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MICHIGAN GEOLOGICAL SURVEY

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January 29, 2015

Michigan Geological Survey MGS Annual Report (2014)

The Michigan Geological Survey is pleased to present the 2014 Annual Report summarizing the activities and accomplishments to the State Geologist per Senate Bill No. 507.

OVERVIEW:

The restructured Michigan Geological Survey (MGS) has been active at the Western Michigan University Geosciences Department for just over three years. The responsibilities of the survey include: investigation of the state's geological resources, the collection and archival of geological samples, cores, cuttings, and the preservation of geological investigations. The purpose of the Michigan Survey is to serve the state's people, industry, and governmental agencies (the clients).

The MGS activities continue to operate primarily on university funding and limited external grants. The goal of the MGS is to be recognized as the "Go To" resource for geologic information in the state. During 2014, the survey established a formalized structure of nine Resource Centers. These are: Michigan Geological Repository for Research and Education (MGRRE), Surface Mapping, Hydrogeology/Environmental geology, Energy, Economic Minerals, Geologic Hazards, Geological Information System (GIS)/Data Management, Remote Sensing, and Outreach which provides scientific information to the public and the state legislature. In order to initially meet this goal, the MGS will utilize the voluntary support of the faculty and other resources until permanent, recurring appropriations and funding can provide for the hiring of a permanent staff.

The MGS Director, John A. Yellich, has taken over 90 opportunities to introduce the restructured survey to clients and to critical stakeholders across the state. Included were meetings with directors in the Governor's office, an invited presentation to the Senate Natural Resources Environment and Great Lakes Committee and a meeting with Representatives Aric Nesbit and Margaret O'Brien (Now Senator Margaret O'Brien), and local Township officials. The focus of many of these meetings was primarily on the benefits of and the need for a funded, functional geological survey, geology and groundwater in Southwest Michigan. There were presentations to specific associations, committees and organizations that include: Michigan Manufacturers Association, Environmental and Mining Policy Committees; Michigan Bar

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Association Environmental Committee, Michigan Farm Bureau Natural Resources Committee, Michigan Tribal Environmental Group, Michigan Petroleum Landmen, Michigan Groundwater Association; representatives of the Michigan Chamber of Commerce, Michigan Oil and Gas Association, MDEQ Geologists Outreach workshop to name a few. The MGS presented the geological issues currently facing the State of Michigan, associated with agriculture, industry, municipal and rural growth, water resources, resource development, and data management. The MGS is proposing the preparation of a geologic data base comprised of the millions of data points in reports and other state controlled documents having geology, water quality and quantity that exist in paper and other formats in the State files that cannot be used effectively by the State or the public. At these presentations and many others meetings the MGS presented the benefit and need for state funding if the MGS is to provide the science needed to address critical geological issues in the state.

The MGRRE core and data repository continues to be the cornerstone scientific geologic resource of Michigan. The MGS was requested to provide documentation and evidence of this geologic resource to a congressional hearing chaired by US Representative Dan Benishek, First District, Michigan. This was formal testimony submitted to a Subcommittee hearing of the US House of Representatives on September 17, 2014. This testimony (Attached) documents the benefits of a core and data repository and the hundreds of millions of dollars in revenue and tax benefits that Michigan has received over the last 20 plus years and yet no State appropriation has been provided to MGS/WMU for this geologic core and data resource.

A funding milestone was achieved in 2014 when the directors of the Michigan Departments of Environmental Quality (MDEQ), Natural Resources (MDNR), Michigan Office of Great Lakes (MOGL), and Michigan Agriculture and Rural Development (MDARD) established a partnership with the MGS to support the ongoing United States Geological Survey (USGS) federal mapping program. This funding partnership is the first state funding for mapping in the state in over 30 years. Funds will be matched by the USGS Federal Geologic Mapping Program matching funds.

Attached to this Annual report is a summary of submitted proposals and awards, publications, map products, presentation abstracts and reports which present Michigan scientific research during the past year.

GENERAL SURVEY ACTIVITIES AND ACCOMPLISHMENTS:

MGRRE – Sample and Data Repository: The Michigan Geological Repository for Research and Education (MGRRE), which has served Michigan for over 30 years, under the direction of Dr. William Harrison III, continues to be the strength of the MGS. Listed below are some of the most recent achievements as a result of the numerous requests and onsite visits for data review at MGRRE.

A collaborative scientific program for carbon sequestration into oil and gas reservoirs has been established and includes MGRRE, MGS, Midwest Regional Carbon Sequestration Partnership (MRCSP), Battelle National Laboratories, and the Department of Energy (DOE). Requests for review of geologic core and other data are incorporated into this program. Technical review of

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core and related data coupled with field validation progressed significantly this past year. This resulted in the further confirmation of Enhanced Oil Recovery (EOR) programs utilizing the capture and injection of CO₂. The EOR program is one of the tangible economic benefits of carbon capture and injection. It has resulted in the recovery of more than an estimated one and three quarters barrels (1.6 million) of incremental oil that was formerly deemed unrecoverable by conventional secondary recovery methods. The program has provided millions of dollars in additional revenue for the Michigan economy, as well as a substantial number of new jobs.

The Michigan Legislature passed a bill to modify and reduce the oil severance tax in order to stimulate support for the CO₂ injection program, and to partially mitigate the substantial additional costs of this type of EOR program. The legislation was signed at MGRRE on April 1, 2014, in recognition of its work and support. MGRRE received a four-year funding extension of DOE grant funds to continue its support of the MRCSP sequestration studies. The MGS and MGRRE also receive funding for core, data storage and services through generous industry donations.

MGRRE received a grant from the National Geological and Geophysical Data Preservation Program (NGGDPP) in support of their data capture and preservation functions. During 2014, 230 oil and gas well cores representing 15,000 feet of well bore, as well as cores from 125 shallow bedrock borings representing 2,310 feet of well bore were cataloged. Approximately 6000 handwritten oil well scout tickets were scanned and preserved.

On September 17, 2014, the US House of Representatives held hearings on bill H.R. 5066 in support of continued funding for NGGDPP, the data and sample preservations act. Representatives of the Association of American State Geologists (AASG) made presentations in support of that legislation. The MGS submitted formal written testimony (Attached) on that date in support of H.R. 5066. The MGS testimony documented over the last 20 years, Michigan's receipt of hundreds of millions of dollars in oil, gas, and mineral revenues, and associated taxes, as a result of the geologic sample resource and scientific work of the MGRRE facility and staff. Several successful student theses, industry research studies, and other geological programs conducted over the last 30 years were also documented, yet as of this date, there has been no direct funding of MGRRE by the State of Michigan.

MGRRE supports the State Geothermal Data Project, organized by the AASG with funding from the Department of Energy (DOE). The project brings data from all 50 States into the National Geothermal Data System (NGDS). The MGS digitized at-risk, legacy geothermal-relevant data, and submitted the same to the U.S. Geosciences Information Network (USGIN) data base.

Geologic Data Base to support geologic resource assessment mapping projects

The Governor's Water Use Advisory Council (WUAC), under the direction of the Director of the DEQ, completed their two-year review of the water resource issues of the state. One of the recommendations of the WUAC was available geologic data not being used. The MGS

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recognized this issue, the abundance of geologic data that is not available for use in assessing any of our resources, which also includes groundwater. This situation is described below.

The State of Michigan has numerous data sets and documents that are either in paper or microfiche format, along with various electronic databases that neither communicate with each other, nor are they retrievable in a uniform electronic format. There could be up to a million data sets that represent information having an estimated minimum value of over \$2.0 billion. Michigan risks the loss of a substantial portion of these data resources due to physical deterioration, mishandling, and to the expense of physical storage. This is called "Orphan data". The inefficiency that is inherent in the use of outdated databases is substantial. The result is that state employees, and the public, spend unproductive time retrieving and sorting data before it can be effectively used. Recent requests for information under the Freedom of Information Act (FOIA) by the public amount to about 12,000 per year for all Michigan state agencies. When staff time is allocated to these requests, the amount of work required is estimated to be that of 12 full time employees (FTE). Meeting FOIA requests using the current data format detracts from the time that state employees are available to meet required goals of each agency's mandated program. Concurrently, the person or agency that is requesting data also expends time acquiring the data and converting paper copies into useable electronic and proprietary formats.

It is implicit that there is a demand for creating a set of central electronic databases that would be used to archive information into formats that are searchable and appropriate for the type of information requested. Such a centralized set of databases would make Michigan's agencies more functional and time responsive. Properly prepared electronically formatted files would also provide the public with an expedited mechanism to fill a FOIA request, and to receive data without a state staff member or the public personally handling paper files. The files would be available through multiple electronic mechanisms of request, review, and receipt. A searchable electronically formatted document program would encourage greater use of data, and would save manpower and time for both state employees and public users. For example many of the databases could be supported by a multi-tiered fee structure, and users would have existing documents almost instantly available. Fees would cover the cost of a continuing input of data.

Drillers Workshop and a DEQ Geologists Outreach glacial core review

In 2014, the MGS pioneered a workshop format for water well drillers to support water resource studies that are required by the state. There were two workshops, one during March and one during September. They were held at MGRRE and in Alpena, respectively. More than 50 local and regional drillers attended, as well as representatives from local DEQ offices, and county and city regulators. The workshops presented a standardized approach to classifying water well drilling cuttings in order to have better data to assess water potential and other natural resources in shallow glacial deposits. The MGS is working to create a sample identification training program for new drillers, and an on-going training program to be presented at Michigan Groundwater Association meetings. In this way, the MGWA members can add real value to an underutilized resource of subsurface data.

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The MGS also presented a core logging display of glacial materials at the annual MDEQ Geologists Outreach Workshop in Roscommon, which confirmed the motivation for the standardization of the drillers sample descriptions.

Oil and Gas

The MGS through the Resource Center at MGRRE continues to be associated with the Petroleum Technology Transfer Council (PTTC), for more than 25 years, that conducts both day and multi-day workshops on oil and gas production technologies. In 2014 the workshops had over 200 participants. These workshops focus on relevant scientific and production topics in the petroleum industry.

MGS and MGRRE Websites

The number of contacts (hits) on a website is a measure of importance of that information resource. The MGRRE and MGS websites contacts indicate greater visibility with an increased exposure and number of data sets. The increase of unique requests at MGRRE (different ID of the request) from 17,838 to 27,425 from 2012 to 2014, respectively, denotes a 153 percent increase in exposure, for MGRRE. This represents 307 inquiries per day or 112,188 for the 2014 year, a tribute to the relevance of the MGRRE information. The MGS website has only been fully functional for the last 1 plus years, and it is growing in the number of unique requests at a rate of 174 per month.

Geologic Mapping: The MGS participates in and submits projects in both of the USGS Federal Geologic Mapping Programs, STATEMAP and Great Lakes Geologic Mapping Coalition projects, under the direction of Dr. Alan Kehew. This past year, the USGS mapping program awarded funding to map in both the Lower Peninsula, under the direction of Dr. Alan Kehew, and the Upper Peninsula, under the direction of Dr. Joyashish Thakurta. In February, the MGS participated in presentations to the Michigan Congressional delegates in Washington D.C., and successfully requested their continued support for funding of the Great Lakes Geologic Mapping Coalition.

The emphasis in the two USGS mapping programs is concentrated in the areas of mineral resources in the Upper Peninsula, and in state-wide water resources. The need for accurate geologic data and aquifer characteristics in the Lower Peninsula (LP) cannot be underestimated. The LP studies are being conducted with a refined 3-D approach that includes a combination of surface geologic mapping, combined with a limited rotonomic and geoprobe drill coring program. The approach includes down hole geophysical logs and validated geologic logs from water well drillers. The combination of these components results in a more accurate geologic depiction of an area's stratigraphic section. This increases the quality of the data used in assessing water-bearing strata, and availability of water for high production users, i.e.,

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primarily the agricultural community. The recent funding partnership with the MDEQ, MDNR, MDARD and OGL will support this mapping program.

Groundwater Resources & Environmental Quality and Energy: The MGS has been asked to sit on the Michigan Governor's Water Use Advisory Council. The council supports the adoption of the Great Lakes Compact that requires permitting of large capacity water wells and quantifies their impact on local stream flows. Local requests are being made to the MGS for information on the quality and quantity of the groundwater in certain areas of the state, but many of the requests cannot be supported by MGS, because the local or personal request does not have funding associated with any proposed study at this time.

Economic Minerals: The Western Michigan University (WMU) hard rock economic mineral geologist/petrologist, Dr. Joyashish Thakurta, has focused on the rock suites of the Upper Peninsula of Michigan. His efforts will be integrated into the MGS's role as a mapping, sample collecting and geochemical analysis of specific geologic data in little known areas throughout Michigan. He has written proposals to conduct studies with mining companies that will utilize students to sample and analyze the data for their respective theses. This represents the educational component of the MGS/University synergy. Student projects and support include the following:

- Jonathon Hayes is sampling and mapping at Sturgeon Falls in the Sturgeon River area near Norway, MI. He is evaluating the gabbroic sills along the river, and has presented his work at the Annual GSA meeting in Vancouver, BC. Support was received from multiple academic sources, and the geochemical data was provided by Aquila Resources.
- Anthony Boxleiter is evaluating the Back Forty sulfide deposits (north of Menominee, MI) in collaboration with Aquila Resources and is preparing a model for the origin of the Volcanic Massive Sulfide (VMS) deposit.
- Andrew Sasso completed an initial sampling trip to Marquette County in order to map peridotite units, and he is now working on the petrography and geochemistry of the rock units.
- Nick Panyard is compiling geochemical data on Total Organic Carbon (TOC) and sulfur isotopes in the Antrim Shale in the northern Michigan basin using core samples from MGRRE.
- Ben Hinks initiated his geochemistry of the sulfide deposit at the Eagle Mine, Barga County.
- Katherine Dvorak is working in the Penocean Volcanic Belt in the UP of Michigan along the Wisconsin border, and has just initiated her PhD studies.

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Dr. Thirkuta's contacts have also stimulated the potential for conducting an aerial geophysical survey of the western Upper Peninsula to enhance the assessment of hidden mineral targets in the hardrock terrain. This would benefit the State and Private leasing potential for buried mineralization targets.

GIS Data Management and MGS Store: Ms. Sita Karki is formatting new and historic maps and other documents to comply with ArcGIS standards. These documents will be archived into the MGS Data Management system. This new role of the MGS has already been initiated, and it includes the preparation of documents and maps for distribution and sale through the MGS website. The MGS believes that there are many older Michigan publications and paper resources that need to be acquired and archived, in order that they can be made available to the scientific community and to the general public.

Outreach and CoreKids K-12 program: The CoreKids K-12 program at MGS-MGRRE has had increasing interest by the Michigan education community under the direction of Dr. Peter Voice. The emphasis of the program is the importance of earth science education of middle and high school students. Many teachers are now turning to the educational resources at the MGS- MGRRE facility. The number of contacts being made with students or the general public at informal presentations, special events or school sessions, has increased in the last year. The Coordinator and staff have made over 16,000 contacts within this budget year, and current expectations are that we will exceed last year's contact numbers in the next year. Teachers are realizing the benefits of this program, and the MGS hopes to incorporate this program into the State K-12 program going forward.

Between July 1, 2013 and July 1, 2014, the CoreKids program performed 65 events including school visits, MGRRE tours, and larger events with allied partners. The CoreKids program also attended 7 conferences and teacher workshops during that period. From July 1, 2014 to January 1, 2015 CoreKids performed an additional 24 events. School events were scheduled with classes from 27 schools in southern Michigan. Over the past 18 months, the program has interacted with 30,439 people including K-12 students, college students, teachers, professional geologists, and the general public (Figure 1).

We have expanded our partnerships over that time with new partners including the University of Michigan, Detroit Museum of Natural History, the Michigan State University Museum, the Michigan Mineralogical Society, and the Central Michigan Lapidary and Mineral Society. The program continued its association with the Cranbrook Institute of Science, the Kalamazoo Air Zoo, and the Kalamazoo Geological and Mineral Society. The CoreKids program strengthened its ties with the state teachers associations (Michigan Earth Science Teachers Association [MESTA] and Michigan Science Teachers Association).

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Dr. Peter Voice and Dr. Heather Petcovic presented this program at the 2014 annual meeting of MESTA. Dr. Voice has also worked with a consortium of other outreach coordinators from state geological surveys across the Midwest to develop collaborating community resources including a recurring scheduled presentation session at the Annual North-Central Section Meeting of the Geological Society of America (NCGSA). Dr. Voice will be co-chairing the session at the 2015 NCGSA meeting in Madison, WI. The GO-MPS (Geological Outreach: Museums, Parks, and Surveys) group has set up an email exchange to pass along information about potential grants, joint outreach events, and new methods and techniques in outreach.

The CoreKids program received a generous gift of \$18,000 from the American Petroleum Institute-Michigan Section in October, 2014. The CoreKids program has also submitted a National Science Foundation (NSF) proposal to support an online Education Portal focused on the resources of the MGRRE facility. This proposal was submitted in October 2014.

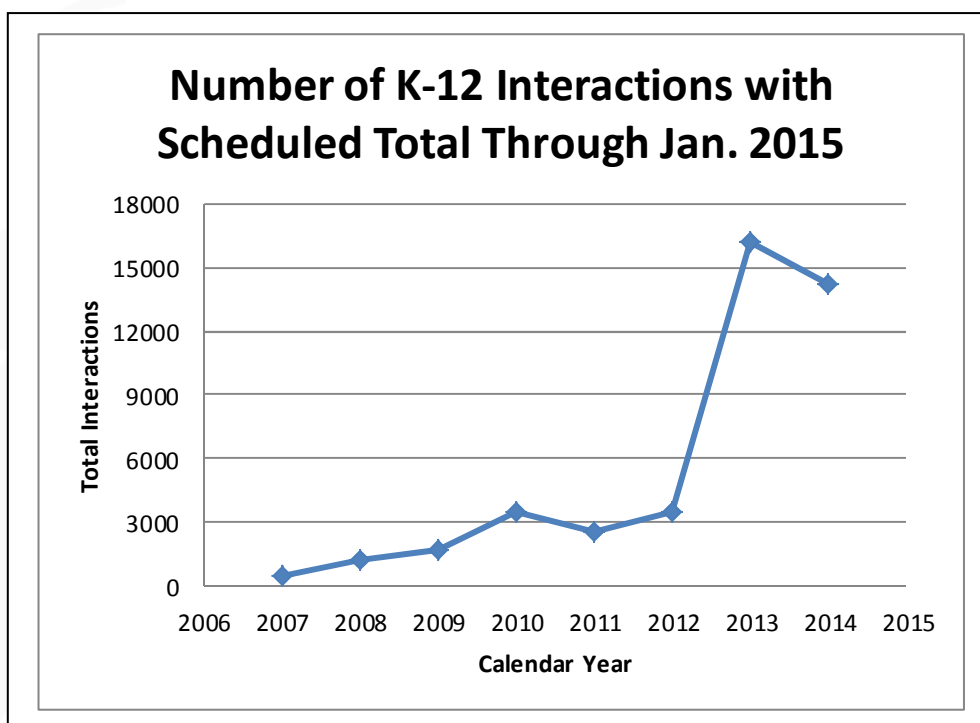


Figure 1: The CoreKids program has generated 70% of its contacts in the past 18 months.

Remote Sensing: The MGS and the Remote Sensing Laboratory under the direction of Dr. Mohamed Sultan is preparing proposals to support satellite imaging and airborne geophysical surveys for mapping faults, karst features, water resources, and other geological features. The primary emphasis has been in areas outside of the US, however, recent studies are being initiated in the US using tested and proven remote sensing techniques.

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2014 - Proposals or Grants submitted:

NOTE: USGS Proposals are submitted in one calendar year and the funding confirmation and grant are not received for up to 6 months of submittal. Funds are then spent over the next two years, e.g., a submittal in 2014 is spent during the period 9/2015 to 8/2016.

- A. Geologic Mapping: Duck Lake, Springport, Norway, Bessemer, and Jones Quadrangles, U.S.G.S. State map program, \$211, 422, Alan Kehew, Joyashish Thakurta, and John Yellich.
- B. Geologic Mapping: USGS: Indian Town and Wood Island SE Quadrangles, Alan Kehew, U.S.G.S. Edmap program, \$17,486.
- C. American Petroleum Institute - \$18,000.
- D. MI Contribution to the National Geothermal Data System – Installing Software for Metadata Management - Arizona Geological Survey \$9,000.
- E. Michigan Department of Agriculture – Strategic Initiative – Pre-proposal submittal which was “Proposal to assess the development of newly identified groundwater resources in previously unknown areas of Barry County” - \$131,000.

(MGS did not receive authorization to proceed with a formal proposal submittal on this initiative.)

- F. National Science Foundation (NSF) proposal to support an online Education Portal focused on the resources of the MGRRE facility - \$449,980.
- G. Michigan Department of Environmental Quality (MDEQ) support for USGS Federal Mapping program, Vandalia Quadrangle, Cass County, MI., mapping of geology and associated water resources.

2014 -Proposals and Grant awarded:

- A. American Petroleum Institute - **\$18,000.**
- B. MI Contribution to the National Geothermal Data System – Installing Software for Metadata Management - Arizona Geological Survey **\$8,997.**
- C. Geologic Mapping: Olivet and Vulcan Quadrangles, U.S.G.S STATEMAP program, **\$73,444**, Alan Kehew, Joyashish Thakurta.
- D. Geologic Mapping: Tekonsha, Union City, Burlington Quadrangles, U.S.G.S. Great Lakes Geologic Mapping Coalition, **\$74,358.** Alan Kehew
- E. MDEQ, MDNR, MDARD and OGL funding for mapping of water resources in Cass County, MI. Vandalia Quadrangle, mapping the geology and associated resources. **\$44,000** for use in the 2015 USGS Federal Geologic Mapping program. John Yellich

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USGS Maps produced and published:

Esch, J.M. and Kehew, A.E., 2014, Surficial Geology of the Ellis Corners 7.5 Minute Quadrangle, Calhoun County, Michigan, Surficial Geologic Map Series SGM-14-03, scale 1:24000.

Esch, J.M. and Kehew, A.E., 2014, Surficial Geology of the Southeast Albion 7.5 Minute Quadrangle, Calhoun and Jackson Counties, Michigan, Surficial Geologic Map Series SGM-14-05, scale 1:24000.

Kehew, A.E. and Esch, J.M., 2014, Surficial Geology of the Southwest Albion 7.5 Minute Quadrangle, Calhoun County, Michigan, Surficial Geologic Map Series SGM-14-04, scale 1:24000.

Kehew, A.E. and Esch, J.M., 2014, Surficial Geology of the East Leroy 7.5 Minute Quadrangle, Calhoun County, Michigan, Surficial Geologic Map Series SGM-14-01, scale 1:24000.

Linker, J.S. and Esch, J.M., 2014, Surficial Geology of the Lyon Lake 7.5 Minute Quadrangle, Calhoun County, Michigan, Surficial Geologic Map Series SGM-14-02, scale 1:24000.



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Published Abstracts of Professional Presentations 2014

(Student Authors are Highlighted in Bold)

Harrison, III, W.B., 2014, Occurrence of Potash-bearing strata (Sylvinite) in the Salina A-1 Evaporite in the Central Michigan Basin, Abstract of Presentation, Eastern Section AAPG Annual Meeting, London, Ontario

Rine, Matthew, Dave Barnes, William B. Harrison III, and Charlotte Sullivan, 2014, Evaluating the Silurian (Niagaran) Reefs in the Michigan Basin for carbon sequestration, Abstract of Presentation, Eastern Section AAPG Annual Meeting, London, Ontario

Voice, Peter, William B. Harrison III and Joyshish Thakurta, 2014, Revising the Basement Map of the Lower Peninsula; New Constraints from Cores and Cuttings, Abstract of Presentation, Eastern Section AAPG Annual Meeting, London, Ontario

Barnes, David, William B. Harrison III, **Steven Kelley** and **Farsheed Rock**, 2014, MICHCAR: A Geological Carbon Sequestration Research Center for Michigan: Saline Reservoir, GCS Storage Resource Estimates for the Michigan Basin, Abstract of Presentation, Eastern Section AAPG Annual Meeting, London, Ontario

Petcovic, H.: Voice, P.; Horvitz, B.; and Bentley, A., 2014, The MGRRE Education Portal: Investigating rocks and fossils under Michigan, Earth Science Teachers Association Meeting 2014, Field Conference, Alpena, MI.

Voice, P.J.; Gilchrist, A.; Barone, S.; Petcovic, H.; and Harrison, W.B., 2014, Expanding the impact of the Michigan Geological Survey's Core Kids Program: Productive Partnerships with Non-profits and Regional Amateur Geology Groups, Geological Society of America, North-Central Meeting, Lincoln, NE. In GSA Abstracts with Programs, 46(4):50.

Cox, K.J.; Emil, M.K.; Sattler, F.R.; Suhaimi, A.; Voice, P.J.; and Harrison, W.B. 2014, Investigation of the Contact between the Traverse Group and the Squaw Bay Limestone in the Subsurface of the Michigan Basin, Geological Society of America, North-Central Meeting, Lincoln, NB. In GSA Abstracts with Programs, 46(4):55.

Guzman, I. and Kehew, A.E. 2014, Stratigraphic Framework and Landsystem Correlation for Deposits of the Saginaw Lobe, Michigan, USA. 60th Annual Institute on Lake Superior Geology, Hibbing, MN, May 14-17

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Other Publications and Presentations 2014

Voice, P. J., and Harrison, W. B. III 2014, Paleozoic Geology of the Central Upper Peninsula of Michigan, Fieldtrip Guidebook, Michigan Basin Geological Society and Michigan Geological Survey, 111 pp.

Abouelmagd, A., Sultan, M., Sturchio, N.C., Soliman, F., Rashed, M., Ahmed, M., Kehew, A.E. and Chouinard, K. 2014, Paleoclimate record in the Nubian Sandstone Aquifer, Sinai Peninsula, Egypt, Quaternary Research 81, 158-167.

Harrison, III, W.B. and Voice, Peter, 2014, Geology, Depositional Environments and Characteristics of Devonian Carbonate Reservoirs in the Michigan Basin: Introduction to Core Workshop, Michigan Basin Field Experiences and Devonian Carbonate Reservoir Core Workshop Presentation, March 20, 2014, Mt. Pleasant, MI.

Harrison, III, W.B. and Voice, Peter, 2014, Geology, Depositional Environments and Characteristics of Devonian Carbonate Reservoirs in the Michigan Basin: Introduction to Core Workshop, Devonian Carbonate Reservoir Core Workshop, March 20, 2014, Mt. Pleasant, MI., p. 3-18.

Voice, Peter, 2014, Outline for the Devonian Carbonate Reservoirs of the Michigan Basin – A Core Workshop, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 23-34.

Harrison, III, W.B., 2014, Lithologic Properties and Facies Characteristics of Devonian Producing Formations in the Michigan Basin, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 35-44.

Emil, Mustafa Kermal, and **Kyle Cox**, 2014, Traverse Limestone and Squaw Bay Formations in the Wolverine-4-40 Club #1-35 and Mannes-Bangor Unit No. 1 well cores, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 45-86.

Sattler, Frank and **Agam Arief Suhaimi**, 2014, Traverse Limestone and Squaw Bay Formations in the Sun-Beyer Farms No. 1 well core, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 87-112.

Voice, Peter, 2014, Rogers City and Dundee Formations in the Midwest Oil Productions-Thelma Rousseau #1-12, the Wiser-State Buckeye “D” #1-36 and the Cronus Development-Tow #1-3-HD-1 well cores, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 113-168.

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Adducci, Joe, Bryan Currie and Abotalib Zaki A Farag, 2014, Rogers City and Dundee Formations in the Sun-Arms No. 10 well core, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 169-202.

Harrison, III, W.B., and **Abraham Abduslam**, 2014, Rogers City and Dundee Formations in the Sun Exploration-Mt. Pleasant Tract 55-1 well core, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 203-216.

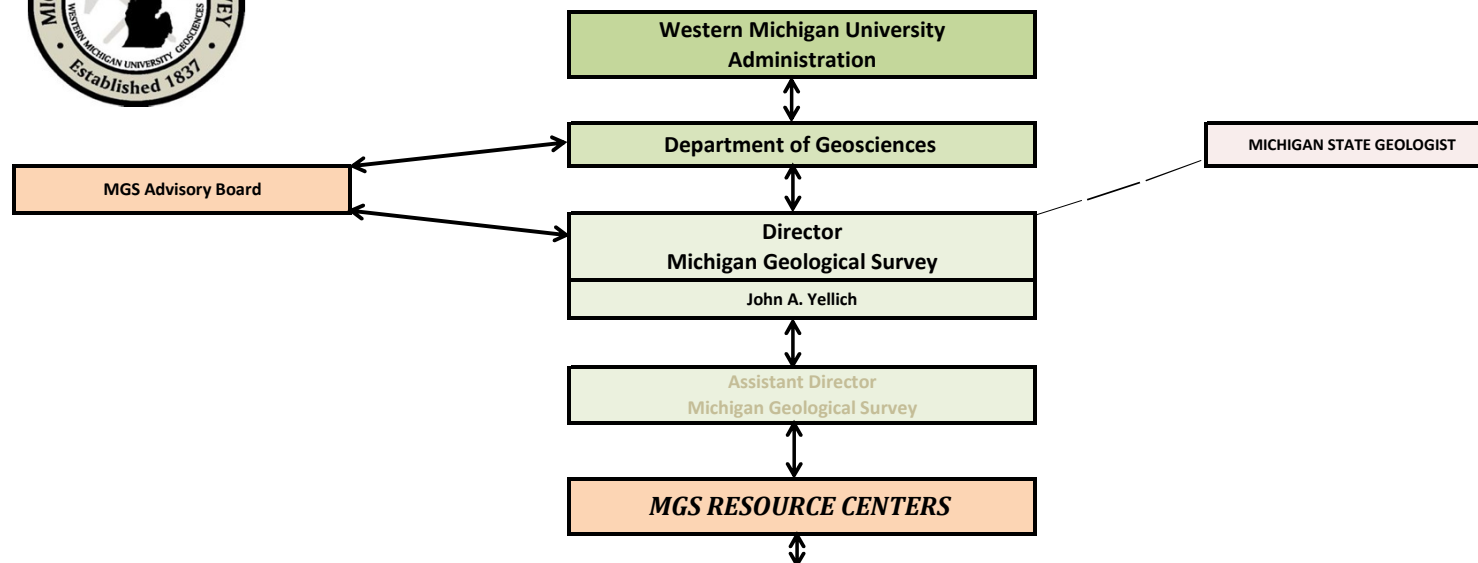
Panyard, Nicholas and Abdulaziz Ibrahim Aljammaz, 2014, Lucas Formation, Richfield Member and Upper Amherstberg Formation in the Dart-Benchley #1-29 well core, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 217-248.

Rine, Matthew and Abdullah Othman, 2014, Bois Blanc and Sylvania Formations in the Michigan Chloride Sales-Gregory #1 well core, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., 249-269

Manche, Cameron J., Khrusrina B. Mohamed and Peter Voice, 2014, Amherstberg, Bois Blanc and Bass Islands Formations in the Core Energy-State Charlton #4-30 well core, Devonian Carbonate Reservoir Core Workshop, Petroleum Technology Transfer Council, March 20, 2014, Mt. Pleasant, MI., p. 271-294.



MICHIGAN GEOLOGICAL SURVEY (MGS) RESOURCE CENTERS WITH CONTACT INFORMATION



| MGRRE, SUBSURFACE GEOLOGY | SURFACE MAPPING | GROUNDWATER RESOURCES & ENVIRONMENTAL QUALITY | ENERGY | ECONOMIC MINERALS | GEOLOGIC HAZARDS | GIS DATA MANAGEMENT "MGS Store" | OUTREACH SERVICE | REMOTE SENSING |
|---|--|--|--|---|--|--|--|---|
| Dr. William Harrison | Dr. Alan Kehew | Dr. Duane Hampton | Dr. Dave Barnes | Dr. Joyashish Thakurta | Mr. John Yellich | Ms. Sita Karki | Dr. Peter Voice | Dr. Mohamed Sultan |
| Repository for core samples & drill cuttings; geologic & geophysical Logs; Water & Energy Resources; Data Bases; Continuing Education | Geologic Mapping; Groundwater resource assessments; Data bases; surface & airborne geophysics; | Groundwater modeling; Water quantity and quality; remediation; Surface water and groundwater interactions; Data bases; Wellhead protection; Student Theses | Carbon Sequestration; Alternative uses of resources & technologies; Student Theses | Geologic investigations of areas of mineral potential; Assessments; Pre-Cambrian rocks of Michigan; airborne geophysics; Student Theses | Evaluations; testing; studies; selective reports | Data output; Information Resource center; document purchases | Education; K-12 - Core Kids; Geosciences Learning center | Assessments of water & minerals surveys; Student Theses |

| TECHNICAL AND COLLABORATIVE SUPPORT SYSTEMS (GROUPS OR TEAMS) | |
|--|--|
| Geosciences Department Faculty Grant funded research positions Affiliated Faculty other Institutions Graduate and undergraduate students (WMU and other Universities) | External experts Collaboration with other State Departments & Organizations Collaboration with Michigan stakeholders |

| MGS Resource Centers Contact information |
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Nov-14

Michigan Geological Survey, Advisory Council

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Testimony in support of H. R. 5066
To the Subcommittee on Energy and Minerals
House Committee on Natural Resources
To reauthorize the National Geological and Geophysical Data Preservation
Program Act of 2005 through 2019.

Respectfully submitted by

John A. Yellich, Certified Professional Geologist (CPG), Director

MICHIGAN GEOLOGICAL SURVEY

MICHIGAN GEOLOGICAL REPOSITORY FOR RESEARCH AND EDUCATION

A

MICHIGAN GEOLOGICAL SURVEY – RESOURCE CENTER

September 17, 2014

Data preservation has been the focus of the Michigan Geological Repository for Research and Education (MGRRE) for more than 30 years. MGRRE has received financial support and has submitted very large datasets to the National Geological and Geophysical Data Preservation Program (NGGDPP) during the past six years. As the National Research Council (NRC) reported in 1995: "Data are the lifeblood of science and the key to understanding this and other worlds. As such, they are a critical natural resource and must be protected, preserved, and made accessible to all people for all time." In Michigan, we have seen how these data are also essential in finding solutions to environmental problems and to supporting economic growth through sustainable natural resource management. Because no one can predict which environmental and resource issues will arise, for which the solutions will depend on these data, we must make every effort to protect and preserve them.

In Michigan, geological samples and data are preserved and used in education and research by MGRRE, a resource center to the Michigan Geological Survey (MGS) at Western Michigan University (WMU). Through MGRRE, industry members and our researchers have furthered development of domestic energy, green-house gas sequestration, discovery of non-metallic natural resources, and worked to define water resources. MGRRE has data from oil, gas, environmental and geotechnical research in over 500,000 feet of core (>95 miles), samples and geophysical data from over 25,000 wells, 10's of thousands of well reports, logs and sample analysis which is all in data bases and scanned digitally and housed in an area having >27,000 sq. ft., over half an acre.

Funding by the NGGDPP for MGRRE and many other data repositories has created a data source for the country and preserved data that previously were at risk of damage and/or destruction. We share these examples from our work at MGRRE, much of which has been sustained by support from the NGGDPP.

Using cores and data donated to or rescued from disposal by MGRRE, largely from the oil and gas industry, our researchers have conducted research about hydrocarbon reservoirs and presented those results at workshops for more than 20 years (Attached picture of Manuals). Attendees represented

industry, government and higher education. By conducting our research in partnership with independent and national oil and gas companies, our faculty and students have provided applied solutions. And our students have gained hands-on experience in becoming geoscience professionals receiving high paid challenging professional positions.

The following examples represent some of MGRRE's major environmental, industry and economic milestones over the last 20 years.

- A. In 1995 WMU and Michigan Technological University (MTU) entered into a partnership to study preserved oil field core samples and data at MGRRE.
 - a. With grant support from the Department of Energy (DOE), MTU-WMU demonstrated effective use of horizontal drilling technology to produce additional oil reserves in Michigan, laying a significant foundation for conventional horizontal drilling used today.
- B. Since 1997, MGRRE has been the Michigan Center for the Petroleum Technology Transfer (PTTC), initially funded by the DOE, a program where industry and academia share in oil industry geological, geophysical and current operational technology.
 - a. MGRRE has presented one to two workshops each year, utilizing archived core and data.
 - b. This program is now entirely self-funded by MGRRE through workshop fees and industry sponsorship.
 - c. Many of the environmental and industry accomplishments in the last 20 years were the result of data, well-field experience, and research shared at these open industry events.
- C. In 2005, the DOE established a national environmental program to evaluate the potential of capturing and safely storing Carbon Dioxide (CO₂), in subsurface geologic reservoirs. MGRRE, and other States, submitted proposals that would utilize preserved core and geophysical data to explore this concept.
 - i. MGRRE was funded to evaluate Michigan's reservoirs through the Midwest Regional Carbon Sequestration Partnership (MRCSP) and conducted a successful test of CO₂ sequestration in a collaborative partnership of DOE, MGRRE and industry partner, Core Energy, LLC.
 - ii. This basic program and subsequent successful testing and evaluations have continued for more than 9 years and demonstrated the potential underground storage capacity of tens of billions of tons of CO₂.
- D. The CO₂ sequestration program further evolved in Michigan when CO₂ injections into old oil fields resulted in the added benefit of more energy production through the recovery of previously stranded oil. Typically these fields would yield about 25% of their reserves initially through primary recovery. The remaining oil was "stranded" in isolated small pore spaces.
 - a. Injecting the captured CO₂ in these oil-bearing formations produced an additional 20% to 25% of the oil, an economic benefit to Michigan, new wealth.
 - b. This technology has recovered more than 1.6 m barrels of oil, which had an estimated revenue of \$112,000,000 at \$70/BBL price, netting Michigan an estimated tax revenue of \$7.3 million.

- E. Legislation in Michigan was passed in April 2014 to entice the oil industry to invest in this capital-intensive process of CO2 capture and injection by providing them a tax benefit for the additional cost.
 - a. Millions of barrels of additional oil will now be recovered through this technology, resulting in \$10's of millions of dollars of both un-realized income for Michigan residents and millions of dollars of otherwise un-realized tax revenue to the state of Michigan.
- F. In 2003, MGRRE researchers, MTU and members of the oil and gas industry presented their research and experience at a PTTC workshop focusing on the potential of undiscovered hydrocarbon reserves, particularly those in the Trenton Black River Formations.
 - a. Subsequently, in 2006, USGS began a Michigan basin assessment of unrecovered oil resources and WMU geoscientists compiled data for Michigan using archived core samples and geophysical data.
 - b. This compilation and research was presented at a subsequent MGRRE/PTTC workshop, and this resulted in industry coming to MGRRE to study and sample cores for developing exploration targets.
 - c. New Trenton/ Black River Formation oil-bearing zones were discovered in 2006.
 - d. The Trenton/ Black River continues to be successfully explored and developed, resulting in additional millions of dollars in economic benefits for our citizens and new tax revenues for the State today.
 - i. An estimated 5 million Barrels of previously undiscovered oil from five newly discovered fields has been produced to date, an additional revenue and tax benefit.
- G. In 2009 and 2010, MGGRE hosted conferences about potential unconventional oil and gas resources in the Collingwood, Utica and A-1 Carbonate formations.
 - a. Industry professionals visited MGGRE, studied the samples and data and developed a geological and exploration model.
 - b. In 2010, \$178 Million was paid by the oil industry to lease thousands of acres of State land, the largest single lease sale to date in Michigan, providing a major source of revenue to the Natural Resources Trust Fund of Michigan.
 - c. In 2010 and 2011, industry began exploration on these leases, which has already resulted in several discoveries of commercial quantities of oil and gas and provides the potential for additional millions in economic benefits and tax revenue to Michigan.
- H. In 2013 the industrial mineral industry recognized that MGGRE had the only collection of geological cores and geophysical data for an extensive deposit of potash: a critical ingredient in fertilizer, essential to US agriculture.
 - a. Industry professionals and MGRRE researchers conducted tests and completed an evaluation of this material and determined that this represented a significant potash resource to Michigan and to the United States.
 - b. The area of study has an estimated in-place value of more than \$65 Billion, with additional geologic data indicating an even larger resource area.
- I. Michigan has a coastline contact with four of the five Great Lake and is perceived as having an abundance of and understanding of water resources, including groundwater. Scientific data collection and mapping of subsurface geologic materials and water resources has been limited for more than 30 years. The Michigan Geological Survey, assigned to WMU in October 2011, is now

mandated to function through WMU will utilize the MGGRE samples and data collections with a scientific geosciences emphasis to develop a greater understanding of the groundwater resources of Michigan.

- a. The MGRRE facility has water well drill samples from over 2000 public water supply wells and combined with more than 20,000 oil well sample sets. These samples will be used in conjunction with other geologic and geophysical information to support the program for effective and rational management of our water resources.
- J. Since 2005, MGRRE and WMU has been a major educational foundation for numerous students who have utilized the resources of MGRRE and faculty to develop the next generation of geosciences professionals. In the last 10 years, there have been over 45 Masters graduates from WMU that have benefited from the MGRRE and faculty experiences, some whom have gone on for PhD's. These graduates are now experienced contributing professionals in the environmental, industrial and academic world.

Through NGGDPP funding, MGRRE has continued to rescue cores that were literally destined for landfills, recovered cores that had been damaged by poor storage conditions, brought cores and samples back to Michigan from out-of-state, scanned thousands paper records (mudlogs) so they are now available in digital form, inventoried thousands of well records, hand-entered porosity and permeability numbers from old records into individual spreadsheets, uploaded all this data to the National Data Repository, thereby increasing the amount of data available and making these data publically accessible.

Without NGGDPP funding, this recent work would still be in progress. Funding for data preservation is very limited and so critically needed. We urge your consideration to continue this funding so that more data can be saved and preserved for today and tomorrow.

Attached are the examples of the workshop manuals, press announcements and supporting documentation of data preservation and the benefits.



Damaged core in boxes is repackaged and catalogued at MGRRE using NGGDPP funds.



The MGRRE core facility storage, examination & technical workshop areas. (>27,000 sq ft.)



Core workshops with student poster sessions showcase Thesis project work



MGRRE - Petroleum Technology Transfer Council (PTTC) Manuals prepared and used in conferences conducted since 1997 to 2014.

Relevant press announcements supporting the NGGDPP, the data preservation program.

March 15, 2014 at 6:00 AM, updated March 18, 2014 at 10:15 PM

WMU partners with energy company to inject carbon dioxide underground, flush out leftover oil

[Chuck Miller](#) | [MLive.com](#)

By [Yvonne Zipp](#) | [yzipp@mlive.com](#) on March 15, 2014 at 6:00 AM, updated March 18, 2014 at 10:15 PM

KALAMAZOO, MI – It sounds like a science project designed by Al Gore: Take excess carbon dioxide, liquidize it and inject it into abandoned oil fields, filling the porous rocks beneath with the CO₂ and -- not so incidentally -- flushing out the oil that remains.

A Michigan company has used the technique to retrieve 1.6 million barrels of oil that, its owner says, would not otherwise have been produced.

Core Energy, based in Traverse City, says it is the only company east of the Mississippi River doing this kind of Enhanced Oil Recovery (EOR) — with the help of [Western Michigan University's](#) Michigan Geological Repository for Research and Education. Around the U.S., about 80 projects reportedly produce 230,000 barrels of oil per day using this technique.

"The potential in Michigan is tens of millions of barrels," said Bob Mannes, president and CEO of Core Energy LLC, and a third-generation Michigan oilman.

"It's a win-win. It's absolutely the right thing to do," Mannes said. "It's the ultimate recycling project because we utilize existing well bores wherever possible."

That said, the company does often drill additional wells, he said. The carbon dioxide Core Energy uses comes from natural gas production from the Antrim Shale in northern Michigan.

A study done by Clean Wisconsin found that crude oil produced from CO₂ EOR creates 40 percent less carbon dioxide than conventional crude oil.

There are potentially 800 Michigan oil fields where the technique could be used, William Harrison, professor emeritus of geosciences and director of MGRRE, said. So far, Core Energy has used EOR on seven.

"We think the potential is phenomenal," Harrison said on a recent tour of the repository, which is essentially a library or archives for rocks. It houses 500,000 feet of core samples, as well as an additional 20,000 samples. The facility is also home to the former University of Michigan collections and the Michigan Geological Survey, which was transferred to WMU in 2011, making the MGRRE the primary geological resource in the state.

"That's additional oil that never would have been recovered otherwise," Harrison said.

WMU's research suggests that 180 to 200 million barrels of "stranded" oil in old fields in the state could be recovered through this technology, Harrison said.

MGRRE originally teamed up in 2005 with Core Energy and Battelle Memorial Institute, an Ohio-based company, in a public-private partnership to study geologic carbon sequestration. The effort, known as the Midwest Regional Carbon Sequestration Partnership, collects data and samples of Michigan's geological formations relevant to CO₂ storage, containment and potential for enhanced oil recovery.

The regional partnership is one of seven established by the U.S. Department of Energy's National Energy Technology Laboratory to study carbon sequestration as an option for mitigating climate change.

In 2009, they received more than \$600,000 in federal funding secured with the assistance of U.S. Rep. Fred Upton, R-St. Joseph.

Suggesting that energy companies should pay to store carbon dioxide underground hasn't proved terribly popular with the industry, Harrison said.

The big question: Why should we spend hundreds of millions of dollars to get rid of carbon dioxide?

Relevant press announcements supporting the NGGDPP, the data preservation program.

"The cost was phenomenal," said Harrison. "We needed to find some way for it to pay for itself."

Enter the enhanced oil recovery effort.

In a process known as "piggy-backing," after a company such as Core Energy made a profit from the oil, another organization — such as the state or federal government or a nonprofit — potentially could then use the drill and other infrastructure already installed as a carbon dioxide dispersal well, Harrison explained.

"To me, this is an enormously logical and ecologically driven approach," Harrison said.

Mannes said that no federal money has gone toward Core Energy's exploratory efforts. The company also uses 3-D seismic technology in its exploration, which it says allows it to be more accurate when drilling, leading to fewer negative environmental effects.

The partnership with MGRRE has been a tremendous help, he said, calling Harrison's more than three decades of work collecting samples from all over the state "invaluable."

"They're a valuable resource. Their contributions to the state of Michigan go beyond the regional partnership," Mannes said. "Michigan is very fortunate to have that facility in the state.

"We're always looking for ways of further understanding of Michigan geology and MGRRE is the tool to do that in the state of Michigan," he said. "The usefulness of that organization goes far beyond the oil and gas industry."

Yvonne Zipp is a staff writer at the Kalamazoo Gazette. Email her at yzipp@mlive.com or follow her on Twitter.

Lt. Gov. Brian Calley signs law offering incentives for enhanced oil recovery at Western Michigan University

By [Yvonne Zipp](#) | yzipp@mlive.com on April 01, 2014 at 2:48 PM, updated April 01, 2014 at 4:12 PM

KALAMAZOO, MI – With half a million linear feet of core samples as a backdrop, Michigan Lt. Gov. Brian Calley signed a package of bills into law Tuesday that provides incentives for an oil recovery method that retrieves more oil and natural gas from existing wells while sequestering carbon dioxide deep underground.

Western Michigan University's Michigan Geological Repository for Research and Education, where Public Act 82 was signed, **is part of a regional partnership set up by the federal government** to study carbon capture and sequestration. Since 2011, it also has been home to the Michigan Geological Survey.

"I must say, you have a really cool rock collection going," Calley told WMU President John Dunn before the signing.

"It's an honor to be back on campus," Calley said. The signing "recognizes the strength of the partnership state has with WMU. This is an outstanding place for us to take a step forward help both entrepreneurs and the government to make intelligent, scientific, fact-based policy decisions."

Saying that MGRRE had "played a critical role in the legislation being signed today," Dunn called the repository "an amazing resource for Michigan's citizens."

Under a bill sponsored by state Rep. Aric Nesbitt, R-Lawton, enhanced oil recovery projects will be taxed at a 4 percent severance rate, rather than 6.6 percent for oil and 5 percent for natural gas. The oil and gas severance tax generates about \$60 million for the general fund each year.

The process is more expensive than traditional methods, but is considered the most cost-efficient method of carbon capture and sequestration, Calley said.

With enhanced oil recovery, liquidized carbon dioxide is injected more than 2,000 feet underground, often in existing oil and natural gas well-bores, allowing companies to retrieve about 20 percent more of the

Relevant press announcements supporting the NGGDPP, the data preservation program.

"stranded" oil left behind by conventional drilling. The carbon dioxide remains behind, sequestered underground.

"In the case of CO₂, there is the added benefit that CO₂ that would otherwise be emitted into the atmosphere is being sequestered in geologic formations that have proved capable of storing it for 300 million years," said John Wilson, one of the founders of Core Energy, of Traverse City, at Tuesday's signing.

In an interview with the Kalamazoo Gazette last month, Core Energy said that, since 1997, it has used the process on seven old oil fields in Michigan to retrieve 1.6 million barrels of oil that otherwise would not have been retrieved. Wilson estimated that an additional 200 million barrels in the state potentially could be captured using the process – about 30 times Michigan's annual output. At today's prices, he said, the potential value of the oil is \$20 billion.

"Michigan is committed to the wise use of its natural resources," Calley said. "Providing incentives to fully develop old, traditional oil fields benefits consumers and our economy. Protecting our environment while fueling our economy is a win for everyone."

On Tuesday, Calley also signed three additional bills that promote the use of enhanced oil recovery. HB 5254, sponsored by state Rep. Rick Outman, R-Six Lakes; HB 5255, sponsored by state Rep. Thomas Stallworth III, D-Detroit; and HB 5274, sponsored by state Rep. Peter Pettalia, provide for the exercise of eminent domain when laying pipelines to transport carbon dioxide.

After the signing, Nesbitt pointed to the fact that his bill passed the state House 85 to 25 as an example of its bipartisan support and thanked Stallworth for his work on the issue. Nesbitt said he believed the incentives were necessary, since the process is more expensive than conventional drilling.

"I believe this is a valuable first step," he said, calling it a "win-win-win" for jobs, domestic energy output and the environment. "This will help put Michigan on the map."

The law does not apply to the controversial practice of hydraulic fracturing, commonly known as fracking.

However, after the laws' passage, environmentalists and Democrats questioned the need to offer more incentives to oil companies. They said any environmental benefits from carbon sequestration should be weighed against new pipeline construction, well conversions, additional air pollution and costs and environmental impacts of increased transport of oil.

"Giving more tax breaks to big oil companies just shows that this administration is out of touch, and has the wrong priorities for Michigan," said Mark Schauer, the Democratic candidate for governor, in a statement. "At a time when dozens of Michigan school districts are in deficit because of Snyder's education cuts, the last thing we should be doing is giving more handouts to big oil companies. Instead, we should be investing in clean, renewable energy sources to reduce our dependence on foreign oil and create good Michigan jobs."

The Sierra Club's Michigan Chapter and Clean Water Action also expressed dismay about the law's signing. "Our elected officials should not be reducing state revenue and giving tax breaks to companies who put our Great Lakes, rivers, and streams at risk," said Nic Clack, Michigan director of Clean Water Action. "We should be moving Michigan away from our dependence on corporate oil to clean energy, not pandering to oil and gas companies."

And the Sierra Club specifically took issue with the extension of eminent domain.

"This law poses an alarming new threat for all Michigan residents who are facing aggressive oil, gas and related pipeline construction in their communities. The Sierra Club strongly opposes the expansion of eminent domain authority to private oil and gas companies at the expense of the rights of private property owners and the public," said Anne Woiwode, director of the Sierra Club Michigan Chapter, in a statement. "Giving oil and gas companies more ability to take lands for the transportation of fossil fuels and carbon dioxide pipeline development is the wrong decision for Michigan, for clean water, and for property owners."

Relevant press announcements supporting the NGGDPP, the data preservation program.

For his part, Nesbitt pointed to a 2008 National Resources Defense Council paper that found that "to date, no significant documented environmental impacts from CO₂ injections, such as groundwater sources, have been reported."

The report went on to note that, "as with any other oil-extraction process, responsible operations are essential and sound regulations can help minimize any surface or subsurface risks."

Geologists' mission in Kalamazoo and Northern Michigan is still a bit below the surface

By [Yvonne Zipp](#) | yzipp@mlive.com

Published: Friday, October 01, 2010, 6:51 PM Updated: Friday, October 01, 2010, 6:59 PM

Courtesy Photo William B. Harrison III, at right, talks Wednesday to geologists from industry and government who attended a shale workshop presented at the Eastern Section of the American Association of Petroleum Geologists. In the wooden framing are shale samples.

KALAMAZOO — Rocks, gas and geology are not necessarily exciting stuff. But the importance of work being done with them in Michigan appears to be rising to the surface.

Attention has been focused on Michigan and its potential for greater natural gas and oil production since a major discovery of shale was announced last spring in the northern Lower Peninsula. It led to unprecedented participation by exploration companies in the state's spring 2010 auction of oil and gas leases on state-owned lands.

The May 4 auction for the rights to explore on state-owned land in 22 northern Michigan counties netted the state \$178 million, explains William B. Harrison III, emeritus professor of geosciences at Western Michigan University. That rivals some \$190 million the state has raised cumulatively in such auctions over the last 80 years, he said.

Money from the auction goes into a trust (the Natural Resources Trust Fund) that is used for recreational areas, she said.

"It means that companies that have never come to Michigan looking to explore for natural resources are going to look to Michigan," said Harrison, who co-chaired the annual meeting of the Eastern Section of the American Association of Petroleum Geologists, held this past Saturday through Wednesday at the Radisson Plaza Hotel & Suites in downtown Kalamazoo.

The meeting attracted 510 petroleum geologists, researchers, educators and business people, with the geologists, from 22 states and three Canadian provinces, attended any of 72 technical talks, three workshops and three field trips to learn about Michigan rocks, new technology and how to do their work in environmentally sensitive and respectful ways, said Linda K. Harrison, manager of the Michigan Geological Repository for Research and Education at Western Michigan University.

"They hoped to find out how to explore in Michigan and other basins (and) how to produce gas from shale formations and hydrocarbon-bearing (oil and gas rich) limestones," said Linda Harrison, who is also William Harrison's wife. Her organization, the MGRRE, is a repository of the greatest amount of subsurface rocks and data in the state. A part of WMU's Department of Geosciences, it is at 5272 W. Michigan Ave. in the university's College of Arts and Sciences.

"We do applied research in a number of fields," Linda Harrison said. That includes CO₂ sequestration.

Carbon-dioxide is among the primary gases blamed for causing global warming, via the greenhouse effect.

The result of explorations that are to be done in northern Michigan on what is being called the Collingwood Shale, could mean lots of new jobs, involving the explorations, the drilling and related endeavors, the Harrisons said.

"It could be a huge economic boost for the state," she said.

The Collingwood Shale is a rock formation that is 3,000 to 10,000 feet below the surface of the northern third of Michigan's Lower Peninsula, William Harrison said. Shale has tiny pockets that may be filled with gas.

Michigan Geological Survey - Michigan Geological Repository for Research and Education (MGRRE) – September 17, 2014 Testimony documentation. H.R. 5066

Relevant press announcements supporting the NGGDPP, the data preservation program.

“This could be one of the few bright spots in the Michigan economy,” Linda Harrison said.

The American Association of Petroleum Geologists meeting here was hosted by the Michigan Basin Society of Geologists, WMU's Department of Geosciences, and the MGRRE

Discussion among geologists at the meeting included the theory that Michigan may have huge, untapped reservoirs of natural gas.

Co-chairing the meeting with William Harrison was Robb Gillespie, WMU assistant professor of geosciences

The theme of the gathering, “Perseverance — the Pipeline to Prosperity,” called attention to challenges petroleum geologists face in “exploring for, developing and responsibly utilizing energy resources in the mature basins of the eastern United States and eastern Canada,” according to information provided by the MGRRE.

Petroleum geologists are the people involved in the science of finding and unearthing useful oil and gas products, an industry that has been in great focus since the disaster in the Gulf of Mexico and the Enbridge oil spill into the Kalamazoo River.

WMU partners with energy company to inject carbon dioxide underground, flush out leftover oil



Director of Michigan Geological Repository Bill Harrison points out different well locations on a map throughout Michigan inside the warehouse at the repository Friday. Harrison and WMU are the lead researchers in a project to capture carbon dioxide and store it underground.

Lt. Gov. Brian Calley signs law offering incentives for enhanced oil recovery at Western Michigan University



Michigan Geological Survey - Michigan Geological Repository for Research and Education (MGRRE) – September 17, 2014 Testimony documentation. H.R. 5066
Relevant press announcements supporting the NGGDPP, the data preservation program.

Geologists' mission in Kalamazoo and Northern Michigan is still a bit below the surface

