Information in Support of Rocky Mountain Oilfield Testing Center as a Demonstration Site for Microhole Technology Development

Background

The Rocky Mountain Oilfield Testing Center (RMOTC) administers the only stripper oil field currently owned by the U. S. government, and operated by the Department of Energy. Known as the National Petroleum Reserve No. 3 (NPR-3), it includes 10,000 surface acres of federally managed lands, significant oil and gas infrastructure and hundreds of existing wells at the southern end of the Powder River Basin in Wyoming. The field itself contains nine stratigraphic units that bear oil, and at least six that bear water from depths of 500 to 8,000 ft.

As reported by Friedmann et. al. 2003, the field contains over 1,200 wells, with a range of logs, cores, 3D seismic, production data, and reservoir analyses which serve as the primary data set. Proved reserves include 89 million barrels of oil and 0.5 billion cubic feet of gas. The field also has over 80 years of production data, including the results from steam and water floods and a recently acquired 3D seismic survey. As such, RMOTC's NPR-3 provides a high-resolution, stable platform for long term experiments (7-10 years) as well as high-risk experiments and novel approaches. It includes both siliciclastic and carbonate reservoirs, and a wide range of depositional systems including eolian, fluvial, tidal, deltaic, and shoreface units, some with significant fracture permeability. Hence, the field provides an astonishing geological geophysical and geochemical range – by far the largest of any comparable experimental facility. The exceptional knowledge of reservoir geometry, chemistry, and petrophysics improves the reliability and calibration of different methods and allows for direct validation.

For the above reasons, RMOTC is offering to serve as a team member, with NPR-3 as a demonstration site, to potential testing partners responding to solicitation No. DE-PS26-03NT15392-0, Microhole Technology Development, issued September 30, 2003, by the National Energy Technology Laboratory. RMOTC experience with Microhole technology and related programs are summarized below.

RMOTC Microhole Technology Experience

One advantage that RMOTC can offer to potential teaming partners is that we have a staff with significant experience – present, past, and future – with the testing and demonstration of microhole drilling technologies. That experience is briefly summarized below.

1. Work to Date with Los Alamos National Laboratory (LANL). This work was done in association with the scientists who initially advanced the concept for drilling deep, small holes with diameters from 2-3/8-in. to 1-3/8-in. for exploration holes, for reservoir monitoring, and for production of shallow- and medium-depth low-productivity reservoirs. That concept is the underlying basis for the technology development

"roadmap" presented as background information with the NETL procurement (Albright et. al. undated).

RMOTC supported and enhanced the first successful drilling demonstration of Microhole technology as conceived by LANL. The first well was drilled at RMOTC in the fall of 2003. The well was successfully drilled, casing run, and cemented to surface. In addition, RMOTC has recently perforated the wellbore with our commercial partners.

RMOTC was able to supply oilfield equipment, such as a workover rig, to complete the wellbore successfully to 500 feet. Our field personnel assisted in the operation. In addition, our commercial contacts with local oilfield service companies ensured a successful cementing operation. In addition, RMOTC worked closely with Black Warrior Wireline to select the proper perforating equipment and procedure for the small diameter casing. The well was successfully perforated in December, 2003.

RMOTC has also worked closely with Halliburton to design a fracture stimulation operation that should be successful in establishing production from the MicroHole. The Microhole will be produced using techniques developed at RMOTC previously for other slim hole situations. These techniques are somewhat unique in the oilfield and were developed from fifteen years of Enhanced Oil Recovery (EOR) projects at NPR-3.

2. Work to Date Testing High-Pressure Jet Assisted Drilling System for Maurer Technology, Inc.

RMOTC is in the process of developing a high-pressure, coiled tubing drilling test (10,000 psi) for Maurer Technology as funded by National Energy Technology Laboratory (NETL). RMOTC's drilling rig (DOE #2) will be completely retrofitted with high pressure equipment to accomplish this unique drilling test. RMOTC was able to identify, early in the process, the necessary equipment and vendors to accomplish the test.

RMOTC has purchased the individual equipment items, including an advanced mud pump system, and is preparing to convert the rig in January of 2004, and complete the high pressure drilling test. Previous testing of the drilling technology at other sites was plagued by equipment and operational inadequacies. RMOTC expects to correct these and complete a successful test.

3. Additional Work Planned with LANL.

Based on the knowledge and experience gained at RMOTC, LANL is proposing to perform additional MicroHole drilling at NPR-3. Current plans include completing a second MicroHole in the Shannon formation at 500 feet. In addition, three or more fractured Shale wells may be drilled up to a depth of 3000 feet. RMOTC has agreed to support next year's program with field and engineering support, existing wellbores, and our commercial contacts.

Due to a large number of existing wellbores and extensive production history, RMOTC is able to identify viable options for further field development of the MicroHole technology. RMOTC is offering to abandon wellbores, if necessary, and convert the wellbores into suitable wellbores for further MicroHole drilling. The field has known producing horizons from a few hundred feet in depth (Shannon) to the Tensleep at thousands of feet in depth (~5,500 ft) with additional targets in between. With this depth coverage, RMOTC can help to incrementally advance the MicroHole drilling technology.

Related RMOTC Experience and Programs

National Test Center for Geological Carbon Storage

A new, experimental, national geological carbon storage test center, has been established to focus on a suite of geoscience approaches aimed at maximizing carbon storage and reducing risk of CO_2 leakage. The test center, announced this October, will serve as a flagship national and international facility to conduct field experiments within a well understood geological framework. (Friedmann et. al. 2003).

As noted, in the NETL solicitation, "The wells [used for field demonstrations] may be new or reentries and used for exploration or production. The wells may also be used for downhole seismic data gathering with geophones or Vertical Seismic Profiling [VSP]." The application and use of VSP is being proposed as a part of the geological carbon storage test center research program by Ernest Majer of the Lawrence Berkeley National Laboratory. Mr. Majer is currently soliciting the involvement of a wide range of industrial partners in the further development and application of VSP technology including (1) micro-miniaturization of sensors, (2) improved analysis and processing methods and (3) improved understanding of seismic wave propagation in complex media. It is suggested that combining the micro-drilling RD&D called for in the NETL solicitation with VSP technology research proposed for the Carbon Storage Test Center could solve one of the greatest obstacles to extracting more oil and gas our of the ground, i.e., how one scales information from the core/well log scale to the reservoir scale. Scientists at Lawrence Berkeley Laboratory argue cheap access to the subsurface through micro-drilling technology could thus become the most significant advance for the energy industry in the last 50 years.

Academic institutions participating in the NPR-3 Test Center include the University of Wyoming, Colorado School of Mines, the University of Maryland, and five National Laboratories, including in addition to Lawrence Berkeley, Lawrence Livermore, Idaho National Engineering and Environment Lab, Los Alamos, and Sandia. Partnered companies include Anadarko Petroleum Company and iReservoir.com. Any or all of these institutions have intimate knowledge of NPR-3 and may be available to assist in the development of micro-hole technologies under the NETL solicitation. For example, Dr. Ken Dueker of the University of Wyoming, one of the reigning experts in geological sensing technologices, is interested in working with others in the following areas:

1. cross-borehole tomographic imaging to monitor flood front, crack density, and oil/brine saturation levels (using Vp, Vs, and SV/SH anisotropy imaging),
2. fracture activation (shear and opening) via real-time earthquake monitoring, and

3. setting up telemetry for real-time data transmission and processing to UW, with data cloning in real time to other interested parties, as well.

Complex Well Technology Testing Facility

In addition to the above, if the energy bill currently under consideration by Congress should pass, the following language in the bill directs the establishment of yet another research technology at RMOTC that has a high potential for micro-hole technology applications:

> *The Secretary* [of the Department of Energy] *in coordination with industry leaders in extended research drilling technology, shall establish a Complex Well Technology Testing Facility at the Rocky Mountain Oilfield Testing Center to increase the range of extended drilling technologies.* (Section 936 of the Energy Policy Act of 2003)

References Cited

S. Julio Friedmann; Nummedal, Dag; and Stamp, Vicki. November, 2003. "Carbon Storage Experimental Facility: The Teapot Dome [NPR-3] Test Center." International Energy Agency. Greenhouse Issues Newsletter. Issue 69: p. 4-5.

Jim Albright; Don Dreesen, Dave Anderson, and Jim Blacic; Los Alamos National Laboratory; Jim Thomson, Lithos Associates; and Tom Fairbanks, Nambe Geophysical, Inc. Undated. Road Map for a 5,000-ft Microborehole.