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January 14, 1985
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Mr. Benjamin Rice, Project Manager
Geotechnical Branch
Division of Waste Management
Office of Nuclear Material Safety & Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Yucca Mountain Site, Nevada DEA Review Comments

Dear Mr. Rice:

The enclosed comments are the result of Weston Geophysical's review of the above referenced DEA. Our comments are presented in the format described in "Standard Review Plan for Draft Environmental Assessments", dated December 12, 1984.

As directed by you and your fellow staff members, we have concentrated our comments on significant aspects of the DEA documents which impact guideline criteria.

Should you have any questions or require clarification regarding this submittal, please contact us.

Very truly yours,

WESTON GEOPHYSICAL CORPORATION

John P. Imse

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Post Office Box 550 • Westboro, Massachusetts 01581 • (617) 366-9191

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DEA

YUCCA MOUNTAIN SITE, NEVADA

REVIEW COMMENTS
PREPARED BY
WESTON GEOPHYSICAL CORPORATION

FOR
THE UNITED STATES NUCLEAR REGULATORY COMMISSION

MAJOR COMMENT #1 DEA: YUCCA MOUNTAIN

SUBJECT: Tectonics

Comment: Virtually all tectonics discussions and conclusions consider and depend on two references that are used in a manner that is believed to be either misstated or misleading;

1. The Yucca Mountain area has had no significant surface displacement for the past 500,000 years is referenced to Rogers, et.al., 1983, [OFR-83-669]. The Open File Report is titled "Southern Great Basin Seismological Data Report, 1981 and Preliminary Data Analysis".

   Attached to this comment are pages 25 and 31 of the OFR. The seismic evidence has a clear conclusion based on the authors preliminary data analysis. The "500,000 year" and "40,000 year" elements, however, are geologic data, without evidence and apparently not based on seismological data and analyses of the subject Open File Report.

2. A statement is made repeatedly which includes the following "--shows no unequivocal evidence of surface displacement for 40,000 years--" this statement is based on an oral communication; it is specifically related to an absence of evidence as opposed or in contrast to unequivocal evidence of <u>no</u> surface displacement.

The 500,000 year element is a geologic conclusion without basis or separate reference in the OFR; the 40,000 year element is in reference to "--no unequivocal evidence--"; that is, only to an absence of evidence in order to demonstrate a significant conclusion concerning tectonic activity.

MAJOR COMMENT #2 DEA: YUCCA MOUNTAIN

Subject: Technical References and Uses of Reference Materials

Comment: Geophysical surveys and studies of regional significance, aeromagnetic surveys, gravity survey, and seismic refraction profiling, provide useful data concerning geologic crustal sections and constraints on modeled crustal sections. Some references such as OFR-84-120 concerning magnetic anomalies and OFR-82-701 concerning gravity investigations are referenced correctly; however others are not referenced: OFR-83-588 concerning the seismic refraction profiling, OFR-83-616 which is the aeromagnetic map of Yucca Mountain and

OFR-83-669

3. The most seismically active areas occur in regions of major Tertiary northeast-trending left-lateral shear. Three important zones in this categary are the Pahranagat, southern NTS, and Gold Mountain shear zones. Although some earthquakes are probably occurring on the northeast-trending faults, the larger earthquakes in these zones, for which focal mechanisms are available, have occurred on shorter intervening fault segments with a north strike.
4. Seismicity also occurs in north-trending faults zones. These earthquakes occur on or near segments of north-trending faults such as the Thirsty Canyon fault, Yucca fault, and Pahute Mesa faults (north-northeast trending) or are visible as north-trending epicenter lineations such as at Indian Springs Valley and Sarcobatus Flat.
5. Yucca Mountain lies within a broad zone of low-level seismicity extending on the west to the Funeral Mountains, on the south to the Black Mountains and Nopah Range. Another region of relative quiescence extends from near Gold Flat to Tonopah.
6. Focal mechanisms, epicenter lineations, and epicenter-fault associations indicate that earthquakes occur principally as right-lateral strike-slip events on north-trending faults. A focal mechanism for an M ~6 earthquake near the Nevada-Utah border in 1966 also indicated strike slip on a north-northeast-trending fault. Two M 4 earthquakes in 1971 and 1973 in southeast NTS were strike slip. Artifically induced earthquakes at Pahute Mesa and Lake Mead are either strike slip on north-trending faults or normal faulting on northeast-striking faults, indicating the likelihood that the northeast-trending faults are also active or potentially active.
7. A least principal stress with northwest orientation, and a greatest and intermediate principal stress of about equal magnitude are implied by the results to date. With this stress configuration faults of northwest orientation are less likely to produce earthquakes, a result that is supported by the current and historic seismicity, and by scarcity of northwest-striking Quaternary fault scarps east of Death Valley. The Death Valley-Furnace Creek, La Madre, and Las Vegas Valley shear zones are not presently producing earthquakes, although the presence of Holocene scarps on the Death Valley-Furnace Creek zone suggest that present quiescence there may be due to causes other than fault orientation.
8. From the historical seismicity of the southern Great Basin (two earthquakes of M ~6), and length of active faults, a maximum magnitude of M 6-7 is inferred for the SGB. Earthquake depths range between 0 and about 10 km; very few well-located events are deeper than 10 km. This observation suggests that faults of significant width are active in the SGB and supports the conclusion that a large earthquake is possible.
9. The only earthquake that has been located at Yucca Mountain in about 1 year of intensive monitoring has a magnitude of about 1.7. Faults there do not exhibit evidence of significant movement in at least the last 500,000 years, although their trend would permit slip in the present-day stress field similar to that resulting from historic and present-day seismicity on other north-to-northeast-trending faults in the SGB.

OFR 83-669

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shock (M = 6.1, USGS) was followed by an extensive aftershock series (fig. 15) in a single zone with a north-northeast orientation, as opposed to the finding of two active patches of aftershocks well-removed from the cluster of aftershocks surrounding the main shock (Beck, 1970). The focal mechanism of the 1966 main shock indicates nearly pure strike slip on either a vertical north-northeast-striking fault (right-lateral) or a nearly vertical east-southeast-trending fault (left-lateral) (Smith and Lindh, 1978). Although little is known of the geology in the epicentral region, transcurrent northeast-trending faults do occur there together with north-trending faults (Ekren and others, 1977). Because of the orientation of the 1966 aftershock zone and the existence in this region of north-trending faults, we conclude that the most likely faulting for the 1966 main shock was nearly pure right-lateral strike slip on a vertical north-northeast-trending fault.

In some respects the evidence for seismic hazard from the geologic record is in conflict with that from the seismic record. From the seismic evidence we must conclude that any faults of north to northeast trend are potentially active in the current stress field, whereas, the geologic data suggest that faults of this orientation, such as those at Yucca Mountain, have not had large (>1 m) surface displacement in the last 500,000 years, and have had no surface displacement in the last 40,000 years. That such disparities in fault activity are possible is the conclusion of studies in the northern Great Basin as well (Wallace, 1978). Even in active zones, areas exist that have been stable for hundreds of thousands of years. Until more is known about why areas are stable or unstable in the same region, however, it is not possible to rule out significant future seismic activity on faults at Yucca Mountain. This position is taken partly because (1) stress measurements at Yucca Mountain indicate that faults there may be near failure (Healy and others, 1982), and (2) faults of orientation and style similar to those at Yucca Mountain exist on Pahute Mesa, where extensive stress release has occurred after nuclear tests on faults approaching 10 km in length. Although movement on these faults was induced by nuclear explosions, the extent of faulting, the size of fault displacements, and the magnitude and depths of accompanying aftershocks indicate that these faults were tectonically stressed near the failure point, with slip being triggered by additional stresses produced by the nuclear explosions.

It should be noted that stress data alone cannot be used to conclude that earthquakes are likely in a given area. Important factors in rock failure along faults are the coefficient of friction and pore pressure. The former is derived from laboratory measurements, the latter assumes a hydrostatic condition due to the thickness of the saturated zone. Furthermore, the conditions required for a large earthquake to occur are (1) shear stresses approaching that required for failure over a large area of a fault zone, and (2) significant displacement at the time of failure. Alternatively, stresses could be relieved aseismically by fault creep, or in a series of numerous very small events. Abundant evidence suggests that scarps in the Great Basin are produced by large earthquakes, not creep (Bucknam and others, 1980; Crone, 1983), and there is very little evidence that creep is a significant mode of stress release in the Great Basin (R. C. Bucknam, oral commun., 1983). For instance, significant creep events on any of the numerous faults that are crossed by cultural features would be easily noted. Some Basin and Range

MAJOR COMMENT #2 Continued DEA: YUCCA MOUNTAIN

surrounding regions, and nearby geophysical surveys [OFR-81-101 and OFR-81-1350 are not referenced in the Chapter 6 reference list but are noted in Chapter 2 references].

A number of graphics included with those references, such as crustal sections across the Yucca Mountain area and vicinity which presents both gravity and seismic velocity data to depths of several kilometers are essential for understanding the geologic setting of Yucca Mountain.

DETAILED COMMENTS #6-1 DEA: YUCCA MOUNTAIN

Section: 6.3.1.7.5, 6.3.1.7.6, 6.3.3.4.3, 6.3.3.4.4, 6.3.3.4.5, 6.3.3.4.6

Comment: The above sections all refer to "no significant surface displacement for the past 500,000 years" - reference OFR-669, Rogers et.al. and/or personal communication from W.C. Swadley, USGS, 1984, Concerning the 40,000 year period. See Major Comment #1.

DETAILED COMMENT #4-1 DEA: YUCCA MOUNTAIN

Section: 4.1.1.2

Comment: The geophysical surveys and techniques described are presented rather succinctly and indicate the use of off-road vehicles. Such would be used for SITE-CHARACTERIZATION ACTIVITIES; some shallow drillholes may also be required for seismic energy generation by use of explosives set off in drilled shotholes. Such transportation and data acquisition efforts in a relatively arid area such as the Yucca Mountain site and vicinity will no doubt disturb the desert type vegetation, leave wheel tracks that will be susceptible to gullying during periods of heavy rainfall, and may therefore be considered as an effect on the landscape.