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March 4, 1986
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Communication No. 35

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

RE: NTS

Dear Jeff:

I am enclosing a review of the following document:

1. Claassen, H.C., 1983, Sources and Mechanisms of Recharge for Groundwater in the West-Central Amargosa Desert, Nevada--A Geochemical Interpretation. USGS Open-file Report 83542, Denver, 61 p.

If you have any questions concerning this review, please call.

Sincerely,

James Osiensky /sl

James Osiensky

JO:sl

WM-RES
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~~WHA~~

WM Project 10, 11, 16
Docket No. ____
PDR ✓
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Distribution:
Pohle

(Return to WM, 623-SS)

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WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT: Claassen, H.C., 1983, Sources and Mechanisms of Recharge for Groundwater in the West-Central Amargosa Desert, Nevada--A Geochemical Interpretation: U.S.G.S. Open-file Report 83-542, Denver, 61 p.

REVIEWER: Williams and Associates, Inc.

DATE REVIEW COMPLETED: February 28, 1986

ABSTRACT OF THE SUMMARY: APPROVED BY: Roy E. Williams

The report under review presents data and interpretations which suggest strongly, that overland flow of snowmelt and storm runoff may be a primary source of recharge to the tuff aquifers in the vicinity of the west-central Amargosa Desert. Geochemical interpretations are used to support the conclusions. Recharge is believed to be concentrated in the major stream drainages. The report contains no major problems or deficiencies. The report is very significant with respect to the development of conceptual models for the saturated zone in the vicinity of the Nevada Test Site.

BRIEF SUMMARY OF DOCUMENT:

The purpose of the report under review is to present supporting data for and interpretations of a hydrogeochemical model of groundwater flow in the vicinity of the Nevada Test Site. The report utilizes geochemical concepts to estimate ground water sources and pathways of groundwater movement in the west-central Amargosa Desert in southern Nevada. Geochemical data are combined with hydraulic data in an attempt to explain the sources and mechanisms of recharge to the groundwater flow systems in the west-central Amargosa Desert.

The report incorporates water quality data collected by the U.S.G.S. in 1971, 1974, and 1979. Additional water quality data collected by other agencies and not published previously are included in Table 1 of the report. Groundwater chemistry data can be interpreted to indicate that groundwater in the west-central Amargosa Desert can be divided by composition into: 1) groundwater originating from reaction with tuffaceous rocks or tuffaceous valley fill, 2) groundwater that has reacted primarily with carbonate rocks or carbonate valley fill, and 3) groundwater that has reacted with the mixed lithology of carbonate and tuffaceous material. The report notes that carbonate derived waters that enter a region of tuffaceous valley fill (or vice-versa) are indistinguishable in composition from those waters resulting from reaction in the valley fill deposits of mixed lithology. This fact complicates the interpretation of the groundwater chemistry data in the vicinity of the Nevada Test Site. Another factor that complicates the interpretation of the geochemical data is the existence of Quaternary playa deposits within the area of investigation. Maps showing the concentrations of sodium, calcium, bicarbonate and sulfate, are shown in Figures 4 through 7 of the report.

The report suggests that the compositions of groundwater in the tuffs of the Nevada Test Site are due primarily to the formation of montmorillonite and clinoptilolite. Composition of the groundwater in the tuffs depends on the quantity of clinoptilolite precipitated relative to the quantity of montmorillonite. According to the report, greater percentages of sodium in the groundwater are associated with greater clinoptilolite/montmorillonite ratios.

Recharge water (i.e., infiltrating precipitation or surface runoff) that reacts with vitric tuff would result in the precipitation of montmorillonite and clinoptilolite in varying quantities, depending on the lithology and flow path. According to the report, sodium probably would comprise more than 70% of the three major cations (sodium, calcium, and magnesium) in recharge that occurs through the rocks in the highlands north of the study area. However, the compositions of most of the groundwater in the Amargosa Desert (sodium, calcium, and magnesium) in tuffaceous valley fill are inconsistent with the expected composition of recharge water entering aquifers of the rock types that exist to the north. This fact suggests that the water in the tuffaceous valley fill in the Amargosa Desert was <u>not</u> derived from recharge in the highlands to the north. The report suggests that a reasonable alternative is that surface runoff recharges the valley fill directly.

Winograd and Thordarson (1975) suggested that a potentiometric high in the vicinity of the intersection between the gravity fault and the Spector Range thrust fault was due possibly to a breach of the confining properties of the Gravity fault along the Ash Meadows spring line. Geochemical data were used to evaluate whether groundwater that appears to be flowing from east to west across the Gravity fault is derived from the unconfined (valley fill) or the confined (lower carbonate) aquifer discussed by Winograd and Thordarson (1975). Water level data indicate that the potentiometric surface in the valley fill is about 10 m lower than than in the underlying carbonate aquifers. These data indicate that the vertical component of the fluid potential gradient is upward in this area.

According to the report, groundwater from well 17S/51E-23B may be due to upward leakage from the lower carbonate aquifers; however, significant upward leakage and calcium carbonate precipitation cannot explain adequately the water quality of the other valley fill derived samples. The report notes that much of the valley fill from which these samples were obtained consists of limestone and dolomite. Therefore, the geochemical data cannot be interpreted uniquely. However, according to the report, three possible mechanisms can explain the water quality data in the vicinity of the potentiometric high. 1) Upward leakage of ground water from the lower carbonate aquifer may occur into the valley fill. This water is believed to be mixed with water that has been recharged into the valley fill directly. 2) Upward leakage from a carbonate aquifer may occur and react with rock fragments, including evaporites, in the valley fill. 3) Water may recharge primarily through the valley fill and reside therein. The report suggests that the mechanism that best explains the water quality data in the vicinity of the potentiometric high is upward leakage from the lower carbonate aquifer into the valley fill deposits in combination with water that has been recharged directly into and is now resident in the valley fill.

Figures 4 through 7 of the report present water quality maps in the study area. Contours of equal concentrations of sulfate, bicarbonate, calcium and sodium indicate that the best quality water exists within the central portion of the study area (i.e., a trough in the contours). The report suggests that the water within these troughs originated as local surface runoff. The report suggests also that infiltration of this runoff occurred primarily in the vicinity of present-day drainageways and that reaction with vitric tuff resulted in the observed water quality. This interpretation is plausible.

The water quality maps suggest that large chemical gradients exist between the valley fill containing principally carbonate detritus near the Amargosa River and the valley fill to the northeast, in the central part of the study area. According to the report, the valley fill in the central part of the study area is presumed to be principally tuffaceous. In order to explain the water quality data, the report presents the hypothesis that a greater number of floods which result in recharge occur in Forty Mile Canyon than in the Amargosa River. If this hypothesis is correct a greater fraction of runoff recharge would occur in the tuffaceous valley fill than in the valley fill containing carbonate detritus. This hypothesis could explain the large hydrochemical variations that exist in the study area. However, the report notes that additional data are necessary to explain the occurrence of groundwater with higher TDS along the upstream reach of the Amargosa River than along the downstream reach.

According to the report, the potentiometric surface in the valley fill along the Amargosa River suggests that subsurface groundwater flow parallel to the river is possible. The report suggests that groundwater may flow from the valley fill in Oasis Valley, near Beatty, Nevada, into the valley fill in the upstream reach of the Amargosa Dessert. However, the groundwater chemistry data are difficult to interpret. The report suggests that two mechanisms may account for the groundwater quality along the upstream reach of the Amargosa River: 1) recharge of surface runoff or 2) underflow of groundwater from Oasis Valley. The report notes that the groundwater chemistry along the downstream reach of the Amargosa River can be explained only by recharge of surface runoff. Therefore, the author of the report favors this mechanism as the dominant source of recharge along the entire reach of the Amargosa River.

Figure 14 of the report presents a map of unadjusted carbon-14 age dates of groundwater in the vicinity of major surface drainageways. The map indicates that the youngest ages are located in or near present-day drainageways. The present-day drainageways are assumed to correlate with the paleodrainageways. Based on this assumption, the distribution of groundwater ages supports the conclusion that a primary source of recharge is overland flow in the drainageways.

It is important to note the absence of groundwater dates older than 17,000 years before present in the tuff aquifers. The report offers three possible explanations for the absence of groundwater ages greater than 17,000 years before present: 1) The relatively young groundwater ages are an artifact of well completion and location. 2) Groundwater velocity is sufficient to have moved the older groundwater beyond the study area. 3) Snowfall earlier than about 20,000 years before present was insufficient to produce snowmelt recharge, whereas subsequent climatic conditions caused such recharge. The author of the report favors the third explanation.

An interesting contradiction exists between the chemical data and the isotope and hydraulic data with respect to Ash Tree Spring. Ash Tree Spring is located approximately in line with the trend of other tuff derived water samples from the central part of the study area (the trough in the water quality maps). However, the carbon-14 age of this water is 15,900 years before present. This age is significantly older than the upgradient groundwater in most other parts of the valley fill downgradient from Forty Mile Canyon. In addition, the water level altitude of the spring is approximately 21 m higher than the water levels in wells within 1 km of the spring. According to the report, the nearest wells also contain water of very different chemistry than water from Ash Tree Spring. The author offers the following two explanations for these contradictions in the data: 1) Water level altitude at Ash Tree Spring reflects recharge in the valley fill at a time when the land surface was higher than it is today. Subsequent erosion or subsidence left the aquifer material of Ash Tree Spring topographically higher than the surrounding valley fill. Flow from the spring represents draining of the aquifer. 2) Recharge to Ash Tree Spring originates from a different source than the source that recharged valley fill to the northwest.

SIGNIFICANCE TO THE NRC WASTE MANAGEMENT PROGRAM:

The report under review presents very significant data and interpretations with respect to conceptual models of groundwater flow in the vicinity of Yucca Mountain. The report is significant with respect to understanding the mechanisms of recharge to the tuff aquifers. Most of the interpretations presented in the report are supported by groundwater chemistry data, groundwater isotopic data, and hydraulic head and gradient data. The information and interpretations presented in the report are very significant with respect to the development of conceptual models for the saturated zone at Yucca Mountain.

The sources of groundwater recharge indicated by Claassen (1983) are taken into account by USGS papers dealing with this subject published after 1983 (e.g., Czarnecki and Waddell, 1984; and Czarnecki, 1984). However, potential recharge along Forty Mile Wash and Forty Mile Canyon are not mentioned in the draft EA or by Rice (1984). This is a serious deficiency in the report by Rice (1984). Claassen (1983) is referenced in Chapter 6 of the draft EA; however, Claassen (1983) is referenced as a source of groundwater chemistry data only. No interpretations of the data are presented in the EA.

PROBLEMS, DEFICIENCIES, OR LIMITATIONS OF REPORT:

The report under review contains no significant problems, deficiencies, or limitations. Most interpretations presented in the report are supported by groundwater chemistry data, groundwater isotopic data, and hydraulic data. The data base is not sufficient to explain fully all of the conditions observed within the study area. However, this is not a deficiency of the report. The author offers alternative explanations to explain the occurrence of apparently anomalous conditions whenever the data base is inadequate to support a unique interpretation.

SUGGESTED FOLLOW-UP ACTIVITY:

The groundwater chemistry data and interpretations presented in the report are important with respect to supporting or disproving potential conceptual models of groundwater flow in the vicinity of Yucca Mountain. We believe that any conceptual models developed for the saturated zone in the vicinity of the Nevada Test Site should agree with the interpretations presented in the report or should offer alternative interpretations of the data.

REFERENCES CITED:

Winograd, I.J., and Thordarson, William, 1975, Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada, Test Site: USGS Prof. Paper 712-C, 126 p.

Czarnecki, J.B., and Waddell, R.K., 1984, Finite-Element Simulation of Ground-Water Flow in the Vicinity of Yucca Mountain, Nevada-California. USGS Water Resources Investigations Report 84-4349, Denver, 38 p.

Czarnecki, J.B., 1984, Simulated Effects of Increased Recharge on the Ground-Water Flow System of Yucca Mountain and Vicinity, Nevada-California. USGS Water Resources Investigations Report 84-4344, Denver, 33 p.