University of South Florida

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

PI: Mark Stewart **Co-PIs:** Jeffrey Cunningham, Maya Trotz
Students: Arlin Briley, PhD, Mark Thomas, PhD

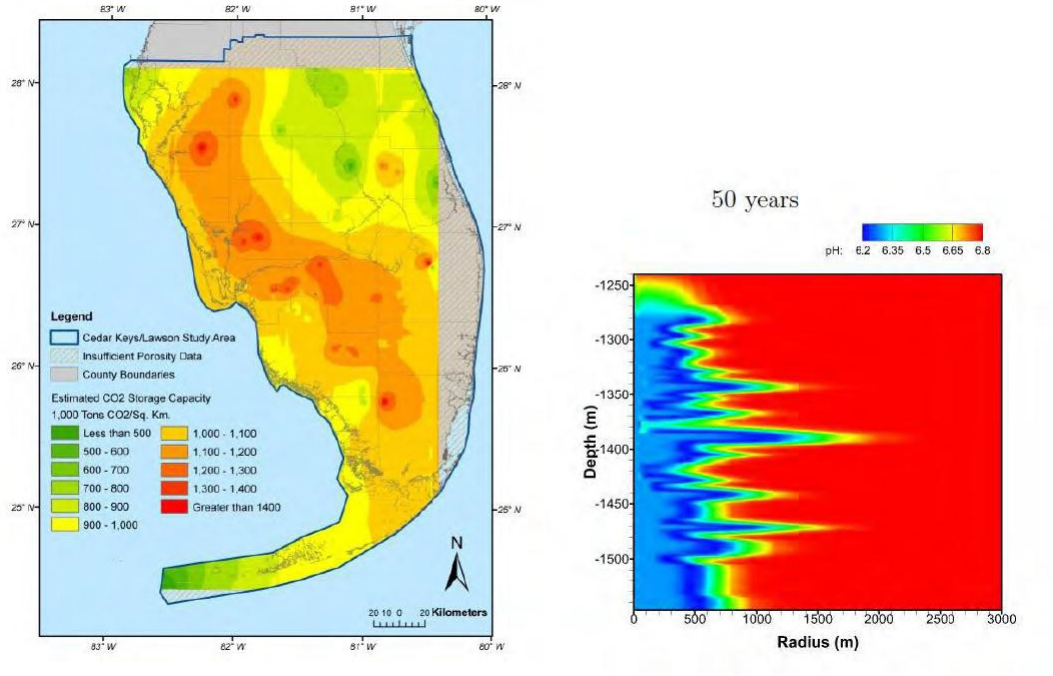
Description: Rising concerns over increasing levels of greenhouse gases, especially carbon dioxide, have led to suggestions to capture carbon dioxide at fixed sources, such as fossil fuel power plants, and sequester the carbon for millennia by injecting it underground. Florida overlies many thousands of feet of carbonate rocks which may be suitable for geologic sequestration of carbon dioxide. This project is investigating 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. This project has graduated two PhD students, Tina Roberts-Ashby, US Geological Survey, and Roland Okwen, Illinois State Geological Survey, one post-doctoral student, Anwar Shadab, Missouri University of Science and Technology, and currently supports two PhD students.

Budget: $479,640
Universities: USF
External Collaborators: TECO, RTI, ECT, DOE

Progress Summary

Progress continued on the collaboration with Tampa Electric Co, DOE and RTI on the carbon sequestration and wastewater injection pilot project at the Polk Power Station (PPS). The total DOE funding for this project is $171 million. USF is responsible for the mathematical modeling of the pilot carbon sequestration and wastewater injection project at the PPS. In conjunction with this project, USF had a grant in 2011-2012 through Tampa Electric/ECT Inc that supported two PhD students. Four refereed publications on carbon sequestration appeared in print in 2012, one is in press, and one is in review. Four presentations/posters on research results were given at national and regional meetings by faculty members and graduate students. A proposal was submitted to DOE to investigate an innovative and potentially very important conjunctive injection of carbon dioxide and wastewater and is in review. This proposed project would provide a new source of potable water, help municipalities deal with wastewater disposal, increase the efficiency and safety of carbon sequestration, and reduce costs through shared facilities. This proposal would leverage current Federal funding at the PPS project. Two USF GCS PhD students, Tina Roberts-Ashby, USGS, Washington, DC, and Roland Okwen, Illinois State Geological Survey/Univ Illinois, are continuing to collaborate with the USF Carbon Sequestration Group on GCS research. The USF GCS group has achieved international recognition through its refereed publications in international journals and presentations at national meetings. As a result of USF GCS Group work, Florida was selected for one of the few DOE funded carbon capture/sequestration pilot projects in the US. The USF GCS group will continue to attempt to leverage the existing funding at PPS to further funded research and graduate training in carbon sequestration. The expertise and technology for physical and geochemical modeling of co-injection of reverse-osmosis reject water, supercritical carbon dioxide and industrial process water developed by USF GCS at the Polk Power Station has resulted in a new project transferring the technology to a facility operated by the Mosaic phosphate company. This expertise may have wide applicability for safely treating and reusing of municipal wastewater, reducing

industrial demands on potable water supplies, and providing a safe disposal method for industrial process waters.



Funds leveraged/new partnerships created:

During 2012 the USF Geological Carbon Sequestration (GCS) group had a continuing collaborative relationship with Tampa Electric and DOE to provide mathematical modeling expertise for the DOE-funded carbon sequestration and wastewater injection project at the Polk Power Station in Polk County, Florida. This collaboration provided research funding and training for two PhD students, Arlin Briley and Mark Thomas. This project was used as leverage for a proposal submitted to DOE in April, 2012, to investigate the conjunctive injection of wastewater from a reverse osmosis plant and CO2 captured at the Polk Power Station. Municipal wastewater from the City of Lakeland will be treated to potable water standards in a reverse osmosis plant. Ninety percent of the original wastewater will become potable water, and the 10% reject water from the RO plant will be injected in a deep well after CO2 injection. Preliminary modeling suggests that the waste water injection transfers the CO2 from a supercritical gas phase to a dissolved phase, safely sequestering it for millennia. This process could provide for efficient wastewater reuse, safe CO2 sequestration, and lowered costs through shared facilities. The technology and expertise developed during this project has resulted in a new grant from the Mosaic company to investigate the potential for a similar injection project at a phosphate chemical plant. This expertise and technology has the potential to be widely used in Florida.

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Active Grants:

Tampa Electric/ECT Inc, 2010-2012, Numerical modeling of carbon sequestration and waste water injection at the Polk Power Station, Polk County, Florida, approximately $60,000 in 2012.

Grants Submitted:

Numerical and geochemical modeling of conjunctive injection of reverse osmosis reject water and industrial process water, Mosaic/ECT Inc, 10/12, awarded.

Evaluation of Wastewater Flooding on the Efficiency and Safety of Geologic Sequestration of Carbon Dioxide, US DOE, $760,000, 4/12, pending.

Refereed Publications:

Roland T. Okwen, Mark T. Stewart, Jeffery A. Cunningham, 2012. An Analytical model for screening potential CO2 repositories, Computational Geosciences ,05/2012; 15(4):755-770. DOI:10.1007/s10596-011-9246-2

Roland Okwen, Mark Stewart, Jeffrey Cunningham, 2012. Effect of Well Orientation (Vertical vs. Horizontal) and Well Length on the Injection of CO2 in Deep Saline Aquifers Transport in Porous Media, 05/2012; 90(1):219-232. DOI:10.1007/s11242-010-9686-5
Roland T. Okwen, Mark Thomas, Mark T. Stewart, Maya Trotz, Jeffrey
A. Cunningham, 2012. Conjunctive Injection of CO2 and Wastewater in a

Heterogenous Porous Formation, Technology and Innovation, National Academy of Inventors, DOI: http://dx.doi.org/10.3727/194982412X13462021397778.

Tina Roberts-Ashby, Mark Stewart, 2012. Potential for carbon dioxide sequestration in the Lower Cretaceous Sunniland Formation within the Sunniland Trend of the South Florida Basin, U.S., International Journal of Greenhouse Gas Control, doi:10.1016/j.ijggc.2011.11.009

Presentations and Poster Sessions:

Roland T. Okwen, Mark Thomas, Mark T. Stewart, Maya Trotz, Jeffrey A. Cunningham, 2012. Conjunctive Injection of CO2 and Wastewater in a Heterogenous Porous Formation American Geophysical Fall Meeting, San Francisco, 12/11

Geochemical Modeling of CO2 Sequestration in Deep, Saline, Dolomitic Limestone Aquifers: Sensitivity to Physico-Chemical Conditions. Participants: M. W Thomas, M. Stewart, M. A Trotz, and J. Cunningham, Florida Energy Summit August 15-17, 2012

At the University of South Florida 4th Annual College of Engineering Research Day, Engineering II (ENB), First Floor, Thursday, November 17, 2011:
Simulation of Alternating Wastewater/CO2 Injection into a Deep Saline Aquifer. Mark Thomas, Roland Okwen, Arlin Briley, Mark Stewart, Maya Trotz, Jeffrey Cunningham University of South Florida 4th Annual College of Engineering Research Day, 10/2012.

Funded research:

Project 1: : Physical and geochemical modeling of geologic sequestration of carbon dioxide and RO reject water at the Polk Power Station (PPS), Polk County.
Principal Investigators: M Stewart (USF), J Cunningham(USF), M Trotz(USF), R Okwen(ISGS)
Students: Arlin Briley (CEE, PhD), Mark Thomas (CEE, PhD)
Grantors and Collaborators: Tampa Electric Company, ECT Inc.
Funding: Funding was provided on a continuing and as needed basis, for specific tasks. 2012funding was about $40,000-$50,000. Funds provided research support for faculty members Cunningham, Trotz, and Stewart, a sub-contract with Dr Roland Okwen (USF PhD) of the Illinois State Geological Survey, licenses for advanced modeling software, and support for two PhD students, Arlin Briley and Mark Thomas in CEE.
Description: This project is part of a >$160,000,000 project funded by DOE and the SWFWMD. SWFWMD funded two deep injection wells at PPS to dispose of reverse osmosis reject water from a RO plant that will process City of Lakeland wastewater. The potable water from the RO plant will replace Floridan Aquifer water currently used by Tampa Electric at the PPS. The existence of a suitable deep injection zone was confirmed by earlier USF research. As a result of the availability of deep injection wells and the integrated coal gasification-combined cycle (IGCC) power plant at PPS, the PPS was selected by DOE for a pilot project for hot-gas clean up, carbon capture, and carbon sequestration. USF is responsible for modeling the physical and chemical behavior of both the injected carbon dioxide that will be captured by the CCS pilot plant and the reject water from the RO plant. This project provided a unique research opportunity, as it is the only CCS project where injection of CO2 will can be followed by wastewater injection. The majority of the refereed publications and meeting presentations of the USF Carbon Sequestration group have been based on research results from this project.
Project lifespan: The DOE has put the sequestration project on hold, but the wastewater injection will start in 2014 and continue indefinitely.

Project 2: Monitoring of carbon sequestration using InSAR

Principal Investigator: Tim Dixon (USF)
Grantor: DOE
Funding: This is part of a larger grant from DOE held by Tim Dixon. Funding on the FESC project is probably about $50,000
Project description: This project will use the carbon dioxide and wastewater injection projects at the Polk Power Station (PPS) to investigate the use of radar interferometry to monitor the progress of CO2 injection at CCS sites. Dixon has received permission to include the PPS site as one of the investigative sites for this DOE grant.

Proposals submitted:

1**:** The current CCS and wastewater injection project at the Polk Power Station (PPS) provides a unique research opportunity. As the principal purpose of the deep wells is disposal of RO plant reject water and waste streams from PPS facilities, wastewater will be injected into the deep disposal well after possible injection of supercritical CO2. Preliminary modeling (see figures below) suggests that the carbon dioxide sequestered as a supercritical gas phase will dissolve in the injected waste water. This will convert the CO2 from a very buoyant supercritical gas to a more dense dissolved phase. This nearly eliminates the buoyancy effect of sequestered CO2, greatly reducing the importance of caprock continuity and sequestering the CO2 in a chemically stable form. The proposed project will create predictive geochemical models for the conjunctive injection of CO2 and wastewater, calibrated to monitoring data from the PPS.
Submission: A proposal was submitted to DOE in April, 2012. Funding would be about $760,000 for three years, 2013-2016

2**:** Numerical and geochemical modeling of conjunctive injection of reverse osmosis reject water and industrial process water, Mosaic, submitted 9/2012.