

JAN 11 1994

MEMORANDUM FOR: Joseph J. Holonich, Director
Repository Licensing and Quality
Assurance Project Directorate, HLWM

FROM: Ronald L. Ballard, Chief
Geology and Engineering Branch, HLWM

SUBJECT: PRELIMINARY DETAILED HLGE CONCERNS ON THE TOPICAL
REPORT "EVALUATION OF THE POTENTIALLY ADVERSE
CONDITION OF EXTREME EROSION DURING THE QUATERNARY
PERIOD AT YUCCA MOUNTAIN"

You will find enclosed preliminary HLGE concerns resulting from its review of the subject topical report. HLGE will use these concerns as the basis for discussion at the planned DOE/NRC site visit currently scheduled for February 1-2, 1994. Consequently, they are subject to change and should not be treated as open items at this stage.

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Ronald L. Ballard, Chief
Geology and Engineering Branch
Division of High-Level Waste
Management

Enclosure:
As stated

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PRELIMINARY NRC CONCERNS WITH EROSION TOPICAL REPORT

1. SCOPE OF THE TOPICAL REPORT

CONCERN 1

The Topical Report does not adequately address extreme erosion during the Quaternary period but rather addresses primarily long-term denudation as evidenced by dating relict boulder fields.

CONCERN 2

The methods used to calculate long-term average hillslope degradation rates, quoted in Topical Report Table 5 (p. 48), could underestimate the rates of erosion which have occurred in the Yucca Mountain region during individual (short-term) periods of erosion because pre-erosional topography cannot be determined. As a result, the staff is unable to determine how DOE will calculate reasonable rates of erosion which can be expected during the proposed repository's period of performance.

CONCERN 3

The rate of canyon cutting quoted on page 55 of the Topical Report apparently does not include erosion of stratigraphic units considered to overlie the Tiva Canyon member of the Paintbrush Tuff. As a result, the Topical Report could underestimate the past erosion rates in the Yucca Mountain region within such canyons. Since the canyon cutting rate cited on Topical Report page 55 is expressed in terms of incision into an unknown thickness of Miocene volcanics nearly 13 million years old, the staff is uncertain what methodology DOE will use for determination of the rate of canyon cutting expected to occur during the period of performance.

2. RELIANCE UPON A SINGLE CONTROVERSIAL DATING METHOD

CONCERN 4

The basis for the varnish cation ratio (VCR) dating method is not justified in the Topical Report. There are at least two different theories on why cation ratios vary in rock varnish, neither of which is discussed in sufficient detail to validate use of the dating method.

CONCERN 5

Different types of rock varnish may be present in an area, of which only some are suitable for cation-ratio dating (Dorn, 1989; Krinsley et al., 1990; Dorn and Krinsley, 1991). The Topical Report does not, but should, address how different types of rock varnish were recognized, and if different types of varnish textures were present in the studied rocks. Some researchers believe that measured cation-ratio variations may result from analysis of different textural types of rock varnish, rather than differences in the ages of the deposits.

CONCERN 6

Varnish from two compositionally and texturally distinct rock substrates, such as basalt and rhyolite as was used in the calibration curve, may not be directly comparable. Variations in varnish cation ratios may be influenced by differences in substrate composition or texture in addition to time-dependent processes.

CONCERN 7

The Uranium-Thorium disequilibrium dating method is reported as unsuitable for dating hillslope surfaces because this technique may not closely reflect the true age of the surface. If the U/Th dating technique is unsuitable for hillslope surface dating, then it must be explained how in more detail why the U/Th technique is suitable to establish the ages of the three alluvial deposits in the calibration curve.

CONCERN 8

Uncertainties for VCRs used to calculate dates in the Topical Report do not adequately represent the uncertainties commonly associated with SEM-EDS analyses which may be 10 to 15% (cf. Reneau et al, 1992).

CONCERN 9

The calibration curve used to calculate cation-ratio dates does not adequately represent the uncertainty associated with the data used to construct the curve.

CONCERN 10

What is the basis for selecting dates of 1.12 ± 0.07 Ma for Red Cone and 1.1 ± 0.3 Ma for Black Cone varnishes used in the calibration curve, when other different multiple dates of varying precision and accuracy are available for these volcanoes?

CONCERN 11

Why are the error bars for the VCRs in the calibration curve in the Topical Report roughly 75% smaller than reported in the original reference (Harrington and Whitney, 1987), when apparently identical analytical methods were used?

CONCERN 12

What is the basis for using the standardless semiquantitative (SSQ) program for VCR analyses when this program may not accurately determine Ti abundances in the presence of Ba? How was the Topical Report correction for these inadequacies derived? Has the correction to the SSQ-generated data also been applied to the calibration data?

CONCERN 13

What criteria were used to apparently discard selected VCR analyses from each sample set? In the data from the boulder deposits there are sometimes 7, 8, or 9 analytical sites on single disks (even taking into account that there are sometimes multiple readings at different KEVs at single sites). Why were more than six disk sites analyzed? Why, in some instances, were as many as 40% of the readings rejected?

CONCERN 14

In the raw VCR data for the 12 boulder-mantled geomorphic surfaces there appear to be considerably more data sets (readings from individual disks/boulders) than are referred to in the Topical Report (Table 4). Please clarify (1) which data were used to obtain the mean VCR's presented in the Topical Report (and in Harrington and Whitney, 1993) and (2) why some data were discarded.

CONCERN 15

Hooke and Dorn (1992, *Earth Surface Processes and Landforms*, v. 17, pp. 557-574) state that several VCR ages of greater than 250 ka from Death Valley "are near the limits of usefulness of the . . . technique" and may have uncertainties in excess of 100 ka. Might these comments also apply to the VCR dates presented in the Topical Report? If not, why not?

3. THE QUALIFICATION OF EXISTING DATA ON EROSION

CONCERN 16

The Peer Review Group (Birkeland, Oberlander and Hawley, 1989) indicated that more VCR calibration points were required and that additional absolute dating methods should be used (i.e., other than U-Trend analyses of the Crater Flat and Fortymile Wash alluvial terraces). This has not been done. The present VCR calibration curve appears to have no more data than that originally published by Harrington and Whitney (1987).

CONCERN 17

The Peer Review Group (1989) also suggested that there should be a check on the procedure for determining that the SEM-EDAX data truly represent the VCR data from the basal varnish layer and that substrate (host rock) is not interfering with the VCR determination. There is no information in the Topical Report to indicate that this suggestion has been incorporated in the current analysis. In some cases different KEVs (15, 20, 25, and 30) are used to obtain a cation ratio "profile" at one disk site. The lowest VCR reading is used in the calculations of the mean VCR. On some disks, however, only one KEV is used (for example, see samples from YMW-2). How can one be certain that even lower cation ratios are not present? In some instances, the lowest VCR readings on a single disk or individual boulder occur at different KEVs (for example, see YMW-1 sample identification WYM-03) but sometimes only one reading will be taken at some of the other sites on the same disk. This leads

to the possibility that still lower VCRs may be present. Clearly, this would lower the mean VCR for the disk, boulder, and geomorphic surface; however, it might also increase the standard deviation about the mean, thereby increasing the level of uncertainty.

4. COMPREHENSIVENESS OF THE DATA SUBMITTED

CONCERN 18

Although the development and issuance of a geomorphic map of Yucca Mountain is an important factor in the analysis for the evaluation and determination of the presence, or absence, of geomorphic processes such as extreme erosion, apparently no such map has been prepared by the DOE and submitted with the Topical Report.

CONCERN 19

Why does the Topical Report include no "data" supporting the amount of landscape change?

CONCERN 20

The raw VCR data for the Red Cone/Black Cone data points used on the calibration curve have not been provided. These data were assumed to have been included (but were not) with the data packages requested in NRC's Topical Report Acceptance Review letter of October 15, 1993 (Joseph J. Holonich, NRC, to Dwight E. Shelor, DOE).

CONCERN 21

Reneau et al. (1992) conclude that the initial composition of rock varnish controls VCRs and that Ca and K may not be preferentially leached out of varnish minerals. This hypothesis is based on variations in Ca, K, and Ti relative to Si, Mn, and Fe. Harrington and Whitney (1987) report that some varnish samples were analyzed for Si, Al, Fe, Mn, Mg, P, and S in addition to Ca, K, and Ti. These analyses should be provided in order to evaluate the hypothesis of Reneau et al. (1992).