the ENERGY lab

PROJECT FACTS

Carbon Sequestration

GEOSEQ: Monitoring of Geological CO_2 Sequestration Using Isotopes and Perfluorocarbon Tracers (PFTs)

Background

The purpose of this project is to develop monitoring, verification, and accounting (MVA) tools to ensure the safety and viability of long-term geologic storage of CO_2. The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) and Oak Ridge National Laboratory (ORNL) will expand the lessons learned at the Frio Brine Pilot (as part of the GEO-SEQ project) to prepare a strategic plan for deployment of tracer and isotope MVA methods that will consider gas-brine-rock interactions associated with larger volume CO_2 injection systems such as at Cranfield, MS.

GEO-SEQ is a public-private research and development partnership that delivers the technology and information needed to facilitate the application of safe and cost-effective methods for geologic sequestration of CO_2 by 2015. The GEO-SEQ project utilizes scientific understanding and technology development from three ongoing, world-class, recognized, geologic CO_2 storage projects through leadership and collaboration in the scientific and engineering objectives. The three projects are the Frio Brine Pilot (United States), Otway Basin Project (Australia), and the In Salah Industrial Scale CO_2 Project (Algeria).

ORNL is focusing on developing and using geochemistry-based techniques in this study to monitor and assess CO_2 injection operations. The resulting data can be used to calibrate and validate the predictive models used for (a) estimating CO_2 residence time, reservoir storage capacity, and storage mechanisms, (b) testing injection scenarios for process optimization, and (c) assessing the potential leakage of CO_2 from the reservoir. This effort will provide a means for calibrating the transport model and aid interpreting the time-series geophysical data.

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PROJECT DURATION

Start Date
05/01/2000

End Date
09/30/2012

COST

Total Project Value
$2,825,000

DOE/Non-DOE Share
$2,825,000/$0

PARTNERS

None

Figure 1: Perfluorocarbon tracers in a syringe pump located in the back of the NETL van are being added to carbon dioxide as it is injected underground at the Frio saline reservoir sequestration test site near Houston, Texas.

Project Description

Based upon the work described at the previously described projects, ORNL has conducted field studies that utilize isotopes and perfluorocarbon tracers (PFT) to monitor CO_2 and reservoir conditions and obtain baseline data on the chemistry (including isotopes) of fluids and gases prior to injection at the Southeast Regional Carbon Sequestration Partnership (SECARB) Cranfield Site. Small quantities of tracer will be combined with the CO_2 stream and be used to detect both the breakthrough and transport of the plume as well as the stable isotopes of carbon, oxygen, and hydrogen in CO_2 and fluids sampled from monitoring wells. Isotope analyses will also be obtained on carbonates in rock samples recovered from key well sites. These data form the foundation upon which quantitative evaluation of the hydrodynamic nature of the formation and the extent to which the CO_2 interacts with both the brine and host rock can be performed. This information will be (1) integrated into a monitoring, verification, and accounting system model with other data derived from geophysical and hydrological tests, and (2) compared with results from the Frio Brine Pilot test. These data, in turn, will provide guidance to regulators and other stakeholders through the development of protocols for standardizing the use of isotopes and PFT as monitoring tools for future CO_2 storage operators.

Goals/Objectives

The goal of this study is to develop and field test geochemistry-based techniques to monitor and assess CO_2 injection operations and provide methods to interrogate the subsurface that will allow direct improvement of CO_2 sequestration during enhanced oil recovery (EOR), enhanced coalbed methane recovery (ECBM), enhanced gas recovery (EGR) operations, or use of saline formations. Natural (isotopic) and introduced tracers will be used to determine the fate and transport of CO_2 injected into the subsurface as well as those of other relevant processes. These methods have the potential to provide near-real-time information on process optimization. Resulting data will be used also to calibrate and validate the predictive models used for (a) estimating CO_2 residence time, reservoir storage capacity, and storage mechanisms, (b) testing injection scenarios for process optimization, and (c) investigating the potential leakage of CO_2 from the reservoir. The core project objectives are to investigate innovative monitoring of CO_2 underground and develop a comprehensive strategy for technology transfer and application to larger volume CO_2 injections.

Accomplishments

- Provided geochemistry support for the design of the Frio brine injection pilots.
- Provided all the baseline gas chemistry, and gas and brine isotope chemistry for both the Frio I and II pilot injection studies.
- Completed assessment of brine isotope analysis, as well as gas chemistry and stable isotope analyses, for samples obtained post-Frio II injection. Results indicate that, by combining the geochemical and Perfluorocarbon Tracer (PFT) technologies, definitive tracking of the CO_2 was possible.
- Existing project results were published in numerous publications and conference presentations.

Benefits

This work benefits DOE's Carbon Sequestration Program by directly addressing a key geologic sequestration objective to increase confidence in and the safety of geologic sequestration by identifying and demonstrating cost effective and innovative monitoring technologies to track migration of CO_2 and its reaction products in geologic formations. This technology is relatively inexpensive compared to other monitoring methods. For these reasons, the Environmental Protection Agency (EPA) is also interested in supporting the use of this technology.