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# Center for Nuclear Waste Regulatory Analyses

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May 20, 1994  
Contract No. NRC-02-93-005  
Account No. 20-5702-441

U.S. Nuclear Regulatory Commission  
Attn: Dr. Keith McConnell  
Division of Waste Management  
ENGB, (7F-12)  
Washington, DC 20555

Reference: Letter McConnell to McKague - Completion of Intermediate Milestone  
20-5702-441-431 (Review of DOE Topical Report (TR) "Evaluation of  
Potentially Adverse Condition 'Evidence of Extreme Erosion During  
the Quaternary Period' at Yucca Mountain, Nevada" Dated April 14,  
1994)

Subject: Assessment of Sufficiency of 0.17 and 1.38 Ma to Identify Extreme  
Erosion Events

Dear Dr. McConnell:

As requested in the referenced letter, we have assessed the sufficiency of  
the time period (0.17 to 1.38 Ma) used by DOE to determine the presence or  
absence of the potentially adverse condition. Summarizing the attached letter  
report, the time period 0.17 to 1.38 Ma is not adequate for identifying past  
credible extreme erosion events because i) the most recent timeframe (0 - 170 ka  
events) is not investigated; ii) the gaps in the age-dates assigned to the  
boulder deposits are so large (750 k.y.) that about one-half of the total time  
spanned by the DOE investigation is not represented; and iii) there is a  
considerable length of time older than the 1.38 Ma to the beginning of the  
Quaternary (1.6 or 2.0 Ma) which is unrepresented. Additionally, the TR fails  
to address the occurrence of significant, relatively instantaneous erosion events  
before, during, or after the time interval covered by the boulder deposits  
studied by DOE.

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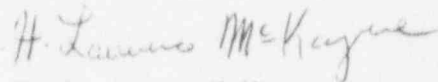
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U.S. Nuclear Regulatory Commission  
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If further information or clarification is needed, please contact  
Mr. Michael Miklas, Jr. at (210) 522-5207 or me at (210) 522-5183.

Very truly yours,



H. Lawrence McKague  
Element Manager,  
Geologic Setting

HLM/ec  
(K:\HLM\N)  
Enclosure

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**ASSESSMENT OF SUFFICIENCY OF 0.17 TO 1.38 MILLION YEAR PERIOD  
REPORTED IN DOE TOPICAL REPORT ON EXTREME EROSION AS THE  
LENGTH OF TIME IN WHICH TO DETERMINE THE PRESENCE OR ABSENCE  
OF THE POTENTIALLY ADVERSE CONDITION DURING THE QUATERNARY PERIOD**

The DOE Topical Report (TR) entitled "Evaluation of the Potentially Adverse Condition 'Evidence of Extreme Erosion During the Quaternary Period' At Yucca Mountain, Nevada" (DOE, 1993) contains a discussion by DOE which ascribes a length of 1.6 million years to the Quaternary Period. The NRC in its staff analysis of the proposed rule 10 CFR Part 60 (NRC, 1983) suggested a length of 2.0 million years for the Quaternary Period. The NRC suggested length was to provide certitude that a reasonable range of events occurring within the recent geologic past was investigated by DOE. The exact length of the Quaternary Period is not the critical issue, rather, the desire of the NRC is to assure that a representative range of time is investigated and that events within that timeframe are evaluated for instances or episodes of extreme erosion. Erosive events deemed credible would be further evaluated for potential effect on the waste isolation capabilities of the proposed repository at Yucca Mountain. An erosive event would not have to have occurred at Yucca Mountain *per se* to be considered potentially adverse, rather, extreme erosion would be considered credible and its effect assessed by DOE if such erosion had occurred within the geologic setting during the past few million years. For the purposes of discovering past credible erosive events the 1.6 million year timeframe for the Quaternary Period, as proposed by the DOE, is considered by CNWRA to include a reasonable sampling of the past. The DOE should investigate and evaluate geologic events deemed credible for consideration because if they were to be repeated in the next 10,000 years they might affect waste isolation.

The time period of 0.17 to 1.38 Ma in the TR is not adequate to identify past credible extreme erosion events. In order for the DOE to demonstrate that a reasonable portion of the past (i.e. Quaternary Period of either 1.6 or 2.0 Ma duration) has been investigated and adequately evaluated for evidence of extreme erosion, DOE research should if possible, examine a range of suitable deposits or features that could occur throughout the extent of the Quaternary Period. There is no requirement that a single type of deposit has to span the entire Quaternary Period, nor that a single dating technique has to be used on different deposits that may have formed hundreds of thousands of years apart. For example, uranium-series disequilibrium on soil carbonates may be suitable for deposits younger than about 500 ka, whereas older coarse-grained Quaternary-Period sediments may only be dateable through indirect stratigraphic methods. Other direct and indirect evidence pertinent to determining the presence or absence of extreme erosion apparently exists in addition to the dated boulder deposits described in the TR. For example, the relative decrease in the amount of colluvium at the headwalls of east-trending drainages on Yucca Mountain indicates that these areas have undergone more erosion than the colluvial boulder deposits examined at the mouth of some of the same canyons; this relationship deserves DOE explanation including establishing relative age. The quantity and provenance of sediment in Fortymile Wash also may provide important constraints on possible episodes of extreme erosion during the Quaternary history of Yucca Mountain. Each of these erosive processes will produce different types of deposits or evidence at potentially different intervals of time and will require different dating techniques. It is not acceptable to ignore these other types of data related to erosion because they cannot be dated by rock-varnish techniques or because they do not directly represent a hillslope surface.

There are major concerns regarding the reliability of the age-dating of boulder deposits as reported in the TR. However, assuming the data in the TR are representative, they can be used to give an indication of the range of ages of such hillslope deposits. In the TR, the DOE-dated hillslope boulder deposits range

in apparent age from 170 to 1380 ka. A histogram of these 12 dates is shown in Figure 1. These data appear to be normally distributed and have an average of 800 ka, with one standard deviation of 300 ka (Figure 1). However, samples collected on Yucca Mountain only range in age from 170 to 760 ka. Using a 1.6 m.y. duration for the Quaternary Period, only 37 percent of the Quaternary Period is represented by the dates on Yucca Mountain. The remaining 6 dates for the surrounding region are thought to represent 75 percent of the DOE-defined Quaternary Period. Thus, it is clear that only a portion of the Quaternary-Period geologic record at Yucca Mountain and the surrounding region has been examined in the TR as a result of concentrating on and investigating only the boulder deposits. The TR fails to address how the investigated intervals of time relate to the entire Quaternary Period, or, for that matter, if the geologic processes that operated during the investigated intervals of time may be present since 170 ka but undetected due to limitations in the analytical technique or study methodology. Additionally, within the reported range of dates in the TR, there are numerous 100 to 250 k.y. intervals that apparently lack any representative boulder deposits (Figure 1). The TR fails to address if relatively instantaneous events, such as short-term episodes of extreme erosion, could have occurred during one of the non-dated intervals of time while failing to produce dateable hillslope deposits. A robust evaluation of the evidence of extreme erosion includes evaluation of the potential geologic and climatologic conditions during the period of repository performance (i.e., 10 k.y. in the future) which requires collection and evaluation of data from the recent geologic past, focusing on the most recent 150 ka which timeframe is not discussed currently in the TR and cannot be dated using the cation-ratio desert varnish age dating technique.

#### REFERENCES:

Nuclear Regulatory Commission (NRC), "Staff Analysis of Public Comments on Proposed Rule 10 CFR Part 60, Disposal of High-Level Radioactive Waste in Geologic Repositories," Office of Nuclear Regulatory Research, NUREG-80804, December 1983.

United States Department of Energy (DOE), Topical Report, "Evaluation of the Potentially Adverse Condition 'Evidence of Extreme Erosion During the Quaternary Period' At Yucca Mountain, Nevada." Yucca Mountain Site Characterization Project,

OCRWM, YMP/92-41-TPR, 1993. 71 pps.

Figure 1. VCR Dates for Yucca Mountain Region (DOE, 1993)

