MAR 1 8 1991

Mr. Dwight E. Shelor, Acting Associate Director
for Systems and Compliance
Office of Civilian Radioactive Waste Management
U. S. Department of Energy, RW 30
Washington, D.C. 20585

Dear Mr. Shelor:

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION (NRC) STAFF REVIEW OF STUDY PLAN FOR CHARACTERIZATION OF VOLCANIC FEATURES

In a letter to the U.S. Department of Energy (DOE) dated August 20, 1990, NRC informed DOE that the NRC had found the Study Plan for Characterization of Volcanic Features (Study Plan 8.3.1.8.5.1) acceptable for further review, and in addition, that the NRC staff's Start-Work Review of that study plan had identified no objections with the activities proposed. NRC also indicated that it had decided to proceed with a Detailed Technical Review of that study plan. The purpose of this letter is to transmit the results of the NRC staff's Detailed Technical Review.

This study plan is one of a large group of study plans, perhaps 22 or more, which will provide information related to volcanism at Yucca Mountain. The NRC staff considers that this plan, by itself, is generally adequate to provide the information that it was designed to provide. However, inasmuch as this study plan represents only a small part of DOE's volcanism program, the overall sufficiency of DOE's program to address volcanism can only be evaluated after DOE submits the other study plans to NRC for review.

A concern regarding integration of the various programs in DOE's Site Characterization Plan (SCP) has been raised by NRC in its Site Characterization Analysis (SCA). This concern's applicability to the area of volcanism is apparent in the number of interrelated study plans that must be reviewed to understand the overall DOE volcanism program. The NRC staff considers that given the potential importance of volcanism at Yucca Mountain with respect to site suitability and licensing, it would be beneficial for DOE to prepare a summary document that clearly portrays the overall volcanism program, and in addition, the integration of the investigations, studies, and activities with other components of the site characterization program.

As DOE recognized in its transmittal of the procedures for this study plan, different procedures were prepared over a long period of time and under varying quality assurance (QA) requirements, giving rise to the possibility of inconsistent application of QA for this study plan. In the letter transmitting the procedures the DOE expressed a commitment to evaluate these procedures and to update them as necessary. The NRC staff considers that this action should be taken in the time frame necessary to assure that the data collected will be usable for licensing.

WM-11
102.8
NH16

In addition, many of the procedures transmitted to NRC either contain no acceptance criteria for accepting or rejecting information obtained in this study or lack sufficient acceptance criteria. This concern has previously been raised during NRC Observation Audits of the Los Alamos National Laboratory, which has the main responsibility for conducting the volcanism studies in the SCP. The NRC staff considers that the preparation of acceptance criteria which clearly identify the bases used to accept or reject information should be developed promptly so that these criteria are ready to be applied when data-gathering activities under this study plan begin.

Aside from these concerns, which have been raised in previous NRC communications to DOE, the NRC staff has identified three questions (Enclosure 1) with respect to the material in the subject study plan. These questions seek clarification of: why certain data from drill holes are not needed (Question 1); the geochronology methods considered and the rationale for the selection of methods ultimately chosen (Question 2); and the criteria used to select analog volcanic fields (Question 3).

The Detailed Technical Review questions on this study plan will be tracked by the NRC staff as open items similar to SCA objections, comments, and questions. NRC recommends timely resolution of these questions and is prepared to interact with DOE upon DOE's request to work toward resolution.

If you have any questions concerning this letter or the enclosure, please contact King Stablein (FTS/(301) 492-0446) of my staff.

Sincerely,
ORIGINAL SIGNED BY Joe Holonich
John J. Linehan, Acting Director
Repository Licensing and Quality
Assurance Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As Stated

cc: R. Loux, State of Nevada
C. Gertz, DOE/NV
S. Bradhurst, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO

DISTRIBUTION

CNWRA	NMSS R/F	HLPD R/F	LSS
LPDR	ACNW	PDR	Central File
BJYoungblood, HLWM	JBunting, HLEN	JLinehan, HLPD	RBallard, HLGP
On-Site Reps	JTrapp, HLGP	JBradbury,HLGP	PJustus, HLGP
DBrooks, HLGP			

*See previous concurrence

OFC	:HLPD*	:HLGP*	:HLGP*	:HLGP*	:HLPD	:
NAME	:KStablein	:JTrapp	:PJustus	:RBallard	:JLinehan	:
Date	:03/03/91	:03/04/91	:03/11/91	:03/13/91	:03/18/91	:

OFFICIAL RECORD COPY

Activity 8.3.1.8.5.1.1. Volcanism Drill Holes

Question 1

Why does the plan exclude collecting oriented core from drill holes?

Basis

"Magnetic polarity measurements require only preserving identified top and bottom segments of the drill core. Oriented samples are not needed for core from the volcanism drill holes" (p. 25).

However, in the paleomagnetic studies, the surface samples collected using a portable rock drill will be oriented (p.37). Thus, the magnetic inclination and declination can be determined.

Lacking orientation of the core, magnetic polarity can be determined only relative to the drill hole axis (equivalent to the magnetic inclination). Rotation about that axis is indeterminate. Thus, information that could be used to differentiate volcanic units will not be collected.

Recommendation

Explain why oriented core is not needed for the drill holes.

Activity 8.3.1.8.5.1.2. Geochronology Studies

Question 2

What constituted the suite of geochronology methods from which uranium-series disequilibrium, helium ratio, and thermoluminescence were chosen, and how was the selection made?

Basis

The approach of this activity is to determine the age of basaltic volcanism in the Yucca Mountain region using enough geochronology measurements (including repetition of measurements and use of alternative measurement techniques) to provide the maximum precision and accuracy of the techniques. "These measurements will constrain the x-axis error bars on a plot of cumulative magma volume versus time for the Yucca Mountain region" (p.30).

"Multiple K-Ar ages have been obtained for many of the Quaternary volcanic centers" (p.30). However, Sinnock and Easterling (1983) conclude that "Quaternary basalts with approximately 1.5% potassium content can be assigned an age at 90% confidence to within an interval of about 1 my if multiple samples are dated by several laboratories. If only one sample is dated by a single laboratory, the interval increases to about 1.4 my." The whole Quaternary is only 1.6 my, so K-Ar dating probably cannot be used to differentiate one Quaternary volcanic unit from another.

"Multiple techniques are being developed to attempt to date the youngest volcanic events and to refine the K-Ar chronology of the Quaternary volcanic centers in the Yucca Mountain region" (p.30). Uranium-series disequilibrium, helium ratio, and thermoluminescence "were chosen from a suite of possible geochronology methods because they are judged to have the maximum chance of success for estimating the ages of the volcanic rocks in the age range of 5000 to 100,000 years" (p.31).

The geochronology methods require the assumed existence of various conditions to be yield accurate ages. For example,

> The uranium-series disequilibrium method is based on developing an isochron by plotting Th-230/Th-232 versus U-238/Th-232 for cogenetic minerals that crystallized at the time of eruption and have remained closed to exchange ever since. "The samples will be crushed, and minerals (olivine, plagioclase, and iron-titanium oxides) will be separated..."(p.33). If these minerals occur as phenocrysts (or phases large enough to separate from the basalt), the assumption that crystallization occurred at the time of eruption could be suspect. Furthermore, as phenocrysts, it would be necessary to independently establish whether they are cogenetic. Gill and Williams (1990) state that the presence or absence of Th-U equilibrium is not related to volcano age or recharge rate.

The discussion on He-3 accumulation in basaltic volcanic rocks states that "the first process by which He-3 is produced in exposed rocks is by cosmic-ray-induced spallation of the major elements, and the second process is by capture of thermal neutrons by Li-6 to produce tritium, which decays to He-3" (p.33). The study plan does not discuss the effect of tritium produced by nuclear explosions on the estimation of He-3 accumulation.

Recommendation

Describe the suite of geochronology methods from which uranium-series disequilibrium, helium ratio, and thermoluminescence were chosen, and discuss the rationale for how the selection was made?

References

Gill, J.B. and Williams, R. W. 1990, Th isotope and U-series studies of subduction-related volcanic rocks, Geochimica et Cosmochimica Acta, vol. 54, pp.1427-1442.

Sinnock, S. and Easterling, R. G., 1983, Empirically determined uncertainty in potassium-argon ages for Plio-Pleistocene basalts from Crater Flat, Nye County, Nevada, Sandia Report, SAND82-2441.

Activity 8.3.1.8.5.1.5. Evolutionary Cycles of Basaltic Volcanic Fields

Question 3

How were the criteria established for the selection of analog volcanic fields in this activity?

Basis

"The approach of this study is to compile geologic data from the literature and obtain original data where required on the volcanic evolution of post-Miocene (§5.3 million years) volcanic fields of the southwest United States" (p.50).

"The lifetime of activity of basaltic volcanic fields generally appears to be bounded by the range of 1 to 10 million years, with most of the fields active for intervals of 3 to 6 million years" (p.22). In order to determine the patterns of the evolutionary cycles of volcanism, the temporal scale studied should be larger than the lifetime of an individual field (e.g., Shaw, 1988).

"Emphasis will be placed on selecting volcanic fields that are the most analogous to the Crater Flat volcanic field (small volume, alkali basalt)" (p.50). However, based on the age of the Lathrop Wells Cone, the Crater Flat volcanic field could still be considered active and thus, be significantly different in the future when the field is no longer active.

Recommendation

Describe the criteria that are used to constrain the selection of analog volcanic fields.

Reference

Shaw, H. R., 1988, Uniqueness of Volcanic Systems, USGS Professional Paper 1350.