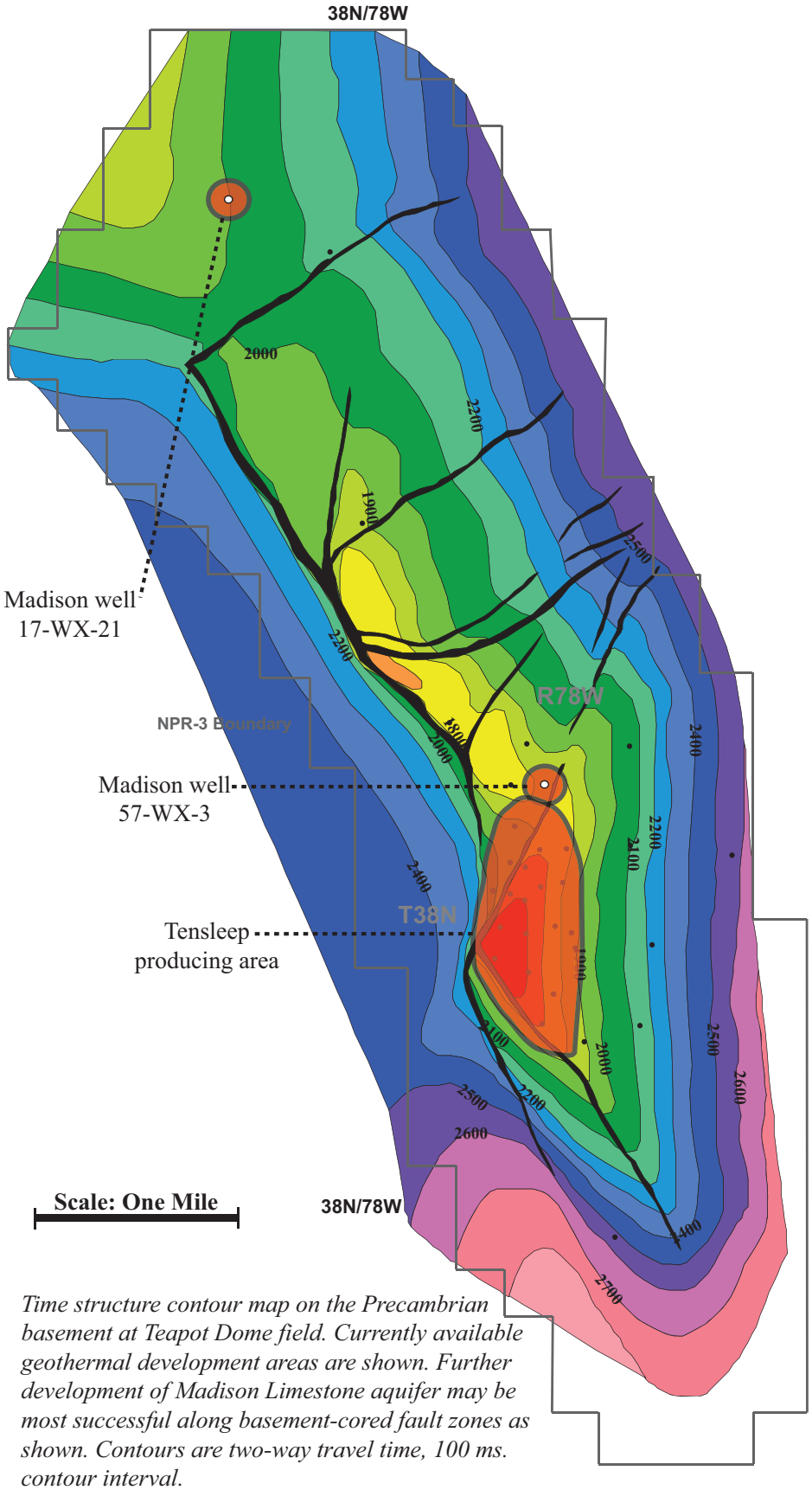
ROCKY MOUNTAIN OILFIELD TESTING CENTER

2006 FALL NEWS

Office of Fossil Energy

GEOTHERMAL

RMOTC EXPANDS GEOTHERMAL TESTING POSSIBILITIES



Time structure contour map on the Precambrian basement at Teapot Dome field. Currently available geothermal development areas are shown. Further development of Madison Limestone aquifer may be most successful along basement-cored fault zones as shown. Contours are two-way travel time, 100 ms. contour interval.

PROJECT LEAD: LYLE JOHNSON

BUSINESS DEVELOPMENT: MARK MILLIKEN

In 2006, several geothermal power production companies and the Department of Energy expressed interest in demonstrating low-temperature geothermal power projects at the Rocky Mountain Oilfield Testing Center (RMOTC). Located at Teapot Dome field in Naval Petroleum Reserve No. 3 (NPR-3), RMOTC intends to expand its testing and demonstration of power production from low-temperature co-produced oilfield geothermal waste water in 2007.

As old oil fields reach late-stage decline, the main cost affecting the economics of continuing production is the cost of electricity to power the pumps. And yet there is latent heat energy contained in the associated produced water that is lost by injection or discharge.

Initially, the new projects will use 190° F water co-produced with oil, primarily from the Tensleep Formation, at depths of about 5,200 feet. Currently, like all oil fields in Wyoming, when NPR-3's produced water is disposed of, all heat energy value is lost.

An abundance of relatively fresh, hot water (180°-200°) is produced in association with Pennsylvanian Tensleep oil. Prior to surface discharge, the water is cooled to about 60°. Water supply wells drilled to the underlying Mississippian Madison

Limestone Formation have yielded rates exceeding 20,000 BWPD on flow at formation temperatures projected to be about 230°. Artesian flow of the NPR-3 geothermal system is caused by forced convection of hot water at great depth recharged in the Big Horn Range located 90 miles to the northwest. The Big Horn recharge area represents a hydraulic head of about 8,000 vertical feet above the NPR-3 surface.

Pumping in the Madison Formation could increase water production rates by a factor of two to four. Fractured Precambrian basement granitic rocks at depths of 7,000 feet and more may yield substantially larger volumes of water at temperatures exceeding 250°.

Further development of the geothermal resource may result in production of deeper and hotter aquifer rocks below the oil-producing zones. The geothermal gradient of 25° per 1,000 feet of depth at NPR-3 is 9 percent higher than the average for the nearby Southern Powder River Basin.

Teapot Dome's geological structure is a typical northwest-trending Laramide asymmetrical drape fold, bounded on the west by a basement-involved blind thrust fault. Commercial oil production occurred in the early 1920s for a brief period, followed by a long shut-in period. NPR-3 was opened to full field development in 1976.

Representative Barbara Cubin, Senator Mike Enzi and Senator Craig Thomas begin the groundbreaking for the Center of Excellence in October.

CENTER OF EXCELLENCE

STATE LEADERS TAKE PART IN GROUNDBREAKING

RMOTC makes continued efforts to stay on the leading edge of oil field technology. The Center of Excellence has broken ground with its primary purpose being to bring together all of the known techniques and technologies that improve oil field operations to one location at NPR-3.

Representative Barbara Cubin, Senator Mike Enzi and Senator Craig Thomas joined RMOTC for the groundbreaking this fall. The Wyoming congressional delegation used gold shovels to mark the beginning of construction. The center will use existing buildings and upgrade them with new state-of-the art technology, along with a customer operations center.

"The development of better technologies is oftentimes stunted if those technologies are not tested in the field," said Enzi. "For years, RMOTC has provided a site where companies can test out new technologies in an operational environment. RMOTC takes on the production risks and the entire industry benefits when those ideas are successful."

The focus for the Center of Excellence will be on the best practices in the industry that ultimately increase recovery from U.S. reserves, specifically extending the life of stripper wells. The field will be equipped with state-of-the-art production monitoring and automation technologies which will be subsequently published while also holding workshops for operators to see the new practices.

The new operation will require close collaboration with academia, industry and state and federal government offices. It also requires working closely with organizations charged with technology transfer so that the information is properly dispersed.

Development of the center will cost between $3 million and $5 million over the next several years, with some of that being shared with companies that use RMOTC.

RMOTC'S DOWN-HOLE CAMERA GIVES 360-VIEW

While today's technology allows for more capability than ever, seeing is still better than believing. And that's where video cameras come in handy. A down-hole video camera is one of the latest advances offered at RMOTC, and proved especially useful for Blast Energy's most recent RMOTC project.

"The use of the down-hole camera was an invaluable resource for this stage of our development," said David Adams, president and co-CEO of Blast Energy Services Inc., who used the camera for a project in October and November.

The camera is primarily used to verify information, as well as to diagnose problems in well casing. But the down-hole camera also serves as a unique marketing tool both for RMOTC and its clients.

Based on RMOTC field experience, the camera has produced videos superior to those created by commercial services that typically charge $10,000 per run. Some of the camera runs are truly remarkable; down-hole features can be clearly seen, including casing walls, whipstock and milled opening in the casing wall. RMOTC will continue to select candidate wells in the field and shoot footage of collapsed casing, stuck tubing and various other down-hole scenarios. The camera is equipped with a ring of nine LED lights to illuminate the hole and is sent down the hole from a winch with about 1,600 feet of wire. It is watched through a small digital monitor and recorded for later viewing and analysis.

JET ABRASIVE TEST

BLAST ENERGY TESTS PROPRIETARY TOOL AT NPR-3

PROJECT LEAD: MATT SLEZAK

Blast Energy Services Inc. successfully completed the test of innovative new oil and gas drilling technology at RMOTC this fall. When commercialized, the new technology should facilitate lower production costs and increased access to reserves.

Blast's prototype unit, primarily a modified coil tubing unit with an abrasive mixing module, combines water and fine abrasive sand and pumps this mixture through a nozzle at up to 16,000 pounds per square inch. It is designed to cut holes, slots and windows in existing well casing. The new technology is expected to provide oil and gas producers with an alternative to existing well stimulation services at a lower cost, while having the ability to access previously uneconomical reserves by creating new access points to previously drilled reservoirs. It could also apply to new reservoirs that were previously uneconomical to access.

Abrasive cutting represents an off-the-shelf technology requiring application to drilling, rather than developing a new invention. In addition to the unique process that Blast has introduced, the tool is environmentally sound. At lower comparative costs, Blast expects the new tool will appeal to both small independent operators as well as large oil and gas companies. As cost is often a large consideration in enhancing production, the lower cost of this tool makes it feasible to enhance production

from a large potential market in North America, which would otherwise be cost prohibitive to recover.

Blast signed a Cooperative Research and Development Agreement with the U.S. Department of Energy in October. This agreement provided for Blast to test in up to five wells to evaluate its new technology. The parties plan to continue this project at the RMOTC site in the spring of 2007.

Additional improvements are required to adapt the unit to cold weather. Because the unit uses water, there were problems with cold temperatures. Blast achieved about 80 percent of the testing planned before the Wyoming winter weather season caused them to suspend operations until spring.

Benefits of Blast Energy's new jet abrasive tool:

- Increase production rate and recoverable reserves from marginal wells
- Allows stimulation of wells with acid, steam, CO_2, etc.
- Allows multi-layer application in thicker reservoir zones
- Provides an economic alternative to conventional infield drilling programs
- Provides a time-efficient and cost-effective casing milling process
- Offers an alternative to high-cost well stimulation services such as hydraulic fracturing
- Limits the time the well is out of production due to rapid jetting times

LEFT: Blast Energy's coil tubing unit is pictured.
BELOW: The Department of Energy Smeal service rig with the Blast coiled tubing unit.

LEAK DETECTION

PARTNERS TEST NEW TECHNOLOGY ON RMOTC VIRTUAL PIPELINE

PROJECT LEAD: LYLE JOHNSON

The sky above Teapot Dome became an area of interest in August and September as three different companies tested gas leak detection technologies using NPR-3's virtual pipeline. RMOTC strives to offer testing partners a location tailored to their needs and the virtual pipeline is a prime example of how this is accomplished. The simulated pipeline was previously utilized in 2003 by five testing partners who simultaneously tested different gas leak detection technologies.

On the ground, gas plant operators and maintenance workers set up simulated leaks using tanks filled with various gases or by tying into the field gas system. The type of gas leaked depended upon the needs of the partners. Workers were required to travel to numerous locations to manually open and close valves in preparation for and following specific phases of the tests. The tests require multiple flyovers and most extended into several days.

The full route of the virtual pipeline was marked and extended the full length of the nine-mile field. Full sheets of plywood painted with fluorescent arrows were used to keep the detection teams on the right route. Actual leaks were not marked on the route.

There were 15 separate sites and three different types of leaks: above ground, underground and lateral. Both high-volume and low-volume leaks were used, with the rates being varied from day to day. Each leak site required constant supervision to assure that the leakage rates were consistent and maintained at the required rates. RMOTC workers turned the leaks on early so they had enough time to allow the gas to collect in a plume.

In early August, the University of California at Santa Cruz conducted calibration testing for one day using two fixed-wing aircraft. Flights were at heights ranging from 300 to 3,000 feet testing two separate monitoring systems. The gases of interest for this partner were methane for the first system and a combination of methane and CO_2 for the second system. It was the first test-run of this particular equipment.

Aviation Technology Services and Pergam took to the air with a different aircraft in September – each secured a helicopter for their tests. Over a four-day period, the two helicopters flew in a pattern that covered the entire field searching for methane leaks. The equipment was designed to identify both the location and the size of the leaks. Partners were given the location of two leaks for calibration purposes, but the location and magnitude of the remaining leaks were not revealed to them until they analyzed and reported their findings.

The only complication reported during both testing periods was wind related. Welcome to Wyoming.

Over a four-day period in September, two helicopters flew in a pattern covering the entire field searching for methane leaks.

DUAL-ACTION PUMP

RMOTC PARTNER HOPES TO INCREASE WELL PRODUCTION BY 80 PERCENT

PROJECT LEAD: KENNY COLINA

Coil Tubing Americas with Trican coil tubing capability began testing of a coiled tubing dual-action pump at NPR-3 this fall. The pump is expected to produce 50 to 80 percent more fluid than traditional pumping.

The system consists of a unique down-hole plunger pump capable of pumping oil and water on both the upstroke and the downstroke.

By making full use of the entire pumping cycle, this system can produce up to 80 percent more fluid on each stroke.

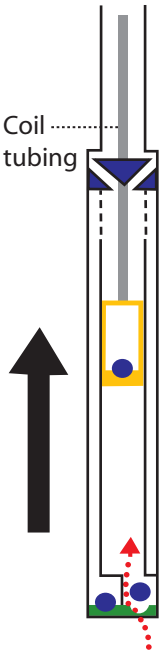
Previous testing of the pump was not done with coiled tubing. The coiled tubing acts as a sucker rod string, moving the plunger up and down. On the upstroke, fluid is produced similar to how oil is produced with sucker rods. But on the downstroke, fluids are lifted to the surface through the coiled tubing.

The principal market for this new technology will be wells on secondary recovery because of the large volume of water that has to be lifted to produce oil. If successful, the pump will be a less expensive alternative to electro-submersible pumps.

In addition to greater production efficiency, the pumping system also presents other distinct advantages including:

- Higher production rates given the same pumping speed
- Decreased rod loading and speed and reduced tubing wear
- Slower rates lead to down-hole efficiencies and optimization of the pump
- Attaches to any surface pumping unit

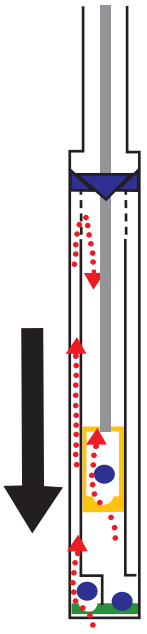
HOW IT WORKS



On the upstroke ...

1. The inside standing valve opens allowing fluid to load in the bottom chamber of the pump.

2. The outside standing valve is seated preventing fluids from exiting the bottom of the pump.

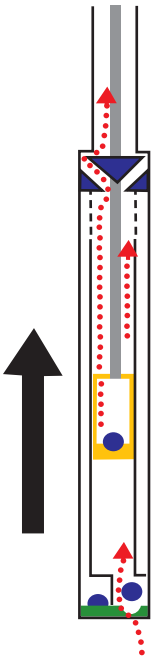


On the downstroke ...

1. The inside traveling valve closes allowing fluid to enter the upper chamber of the pump.

2. The plunger traveling valve opens allowing fluid to be transferred from the bottom chamber to inside the coil tubing.

3. The outside standing valve opens allowing fluid to enter the top chamber of the pump.



On the upstroke ...

1. The plunger traveling valve closes lifting the production from the top chamber.

2. The floating valve (ring valve) opens allowing fluid to enter the annulus between the coil tubing and production tubing.

3. The inside standing valve opens allowing fluid to enter the lower chamber of the pump.

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Oilfield

Testing

Center

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RMOTC BRIEFS

RMOTC receives new mapping software

Scientific Computer Applications, Inc. has agreed to donate its unique mapping software to RMOTC. Mapping-Contouring System (MCS) is a multi-surface geological/geophysical modeling system that can be applied to many tasks including geological, geophysical, environmental and mining.

MCS can contour up to 125 surfaces simultaneously. The system also does an automatic 3-D time-to-depth conversion using all seismic and geologic data. It honors every data point and maps actually look hand-contoured. It has the capability to interface with several other programs including Landmark, GeoQuest, GeoGraphix and others.

Annual DOE-sponsored Science Bowl set for Feb. 3

The Department of Energy-sponsored Wyoming Regional Science Bowl will take place Feb. 3 in Casper. Several RMOTC employees will spend their time assisting with registration, timekeeping, and other basic functions of the competition.

The Science Bowl is a team competition consisting of four student members, one alternate student member and one coach. The teams compete in timed rounds of multiple choice and short answer questions in several scientific disciplines.

The top three teams receive money for their clubs. There are also awards for sportsmanship and individual savings bonds for the top three team members. The team who places first in the regional bowl will receive an all-expense paid trip to the National Science Bowl in Washington, D.C., April 26-30.