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

Progress Report
for Period June 1, 1976 - August 1, 1976

David A. Summers and Dwight J. Bushnell

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

August 1976

Prepared For
THE U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
UNDER CONTRACT NO. E(11-1)-2677

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.

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.

MASTER

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.

Introduction

During the first two months of the second year of this contract research has concentrated on two areas: firstly, the laboratory testing of harder rock material such as granite and limestone, and secondly, the development of the field testing equipment and its preliminary proof-testing in the field.

Laboratory Tests

Tests have been carried out on four rocks: Berea sandstone, Indiana limestone, Tennessee marble, and Missouri granite. The tests have been carried out under simulated down-hole conditions, as tests in the same manner have been previously described (Report C00-2677-2). Confining pressures on the rock samples have been increased from 0 to 6,000 psi, and back pressures in the borehole and the pressure range from 0 to 2,000 psi have been supplied. In both cases, the increase in pressure decreases the diameter of the hole which is cut by the jet. The effect is, however, reduced with a stronger rock. For example, application of 500 psi borehole pressure to the sandstone will decrease the hole diameter 44 percent, from 2.25 in. to 1.25 in. Where such a back pressure is applied to a test on a Missouri granite system, the decrease in hole diameter will be only 12 percent, from 1 in. to .82 in. Some slight problems were encountered in the drilling of the crystalline granite since while the granular material is eroded on a grain by grain basis, the crystalline rock breaks transgranularly in larger fragments which may contain several grains and fragment sizes. Fragments over half an inch in length have been removed from the test chamber. This causes a slight problem in that it tends to block the valve which is used to control back pressure.

Field Tests

The field drilling rig (Fig. 1) was completed on August 1, 1976, and is being used for field trials. Tests to date have been carried out locally in the dolomite which surrounds Rolla. The dolomite is a very fine grained material of which the compressive strength is approximately 30,000 psi. Drilling rates of the order of 3 ft/min have been achieved in this rock, although the rate is sensitive to the degree of weathering which the material has undergone. The rig has been taken to a local quarry where the rock is completely unweathered to obtain some of the data points.

In the test program to date, the tests have been carried out both with nozzles welded to the drilling stem and with nozzles attached to the drilling stem by a small nozzle holder. At the present time the experiments are continuing using the nozzle holder because of the difficulty in obtaining a good bond between the nozzle and the drilling stem. It has been found in the field test program that the presence of ribs on the side of the hole can slow the drilling rate and these ribs do tend to catch the nozzle holder, emphasizing the importance of a high rotational speed relative to drilling rate in order that these things be removed.

Some problems have been encountered with the small supply pump providing water to the intensifier unit, and this has slowed work a little during this phase. However, the problem has been solved.

The field unit has also been used to drill various samples of granite and limestone which are available in 1-ft cubes at rates in excess of 1 ft/min. At the present time the drilling unit is still being proof-tested. At the end of this proof phase it is intended to take the unit to a coal mine and to the granite quarry to obtain field drilling rates in these rocks.

Figure 1. Field Test Rig