Estimating solubility trapping rates in GCS

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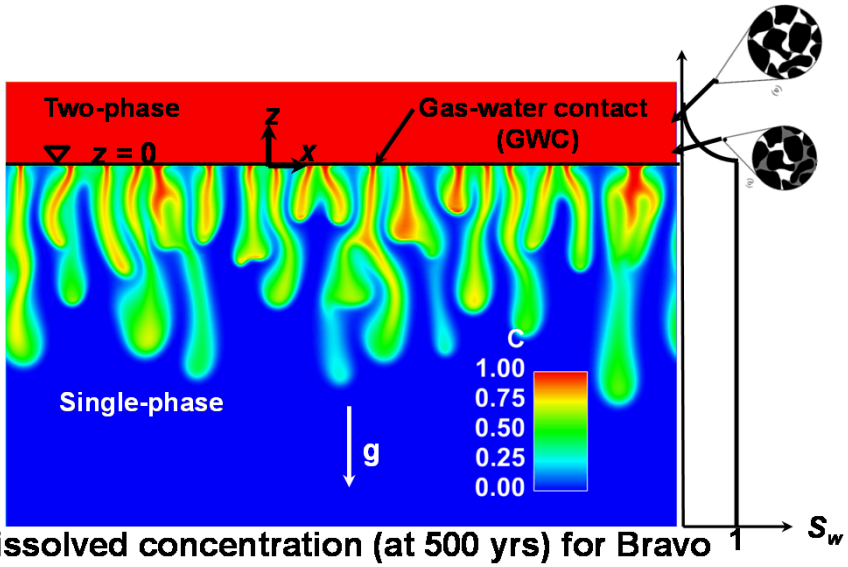


Dissolved concentration (at 500 yrs) for Bravo Dome properties with 50 kPa entry pressure.

Figure shows sinking plumes of dense CO_2-saturated brine in the brine-saturated region below the gas-water contact. The upper (red) region is the two-phase capillary transition zone occupied by a brine and separate-phase CO_2.

Martinez, M. J., and M. A. Hesse (2016), Two-phase convective CO2 dissolution in saline aquifers, Water Resour. Res., 52, doi:10.1002/2015WR017085.

Work was performed at Sandia National Labs.

Scientific Achievement

Developed an advanced model for buoyantly driven convective dissolution of CO_2 into brine.

Significance and Impact

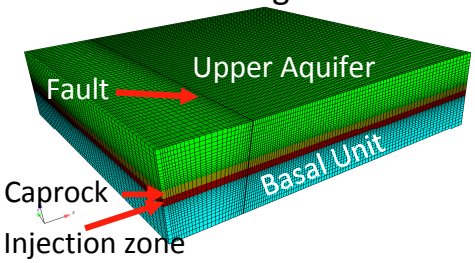
- Buoyantly driven convective dissolution enhances the rate of dissolution, but is difficult to quantify in the field
- Our new model demonstrates an new correlation between entry pressure and dissolution rate, enhancing dissolution flux more than 3 times previous estimates.

Research Details

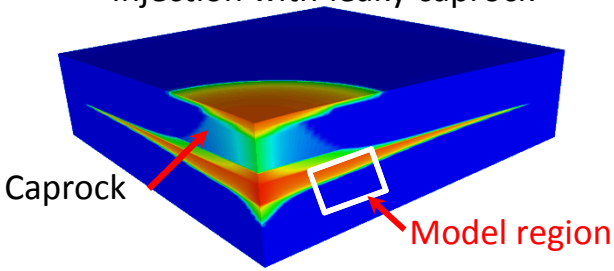
- Models have heretofore ignored the two-phase region above the gas-water contact where dissolution actually takes place
- The dissolution rate increases with capillary wicking potential (entry pressure) via convective current loops penetrating above the gas-water contact.
- An upper bound may be 5x based on a mixing model analog

Model Problem

Discrete Geologic Model

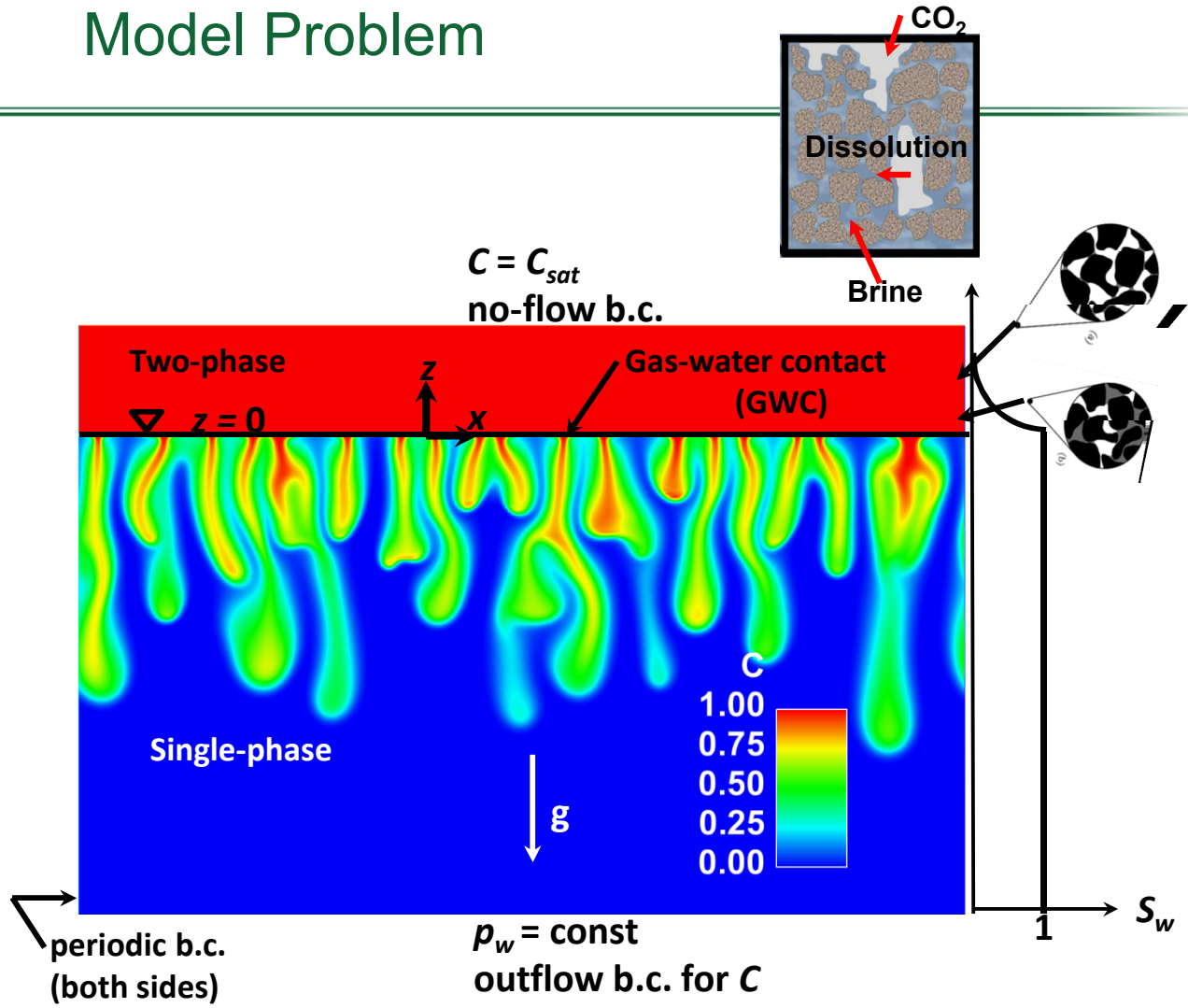


Injection with leaky caprock



Two reservoirs are modeled

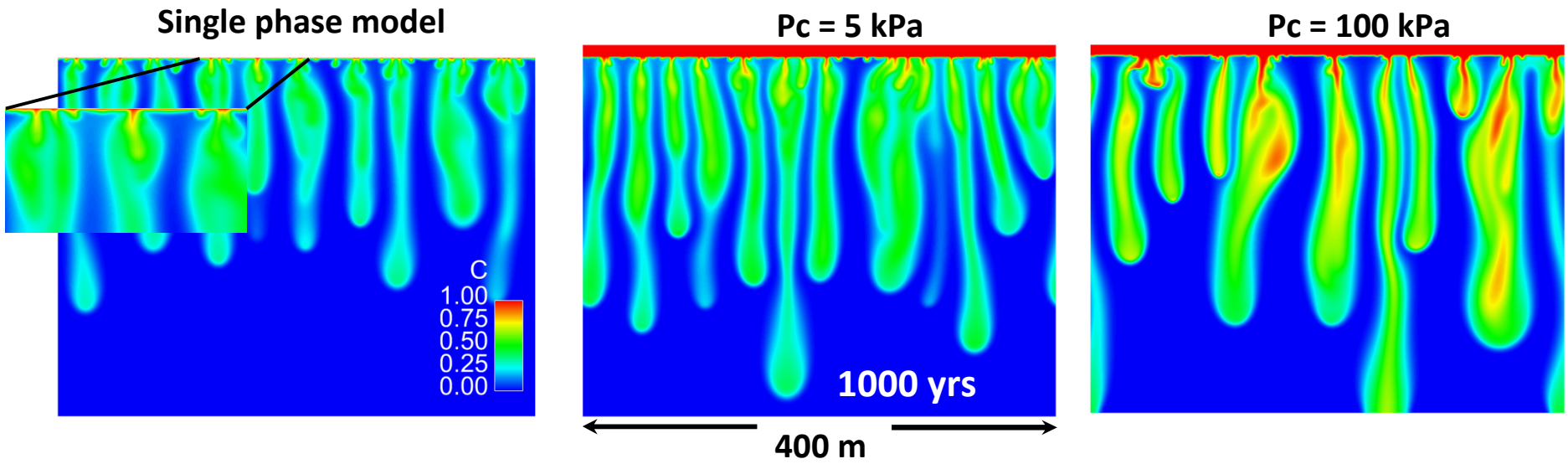
Property	Sleipner Utsira	Bravo Dome
porosity	0.37	0.15
perm. (mD)	2000	50

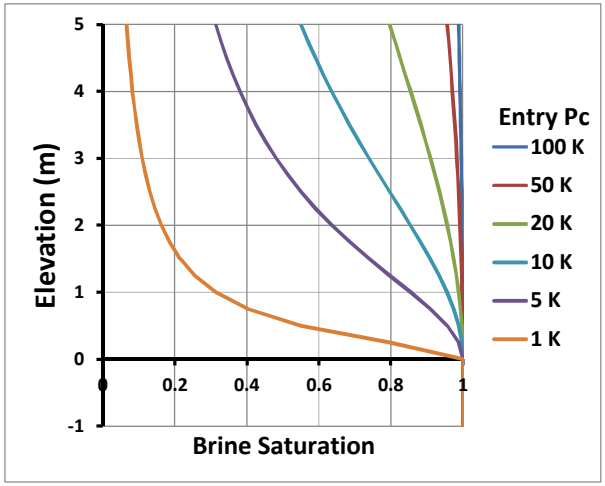


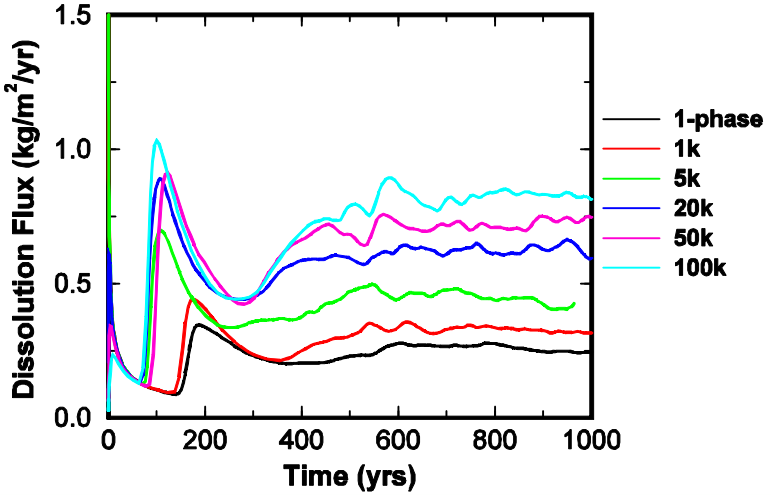
Problem definition and dissolved concentration (at 500 yrs) for Bravo Dome properties with 50 kPa entry pressure.

Impact of Capillary Transition Zone on CO_2 Dissolution Into Brine

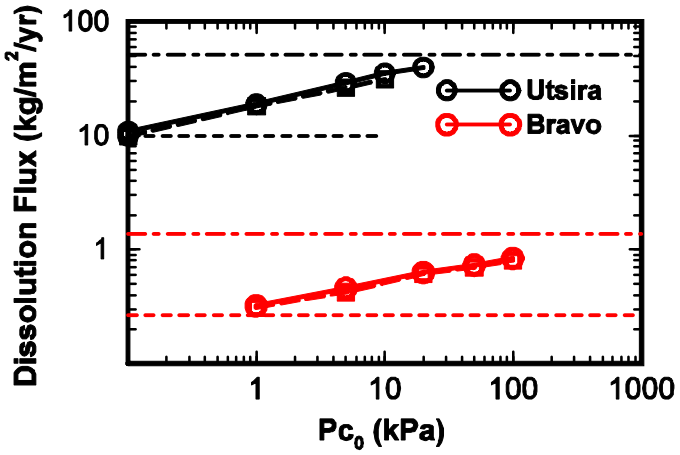
Dissolved CO_2 in Bravo Dome (k= 50 mD poro = 0.15) reservoir

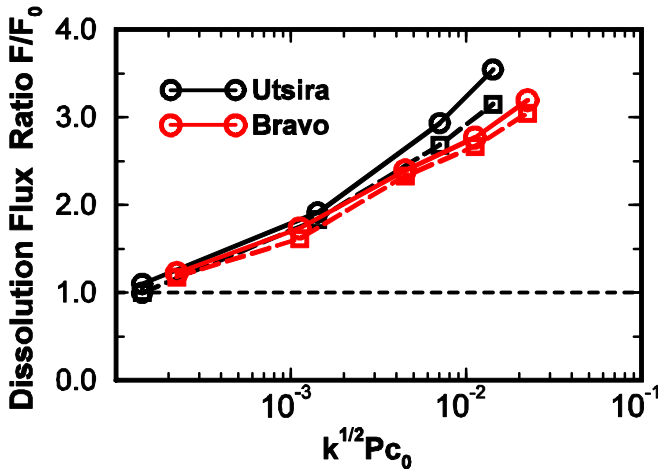






Long-term quasi-steady dissolution flux





- $p_{c0} \rightarrow 0$ recovers the single-phase, closed top dissolution rate
- For "large" but feasible p_{c0}, Flux ~ 3.5x single-phase fluxes
- An upper bound on flux is ~5x single-phase value, based on a convective mixing analog

Mixing Problem