the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Prototyping and Testing a New Volumetric Curvature Tool for Modeling Reservoir Compartments and Leakage Pathways in the Arbuckle Saline Aquifer: Reducing Uncertainty in CO_2 Storage and Permanence

Background

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is currently funding research aimed to advance state-of-the-art technologies that address geologic storage of carbon dioxide (CO_2) in multiple formation types and across all phases of CO_2 geologic storage operations.

Geologic storage involves the injection of CO_2 into underground formations that have the ability to securely contain it over long periods of time. Research efforts are currently focused on several geologic storage formation types: several clastic and carbonate types, coal, organic rich shale, and basalt formations. These formations contain different fluids such as saline water, oil and natural gas. A principal element of DOE's Carbon Sequestration Program is Core Research and Development (R&D), and one of the R&D focus areas—geologic storage—is aimed at addressing the challenges of CO_2 storage in these formations.

Critical challenges identified in the geologic storage focus area include CO_2 well bore integrity, geochemical and mechanical responses, fluid flow and containment, and development of mitigation technologies. This research will evaluate the effectiveness of the volumetric curvature seismic tool to assess geologic storage formations and structural features such as sags, flexures, and fractures. This assessment will be completed for a saline carbonate formation in Kansas, and confirmed by the installation of a horizontal test boring that intersects the predicted paleokarst compartments. Prior to installation of the test boring a geologic model will be developed from production, geologic, and seismic data to indirectly confirm the presence of paleokarst compartments and help locate the horizontal test boring. This model will be updated with information obtained from the drilling program and used for simulations designed to estimate formation storage capacity, optimum CO_2 injection rate, CO_2 injection plume migration, reservoir containment, and CO_2 leakage risk.

CONTACTS

John Litynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
Phone: 412-386-4922
john.litynski@netl.doe.gov

Brian Dressel
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
Phone: 412-386-7313
brian.dressel@netl.doe.gov

Jason Rush
Principal Investigator
University of Kansas
Center for Research, Inc.
1930 Constant Ave.
Lawrence, KS 66047
Phone: 785-864-2178
rush@kgs.ku.edu

PARTNERS

Kansas State University
Murfin Drilling Company
CMG Simulation Services
Susan Nissen
Weatherford Laboratories
Hedke Saenger

PROJECT DURATION

Start Date
10/1/2010

End Date
9/30/2013

COST

Total Project Value
$1,999,997

DOE/Non-DOE Share
$1,598,537/ $401,460

NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Fairbanks, AK • Morgantown, WV • Pittsburgh, PA • Sugar Land, TX

Website: www.netl.doe.gov

Customer Service: 1-800-553-7681

U.S. DEPARTMENT OF ENERGY

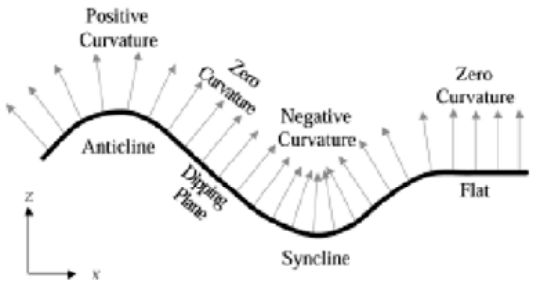
Project Description

The University of Kansas (KU) is evaluating the effectiveness of a new seismic tool (volumetric curvature analysis) to identify the presence, extent, and impact of paleokarst compartments and faulting structures in the Arbuckle Group, a saline carbonate formation in southwestern Kansas. This tool has the potential to be cost-effective for helping to assess geologic storage capacity and developing an understanding of CO_2 plume migration and containment in deep saline aquifers.

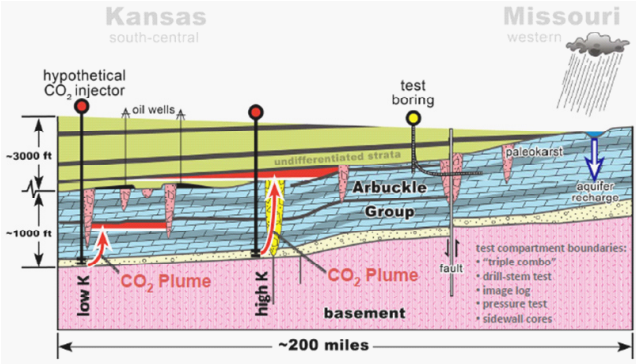
The Arbuckle aquifer is an ideal candidate for CO_2 sequestration because of its thickness, total depth, and isolation from freshwater aquifers. However, the Arbuckle aquifer may contain areas of paleokarst (areas of carbonate dissolution like caves or sinkholes) which are often associated with faults. Identification of these potentially conductive, through-going fault systems is important for reducing risks of CO_2 sequestration operations, especially the risk of CO_2 or saline formation fluids migrating into fresh water aquifers.

Existing seismic and well data will be reprocessed and analyzed using volumetric curvature (VC) analysis. An integrated geologic model will also be developed to indirectly confirm the presence of VC identified compartments. This model will be used to locate a test boring in the vicinity of a VC-identified compartment boundary. KU will attempt to directly confirm the utility of VC as a means to analyze and identify subsurface features with a horizontal test boring that intersects the paleokarst compartments and boundaries.

After the analysis of the information obtained from the horizontal test boring is complete, the volumetric curvature model and geologic model will be updated with the new information. Simulations designed to estimate geologic storage capacity, optimum CO_2 injection rate, CO_2 plume migration, reservoir containment, and CO_2 leakage risk will be conducted.



Depiction of a 2-Dimensional Volumetric Curvature (VC) analysis. VC is a measurement of the bending of a surface and will be used to delineate subtle faults, fractures, flexures, and folds in the Arbuckle Saline Aquifer.



Bemis-Shutts Field proposed test boring concept

Goals/Objectives

The goals of the project are to use the results from existing field studies as a supplement to the seismic prototype being developed at KU in order to assess multiple parameters in a saline aquifer that contains areas influenced by paleokarst.

The project consists of three phases:

- First phase (Year 1) - The objectives are to collect geologic and engineering data, reprocess seismic data, conduct VC analysis, initiate Petrel geologic modeling, and simulate and history-match performance of existing wells to verify VC-identified compartments. Field activities include drilling, logging, and testing the vertical well and sidetracked horizontal lateral.
- Second phase (Year 2) - The objectives are to complete formation evaluation, re-interpret seismic data, optimize the VC, and model seismic attributes, followed by integration of seismic data, VC analysis, and well data into a comprehensive model.
- Third phase (Year 3) - The objectives include simulation studies to model CO_2 storage and plume movement (dispersal, leakage at compartment boundary, and attenuation over time) and thereby determine the effectiveness of VC as a tool to better estimate CO_2 sequestration capacity and permanence in saline aquifers containing localized paleokarst areas.

The project will be conducted through applied research into the theoretical and applied aspects of geophysical surveys for multiple rock types and at different conditions (environmental parameters) in a saline geologic formation.

Benefits

This project will benefit CO_2 sequestration by analyzing how a new seismic tool, VC, can verify existing data for the geologic storage capacity, optimize CO_2 injection rates, and develop a better understanding of CO_2 plume migration, reservoir containment, and CO_2 leakage risk in deep saline geologic storage formations. This proposed project will also provide a valuable data set to complement a DOE funded regional assessment of Arbuckle CO_2 sequestration potential focused on south-central Kansas.