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December 23, 1992

Dr. John W. Bartlett, Director
Office of Civilian Radioactive
Waste Management, RW-1
U.S. Department of Energy
1000 Independence Ave. S.W.
Washington, DC 20585

Dear Dr. Bartlett:

The State of Nevada has reviewed the DOE Study Plan "Study Plan for Mineralogy, Petrology, and Chemistry of Transport Pathways" (Study Plan 8.3.1.3.2.1, revision 0) and is providing its comments in this letter and attachment. The State's comments address the adequacy, completeness, and technical accuracy of the Study Plan to meet the Department's objective in site characterization.

The State has the following general comments relative to the subject Study Plan.

1. The purpose of this study is to characterize the mineralogy and associated parameters along ground-water flowpaths leading from the repository to the accessible environment. This study recognizes vadose and saturated-zone matrix and fracture flow pathways and accurately states that at Yucca Mountain, they are not well-defined. Due to this lack of definition, this study will investigate all possible flowpaths between the repository and the accessible environment. Given that the Study has the lofty goal of investigating all possible flowpaths, the study provides little confidence that scientifically the goal is achievable. It is doubtful that the Study can obtain conservative data representative of pre-emplacment behavior along critical pathways required for licensing.

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2. Given the indecision portrayed in the Study Plan relative to defining flowpaths for sampling, sampling techniques, quantity of samples, and the representativeness of the samples, there appears to be little value in the overall Study Plan as well as the study itself. Unless the overall unsaturated-zone program can define a focused well-planned sampling strategy that has the ability to intersect critical elements in the subsurface stratigraphy that can be used to characterize rock matrix and fracture-flow pathways between the repository and the accessible environment, characterization with respect to the performance objective as required by 10CFR60.113 will not be accomplished. Rigorous analytical efforts on poorly chosen samples will do nothing other than provide volumes of useless data. Predictive models of mineralogy and chemistry derived from such data through kriging exercises will be unconvincing. Therefore, this Study Plan demands significant revision. Improvement needs to be made on a conceptual design basis and not with respect to argumentative justification of the value of extrapolation techniques.

Should you have questions, this Office is available to meet with the Department to discuss the State's comments at any time.

Sincerely,



Robert R. Loux
Executive Director

RRL:CAJ

Attachments

cc: Carl Gertz, YMPO
✓ Joe Youngblood, NRC
Dade Moeller, NRC-ACNW
Dwayne Weigel, GAO
Steve Kraft, EEI
John Cantlon, NWTRB

ATTACHMENT

The State of Nevada comments on Study Plan 8.3.1.3.2.1 "Study Plan for Mineralogy, Petrology, and Chemistry of Transport Pathways."

1. It appears the objective of this study is to provide data for all possible flowpaths between the repository and the accessible environment. In order to provide these data, this study will characterize drill core, surface outcrops, and exploratory study facility (ESF) material. At this point in time, it is not known with certainty whether ESF drifts will penetrate the Calico Hills horizon, which has been designated as the primary barrier for waste isolation. The Calico Hills formation will be characterized by use of drillholes shown in figure 2 (a total of nine holes in the exploration block and about twelve holes outside the exploration block boundary). It is uncertain whether these drillholes are adequate to characterize all possible flowpaths. Drillholes in figure 1 (page p. 8) are not appropriately QA classed and therefore their utility is uncertain.
2. Section 2.2 (page 6) discusses the types of measurements and determinations to be made. This section needs to match the types of measurements and determinations that are planned in the objectives of the study. Section 2.3 can then provide further rationale. At present, it is unclear how the measurements described in Section 2.2 will actually address the specific objectives of this study.

Textural relationships of minerals in fractures by SEM needs to be more detailed. For example, are crystal orientation studies going to be made?

When abundance of minerals in fractures using X-ray diffraction are made, how will these data relate to mineral accessibility to fracture flow liquids? If a general scraping technique is being used to collect all authigenic minerals located on a fracture surface, this would presumably include authigenic minerals buried by other authigenic minerals. Knowledge of the authigenic fracture mineralogy, in part, is required for retardation studies. Minerals require accessibility to transport fluids if they are to provide sorption.

3. Section 2.4 describes the sampling program planned for this study. Subsection 2.4.1 describes the location of drillholes anticipated for sample collection. The distribution of the systematic drillholes presents the following problems:
 - (1) Limited accessibility to zeolitic Calico Hills formation - the primary barrier.

- (2) No apparent attempt towards drilling fracture-zone intersections within the Calico Hills formation to ascertain the potential retardation characteristics of the more likely paths of transport. An attempt to "investigate all possible flow paths" between the repository and the accessible environment is therefore not apparently being accomplished.
- (3) Drillholes USW G-5 and USW G-6 are presumably located in the zeolitic Calico Hills formation. Only the WT-23 and WT-24 holes are located between the USW holes and the SD-1 and SD-2 holes. It is unknown what retrievable core data will be acquired from the WT holes (presumably only cuttings). Consequently, it will be difficult to establish a correlation that will be statistically valid between the SD hole and the USW holes. The utility of the USW holes will be limited with respect to characterizing flow pathways.
- (4) "For purposes of characterization of potential transport pathways, the holes used need to be fully cored and extended to the first major laterally transmissive zone below the water table." (Section 2.4.1, p. 10, paragraph 3). This also has not been defined (with respect to the SD holes) as noted in the study plan. Consequently, drillholes G-5, G-6, and G-7 are to be used for characterization, neither of which is located within the exploration block boundary. There are apparently, therefore, only three drillholes that at present can be utilized to characterize transport pathways and these are outside the licensing zone.

The Calico Hills formation is an ash-flow tuff which is presumably well-zeolitized in the north end of the exploration block and becomes increasingly vitric southward. Holes SD-1 and SD-2 are therefore the dominant locations for the penetration and characterization of well-zeolitized Calico Hills formation, whereas UZ-2, UZ-3, UZ-8, UZ-7, SD-7, SD-8, SD-9, SD-10, SD-11, SD-12, and VSP-1 can be utilized to characterize the more vitric ash-flow tuff. Holes SD-3, SD-4, SD-5, and SD-6 can be used to assess the transition between the zeolitized and vitric areas. The distribution of sampling locations to obtain data characterizing the Calico Hills formation (the primary barrier) could be justifiable if the exploratory study facility would also penetrate the Calico Hills formation. As this is not known presently, a serious concern is raised as to the adequacy of sample distribution. Special concern is raised with respect to sorption characteristics within paths of most likely transport.

The systematic drilling program described in the SCP, indicates that the holes will be drilled to 100 feet below Static Water Level (SWL) and in this Study Plan, page 9, figure 2 hole depth is proposed to be at 200 feet below SWL. It is unknown which of the two, the Study Plan or the SCP, is correct in their notation.

4. Section 3.1.2. (page 15) discusses the required accuracy and precision for identification of minerals present in tuffs. The Plan indicates detection precision to $\pm 5\%$ of the determined amount for bulk samples. There is no discussion of minerals which occur in percentages below 5%. Further the Plan is silent on whether X-Ray powder diffraction will include "unambiguous" volcanic glass determinations.

The section also discusses an analysis of fracture coatings and emphasizes that the primary purpose is the identification of minerals in fractures, not quantification of amount. If quantification of fracture coatings is not an objective, how will the acquired fracture mineral data be utilized for retardation-sorption studies. Further discussion is required.

5. Section 3.1.4 (page 16) addresses data reduction and analysis. Quant 5 and XRF-11 software procedures are critical with respect to defining a large portion of the study plan data. These procedures should be broken out and discussed on a more comprehensive basis.
6. On page 16-17 the following statement is made:

"As outlined above, our ability to define the mineralogy along potential groundwater pathways from the repository to the accessible environment will ultimately be limited by our ability to predict the locations of these pathways, not by our ability to obtain mineralogic data for the site."

This statement underlines the basic issue relative to the value of this Study Plan. It appears that this Study Plan is written in a manner that attempts to justify a sampling strategy which was really not designed to locate and assess groundwater pathways. This Study Plan needs to recognize that criteria have to be set on what constitutes a pathway, to what extent it (that "pathway") can be recognized as a pathway, how well that pathway needs to be defined in a lateral and stratigraphic sense, and what mineralogical and chemical data need to be acquired in that pathway to respond to key characterization issues. A well-focused organizational framework is not evident. This problem is not unique to this Study Plan, rather it appears that this Study Plan is uniquely cognizant of these problems but is unable to resolve them with the Yucca Mountain program structure.

7. Page 21 discusses the determination of mineral and glass compositions. It should be noted that when analyzing volcanic glass, it will be important to obtain concentrations of water of hydration. The methods for these analyses need to be discussed.

8. In Section 3.4 (page 23) the Plan states that isotopic data obtained on fracture-lining minerals and fluid inclusion data will be integrated with the results from this activity to interpret mineral paragenesis. The isotopic data needed for this integration should be outlined in this Section.

Past-transport pathways studies are very important. It would be beneficial to discuss dating methods that might be used to ascertain the timing of various events beyond mineralogical overgrowth data.

9. Section 3.5 (page 26) describes a statistical evaluation of mineralogic, petrographic, and chemical data. The discussion fails to relate the statistical evaluation to the objective of the study: mineralogy, petrology, and chemistry of the transport pathways. Until the sampling program focuses on groundwater (transport) pathways, a statistical evaluation of the data has little or no validity.

10. There is a serious attempt in this Study Plan to address the mineralogic and chemical characterization along groundwater flowpaths leading from the repository to the accessible environment. It is doubtful; however, that objectives of this study will be met given the constraints which include:

- (1) Poor sampling strategy;
- (2) Lack of defining criteria, which provides recognition of such pathways; and
- (3) An incomplete focus on analytical techniques that might be diagnostic in responding to the key objective and associated issues.