Department of Energy
Washington, DC 20585

DEC 19 1990

Mr. John J. Linehan
Director, Division of High-Level
Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Linehan:

Enclosed are responses to four comments and six questions made by the NRC on three activities in Site Characterization Plan (SCP) Study Plan 8.3.1.5.2.1, "Characterization of the Quaternary Regional Hydrology." It is the Yucca Mountain Site Characterization Project Office (YMSCPO) decision that no change is required to the Study Plan at this time.

None of the NRC concerns are directly linked with comments or questions already provided in its site characterization analysis. Revision 2 of Administrative Procedure (AP)-1.10Q (Preparation, Review, Approval, and Revision of SCP Study Plans) specifies that comments on Study Plans are handled by the process defined in AP-1.14 (Disposition of Comments on the Site Characterization Program).

Each NRC comment or question on this Study Plan has been given a unique identifier for YMSCPO tracking purposes. The DOE response package was forwarded to the U.S. Geological Survey Technical Project Officer and Principal Investigator(s) for an assessment of potential impact on the planned study/activity and a recommendation for how each comment may be addressed if the NRC concerns were not already being addressed in the planned study.

These responses may not provide a final disposition of the NRC comments, because some comments cannot be resolved without accumulating further data from the field, or without involving additional interactions with regard to further interpretation of regulatory requirements.

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NH03

Should you have any questions in this regard, please contact either Sharon Skuchko of my office on (202) 586-4590 or me on (202) 586-1462.

Sincerely,

Linda J. Desell

Linda J. Desell, Acting Chief
Regulatory Integration Branch
Office of Systems and Compliance
Office of Civilian Radioactive
Waste Management

Enclosure:
DOE Responses to NRC Comments on Study Plan 8.3.1.5.2.1, "Characterization for the Quaternary Regional Hydrology"

cc:
R. Loux, State of Nevada
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
S. Bradhurst, Nye County, NV

NRC COMMENTS ON
STUDY PLAN 8.3.1.5.2.1

Comment Number	Page	Group Assigned	Comment description
1	3	HYD	Evidence to be considered for establishing paleowater table evaluations appears to be restricted to near-surface calcite-silica veins.
2	6	G	Planned thermal flight data may not provide sufficient areal coverage for the characterization of regional properties.
3	7	HYD	Characterization of organic material in spring and other water-precipitated deposits is not planned.
4	14	ADM	DOE should provide the "unpublished data" cited in the subject study plan.

Question Number	Page	Group Assigned	Comment description
1	8	G	Resolution of LANDSAT data adequate to provide the information needed?
2	9	HYD	Can electromagnetic conductivity be used to determine depth to the ground-water table as needed in this study plan?
3	10	HYD	What techniques will be used to determine the age of the ground water?
4	11	HYD	How will the estimate of analog recharge be determined if the chloride ion mass balance and the water budget approaches do not agree well?
5	12	G	What techniques will be used to characterize the silica deposits?
6	13	HYD, GC	Will tracer isotopic compositions be determined for analog deposits and compared to those in trench 14?

"ENCLOSURE"

U.S DEPARTMENT OF ENERGY RESPONSES TO COMMENTS RECEIVED FROM THE U.S. NUCLEAR REGULATORY COMMISSION ON STUDY PLAN 8.3.1.5.2.1

The U.S. Nuclear Regulatory Commission (NRC) submitted comments on 3 activities that are part of Study Plan 8.3.1.5.2.1 in a letter to the U.S Department of Energy dated June 8, 1990. The DOE prepared an index summarizing the comments, which are as labled in the NRC's letter and enclosure. Four comments and 6 questions were identified. Comment 4 was identified in the body of the cover letter. A copy of the original comment package is provided for cross reference. The DOE response package reproduces each comment, followed by a response. Responses have been cross-referenced to other responses that address comments on similar overall themes, as appropriate.

NRC COMMENTS AND RESPONSES TO STUDY PLAN 8.3.1.5.2.1

Study Plan 8.3.1.5.2.1, Characterization of the Yucca Mountain Quaternary Regional Hydrology

COMMENT 1:

Evidence to be considered for establishing paleowater table elevations appears to be restricted to near-surface calcite-silica veins.

Basis

One of the major aspects of the present study is to identify Quaternary fluctuations of water table elevation.

The work planned for this study is focused on near-surface (trench) deposits. For example,

"The objective of the activity on studies of calcite and opaline-silica vein deposits is to determine the ages, distribution, origin, and paleohydrologic significance of calcite and opaline-silica deposits along faults and fractures in the vicinity of Yucca Mountain. Geologic investigations at Yucca Mountain have exposed a large, vein-like deposit of calcite and opaline silica in a fault intersected by Trench 14. These deposits are also exposed in trenches north and south of Trench 14."

"A multidisciplinary approach to the origin of the hydrogenic deposits in Trench 14 is advocated."

"The number of locations studied will have to be left open to a degree. At least one example of each of the four main possible analogs [to the deposits exposed in trenches in the vicinity of Yucca Mountain] will be studied in detail; pedogenic, hydrothermal spring, deep-circulating cold spring, and perched water table spring or seep."

Although the study plan calls for deepening Trench 14 and sequential drilling to intersect the fault at increasingly greater depths under Trench 14, this effort is only to "determine the vertical extent of the calcite and opaline silica below the present level of exposure in Trench 14..." Maximum depth of these drill holes is 80m.

One other statement in the study plan mentions characterization of subsurface conditions. In the activity on evaluation of past-discharge areas, it is stated that "a few very deep holes (2,500 to 5,000 ft) may also be required in conjunction with the regional hydrology program in order to evaluate deep flow properties or other aspects of the hydrogeology of particular aquifers that are of concern to this program." It is not clear that the "other aspects of the hydrogeology" include paleowater-table elevations.

Minerals found within faults and fractures can vary as a function of depth. This variation may be due to changes in conditions or processes (e.g., Carlos, 1985). Deposits near surface tend to reflect near-surface conditions and processes; deposits at depth tend to reflect subsurface conditions and

processes. Thus, although Trench 14 may show evidence that pedogenic conditions and processes have occurred there, evidence for elevated groundwater tables in the subsurface have already been suggested. For example, "Nonwelded glass shards preserved in the host rock above the zeolite-mineral transition in the fractures indicate that the water table was never higher than the lithic-rich base of the Topopah Spring Member in the vicinity of USW G-4" (Carlos, 1985). This is 400 feet above the present water table level.

The study of vein deposits appears limited to characterizing veins that contain calcite and opaline-silica. However, other studies indicate calcite is not a common vein-filling material in some drill core. For example, Carlos (1989) states that "No calcite was found in any of the fractures in J-13." This is to be expected as the groundwater from well J-13 is unsaturated with respect to calcite (Kerrisk, 1987). On the other hand, zeolites are common in fractures at depth. Furthermore, Carlos (1989) states "the presence of heulandite in fractures could be used to map the highest position of paleowater tables since the formation of the heulandite." Also, it may be possible to establish time constraints on water table fluctuations inasmuch as Sturchio et al., 1989, has demonstrated the use of U- and Th-series disequilibrium in age determinations of zeolites.

Recommendation

Include in this study the evaluation of subsurface evidence of paleowater table levels such as the characterization of available subsurface samples containing calcite and opaline-silica veins as well as other minerals that could be used to establish paleowater table elevations.

References

Carlos, B.A., 1985, Minerals in fractures of the unsaturated zone from drill core USW G-4, Yucca Mountain, Nye County, Nevada, Los Alamos National Laboratory, LA-10415-MS.

Carlos, B.A. 1987, Minerals in fractures of the saturated zone from drill core USW G-4, Yucca Mountain, Nye County, Nevada, Los Alamos National Laboratory, LA-10927-MS.

Carlos, B.A., 1989, Fracture-coating minerals in the Topopah Spring Member and Upper Tuff of Calico Hills from drill hole J-13, Los Alamos National Laboratory, LA-11504-MS.

Kerrisk, J.F., 1987, Groundwater Chemistry at Yucca Mountain, Nevada, and Vicinity, Los Alamos National Laboratory, LA-10929-MS.

Sturchio, N.C., Bohlke, J.K. and C.M. Binz, 1989, Radium-thorium disequilibrium and zeolite-water ion exchange in a Yellowstone hydrothermal system, Geochemica et Cosmoschimica Acta, Vol 53, 1025-1034.

Response:

Obtaining evidence for establishing paleowater table elevations is not restricted to near-surface calcite-silica veins as suggested by Comment 1. This task is addressed by Activity 8.3.1.5.2.1.3 (Evaluation of Past Discharge Areas) of the subject study plan. Currently, the scope of work for the Quaternary Regional Hydrology Study Plan does not explicitly include acquisition of core material for analysis of calcite-silica fracture and vein-filling material. Information about the deposition of minerals on fractures and faults obtained from drill core will be accomplished as part of Study 8.3.1.3.2.1 (Mineralogy, Petrology and Chemistry of Transport Pathway) and Study Plan 8.3.1.3.2.2 (History of Mineralogic and Geochemical Alteration of Yucca Mountain) to be conducted by Los Alamos National Laboratory (LANL). These studies are to provide data to evaluate the existence of paleowater table(s) by investigating the geochemical and isotopic composition of the fracture filling minerals and its variation with depth. Cooperation will take place between the United States Geological Survey (USGS) and LANL so that information and samples can be exchanged between these USGS and LANL studies.

Activity 8.3.1.5.2.1.3 Evaluation of past discharge areas

COMMENT 2:

Planned thermal scanner flight data may not provide sufficient areal coverage for the characterization of regional properties.

Basis

Figure 3.3-4 of the study plan illustrates the approximate boundary of the thermal scan. The area is a rectangle measuring 1.5 km x 4.5 km (7 square kilometers) along the south end of Yucca Mountain.

Figure 3.3-3 of the study plan illustrates selected present- and past-discharge areas addressed by activity 8.3.1.5.2.13. This map measures 123.4 km x 171.6 km (21, 180 square kilometers).

Thus, the thermal scan will cover only three hundredths of a percent of the region under consideration in this study plan.

Recommendation

Either the area proposed to be investigated by thermal scanning should be justified or it should be expanded to a size more appropriate for characterizing the Yucca Mountain Quaternary regional hydrology.

Response:

The thermal scanning mission, as described in the study plan, is a prototype-methods study to determine if this form of remote sensing can be used for characterizing hydrologic properties. As such, it is not meant to produce results applicable to the entire region to be examined by the past discharge activity. If the prototype method works on a site-specific scale, application to a regional scale should be possible. The specific test area was chosen so that the technique could be tested by researchers examining the unsaturated zone (Study Plan 8.3.1.2.2.3). The results of the prototype scanning mission can be used to evaluate the utility of increasing the areal coverage by subsequent scanner missions.

Activity 8.3.1.5.2.1.5 Studies of calcite and opaline-silica vein deposits

COMMENT 3:

Although shallow opaline deposits, where organic factors have affected uranium distribution, will be compared with deeper opaline deposits to model uranium transport, characterization of organic material in spring and other water-precipitated deposits is not planned.

Basis

The plan states (3.5-19) that organic factors (e.g., roots) have an effect on the distribution of uranium in opaline deposits near the surface.

The geochemical tests in Section 3.5.3.5 will examine bulk compositions of spring deposits and other water-precipitated deposits in terms of major-, minor-, and trace-element compositions.

In these studies only inorganic species will be analyzed.

Although the role of organic species may be minor in volcanic terrains at depth, it is not clear whether organic species are unimportant in depositional processes near the surface.

Organic material present in surface and ground water may influence the minor- or trace-element composition of water-precipitated deposits due to their ability to complex or adsorb various elements (Means and Hastings, 1979).

The ages of the deposits will be determined using methods that involve uranium (uranium-series disequilibrium and uranium trend). Thus, organic factors might affect age determinations.

Analysis of organic material, if present in sufficient amounts, may provide additional information regarding the thermal history of the deposits.

Recommendation

Include in this activity the analysis of organic "factors" affecting uranium distribution or explain why such an analysis is not needed.

Reference

Means, J.L. and D.W. Hastings, 1979, Status report on the importance of natural organic compounds in groundwater as radionuclide-mobilizing agents, OWNI-84.

Response:

The reference to uranium mobility was intended to indicate that quantities of water needed to form the deposit as calculated from the quantity of opaline silica and standard inorganic chemical parameters might not produce a definitive result. Evidence for this caveat is provided by the fact that living matter apparently affects uranium distribution in opal. The fact that the redistribution is caused by near-surface organic matter can be

demonstrated by comparing deep and shallow opals. There is no intent in the study to address the detailed question of organic effects on mineral precipitation.

COMMENT 4:

One final point is that in the subject study plan there is "unpublished data" cited as supporting information. As NRC has previously requested in regard to DOE documents submitted for review, unpublished data and reports should be submitted to NRC with the document to be reviewed. Hence, DOE should provide the "unpublished data" cited in the subject study plan.

Response:

The U.S. Department of Energy (DOE) has requested that the Principal Investigator for Study Plan 8.3.1.5.2.1 (Characterization of the Quaternary Regional Hydrology) submit the "unpublished data" cited in the study plan to DOE. When DOE receives this information it will then provide the U.S. Nuclear Regulatory Commission with the "unpublished data."

Activity 8.3.1.5.2.1.3 Evaluation of past-discharge areas

QUESTION 1:

Is the resolution of LANDSAT data adequate to provide the information needed in the study plan?

Basis

"LANDSAT data are chosen for the following reasons: 1. good spatial resolution (30 x 30 meters per picture element), 2. good spectral resolution, and 3. the regional nature of the study" (pp. 3.3-8,9).

The 30 x 30 meter resolution of LANDSAT limits its use to distinguishing only large discharge areas (greater than 30 x 30 meters) and may not be useful in thematic mapping and correlation development relative to the Yucca Mountain block itself.

Recommendation

Provide evidence supporting the use of this technique in this study.

Response:

The LANDSAT data are adequate for the stated purposes. The LANDSAT Thematic Mapper (TM) data were chosen for reconnaissance-level paleodischarge analysis. As stated in the Study Plan, site-specific studies will follow to provide finer-scale resolution for areas of potential discharge. The LANDSAT TM data level (approximately 4,000 by 4,300 pixels which converts to 16 megabytes per channel) was also chosen for data management purposes. Airborne scanning would provide greater resolution, but at much greater cost. Furthermore, the number of pixels needed to cover the study area would exceed the data storage and manipulation capabilities of the computational facility. Finally, the spatial resolution of LANDSAT TM data is better than 30 m^2 in cases where the spectral differences between background and features of interest are large. This is exemplified by the resolution of roads crossing vegetated areas. The spatial dimensions and true location of the road may not be properly represented, but the road will be observable.

Activity 8.3.1.5.2.1.3 Evaluation of past-discharge areas

QUESTION 2:

Can electromagnetic conductivity be used to determine depth to the groundwater table as need in this study plan?

Basis

"This work will be coordinated with regional groundwater flow-system work (Study Plan 8.3.1.2.1.3) to map the water table in areas where well data are scarce. This effort will be done as a precursor to the drilling program" (p. 3.3-25).

"Water levels showing large vertical changes in small distances near the edges of groundwater basins may indicate changes in transmissivity, changes in structural thickness, or both. They may also represent buried structural features. Furthermore, they will have to be investigated if alternate conceptual models for past and present regional hydrology are to be tested" (p. 3.3-25).

Variation in water content both above and below the water table can affect the ability of this method to define the depth to the water table (e.g., Lahoud et al., 1984 and Rush et al., 1983).

Recommendation

Provide evidence supporting the use of this technique in this study.

References

Lahoud, R.G., D.H. Lobmeyer, and M.S. Whitfield, Jr., 1984, Geohydrology of volcanic tuff penetrated by Test Well UE-25b-1, Yucca Mountain, Nye County, Nevada, USGS-WRI-84-4253, Water Resources Investigation Report, The United States Geological Survey, Denver, CO.

Rush, F.E., W. Thordarson, and L. Bruckheimer, 1983, Geohydrologic and drill-hole data for Test Well USW H-1, Adjacent to Nevada Test Site, Nye County, Nevada, USGS-OFR-83-141, Open File Report, The United States Geological Survey, Denver, CO.

Response:

The use of the Geonics model EM-34 for the measurement of electromagnetic ground conductivity is to be tested in the study area as a possible tool for locating shallow water tables or perched water and geologic structures. Such a tool is essential because the area near the spring line in the Amargosa Desert is under the control of the U.S. Fish and Wildlife Service and that agency prefers that surface disturbing work be avoided where possible. Maximum resolution for the EM-34 is reported to be 60 m depth for homogeneous deposits, and reliable measurements may be obtained for 10 to 30 m depth in non-homogeneous deposits (McNeill 1980a,b). The Amargosa Desert near the Moretti Pit is known to have a shallow water table 5 to 6 m below land surface. The EM-34 will be run near the Moretti Pit to see if it will produce

a good match to the known depth. Application of the EM-34 by Downey and Sinton (1990) produced good results in an inhomogeneous glacial outwash deposit where water table depths were 3 to 6 m.

References:

Downey, J.S., P.O. Sinton, 1990, Geohydrology and groundwater geochemistry at a sub-arctic landfill, Fairbanks, Alaska: US Geological Survey, Water-Resource Investigations Report 90-4022, 25p.

McNeill, J.D., 1980a. Electromagnetic terrain conductivity measurement at low induction numbers: Technical note TN-6, Geonics Ltd., Ontario, Canada, 15p.

McNeill, J.D., 1980b. EM34-3 Survey Interpretation techniques: Technical note TN-8, Geonics Ltd., Ontario, Canada. 15p.

Activity 8.3.1.5.2.1.3 Evaluation of past-discharge areas

QUESTION 3:

What techniques will be used to determine the age of the ground water?

Basis

It is stated in Section 3.3.3.3, Estimation of Past-potentiometric Head By Analysis of Mineral Deposits, that "Samples [of carbonate and water] will be dated using various chemical or physical dating methods (as described in Section 3.5.3)," and "Radioisotopic analysis may be run on up to 50 water samples to attempt to determine the age of water in the aquifers ..."

However, there is no discussion of groundwater dating techniques in Section 3.5.3.

Recommendation

Describe the groundwater dating techniques.

Response:

Groundwater dating will be done under Study Plan 8.3.1.2.3 (Characterization of Percolation in the Unsaturated Zone--surface based study). Groundwater ages are to be calculated using the following radioisotopes; tritium, C-14, CI-36, I-129, Kr-85, U-series, Ar-39 and Kr-87.

Activity 8.3.1.5.2.1.4 Analog recharge studies

QUESTION 4:

How will the estimate of analog recharge be determined if the chloride ion mass balance and the water budget approaches do not agree well?

Basis

In Section 3.4.3.4 Estimation of recharge by the chloride-ion mass balance model (Claassen et al., 1986), the statement is made that "If results from the two models [hydrologic-budget model and chloride-ion mass balance model] do not agree well, it may be necessary to obtain a third estimate in order to reduce uncertainty.

The method for obtaining the third estimate has not been identified.

Recommendation

Provide a description of the steps that will be taken in the event that the two models do not agree well.

Reference

Claassen, H.C., Reddy, M.M., and Halm, D.R., 1986, Use of the chloride ion in determining hydrologic-basin water budgets - a 3-year case study in the San Juan Mountains, Colorado, U.S.A.: Journal of Hydrology, Vol 85, pp. 49-71.

Response:

If the chloride ion and water budget models do not agree, the choice between them or use of both will depend on the results obtained and perhaps an analysis of why the results disagree. It may be that the more conservative of the two results will be used. Reference to a third model was made with the knowledge that U.S. Geological Survey research personnel from outside the YMP were trying to develop an alternative model. Reference to two alternative approaches are presented in Section 3.4.3.4. These are 1) an approach using soil properties and vegetation analysis only, and 2) an approach using estimates of paleotemperature and paleoprecipitation derived from biological evidence in packrat middens.

Activity 8.3.1.5.2.1.5 Studies of calcite and opaline-silica vein deposits

QUESTION 5:

What techniques will be used to characterize the silica deposits?

Basis

"The proposed studies [on fracture-filling material, wall rock of the fractures, and samples of possible analog materials] will use standard mineralogic techniques, including X-ray diffraction analysis of bulk samples and mineral separates, petrographic microscopy of thin sections, polished sections, and grains in oils, and scanning electron microscopy of fresh surfaces, etched surfaces, and grain mounts" (p. 3.5-18).

However, in the next paragraph it is stated that "mineralogical studies of the silica deposits, including the drusy quartz, will utilize some or all of the same techniques listed above" (p. 3.5-18).

If only "some" of the techniques are used, without stipulating which specific techniques will be used, it is not possible to assess whether the silica material will be adequately characterized.

Recommendation

The study plan should state which techniques will be used in characterizing geologic materials.

Response:

Until all or at least some of the techniques have been tried to determine what techniques will provide the more useful results, the principal investigator cannot predict which, if any, techniques will not be used.

All or some of the techniques identified will be used. The techniques that appear to be more effective will be identified as a result of early testing. Results and the techniques used will be identified in an appropriate Site Characterization Progress Report.

Activity 8.3.1.5.2.1.5 Studies of calcite and opaline-silica vein deposits

QUESTION 6:

Will tracer isotopic compositions be determined for analog deposits and compared to those in Trench 14?

Basis

Isotopic compositions of materials precipitated from ground waters may record the paleopath of water movement. Thus, comparisons of isotopic compositions between analog deposits and the calcite-silica veins in Trench 14 may give clues to their genetic relationships.

In Section 3.5.3.8 Tracer-isotope investigations, it is stated in the first paragraph that "isotopic compositions of strontium and lead in the calcite-silica deposits and in samples from possible analog materials will be determined to see if these data will provide constraints on the calcite and opaline-silica deposits."

In the third paragraph of this section, it is stated that "radiogenic tracer isotopes will not be determined for the analog deposits."

Recommendation

Correct the conflicting statements such that it is clear whether isotopic compositions of analog deposits will be determined.

Response:

Tracer isotopes will not generally be used on the analog deposits because the results are not directly related to the Trench 14 problem. Although tracer isotopes such as strontium reflect the history of the depositing fluid, the reflection is only a picture of the local geology through which the fluid passed. For example, the strontium in an analog deposit may reflect isotopic equilibrium with a particular formation at great depth, an identical isotopic composition for a deposit of unknown origin need not lead to the same conclusion because the formation from which the analog deposit derived its isotopic signature may not occur anywhere near the deposit of unknown origin.

NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

6/8/90

Mr. Ralph Stein, Associate Director
for Systems Integration and Regulations
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, RW-30
Washington, D.C. 20585

Dear Mr. Stein:

SUBJECT: NRC STAFF REVIEW OF QUATERNARY REGIONAL HYDROLOGY STUDY PLAN

In my letter to you dated November 24, 1989, I informed you that the NRC staff had found the study plan "Characterization of the Yucca Mountain Quaternary Regional Hydrology" (Study Plan 8.3.1.5.2.1) 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. These results were qualified to the extent that inasmuch as DOE submitted material on only three of the five activities in that study plan, the review results apply only to the three activities that were submitted for review. I also indicated that the NRC 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 of the three activities submitted for review.

In conducting its Detailed Technical Review, the staff noted that the study plan indicates work from other studies as well as information from the two missing activities of the subject study plan will be used to meet the objectives of the subject study plan. As those other study plans and missing activities are submitted for NRC review, the staff will need to revisit the subject study plan in the light of the later submittals to evaluate whether the totality of activities laid out will provide the information needed to meet the study's objectives.

With respect to the material in the subject study plan, the staff has identified three comments and six questions. Most of the concerns relate to whether carrying out the activities described can provide adequate or sufficient data to meet the study plan's objectives; however, Comment 1 identifies a possible gap in the planned work which might prevent meeting one of the objectives.

Comment 4

One final point is that in the subject study plan there is "unpublished data" cited as supporting information. As NRC has previously requested in regard to DOE documents submitted for review, unpublished data and reports should be submitted to NRC with the document to be reviewed. Hence, DOE should provide the "unpublished data" cited in the subject study plan.

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

Sincerely,

John J. Linehan, 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

DETAILED TECHNICAL REVIEW COMMENTS ON THE STUDY PLAN CHARACTERIZATION OF THE YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY (8.3.1.5.2.1)

Study Plan 8.3.1.5.2.1. Characterization of the Yucca Mountain Quaternary Regional Hydrology

Comment 1

Evidence to be considered for establishing paleowater table elevations appears to be restricted to near-surface calcite-silica veins.

Basis

One of the major aspects of the present study is to identify Quaternary fluctuations of water-table elevation.

The work planned for this study is focused on near-surface (trench) deposits. For example,

> "The objective of the activity on studies of calcite and opaline-silica vein deposits is to determine the ages, distribution, origin, and paleohydrologic significance of calcite and opaline-silica deposits along faults and fractures in the vicinity of Yucca Mountain. Geologic investigations at Yucca Mountain have exposed a large, vein-like deposit of calcite and opaline silica in a fault intersected by Trench 14. These deposits are also exposed in trenches north and south of Trench 14."
>
> "A multidisciplinary approach to the origin of the hydrogenic deposits in Trench 14 is advocated."
>
> "The number of locations studied will have to be left open to a degree. At least one example of each of the four main possible analogs [to the deposits exposed in trenches in the vicinity of Yucca Mountain] will be studied in detail; pedogenic, hydrothermal spring, deep-circulating cold spring, and perched water-table spring or seep."

Although the study plan calls for deepening Trench 14 and sequential drilling to intersect the fault at increasingly greater depths under Trench 14, this effort is only to "determine the vertical extent of the calcite and opaline silica below the present level of exposure in Trench 14..." Maximum depth of these drill holes is 80m.

One other statement in the study plan mentions characterization of subsurface conditions. In the activity on evaluation of past-discharge areas, it is stated that "a few very deep holes (2,500 to 5,000 ft) may also be required in

conjunction with the regional hydrology program in order to evaluate deep flow properties or other aspects of the hydrogeology of particular aquifers that are of concern to this program." It is not clear that the "other aspects of the hydrogeology" include paleowater-table elevations.

Minerals found within faults and fractures can vary as a function of depth. This variation may be due to changes in conditions or processes (e.g., Carlos, 1985). Deposits near surface tend to reflect near-surface conditions and processes; deposits at depth tend to reflect subsurface conditions and processes. Thus, although Trench 14 may show evidence that pedogenic conditions and processes have occurred there, evidence for elevated ground-water tables in the subsurface have already been suggested. For example, "Nonwelded glass shards preserved in the host rock above the zeolite-mineral transition in the fractures indicate that the water table was never higher than the lithic-rich base of the Topopah Spring Member in the vicinity of USW G-4" (Carlos, 1985). This is 400 feet above the present water table level.

The study of vein deposits appears limited to characterizing veins that contain calcite and opaline-silica. However, other studies indicate calcite is not a common vein-filling material in some drill core. For example, Carlos (1989) states that "No calcite was found in any of the fractures in J-13." This is to be expected as the ground water from well J-13 is unsaturated with respect to calcite (Kerrisk, 1987). On the other hand, zeolites are common in fractures at depth. Furthermore, Carlos (1989) states "the presence of heulandite in fractures could be used to map the highest position of paleowater tables since the formation of the heulandite." Also, it may be possible to establish time constraints on water-table fluctuations inasmuch as Sturchio et al., 1989 has demonstrated the use of U- and Th-series disequilibrium in age determinations of zeolites.

Recommendation

Include in this study the evaluation of subsurface evidence of paleowater table levels such as the characterization of available subsurface samples containing calcite and opaline-silica veins as well as other minerals that could be used to establish paleowater table elevations.

References

Carlos, B.A., 1985, Minerals in fractures of the unsaturated zone from drill core USW G-4, Yucca Mountain, Nye County, Nevada, Los Alamos National Laboratory, LA-10415-MS.

Carlos. B.A., 1987, Minerals in fractures of the saturated zone from drill core USW G-4, Yucca Mountain, Nye County, Nevada, Los Alamos National Laboratory, LA-10927-MS.

Carlos, B.A., 1989, Fracture-coating minerals in the Topopah Spring Member and Upper Tuff of Calico Hills from drill hole J-13, Los Alamos National Laboratory, LA-11504-MS.

Kerrisk, J.F., 1987, Groundwater Chemistry at Yucca Mountain, Nevada, and Vicinity, Los Alamos National Laboratory, LA-10929-MS.

Sturchio, N.C., Bohlke, J.K. and C.M. Binz, 1989, Radium-thorium disequilibrium and zeolite -water ion exchange in a Yellowstone hydrothermal system, Geochimica et Cosmochimica Acta, Vol 53, 1025-1034.

Activity 8.3.1.5.2.1.3 Evaluation of past discharge areas

Comment 2

Planned thermal scanner flight data may not provide sufficient areal coverage for the characterization of regional properties.

Basis

Figure 3.3-4 of the study plan illustrates the approximate boundary of the thermal scan. The area is a rectangle measuring 1.5 km x 4.5 km (7 square kilometers) along the south end of Yucca Mountain.

Figure 3.3-3 of the study plan illustrates selected present- and past-discharge areas addressed by activity 8.3.1.5.2.1.3. This map measures 123.4 km x 171.6 km (21,180 square kilometers).

Thus, the thermal scan will cover only three hundredths of a percent of the region under consideration in this study plan.

Recommendation

Either the area proposed to be investigated by thermal scanning should be justified or it should be expanded to a size more appropriate for characterizing the Yucca Mountain Quaternary regional hydrology.

Activity 8.3.1.5.2.1.5 Studies of calcite and opaline-silica vein deposits

Comment 3

Although shallow opaline deposits, where organic factors have affected uranium distribution, will be compared with deeper opaline deposits to model uranium transport, characterization of organic material in spring and other water-precipitated deposits is not planned.

Basis

The plan states (3.5-19) that organic factors (e.g., roots) have an effect on the distribution of uranium in opaline deposits near the surface.

The geochemical tests in Section 3.5.3.5 will examine bulk compositions of spring deposits and other water-precipitated deposits in terms of major-, minor-, and trace-element compositions.

In these studies only inorganic species will be analyzed.

Although the role of organic species may be minor in volcanic terrains at depth, it is not clear whether organic species are unimportant in depositional processes near the surface.

Organic material present in surface and ground water may influence the minor- or trace-element compositions of water-precipitated deposits due to their ability to complex or adsorb various elements (Means and Hastings, 1979).

The ages of the deposits will be determined using methods that involve uranium (uranium-series disequilibrium and uranium trend). Thus, organic factors might affect age determinations.

Analysis of organic material, if present in sufficient amounts, may provide additional information regarding the thermal history of the deposits.

Recommendation

Include in this activity the analysis of organic "factors" affecting uranium distribution or explain why such an analysis is not needed.

Reference

Means, J.L. and D.W. Hastings, 1979, Status report on the importance of natural organic compounds in groundwater as radionuclide-mobilizing agents, BWNI-84.

Activity 8.3.1.5.2.1.3 Evaluation of past-discharge areas

Question 1

Is the resolution of LANDSAT data adequate to provide the information needed in this study plan?

Basis

"LANDSAT data are chosen for the following reasons: 1. good spatial resolution (30 x 30 meters per picture element), 2. good spectral resolution, and 3. the regional nature of the study" (pp. 3.3-8,9).

The 30 x 30 meter resolution of LANDSAT limits its use to distinguishing only large discharge areas (greater than 30 x 30 meters) and may not be useful in thematic mapping and correlation development relative to the Yucca Mountain block itself.

Recommendation

Provide evidence supporting the use of this technique in this study.

Activity 8.3.1.5.2.1.3 Evaluation of past-discharge areas

Question 2

Can electromagnetic conductivity be used to determine depth to the ground-water table as needed in this study plan?

Basis

"This work will be coordinated with regional ground-water flow-system work (Study Plan 8.3.1.2.1.3) to map the water table in areas where well data are scarce. This effort will be done as a precursor to the drilling program" (p. 3.3-25).

"Water levels showing large vertical changes in small distances near the edges of ground-water basins may indicate changes in transmissivity, changes in structural thickness, or both. They may also represent buried structural features. Furthermore, they will have to be investigated if alternate conceptual models for past and present regional hydrology are to be tested" (p. 3.3-25).

Variation in water content both above and below the water table can affect the ability of this method to define the depth to the water table (e.g., Lahoud et al., 1984 and Rush et al., 1983).

Recommendation

Provide evidence supporting the use of this technique in this study.

References

Lahoud, R.G., D.H. Lobmeyer, and M.S. Whitfield, Jr., 1984, Geohydrology of volcanic tuff penetrated by Test Well UE-25b-1, Yucca Mountain, Nye County, Nevada, USGS-WRI-84-4253, Water Resources Investigation Report, The United States Geological Survey, Denver, CO.

Rush, F.E., W. Thordarson, and L. Bruckheimer, 1983, Geohydrologic and drill-hole data for Test Well USW H-1, Adjacent to Nevada Test Site, Nye County, Nevada, USGS-OFR-83-141, Open File Report, The United States Geological Survey, Denver, CO.

Activity 8.3.1.5.2.1.3 Evaluation of past-discharge areas

Question 3

What techniques will be used to determine the age of the ground water?

Basis

It is stated in Section 3.3.3.3, Estimation of Past-potentiometric Head By Analysis of Mineral Deposits, that "Samples [of carbonate and water] will be dated using various chemical or physical dating methods (as described in Section 3.5.3)," and "Radioisotopic analysis may be run on up to 50 water samples to attempt to determine the age of water in the aquifers ...."

However, there is no discussion of ground-water dating techniques in Section 3.5.3.

Recommendation

Describe the ground-water dating techniques.

Activity 8.3.1.5.2.1.4 Analog recharge studies

Question 4

How will the estimate of analog recharge be determined if the chloride ion mass balance and the water budget approaches do not agree well?

Basis

In Section 3.4.3.4 Estimation of recharge by the chloride-ion mass balance model (Claassen et al., 1986), the statement is made that "If results from the two models [hydrologic-budget model and chloride-ion mass balance model] do not agree well, it may be necessary to obtain a third estimate in order to reduce uncertainty.

The method for obtaining the third estimate has not been identified.

Recommendation

Provide a description of the steps that will be taken in the event that the two models do not agree well.

Reference

Claassen, H.C., Reddy, M.M., and Halm, D.R., 1986, Use of the chloride ion in determining hydrologic-basin water budgets - A 3-year case study in the San Juan Mountains, Colorado, U.S.A.: Journal of Hydrology, Vol 85, pp. 49-71.

Activity 8.3.1.5.2.1.5 Studies of calcite and opaline-silica vein deposits

Question 5

What techniques will be used to characterize the silica deposits?

Basis

"The proposed studies [on fracture-filling material, wall rock of the fractures, and samples of possible analog materials] will use standard mineralogic techniques, including X-ray diffraction analysis of bulk samples and mineral separates, petrographic microscopy of thin sections, polished sections, and grains in oils, and scanning electron microscopy of fresh surfaces, etched surfaces, and grain mounts" (p. 3.5-18).

However, in the next paragraph it is stated that "mineralogical studies of the silica deposits, including the drusy quartz, will utilize some or all of the same techniques listed above" (p. 3.5-18).

If only "some" of the techniques are used, without stipulating which specific techniques will be used, it is not possible to assess whether the silica material will be adequately characterized.

Recommendation

The study plan should state which techniques will be used in characterizing geologic materials.

Activity 8.3.1.5.2.1.5 Studies of calcite and opaline-silica vein deposits

Question 6

Will tracer isotopic compositions be determined for analog deposits and compared to those in Trench 14?

Basis

Isotopic compositions of materials precipitated from ground waters may record the paleo-path of water movement. Thus, comparisons of isotopic compositions between analog deposits and the calcite-silica veins in Trench 14 may give clues to their genetic relationsnips.

In Section 3.5.3.8 Tracer-isotope investigations, it is stated in the first paragraph that "isotopic compositions of strontium and lead in the calcite-silica deposits and in samples from possible analog materials will be determined to see if these data will provide constraints on the calcite and opaline-silica deposits."

In the third paragraph of this section, it is stated that "radiogenic tracer isotopes will not be determined for the analog deposits."

Recommendation

Correct the conflicting statements such that it is clear whether isotopic compositions of analog deposits will be determined.

COMMENT 4

One final point is that in the subject study plan there is "unpublished data" cited as supporting information. As NRC has previously requested in regard to DOE documents submitted for review, unpublished data and reports should be submitted to NRC with the document to be reviewed. Hence, DOE should provide the "unpublished data" cited in the subject study plan.

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

Sincerely,

ORIGINAL SIGNED BY
John J. Linehan, Director
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Enclosure: As stated

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