UNIVERSITY OF SOUTH FLORIDA

Creation of Carbon Sequestration Data, Technologies and Professional Cohorts for Florida

PI: Mark Stewart, USF; **Co-PI's:** Jeffrey Cunningham, Maya Trotz, Yogi Goswami
Students: Shadab Anwar (Post-doctoral scholar) Drupatie Latchman (MS, Chemical & Biomedical Engineering), Mark Thomas, MSEV, Civil and Environmental Engineering, Arlin Briley, MEVE, Civil and Environmental Engineering, Tina Roberts-Ashby, Ph.D., Geology, Drupatie Latchman, MSChE, Chemical and Biomedical Engineering

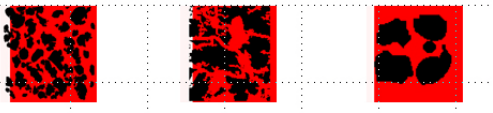
Description: Rising concerns over increasing levels of green house gases, especially carbon dioxide, have led to suggestions to capture carbon dioxide at fixed sources, such as fossil fuel power plants, and sequester the carbon for millennia by injecting it underground. Florida overlies many thousands of feet of carbonate rocks which may be suitable for geologic sequestration of carbon dioxide. This project will investigate the potential for geologic sequestration of carbon dioxide in Florida, the physical and chemical changes that may occur as a result of injection, assess the potential for escape of injected carbon dioxide, determine the risk, if any, to aquifer systems used for water supplies, develop methodologies for Florida utilities to predict the performance and risks of proposed sequestration projects, and educate a cohort of geologic sequestration professionals to create a carbon sequestration industry in Florida.

Budget: $479,640
Universities: USF
External Collaborators: TECO; USGS; Environmental Consulting & Technology, Inc.

Progress Summary

Summary of Progress: Physical and Geochemical processes at multiple scales are yet to be understand for the mitigation of Carbon concentration in the atmosphere by capture and storage of CO2 in aquifers. The pores in the potential aquifers for CO2 storage are most likely filled with saline water (brine aquifers) or oil, and gas (depleted hydrocarbon reservoirs). There are some major questions, which need to be answered before the deployment of any sequestration project. How much CO2 a potential aquifer can hold? How long it can hold? What will happen to the surrounding porous media after injection of CO2 in the saline aquifer? How much and how far CO2 will rise by buoyancy? How much will be trapped by viscous-fingering? The linkage of flow and geochemical models investigated these questions. Lattice Boltzmann method (LBM) is a recently developed numerical tool for the pore-scale modeling of single/multi-phase, miscible/immiscible fluid mixtures in complex geometry as observed in porous media. The pore scale flow model combined with geochemical models can predict the precipitation or dissolution of porous media, which can be a potential cause for the clogging of injection wells or development of new fractures/pores in the aquifer that can lead to leakage of CO2 back into the atmosphere.

How much minerals dissolve or precipitate?



Minerals/CO_2	Case1	Case2	Case3
Calcite (L/L of aquifer)	-1.133E-04	-1.23E-06	-1.3E-04
Dolomite (L/L of aquifer)	-7.1E-06	-7.7E-08	-8.29E-06
Gypsum (L/L of aquifer)	8.2E-05	9.E-07	9.6E-05
CO_2 dissolved (L/L of aquifer)	0.0257	0.00028	0.03

Graphical Processing Units (GPU's) are used to meet the high-performance-computing requirement for the modeling project. Geochemical reaction models were evaluated for their sensitivity under saline conditions as well as the availability of thermodynamic data applicable to reaction conditions. Various calcite, dolomite and gypsum configurations were evaluated for changes in solubility, amount of CO2 dissolved, and porosity.

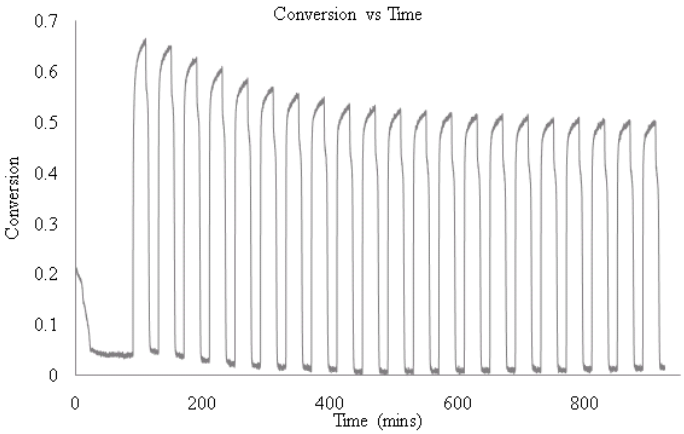


Figure 1: Conversion Cycles for Calcium-magnesium Carbonate Sorbent

Another goal of this research is to develop a sorbent that will effectively and inexpensively capture carbon dioxide from power plant flue gas. Current efforts include investigating the metal oxide to develop a sorbent with a better conversion stability and higher conversion rate. This was done by applying calcium-magnesium carbonate mixture to alumina fabric and conditioning it for 12 hours. Results show that the conversion becomes stable at 50% for a sorbent that has been conditioned for 12 hours as seen in Fig.1. At first carbonation/calcination cycles, the sorbent has a conversion higher than 60%, however has cycling continues the sorbent degrades and stabilizes at 50% after 21 cycles. Future investigations aim at increasing the conversion by changing the conditioning parameters, for example, conditioning time and weight of calcium- magnesium oxide deposited on the alumina fabric.