Microholes for Designer Seismic in Support of CO_2 EOR

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Goal

The primary goal is to show that microholes provide downhole access at significantly lower cost than conventional wells and provide superior acoustic performance when compared with the use of temporarily converted production or injection wells. A secondary goal of the project is to evaluate new prototypes of commercial drilling equipment. The Los Alamos National Laboratory microdrilling rig serves as a platform to evaluate commercial technology that is suitable for microdrilling and completion service.

Performers

Los Alamos National Laboratory (LANL)
Los Alamos, NM

Lawrence Berkeley National Laboratory (LBNL) Berkeley, CA

Rocky Mountain Oilfield Testing Center (RMOTC) Casper, WY

Dennis Tool Company
Houston, TX

Quality Tubing
Houston, TX

Results

Researchers have demonstrated the technical feasibility of microdrilling 1¾-2⅝-inch holes to depths of as much as 1,310 feet using coiled tubing-deployed drilling assemblies consisting of PDC (polycrystalline diamond compact) bits and PDM (positive displacement) motors.

Field demonstrations have been conducted at RMOTC's Teapot Dome oilfield at the Naval Petroleum Reserve No. 3 in Central Wyoming using a prototype coiled tubing unit, an off-the-shelf drilling-mud cleaning unit, and a surplus shallow-well cementing unit to simulate a highly mobile, self-contained, microhole drilling system. These have been adapted by the LANL drilling team to support microdrilling operations and optimize drilling performance using off-the-shelf components that in many cases were not designed for—nor well suited for—openhole drilling service.

LANL microdrilling at the RMOTC-operated Teapot Dome Field at NPR No. 3. The microdrilling rig includes the coiled tubing drilling unit on the right, mud cleaning system on the left, and the RMOTC drilling water truck in the center.

Benefits

Micro-instrumentation holes potentially could cost as little as a quarter to a tenth that of conventional boreholes. Successful demonstration of a nonmetallic casing such as PVC line pipe may reduce acoustic noise and improve the performance of micro-instrumentation holes dedicated to reservoir-monitoring service. Successful demonstration of prototype drilling and completion equipment on a microdrilling system may accelerate commercialization of new products.

Background

Providers of geophysical data to the oil and gas industries seek low-cost access to the subsurface for the emplacement of seismic instrumentation for a variety of purposes. LANL's experience with seismic data acquisition in oil fields indicates that low-cost, dedicated microholes for deployment of seismic sensors are needed to enhance acoustic data monitoring of the subsurface. Dedicated data aqusition holes provide reduced natural surface and cultural noise, reduced or eliminated seismic-signal travel paths through highly attenuating surface layers, and a greatly improved signal-to-noise ratio.

Accordingly, microholes promise a low-cost alternative to conventional wells; they can be placed in the desired location and designed for optimal acquisition of seismic data.

Summary

Project researchers are demonstrating the technical and economic feasibility of developing a highly mobile, self-contained, microhole drilling system for seismic data acquisition and other applications. Using prototype systems to simulate the concept microhole drilling system, LANL has drilled and completed six microwells at the RMOTC Teapot Dome field:

- A 500-foot microhole to demonstrate the feasibility of oil production.

- Four 800-foot microinstrumention holes completed with either PVC or steel tubing to emplace the retrievable microgeophone arrays. LBNL's early results indicate that the PVC-completed microwells may produce higher-quality seismic data than similar steel completions.

- A 1,310-foot microinstrumention hole completed with steel tubing. This hole was drilled after the LANL drilling system was adapted successfully to support deeper, high-performance drilling.

The LANL coiled tubing unit was reconfigured in 2005 to increase capability of the prototype system to support the use of high-performance drilling assemblies and increase the maximum drilling depth:

- The maximum drilling fluid pressure was increased from 2,000 psi to 5,000 psi. A rental high-pressure mud pump is presently required for operating pressures above 2,000 psi and pump rates in excess of 30 gpm.

- The coiled tubing reel was modified to increase the maximum drilling depth from

800 feet to 1,500 feet by reducing the core diameter of the reel.

LANL is evaluating commercial equipment with the potential to enhance the performance of microdrilling. Two demonstrations are ongoing with good early results:

• Quality Tubing Inc.'s QT16Cr80 stainless steel coiled tubing as a drill stem for microdrilling.

• Dennis Tool Company's low-torque, low weight-on-bit drilling assembly.

Current Status (December 2005)

The LANL drilling team has completed drilling a four-microinstrumentation-hole pattern to field LBNL microseismic arrays at Teapot Dome field. During the three year, six-well demonstration at RMOTC, LANL has demonstrated that the microdrilling capability developed in earlier DOE projects could be adapted to a shallow oilfield drilling environment. With RMOTC support, researchers adapted their drilling equipment and procedures to drill and complete microholes that meet the field operators' and local regulatory requirements. They presently are preparing to deploy to—as yet undetermined—CO_2 EOR sites that very likely will require more adaptations of the microdrilling systems to operate in new drilling conditions and possibly different regulatory requirements.

This project has completed the early stage demonstrations. The research effort to demonstrate the applications will begin in the new project FWP 03FE06-6.

Funding

This project was funded through the Department of Energy's Natural Gas and Oil Technology Partnership Program.

David Anderson (left) and Mike Fehler (right), LANL Geophysics Group Technician and Group Leader, respectively, on a Teapot Dome microwell drilling location with the LANL coiled tubing unit in the immediate background and the blue mud-cleaning unit behind the coiled tubing unit. The blowout preventer equipment on the micro wellhead in the right center is covered with a white hardhat to keep junk out of the hole before the next drilling assembly is assembled and run.

Publications

Thomson, J.C., and Dreesen, D.S., Microdrilling Field Tests at RMOTC in 2004, (LA-UR-04-8578), 2004.

Thomson, J. C., Demonstration of Microholes for Oil Production and Emplacement of Subsurface Seismic Instrumentation, (LA-UR-04-8578), 2004.

Thomson, J. C., and Dreesen, D.S., Summary of Microdrilling Operations—2003, (LA-UR-04-1904), 2004.

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Performer Contribution: $0

Contact Information

NETL – Paul West (paul.west@netl.doe.gov or 918-699-2035)
LANL – Donald Dressen (dressen@lanl.gov or 505-667-1913)