Reactive Transport Modeling of Water-CO_2 Interactions in the Farnsworth Unit, Texas

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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

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}

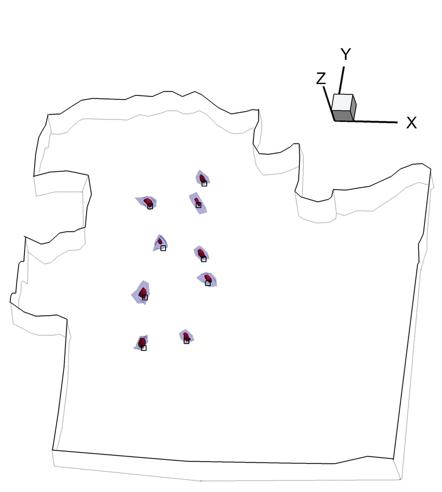
pH = 7

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

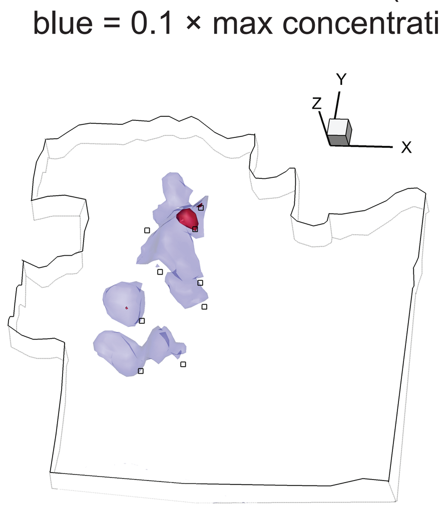
TOUGHREACT Results

Aqueous CO_2 concentrations (mol/kg H_2O)

i) **10 years**
red = max concentration (0.053)
blue = 0.1 × max concentration

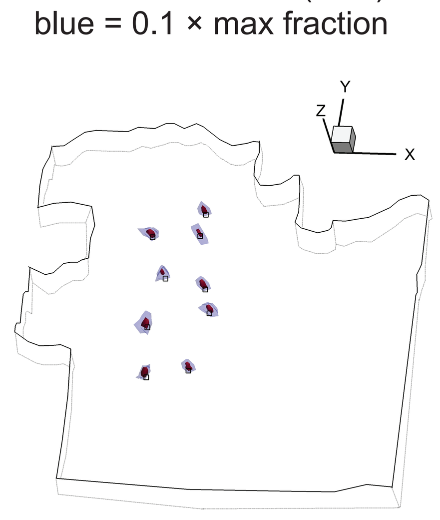


ii) **50 years**
red = max concentration (0.053)
blue = 0.1 × max concentration

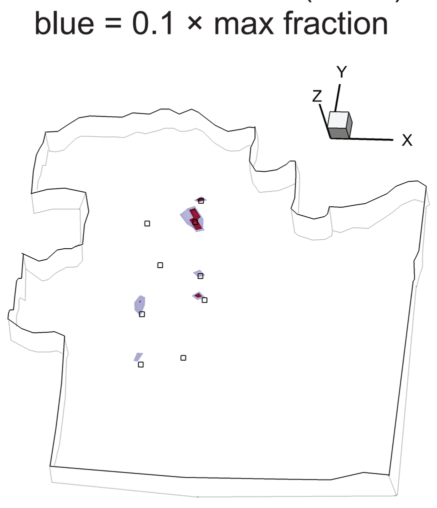


Immiscible CO_2 fractions

i) **10 years**
red = max fraction (0.19)
blue = 0.1 × max fraction

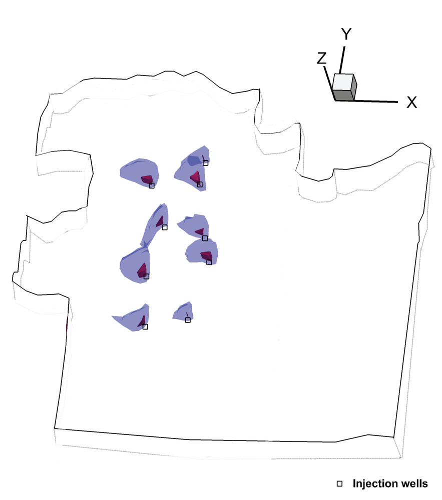


ii) **30 years**
red = max fraction (0.023)
blue = 0.1 × max fraction

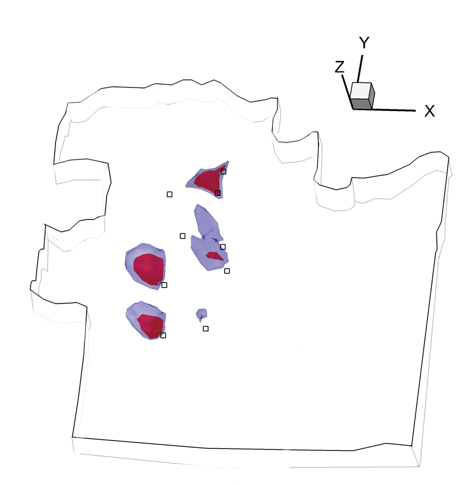


pH

i) **10 years**
red = 4.8 (minimum)
blue = 7

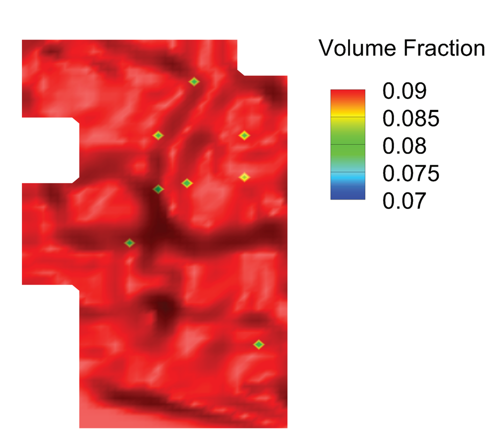


ii) **50 years**
red = 6 (minimum)
blue = 7



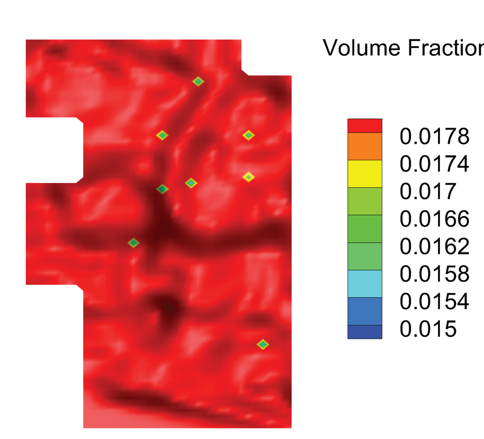
Albite

50 years



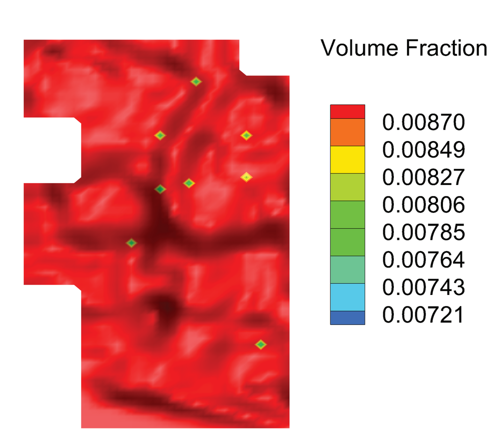
Clinochlore

50 years



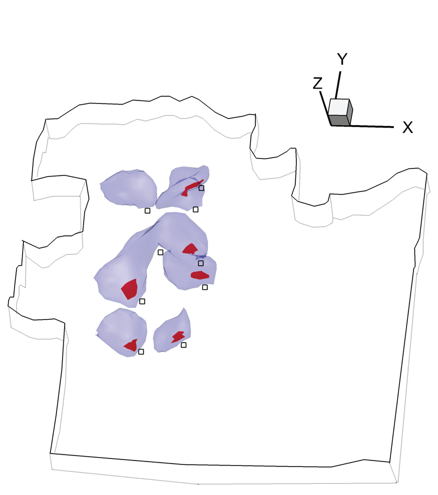
Illite

50 years



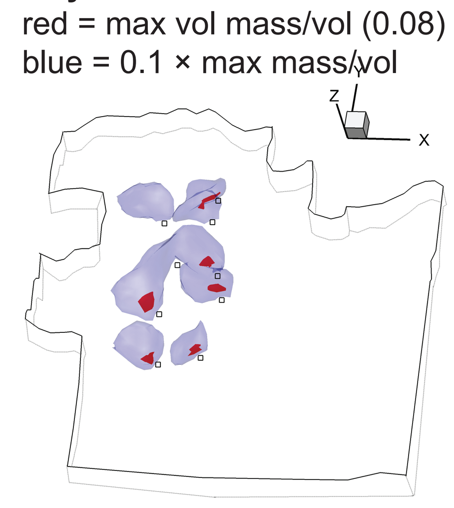
Dolomite

50 years
red = max vol fraction (0.00175)
blue = vol fraction = 0.001



Total CO_2 precipitated as carbonate minerals (kg/m^3)

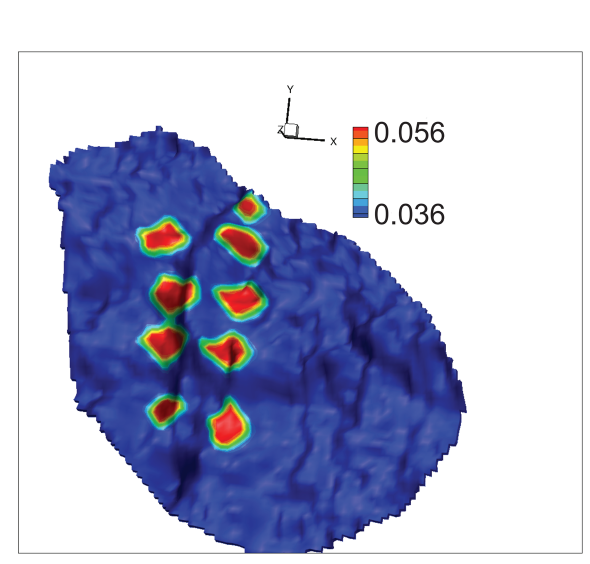
50 years
red = max vol mass/vol (0.08)
blue = 0.1 × max mass/vol



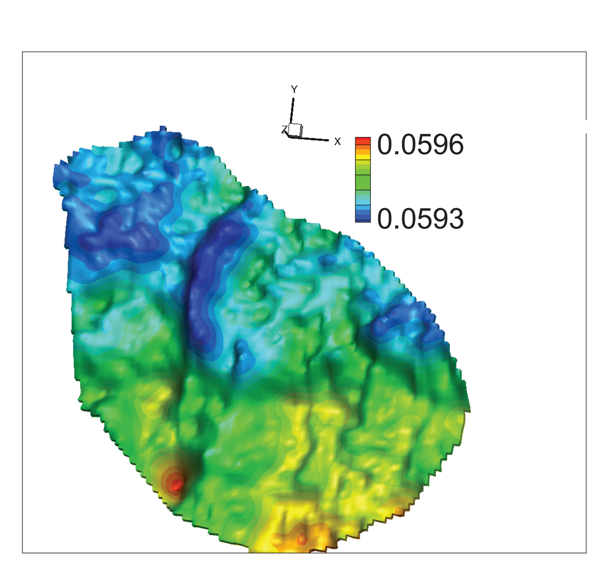
STOMP Results

Aqueous CO_2 concentrations (g/cm^3)

i) **10 years**

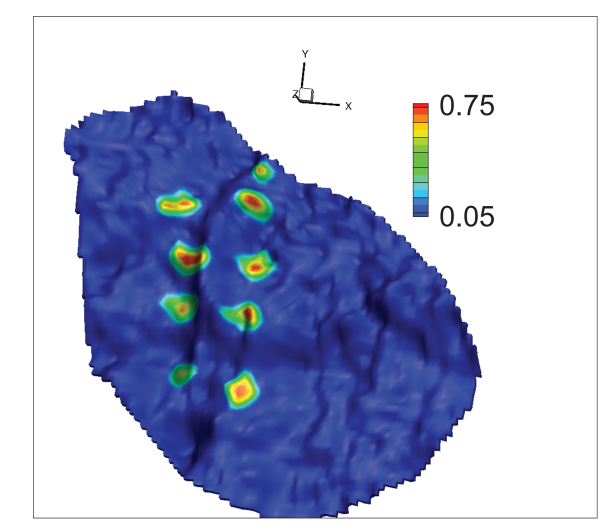


ii) **50 years**

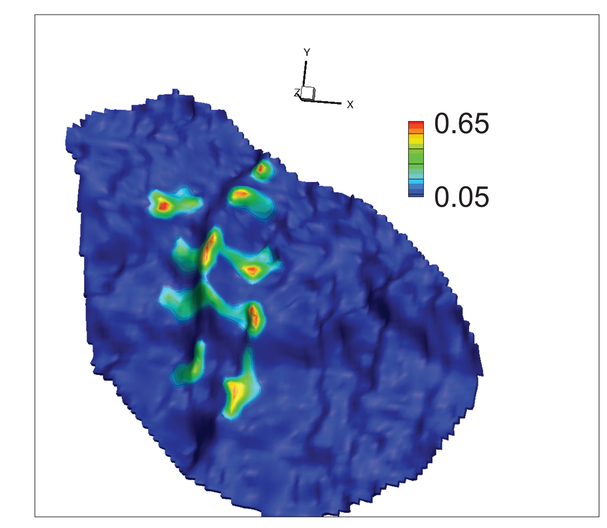


Immiscible CO_2 fraction

i) **10 years**



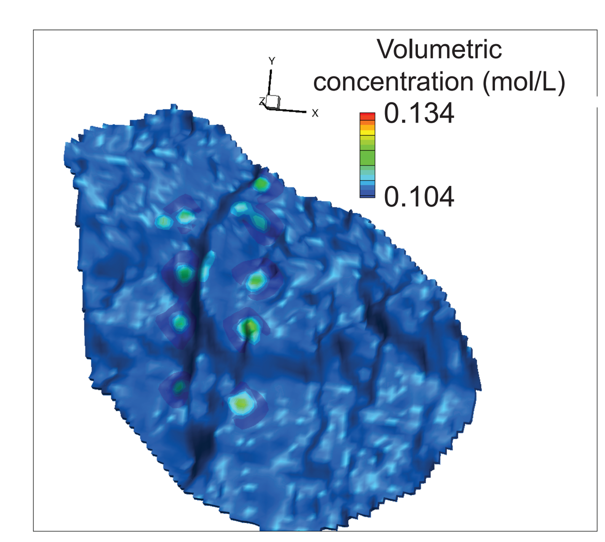
ii) **50 years**



STOMP simulations predict negligible changes in albite, clinochlore, and illite up to 50 years

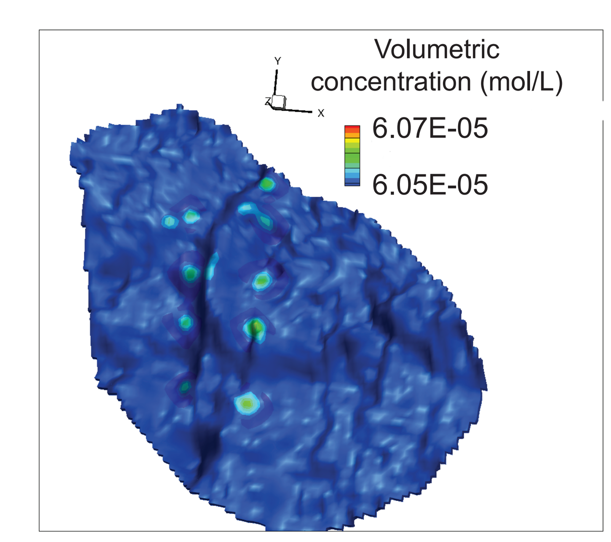
Calcite

50 years



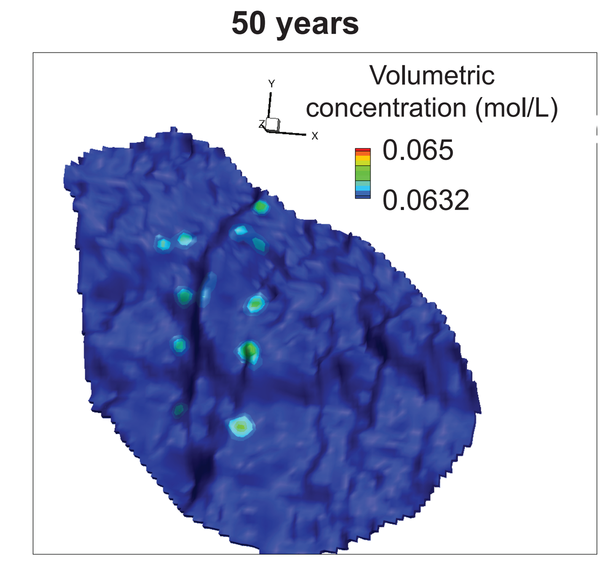
Magnesite

50 years



Siderite

50 years



Conclusions

TOUGHREACT simulations show that:

- CO_2 injected into the Morrow B Sandstone mainly enters the aqueous phase and is advected westward
- Principal reservoir minerals should dissolve
- Mineral sequestration of CO_2 should occur principally as dolomite

STOMP simulations are more preliminary; compared to TOUGHREACT simulations they predict:

- Higher aqueous and immiscible concentrations of CO_2
- Less dissolution of reservoir minerals
- Mineral sequestration of CO_2 principally by calcite, magnesite and siderite

Acknowledgments

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