the ENERGY lab

E&P Focus

Spring 2009 Oil & Natural Gas Program Newsletter

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U.S. DEPARTMENT OF ENERGY

Dear E&P Focus Readers:

I would like to welcome our past and new readers to the Spring 2009 issue of E&P Focus, one of a number of outreach publications that the Department of Energy's (DOE) National Energy Technology Laboratory (NETL) publishes to keep oil and natural gas industry stakeholders informed about the research under way at the Department. A lot has happened since the last issue, and even more momentum is being gained as research activities progress in three main areas under the "oil and natural gas exploration and production" banner. For news dealing specifically with the Methane Hydrate Program, I refer you to the Fire in the Ice quarterly newsletter available on the NETL Web site at http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/newsletter/newsletter.htm.

First of all, the appropriated funds program of extramural oil and natural gas research continues to advance. A very successful solicitation was carried out in 2008 with 16 awards being made for research projects targeting recovery of oil in unconventional reservoirs (e.g., the Bakken shale), enhanced oil recovery, and Alaskan North Slope heavy oil resources, and addressing environmental issues related to oil and natural gas production. The total value for all of the selected projects represents more than $24 million (with $17.5 million DOE funding and $7 million cost share from research partners).

NETL Technical Support Facility at Morgantown, WV, promotes energy efficiency through "green" building design (see sidebar on page 3).

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A new solicitation focusing on research that addresses key water resources and water management issues related to environmentally responsible oil and natural gas production is planned for 2009. At the same time, a number of projects initiated over the past five years are reaching their conclusions, and the results of these efforts are ready for publication. E&P Focus will be providing additional details on all of these efforts in 2009 and beyond.

Second, an innovative new research program launched by the Energy Policy Act of 2005 ([EPAct] Title IX, Subtitle J, Section 999) has gathered steam and is now moving rapidly forward with a portfolio of new research projects. This R&D program, commonly referred to as "EPAct 2005–Section 999" after the legislation that initiated it, is being administered in part by the Research Partnership to Secure Energy for America (RPSEA), a consortium of more than 130 companies, universities, and research organizations. Each year, RPSEA solicits proposals for research under an Annual Plan that is crafted by DOE and the consortium, with input from two Federal Advisory Committees made up of experts from industry, academia, and non-governmental organizations. Funding for this research, nearly $32 million per year, is provided from revenue generated by offshore Federal lease royalties, rents, and bonuses. The funds are directed towards research specifically targeting three areas: (1) ultra-deepwater resources, (2) unconventional natural gas and other petroleum resources, and (3) the technology challenges of small producers.

The initial Annual Plan resulted in the award of 43 projects, all of which are now under way and three of which are highlighted in this issue. More details on all of these projects, as well as the active solicitations under the 2008 Annual Plan and the 2009 Annual Plan, are available on the NETL Web site (http://www.netl.doe.gov/technologies/oil-gas/EPAct2005/Index.html) and on the RPSEA Web site (http://www.rpsea.org/)

Third, the EPAct 2005–Section 999 legislation also directed NETL to plan and implement a $12.5 million per year program of on-site research that is complementary to the extramural projects being administered by RPSEA. These efforts, which are being carried out primarily by NETL's Office of Research and Development (ORD), are focused on four topical areas: (1) reducing the environmental impacts of oil and natural gas development, (2) advancing enhanced and unconventional oil recovery technologies, (3) assessing poorly understood oil and gas resources, and (4) carrying out fundamental research to improve drilling under extreme conditions of pressure and temperature. As well, NETL's Office of Systems Analysis and Planning is assessing the potential benefits of the consortium-administered elements of the program.

A key element of the fourth complementary research focus area is the Ultra-deep Single Cutter Drilling Simulator (UDS), a unique, world-class research tool located at the NETL laboratory in Morgantown, WV, that will permit the simulation of a 30,000 psi, 250 °C downhole environment where the action of a drill bit cutter can be visualized in opaque drilling fluids through an X-ray video capability. Using this one-of-a-kind facility, researchers will be able to observe first-hand the poorly understood interaction of a bit cutter, drilling fluid, and rock under extreme conditions.

ENERGY EFFICIENT OFFICES AT NETL-MORGANTOWN (FROM COVER GRAPHIC)

The newest building at the NETL Morgantown campus, the Technology Support Facility (TSF), is a four-story, 108,000-square foot facility with 168 offices. The TSF was designed to obtain U.S. EPA Energy Star Certification as a building that uses about 35 percent less energy than average buildings, and also registered with the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) Certification Program with a LEED Platinum Certification as its goal. NETL expects to save more than $82,000 in utility/energy costs per year as a result of the building's "green" design. One feature of the design is a green roof, shown above during installation.

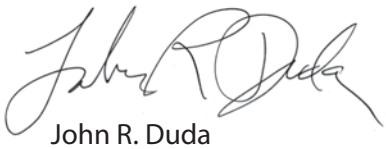
This issue of E&P Focus includes an update on the installation of this exciting new system.

These three elements (the appropriated funds projects, the RPSEA-administered projects, and the NETL complementary R&D projects) form the primary structure of NETL's oil and natural gas research portfolio. The purpose of this structure is to support the Fossil Energy mission to enhance domestic energy security, support economic growth, and protect the environment. NETL understands that much of the remaining domestic resource base is "unconventional"—either because the oil and natural gas is held in unconventional reservoirs (e.g., tight sands, shales, coal seams, tar sands, heavy oil deposits, and oil shale) or because unconventional technologies will be required to unlock the hydrocarbons from reservoirs that have received little attention in the past (e.g., the fractured Bakken shale, residual oil remaining in mature fields, and ultra-deepwater accumulations). DOE is investing in the development of new technologies that can accelerate or enable the production of these domestic sources of energy, in pursuit of its mission.

While managing these research efforts, NETL implements a robust technology transfer program to ensure that the research results produced are made available to a wide audience of potential users. This is important for the translation of these R&D investments into commercial products or the raw material for further research and innovation. The Federal Advisory Committee responsible for the "unconventional and other resources" portion of the EPAct Section 999 Program mentioned above—a group that is particularly attuned to the needs and interests of independent producers—has made it clear that it considers a comprehensive technology transfer effort to be a critical part of the entire DOE oil and natural gas R&D program. E&P Focus is one element of this effort, along with the NETL Web site, workshops presented by the Petroleum Technology Transfer Council, participation by both NETL and RPSEA in a range of industry conferences and meetings, focused technology workshops held by RPSEA to solicit input on research needs, and a suite of other outreach publications and products.

We hope that you will find this publication informative and will look forward to its quarterly publication. Please feel free to forward it on to anyone you feel may share an interest in the results of DOE's oil and natural gas research program.

Best Regards,



John R. Duda

Director, NETL Strategic Center for Natural Gas and Oil

New Research Effort Aims to Develop Seafloor Power Systems for Deepwater Oil and Gas Operations

In the future, the most productive offshore oil fields in the Gulf of Mexico may be nowhere to be seen. As oil and gas production has moved into deeper and deeper water, increasing numbers of development projects are being carried out via subsea production systems. As these systems are designed to extract oil and gas from locations that are farther and farther away from their surface base facilities, the technical difficulties (and costs) of transmitting electric and hydraulic power to operate the subsea equipment rise. A point will soon be reached where the next logical step will be to locate all of the required production and processing equipment on the seafloor, including the power generation units required to operate the system. A recently launched research project being funded under the EPAct 2005 Section 999 research program and carried out by a team led by the Houston Advanced Research Center (HARC) aims to lay the groundwork for just such a future (See photo).

The number of subsea installations is increasing worldwide and the length of subsea tiebacks is also increasing; tiebacks for some subsea gas wells planned through 2012 are expected to reach more than 100 miles and some oil tiebacks nearly 60 miles. These flowlines, together with the umbilicals used for the transmission of hydraulic and electrical power, data monitoring and chemical injection, can represent the largest cost items in the post-drilling phase of production system installation. In addition to the cost, as the transmission lines stretch to greater and greater lengths, a significant share of the power supplied from the surface location is lost in direct drive scenarios, requiring increased generation capacity (and emissions) and increased payload requirements at the surface.

Removal of the need for umbilical power transmission through subsea power generation will reduce the power generation requirements at the surface platform, increasing its payload flexibility and lowering costs. Lower costs mean that smaller accumulations of hydrocarbons can be economically developed and produced, increasing the domestic supply of energy. In extreme cases, at ultra-deep locations, subsea power may become an enabling technology that permits development where it would otherwise be impossible.

Houston Advanced Research Center (HARC) campus

This project will evaluate alternatives and recommend equipment to develop into hybrid energy conversion and storage systems for deep ocean operations. The result will be a comprehensive analysis of the options available for developing such a system, culminating in a conceptual design for the best option based on both economic and technical criteria. The system will be a "hybrid" system in the sense that it will combine both energy

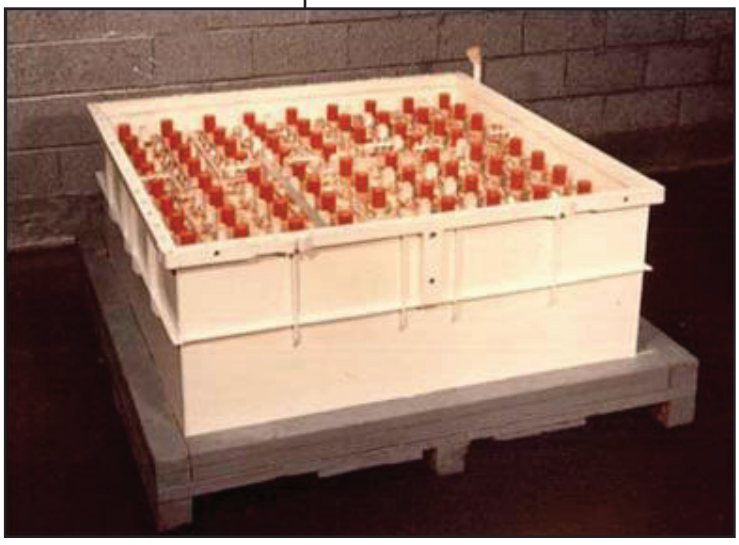
conversion and storage capabilities. The evaluation will result in an unbiased assessment of alternatives—the logical first step in advancing this technology.

The investment in this project, which totals $600,000 and includes a 20% contribution from companies on the research team, is timely. Technologies related to subsea processing are advancing rapidly; subsea multiphase pumping systems, subsea control systems, and flowline heating systems are now proven and available; and subsea compression systems are developing. But a comprehensive look at the options for subsea power generation is needed to focus subsequent research on the best alternatives and accelerate the development of this element of the subsea production system of the future.

Work on what is planned as a four-year project began in November 2008. In addition to HARC, the research team includes experts from Lawrence Livermore National Laboratory (LLNL), Naval Facilities Engineering Service Center (NFESC), Yardney Technical Products (YTP), Shell Oil Company, Chevron Oil Corporation, Total E&P USA, Curtiss-Wright Corporation, and GE.

HARC operates as a "boundary organization" between producers of scientific knowledge (scientists, inventors, and academics) and users of that knowledge (technology adopters, policy makers, the public). In this role HARC engages with the science community by employing a staff with scientific credibility, while appealing to its sponsors by employing a business-like approach to project management and financial accountability.

A 2 x 28 volt, 30Ah lithium ion battery designed for the Mars Rover by project team member YTP



A 2 x 100 volt, 700Ah silver zinc pressure compensated battery designed by YTP for a Navy Deep Submergence Rescue Vehicle (DSRV)

LLNL has a long and distinguished track record in the development of exotic power systems for demanding applications. NFESC provides worldwide technical support to the Navy and other Federal agencies. YTP was among the first companies in the world to successfully produce and commercialize rechargeable silver-zinc, magnesium silver chloride, and silver cadmium batteries and has designed, developed, and delivered high-energy-density batteries for ICBMs, the Mars Explorer Rover missions, and a variety of Air Force and Navy systems (see photos).

The project consists of five primary tasks. First, the team will document the performance and functional requirements expected for subsea hybrid power systems. Based on these results, the team will then screen existing high-performance energy conversion and storage systems and develop a database for the best hybrid power systems. The third task will be to select the two most promising generation-storage combinations, based on performance data, and prepare detailed sub-scale conceptual prototype designs. Initial qualification testing for the purpose of concept demonstration will also be performed. The conceptual designs will have sufficient capacity to power equipment rated to a total of 20,000-100,000 hp (14 to 70 megawatts) and be capable of long-term reliable operations at pressures up to 5,000 psi and temperatures approaching the freezing point of water.

A formal Risk Assessment of the two conceptual prototype systems will then be carried out, and their respective Technology Readiness Levels will be documented. As part of this task, estimates will be developed of the environmental impact (carbon footprint) of these systems when deployed, as compared with conventional gas turbine power generation. The final task will be to document all of the results in a series of publicly available technical reports.

Potential systems to be screened may include ocean-current driven systems, radioisotope thermoelectric generators, thermionic generators, small pressurized-water reactors with low-enrichment fuel (similar to those used on commercial ships), proton-exchange membrane fuel cells powered with hydrogen and oxygen (similar to those used on submarines), and fuel-cells, internal combustion engines, or turbines capable of using natural gas from deep-ocean wells.

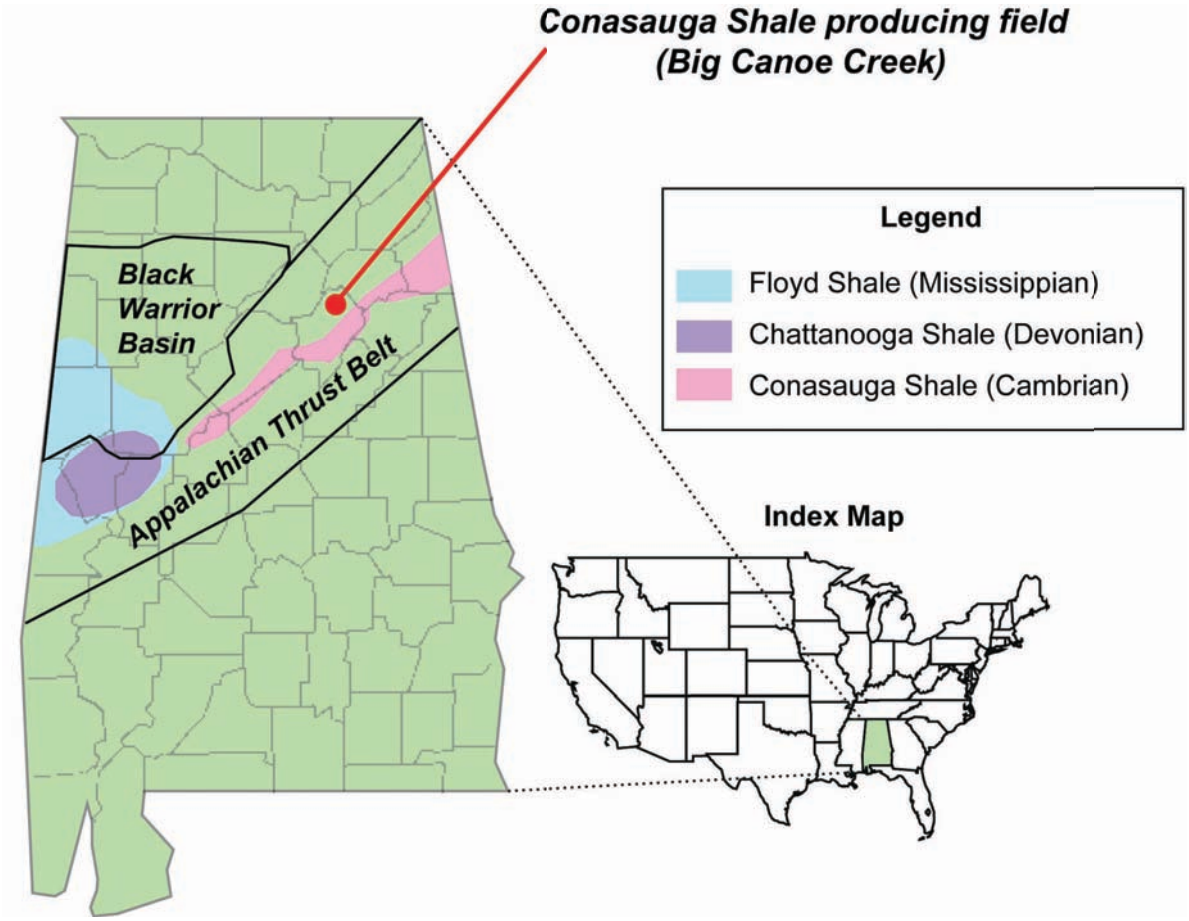
Battery technologies to be screened may include compressed-gas storage, liquid redox batteries, secondary batteries in sealed pressure vessels, pressure-tolerant secondary batteries, and other non-conventional battery systems (for example, oil-compensated polymer-gel lithium-ion batteries), polyurethane potted polymer-gel lithium-ion batteries, lithium-ion batteries, and lead acid batteries.

Following this project, if additional funding is available, work could transition into a second phase that would involve the design and fabrication of prototypes, with both surface and subsea testing. A successful technology would then be commercialized through appropriate industrial partnerships. The cost of this second phase of research is estimated to be between $16 million and $18 million depending on the type of system chosen for sub-scale prototype construction and testing.

Geological Survey of Alabama to Conduct Detailed Assessment of Emerging Gas Shale Plays

The Black Warrior Basin and Appalachian Thrust Belt of Alabama contain three gas shale plays that are currently active: the Cambrian Conasauga formation, Devonian Chattanooga shale, and Mississippian Floyd shale (see figure). While there are only a few dozen wells currently producing from these shales (primarily in the Big Canoe Creek field, a Conasauga shale development), leasing activity has been strong. About a dozen companies are involved, and the bulk of the acreage is held by fewer than 10 operators. Despite strong interest indicated by leasing activity, development of these plays has been hindered by technical challenges, including uncertainties concerning the best practices for exploration, drilling, and well completion that stem from inadequate geologic characterization.

The Geological Survey of Alabama (GSA) has begun a three-year study that will provide a geologic foundation for exploration and development of these shale plays. This study will characterize the stratigraphy, sedimentology, geologic structure, hydrodyamics, geothermics, petrology, and geochemistry of Alabama shale formations found in the Black Warrior Basin (Floyd and Chattanooga) and along the Appalachian Thrust Belt (Conasauga and Chattanooga). The results of this research will be publicly disseminated as they become available, to a wide audience of gas producers and potential shale developers. The final report is expected in the fall of 2011. The $844,000 study includes a more than 40% cost share contribution by the GSA and is one of 43 projects selected by the



Research Partnership to Secure Energy for America (RPSEA) consortium, the administrator of the Section 999 program managed by NETL, in the program's 2007 research solicitation.

There are major differences in composition, thickness, geometry, and fracture architecture among the targeted Alabama shale formations and proven gas shale reservoirs in other regions. To date, no formal, publicly available assessment has been made of resources and reserves in the gas shale plays of the Black Warrior Basin and Appalachian Thrust Belt. Detailed assessments are required to characterize the gas shale plays and provide a reliable assessment of resources and reserves in each play. Publication of a comprehensive report characterizing the resource will accelerate development by reducing the risk of E&P for smaller operators with less capability for carrying out their own resource assessments.

The Middle to Late Cambrian Conasauga shale has seen exploration activity since early 2005. In that year Dominion E&P completed a wildcat (Dawson 34-03-001) in St. Clair Co. that produced at 233 Mcfd from the Conasauga. By May 2008 a total of 18 wells had been drilled, 13 of which were active. Big Canoe Creek field is the only producing field to date. The top three Conasauga players have more than 800,000 acres under lease.

Rock units in this area are highly folded and faulted, making geologic interpretations difficult. Thrust faults (low angle reverse faults) can cause an exaggerated thickness (up to several thousand feet) for the Conasauga as a result of stacking of faulted strata.

In a December 2008 article in the *Oil & Gas Journal*, the CEO of one of the active developers, John Richardson of Energen, was quoted as saying, "There is nothing like the Conasauga anywhere in the country; it is a different kind of formation." Operators are uncertain if hydraulic fracturing can be effective in a zone that is so broken and deformed. The optimal combination of lateral drilling and fracture stimulation has not yet been determined.

Exploration targeting the Floyd-Chattanooga gas shale play has occurred across a wider area than the Conasauga play but has resulted in little gas recovery so far. Most of the drilling has been directed at the Floyd shale. Denbury has produced gas since 2005 from a 2,000-ft horizontal lateral in the Floyd shale in Lamar County. Eight other independents have also drilled wells to the Floyd during the past year, but no test results have been made public. The Chattanooga shale has long been of interest in Alabama because it appears rich in organics but is commonly only 25-40 ft thick.

The work being done by the GSA will provide a strong foundation of basic geological understanding for explorationists to apply as they develop strategies for exploiting these shales. DOE has a good track record of publishing similar basin analyses that over time have provided timely and valuable information for oil and gas producers. Some examples include the *Geologic Play Book for Trenton Black River Appalachian Basin Exploration* (June 2006); *Stratigraphic Framework, Structure, and Thermal Maturity of Cretaceous and Lower Tertiary Rocks in Relation to Hydrocarbon Potential, Crazy Mountains Basin, Montana* (June 2005); *Multi-year Study of the pre-Knox Stratigraphic Interval in the Rome Trough* (May 2005); *Natural Gas Resources of the Uinta Basin, Utah, and the Deep Anadarko Basin, Oklahoma and Texas* (August 2004); and *Natural Gas Resources of the Greater Green River and Wind River Basins of Wyoming* (February 2003). All of these data collections are available from the NETL library via the NETL website (http://www.netl.doe.gov/technologies/oil-gas/ReferenceShelf/index.html).

University of Kansas to Evaluate Potential for "Near Miscible" Carbon Dioxide Floods

Producing well in the Hall-Gurney Field near Russell, KS. DOE-funded research is currently testing the potential for miscible flooding using CO_2 generated by the ethanol plant visible in the background.

Sometimes "almost" *may* be enough. A new effort underway at the University of Kansas Center for Research looks to determine just how effective carbon dioxide (CO_2) enhanced oil recovery (EOR) can be if old oil fields are flooded at pressures below that considered optimal. If large quantities of CO_2 become available from anthropogenic sources in mature Midcontinent basins, such EOR projects may be able to boost domestic oil production (see photo).

Injection of CO_2 for EOR is a proven technology for increasing oil production and is also being considered as one of a number of promising methods for sequestering carbon in geologic formations. CO_2 injection for enhanced oil recovery is normally carried out at a pressure just above the minimum miscibility pressure (MMP), which is determined by crude oil composition and reservoir conditions. This is the lowest pressure at which the injected carbon dioxide is miscible with the oil remaining in the reservoir; the interface between the two fluids disappears. Miscibility means that the carbon dioxide can act like a solvent, more effectively displacing the oil from the rock.

However, many mature reservoirs in the United States with significant residual oil saturations exist at depths or under geologic conditions such that it is not feasible for them to operate at pressures as high as the MMP. "Near miscible" displacement generally refers to the process that occurs at pressures below the MMP, but the actual pressure range has never been clearly defined. At displacement pressures "near to" yet still below the MMP, significant oil recovery has been observed in laboratory slim-tube experiments, and to a lesser extent, in core tests. This laboratory behavior has been attributed to possible improvement of the mobility ratio during displacement and an extraction process, both of which are closely related to operating pressure. It may be possible to achieve a sizable portion of the incremental recovery that would accrue in a higher pressure flood, despite the lack of miscibility.

This project, one of a slate of seven projects focused on the challenges of independent producers and administered under the Energy Policy Act of 2005–Section 999 research program, will be the first study of the application of CO_2 displacement at near miscible pressure conditions for small independent producers active in Arbuckle formation oil fields in Kansas. The two-year project, which began in June 2008, is being funded at $274,000 from the Department of Energy, with an additional $68,500 cost share contribution from the research team. The University of Kansas Center for Research's Tertiary Oil Recovery Project (TORP) is partnering with Carmen Schmitt Inc. of Great Bend , KS, an independent oil and gas producer that owns the Ogallah Unit, which produces from the Arbuckle reservoir. Currently, the 18 wells in production on this 1,600-acre site have a total daily production of 40 bbl of oil and 98% water cut. Carmen Schmitt will provide the project team with representative core samples, crude oil samples, well logging and 3-D seismic data, well performance data, and reservoir production history for computer modeling.

The Arbuckle is an ideal target for this research effort. Three mature Kansas oil fields (Chase-Silica, Trapp, and Bemis-Shutts) in the Arbuckle formation are estimated to have had original oil in place of 2.7 billion barrels, of which only 900 million barrels has been produced by a bottom-water drive mechanism via an underlying aquifer. Previous assessments of CO_2 miscible flooding in these Arbuckle reservoirs indicates that miscibility is not achievable at current reservoir operating pressures and the option has not been implemented. However, near miscible CO_2 flooding could revive these and many similar fields in central Kansas, which will otherwise be abandoned with substantial remaining oil left in place. Depending

on the extent of recovery resulting from CO_2 near-miscible flooding, the incremental oil produced from this formation could vary from 80 to 135 million barrels, assuming a 3 to 5 percentage point recovery improvement. It is estimated that successful near-miscible CO_2 flooding of the Arbuckle over a widespread area could result in recovery of as much as 300 million barrels of incremental oil, depending on the success of the research and if it subsequently leads to a demonstration project. Research will need to proceed to pilot test level before more precise estimates of potential impacts can be made.

The key tasks to be undertaken by the research team at the TORP laboratories include the following. First, they will evaluate the CO_2 displacement process at near miscible conditions by conducting slim-tube experiments to determine minimum miscibility pressure using a 40-ft slim tube. Dead oil and live oil samples collected from Arbuckle reservoirs will be used in the experiments. Completion of this task will provide the data required to characterize the near miscible condition, including the oil recovery performance, phase density and viscosity of CO_2/oil mixtures, and relative permeability of flow through the slim tubes as a function of pressure.

Second, the team will perform routine pressure-volume-temperature analyses on CO_2-Arbuckle crude oil systems to obtain enough data to "tune" a compositional simulator. Phase equilibria data will be obtained and examined for the possible existence of a liquid-liquid-vapor phase region at the reservoir temperature of 110 °F. Swelling tests will be performed to determine the relationship between saturation pressure, swelling factor, and CO_2 volume injected. Extraction tests will be conducted to examine the degree to which extraction of liquid hydrocarbon into a CO_2-rich phase occurs, and the effect of pressure on that behavior.

Third, the researchers will conduct flow tests using CO_2, Arbuckle reservoir rock, and Arbuckle crude oil at waterflood residual oil saturation. A series of displacement experiments will be done in which the pressure will be systematically varied at near miscible conditions. The displacement experiments will be done in cores at various water saturations. Relative permeability data at near miscible conditions will be measured for use in model simulations, and the residual oil saturation remaining in the core sample at the end of each experiment will be evaluated.

When the laboratory results are in hand, the research team will employ a compositional model to characterize the phase interaction between the CO_2 and Arbuckle oil. The compositional model will be adjusted to match the saturation pressure and swelling factors derived from the swelling tests. These model results will in turn be used as input to a compositional simulator tuned to match the slim-tube experiments and used as the basis for describing the core flood tests.

As a final task, the researchers will incorporate the new model into a reservoir simulator representative of the Arbuckle formation to assess the potential for carbon sequestration in oil reservoirs at near miscible conditions. Reservoir simulations will be performed using different reservoir pressures in the near-miscible region to estimate CO_2 storage capacity, *in-situ* concentration, transport velocity, contacted volume, and the timeframe for filling, monitoring, and storage.

The results of this research effort will be made available on the NETL website at http://www.netl.doe.gov/technologies/oil-gas/EPAct2005/Projects/Index.html/. The status reports, quarterly and annual technical reports, and a final technical report will be posted as the work is completed.

Deep Drilling in West Virginia

An ultra-deep, extremely high-pressure, high-temperature play is about to be developed in north-central West Virginia. Exploratory drilling is scheduled to start up later this year, and the operator will encounter conditions typical of depths beyond 20,000 feet with wellbore pressures and temperatures to range as high as 30,000 psi and 250 °C (480 °F). But the high temperature and pressure environment is not the only unique aspect here, as all of the drilling will occur in the Extreme Drilling Laboratory (XDL) at the National Energy Technology Laboratory (NETL) in Morgantown, WV, utilizing NETL's Ultra-Deep Single-Cutter Drilling Simulator (UDS).

...the UDS is a prototype, world-class simulator that can reproduce the drilling environment found at the bottom of ultra-deep wells.

Designed and constructed under a cooperative agreement with industry, the UDS is a prototype, world-class simulator that can reproduce the drilling environment found at the bottom of ultra-deep wells. Both single cutter simulators and full bit simulators have been used successfully by industry to study and improve the drilling process. TerraTek, part of Schlumberger and the designer/developer of the UDS, has tested 6-inch bits at pressures up to 10,000 psi in its full bit simulator. However, no other simulator has the capability for operating at the extreme operating conditions sustainable in the UDS. Also, a unique feature of NETL's UDS is the ability to visualize the cutting action via X-ray images taken through an observation port.

The UDS is an outgrowth of Deep Trek, a deep drilling R&D program implemented and managed by NETL. Between 2002 and 2006 this program funded collaborative R&D efforts with industry to develop technologies that could lower the cost and improve the efficiency of drilling and completing deep wells. One of the Deep Trek projects involved the benchmarking of bit and drilling fluid performance at TerraTek's testing facility, as a first step towards developing the design enhancements needed for reliable higher-pressure/higher-temperature bit/fluid systems. It was during this project that the DOE/industry research partners recognized the need for a simulation facility that would enable testing under extreme conditions.

As a single-cutter system, the UDS simulates a more fundamental aspect of the drilling process than does a full-bit simulator that incorporates a complete bit with multiple cutters. The test apparatus consists of a pressure vessel, a charge pump, circulating pump, heat exchanger, x-ray source, detector, instrumentation and control system. Each test specimen is a cylindrical (8-inch diameter, 12-inch long) rock sample. The rock test specimen is rotated against the cutter assembly, and a hydraulic control system is used to control rotational motion, torque, and linear displacement, or load against the cutter. The sample holder located in the lower half of the pressure vessel is shown in Figure 1. A massive load frame (Figure 2) is used to contain the thrust forces generated by the immense fluid pressure acting on the vessel ends.

A single fixed cutter (e.g., a polycrystalline diamond or carbide insert) is installed in a specially designed holder within the upper section of the pressure vessel. The cutter holder is instrumented to measure and record the tri-axial forces experienced by the cutter during a test sequence. The vessel is then pressurized with a drilling mud of interest, and the entire system is stabilized at a predetermined test condition, within the operating limits of 30,000 psi and 250 deg °C (482 °F). The test specimen is then raised to contact the cutter at a precisely measured load and rotated at a set rotation rate.

An X-ray system will be used to visualize the pressure vessel internals. This feature will enable researchers to essentially "watch" as a cutter imparts the shear and compression forces required to break the mechanical bonds of the rock structure. This capability is unique to the UDS and is expected to prove invaluable to researchers seeking to understand the drilling process as it occurs at the cutter/rock interface.

The UDS system components arrived at NETL from project partner TerraTek during January 2009, and the system is currently being reassembled and

Figure 1: Close-up of sample holder.

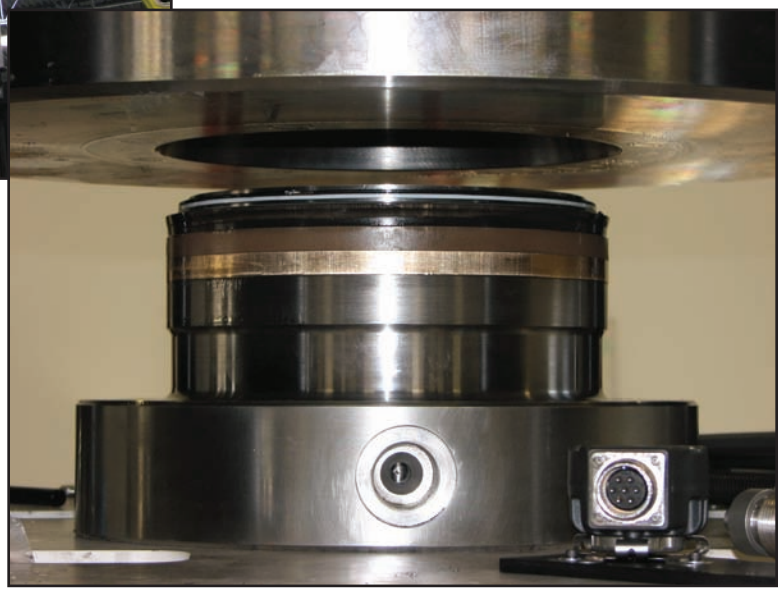


Figure 2: UDS assembly showing load frame with solid aluminum reaction column above the pressure vessel.

prepared for shakedown testing. A rigorous testing regimen will be carried out before the system is commissioned for experimental work

Of particular interest in NETL's studies will be the interactions of a number of independent variables during the experiments—for example, drilling fluid composition, rock properties, cutter design and orientation, and operating conditions. The drilling fluid parameters are thought to influence the pore pressure within the rock formation in the vicinity of the bit. This would include lubrication at the bit-rock interface and rock degradation via chemical effects. Rocks respond differently to various drilling systems, and the effects of the porosity and permeability of the rock, its chemical makeup, and its physical or mechanical properties must be thoroughly understood and correlated in order to advance our understanding of drilling technology under extreme conditions.

While a full bit simulator is often used to investigate the performance of a commercial drill bit that may contain dozens of cutters, each contacting the rock at different linear speeds, contact angles, and fluid shear rates, NETL and its industrial partners made a conscious decision to design the UDS as a single point cutter. This is the optimum platform for researching the fundamental parameters required to characterize cutter versus rock type interdependencies for a given set of downhole conditions. Drill bit designers that may collaboratively partner with NETL will be able to utilize UDS data to develop products optimized for ultra-deep drilling.

To complement studies in the UDS, NETL will also undertake work designed to develop and test numerical models that predict rock failure. These models will be used to help understand the data generated during UDS experiments. The UDS will provide the important first step in validation of numerical models through experimentation. This same proof-of-concept testing will help determine the role played by drilling fluid solids and filter cake in the cutting process.

The UDS is an element of the complementary research being performed at NETL as part of the EPAct 2005-Section 999 R&D Program. This fundamental research is designed to support the development of more-efficient drilling systems for reaching the nation's deep resources, both in ultra-deepwater fields and in deep unconventional gas reservoirs. NETL's Office of Research and Development (ORD) is responsible for implementation of the UDS research program. A variety of research partnerships and joint efforts are being formulated as mechanisms for industry, academia, and Federal research labs to work together to fully utilize the capabilities of this unique new facility. For more information contact the Project Manager, Dave Lyons (k.david.lyons@netl.doe.gov), or visit the NETL Website (http://www.netl.doe.gov/).

NETL R&D Tackles Technological Challenges of the Williston Basin's Bakken Formation

Recent development of the Bakken formation in the Williston Basin of western North Dakota and eastern Montana is a good example of persistent analysis of geologic data and adaptation of new completion technologies overcoming the challenges posed by unconventional reservoirs. However, as with most unconventional plays, as Bakken development continues, questions regarding exactly *how* to refine newly applied technologies to optimize recovery and economics become more specific.

The National Energy Technology Laboratory (NETL) is involved in five initiatives to enhance industry's understanding of the Bakken in order to improve oil recovery from this important domestic resource. Research activities include significant collaboration among researchers to maximize results from all efforts. The initiatives include (1) an industry consortium developing and analyzing information on how hydraulic fracturing stimulations perform in the Bakken; (2) an evaluation of key factors affecting production to determine relationships among Bakken rock properties, well completion methods, and well performance; (3) a geo-mechanical study to measure *in-situ* stresses and geo-mechanical properties of the Bakken to better design hydraulic fracture treatments; (4) an initial assessment of the hydrocarbon potential of the Bakken and development of an integrated exploration model; and (5) an effort to determine the controlling mechanisms affecting oil distribution and production and to identify methods for increasing oil flow through monitoring well conditions and (potentially) injecting carbon dioxide (CO_2).

Collectively, these initiatives will accelerate the efficient development of this significant resource. The goal of this research is the development and public dissemination of basic scientific data that can be utilized by industry to more rapidly develop and bring on stream domestic oil resources.

About 105 million barrels of oil were produced from the Bakken formation through 2007. The Elm Coulee oil field in Montana (Figure 1), discovered in 2000, has produced about 65 million barrels of that total. Currently, there are between 900 and 1,000 wells producing in the Bakken, split almost equally between North Dakota and Montana (Figure 2).[1,2] Production in 2006 amounted to approximately 19 million barrels in Montana and 2.25 million barrels in North Dakota, although 2007 production in North Dakota jumped more than three-fold.[3]

The hydrocarbon resources of the Bakken are defined as "continuous-type" resources, where the oil and natural gas have not accumulated into discrete reservoirs of limited areal extent. A number of values have been estimated for the volume of oil generated by the Bakken.[4] These ranged from 413

1. Walker, W., 2006, Bakken Oil Well Frac treatment, a presentation by Bill Walker of Headington Oil Company.
2. North Dakota Department of mineral Resources (https://www.dmr.nd.gov/oilgas/) and Montana Board of Oil and Gas (http://bogc.dnrc.mt.gov/annualreviews.asp).
3. *Ibid.*
4. LeFever, J., and L. Helms, 2006, Bakken Formation Reserve Estimates, at https://www.dmr.nd.gov/ndgs/Bakken/newpostings/07272006 BakkenReserveEstimates.pdf.

billion barrels (BBbls) in an unpublished paper by Dr. Leigh Price, to 10 BBbls in landmark papers by Dow and Williams in 1974. New estimates of the amount of hydrocarbons generated by the Bakken placed the value at 200 BBbls, which was later revised to 300 BBbls in 2006.

How much of the generated oil is technically and economically recoverable remains to be determined and will be based upon an evolving understanding of the best methods for producing the resource. In April 2008, the U.S. Geological Survey (USGS) completed an assessment of the undiscovered, technically recoverable oil and associated gas resources of the Bakken in the U.S. portion of the Williston Basin.[5] In this assessment, the USGS determined the mean undiscovered volumes of technically recoverable resources to be 3.65 billion barrels of oil, 1.85 trillion cubic feet of associated and/or dissolved natural gas, and 148 million barrels of natural gas liquids. The next largest continuous oil accumulation in the United States is the Austin Chalk, with an undiscovered estimate of 1.0 billion barrels of technically recoverable oil.

NETL is involved in five initiatives to enhance industry's understanding of the Bakken and help operators answer a number of unresolved questions. Each of these research activities, which are highlighted in the following sections, involve significant collaboration among researchers to maximize results from all efforts.

Industry Consortium **–** NETL is participating in an ongoing field study to gather a comprehensive suite of geophysical data from surface and subsurface sensors, during and after fracture stimulation of a pair of horizontal wellbores in the Bakken. This experiment, led by Headington Oil, includes a surface geophone array, three ~1,500-foot deep wells with permanently emplaced subsurface geophones dedicated to continuous monitoring (funded by NETL), a series of 18 shallow holes with emplaced geophones, and three horizontal wellbores, one of which includes

5. Pollastro, R. M., *et al*., 2008, "Assessment of undiscovered oil resources in the Devonian-Mississippian Bakken Formation, Williston Basin Province, Montana and North Dakota, 2008": U.S. Geological Survey Fact Sheet 2008–3021, April 2008.

Figure 1: Elm Coulee Oil Field Richland County, Montana Bakken Oil Well frac treatment.

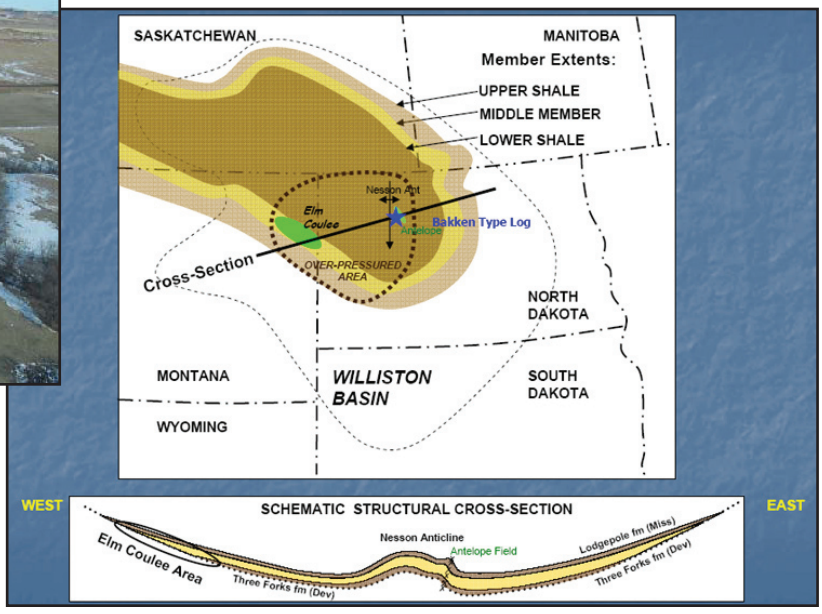


Figure 2: Extent of the Bakken shale in the Williston Basin (Walker, 2006, after Meissner, 1978)

emplaced geophones for monitoring (Figure 3). The initial hydraulic fracturing of two of the horizontal wells, which was conducted in 2008, was monitored by this extensive array of sensors in an effort to understand exactly how hydraulic fractures are created in the Bakken. Downward-looking vertical seismic profiling is being used in a passive seismic acquisition mode to continually monitor the formation for an extended period of time after production was initiated. NETL is also funding Lawrence Berkeley National Laboratory efforts to interpret the wealth of seismic data generated and develop geologic models that can be used to guide future stimulations. The results of this field study are expected to be made public early in 2009. Additional fracture stimulations of the horizontal wells may be conducted during the summer of 2009 and will also be monitored with the sensor arrays to add to industry's understanding of Bakken exploitation.

Evaluation of Key Factors Affecting Production – NETL initiated an effort in September 2008, with the University of North Dakota's Energy and Environmental Research Center (UNDEERC) to perform a Williston Basin Bakken play assessment. This detailed analysis will incorporate data from industry and state agencies on wells, stimulations, locations, completion designs, and productivity to provide critical insights on optimal development strategies.

The investigation entails three activities: analysis of well file data, seismic and geo-mechanical studies, and geochemical studies. The first activity which involves use of the Risk-Based Data Management System (RBDMS) and other databases and records to analyze a wide range of parameters that impact well productivity and oil recovery from the Bakken. Obtaining these data will necessitate manual evaluation of well files and significant personal interaction with companies currently operating in the Bakken play. A collaborative relationship with Marathon Oil has been established that will ultimately provide the project with a wide variety of data on well drilling, completion, stimulation, and production for Bakken wells in western North Dakota.

A second activity of this project involves the analysis of existing sets of seismic data, together with geo-mechanical properties of Bakken reservoir

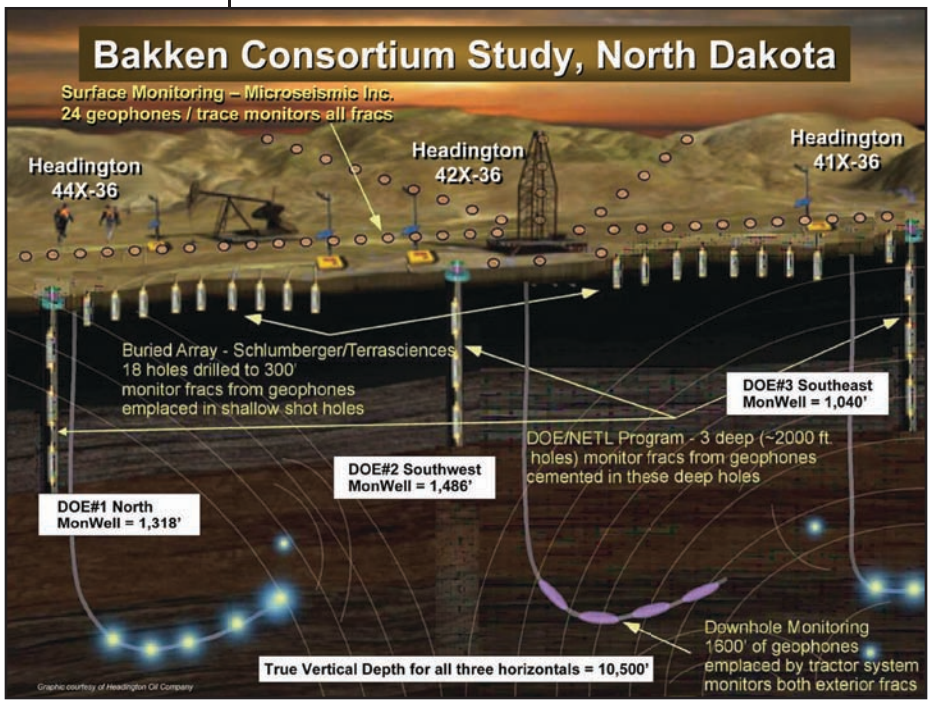


Figure 3: Schematic of surface and subsurface monitoring of Bakken well stimulations

and seal rock samples, to develop a better understanding of how the macroscale stress and strain forces associated with geologic structure in central North Dakota may influence the geo-mechanical properties of Bakken reservoir rock and seal rock on the microscopic scale. These seismic and geo-mechanical data, combined with the knowledge and data gained in the first activity, will be used to develop a comprehensive petrophysical model of a Bakken reservoir system. Analytical activities to evaluate the mineralogical composition of selected Bakken samples and preliminary geomechanical testing on materials related to Bakken stimulations are included in this activity.

The third activity involves the testing of a hypothesis regarding the source of fractures in the Bakken. To achieve this objective, approximately 400 Bakken samples are being characterized for the occurrence of opal, chert, smectite, and illite using x-ray diffraction analytical techniques. The geographical distribution of the analytical results will be compared with the results generated in the first two activities, and conclusions will be drawn regarding the potential influence of water expulsion from hydrated minerals on Bakken productivity.

Geo-Mechanical Study – NETL is also partnering with the University of North Dakota to determine *in-situ* stresses and geo-mechanical properties of the Bakken in an effort to increase the success rate of horizontal drilling and hydraulic fracturing. The geological heterogeneity and special features of the Bakken make it difficult to drill and complete wells successfully without knowing the *in-situ* stress regime and geo-mechanical properties of the rocks; however, these parameters are not well known. Some areas have experienced drilling success rates of less than 10 percent as a result of wellbore instability and unsuccessful fracturing, which is partly due to lack of data.

This project, which began in late 2008, is measuring *in-situ* stresses and related geo-mechanical properties using field and well data, core samples, and lab experiments. The generated database of geo-mechanical properties of the Bakken will enable operators to optimize well placement and completion strategies. So far, the research team has screened nearly 100,000 wells, identified 4,133 wells with Bakken formation information, and collected data from core samples in 30 wells from three USGS-defined assessment units (AU): Nesson-Little Knife Structural AU, Elm Coulee-Billings Nose AU, and Eastern Expulsion Threshold AU. Experimental method and data reduction procedures have been completed for a University laboratory-developed alternative triaxial geomechanical testing system. This system and method will be used to test small rock samples that is much needed for Bakken shale experiments and other similar rocks where standard-size rock samples are not available. The team has also designed, built, and tested a portable Bakken shale core sampling system that allows the preparation of the Bakken shale samples on site in the ND Core Library. The project will continue through September 30, 2011.

Integrated Exploration Model – Another NETL project, this one led by the Colorado Energy Research Institute at the Colorado School of Mines (CSM), is conducting an assessment of the hydrocarbon potential of the Bakken shale in the Williston Basin and developing an integrated geologic model. A fully integrated analysis of the Bakken has not been done, nor has seismic attribute analyses or large-scale scanning electron microcopy (SEM) compositional and textural analyses been attempted for this hydrocarbon system.

The research is developing a new predictive stratigraphic framework and geologic model for the Bakken to improve play and prospect assessment

and allow accurate estimates of reserves. An improved understanding of Bakken producibility is expected to reduce drilling risk and provide more accurate resource estimates, so operators can significantly improve recovery by optimizing drilling and completion strategies.

The NETL/CSM team includes experts from Fidelity Exploration, Samson Resources, The Discovery Group, and the Idaho National Laboratory. In addition, CSM has formed a Bakken Consortium in association with DOE funding received from the award to expand in-kind contributions of seismic, well logs, core, and fracture mapping data; to conduct additional field studies; to obtain additional facies and fracture analyses; and to add source typing, maturity analysis, and burial history to the project work. Consortium funding will also support students in addition to those already funded by this project. Seven companies have currently committed to the consortium, and an additional ten companies are considering joining.

This research project began in late 2008 and is scheduled to continue through September 2011.

Oil Distribution and Production Mechanism **–** Lastly, NETL's Office of Research and Development (ORD) is conducting on-site research to improve the accuracy and reliability of reservoir simulations of oil recovery from fractured reservoirs like the Bakken, in part through the use of discrete fracture models. The ORD team will also assess the possibility of CO_2 enhanced oil recovery in the Bakken. This effort is utilizing reservoir modeling capabilities at NETL and is being carried out as part of the Complementary R&D program NETL is pursuing under EPAct 2005-Section 999.

NETL-ORD is working to acquire core and formation fluid samples from the Bakken and plans to use a CT scanner to image the nature of the fractures within the shale (Figure 4).

In addition, ORD is employing its own naturally fractured reservoir simulator, NFFLOW, to model the migration of fluids within the Bakken and the surrounding rock matrix. ORD is coordinating its activities to complement work being done on the Bakken at TerraTek (core analysis), by the Bakken consortium (modeling), and at the University of North Dakota (see above).

To follow the progress of this research, which is focused on the Bakken—a significant domestic resource—visit the NETL website at http://www.netl.doe.gov/technologies/oil-gas/Projects/EP_TOC.html and click on the appropriate project summary.

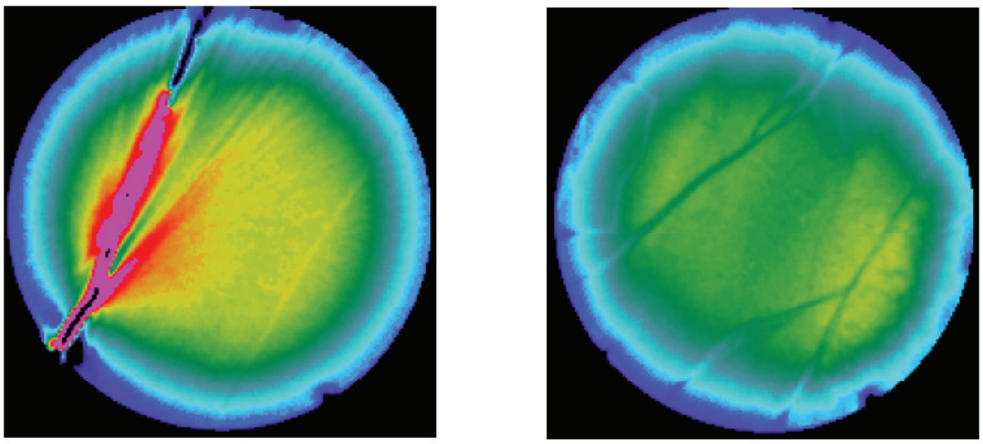
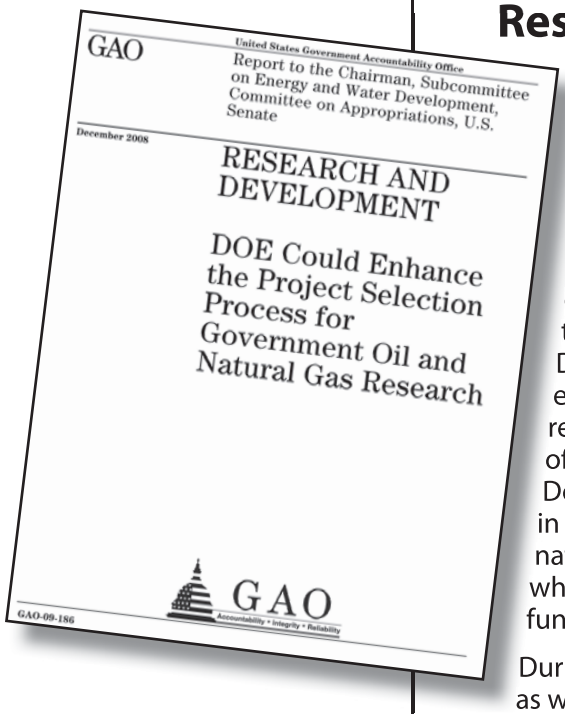


Figure 4: CT scan of open (left) and mineralized fractures in shale core.

Government Accountability Office Reviews Past Decade of DOE Oil and Natural Gas Research



Although competitive oil and natural gas markets generally provide incentives for companies to invest in R&D, some industry experts believe companies may under-invest in certain areas. In 2007 the Government Accountability Office (GAO), at the request of Congress, began a review of the oil and natural gas research being managed by the Department of Energy through the National Energy Technology Laboratory (NETL). The resulting findings generally aligned with previous assessments such as that done by the National Research Council in 2001, which had determined that DOE's Oil and Natural Gas Program provided important benefits in excess of the investment. The initial GAO review led to a more specific request by Senator Byron Dorgan of North Dakota, as Chairman of the Senate Appropriations Subcommittee on Energy and Water Development, for GAO to assess how much U.S. industry has invested in oil and natural gas R&D over the last 10 years, how DOE's oil and natural gas R&D funding and activities compare with industry's and to what extent DOE ensures that its R&D would not occur without Federal funding.

During 2008, NETL provided extensive information on its R&D programs, as well as background information on the need for specific technologies to address gaps between current industry capabilities and expected future requirements. GAO reviewers visited NETL on several occasions.

The resulting report, published in December 2008, presented a number of interesting findings that support the rationale for a Federal role in oil and natural gas E&P research. The GAO report concluded that DOE plays an important role in conducting oil and natural gas R&D that U.S. industry may have limited incentive to conduct, particularly longer-term, high-risk research. Specific findings include:

- "In contrast to industry's primary focus on near-term [< 2 years] challenges, DOE's R&D focuses on both near- and longer-term challenges…research that is longer term and high risk in nature."
- "The large independents we contacted did not conduct in-house R&D; rather, they typically purchase new technologies and adapt these technologies to meet their unique needs. …The small independent producers we interviewed generally do not conduct their own R&D. Small producers reported that they obtain or become aware of new technology through interactions with other companies and "word of mouth," industry-relevant publications and journals … and the Petroleum Technology Transfer Council. While they do not conduct their own, in-house R&D, several small producers told us they could benefit from increased R&D in areas such as enhanced oil recovery."

- "To better ensure that DOE selects oil and gas R&D projects that industry is unlikely to pursue, GAO recommends DOE's project selection process include a formal assessment of the likelihood that the R&D would not have occurred without federal funding. … By making a more formal evaluation in its screening process, DOE could better demonstrate that it selects projects that industry is unlikely to pursue."

In response, NETL has moved to formalize what was a more informal process of assessing areas where Federal investment in oil and natural gas R&D will not duplicate industry efforts. It is important to recognize that GAO's recommendation is an enhancement to what is considered a well-functioning process; the quality of the program in terms of planning and implementation was captured in the report.

This is consistent with the belief that Federal R&D accelerates the process of technology development by reducing risk and catalyzing changes that would otherwise take longer to occur, reducing the time required for widespread adoption of new technology across a large portion of the industry. As part of a balanced energy supply plan, the U.S. needs to efficiently and safely exploit domestic oil and natural gas resources that are technologically challenging to produce at any price. Continued federal sponsorship of oil and natural gas technology development can help to maintain this focus in the face of volatile energy prices…and because independent producers play such a large role in producing America's oil and natural gas, technology transfer efforts that focus on this sector of the industry are particularly important. Visit the GAO website to download the full report (http://www.gao.gov/new.items/d09186.pdf).

Wired Pipe Technology is Here!

Wired pipe telemetry is now being put to use in the oil field, about 12 years after the original concept was initiated by Novatek and developed in partnership with Grant Prideco.

Original prototype development and field testing were funded in part by the Department of Energy's National Energy Technology Laboratory (NETL), in an effort to accelerate commercialization of this technology. Since then, National Oilfield Varco acquired Grant Prideco and added the IntelliServ Broadband Network™ high-speed telemetry drill pipe to its portfolio of oil field technologies.

According to Roy Long, a Technology Manager at NETL, wired pipe broadband telemetry is a good example of a technology that would not have made it this quickly from concept development to commercialization without the support of DOE.

Wired pipe telemetry can transmit data from downhole tools to the surface more quickly and more reliably than conventional mud pulse telemetry. In fact, data transfer rates are about 5 orders of magnitude faster with wired pipe telemetry. This allows evaluation of the down-hole drilling environment, accurate characterization of the formation being drilled, and precise navigation of the well bore to targeted reservoir intervals—all in real time. The result is reduced drilling time, more accurate well placement, and corresponding savings in drilling costs.

The IntelliServ™ system utilizes a milli-hop telemetry system, where electrical conductors inside neighboring pipe segments are coupled electrically by a transmitter that sends data across each threaded drill pipe connection to the next segment. Electrical coupling takes place automatically as each tool joint is made up, and no special handling procedures are needed on the rig floor (See photo).

Successful utilization of the technology was highlighted in March 2009, at the Society of Petroleum Engineers and International Association of Drilling Contractors Conference held in Amsterdam. Chris McCartney of Occidental Petroleum said that the IntelliServ Broadband Network utilized in Occidental's Elk Hills field in California worked efficiently and led to a 10% reduction in drilling time. A representative of National Oilwell Varco IntelliServ explained that the technology allows data acquisition from multiple locations and multiple tools along the drill string, as well as real-time surface control over down-hole instruments.

The IntelliServ Broadband Network™ has been deployed successfully in North America, South America, the Far East, and Europe in onshore and offshore applications and will be the topic of several presentations at the upcoming June, 2009 World Drilling Conference in Dublin, Ireland.

Technician verifying electronics of a network node of IntelliServ Broadband Network™. These nodes have the capability of measuring wellbore temperature and annular pressure at discrete intervals along the drill string.

E&P Snapshots

Stripper Well Consortium Request for Proposals

An RFP soliciting proposals from current Stripper Well Consortium (SWC) Members (Full and Supporting) will remain open until June 2, 2009 (4:00 pm EST). Visit the SWC web site (http://www.energy.psu.edu/swc) to download the RFP. Proposals are being solicited in the following four focus areas: (1) reservoir remediation, characterization, and operations; (2) well-bore clean-up; (3) surface and collection optimization; and (4) environmental/energy efficiency. The SWC anticipates making four to five awards at an SWC funding level of $100,000 to $150,000. In addition to the proposal, each applicant is required to provide the SWC membership with a short presentation on the proposed project at the SWC 2009 Summer Meeting in Whitefish, MT, on June 30 to July 1, 2009.

NETL Funding Opportunity on Technology Transfer Now Open

NETL has posted a new Funding Opportunity focused on Technology Transfer (DE-FOA-0000034). Proposals in response to this solicitation are due by May 15, 2009. This activity is designed to ensure the broad and timely dissemination of research and development results, primarily related to DOE-developed technology and secondarily to industry-developed technology. Technologies from all elements of the DOE Oil and Natural Gas R&D Program will be included (i.e., Petroleum Technology, Arctic Energy Office, Methane Hydrates, Environmental Solutions, and EPAct 2005, Title IX, Subtitle J, Section 9990. Visit the NETL website at http://www.netl.doe.gov/business/solicitations/index.html to view the solicitation.

NETL Funding Opportunity Announcement Related to Environmental Technologies Expected Soon

NETL is planning to post a new Funding Opportunity focused on technologies designed to decrease the environmental impact of oil and natural gas E&P activities. The specific details of this solicitation are still under development. The solicitation will be posted on the NETL website at http://www.netl.doe.gov/business/solicitations/index.html in the near future.

NETL-Funded Technology Enhances Recovery of Natural Gas in Wyoming

Research sponsored by NETL has found a way using isotopic tracers to distinguish between groundwater and the water co-produced with coalbed natural gas, thereby boosting opportunities to tap into the vast supply of natural gas in Wyoming as well as Montana. The University of Wyoming research, funded through NETL's Oil and Natural Gas Environmental Solutions Program, has resulted in a patent application. Read more online at http://www.netl.doe.gov/publications/press/2009/09020-Technology_Enhances_Gas_Recovery.html or contact Jesse Garcia (jesse.garcia@netl.doe.gov) or Dr. Harold Berman (berman@uwyo.edu) for more information.

NETL Project Leads to New Alliance to Promote Low-Impact Drilling

A project supported by NETL has given rise to a major new research consortium to promote advanced technology for low-impact oil and gas drilling. An alliance of the Houston Advanced Research Center, seven universities, and two national laboratories, the University/National Laboratory Alliance will fund and transfer advanced technologies to accelerate development of domestic oil and natural gas resources with minimal environmental impact. The alliance has its roots in a NETL Oil and Natural Gas Environmental Solutions Program project. Learn more about the alliance **here**. (http://www.netl.doe.gov/publications/press/2009/09010-Drilling_Alliance_Takes_Shape.html)

RPSEA Receives Strong Response to FY 2008 Requests for Proposals

The Research Partnership to Secure Energy for America (RPSEA) has received 92 proposals in response to two FY2008 requests for proposals (RFPs) issued under the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program authorized by the Energy Policy Act of 2005 (EPAct). A total of 69 proposals were received in response to the $13.9 million-per-year Unconventional Resources Program, which focuses on gas shales, coalbed methane produced water, and tight gas sands. A total of 23 proposals were received in response to the $3.2 million-per-year Small Producer Program, which focuses on advancing technology for mature fields. The total number of proposals is a 40% increase compared with submittals in 2007, the program's first year. Get more details **here**. (http://www.rpsea.org/en/art/148/)

RPSEA 2009 Annual Plan for Ultra-Deepwater, Unconventional Resources R&D Program Approved

The 2009 Annual Plan for the EPAct program was approved January 13 by then-U.S. Secretary of Energy Samuel W. Bodman, setting the stage for RPSEA to move forward with its 2009 project solicitations. The signing clears the way for 2009 requests for proposals to be issued soon after the completion of the 2008 solicitations later this spring. Details of the plan can be found **here**. (http://www.fe.doe.gov/programs/oilgas/ultra_and_unconventional/2009_Annual_Plan/2009_Annual_Plan_Dec2008.pdf)

Upcoming Presentations

In the next three months seven presentations relating to NETL-sponsored oil and natural gas projects will be given at various conferences throughout the United States and abroad. Please visit the Reference Shelf for more information on these presentations.

May 3–6, 2009: The papers "Mapping Study to Characterize NSCR Performance on a Natural Gas-Fueled Engine" and "Variation in Long-Term Emissions Data from an NSCR-Equipped Natural Gas-Fueled Engine" will be given at the ASME Internal Combustion Engine Division 2009 Spring Technical Conference, in Milwaukee, WI, May 3–6. These presentations are related to the NETL project DE-FC26-02NT15464, titled "Cost-effective Reciprocating Engine Emissions Control and Monitoring for E&P and Gathering Engines." View abstract and other project information.

May 11, 2009: The paper "Comparing the Depositional Characteristics of the Oil-Shale-Rich Mahogany and R-6 Zones of the Uinta and Piceance Creek Basins" will be given at the Geological Society of America-Rocky Mountain Section annual meeting in Orem, UT. The paper is related to the NETL project DE-NT0005671 http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Environmental/Produced_Water/05671_UintaWaterStudy.html titled "Water-Related Issues Affecting Conventional Oil and Gas Recovery and Potential Oil Shale Development in the Uinta Basin, Utah." View abstract and other project information.

May 19-22, 2009: The paper "Geomechanical Study of Bakken Formation for Improved Oil Recovery" will be given at the International Symposium on Rock Mechanics session Rock Characterization, Modeling, and Engineering Design Methods at the University of Hong Kong in Hong Kong, China, May 19–22, 2009. The paper is related to the NETL project DE-FC26-08NT0005643 titled "Geomechanical Study of Bakken Formation for Improved Oil Recovery." View abstract and other project information.

May 20, 2009: The paper "Increasing the Viscosity of CO_2 to Improve EOR Performance" will be given at the 9th International Symposium on Supercritical Fluids, Bordeaux, France, May 18-20, 2009. The paper is related to the NETL project DE-FG26-04NT-15533 http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ImprovedRec/15533.htm titled "Synthesis and Evaluation of CO_2 Thickeners Designed with Molecular Modeling." View abstract and other project information.

June 9, 2009: The poster presentation "Saline Water Disposal in the Uinta Basin, Utah" will be given at the American Association of Petroleum Geologists' annual convention in Denver, CO. The paper is related to the NETL project DE-NT0005671 http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Environmental/Produced_Water/05671_UintaWaterStudy.html entitled "Water-Related Issues Affecting Conventional Oil and Gas Recovery and Potential Oil Shale Development in the Uinta Basin, Utah." View abstract and other project information.

June 28-July 1, 2009: The papers "An Alternative Tri-axial Testing System for CO_2-Rock Interaction Experiments" and "Laboratory Testing on Geomechanical Properties of Carbonate Rocks for CO_2 Sequestration" will be given at the 43rd US Rock Mechanics Symposium and 4th US-Canada Rock Mechanics Symposium in Asheville, NC, June 28–July 1, 2009. The papers are related to the NETL project DE-FC26-08NT0005643 titled "Geomechanical Study of Bakken Formation for Improved Oil Recovery." View abstract and other project information.