THE DESIGN OF A WATER JET DRILL FOR DEVELOPMENT OF GEOTHERMAL RESOURCES

Progress Report

for Period October 1, 1976 - December 1, 1976

David A. Summers and Terry F. Lehnhoff

Rock Mechanics & Explosives Research Center
University of Missouri - Rolla
Rolla, Missouri 65401

December 1976

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Prepared for

The U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

under CONTRACT No. EY 76 S 02 2677.000

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness or any information, apparatus, product or process disclosed or represents that its use would not infringe privately owned rights.

MASTERDISTRIBUTION OF THIS DOCUMENT IS UNLIMITED *eb*

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

The program at UMR is developing along three separate avenues in considering the application of water jets to deep hole drilling for Geothermal Resources. Following the seminar held on deep drilling by Maurer Associates, the emphasis of the program has been slightly changed to reflect a more immediate application orientation for the program. This has not changed the objectives of the program as outlined in the scope statement, but has changed the manner in which these will be carried out.

The first line of research is in parametrizing the design of water jet nozzles to drill in varying rock types, to determine the most effective drilling combination of nozzle pressure and diameters and to combine these with a mechanical roller breaker in order to drill larger diameter holes. It is this system which will be developed to drill to 200 ft rather, as in the original proposal, drilling to this depth with a one inch diameter nozzle system.

The second line of research is into the mechanical components which will be required to develop such a hybrid water jet and mechanical roller system. The study will concentrate on the necessary modifications to the drill head, the pipe couplings and the mounting and drive at the surface.

The third program deals with cavitating the jet flow and will examine three facets of this program: (a) the rock response to cavitation attack, (b) the focal distance from the nozzle at which cavitation damage is most severe, as a function of jet pressure and nozzle diameter and, (c) the design of the nozzle which will be most effective in inducing cavitation. The program is moving towards a

more direct involvement with industry. We are working with Mr. Evans of Smith Tool on the development of the nozzle drilling bit. As for the cavitation, we intend examining the effect of just inserting a probe in the throat of a conventional jet bit nozzle and determining what effect this has on rock cutting ability.

Because of delays in getting equipment and the need for large experimental times for development of some of the information, we will request a further year of funding to continue under the current scope of work, however this scope will be changed in that we will be working with six inches rather than one inch diameter drilling.

Research in drilling, to date, has had two identifiable benefits, Flow Research Inc., of Seattle, are using the nozzle design already developed on this contract in work being carried out for the US Bureau of Mines as a high speed drill for roof bolt emplacement. Secondly, St. Joe Lead Company is currently seriously interested in a demonstration and possible development program to solve the severe problems that they are encountering in the Lead Belt of Missouri.

Program Elements Contract Ell-1-2749

Drilling for
Geothermal
Resources

Effects of Nozzle
& Rock Parameters

Design of
Components

Utilization of
Cavitation

Effect of
Pressure,
Nozzle
Diameters, 1
Rotation Speed,
Nozzle Angles

Effect of
Rock
Properties
(strength,
structure)

Effect of
Varying
Rock
Geology
the presence
of bedding
and joint
planes

Behavior of
Rock Under
Cavitation
Attack

Environmental
Controls (hole
pressure, fluid
content) on
cavitation
behavior

Design
of an
Effective
Cavitating
Nozzle

Development of
A Combined Jet/
Mechanical Drill
Bit

Development of
of a Field
Drilling Unit

Development of
Components for
Deep Hole Drilling