

Quarterly Report

Grant No. DE-SC-0001761

Report period: From December 31, 2009 to March 31, 2010

1) Project activity during this quarter

(a) Planned activities

1. Continue to obtain and analyzing data
 - Creating statewide digital databases for samples and well records for Michigan's geological formations relevant to CO₂ storage, containment and potential for enhanced oil recovery
 - Continuing to accumulate data with which to construct maps and tables of physical properties
 - Continued implementation of an internal data share (intranet) to facilitate compilation of information into a digital atlas
2. Finalizing software implementation and data acquisition needed to conduct geologic and fluid flow modeling to address specific predictive uses of CO₂ storage and enhanced oil recovery, including:
 - Compiling data for geological and fluid flow models
 - Formulation of models, integrating data, and running the models
 - Applying models to specific predictive uses of CO₂ storage and enhanced oil recovery
3. Continue to lay the groundwork for technology transfer to members of industry and governmental agencies by:
 - Establishing an Internet Website at which all data, reports and results will be accessible (site usage statistics will be maintained)
 - Introducing MICHCARB programs at industry and governmental workshops and meetings
4. Continuing to creating educational materials and conducting outreach
 - Including physical demonstration models and displays that can be used in outreach and for education events
 - Working 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) 1-4, above.

(b) Results consisted of:

- See Attachments 1-4, *Reports on Planned Activities and Press Release*

3) Activities which went better or worse than expected:

(a) We continued to supervise a large staff of work-study students who helped sort and inventory well samples and data. As was true last quarter, we made much greater progress than we anticipated.

- (b) Another collection of 16 pallets of cores were obtained this quarter. These were from a gas-storage field for which we previously had no data. Many well preserved Stray and Niagaran Formation cores were obtained. Also, 2 pallets of shallow bedrock cores (Mississippian) were obtained. An additional set of well records (4 filing cabinets) were also donated to the Center. All these data will add to the project. These collections were not known to us prior to this quarter, so these were good surprises.
 - (c) We experienced an unexpected setback: using STOMP. We found that STOMP's documentation was seriously lacking in some important areas, necessitating communication with modelers at Pacific Northwest National Laboratory in Washington to fill in the missing information. However, some work went forward better than expected: Mr. Rock's geologic correlation between wells based on wireline logs and some rock samples was very well done which expedited the modeling work. For example, there were two wells seven miles apart that correlate very closely, showing that confident inferences can be made over that distance. In summary: Dr. Hampton and his team feel they have overcome the remaining software obstacles and modeling hurdles so that they are now in a position to produce significant results.
 - (d) We have very largely overcome implementation issues with our intranet server and have added massive quantities (tens of thousands) of data and refined large existing datasets.
 - (e) Susan Grammer and outreach staff have visited with hundreds of K-12 students and their teachers in southwestern Michigan, taking displays and exercises with them to explain GCS. They have been warmly received. Her door is covered with thank-you notes. The website has been accessed by visitors from four continents.
- 4) **Project problems, solutions and changes during the quarter**--No significant problems or changes occurred this quarter.
- 5) **Other topics of interest:** Please see attachments
- 6) **Status of project at end of period:** Project is on time and on budget to date.

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Please see following Attachments 1-6.

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 204 wells
 - Mudlogs—122 scanned and added to database
 - Wireline logs—sorted 720 donated logs to be added to database
 - Cuttings—mounted cuttings sorted and inventoried from 34- wells
 - Cores—16 pallets of donated cores from a gas storage field were sorted, added to existing core inventory
 - Cores—2 pallets of shallow bedrock cores (Mississippian), sorted and added to existing core inventory

- 4 4-drawer filing cabinets of well records (drillers reports, wireline logs, mudlogs, etc.) were donated by two companies and we have just begun to sort these

- **Compiling all information into a digital atlas**

A. The master project for combining and curating MDNRE and MGRRE data in one relational database type project includes 63,302 wells. Of these, about 470 are mineral or other non-oil and gas wells.

1. The wells were imported using well attribute files generated through the use of comma delimited Excel files extracted from the original MI DEQ Access datasets. Additional wells will be added from the MI DEQ Mineral Wells database once location information is generated. A few other wells with data held by MGRRE, not found in the state datasets may also be added.
2. Well data is referenced by a unique well identifier, by default the API number for each well; though for mineral and other wells a different unique well identifier type will be used such as state assigned permit number or index number.
3. The map projection was set to the North American Datum 1983 (NAD83), Polyconic Projection, with the Ellipsoid of Clarke 1866. The value for Central Meridian is -84.3666667, and the Latitude of Origin is 43.3166667, with the XY Units in Meters.
4. Location data was primarily referenced by state given latitude and longitude data. Several wells, especially in the mineral well data set, do not have latitude/longitude data, but have Michigan Georef coordinates and/or public land survey coordinates. The public land survey data is typically referenced to the quarter-quarter-quarter section. Legacy software provided by the DEQ for converting the reference data from georef coordinates and TRS coordinates is available but needs to be tested. Otherwise, the centroids of partial sections will be used for relevant wells.
5. Formation tops data is organized by top acronym such as AMBG for the Amherstberg formation. It is further divided by source of top pick such "G" for a MIGS Pick. Due to the large number of top acronyms, the FMTops window may be slow to load, but this can be made faster by only displaying active tops. Top picks for slanted wells will only display the MD pick values, even in the TVD column, as Petra links the MD and TVD categories, which does not allow the actual TVD pick to be represented.
6. Zone data such as elevations (well datums) and cumulative oil, gas, and water production were extracted from the State files. Other zone data will be added from the MGRRE datasets such as Yes/No values of 1 and 0 for the existence of core at MGRRE, and core analyses files, for example.
7. Raster logs were imported into a minimum of 27,708 wells, representing 57,113 raster images available from State of Michigan sources. These do not include any scanned logs from MGRRE's files.

B. We have begun extensive work on MGRRE datasets, reformatting and checking data for two primary in-house database: Core analyses and Wireline Logs. We are checking and verifying several fields for accuracy and data continuity. We are standardizing API numbers, using the Stat of Michigan DNRRE database to fill in missing values, and removing extraneous characters from data fields. The goal is to provide for a clean and efficient workflow from spreadsheet to datashare to web. Definitions, ranges and rules for variables are being created for basic data entry to ensure consistency and reduce "outliers". Variable definitions will carry through all data files with new definitions being created as needed. The end result should provide for a means by which a "relational database" can be conceptualized.

1. About 50% of the core analysis database has been updated. About 30% of the wireline logs have been updated and reformatted.
2. We are beginning to update and reformat another critical dataset: our core collection.

C. We are reviewing a model for searchable and sortable html tables that will reduce file size of several large datasets, facilitating faster data download/retrieval.

Attachment 2 Report on Conducting Geologic and Fluid Flow Modeling

- **Compiling data for geological and fluid flow models**

- Dr. Hampton and two students met with Michigan State Department of Natural Resources and Environment (MDNRE) personnel in Lansing to acquire data from 27 waste disposal wells. The State requires annual injectivity tests for continued well use. These tests yield pressure fall-off data that is very useful to determining CO₂ sequestration potential. The data address these issues:

1. How easily fluids can be injected into the reservoir, and

2. Whether there are local boundaries that impede injection/fluid flow

A variety of fluids are injected into these wells. Because their properties affect fluid flow, Dr. Hampton collected data for each well relative to fluid density, viscosity/temp, and salinity.

Data was obtained from 27 injection wells throughout Michigan. Many were injecting into the Mt. Simon and the Sylvania formations, our two primary target formations. Dr. Hampton and his staff are now beginning to analyze these data.

- Dr. Hampton continues to supervise two students working on modeling using Stomp software. One of these students, Tony Clark, is preparing a paper for the 2010 Carbon Capture and Sequestration Conference in Pittsburgh in May. The paper addresses the sequestration potential of the Sylvania Formation. Mr. Clark is working with the second student, Farsheed Rock, who has done the geological characterization work. Mr. Clark has input Mr. Rock's data into Stomp. Mr. Rock's data were derived from wireline logs (neutron porosity, gamma ray, and bulk density) and some rock samples from Sylvania wells.
- Dr. Hampton has also begun to train a third student, Amy Manley, in groundwater modeling prior to her learning to use STOMP.
- **Formulation of models, integrating data, and running the models**
 - We found that STOMP's documentation was seriously lacking in some important areas, necessitating on-going communication with modelers at Pacific Northwest National Laboratory in Washington to fill in the missing information.
 - However, some work went forward better than expected: Mr. Rock's geologic correlation between wells based on wireline logs and some rock samples was very well done which expedited the modeling work. For example, there were two wells seven miles apart that correlate very closely, showing that confident inferences can be made over that distance. In summary:
 - Dr. Hampton and his team feel they have overcome the remaining software obstacles and modeling hurdles so that they are now in a position to produce significant results.

Attachment 3 Report on Technology Transfer to Members of Industry and Governmental Agencies

- **Disseminating information about MICHCARB/accelerating the deployment of CC&GS in Michigan**
 - Dr. Barnes addressed the Michigan PTTC workshop, organized by MGRRE, in Mt. Pleasant. The meeting was attended by 190 professionals from industry, government and academia. He discussed the application of traditional subsurface reservoir characterization methodology to geological sequestration studies in the Michigan Basin. He also emphasized that geological sequestration investigations are rapidly expanding applications of many familiar petroleum geology and engineering applications and methodologies and discussed how this work represents an opportunity for such work to even more professionals.

Attachment 4 Report on Outreach to Industry, the General Public and K-12 Community

- **Outreach to industry and the general public**
 - Have begun preparing presentations for different audiences.
 - Staff exhibited at Michigan Science Teacher's Association Conference, March 4-6, 2010.
 - Presented summary of MichCarb goals and results to Rep. Fred Upton in Jan. 2010.
- **Outreach to the K-12 community**
 - **Partnership development**
 - MGRRE's K-12 Outreach Program, CoreKids, has continued to establish new partnerships with K-12 schools, scouting groups and other youth organizations which are now part of MICHCARB's network.
 - **Creation of Educational Materials**
 - Posters about climate change and geological CO₂ sequestration and model of EOR remains on display at MGRRE for all visitors to observe.
 - Temporary MICHCARB website visited 75 times.
 - Map of visitors:



- <http://www.wmich.edu/corekids/CarbonDioxideSequestration.html>.
- **Development of dissemination plans**
 - Outreach staff has discussed content and venues for presentations, teacher workshops, website, science fairs, and exhibits. Many of these events will be at schools and venues previously visited by CoreKids staff.
 - School, scout and summer camp visits scheduled for April – July 2010 (~600 students)
 - Teacher Workshop: CO₂ sequestration will be major topic of Keystone Science School Climate Status Investigations teacher training to be held at WMU July 27-28, 2010. This will reach approximately 40 teachers from around the state of Michigan.
 - Keystone Science School will hold 2nd Youth Policy Summit in partnership with CoreKids, MGRRE and MICHCARB July 24-29, 2010. Forty high school students and their teachers will spend a week discussing energy related issues, to include CO₂ sequestration, and come to consensus on recommendations to be made public.
- **Dissemination of educational information on GCS**

- Dr. Hampton presented “Climate Change” to 300 8th graders at Mattawan public schools on March 18. He spoke and then answered questions during this nearly one-hour-long presentation. His talk began the 8th-grade’s two-week focus on climate change.
- Susan Grammer exhibited at the Michigan Science Teachers’ Association Meeting in March 2010.
- Susan Grammer presented workshop for Teachers including CO₂ sequestration content at MSTA meeting March 2010.
- Since Jan.1, 2010, Susan Grammer and staff has presented CO₂ sequestration educational content to:
 - Plainwell Starr Elementary School 3rd grade GT students – 20 students
 - Northglade Montessori, Kalamazoo Public Schools, grades 3-5 150 students
 - Springfield Middle School Battle Creek – 100 students
 - Pansophia Academy, Coldwater, MI – 150 students
 - Hastings Middle School grade 8, Hastings, MI, 275 students
 - Plainwell Science Night – 250 adult and K-12 student visitors