

Quarterly Report

Grant No. DE-SC-0001761

Report period: From January 1 to March 31, 2011

1) Project activity during this quarter

(a) Planned activities

1. Development of data archive and resource center
 - Create statewide digital databases for samples and well records for Michigan's geological formations relevant to CO₂ storage, containment and potential for enhanced oil recovery
 - Accumulate data with which to construct maps and tables of physical properties
 - Implement internal data share (intranet) to facilitate compilation of information into a digital atlas
2. Conduct technical research on CO₂ sequestration:
 - Conduct basic and applied research to characterize Michigan saline reservoirs for CO₂ storage potential volume, injectivity and containment
 - Integrate any new data from wells drilled primarily by the oil and gas industry.
3. Data acquisition and software implementation to conduct geologic and fluid flow modeling to address specific predictive uses of CO₂ storage and enhanced oil recovery, including:
 - Compile data for geological and fluid flow models
 - Formulate models, integrate data, and run the models
 - Apply models to specific predictive uses of CO₂ storage and enhanced oil recovery
4. Establish effective technology transfer to members of industry and governmental agencies by:
 - Establish an Internet Website at which all data, reports and results will be accessible (site usage statistics will be maintained)
 - Introduce MICHCARB programs at industry and governmental workshops and meetings
5. Create and deploy educational materials for public outreach
 - Construct physical demonstration models and displays that can be used in outreach and other educational events
 - Work with partners in Michigan geo-resource industries, energy utility companies, State and local governments, K-12 classrooms and teachers and public groups

(b) Actual activities: All planned activities were conducted and good progress was made as described in detail in attachments.

2) Results achieved on the project during this QPR time period

(a) Results planned consisted mainly of:

- See *Planned Activities* 1) (a) 1-5, above.

(b) Results consisted of:

- See Attachments 1-5, *Reports on Planned Activities and Press Release*

3) **Activities which went better or worse than expected:**

(a) Coordinating and managing data produced by multiple users is still a challenge to coordinate while maintaining data integrity, given varying types of formatting needs.

(b) As a direct result of their conducting a “virtual 3-day modeling trip” (see Attachment 3), Dr. Hampton and Tony Clark were able to reduce computer simulation times from days to minutes. This far exceeded their expectations and will move the work along much more quickly using the improved techniques.

Project problems, solutions and changes during the quarter

(a) Because we are checking and updating our entire core inventory, including reboxing and reinventory over 40 pallets, we are finding errors in previous records. Those are due to the many layers of organizations and differences in skill levels of people who previously recorded data. Some errors were found because the contents of the boxes were not accurately reflected by the labels. Correcting the errors and noting metadata has been frustrating and time consuming but worth the effort. For some of the very oldest wells, the labels and boxes have deteriorated so much (due to water damage and salt in cores), that we may never have an accurate record of each box, but we are doing our best to record and preserve as much original data as possible.

(b) We installed a new firewall to guard against malicious attacks on the server and are archiving all data off-site.

(c) The bulletin board system we initiated last quarter as a solution for in-house discussion and documentation about data anomalies is getting some use but several people find it more convenient to speak with staff personally about issues.

5) **Status of project at end of period:** Project is on time and on budget to date.

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Please see following Attachments 1-5.

Attachment 1 Report on *Establishing the Resource Center at MGRRE*

- **Developing statewide and site-specific digital research databases—Data added this quarter:**
 - Core analysis data (largely porosity and permeability data)—hand entered from paper records 16 wells
 - Mudlogs—61 scanned and added to database
 - Wireline logs—inventoried 231 donated logs to be added to database
 - Cuttings—We have now inventoried about 85% of the State Geological Survey’s cuttings collection, obtained during the last 80 years. We now estimate this inventory will be complete by July.
- **Newly available data**
 - Cuttings—Six pallets of cuttings were donated to MGRRE from private industry. They had been housed in a salt mine in Kansas. We have now finished inventorying this collection and are currently bar-coding the boxes.
- **Compiling all information into a digital atlas**

We continue to update our databases, resolving discrepancies where necessary. We have been reinventorying about 40 pallets of cores that had been out for examination. Many were reboxed and checked for actual footage inside boxes. We are also cross-checking well identification data against all public sources of data.

- We continue to implement our digital asset management system (bar-coding), working primarily with the State’s cuttings collection and the recently acquired industry cuttings collection.
- Updating MichCarb’s Web site—please see attachment 5.
- We installed three more graduate student workstations for data input. Procedures for protecting each station from viruses and spyware are being reviewed and resources are being reallocated to accommodate set-up of operating systems, networking and general assistance.
- Updating MichCarb’s Web site—please see attachment 5.

Attachment 2 Report on Technical Research on CO2 Sequestration and Enhanced Oil Recovery

- **Technical Research on CO2 Sequestration**
 - Geological characterization research by Drs. Barnes, Hampton and Harrison and graduate research assistants (Shannon Towne, Kate Pollard, Beth VandenBerg, and Steve Zdan), continues to focus on two important saline reservoir sequestration targets in Michigan: (1) the Cambrian Mount Simon Sandstone and (2) the Devonian Sylvania Sandstone.
 - Dr. Barnes is directing digital well log data collection by undergraduate student assistants (Greg Sawatski, Brandon Vanderbeek, and Jessica Slagter).
 - Drs. Barnes and Harrison identified several significant well cores archived at Michigan Chloride in St. Louis, Michigan. They met there with the owners to pursue acquiring these cores for research here. These cores are from very promising formations and are not available elsewhere. They secured agreement to bring the cores here, dependent upon terms of confidentiality which are now being resolved with Western Michigan University’s legal department. We hope to finalize this agreement and bring those cores here during the summer.
 - Dr. Barnes has been working with Dr. Shameem Siddiqui, a reservoir engineering professor at Texas Tech University in Lubbock, Texas. We are negotiating for some special core analysis work. Some applications being considered include core inspection under regular light and ultraviolet light; Dean-Stark Analysis for fluid volumes, and Neurologica Ceretom NL-3000 research CT-scanner (multi-slice) for non-destructive

imaging. Dr. Siddiquie has published several papers demonstrating use of these techniques in characterizing reservoir rocks and flow in porous media.

- See also Attachment 3 below.

Attachment 3 Report on Conducting Geologic and Fluid Flow Modeling

- Dr. Hampton focused on conceptual geologic model formulation, deployment of modeling software, e.g., STOMP, and general guidance and coordination.
 - He continued to work with graduate students Tony Clark, Amy Manley, Kyle Patterson, and Farsheed Rock to help them accomplish these project goals.
 - Dr. Hampton participated in a macropore webinar in January to learn about how this analysis could benefit reservoir characterization.
 - Dr. Hampton and Tony Clark conducted a “virtual 3-day modeling trip” to PNNL in Richland, Washington, to work with Mark White on using STOMP to simulate CO₂ injection into the Sylvania sandstone. They worked together each day from 9am to 6pm and called Mark when questions arose. Tony made the switch from a fixed mass injection rate to a fixed wellbore pressure controlling injection. He also switched the matrix solver. Solution times began to decrease. By the end of the quarter, his computer simulation times had decreased dramatically from days to minutes.
 - Dr. Barnes, Hampton and Harrison, along with graduate student Amy Manley, met at MGRRE with John Rupp of Indiana Geological Survey. They discussed the geologic characterization tests needed for parameterizing the CO₂ injection models. After weighing potential options, they reached consensus on testing two samples from the Eau Claire, the caprock layer.

Attachment 4 Report on Technology Transfer to Members of Industry and Governmental Agencies

- **Disseminating information about MICHCARB/accelerating the deployment of CC&GS in Michigan**
 - We presented a one-day PTTC conference in Mt. Pleasant, at which several graduate students presented poster papers about subsurface geological formations, some of which are candidates for sequestration. About 200 people attended.
 - Dr. Barnes met several times with colleagues from Consumers Energy to discuss potential CO₂ sequestration.
 - Dr. Barnes had several conferences with personnel from Core Energy concerning on-going CO₂ injection by that group in the Niagaran Reef trend.

Attachment 5 Report on Outreach to Industry, the General Public and K-12 Community

- **Outreach to industry and the general public.**

MichCarb's website continues to grow with over 2000 pages being served to interested readers. This is in addition to over 900 related data requests from the MGRRE website. We continue to review, revise, update and standardize our on-line datasets. This process is detail intensive and time consuming, but we are making headway.

Additional Outreach to industry—see Attachment 4 above

- **Outreach to the K-12 and higher education community**
 - Our K-12 outreach program, CoreKids, continued to welcome school groups to MGRRE and to make visits to public schools, primarily in southwestern Michigan.
 - MichCarb staff and volunteers attended a Kalamazoo gem and mineral show for two days to display examples of Michigan rocks, show their porosity and permeability, and talk about sequestration. More than 1100 K-12 students visited the display.
 - Dr. Harrison met with several high-school students from Troy, Michigan, for an interview and video production to discuss the concept of “Peak Oil”. Part of that discussion revolved

around using CO₂ for enhanced oil recovery. These students will provide us a final copy of the video project they are presenting to their fellow students and teachers.