Evaluation of Geologic CO_2 Sequestration Potential of the Morrow B Sandstone in the Farnsworth, Texas Hydrocarbon Field using Reactive Transport Modeling

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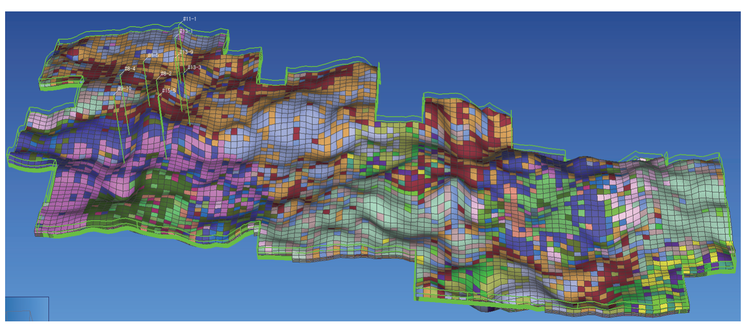
Research Objectives

- Simulate the movement of injected CO_2 in the Morrow B reservoir and the reaction of CO_2 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

Porosity (%) / Permeability (m^2)	0	>0 – 0.1	>0.1 – 0.125	>0.125 – 0.15	>0.150 – 0.2	>0.20
1×10^{-17}	rock1					
$> 1 \times 10^{-17}$ - 2.46×10^{-14}		rock2	rock3	rock4	rock5	rock6
$> 2.46 \times 10^{-14}$ – 4.93×10^{-14}		rock7	rock8	rock9	rock10	rock11
$> 4.93 \times 10^{-14}$ -7.4×10^{-14}		rock12	rock13	rock14	rock15	rock16
$>7.4 \times 10^{-14}$ – 9.87×10^{-14}		rock17	rock18	rock19	rock20	rock21
$>9.87 \times 10^{-14}$ – 1.23×10^{-13}		rock22	rock23	rock24	rock25	rock26
$>1.23 \times 10^{-13}$ – 1.48×10^{-13}		rock27	rock28	rock29	rock30	rock31
$>1.48 \times 10^{-13}$ - 1.72×10^{-13}		rock32	rock33	rock34	rock35	

Model Set-Up Highlights

- Initial pressure distribution from reservoir history matching of Ampomah et al. (2016), ~32 MPa average
- Uniform initial temperature of 75^o C
- Prescribed pressure and temperature boundary conditions along top and bottom grid boundaries
- Prescribed CO_2 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)

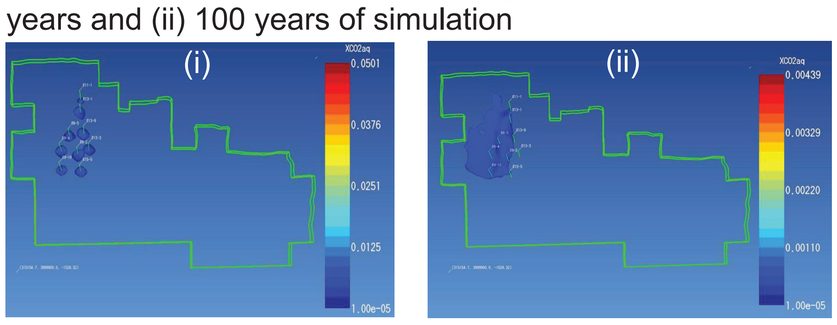
Basis Species	Conc. (mol/L)
AlO_2^-	3.7×10^{-8}
Ba^{2+}	1.4×10^{-7}
Ca^{2+}	8.9×10^{-4}
Cl^-	0.051
Fe^{2+}	2.3×10^{-12}
HCO_3^-	0.0011
K^+	1.8×10^{-4}
Mg^{2+}	3.7×10^{-5}
Na^+	0.059
$SiO_{2(aq)}$	2.3×10^{-12}
SO_4^{2-}	1.4×10^{-4}
Mn^{2+}	1.0×10^{-13}

pH = 7

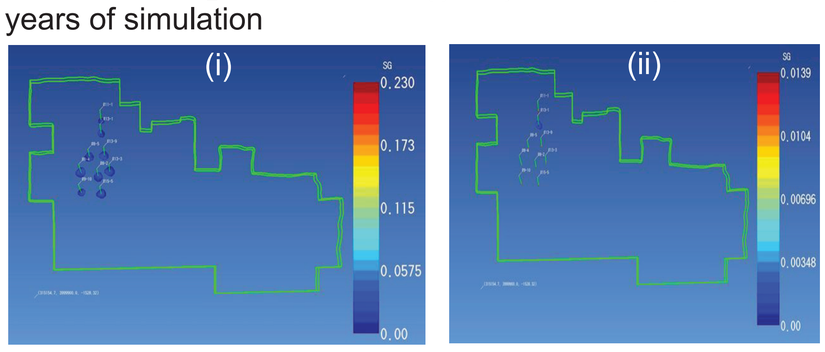
Mineral	Volume (%)
Albite	9.0
Ankerite	0.25
Calite	0.75
Clinochlore	1.8
Illite	0.88
Kaolinite	2.72
Quartz	84.3
Siderite	0.25
Smectite	0.1

Results

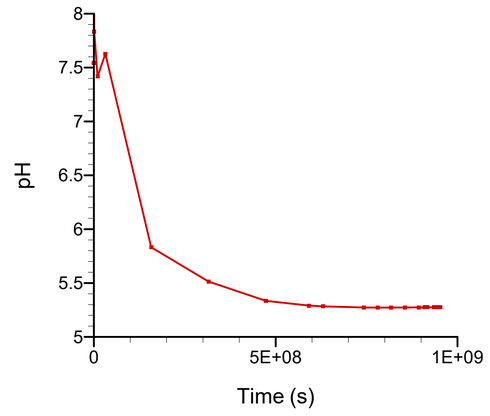
Aqueous CO_2 concentrations (mol/kg H_2O) after (i) 10 years and (ii) 100 years of simulation



Immiscible CO_2 fractions after (i) 10 years and (ii) 100 years of simulation

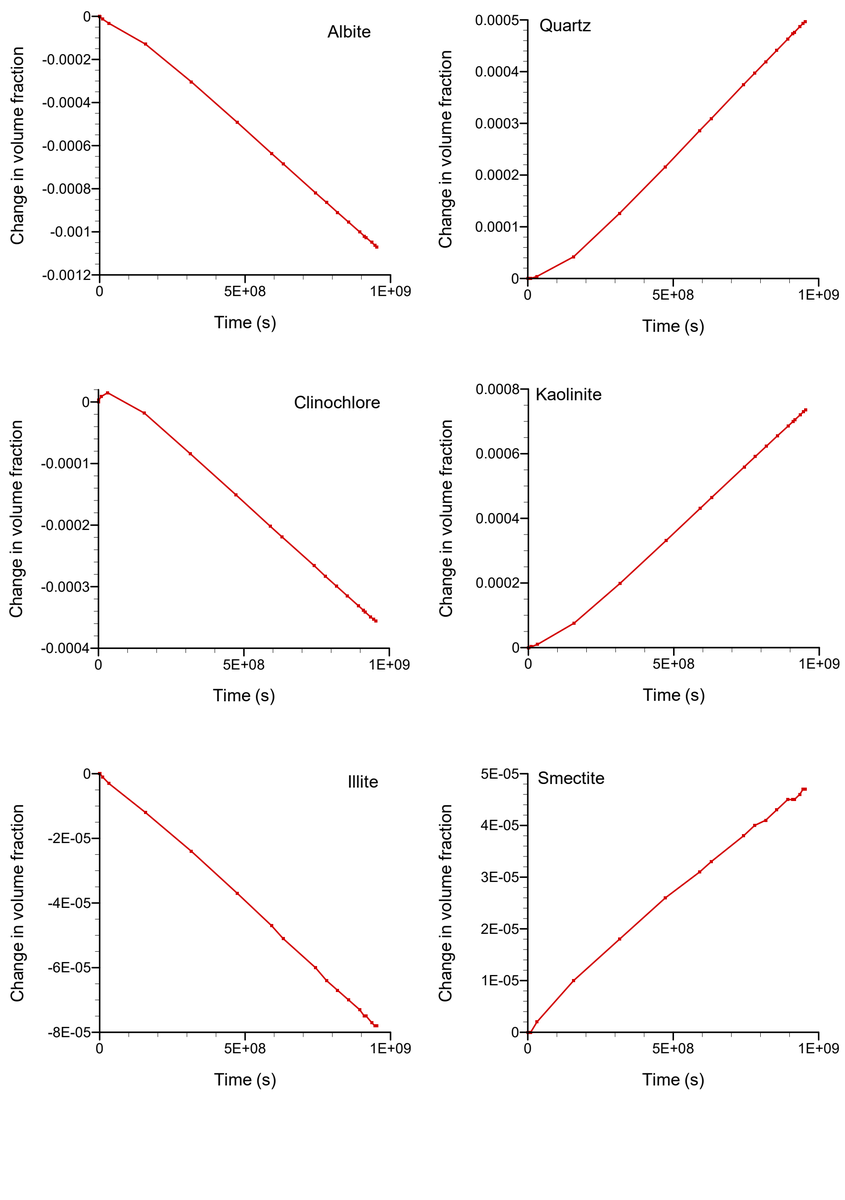


Simulated temporal variation of pH up to 30 years near well 8-4

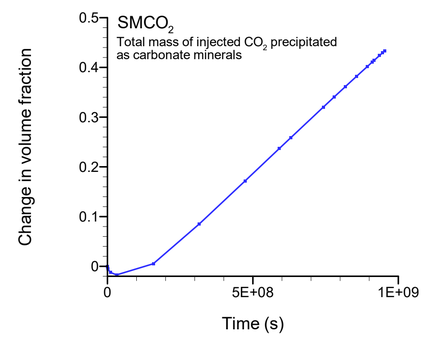


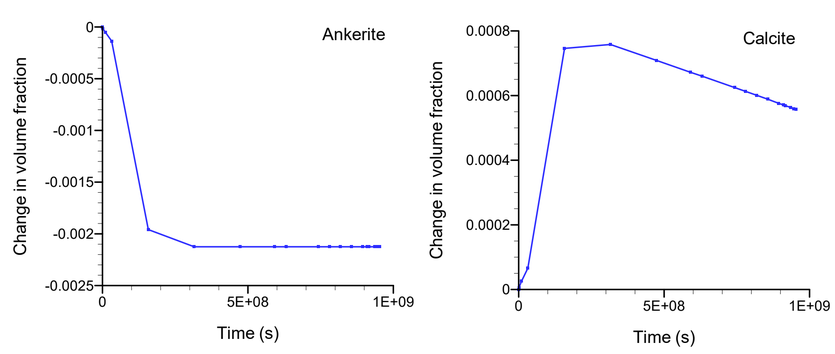
Simulated temporal changes in volume fraction of non-carbonate native reservoir minerals up to 30 years near well 8-4

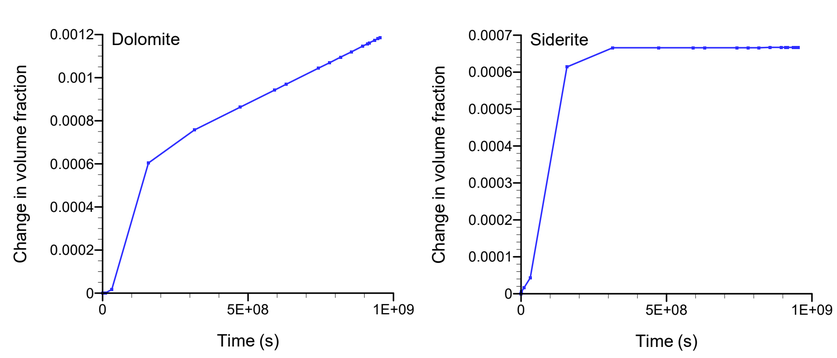
- Positive values indicate net precipitation
- Negative values indicate net dissolution



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







Conclusions

- Aqueous CO_2 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, clinochlore, illite, and ankerite are predicted to dissolve

  Quartz, kaolinite, and smectite are predicted to precipitate
- Net precipitation of carbonate minerals is predicted
- More CO_2 is sequestered by aqueous solution than by mineral trapping

Acknowledgments

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References

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