 3.54 million tons of CO2 had been injected by February 2012. Field characterization and extensive monitoring provide unique insights into the trapping processes that help in immobilizing injected CO2. The four-way closure of the injection zone ensures effective structural trapping of buoyant CO2 and maximum opportunity for chemical trapping. The fluvial reservoir shows a high degree of lithologic and petrophysical heterogeneity associated with multiple episodes of fluvial-channel incision and deposition. Variable diagenetic chlorite further exerts a complex overprint on rock properties because chlorite grain coatings prevent quartz cementation and preserve porosity. CO2 solubility in the brine under the field condition is approximately 36 g/L (9 kg/m3 rock volume). The CO2–brine contact area is maximized within the sinuous and focused flow pathways that could increase dissolution. Yet geochemical reactions are found to be very slow in the reservoir. Mineral trapping capacity is limited because the reservoir rocks contain only trace amount of reactive minerals that supply cations to convert CO2 into carbonate minerals. Two parallel multiphase flow experiments show that CO2 residual saturation varies significantly between conglomerate and sandstone (31% and 3.5%) facies in the reservoir, which complicates estimates of residual trapping capacity.

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