SAND--92-0673C
DE92 017425

OVERVIEW - HARD ROCK PENETRATION

James C. Dunn
Sandia National Laboratories
Albuquerque, New Mexico

ABSTRACT

The Hard Rock Penetration program is developing technology to reduce the costs of drilling and completing geothermal wells. Current projects include: lost circulation control, rock penetration mechanics, instrumentation, and industry/DOE cost shared projects of the Geothermal Drilling Organization. Last year, a number of accomplishments were achieved in each of these areas.

A new flow meter being developed to accurately measure drilling fluid outflow was tested extensively during Long Valley drilling. Results show that this meter is rugged, reliable, and can provide useful measurements of small differences in fluid inflow and outflow rates. By providing early indications of fluid gain or loss, improved control of blow-out and lost circulation problems during geothermal drilling can be expected. In the area of downhole tools for lost circulation control, the concept of a downhole injector for injecting a two-component, fast-setting cementitious mud was developed. DOE filed a patent application for this concept during FY 91.

The design criteria for a high-temperature potassium, uranium, thorium logging tool featuring a downhole data storage computer were established, and a request for proposals was submitted to tool development companies. The fundamental theory of acoustic telemetry in drill strings was significantly advanced through field experimentation and analysis. A new understanding of energy loss mechanisms was developed.

PROGRAM SUMMARY

Major accomplishments during the past year have occurred in the task areas of lost circulation control, instrumentation, acoustic telemetry, and geothermal drilling system studies. Dave Glowka will describe the lost circulation task and show important results of the effort to develop a fluid flow meter to accurately measure drilling fluid outflow rates. Peter Lysne will describe our current instrumentation project based primarily upon development of downhole memory tools for application in high-temperature geothermal wells. Doug Drumheller will review the status of our Acoustic Telemetry project, describe newly discovered attenuation mechanisms, and outline upcoming full-scale tests. I will briefly review our geothermal drilling system study and recent plans for addressing problems associated with installing heat exchanger systems for geothermal heat pumps. Following this, I will describe plans that Jim Combs and I have developed in conjunction with many of the attendees here today for Slimhole Drilling for Geothermal Exploration and Reservoir Assessment.

The geothermal drilling system study was carried out over the past year by Ken Pierce of Sandia working with Bill Livesay and obtaining important information and drilling data from many industry groups. Results of this study are being finalized and will be published in a report this year. The bottom line conclusions are not surprising. Three high priority areas are identified: (1) lost circulation and cementing, (2) high-temperature tools and instrumentation, and (3) slimhole drilling. Several additional areas are also identified as important for reducing costs. Included are: development of expert systems, materials to reduce corrosion and scale build-up, fishing-related problems, and the need for improved information access and transfer.

Currently, loop installation cost for geothermal heat pumps are on the order of $5,000 per residence and this high cost limits market penetration. Traditional installation methods utilize trenching or drilled vertical holes. There is a need for more innovative methods to reduce costs or environmental impact. Techniques such as directional horizontal boring or coiled pipe installation are being developed by the industry. Other ideas based on the use of small mining-type drills have been proposed. Sandia recently teamed with the National Rural Electric Coop Association (NRECA) to investigate possible improvements in loop installation methods. Phase I of this effort will evaluate existing small drilling systems that could be used for loop installation. A report of this evaluation will be published describing

DISCLAIMER

DISCLAIMER

existing hardware, modifications needed, and estimated installation costs. Phase II will select one or two promising small drilling systems, make required modifications, test in a known test range, and then conduct real installations at NRECA sites.

The industry panel that reviews Sandia's Hard Rock Penetration program recommended in 1989 that work be initiated in slimhole drilling for geothermal exploration and reservoir assessment. Several proposals were put together since this time to define a slimhole project. Now it appears there is an excellent opportunity to initiate this work in a cooperative DOE/industry program that will also support development of geothermal energy in the Pacific Northwest to meet utility needs.

The goal of the geothermal slimhole program is to expand the proven geothermal reserves of the U. S. by working in user-coupled partnerships with utilities and geothermal operators to develop a cost-effective exploration and reservoir assessment technique. The benefits of such a program are based on the fact that geothermal energy is an environmentally benign, indigenous, alternative energy resource with an estimated capacity in the U. S. of 72,000 to 127,000 MWe. The geothermal resource that can be developed in the Pacific Northwest has been conservatively estimated as 5,000 MWe. Development of this resource, however, is limited by high costs of exploration and reservoir assessment. Slimhole drilling has the potential to reduce these costs by 50%.

The significant geothermal potential of the Pacific Northwest has been recognized for many years. Now there is strong utility interest in developing this alternative energy resource. Recently, the Northwest Power Planning Council predicted power shortages in the 1990s of several hundred megawatts. Several forecast scenarios were developed to guide planning to cover the shortages. In each of these plans, geothermal is identified as a cost-effective near-term resource with an important role in meeting future power needs. In fact, utilities such as Puget Sound Power and Light Company own geothermal rights in the northwest. Bonneville Power Administration (BPA) and the utilities will implement geothermal development with power sales contracts.

In developing geothermal power sales contracts, BPA selected three demonstration projects at three separate locations. The locations and geothermal operators selected are:

Medicine Lake, CA	-- Unocal Geothermal
Newberry, OR	-- California Energy Company
Vale, OR	-- Trans Pacific Geothermal

Projects must be developed in partnership between local utilities and geothermal developers. Each project will initially be 10 to 30 MWe, however, the development team must demonstrate a reservoir potential of 100 MWe to qualify for the lucrative power sales prices.

The Pacific Northwest is primarily situated in the Cascade Province which is dominated by fractured, igneous rock types. Drilling of conventional rotary-type boreholes to explore for geothermal reservoirs is very expensive in these formations because of severe loss circulation problems. Slimhole drilling has the potential to reduce drilling costs in this environment by at least 50%. Slimhole drilling for oil and gas exploration has been shown to reduce costs ranging from 25% to 75%. The much smaller scale operation is a major factor in reducing costs as well as reducing environmental impact.

The technology needs for geothermal application of slimhole drilling lie in three areas: (1) Proof of concept experiments to determine if sufficient reservoir data can be obtained from slimholes, (2) development of reservoir evaluation techniques to optimize use of slimholes, and (3) slimhole drilling technology development to optimize current hardware and techniques for the geothermal environment. First, to evaluate the concept, Japanese slimhole test data will be reviewed and documented. Then, slimholes will be drilled and tested at several locations where reservoir parameters are known from large hole flow tests. This slimhole drilling and reservoir testing phase will be cost shared with industry. The potential user-coupled industry partners include: Bonneville Power Administration, Eugene Water and Electric Board, Portland General Electric, Pacific Power and Light Company, Puget Sound Power and Light Company, Idaho Power Company, Unocal Geothermal Division, California Energy Company, Trans Pacific Geothermal Corporation, Magma Power Company, OESI Power Corporation, and Oxbow Geothermal Corporation. The potential cost-shared proof of concept projects identified at this point are shown in the following Table.

Cost-Shared Proof of Concept Projects

Location	Industry Partner	Cost Sharing: DOE	Cost Sharing: Industry	Est. Budget ($): DOE	Est. Budget ($): Industry
Coso, CA	California Energy	8000 ft Corehole Wellbore Measurements Reservoir Testing	8000 ft Production Well Well & Interference Tests Proprietary Reservoir Data	2 M	3.5 M
Roosevelt, UT	California Energy	8000 ft Corehole Wellbore Measurements Reservoir Testing	8000 ft Production Well Well & Interference Tests Proprietary Reservoir Data	2 M	3.5 M
Philippines	Unocal Geothermal	Corehole Testing Downhole Measurements	6500 ft Corehole Well & Interference Tests Proprietary Reservoir Data	400 K	2 M
Imperial Valley, CA	Unocal Geothermal	5000 ft Corehole Downhole Measurements Reservoir Testing	Drilling Management Well & Interference Tests Proprietary Reservoir Data	2 M	500 K
Medicine Lake, CA	Unocal Geothermal	Corehole Testing Downhole Measurements	Well & Interference Tests Proprietary Well Test Data	200 K	200 K
Surprise Valley, CA	Trans Pacific Geothermal	Corehole Testing Downhole Measurements Well & Interference Tests	3500 ft Corehole Proprietary Exploration Data Proprietary Well Test Data	400 K	800 K
Vale, OR	Trans Pacific Geothermal	4000 ft Corehole Downhole Measurements Reservoir Testing	4000 ft Production Well Well & Interference Tests Proprietary Exploration Data	1.2 M	1.9 M

GT-034-2