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

September 17, 1987
Contract No. NRC-02-85-008
Fin No. D-1020
Communication No. 148

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. Maldonado, F., Muller, D.C., and Morrison, J.N., date unknown, Preliminary Geologic and Geophysical Data of the UE25A-3 Exploratory Drill Hole, Nevada Test Site, Nevada. U.S. Geological Survey, Denver, CO, USGS-1543-6,

2. Thordarson, William, Rush, F.E., and Waddell, S.J., 1985, Geohydrology of Test Well USW H-3, Yucca Mountain, Nye County, Nevada. U.S. Geological Survey, Water Resources Investigations Report 84-4272, Lakewood, CO.

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

Sincerely,

James L Osiensky

James L. Osiensky

JLO:sl

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WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT #: USGS-1543-6

DOCUMENT: Maldonado, F., Muller, D.C., and Morrison, J.N., date unknown, Preliminary Geologic and Geophysical Data of the UE25A-3 Exploratory Drill Hole, Nevada Test Site, Nevada. U.S. Geological Survey, Denver, CO, USGS-1543-6,

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

DATE REVIEW COMPLETED: September 17, 1987

ABSTRACT OF REVIEW: APPROVED BY: Roy L Williams

The report under review presents preliminary geologic and geophysical data from drill hole UE25A-3. Drill hole UE25A-3 is located in the Calico Hills area, approximately 7 miles west of Yucca Mountain. The drill hole penetrates various subunits of the Eleana Formation. Drill hole UE25A-3 was drilled to evaluate the Calico Hills area as a possible nuclear waste repository site. The report has little significance to the local hydrogeology in the vicinity of Yucca Mountain. However, the report may contain useful data with respect to understanding the regional hydrogeology in the vicinity of the Nevada Test Site.

BRIEF SUMMARY OF DOCUMENT:

The report under review presents preliminary interpretations of the geologic and geophysical data collected from drill hole UE25A-3. Drill hole UE25A-3 is located in the Calico Hills area, approximately 7 miles east of Yucca Mountain. The drill hole was drilled during the investigation of Calico Hills as a possible nuclear waste repository site. According to the report, the purpose of the drill hole was to verify the existence of an intrusive crystalline body in the subsurface and to determine the stratigraphy, structure, and nature of fractures in the cored rock.

Drill hole UE25-A was spudded on August 11, 1978. Drilling was completed at a depth of 2530.1 feet (771.2 meters) on October 10, 1978. The drill hole was cored from a depth of 100 feet (30.5 meters) to the total depth. Table 1 of the report presents a lithologic description of the rock units

penetrated by the drill hole. This table indicates that the entire drill hole penetrated various subunits of the Eleana Formation. The Eleana Formation consists primarily of argillite, altered argillite, and marbles. Table 2 of the report lists the locations of brecciated zones which possibly are indicative of fault zones penetrated by the drill hole. Table 3 of the report lists faults intersected by the drill hole.

A core index was calculated for all of the core as part of the engineering geology investigation of the drill hole. Core index is a relative measure of the rock competency. In addition to the core index, a fracture analysis was performed on the core. According to the report, the fracture analysis consisted of sampling a portion of the total population of fractures because of the great number of fractures present in the core. The fracture analysis was performed on a total of 2430 fractures; this number represents approximately 30 percent of the total number of fractures. Figure 5 of the report lists fracture frequencies observed in each 30.5 meter thick sampled that was sampled. Figure 6 of the report presents the average fracture frequencies in the entire cored interval. Figure 7 presents fractures per 10 degree dip interval for the interval between 30.5 and 771.2 meters. Figure 8 of the report lists fractures per 10 degree dip interval in the argillite, altered argillite, calcareous argillite and marble intervals. Figures 9 and 10 of the report present open and closed fractures per 10 degree interval for sampled intervals 30.5 to 396.4 meters, and 396.4 to 771.2 meters, respectively. Figure 11 presents a comparison of open and closed fractures per 10 degree dip interval, in argillite, altered argillite, calcareous altered argillite, and marble intervals. Figures 12, 13 and 14 of the report present the types of fracture sealing and coating observed in the core.

Borehole geophysical logs including caliper, density, resistivity, spontaneous potential, velocity, neutron and gamma logs, plus an in hole Vibroseis geophone survey and a deviation survey were run on drill hole UE25A-3. A copy of the geophysical logs is presented as Plate 1 of the report. According to the report, at the time of logging, the mud level was at a depth of 2104 feet (641.3 meters) which limited the coverage of logs that require fluid filled boreholes. Table 6 of the report presents digitized values of the geophysical logs for the drill hole. The report under review presents a short description of each of the geophysical logs recorded in drill hole UE25A-3.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

The report, when combined with other information, may contain useful information with respect to understanding the regional hydrogeology in the vicinity of the Nevada Test Site.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

The report under review consists of a basic data report. The report contains no major problems, deficiencies or limitations.

SUGGESTED FOLLOW-UP ACTIVITIES

No follow-up activities are suggested with respect to this report.

WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT #: USGS-WRI-84-4272

DOCUMENT: Thordarson, William, Rush, F.E., and Waddell, S.J., 1985, Geohydrology of Test Well USW H-3, Yucca Mountain, Nye County, Nevada. U.S. Geological Survey, Water Resources Investigations Report 84-4272, Lakewood, CO.

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

DATE REVIEW COMPLETED: September 17, 1987

ABSTRACT OF REVIEW: APPROVED BY: Roy L Williams

The report under review presents interpretations of hydraulic tests conducted within the saturated zone in test well USW H-3. Hydraulic tests conducted in the test well consisted of pumping tests, injection tests, and swabbing tests. Interpretations of the data presented in the report are highly subjective due to the poor type curve matches for many of the tests.

BRIEF SUMMARY OF DOCUMENT:

The report under review presents hydrogeologic interpretations of test data collected from test well USW H-3. The data used for the interpretations presented in the report are presented in Thordarson and others (1984).

Test well USW H-3 is located on the southern portion of Yucca Mountain near its crest. The test hole was rotary drilled with an air-foam drilling fluid. The drilling fluid consisted of air, detergent, and water obtained from well J-13. The rocks penetrated by test well USW H-3 consist primarily of ash flow tuff, plus "four thin, poorly lithified, bedded, or reworked tuffs at the bases of several stratigraphic units." Table 1 of the report presents a generalized lithologic log of the test well. The test hole was drilled to a total depth of 1,219 meters; it penetrates the Paintbrush Tuff, the Calico Hills, the Crater Flat Tuff, and bottoms in the Lithic Ridge Tuff.

Sixteen different geophysical logs were recorded in the well. The report explains that a summary of the geophysical logs is presented in Thordarson

and others (1984). Figure 2 of the report presents a graph of the distribution of porous rock in the well as interpreted from the geophysical logs. A television camera log showed water to be seeping from fractures above the static water level at a depth of 277 meters.

A borehole flow survey using a radioactive tracer (iodine 131) was conducted to measure vertical flow rates in the well while water was pumped into the well at a rate of 2.7 L/s at a constant head. The flow survey was conducted between the depths of 792 m and 1219 m. According to the report, the interval between 809 m to 840.9 m received 63 percent of the injected water. This interval is in the upper part of the Tram Member. The interval between 1060 m and 1120.4 m received 30 percent of the flow. This interval extends from the lower part of the Tram Member into the upper part of the Lithic Ridge Tuff. The remaining part of the injected water entered the tuffs between 840.9 m to 933 m. This interval also is in the Tram Member. The borehole flow survey data are significant in that the authors of the report use these data in conjunction with the results of hydraulic tests to assign values of transmissivity and hydraulic conductivity to the saturated portion of the rocks penetrated by the test well. The results of the borehole flow survey are presented in figure 3 of the report.

Water level measurements were made during the drilling period, during hydraulic tests, and after testing was completed. A packer was installed at a depth of 1,190 m to obtain information on the vertical distribution of hydraulic head in the well. According to the report, on November 3, 1983, the hydraulic head in the rocks above the packer was 732.9 m above mean sea level (MSL); below the packer, the hydraulic head was at 754.0 m above MSL and rising slowly toward static conditions. These data indicate that the zone below the packer had a composite head at least 21.1 m higher than the zone above the packer. These results are significant because they suggest that an upward vertical hydraulic gradient (vertically upward flow) exists in this portion of the test well.

The conceptual model used in the analysis of the hydraulic test data is based on the assumption that "sufficiently dense fracture spacing probably results in the fractured ash-flow tuffs functioning in a hydraulically similar fashion to a granular porous medium." Based on this conceptual model, the authors of the report suggest that homogeneous porous media solutions can be used to define the general hydrogeologic coefficients in fractured media, using late time test data to define the dual porosity system that exists in the tuffs at Yucca Mountain. The report notes, however, that "data used for computing apparent transmissivity for all types of tests in this well probably are early time data, as concluded by Rush and others (1984) for test well USW H-1, and therefore apply only to the fractured part of the system." The magnitude (small, moderate, and large) of the departures from ideal conditions for each test is described in table 2 of the report. It should be noted that the magnitudes of the departures listed in table 2 are subjective in nature.

Several different aquifer tests were conducted to evaluate the hydrogeologic coefficients for the tuff penetrated by test well USW H-3. The initial pump

test conducted in the well consisted of pumping the well at a rate of "several liters per second." According to the report, the well could not sustain the initial pumping rate so the pump test was converted to a cyclical test. The well was pumped and allowed to recover several times during the test. Figure 4 of the report presents the semi log plot of the second cycle of pumping. These data were analyzed by the Jacob straight line method of analysis. Figure 5 of the report presents a graph of drawdown and recovery for the entire aquifer test. These data were analyzed using Brown's method for a cyclically pumped well. Brown's method is described by Ferris and others (1962, p. 122).

According to the report, "a long-term, small-discharge-rate pumping test" was conducted within the interval between 822 m to 1219 m. The discharge rate was about 0.16 L/s for a 20,520 min pumping period. A log-log graph of drawdown versus time for this aquifer test is presented in figure 6 of the report. Figure 6 shows that drawdown data deviate from the theoretical Theis curve after approximately 2,000 min of pumping. The authors of the report attribute the deviation to leaky aquifer conditions, a recharge boundary, or the transition from early time to late time in a dual porosity system.

Six injection tests were conducted within selected depth intervals by using inflatable packers in the well to isolate the test zones. The injection test data were analyzed by the Jacob straight line method, by the slug test method of Cooper and others (1967), and by the slug test method of Papadopulos and others (1973). Data for the injection tests are plotted in figures 13 through 18 of the report. According to the report, data plotted in these figures are affected significantly by wellbore storage and fracturing. According to the report, hydraulic fracturing probably occurred during the early parts of the injection tests because of the large hydraulic head exerted. The effects of wellbore storage and fracturing are most obvious during the early time data during the first 5 to 7 min of each test.

Values of storage coefficient calculated from injection test data range from 4×10^{-6} to 7×10^{-6}. According to the report, these values of storage coefficient are very small, but probably are reasonable. However, a calculation by Williams and Associates suggests that the calculated storage coefficients probably are too small by as much as one order of magnitude. The values of storage coefficients calculated by the authors suggest that the aquifer is completely incompressible (storativity attributed to expansion of water only) and that values for porosity range between 0.006 and 0.02. According to table 2 of the report, departure from ideal conditions during the injection tests range from moderate to large for calculation of the storage coefficients.

Swabbing tests were conducted in the open uncased part of the well between two inflatable straddle packers. According to the report, the swabbing tests consisted of multiple swabbing runs. Data for the swabbing tests were analyzed by the authors by using the Jacob straight line method. Analyses of two of the swabbing tests are presented in figures 19 and 20 of the

report. Results of the swabbing tests are presented in table 2 of the report.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

The report under review is significant with respect to understanding the hydrogeologic characteristics of the tuff in the saturated zone in the vicinity of test well USW H-3. According to the results of the hydraulic testing, the "apparent horizontal transmissivity" of the section of tuff penetrated by the test well is about 1 m^2/day. Hydraulic conductivity generally ranges between 10^{-2} and 10^{-4} m/day.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

The primary limitation of the report under review is that data from several of the hydraulic tests produce type curves that deviate significantly from ideal curves, thereby precluding reliable curve matches. As an example, only four data points for the injection test of the interval from 1,063 to 1,124 m fall on the type curve for slug testing. This poor type curve match is reflected in the very low value for the storage coefficient ($7x10^{-6}$) that was calculated for this particular test. The values of hydrogeologic coefficients calculated from the test data are questionable. However, interpretations of the data are limited because the field curves deviate from the ideal curves. This is not a limitation of the report; it is a limitation of the data base.

SUGGESTED FOLLOW-UP ACTIVITIES:

No follow-up activities are suggested at the present time. However, data presented in this report may prove to be important with respect to characterization of the saturated zone beneath Yucca Mountain.

REFERENCES CITED:

Cooper, H.H., Jr., Bredehoeft, J.D., and Papadopulos, S.S., 1967, Response of a finite-diameter well to an instantaneous charge of water. Water Resources Research, v. 3, no. 1, p. 263-269.

Ferris, J.G., Knowles, D.B., Brown, R.H., and Stallman, R.W., 1962, Theory of aquifer tests. U.S. Geological Survey Water-Supply Paper 1536-E, 174 p.

Papadopulos, S.S., Bredehoeft, J.D., and Cooper, H.H., Jr., 1973, On the analysis of "slug test" data. Water Resources Research, v. 9, no. 4, p. 1087-1089.

Rush, F.E., Thordarson, William, and Pyles, D.G., 1984, Geohydrology of test well USW H-1, Yucca Mountain, Nye County, Nevada. U.S. Geological Survey Water-Resources Investigations Report 84-4032, 56 p.

Thordarson, William, Rush,, F.E., Spengler, R.W., and Waddell, S.J., 1984, Geohydrologic and drill-hole data for test well USW H-3, adjacent to Nevada Test Site, Nye County, Nevada. U.S. Geological Survey Open-File Report 84-149, 28 p.

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