HYDROLOGY DOCUMENT NUMBER 392

3279

WILL BE REFERENCED IN 8.3.1.4.1
AS "MONTAZER, 1986".

J. Younker

United States Department of the Interior
GEOLOGICAL SURVEY
BOX 25046 M.S. ____
DENVER FEDERAL CENTER
DENVER, COLORADO 80225

IN REPLY REFER TO:

11/26 Pls copy for
M D Voegele
Bill Sublette
R Morissette
M. L. Brown
D B Jorgensen
S. Jones
Thx
JLY

CC: Blanchard
CC: Jorgensen
CC: Iley
CC: Voegele
CC: Kunich
CC: ____

November 21, 1986

Dr. Maxwell B. Blanchard
Regulatory and Site Evaluation Branch
Waste Management Project Office
Department of Energy
P. O. Box 14100
Las Vegas, Nevada 89114-4100

REC'D IN WMPO
11/24/86

Through: W. E. Wilson, Chief, Nuclear Hydrology Program
R. V. Watkins, Associate Chief, NNWSI Branch
L. R. Hayes, Chief, NNWSI Branch

Dear Max;

This is in response to your letter of September 16, 1986 requesting clarification of and justification for the dry core drilling program (WMPO action item # 86-2293). The problem of dry-versus-wet coring has been the major topic of discussion at many of the Exploratory Shaft Test Plan Committee (ESTPC) meetings. In response to some of the questions raised in these meetings, the USGS/WRD has generated two draft documents (enclosed), one on dry coring and the other on the dry-versus-wet mining, which were not finalized because of other program priorities. I am preparing this letter to answer some immediate questions and concerns; a position paper, presenting a more detailed response, is in preparation and will be submitted shortly. Also, we are in the process of evaluating the problem of wet-versus-dry drilling by conducting some numerical analyses under the direction of Dwight Hoxie. When this numerical analysis is completed, we will finalize our position paper on the subject. We have spent a significant amount of time and money in the NNWSI project on deliberating the issue of wet-versus-dry coring and mining, but we believe that this issue will not be resolved until prototype testing is done and some hard data are produced.

Many of the questions asked by Mr. Murphy will be answered more adequately in our position paper, and we anticipate that all the issues will be resolved after prototype testing is completed. In the meantime, I will try to answer some of his questions by reviewing our past experiences with regard to the subject matter.

1. Is it really necessary to dry core drill?

Most hydrologists believe that wet drilling within the unsaturated zone alters ambient conditions substantially, especially in fractured rocks. As

Principal Investigator, I have not arbitrarily decided that dry coring is necessary; my opinion represents the opinion of many experts in the Water Resources Division of the USGS. In addition, I spent four years underground observing and measuring movement of water and air through unsaturated fractured rocks, and I have been involved in the site characterization of the unsaturated zone at Yucca Mountain for the past four years.

About four years ago, the NTS contractors were against dry drilling in the unsaturated zone at Yucca Mountain. Since then the USGS , under Dale Hammermeister's perseverance and R. K. Blankennagel's direction , has demonstrated that dry coring in vertical boreholes is both practical and advantageous. We have learned that there are several methods that enable us to dry drill the unsaturated fractured tuffs (reverse air vacuum and ODEX are two of the more successfull techniques). Dale Hammermeister and his staff are in the process of preparing a proposal to prototype test the effects of dry-versus-wet drilling.

We know of the consequences of drilling with polymer mud in the USW G-1 borehole; this procedure created a perched water system in the unsaturated zone beneath Drill Hole Wash that was encountered in USW UZ-1. The perched drilling fluid not only interrupted our site characterization effort, it has created questions that may affect the licensing of the site if additional clarifying studies are not conducted at the UZ-1 site. To seek answers to these questions we may have to spend several millions of dollars with no assurance of success. Now we are more careful in planning the ES tests and we will add all the necessary tracers to avoid confusion in interpretation of the observations. But how certain can we be of the success of the precautionary measures? Are we willing to make the same mistakes and jeopardize our capability to defend the site? Or, should we take all the possible precautionary measures that are necessary to avoid future confusion? I believe the letter from R. R. Loux of the State of Nevada, dated July 30, 1984, a copy of which is enclosed, answers my last two questions. Therefore, there is no question in my mind that drilling with water would have serious deleterious effects on the results of testing and analyses.

Some engineers have suggested foam drilling as an alternative. USW G-4 was drilled with foam, and the TV camera run of this borehole, which was made several hours after drilling, shows so much water dripping from the fractures intersected by the borehole that one would think the Topopah Spring welded unit is in the saturated zone . Other drilling engineers suggested air mist as an alternative method. This method was employed for drilling of the first 60 feet of the UZ-1 borehole. Drilling of this borehole was interrupted because of the bit plugging problems and inability of the vacuum system to remove cuttings because of a standing water column in the borehole. After resumption of drilling with only air circulation, no further problems were encountered until another standing water column (noted above) was encountered at a depth of about 1250 ft (Whitfield, 1985). Therefore, we have concluded that the amount of water that is needed to drill using air mist is excessive for hydrologic purposes. It is clear to us that standing water or positive head is not acceptable in either horizontal or vertical boreholes. Furthermore, drilling with water disturbs the in-situ ambient conditions.

Why do we need to preserve the ambient moisture conditions for our testing purposes? My personal experience is based on conducting experiments at the Colorado School of Mines Experimental Mine in Idaho Springs, Colorado. The rock is metamorphic and not as fractured as the Topopah Spring welded unit and consequently not as permeable. During drilling and coring of a horizontal borehole with water, a fracture in an adjacent drift (12 ft away) started producing water in the ceiling of the drift (about 12 ft higher than the borehole level). Later observations during testing of the same borehole indicated that it was not only the major fracture that was affected; rather, water had wetted an area of an adjacent borehole (about 4 feet above the test borehole) through flow into ubiquitous fractures. Borehole injection experiments with water and air indicated that the water front traveled a significant distance into the fractures and that it modified the ambient pneumatic and hydraulic conductivity of the fractures. Trautz (1984) also concluded from experiments in Arizona that water injection and natural recharge change the pneumatic conductivity of the fractures in welded tuff by significant amounts. Many of the in-situ hydrologic tests in the Exploratory Shaft are aimed at measuring the hydraulic conductivity of the fractured rock mass. These measurements will be used in calculations of travel time from the repository to the accessible environment. A change in the saturation of the rock mass by about 10 percent could result in a change in hydraulic conductivity of the rock by one to two orders of magnitude. These uncertainties may have significant impact on travel-time calculations. Obviously, similar arguments can be made against the effects of dry coring on the hydraulic conductivities of the matrix; however, such arguments cannot be rejected without some well designed prototype tests. Dale Hammemeister is preparing an SIP for this prototype test.

2. If it is a requirement to dry core drill, would it not be advisable, even before an attempt is made to rent, lease, or buy a drill for use of the ODEX system, to undertake a test in G-Tunnel as soon as possible with standard core drilling equipment with air used as the cutting removal medium?

I am quite certain that conventional methods will be successful in short boreholes drilled in good ground. However, we already know that the ground, such as that found at Fran Ridge, is not amenable to conventional drilling and, according to our geologists, there is a likelihood of encountering such fractured zones in the ESF. In fact, several of our tests are designed to be conducted in boreholes drilled through faults and fractured zones. Therefore, I believe we need a method of dry horizontal drilling that can be used in bad ground. The ODEX system is just one of these and there may be others which may or may not need to be tested. In any case, during shaft construction we cannot afford to wait for several months to procure, test, and prepare unknown equipment and methods.

3. If the hole has to be logged or instruments placed in the hole, the casing would have to be removed. If the hole is not stable enough to stay open after the casing is removed, what has been gained by using the ODEX system?

The casing of the ODEX system can be retrieved, during which the instrumentation package can be installed in the borehole. Most of the geophysical logs can be run with the casing in the borehole. The most important of these is the neutron log, which routinely is run in the cased surface-based boreholes. In the worst case of a stuck casing in the borehole, the casing can be perforated and the instrumentation package placed at the perforated intervals.

4. How smooth does a drill hole have to be to install gages and instruments? Could a percussion drilled hole using air as a cutting medium be used in an instrument hole?

A borehole does not need to be smooth to install most of the gages and instrument packages that will be used for the ES hydrologic tests; however, some gages do require a smooth-walled borehole. The need for a smooth wall also is important for borehole TV camera surveying and geophysical logging. Percussion drill holes are shown to have more skin damage than diamond-drilled boreholes (Gale, 1975); therefore, for permeability test boreholes, core drilling is preferred. Another advantage of the cored holes is the samples that are obtained for matrix hydrologic properties testing, which is a requirement for many of our ES hydrologic tests. However, we are aware of some problems that are involved with ODEX drilling and coring, i. e. the wall cake formed on the borehole walls creates a positive skin effect (plugging of the fractures).

5. The Prototype Testing Program at G-Tunnel was projected to start October 1, 1986 according to the schedule with the estimate. The lead time on the drill for the ODEX is at least 4 months.

Obviously the October 1 start-up did not happen. If it is certain that the conventional methods may work in G-tunnel we can start preparation of the test facilities by conventional dry drilling and conduct the ODEX (or equivalent) prototype testing at a later time.

6. The Ingersoll-Rand Drill that was selected as the machine to handle the ODEX system cannot be leased or rented. There is a possibility that other vendors might rent or lease. Should a drill other than the Ingersoll-Rand Drill be considered, even though it may not meet the requirements for torque and rotational speed of the ODEX system and coring?

This question should be referred to LANL.

I would welcome any further comments, questions, or discussions; however, it would be advantageous to await completion of our position paper.

Parviz Montazer

List of References:

Gale, J. E. 1975. A numerical field laboratory study of flow in rocks with deformable fractures. Phd Thesis. University of California at Berkely. 255 pages.

Trautz, R. C. December 1984. Rock fracture aperture and gas conductivity measurements in-situ. MS Thesis. University of Arizona. 141 pages.

Whitfield, M. S. 1985. Vacuum drilling of unsaturated tuffs at a potential radioactive waste repository, Yucca Mountain, Nevada. Proceedings of the NWWA Conference on Characterization and Monitoring of the Vadose (Unsaturated) Zone. November 19 - 21, 1985, Denver, Colorado. 10 pages.

cc: R. K. Blankennagel
W. W. Dudley
D. P. Hammermeister
Paul Aamodt, LANL

RICHARD H. BRYAN
Governor

STATE OF NEVADA

NUCLEAR WASTE PROJECT OFFICE
OFFICE OF THE GOVERNOR
Capitol Complex
Carson City, Nevada 89710
(702) 885-3744

July 30, 1984

ACTION WMPO
INFO
R.F.
AMA ✓
AME&S ✓
AMO

Dr. Donald Vieth
U. S. Department of Energy
Nevada Operations Office
P.O. Box 14100
Las Vegas, Nevada 89114-4100

Dear Dr. Vieth:

Field observations by our contractors have indicated that recent lon term pump tests of H-6 have produced a large volume of water whi infiltrated into the alluvium in Solitaro Wash. The majority of t infiltration has occurred at a distance some 3,500 feet from a approximately 700 feet below the new UZ-6 unsaturated zone experiment pa Visual observations indicate that nearly all of the pump test water rapid infiltrated into the wash alluvium after issuing from steep tributa drainage. Calculations, based upon pumping rates and duration, indica that about 23 acre feet of water was pumped over the past month.

Such water management in and around the proposed repository site h the potential to create unnecessary and undesirable uncertainty in da developed in unsaturated zone experiments. Water infiltrating from vario man-caused activities, when concentrated in time and space, has t potential to create an unsaturated zone data base markedly biased induced recharge.

To date, both principal unsaturated zone experiments (UZ-1 and UZ- are located in areas where unnatural sources of water in sufficient volu to impact the unsaturated zone moisture data have been either inject during drilling of adjacent test holes or have been applied to the la surface.

We continue to be very concerned about the feasibility of separati natural moisture phenomena in the unsaturated zone from induced phenome caused by water management practices and drilling activities.

I hope that you find these comments useful. Should you have a questions, please do not hesitate to contact me.

Sincerely,

Robert R. Loux

Robert R. Loux
Director

RRL:sk