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Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

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'87 FEB 27 A10:57

February 18, 1987
Contract No. NRC-02-85-008
Fin No. D-1020
Communication No. 113

Mr. Jeff Pohle
Division of Waste Management
Mail Stop 623-SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: NTS

Dear Jeff:

A copy of the review of each of the following documents is enclosed.

1. Lin, W., and Daily, W., 1984, Transport Properties of Topopah Spring Tuff. Lawrence Livermore National Laboratory, Livermore, CA, UCRL-53602, 20 p.

2. Muller, D.C., and Kibler, J.E., 1983, Commercial Geophysical Well Logs of the USW G-1 Drill Hole, Nevada Test Site, Nevada. USGS Open-file Report 83-321.

Please contact me if you have any questions concerning these reviews.

Sincerely,

James L. Osiensky

James L. Osiensky

JLO:sl

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WM Record File
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WM Project 10, 11, 16
Docket No.
PDR ✓
LPDR ✓ (B, N, S)

Distribution:
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PDR WMRES EECWILA
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WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT #: UCRL-53602

DOCUMENT: Lin, W., and Daily, W., 1984, Transport Properties of Topopah Spring Tuff. Lawrence Livermore National Laboratory, Livermore, CA, UCRL-53602, 20 p.

REVIEWER: Williams & Associates, Inc., James L Osiensky

DATE REVIEW COMPLETED: February 18, 1987

ABSTRACT OF REVIEW: APPROVED BY: Roy E Williams

The report under review describes laboratory experiments conducted on samples from the Topopah Spring Member of the Paintbrush tuff. Electrical resistivity, ultrasonic P-wave velocity, and permeability to water were measured on intact and fractured samples of Topopah Spring tuff. These measurements were taken at a confining pressure of 5.0 MPa, pore pressures to 2.5 megapascals (MPa), and temperatures to 140°C. Electrical resistivity measurements were used to monitor fluid flow in the rock samples. Ultrasonic velocity also was used to evaluate fluid flow; however, the velocity measurements did not give detailed information on the dehydration and rehydration processes. The permeability of the unfractured sample was found to be independent of temperature, dehydration and rehydration cycles, and time. Permeability of the fractured sample was found to decrease by more than one order of magnitude after each dehydration and rehydration cycle. The decrease in permeability of the fractured sample is attributed to fracture healing due to the redeposition of minerals such as silica.

BRIEF SUMMARY OF DOCUMENT:

The report under review presents the results of electrical resistivity, ultrasonic P-wave velocity and permeability to water measurements on intact and fractured samples of Topopah Spring tuff. The experimental conditions were designed to simulate a nuclear waste repository environment. Tests were conducted under a hydrostatic confining pressure of 5.0 megapascals (MPa), pore fluid pressure up to 2.5 MPa, and temperatures ranging up to 140°C.

The samples from the Topopah Spring Member of the Paintbrush tuff used in the experiments were collected from Fran Ridge at the Nevada Test Site. An auxiliary sample was obtained from a depth of 373 meters in borehole USW G-1. These samples were machined into right circular cylinders approximately 9 centimeters (cm) long and 2.54 cm in diameter. Testing of the samples was conducted during dehydration, rehydration, and full saturation with respect to water. Page 5 of the report outlines the steps taken from the initial saturation of the samples at room temperature through the various cycles of dehydration and rehydration at various temperatures and pore water pressures. The confining pressure was held constant throughout the experiment.

Table 2 of the report lists the permeability values obtained under the various experimental conditions. According to the report, the permeability (to water) of the intact sample was independent of temperature and time over the two month period of the experiment. Repeated dehydration and rehydration did not change the permeability of the intact sample of tuff; however, the permeability (to water) of the first fractured sample was found to decrease by approximately one order of magnitude for each dehydration and rehydration cycle that it was subjected to.

A second fractured sample of tuff was tested to investigate the potential for fracture healing under the conditions of the experiment. This sample was tested to evaluate the effects of temperature changes. The sample was not subjected to cycles of dehydration and rehydration. Constant saturation was maintained throughout the experiment. Figure 3 of the report shows that an increase in temperature from 23°C to 96°C caused the permeability to decrease by more than an order of magnitude. The report notes that further increases or decreases in the sample temperature did not have a significant effect on the permeability. The authors of the report suggest that the decrease in permeability shown on Figure 3 was due to healing of the fracture by mineral deposition rather than the effects of temperature alone.

In addition to permeability measurements, electrical resistivity and ultrasonic velocity measurements were made during the cycles of dehydration and rehydration. Figures 4 and 5 of the report present plots of resistivity versus time for the intact tuff sample and the first fractured tuff sample, respectively. Both Figures 4 and 5 show a rapid increase in resistivity during the first drying stage, followed by a much slower increase in resistivity during the second drying stage. The report suggests that the rapid increase in resistivity probably is due to the rapid escape of water from the sample; the much slower increase in resistivity is attributed to the slow release in moisture held in microfractures or microcavities. According to the report,

> The resistivity versus time behavior of the intact and fractured sample during the third drying period (after the steam flow) is about the same. During this dehydration, both samples show resistivity maxima followed by a decrease of resistivity with time.

Figure 6 of the report is a graph of the relative variation of the electrical resistivity as a function of time during the drying process for the fractured and unfractured samples. Figure 6 indicates that the dehydration time for the fractured and intact samples was nearly the same. However, the presence of the fracture in the fractured sample apparently caused drying of that sample to be nonuniform relative to the unfractured sample. The authors of the report note that it is not clear why the moisture distribution, but not the evaporation rate, would be affected by the presence of the fracture.

Figure 7 of the report shows the spatial distribution of resistivity measurements of the fractured sample for steam saturation and for the intact and fractured samples for water saturation during the resaturation process. According to the report, during the rehydration process of the intact sample, the saturating fluid was imbibed by the sample in a fairly uniform manner perpendicular to the flow direction. The report notes that flow of water in the fractured sample was nonuniform. The report suggests that fracture roughness contributed to the nonuniform flow of water. Steam flow in the fractured sample was more uniform than the water flow.

The P-wave ultrasonic velocity measured on the intact and fractured samples are plotted against time in Figures 9a and 9b, respectively. The report notes that measurements were not sensitive enough to yield detailed information about the dehydration and rehydration processes.

According to the report, when the fractured tuff sample was removed from the pressure vessel, the fracture was observed to have healed so that the pieces of tuff in the sample were bonded together. Analysis of the fracture by scanning electron microscopy indicated that layers of silica were deposited on the fracture after the drying and resaturation cycles. Testing of the strength of the fracture healing showed that the tensile strength of the healed fracture was about half that of the intact sample. According to the report, a second fractured sample containing a natural fracture with the surface conditions similar to the first sample was tested to isolate the main factor contributing to the fracture healing. According to the report, testing of the fracture in the second sample indicates that "fracture healing by water transport of minerals (mainly silica) in the fracture occurs as temperature increases about 100°C." The report notes that it is not known whether further fracture healing would be induced by elevated temperatures alone or whether other factors are important.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

The report under review describes a series of experiments conducted on rock samples from the Topopah Spring Member of the Paintbrush tuff. The purpose of the experiments was to subject the tuff to pressures and temperatures expected in the vicinity of a geologic repository in Yucca Mountain. The experiments were conducted under the Waste Package Task of the Nevada Nuclear Waste Storage Investigations. The report is not significant to the NRC Waste Management Program with respect to prewaste emplacement conditions. However, the report is significant with respect to evaluation of the conditions expected after waste emplacement.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

The report under review presents a detailed description of the experimental procedures performed during testing of tuff samples from the Topopah Spring Member. In addition to the usual limitations inherent in laboratory scale experiments, the primary limitation of the report is the fact that many of the results cannot be interpreted uniquely.

SUGGESTED FOLLOW-UP ACTIVITIES:

The report under review deals with the effects of conditions expected during post-waste emplacement. The report should be of most interest to the NRC staff involved directly with evaluation of the waste package.

WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT #: USGS-OFR-83-321

DOCUMENT: Muller, D.C., and Kibler, J.E., 1983, Commercial Geophysical Well Logs of the USW G-1 Drill Hole, Nevada Test Site, Nevada. USGS Open-file Report 83-321.

REVIEWER: Williams & Associates, Inc., James L Osiensky

DATE REVIEW COMPLETED: February 18, 1987

ABSTRACT OF REVIEW: APPROVED BY: Roy E Williams

The report under review presents a brief description of the geophysical logs recorded in saturated and unsaturated portions of drill hole USW G-1. The authors of the report suggest that the geophysical logs are of good quality; however, the logs are of limited usefulness for stratigraphic correlation due to the similar responses of the different tuff units penetrated by the borehole. The usefulness of the logs as lithologic indicators within the bore hole are limited to zones of welding in the tuffs, and to "noisy" density, caliper, and neutron traces in the lithophysal zone in the Paintbrush tuff. The report is of very limited significance to the NRC Waste Management Program at the present time.

BRIEF SUMMARY OF DOCUMENT:

The report under review presents a very brief description of the commercial geophysical well logs that were recorded for drill hole USW G-1. The geophysical logs were recorded during six periods of logging during and after completion of drilling. Table 1 of the report presents a summary of the logging operations. Plates 1 and 2 of the report are graphs of the geophysical logs compared with the lithology, stratigraphy, fracturing, and core index. Plates 1 and 2 are not included in the photocopy of the report that is available to Williams and Associates, Inc. for review.

According to the report, its purpose is to document the geophysical log data for drill hole USW G-1 and to present the log data in a usable form for use by other investigators. The authors of the report note that some data are missing on Plates 1 and 2. Data gaps on Plates 1 and 2 indicate that either no data were obtained in that interval, or that the data that were obtained were "discarded due to poor quality." Some of the missing data are the result of the unsuccessful attempt to record geophysical logs in the unsaturated portion of the hole by filling that portion of the hole with viscous mud.

Pages 1 through 6 of the report present very brief descriptions of the geophysical logs recorded for drill hole USW G-1. These logs include caliper, gamma-ray, spontaneous potential, resistivity, neutron, density, velocity, porosity, and calculated logs. These descriptions include a discussion of the principles and applications of each log. The authors of the report reached the following conclusions:

1. The geophysical logs recorded in drill hole USW G-1 generally are of good quality.

2. The usefulness of the logs as lithologic indicators is limited primarily to the identification of welded zones, and the lithophysal zone in the Paintbrush tuff.

3. The physical properties of the tuffs above the Tram unit are quite variable whereas the Tram and tuff of Lithic Ridge are more uniform and predictable.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

The report under review presents a brief discussion of the geophysical well logs recorded for drill hole USW G-1. The descriptions of the geophysical logs presented in the report probably will be of little value to the NRC Waste Management Program. The authors of the report conclude that the usefulness of the geophysical logs as lithologic indicators is limited primarily to identification of welded zones in the tuffs and seemingly noisy density, caliper, and neutron traces in the lithophysal zone of the Paintbrush tuff. While the actual geophysical logs eventually may become very significant to the NRC Waste Management Program, the report under review probably will be of relatively minor value.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

The primary limitation of the report under review is that the descriptions of the geophysical logs are very brief. In addition, the authors of the report note that the logs are of limited usefulness as lithologic indicators.

SUGGESTED FOLLOW-UP ACTIVITIES:

No follow-up activities are suggested.