SAND2011-3579C

Science for our Nation's Energy Future

Energy Frontier Research Centers
Summit & Forum

Center for Frontiers of Subsurface Energy Security

Director
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Partner Institution
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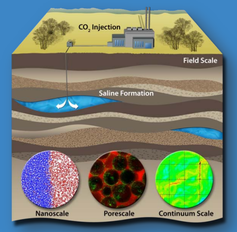
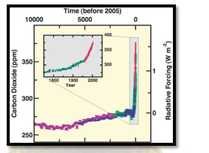
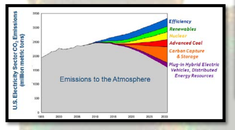
The Center for Frontiers of Subsurface Energy Security (CFSES) is pursuing scientific understanding of multi-scale, multi-physics processes to ensure safe and economically feasible storage of carbon dioxide and other byproducts of energy production without harming the environment.



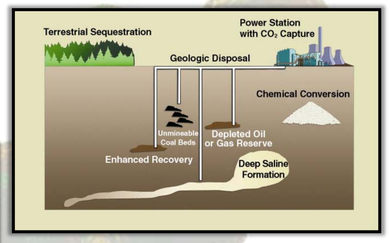
An Energy Frontier Research Center supported by the US Department of Energy, Office of Basic Energy Sciences



Fossil fuel consumption has caused a dramatic increase in atmospheric CO_2 levels



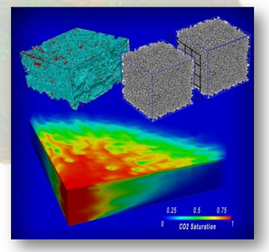
Carbon capture and sequestration could reduce CO_2 emission by 11% in 2030 (EPRI, 2009)



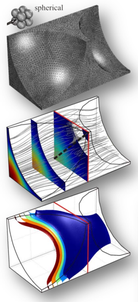
Natural underground reservoirs of CO_2 and the successful injection of CO_2 into the subsurface for enhanced oil recovery indicate that it is feasible to store CO_2 in geological formations.

Research Questions:

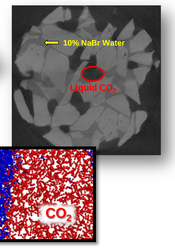
- How does supercritical CO_2 interact in the subsurface?
- What are the relevant physics of CO_2 fate and transport in the subsurface?
- Can we engineer solutions to mitigate leakage pathways?
- How can we represent the essential features of large-scale behavior that emerge from small-scale phenomena?



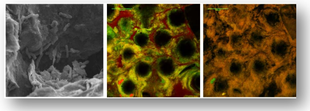
Detailed small-scale experimental results are being integrated with state-of-the-art numerical methods to develop computational tools that capture geological complexity, variability, and uncertainty. These tools will be used to determine what will happen when CO_2 is injected underground.



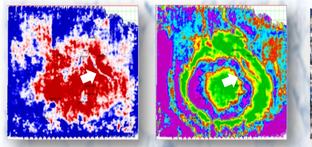
Quantifying permeability parameters for larger-scale models from pore-scale models



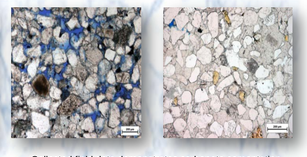
Connecting experimental results to molecular dynamics modeling to better understand how CO_2 interacts with other dissolved species and mineral surfaces



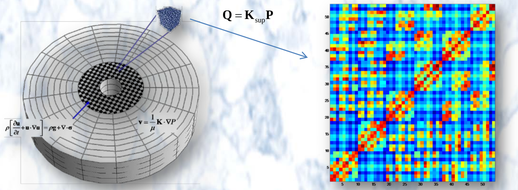
Determined that mineral surfaces affect microbial survival which, in turn, impacts hydraulic properties - This is important for understanding how hydraulic properties will change during and after CO_2 injection due to biological activity.



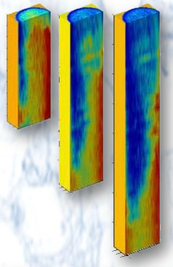
Developed new theory to calculate changes in large-scale properties of rocks due to chemical dissolution and mechanical stress - Incorporation of this theory into seismic imaging improves our ability to better discern fine-scale channels, important to detecting potential CO_2 leakage pathways.



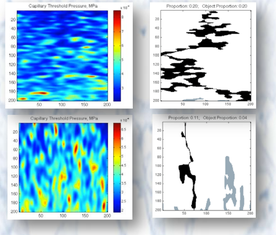
Collected field data demonstrates carbonate cementation obstructs permeability at the pore scale but not potential CO_2 leakage pathways at the field scale



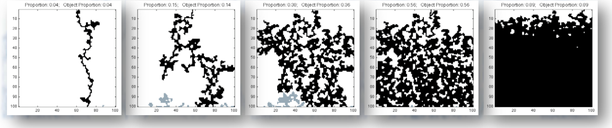
Investigating upscaling approaches to link pore-scale physics to continuum scale models. The "super permeability tensor" (above) retains local heterogeneity in larger-scale models. This allows development of efficient models for predicting CO_2 migration spanning multiple time and space scales.

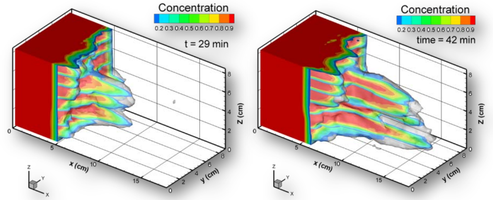


Flow coupling is 10 – 100 times greater when three phases, (oil, water, & gas), rather than two, are present.

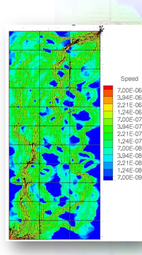


Gained a better understanding of the complex control that the spatial patterns of rock properties exert on invading fluids

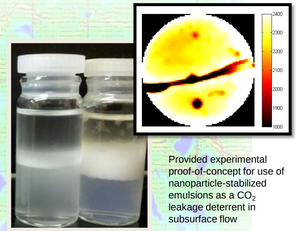




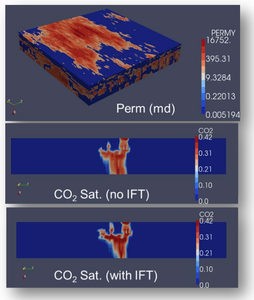
Improved our ability to estimate heterogeneous formation properties from limited measurements using inverse modeling. This is important for accurate predictions of the migration of injected CO_2.



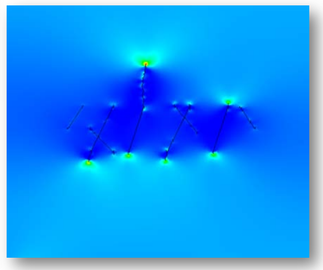
Developed new numerical methods for simulation of CO_2 sequestration to increase the accuracy and speed of models for large-scale CO_2 storage predictions



Provided experimental proof-of-concept for use of nanoparticle-stabilized emulsions as a CO_2 leakage deterrent in subsurface flow



Added interfacial tension and buoyancy effects so that they more accurately predict the migration of CO_2



Modeling stress induced fracture growth in caprock

THE UNIVERSITY OF TEXAS AT AUSTIN

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CFSES

This material is based upon work supported as part of the Center for Frontiers of Subsurface Energy Security, an Energy Frontier Research Center funded by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Award Number DE-SC0001114.