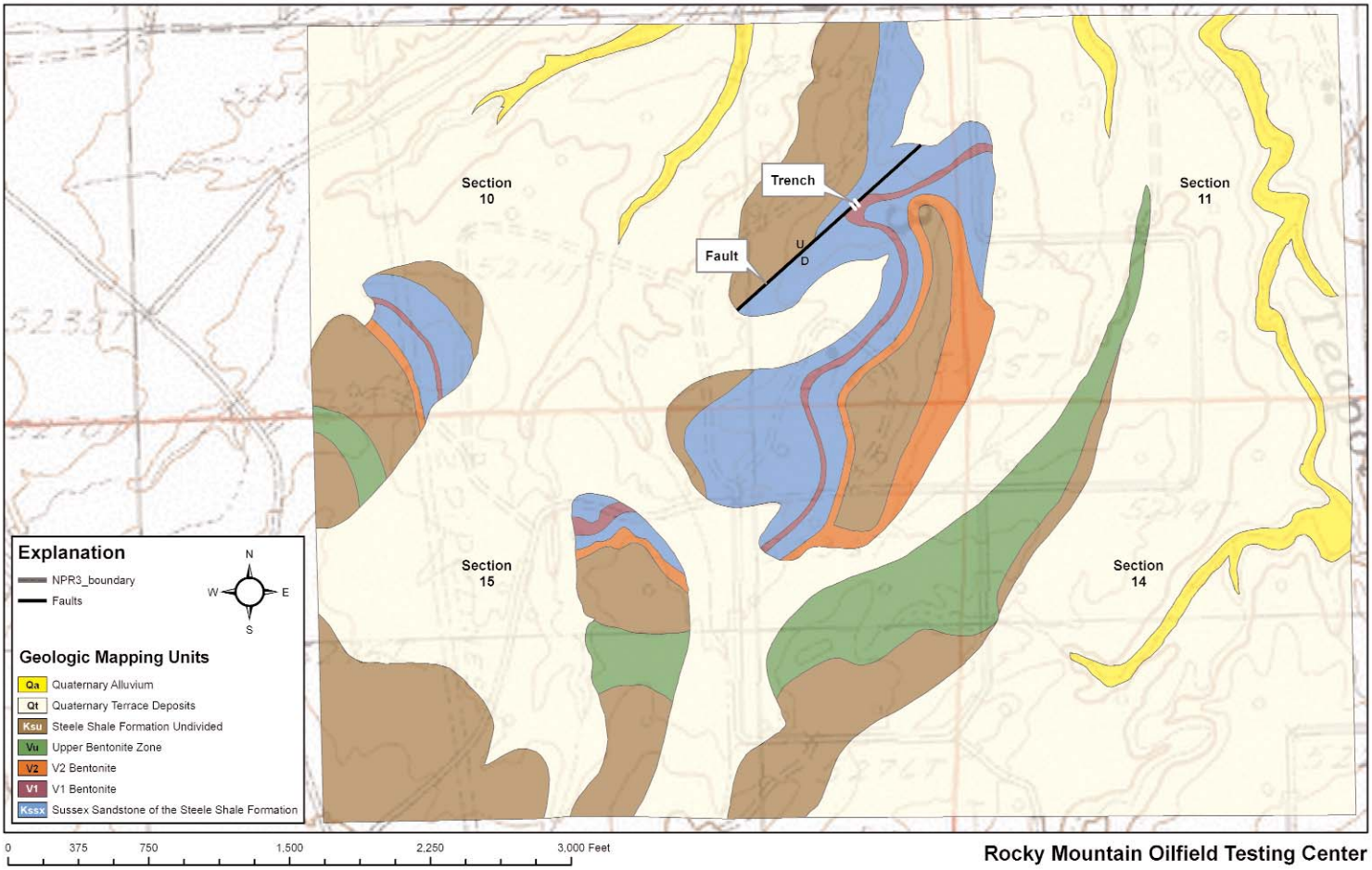
ROCKY MOUNTAIN OILFIELD TESTING CENTER

2007 SPRING NEWS

Office of Fossil Energy



Rocky Mountain Oilfield Testing Center

GEOLOGIC TRENCH STUDIES

NEW STUDY PROVIDES NEW INSIGHT ON NPR-3 FAULTS

The wall of a trench reveals a fault at NPR-3.

PROJECT LEAD: MARK MILLIKEN

In many oil fields, faults provide either pathways or barriers to fluid migration. As recently as this spring, a geology surface mapping project added new knowledge about the character, geometry, and spatial distribution of faults at Teapot Dome.

In May, Dr. Ron Klusman, a geochemist from the Colorado School of Mines, and Mark Milliken, a RMOTC geologist, began logging and sampling calcite vein filling material for Carbon 13 isotope studies. In order to study the fault, a trench was excavated obliquely across the fault outcrop. Working in the trench, they described the geologic units and interpreted structures related to faulting, fracturing, and folding. They are hoping to determine if the calcite precipitated as a result of CO_2 generated from oxidized methane sourced from deeper oil reservoirs.

In order to identify a fault on the surface, geologists first establish criteria for identification.

RMOTC partnered with the Colorado School of Mines this spring and excavated a trench to study a fault.

The primary criteria include the placement of geologic units and the presence of fracture-filling calcite. In order to identify a fault based on the placement of units, the stratigraphy of the area must be well known. At NPR-3, geologists have studied numerous measured sections that offer insight into the unique characteristics of various units. These differences are used to identify stratigraphic relationships related to fault. In addition to field mapping, studies are complemented with air photo interpretation.

At NPR-3, many fault maps have been made over the years with reliance on subsurface geologic data from wells and production performance. Although this information is important for understanding field structure, subsurface data can be greatly enhanced by incorporating surface mapping.

An understanding of faulting is essential for the proper development of a field and maximizing recoverable reserves. For enhanced oil recovery (EOR) projects, an understanding of fault character is critical to predicting sweep efficiencies and fluid movement pathways.

Kelly Walsh High School students Jenna Buffington, Elly Zimmer, Chris McAulay, Abbie Patik, and Daniel Bulfur pose for a picture at the Jefferson Memorial in Washington, D.C., while attending the National Science Bowl competition.

SCIENCE BOWL

CASPER TEAM WINS REGIONAL EVENT AND HEADS TO NATIONAL COMPETITION

In a nail-biting final few seconds, Kelly Walsh High School students reigned supreme at the RMOTC-sponsored Wyoming Regional Science Bowl in February after competing against 10 other teams. The competition came down to the final bonus question which pushed the Casper team's score over the top of the second-place team, Natrona County High School, also of Casper. After winning the competition last year, two students on the NCHS team were hoping for another stab at nationals before the upset victory. A second Kelly Walsh team took third place home.

The winning team, along with their coach Mark Hileman, won an all-expense paid trip to Washington, D.C., and a chance to compete against 66 other teams for the national title at the National Science Bowl in April. While the team didn't place at nationals, it did take home cash for the school's science department and individual savings bonds.

Sponsored by the Department of Energy (DOE) and RMOTC, the Science Bowl is the only educational and academic competition of its kind sponsored by a federal agency. DOE launched its National Science Bowl competition in 1991. The National Science Bowl's high school competition now involves more than 12,000 students nationwide.

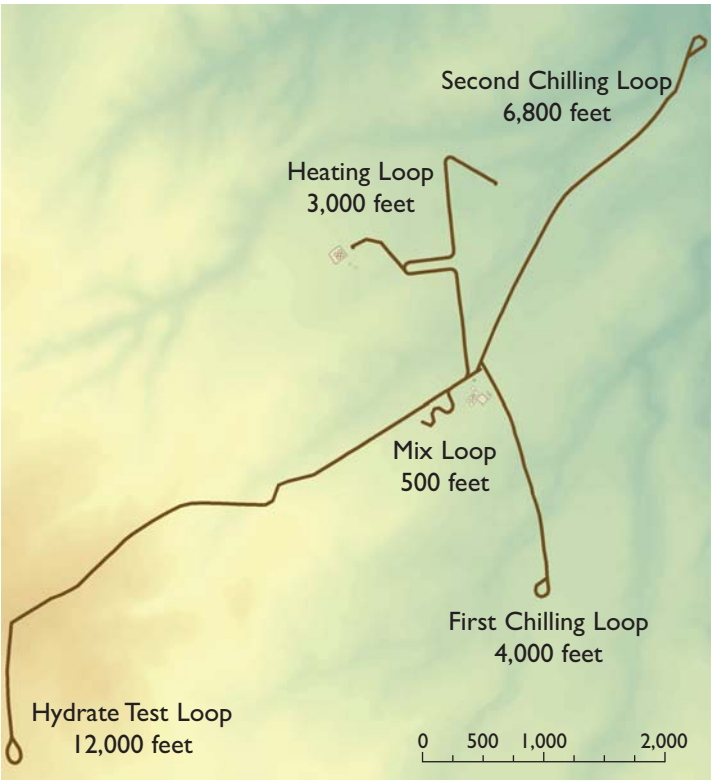
NPR-3 SIMULATES OFFSHORE SCENARIOS

PARTNERS HAVE NEW OPTIONS FOR TESTING IN SUB-SEA CONDITIONS

PROJECT LEADS: RALPH SCHULTE & KENNY COLINA

Providing a broad spectrum of testing scenarios is important for developing new technologies and RMOTC prides itself on the versatility of the facilities at NPR-3. In recent years, a flow assurance loop and large bore test well were added to the list of unique facilities RMOTC offers. Although NPR-3 is located many miles inland and bears no resemblance to an offshore environment on the surface, these facilities make it possible to test and demonstrate new offshore technologies in a simulated environment. **These versatile facilities have a broad range of testing capabilities and may be available for future development projects.**

RMOTC Flow Loop Facility Layout



Flow Loop Facility

Over a decade ago, RMOTC began cooperatively building a full-scale facility to test new flow assurance technology, mainly in the areas of hydrates and paraffins. Today, RMOTC's test facility consists of five individual loop sections, including chilling and heated pipe-in-pipe water sections, bare lines, and a mixing section.

The facility was designed to represent typical deepwater production systems in order to simulate full-scale tests and apply the results to flow assurance field applications and technology. The current facility design consists of a 6", 3,600 PSI maximum allowable operating pressure test pipeline in five separate loops. The test line begins and terminates at a manifold center located just north of the Customer Operations Center at Naval Petroleum Reserve No. 3 (NPR-3). Tests can be run in the loop without interfering with other field production activities.

Pipe-in-pipe jacketed section

Bellholes constructed with galvanized steel culvert material are

spaced along all of the lines for valving, instrumentation, and sampling access. Measuring 10' wide and 10' deep, each bellhole has heavy gauge hinged sheet metal lid.

This versatile facility has a broad range of testing capabilities and may be available for future development projects.

Large Bore Test Well Facility

RMOTC's large bore test well facility at NPR-3 is designed to test offshore technology including submersible pumps, swab equipment, plunger lift equipment, gas lift equipment, and mud drilling fluids. With this facility, RMOTC has the capability to simulate a sea-floor environment of up to 3,000 feet of water depth.

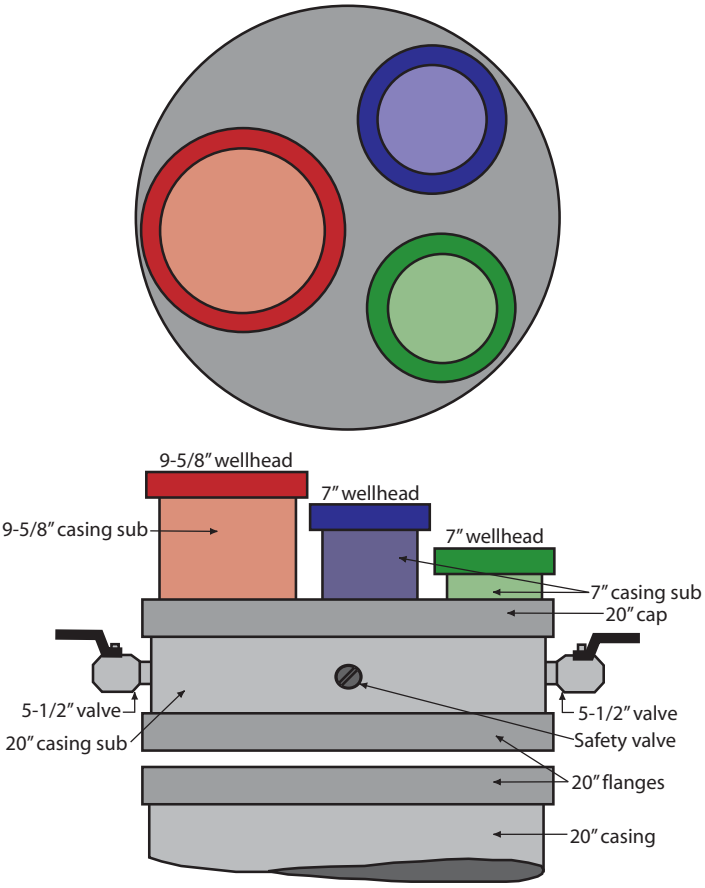
NPR-3 bears no resemblance to an offshore environment on the surface, but with the help of RMOTC and its partners, NPR-3 can be transformed to simulate an offshore environment. Testing at the facility, which is located adjacent to the water treatment plant to provide a water source and storage, could be altered to mirror sub-sea conditions worldwide. Since becoming available to test partners, the facility has simulated the environment of the Perth Basin in Australia to test a hydraulic pump.

A special wellhead was designed for the 20" casing with 5-1/2" thick flange to fit over the 198 foot hole

The large bore test well facility has a large diameter 20" casing set at 198 feet and cemented to the surface. Inside the 20" casing are two strings of 4-1/2" diameter casing and one string of 5-1/2" diameter casing. A special well head was designed by a RMOTC engineer especially for the site and pressure tested to 1,400 PSI. The 20" casing used is 94#/ft., K-55, buttress thread which has an internal pressure rating of 2,110 PSI. The well head has a 5-1/2" thick flange to fit on the 20" diameter hole. Each of the three casing strings run has its own well head. The well head is equipped with a safety valve, as well as two 5-1/2" valves on the sides. The well head flange is attached to the 198-foot hole by 20 bolts.

For this testing, it was important to simulate produced water from the reservoir in the Perth Basin where the pump would be primarily used. For the first stage, this was accomplished by adding calcium chloride. Near the start of the test, the chlorides of the power fluid was raised from 1,040 ppm found in the Tensleep supply water to 2,240 ppm in a sample taken four days after the test began. Prior to the start of the second stage of the test, sodium bicarbonate was also added to the power fluid tank. Specific measurements were developed to simulate real produced water and to minimize damage to the pump.

Wellhead (top view) for RMOTC NPR-3 67-LBT-3



The large bore test well is available for additional test partners to design a sub-sea operating environment appropriate for technology testing. In addition to the facility described, RMOTC has another large bore well with 17-1/2" casing set at 1,200 feet.

Looking Ahead

RMOTC will continue to pursue projects simulating offshore scenarios. In coming months, the facility will be utilized for lithologic calibration of an acoustic well stimulation tool.

SOLAR ENERGY

RMOTC AND PARTNER PUT WYOMING SUN TO THE TEST

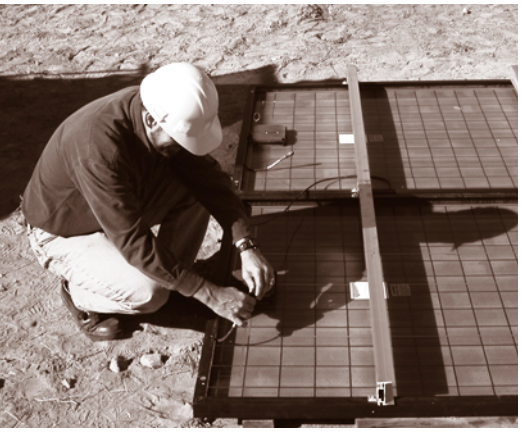
PROJECT LEAD: ROGER HALL

The use of solar power is not new to the oil industry. The renewable energy has been used for remote telemetry units, lighting, and communications, among other things in the industry. But more recently, RMOTC and DOE's National Renewable Energy Laboratory (NREL) began conducting experiments using solar panels to supply the power to a fluid transfer pump at NPR-3.

A two-kilowatt photovoltaic (PV) array was used for the production and delivery of oil. The PV system provides electricity to a shipping pump which transfers the pumped oil from an intermediate collection point to a central collection point. When the sun shines, the oil is transferred.

The system was designed to ship 30 barrels of oil every day, including in the winter. Working in an oil production environment did prove to be a challenge when it came to equipment selection. The motor and pump equipment had to be inverter-rated, explosion-proof, and compatible with the fluid being shipped. The motor also had to be compatible with commercially available solar-direct motor controllers.

The solar panels were used in conjunction with the grid to supply the needed energy. The grid fell back into a "redundant" system to assure that electrical power was available at all times. The grid-connected pump was kept as a backup, but has been only minimally needed.



Current use of solar panels is mainly used to generate electricity instead of using grid-supplied electricity. In remote areas, the solar panels replace the grid which eliminates the need to install expensive grid service equipment. Although this particular test is located in an oil field, this technology could be used in any industry that utilizes electrical power. The main drawback of this technology is that it is expensive to install and pay-out takes a long time. The cost of solar equipment has decreased more recently because of the popularity of the technology. Combined with the increased cost of grid-supplied power, solar-powered/renewable energy systems are becoming more economical and attractive to the general consumer as well as industry as a whole.

RMOTC and NREL installed solar panels to supply power to a fluid transfer pump at NPR-3.

Other Alternative Energy

In 2007, RMOTC plans to install a binary geothermal power plant to demonstrate beneficial use of high-temperature produced water. A wind turbine is also planned for late 2007.

SURFACTANT FLOOD

PARTNERS SEEK TO UNDERSTAND RESULTS OF WATERFLOODS AT NPR-3

PROJECT LEAD: LYLE JOHNSON

Having an accurate, cost-effective understanding of the effects of waterflood and steam injection practices can reduce costs of managing and directing the injected fluids used to produce oil reserves and ultimately increase revenues for the oil industry as a whole.

RMOTC recently partnered with the industry to analyze the results of waterfloods and to determine the most beneficial places to use enhanced oil recovery (EOR) processes.

In two recent RMOTC projects, testing partners hydroGEOPHYSICS Inc. (HGI) and Aflotech conducted tests using their technologies to monitor fluid movement and pressure in the Shannon Sandstone. Information obtained by these surveys can facilitate the understanding of how waterflood practices are likely to influence oil production and also provide insight as to how the reservoir may be managed and monitored to improve optimization of oil production.

hydroGEOPHYSICS Inc. (HGI)

This spring, HGI and RMOTC completed a test of HGI's patented High Resolution Resistivity (HRR) subsurface fluid monitoring technology to demonstrate the effectiveness of a non-intrusive measurement method to monitor fluid movement during a series of formation water and surfactant floods designed for EOR. The HRR method relies on contrasts in electrical properties between the host formation and that of the injected fluid, and uses existing metallic infrastructure, such as the casing of oil field wells, to monitor these changes.

The objective of this project was to demonstrate the applicability of HRR to deep subsurface problems, where the top of the sandstone formation was approximately 515 feet below ground surface. The results of the test showed that HRR was able to monitor the changes in the electrical properties during the individual injection periods as well as over the entire run of the test. In both cases, the changes were subtle due to the small electrical contrast between the electrically conductive formation and the injected solutions.

Collectively, the HRR data suggests an explanation for the poor performance of the surfactant test at NPR-3. It also indicates hydraulic characteristics of the target reservoir and offers possibilities for improving subsequent tests.

Aflotech

Aflotech installed highly sensitive pressure monitoring devices in two NPR-3 Shannon wells recently. Both wells were outside the fault block where a surfactant test was conducted. The devices monitor the downhole pressure during surfactant injection cycles. Any detection of pressure increases during the surfactant and water injection cycles indicated that the faults in the test area are non-sealing faults. This information can be used for designing future projects.

The Aflotech results found that the pressure/liquid level in the testing area was rising steadily with the pressure at the south edge high compared to the north edge of the test area. The high-pressure south area exhibited a steadier pressure build than the north area. Most of this pressure increase was attributed to the natural increase in the water level resulting from the decrease in production in the area of the testing over recent years. The injected water and surfactant did not make significant pressure impacts relative to the background pressure increase continuing during the test period.

For a full report on the tests conducted, or for more information on RMOTC's test facilities, visit www.rmotc.com.

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RMOTC BRIEFS

Three summer interns join RMOTC staff

RMOTC is once again hosting two interns through the Mickey Leland Energy Fellowship (MLEF) summer internship program. Ledell Miles of Tuskegee University joins RMOTC for the second year during his mechanical engineering internship. Adrian McCoy of Elizabeth City State University is a geology intern.

Sponsored by the Department of Energy, the program supports minority students studying in academic disciplines related to the Fossil Energy mission.

In addition to the two MLEF interns, RMOTC is also joined by a University of Wyoming civil engineering student, Eric Milliken.

World Oil features NPR-3 projects

You may have noticed a couple of articles featuring RMOTC projects in recent issues of World Oil, and you will see more in the coming months. Check out the past articles on abrasive casing treatment and the large bore test well in the February and April issues, respectively. Keep your eyes open for more features this summer and fall.

RMOTC to launch new website, changes URL

Last fall, RMOTC employees started diligently working on a new website with a new look and better navigation features.

With this new website will also come a new URL. While www.rmotc.com will still work for several months after the launch, look for RMOTC online at www.rmotc.doe.gov this summer.