

Intro to CFSES and Carbon Capture and Geological Storage



Overview of carbon capture and geological storage.

Publication:

McNeece and Hesse (2016) Reactive transport of aqueous protons in porous media, *Adv. Water Resour.*, 97, 314-325

Work was performed at the University of Texas at Austin.

Carbon Capture and Geological Storage

1. Capture CO₂ at a large point source.
2. Transport to storage site via pipeline.
3. Injection into deep geological formations

Currently the **only** technology for de-carbonation of base-load fossil-fuel based power generation.

Barriers to CCGS implementation

1. Can CCGS be implemented at scale?
2. Is geological carbon storage safe/permanent?
3. Verification of site performance?
4. Cost of CCS?

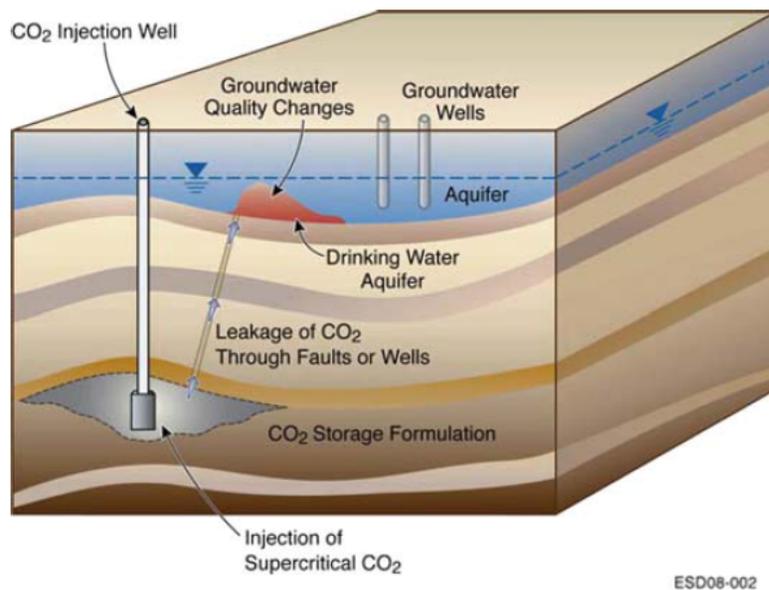
The CFSES Challenges

1. Sustaining large storage rates.
2. Using pore space efficiently.
3. **Controlling undesired/unexpected behavior.**

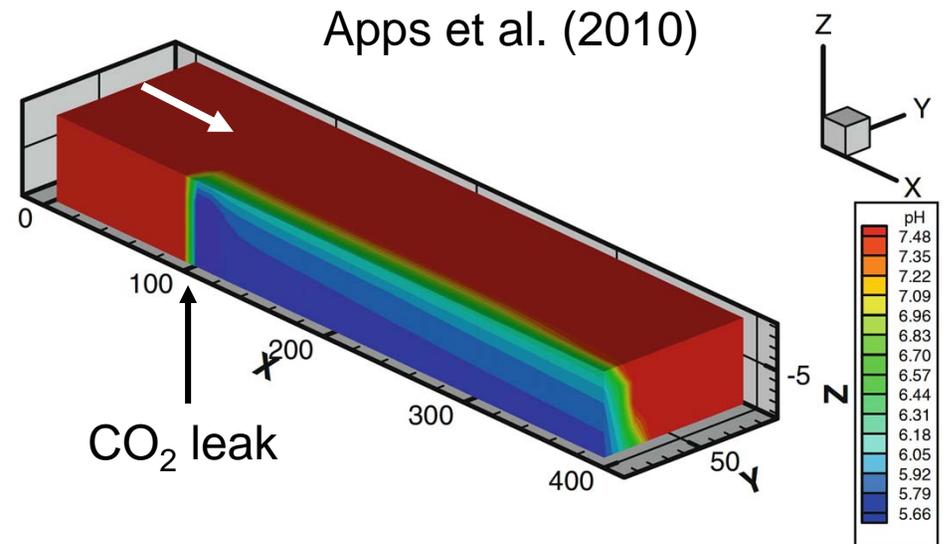
If CFSES achieves any of these challenges it removes a barrier to CCGS implementation.

Aquifer response to CO₂ leakage

CO₂ Leakage into aquifer



pH change due to leak



Change in pH mobilizes adsorbed contaminants and degrades water quality.

Undesired behavior that needs to be controlled.



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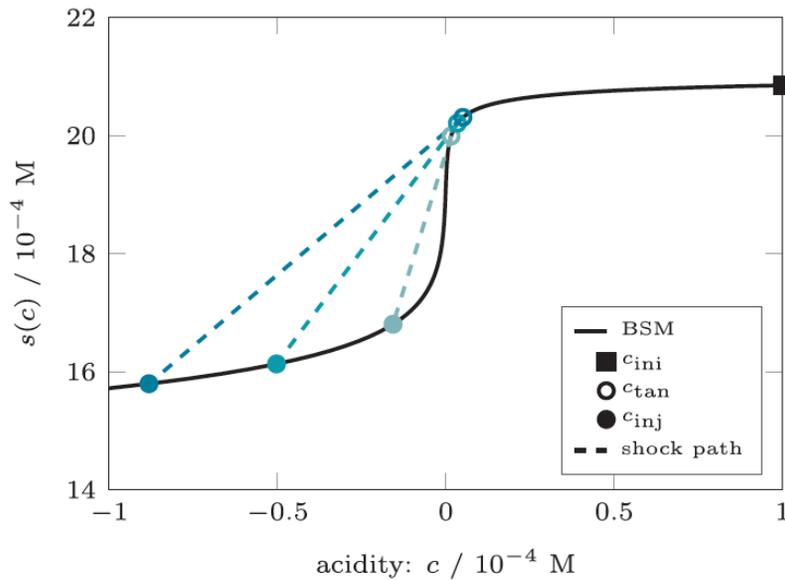
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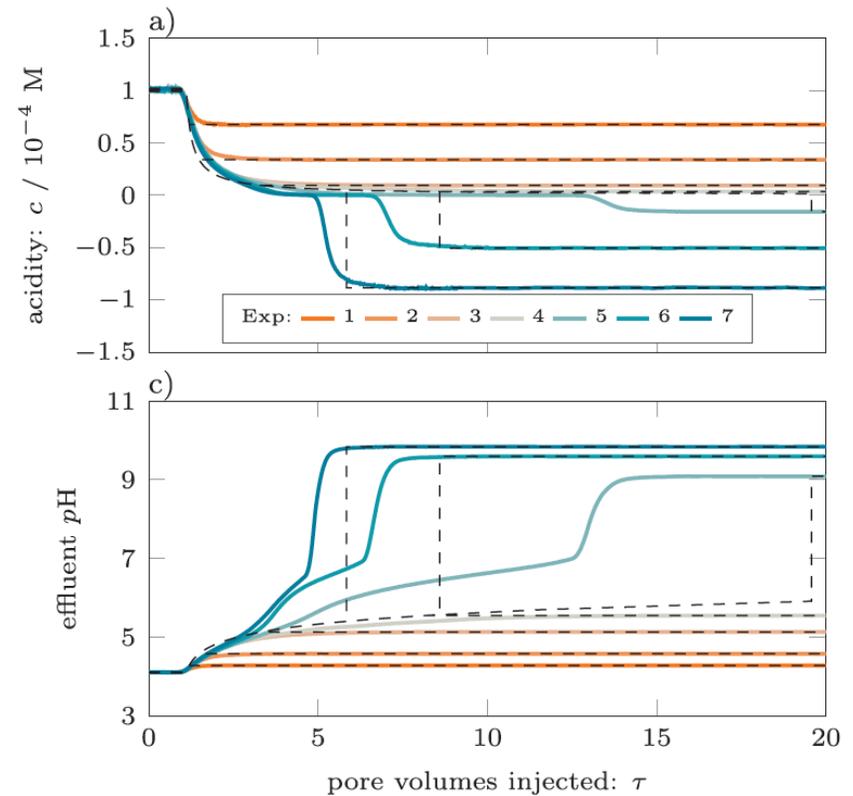
Modeling pH fronts in sandy aquifer

Proton sorption isotherm



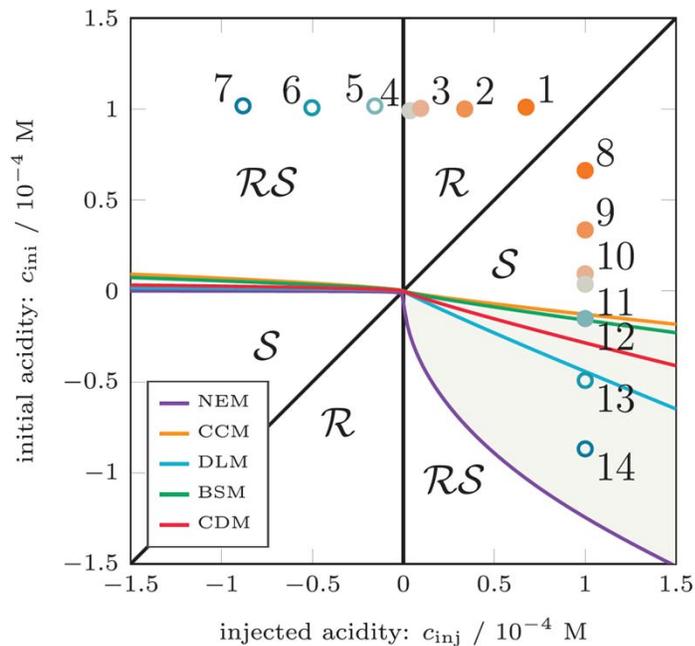
Sigmoidal isotherm leads to new transport behavior, not observed in cation transport.

Composite waves



Completed work: propagation of pH fronts

Regime diagram



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Scientific achievement

Extended theory of chromatography to surface complexation models that describe pH fronts.

Significance and impact

Basis for comparison and selection of geochemical model for aquifer response.

Research Details

Showed that the isotherms for advanced surface complexation models are sigmoidal. Identified chemical mechanism that leads to sigmoidal isotherm.

Applied theory of chromatography to obtain semi-analytic solutions for pH fronts.

Conducted systematic experiments to test theory and calibrate model.



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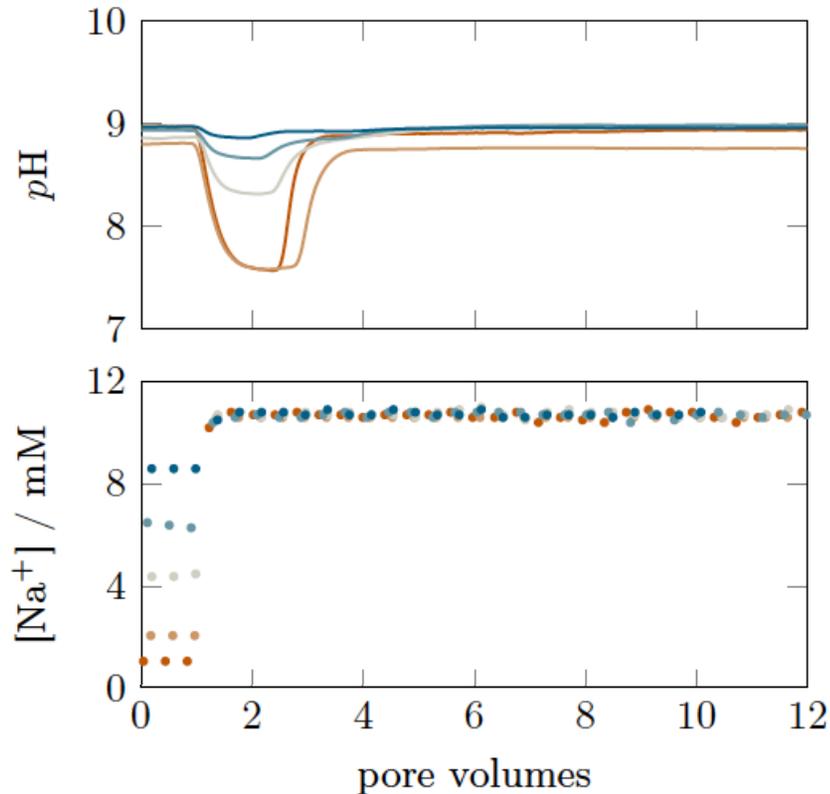
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Ongoing work: coupled pH and salinity fronts

Column experiments



Leakage of saline brine

Increase in salinity decreases pH, which mobilizes contaminant.

Double layer

Salinity collapses diffusive layer and releases protons dropping pH.

Future work: completion with metals

Explain unresolved observations of contaminant transport through the complex coupling between metals, pH and salinity.

Publication:

McNeece and Hesse (2017) Coupling acidity and salinity transport, in prep.



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