Expert Advice is provided by EORI’s Technical Advisory Board
The Enhanced Oil Recovery Institute just completed its 12th Technical Advisory Board (TAB) meeting on January 15th. The TAB was first organized by EORI during 2007 and is currently composed of 12 distinguished members from industry and academia. This group’s contributions have been essential to the success of EORI’s programs. Members include:

- Mr. Brad Bauer, Exploration Manager, Merit Energy Company
- Mr. Mike Blincow, Asset Manager – CO2 Supply, Denbury Resources
- Mr. Charlie Carlisle, President, Chemical Tracers, Inc.
- Mr. Ken Hendricks, Manager Salt Creek Operations Center, Anadarko Petroleum Corporation
- Dr. Peter Hennings, Director, ConocoPhillips Subsurface Technology
- Dr. George Hirasaki, Professor, Rice University
- Mr. L. Stephen Melzer, President, Melzer CO2 Consulting
- Mr. Chuck Peterson, Reservoir Engineering Advisor, Devon Energy Corporation
- Dr. Gary Pope, Director CPGE, University of Texas at Austin
- Dr. Randall Seright, Professor, New Mexico Institute of Mining and Technology
- Ms. Vickie Stamp, Senior Reservoir Engineer, True Oil
- Dr. G Paul Willhite, Professor, University of Kansas

These EOR experts represent leading universities, energy companies, and technical services companies that pursue state-of-the-art implementation of EOR both in North America and internationally. TAB members contribute their time and expertise to participate in semi-annual TAB meetings organized to improve EORI’s program.

The TAB provides technical evaluations of EORI projects and input to EORI’s strategic planning. TAB meetings consist of presentations by UW faculty, research staff, and
graduate students updating progress on EORI sponsored research projects. TAB members provide peer review of work presented during the meetings. Members of the Enhanced Oil Recovery Commission (EORC), EORI staff, and university faculty, staff and graduate students participate in the meetings.

The TAB has contributed to EORI's success by peer reviewing our program's technical work and providing numerous recommendations to improve the quality of that work. They provide advice regarding strategic staffing and help identify key hires for our program. Most recently the TAB has encouraged implementation of field work to demonstrate a variety of new technologies in Wyoming oil reservoirs. These contributions have resulted in rapid advancement of reservoir characterization and reservoir modeling, expanded use of carbon dioxide to implement new EOR projects, and implementation of new chemical floods.

EORI greatly appreciates the contributions of our TAB members. I greatly appreciate the many contributions made by this group of talented people, and encourage our readers to thank these individuals and their respective companies or organizations for their investment of time and effort over that past six years.

OUTREACH

Conference and Workshops

Save-the-Dates – Details and Registration information forthcoming www.uwyo.edu/eori

- Wyoming CO2 Conference – July 9-10, 2014 – Casper Events Center
- Minnelusa Workshops – June 2-5, 2014
  - Minnelusa 1.1 Workshop – June 4th, 2014 – Gillette, WY
  - Minnelusa 2.0 Workshop – June 5th, 2014 – Gillette, WY

Distinguished Speaker Series

Steven Fryberger, Geologist

Wednesday, February 19th – 3:00 PM

UW Energy Innovation Center – Encana Auditorium

A Geometric Approach to the Analysis of Global Eolian Hydrocarbon Reservoirs: With examples from the Wahiba Sands of Oman

Steven G. Fryberger*1 (speaker) and Caroline Y. Hern*2
*1 Enhanced Oil Recovery Institute, University of Wyoming
*2 Shell Exploration and Production, Houston, Texas

Abstract: In this study we offer a geometric approach to the analysis of eolian petroleum reservoirs. It takes advantage of repeated themes in eolian sedimentation that occur at various scales, from global to
microscopic in both time and geography. It is recognized by most workers that eolian rocks can be very good hydrocarbon reservoirs, with high rates of flush production. However, achievement of favorable recovery factors commonly requires use of a variety of secondary and tertiary recovery techniques tailored to the specific rock system at hand. These techniques must be applied to an accurate, three dimensional model of the productive rocks, which can be difficult to create. This is because most eolian reservoirs consist of a mélange of complexities derived from process frameworks operating at multiple scales. Detecting the influence of processes operating from basin-to-microscopic scales helps in correlation and mapping of flow units within the reservoir. Additionally, in almost all eolian reservoirs, there exist microscopic permeability contrasts within and among primary eolian strata. These are likely to be a significant part the production performance. These microscopic factors work in concert with macroscopic permeability-porosity architecture driven by dunes and genetic unit stacking. The whole comprises the compartmentalization of eolian reservoirs. In summary, eolian reservoirs may have low recovery factors without proper handling of scale elements in reservoir characterization. In our talk we review a simple a geometric approach to recognizing scales of reservoir geometry, and provide several examples of the evolution of eolian reservoir heterogeneity from the modern Wahiba Sands of Oman.

**EOR Forums**

EORI continues to build relationships and collaborations with industry partners. EORI recently partnered with Trihydro Corporation of Laramie in offering an air quality forum to those in the oil and gas industry. *Avoid Air-rors! Discussing the Air Regulations that Impact Oil and Gas Development* was held January 29th in Laramie. Close to 100 participants attended either in person or via webinar. Jay Christopher and Il Kim of Trihydro’s Air Quality Consulting and Process Management team offered their expertise on the following:

- NSPS OOOO – EPA’s recent “Quad O” regulations primarily affect the production-side of oil and gas development. Recent updates to the storage tank portion of the regulation may require controls, permitting, regulatory notifications, and recordkeeping for storage tanks that were installed after August 2011.
- Leak Detection and Repair (LDAR) – Regulations under NSPS KKK or OOOO may affect your gas plants if you capture and recover hydrocarbon streams in addition to CO2.
- Greenhouse Gas (GHG) Inventory/Reporting – In addition to Subpart W (which affects upstream production operations), EPA’s Mandatory Reporting Rule also requires reporting under Subpart UU for EOR operations and Subpart RR for geologic sequestration.
- Optical Gas Imaging with Infrared Cameras – Regulatory agencies are increasingly focusing on fugitive volatile organic emissions from oil and gas production operations, with some states now specifically including methane as a target compound. Learn about the capabilities of infrared camera optical gas imaging technology and how it can help you comply with the state regulations required of operators.

Feedback from the webinar has been very positive. The information was valuable, relevant and timely. One participant responded: “Great Workshop.....these workshops are vital and
effective. They are even more so given the opportunity for stakeholders to participate via the Webinar venues....Please continue this approach...."

Future forums are being planned to discuss topics relevant to the oil and gas industry with regards to policy, regulation and new or emerging science and techniques. Announcements will be emailed and available on our website.  www.uwyo.edu/eori

**EORI in the News**

The Enhanced Oil Recovery Institute was recently featured in the Casper Star Tribune - Wyoming Energy Journal. This issue focused on research and development in the energy industry and features EORI and the work being done with small operators in Wyoming. Read it here:  [http://trib.com/app/specialsections/SpecialSectionpdf/Energy.pdf](http://trib.com/app/specialsections/SpecialSectionpdf/Energy.pdf)

In addition, EORI continues to be seen in the Press. Below are several links to articles which have appeared in several local and national media outlets.

**Making old oil fields new: The Enhanced Oil Recovery Institute**  Casper Star-Tribune Online and the Rapid City Journal

**UW Researchers Unveil Tool to Aid Enhanced Oil Recovery**  University of Wyoming News

**New research may boost Wyoming’s energy industry and diversify its...**  Casper Star-Tribune Online

**Free tool for Wyo. operators estimates EOR viability**  Wyoming Business Report

**Institute builds advanced oil recovery savvy in Wyoming**  University of Wyoming News Service

**UW Enhanced Oil Recovery Research Lab Targets Stranded Reserves**  University of Wyoming News Service

**EOR COMMISSION UPDATE**

The Enhanced Oil Recovery Commission met January 16th in Denver. A copy of the agenda is available at [http://eorc.wy.gov/](http://eorc.wy.gov/) in addition to previous commission meeting minutes. The next commission meeting will be held April 9th in Casper. Questions regarding the commission can be addressed to Chana Conley at chanaa@uwyo.edu.

**TECHNICAL ADVISORY BOARD MEETING**

The Technical Advisory Board (TAB) met January 15th in Denver. Presentations were given on Advanced Core Analysis; Nina Loahardjo – Sequential Flooding Test Results for Minnelusa and Muddy Reservoirs; Brian Towler – Enhanced Oil Recovery of Residual Oil Zones Utilizing the Tensleep; Vladimir Alvarado – Chemical Flooding; Sheena Xie – Results of a Phosphoria Reservoir Evaluation – and Ben Cook – Economic Evaluation of EOR. The next TAB meeting is scheduled for June 18th in Laramie.

**DATABASE DEVELOPMENT & GIS**

Screening and Scoping
The Database and Screening and Scoping group has been busy during the last quarter. Not only did it assist with the release of the CO2Scope scoping tool of Ben Cook (see below), but it also took on five new projects covering a broad range of processes. Three of these screening requests were for general EOR options in various Wyoming reservoirs, including Minnelusa, Tensleep and Muddy. Two were specifically for CO2 amenable fields in Wyoming. We also have four screening prospects in development so it looks like we are going to have a busy spring.

If you are a Wyoming based operator or a company working in Wyoming and need information from the EORI Database contact Glen Murrell at gmurrell@uwyo.edu.

**ECONOMICS**

CO2Scope™ is a software program developed to assist Wyoming oil operators with estimating the economic feasibility of using CO2 as an enhanced oil recovery method. Operators can quickly scope various economic scenarios for injecting CO2 by downloading the software package made available to Wyoming operators at no cost.

CO2Scope™ was co-developed by UW associate professor of economics Klaas van’t Veld and UW assistant visiting professor Benjamin Cook who is with UW’s new energy management MBA program.

CO2Scope™ was launched in late November shortly after the Midland CO₂ Conference. A handful of operators, government agencies and major oil companies have accessed the software. Reports indicate the software has been a valuable tool.

If you are a Wyoming operator you can download CO2Scope™ for free. If you or your company do not operate in Wyoming but feel this tool would benefit your operation there is a 10-day free trial offer, after those ten days you have the option of purchasing the software for a nominal amount.

For more information on CO2Scope™ go to our website [www.uwyo.edu/eori](http://www.uwyo.edu/eori) or read the following articles.

- *The Economic Contribution of CO2 Enhanced Oil Recovery in Wyoming (2010-2012)*, Benjamin R. Cook, PhD.

**RESERVOIR SIMULATION**

**Timber Creek Field Study for Improving Waterflooding**

~ Shaochang Wo, EORI Senior Research Scientist ~

The Timber Creek Field, operated by the Merit Energy Company, is located in Campbell County Wyoming in the Powder River Basin area of northeastern Wyoming, southeast of Gillette. Since the field was discovered in December 1962, more than 20 million barrels of oil have been produced from its Minnelusa Lower ‘B’ and Upper ‘C’ formations at a depth of approximately 9,200 ft. The B Sand trap is a combination of the Opechee seal and structural closure. The C Sand trap is a combination of structural closure...
and porous sand limit. A geologic study conducted by Gene George (2010) concluded that three separate sand bodies form the B Sand reservoir at the Timber Creek Field, while the C Sand is divided into upper and lower units.

As a part of EORI’s contribution to the Minnelusa Consortium, a collaborative study between EORI and Merit was carried out to develop a full-field simulation model of the Minnelusa reservoir and to evaluate potential development scenarios for improving waterflooding for the Timber Creek Field. A total of nine different development scenarios have been simulated. The results and recommendations from the simulation evaluation were used by Merit in making the decision to drill the Gene George #1 in 2011. Water injection in GG #1 started in October 2012 along with other recommended adjustments to production-injection configurations. As a result, the monthly oil production at Timber Creek has more than doubled to 36,317 STBO/month in August 2013 from 16,800 STBO/month in February 2010. At Merit’s request, the Timber Creek model was updated in late 2013 to incorporate the new information from GG #1. The history matching has been extended to October 2013. Under current production-injection configuration, simulation predicts that additional 5.2 million barrels of oil could be produced by the end of 2040.

RESERVOIR CHARACTERIZATION

EORI clay analysis project of the Newcastle at Osage Field

~ Nick Jones, EORI Senior Geologist

EORI recently completed work on a project with Osage Partners, LLC. The purpose of the project was to conduct semi-quantitative analysis of clays within the Newcastle Formation. The results of the analysis will later be used to determine the impact clays may have on an enhanced oil recovery project. The project involved conducting clay analysis of core samples, petrographic analysis of thin sections, and developing core descriptions for the Newcastle Formation at the Osage oil field near Newcastle, Wyoming. Core from four wells were sampled and described of which a total of 35 samples were collected and analyzed using petrographic analysis and X-ray Diffraction (XRD). Ten of the 35 samples were analyzed using Whole Rock-XRD, Scanning Electron Microscope (SEM), and Cation-Exchange Capacity (CEC). The semi-quantitative clay and CEC analyses were performed by Curtis Chopping, sample selection and petrographic analysis of thin sections was conducted by Peigui Yin, and core descriptions and management of the project were accomplished by Nick Jones.

Core used for the project was provided by Osage Partners, LLC and was collected from wells located in an area surrounding the Bradley Unit within the Osage field. The company is planning to implement an enhanced oil recovery project within this unit, and the results of the semi-quantitative clay and CEC analyses will be used to design a chemical waterflood that will mitigate formation damage, reduce chemical adsorption, and ultimately enhance oil recovery in the nearly century old field.

Hydrocarbon Resources in Tensleep Residual Oil Zone (ROZ),
Residual oil zones (ROZ) are previous oil-bearing intervals flooded by natural water due to tectonic movements and meteoric water flushing in. The oil resources in ROZ have not been produced during primary and secondary production due to high water cut and unfavorable economic climate. According to core measurement and well log analysis, Tensleep reservoirs in the Bighorn Basin, Wyoming, contain thick ROZ with oil saturation as high as 80%.

ROZ potential in the Bighorn basin has been evaluated using basin tectonic movement, hydrocarbon migration and accumulation, oil composition, and reservoir properties. Oil in the Tensleep reservoirs of the Bighorn Basin was originally sourced from the Phosphoria Formation in the west and migrated into the Tensleep Sandstone in stratigraphic and broad structural traps before the Laramide Orogeny. After the Laramide movement, the Tensleep oil re-migrated into sharp anticlinal structures on the basin flanks. Expulsion of the Tensleep Sandstone on the surrounding mountain areas due to erosion caused the meteoric water to flush downdip, further changing oil distribution in the previous Tensleep reservoirs. Re-distribution of oil during the recent period left massive oil in ROZ below the main pay zone (MPZ) and areas surrounding the existing reservoirs, as well as in the non-developed oil-bearing structures. Permeability heterogeneity of the Tensleep reservoirs and heavy oil also contribute to thick ROZ. Some of the oil in Tensleep ROZ is mobile based on drilling stem tests and its composition is similar to that of MPZ oil. After decades of water flooding, the remaining oil saturation in the MPZ of Tensleep reservoirs has been reduced to that in the ROZ or even lower, and the average water cut in currently produced oil from MPZ is over 98%. Completion test in some of the residual oil zones revealed lower water cut than that in the current production from the main pay zones.

Development history of ROZ in the Permian Basin reservoirs has demonstrated that CO2-EOR is a promising technique for recovering oil from ROZ in the mature Tensleep reservoirs and undeveloped oil-bearing structures. In addition, combined of MPZ and ROZ for further oil recovery will increase the recovery potential and also be economically valuable. It is estimated that the unconventional EOR resources in Tensleep reservoirs will at least double the EOR reserve in the Bighorn Basin, and the recovery of oil from ROZ will revolutionize the concept of oil recovery.

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<td>• <a href="http://www.uwyo.edu/eori/">http://www.uwyo.edu/eori/</a></td>
<td>Laura Dalles, Outreach Coordinator</td>
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