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**MEMORANDUM FOR:** Joseph Holonich, Director  
Repository Licensing and Quality Assurance  
Project Directorate  
Division of High-Level Waste Management, NMSS

**FROM:** Margaret V. Federline, Branch Chief  
Hydrology and Systems Performance Branch  
Division of High-Level Waste Management, NMSS

**SUBJECT:** REVIEW OF DOE RESPONSE TO NRC COMMENTS ON STUDY PLAN  
8.3.1.3.2.1 MINERALOGY, PETROLOGY, AND CHEMISTRY OF  
TRANSPORT PATHWAYS

This memorandum transmits the staff review of the Department of Energy (DOE) responses to NRC comments on DOE Study Plan 8.3.1.3.2.1, Mineralogy, Petrology, and Chemistry of Transport Pathways. This review was conducted by John Bradbury of the Hydrologic Transport section.

The staff review of the subject study plan resulted in the development of one comment and five questions as open items which were transmitted to DOE in a letter from John Linehan to Dwight Shelor dated March 13, 1991. The DOE response to the comment and questions was presented in the October 29, 1991, letter from John Roberts to John Linehan. The staff evaluation of the response is provided in the attachment.

As a result of our review of the DOE response, the staff considers that Comment 1 and Questions 2, 4 and 5 are closed and Questions 1 and 3 remain open. Both of these questions pertain to the use of the data from this study in transport modeling. It is the staff's opinion that the parameters important for calculating radionuclide migration have yet to be identified. Consequently, although the mineralogic and petrologic techniques described in this study plan are necessary to characterize the stratigraphy and structure of Yucca Mountain, the data collected in this study may not provide the required information needed for modeling radionuclide transport. Identification of important parameters for radionuclide transport is part of the batch sorption studies. The mineralogy, petrology, and chemistry study, apparently, is not waiting for input from the batch sorption tests. The

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possibility exists that different parameters from those identified in this study may need to be determined if indicated by the batch tests.

If there are any questions regarding this review, please contact John Bradbury at 504-2535.

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Margaret V. Federline, Branch Chief  
Hydrology and Systems Performance Branch  
Division of High-Level Waste Management, NMSS

Enclosure: As stated

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| NAME | JBradbury/ga    | DBrooks                 | MFederline |  |  |
| DATE | 07/2/92         | 07/2/92                 | 07/2/92    |  |  |

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### 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. The NRC staff recommended that the study include petrographic analysis for determining textural relationships of minerals along the transport pathways between the Topopah Spring and the accessible environment.

### Evaluation of DOE Response

- o The DOE agrees that petrographic data on mineral textures should be collected for rocks along potential groundwater pathways.
- o Such an activity is not explicitly called out for volcanic tuff units below the Topopah Spring Member.
- o A future revision of the Study Plan will include the statement that "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."
- o The NRC staff considers this comment closed.

### 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? The NRC staff recommended that the DOE explain how methods of characterization were selected and whether contingent plans exist if the requirements for accuracy for transport modeling are not met.

### Evaluation of DOE Response

- o The DOE states that 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.
- o The DOE states that 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.
- o The DOE states that in some cases the methods selected are the only appropriate techniques for determining the parameters of interest.
- o The NRC staff is not convinced that this study plan will provide the parameters important for modeling radionuclide transport. It has not yet been demonstrated that bulk mineralogy has a significant effect on Kd.

At the NEA Sorption Workshop in Interlaken, Switzerland from October 14-18, 1991, it was postulated that sorption of species may be controlled not by the types of aluminosilicate minerals present but by a thin coating of goethite on minerals. The amount of goethite however, is generally below detection limit of the standard, well understood methods. Without understanding the actual mechanisms of sorption, it is premature to state that the methods will provide the parameters of interest. Although the DOE did respond to the question the concern remains and, thus, is considered open.

### 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, and textural relationships of minerals along potential groundwater pathways such that calculated radionuclide retardation would be overestimated?

### Evaluation of DOE Response

- o The DOE states that the thin sections are prepared normal to the plane of foliation because in this orientation samples are considered more representative of the variety of microscopic textures found in this chemically homogeneous but texturally heterogeneous rock unit.
- o 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.
- o The NRC staff understands the DOE response concerning over- or under-representation of the proportions of textures. The question was raised with one possible conceptualization in which a packet of water containing radionuclides might not travel in a predominantly vertical direction, in the plane of the thin section, but instead might take a stepwise path, being diverted laterally along foliation planes, and then cutting across foliations. In this way the proportions of phases and textures encountered by the packet of fluid might be different from that which is estimated from the thin section. The dye technique described in the response to Comment 1 may shed some light on this conceptualization. The question is considered closed.

### 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?

### Evaluation of DOE Response

- o The DOE stated that the information 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.

- o 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.
- o 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.
- o It has yet to be demonstrated that Kds correlate with the mineralogic, petrologic, and chemical data to be collected in this study. The NRC staff considers this question is open.

#### Question 4

What is the method for determining changes in lithology?

#### Evaluation of DOE Response

- o The DOE stated that 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.
- o The NRC staff considers this question closed.

#### Question 5

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

#### Evaluation of DOE Response

- o The DOE states that the word "validation" should not have been included in the sentence referring to the software to be used in this study.
- o The NRC staff considers this question closed.