Evaluation of Geologic CO₂ Sequestration Potential of the Morrow B Sandstone in the Farnsworth, Texas Hydrocarbon Field using Reactive Transport Modeling

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Research Objectives

● Simulate the movement of injected CO₂ in the Morrow B reservoir and the reaction of CO₂ with Morrow B formation water and mineral matrix

Numerical Grid

● 61,600 total cells
● 38,290 active cells
● Cell colors represent 35 discrete rock types categorized by porosity and permeability obtained from Petrel geological model

Model Set-Up Highlights

● Initial pressure distribution from reservoir history matching of Ampomah et al. (2016), ~32 MPa average
● Uniform initial temperature of 75⁰C
● Prescribed pressure and temperature boundary conditions along top and bottom grid boundaries
● Prescribed CO₂ injection in 9 wells in western Farnsworth Unit for time = 0 to 10 years
● Initial formation water and mineralogic composition from Ahmmed et al. (2016), Munson (1989), and Gallagher (2014)

Basis Species Conc. (mol/L) Mineral Volume (%)
Al₂O₃ 3.7 x 10⁻⁶ Albite 9.0
Ba²⁺ 1.4 x 10⁻⁷ Ankerite 0.25
Ca²⁺ 8.9 x 10⁻⁴ Calite 0.75
Cl⁻ 0.051 Clinohole 1.8
Fe³⁺ 2.3 x 10⁻¹² Illite 0.88
HCO₃⁻ 0.0011 Kaolinite 2.72
K⁺ 1.8 x 10⁻⁹ Quartz 84.3
Mg²⁺ 3.7 x 10⁻⁹ Siderite 0.25
Na⁺ 0.059 Smectite 0.1
SiO₂(aq) 2.3 x 10⁻¹²
SO₄²⁻ 1.4 x 10⁻⁴
Mn⁴⁺ 1.0 x 10⁻¹³ pH = 7

Results

Aqueous CO₂ concentrations (mol/kg H₂O) after (i) 10 years and (ii) 100 years of simulation

Immiscible CO₂ fractions after (i) 10 years and (ii) 100 years of simulation

Simulated temporal changes in volume fraction of carbonate minerals up to 30 years near well 8-4

Simulated temporal changes in volume fraction of non-carbonate native reservoir minerals up to 30 years near well 8-4

Conclusions

● Aqueous CO₂ is advected from the injection wells to the western boundary of the Farnsworth Unit by about 100 years
● Only minor changes in mineral abundance are predicted on decadal time scales
● Among the native reservoir minerals:
  Albite, clinohole, illite, and ankerite are predicted to dissolve
  Quartz, kaolinite, and smectite are predicted to precipitate
● Net precipitation of carbonate minerals is predicted
● More CO₂ is sequestered by aqueous solution than by mineral trapping

Acknowledgments

Funding for this project is provided by the U.S. Department of Energy’s National Energy Technology Laboratory through the Southwest Partnership on CO₂ Sequestration under Award No. DE-FC26-09NT42591

References

