the ENERGY lab

PROJECT FACTS

Carbon Storage - Site Characterization

An Evaluation of the Carbon Sequestration Potential of the Cambro Ordovician Strata of the Illinois and Michigan Basins

Background

Carbon capture and storage (CCS) technologies offer the potential for reducing CO_2 emissions without adversely influencing energy use or hindering economic growth. Deploying these technologies in commercial-scale applications requires adequate geologic formations capable of (1) storing large volumes of CO_2, (2) receiving injected CO_2 at efficient and economic rates, and (3) retaining CO_2 safely over extended periods. Research efforts are currently focused on conventional and unconventional storage formations within depositional environments such as: deltaic, fluvial, alluvial, strand-plain, turbidite, eolian, lacustrine, clastic shelf, carbonate shallow shelf, and reef. Conventional storage types are porous permeable clastic or carbonate rocks that have fluids such as brine, oil, or gas in the natural void spaces of the rocks. Unconventional storage types include unmineable coal, organic shale, and basalt interflow zones[1].

The Department of Energy's (DOE) National Energy Technology Laboratory (NETL) selected 10 projects that received $49 million of DOE funding to characterize promising geologic formations for CO_2 storage. The funding was provided by the American Recovery and Reivestment Act of 2009 (ARRA), which was enacted to create new jobs, spur economic activity, and promote long-term economic growth. This research further advances DOE's efforts to develop a national assessment of CO_2 storage resources in deep geologic formtions. These 10 projects are focusing on the regional site characterization of high-potential geologic storage formations. They will assess and develop comprehensive data sets of storage formation characteristics (porosity, permeability, reservoir architecture, cap rock integrity, etc.) to provide insight into the potential for selected geologic reservoirs across the United States to safely and permanently store CO_2. An additional $50 million of ARRA funding was provided to augment the work that the existing projects are conducting. This additional funding is allowing these projects to further characterize reservoir geology, identifying additional storage opportunities for industrial CO_2 sources. This additional funding is allowing these projects to drill additional and/or deeper wells, collect significantly better log and core data to populate models, collect additional geophysical data, and integrate additional data and conduct more extensive reservoir models.

[1]DOE NETL 2010 - **Geologic Storage Formation Classification:** *Understanding Its Importance and Impacts on CCS Opportunities in the United States,* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/BPM_GeologicStorageClassification.pdf

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PARTNERS

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Project Description

NETL is supporting a consortium led by the Illinois State Geological Survey (ISGS) to conduct an evaluation of the carbon storage potential of the Cambro-Ordovician Strata of the Illinois and Michigan Basins, which underlie much of the states of Illinois, Indiana, Kentucky, and Michigan. To date, only cursory studies have been done on the reservoir zones of the carbonate Knox Supergroup, and no field tests or detailed studies have been conducted on the seal potential of the various overlaying shale formations.

During Phase I of DOE's Regional Carbon Sequestration Partnership (RCSP) research program found that the Mt. Simon Sandstone is a major storage opportunity in the region. It was found that some areas of the Mt Simon is either too deep or of limited permeability to be viable for CO_2 storage. Therefore, an evaluation of the storage potential of the Cambro-Ordovician strata, which overlays the Mt Simon, will identify secondary storage opportunities and provide a possible storage resource in the Midwest. The target reservoirs for the Cambro-Ordovician are the porous zones within the Knox Supergroup and the St. Peter Sandstone. The seals of Knox Supergroup include the Maquoketa (Utica) and New Albany shales (Figure 1).

In the early phase of the project, whole core from the MGSC field test in Decatur, Illinois will be collected and a 120 mile 2-D seismic acquisition will be shot in western Illinois. The Kentucky Geologic Survey will conduct a CO_2 injection test in Hancock County, Kentucky. These data and existing data will be used to estimate the regional injectivity and storage capacity of the St. Peter Sandstone (Figure 2) and intervals of the Knox Supergroup (Figure 3). Specific studies include modeling the dissolution of CO_2 in brine and the interaction with carbonate reservoir rocks, geomechanical tests and petrophysical analyses, an evaluation of mineralization rates, and an analysis of seal faulting potential. The project will conclude with recommendations on the types of data needed to characterize particular reservoirs, which will be incorporated into a best practices manual for assessing the suitability of a Cambro-Ordovician site for CO_2 storage. Spatial maps of high- and low-potential areas of the St. Peter Sandstone and Knox Supergroup will be uploaded to the National Carbon Sequestration Database and Information System (NATCARB).

Goals/Objectives

The primary objective of the DOE's Carbon Storage Program is to develop technologies to safely and permanently store CO_2 and reduce Greenhouse Gas (GHG) emissions without adversely affecting energy use or hindering economic growth. The Program-matic goals of Carbon Storage research are: (1) estimating CO_2 storage capacity in geologic formations; (2) demonstrating that 99 percent of injected CO_2 remains in the injection zone(s); (3) improving efficiency of storage operations; and (4) developing Best Practices Manuals (BPMs).

The main objectives of the project are to evaluate the reservoir storage potential and seal integrity of the intervening layers of St. Peter Sandstone and the Knox Supergroup. The project team will map the entire interval in the four-state area using well data and regional 2-D and 3-D seismic datasets. The project team will also develop a best practices manual for assessing the suitability of a site for CO_2 storage in the Cambro-Ordovician and develop GIS layers of areas with high and low resource potential to be included in the National Carbon Sequestration Database and Geographic Information System (NATCARB) database.

Accomplishments

- Compilation of existing available data was completed.
- An Injection test of 333 metric tons of CO2 in Hancock County, KY was completed by Kentucky Geologic Survey in September 2010.
- Knox group cores were successfully retrieved during well drilling at MGSC field test in October 2010
- A public open house meeting was held at Hancock County, KY in October 2010 to present findings and get input from the local community.
- Processing of the 3-D vertical seismic profile (VSP) data on the Hancock County, KY injection well site was completed in March 2011.
- Acquisition of 120 mile 2-D seismic data was completed in February 2011.
- Processing of 120 mile 2-D seismic data was completed in April 2011.
- Preliminary project data was delivered to NATCARB in September 2011.
- Interpretation of 3D seismic data from Blan Well #1 in Kentucky was complete in September 2011.
- Preliminary analysis of the Knox Supergroup core taken from the ADM Decatur site was completed in December 2011 and is currently being integrated with wireline logging data.

Ongoing efforts include data interpretation of processed 2-D and 3-D seismic data and laboratory tests using core samples to determine geochemical reactions with CO2-rich brine.

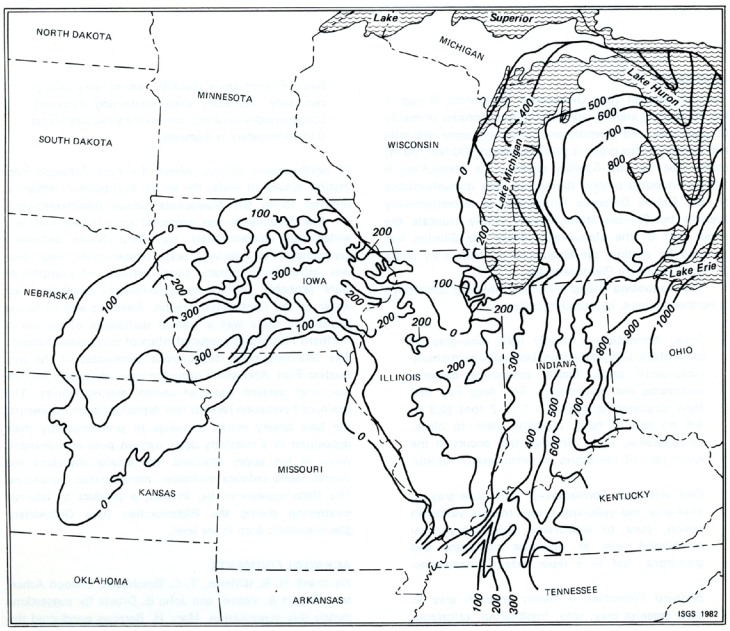

Figure 1: Thickness of the Maquoketa and equivalent strata in the Midcontinent (Kolata and Graese 1983)

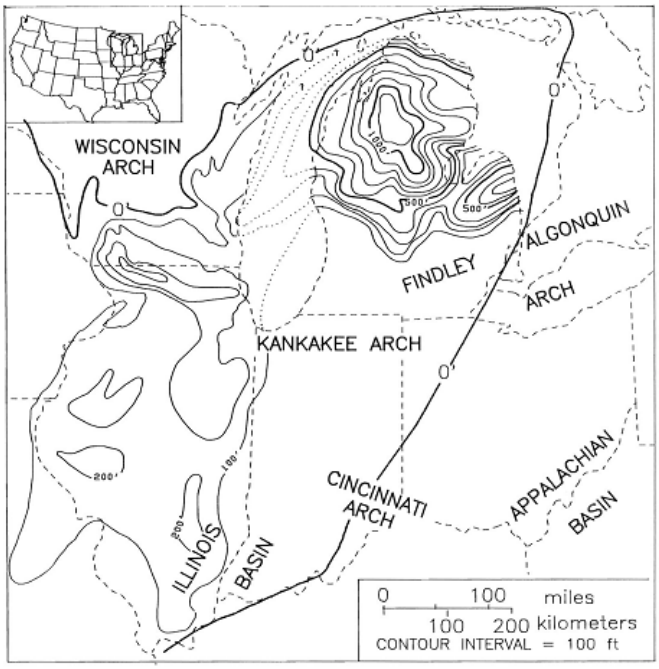

Figure 2: Regional St. Peter Sandstone thickness

Reference

Kolata, D.R. and A.M. Graese, 1983, Lithostratigraphy and depositional environments of the Maquoketa Group (Ordovician) in Northern Illinois; Illinois Geological Survey Circular 528, 49 p.

PROJECT DURATION

Start Date
12/08/2009

End Date
09/30/2014

COST

Total Project Value
$12,805,630

DOE/Non-DOE Share
$9,803,000/$3,002,630

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

Benefits

The overall effort will provide greater insight into the potential for geologic formations across the United States to safely and permanently store CO_2. The information gained from this endeavor will further DOE efforts to refine a national assessment of CO_2 storage resources in deep geologic formations. Specifically, this project will have a significant impact in further characterizing a new geologic interval that could be used for carbon storage. This should open new areas for geologic storage in southern Illinois, southern Indiana, Michigan, and western Kentucky. It will also confirm the Knox and Maquoketa as secondary confining zones for the Mt. Simon. The project's contribution to the Best Practices Manual for site characterization will help reduce risks to the geologic storage of CO_2 by documenting the uncertainties related to fracturing, injectivity, and geochemical interactions for these specific formations. The data gathered as part of this research effort will be shared with the Regional Carbon Sequestration Partnership's (RCSP) MGSC, integrated into NATCARB, and utilized for the 4th Edition of the Carbon Sequestration Atlas of the United States and Canada.

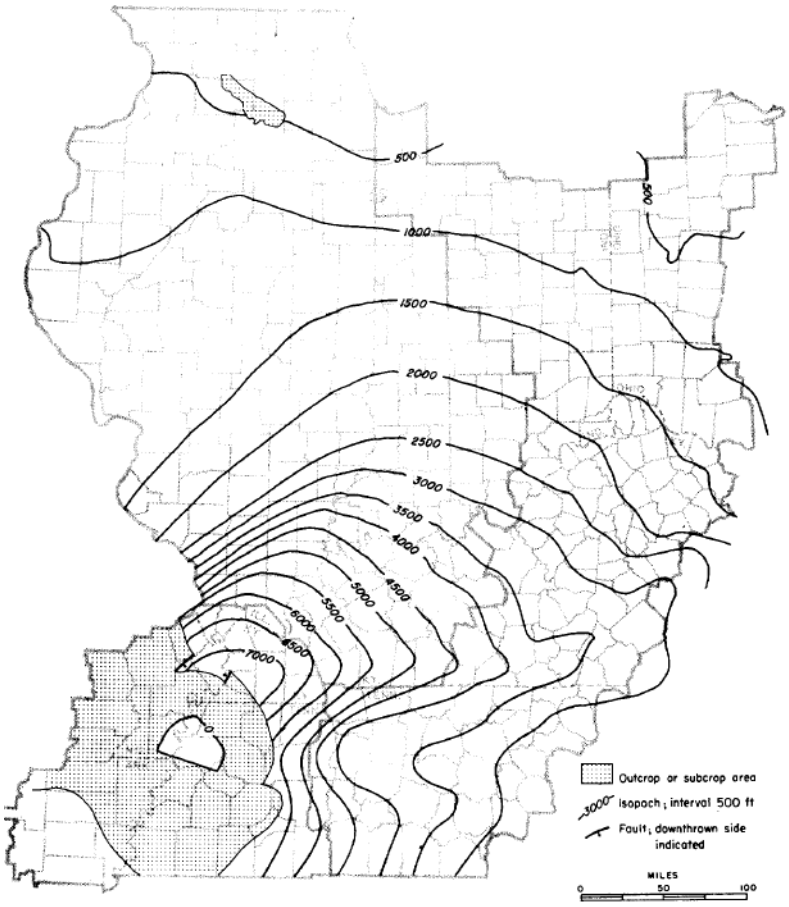

Figure 3: Knox thickness throughout parts of Illinois, Indiana, and Kentucky