Department of Energy
Washington, DC 20585

OCT 29 1991

Mr. John J. Linehan, Acting Director
Repository Licensing and Quality
Assurance Project Directorate
Division of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Linehan:

This is in response to your letter (Linehan to Shelor) dated March 13, 1991, in which the U.S. Nuclear Regulatory Commission (NRC) identified one comment and five questions relative to the U.S. Department of Energy (DOE) Study Plan 8.3.1.3.2.1, "Mineralogy, Petrology, and Chemistry of Transport Pathways."

Accordingly, enclosed are the responses to those concerns. For your information, the Yucca Mountain Site Characterization Project Office (YMPO) uses Administrative Procedure 1.14, Revision 1 ("Disposition of Comments on the Site Characterization Program"), to respond to comments on DOE-approved study plans.

Each NRC comment on this study plan has been given a unique identifier for YMPO tracking purposes. The package was forwarded to the technical project officer and principal investigator at the Los Alamos National Laboratory for an assessment of potential impact on the planned study. The results of that assessment are provided below.

The NRC cover letter raises a question with respect to study plan open items that the DOE would like to clarify. The NRC stated that work planned as part of this study plan "partially addresses an open item from the staff's detailed technical review of the Study Plan for Characterization of the Quaternary Regional Hydrology (8.3.1.5.2.1)." Use of the term "open item" implies that a concern expressed by the NRC was not satisfied by the DOE response for Study Plan 8.3.1.5.2.1. At this time, the DOE regards our responses for that study plan as adequate. In fact, we do not consider any NRC comment or question that the DOE has responded to for any study plan to be "open," except for Comment 1 in this response package. With the exception of Comment 1 on Study Plan 8.3.1.3.2.1, the DOE has made no commitments to perform an action in any written response to the NRC study plan comments or questions.

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If the NRC considers a response to any comment or question to be inadequate, we request that the NRC identify the comment or question that it considers "open." Each comment or question and the DOE's response has a unique identifier and is tracked on a relational data base. In this way, DOE management is aware of unresolved concerns or "open items" with respect to a particular study or activity. It is our intent to satisfy all NRC concerns.

Should you have any questions, please contact Sharon Skuchko of my office at (202) 586-4590.

Sincerely,

John P. Roberts
Acting Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

Enclosure:
DOE Responses to NRC Comments
on Study Plan 8.3.1.3.2.1

cc w/Enclosure:
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U.S. Department of Energy (DOE) Responses to NRC Comments on
Study Plan 8.3.1.3.2.1 (Mineralogy,
Petrology and Chemistry of Transport Pathways)

Comment 1

Although the Study Plan calls for gathering data on "textural relationships of minerals along potential groundwater pathways," which are important to establish stratigraphic location of core samples and to determine the accessibility of potentially sorbing phases to radionuclides, only the candidate host rock will be analyzed petrographically. Thus, it appears that inadequate information will be collected on rock outside the repository horizon.

Basis

The analytical techniques proposed for determining Quantitative Mineralogy of the Host Rock and Along Transport Pathways will be XRD and XRF (p. 14)

In addition to XRD and XRF, the candidate host rock will also be analyzed petrographically (p. 17).

Chemical variability in the host rock and along transport pathways will be determined by XRF, NAA, AA, and electron microprobe analysis (p. 19).

Although "petrographic thin sections will be prepared for all of the mineralogic samples" (p. 11), except for the work to be done on the fractures and faults (p. 23), petrographic analysis is not proposed for rocks outside of the Topopah Spring unit.

Textural information can be used to establish stratigraphic location of core samples and to determine the accessibility of potentially sorbing phases to radionclides.

Recommendation

Include petrographic analysis for determining textural relationships of minerals along the transport pathways between the Topopah Spring Member and the accessible environment.

Response

The DOE agrees that petrographic data on mineral textures should be collected for rocks along potential groundwater pathways. Such an activity is not explicitly called out for volcanic tuff units below the Topopah Springs Tuff Member. The Site Characterization Program Baseline does not explicitly exclude such work. The following text is proposed for a future revision of the Study Plan.

Section 3.1, end of second paragraph; "In addition, thin sections will be made to examine textural relationships between minerals along transport pathways to the accessible environment. Dyes may also be used to determine accessibility of potential sorbing phases to fluids that may carry radionuclides."

"ENCLOSURE"

Section 3.1.1, end of first paragraph; "Petrographic studies of textural relationships will be done, following the procedure for petrography."

LANL Procedure TWS-ESS-DP-03, (Petrography Procedure), will be added to the list of procedures in Study Plan section 3.1.1.

Question 1

Given that the accuracy of data from this study needed for transport modeling has yet to be determined, how were the methods of characterization selected?

Basis

"The purpose of this study is to characterize the mineralogy, petrology, and chemistry along potential groundwater flow paths leading from the repository to the accessible environment. Data gathered in this study will provide information about the types, abundances, distributions, compositions, and textural relationships of minerals along potential groundwater pathways. This information will be used in conjunction with data from sorption experiments (SCP Investigation 8.3.1.2.4) to evaluate radionuclide retardation by sorption processes along flow paths to the accessible environment" (p. 1).

"The accuracy of input required for transport modeling has not been determined yet, therefore the accuracy of results needed in this activity cannot be defined" (p. 15).

If it is determined in the future that greater accuracy is required for transport modeling than proposed in this study plan, work carried out according to this plan may be inadequate.

Recommendation

Explain how the methods of characterization were selected and do contingent plans exist if the requirements for accuracy for transport modeling are not met.

Response

The mineralogy determined in this study provides a framework for applying laboratory sorption data to three-dimensional representations of spatially distributed Kds in transport modeling codes. The methods of characterization were selected because they are standard, well understood techniques for determining mineralogy, petrology, and chemistry, have a high degree of accuracy and precision, and are cost effective. In some cases, the methods selected are the only appropriate techniques for determining the parameters of interest (e.g. X-ray diffraction for mineralogy and electron microprobe for mineral chemistry); in other cases, there is little difference in the quality of information from competing techniques (e.g. X-ray fluorescence vs. atomic absorption) and the method was selected based on cost effectiveness.

While it is true that the needed accuracy of input for transport modeling is not yet been determined in planning documents, this study has taken a conservative approach to site characterization in that the data collected are expected to be far more accurate than what is eventually required by transport modelers. Given the uncertainties in other model parameters, it is extremely unlikely that the analytical methods will fail to be accurate or precise enough to meet the input needs of transport models. A more important problem is the difficulty in determining the numbers of samples that should be studied to adequately characterize the site. Although Los Alamos considers our approach conservative, the possibility exists for sampling drill core at higher densities, should the need arise. The statistical evaluation of mineralogic information, as outlined

in section 3.5 of the Study Plan, will be used to evaluate the adequacy of drill hole spacing for extrapolating data between drill holes.

Question 2

Could the effect of characterizing thin sections of core primarily cut in a vertical orientation significantly bias the estimations of types, abundances, distributions, compositions, textural relationship of minerals along potential groundwater pathways such that calculated radionuclide retardation would be overestimated?

Basis

The Procedure for Determination of Volume Constituents in Thin Sections of Rocks (TWS-ESS-DP-102, R2) describes that only "under exceptional circumstances" will horizontal thin sections be cut where sample size is critical.

"The unsaturated zone beneath the Yucca Crest consists of a layered sequence of tuffs deposited from volcanic eruptions..."(Hoxie, 1989).

Due to contrasts in hydraulic conductivity between horizontal layers, lateral components of flow may be significant. "In aquifer-aquitard systems with permeability contrasts of 2 orders of magnitude or more, flowlines tend to become almost horizontal in the aquifers and almost vertical in the aquitards" (p. 173, Freeze and Cherry, 1979). At Yucca Mountain, for example, Tiva Canyon welded tuff has a saturated hydraulic conductivity of 10E-11 m/s, whereas the underlying Paintbrush nonwelded unit has a saturated hydraulic conductivity of 10E-7 m/s (Hoxie, 1989).

Recommendation

Provide evidence to show that studying thin sections primarily cut in a vertical orientation will not bias estimations of types, abundances, distributions, compositions, and textural relationships of minerals along flow paths to be used in transport modeling.

References

Freeze, R. A. and J. A. Cherry, 1979, Goundwater, Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

Hoxie, D. T., A conceptual model for the unsaturated-zone hydrologic system, Yucca Mountain, Nevada, in Radioactive Waste Management and the Nuclear Fuel Cycle, 1989, Vol. 13(1-4), pp. 632-75.

Response

The use of thin sections cut normal to the plane of foliation (or bedding) refers to studies of the internal stratigraphy of the Topopah Spring Tuff Member. This activity is developing a stratigraphic correlation methodology for the massive, densely-welded, devitrified interior of this ashflow unit. In this activity, thin sections are prepared normal to the plane of foliation because samples in this orientation are considered more representative of the variety of microscopic textures found in this chemically homogeneous but texturally heterogeneous rock unit. Because most of the microscopic textures are elongated in the plane of foliation, thin sections cut parallel to the foliation can easily over-represent or under-represent the proportion of textures present because of the very small area of the thin-section.

Question 3

How do the parameters characterizing rocks and minerals determined in this study correlate with parameters important to sorption to be collected in Study Plan 8.3.1.3.4.1: Batch Sorption Studies?

Basis

"The purpose of this Study is to characterize the mineralogy, petrology, and chemistry along potential groundwater flow paths leading from the repository to the accessible environment. Data gathered in this study will provide information about the types, abundances, distributions, compostions, and textural relationships of minerals along potential groundwater pathways. This information will be used in conjunction with data from sorption experiments (SCP Investigation 8.3.1.3.4) to evaluate radionuclide retardation by sorption processes along flow paths to the accessible environment" (p. 1).

Work planned in Activity 8.3.1.3.4.1.1, Batch sorption measurements as a function of solid phase composition, will determine correlations of sorption coefficients with mineralogy (p. 8.3.1.3-70). The solid parameters, which may be important to sorption, such as surface area, site density, cation exchange capacity, etc.., will be determined on pure mineral separates in the sorption studies.

Recommendation

Explain how the information from this study will be used in the sorption studies.

Response

The information gathered in this study is used by the sorption study to identify the rocks and minerals appropriate for the experiments to be conducted under the sorption Study Plan. Eventually, distributed Kds will have to be assigned to rock units, packages of rock units, or key lithologies (depending on the radionuclide) in order to model radionuclide transport. Because only a limited number of sorption experiments are possible, assignment of the distributed Kds for modeling will be done by relating Kds to the more extensive mineralogic, petrologic, and chemical data sets for Yucca Mountain.

Question 4

What is the method for determining changes in lithology?

Basis

"Analyses will be performed on samples from core and from the exploratory shaft samples whenever changes in lithology are apparent so that complete mineralogical data are available for all lithologies" (p. 14).

It is not evident that the method for determining changes in lithology is described in any of the listed detailed procedures.

Recommendation

Provide a description of the method for determining changes in lithology.

Response

Changes in lithology will be determined by noting changes in rock color, crystallinity, textures, degree of welding, lithic contents, degree of alteration, bedding characteristics, and hardness. Definition of these characters is embodied in technical procedures TWS-ESS-DP-03 (Petrography Procedure) and TWS-ESS-DP-102 (Determination of Volume Percent of Constituents in Thin Sections of Topopah Spring Member and Similar Rhyolites). The latter procedure is your standard thin section point-counting procedure.

Question 5

What is the difference between software verification and validation and model verification and validation?

Basis

"The software used to support licensing will be verified and validated according to the LANL Software QA plan" (p. 13).

The term "model validation" is defined by Brooks and Coplan (1987) as the method taken to assure that a model is a correct representation of the process or system for which it is intended. Consensus on how to achieve assurance does not yet exist.

The term "software validation" is unfamiliar to the NRC technical reviewers, and its meaning is unclear in the study plan.

Recommendation

Discuss the difference between software verification and validation used in this study plan and model verification and validation.

Reference

Brooks, P. and S. Coplan, 1987, the role of verification and validation in licensing repositories for disposal of high-level waste, Proceeding of GEOVAL 1987, vol. 1, p. 41.

Response

Software verification and validation described in this Study Plan refers to software used to collect, reduce, and manage analytical data gathered in the course of this study. Use of the term "validation" in the context of the cited passage (Study Plan p. 13) is incorrect. The Los Alamos software quality assurance plan (SQAP) (LANL-YMP-SQAP) was accepted by the Yucca Mountain Site Characterization Project Office on January 25, 1991. It defines and describes procedures for the verification and validation of analytical software. "Software verification" is defined in the LANL SQAP as, "a process for demonstrating that, 1) the requirements specified for the software are accurately and completely reflected in the emerging software system, and 2) that the performance and operation of the system is correct and consistent with these requirements." The principal investigator and Los Alamos stand corrected with respect to inclusion of the word "validation".

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