ENCLOSURE B

PHASE I REVIEW: CHARACTERIZATION OF THE VERTICAL AND LATERAL DISTRIBUTION OF STRATIGRAPHIC UNITS WITHIN THE SITE AREA (DOE STUDY PLAN 8.3.1.4.2.1, REV. 0)

by

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August 27, 1992

I. PURPOSE AND OBJECTIVE

1. Is the information to be obtained in the study described?
   Yes__X__ No_____ N/A_____

2. Is the rationale for information to be obtained provided?
   Yes__X__ No______ N/A______

II. RATIONALE FOR STUDY/INVESTIGATION

1. Does the study plan provide the rationale for tests and analysis, indicating alternatives considered and options, advantages, and limitations?
   Yes__X__ No_____ N/A________

2. Does the study plan provide the rationale for the number, location, duration and timing of tests, considering uncertainty, and identify obvious alternatives?
   Yes__X__ No______ N/A_________

   Staff Comment: Reference is made in the rationale and justification section of each of the five activities to Study Plans/Activities not yet submitted to the NRC for review.

<u>Suggestion</u>: It would appear that the NRC has at least two options wherein this matter could be handled. One way would be to enumerate (perhaps by a blanket statement) those sections of the subject study plan for which the NRC would <u>not</u> give its approval until submittal and approval (no objection) being referenced. The other option would be to raise an objection to the conduct of the entire study pending submittal of the referenced study/activity and approval (no objection) of such documents.

3. Does the study plan describe the constraints for the study?
   Yes__X__ No______ N/A_________

4. In describing the constraints for the study, does the study plan consider potential site impacts?
   Yes__X__ No_____ N/A_____

<u>Staff Comment</u>: The constraint section of each of the five activities indicates that conducting the described tests would have no potential impact on the site yet Section 2.4.4 (p. 2-17) indicates that drilling and coring operations being conducted under another activity (not part of this study) may have some potential impact on the site. Neither the nature of the impact nor the identification of the activity potentially impacting the site are identified.

5. In describing the constraints for the study, does the study plan consider the need to simulate repository conditions?
   Yes__X__ No_____ N/A______

6. In describing the constraints for the study, does the study plan consider the required accuracy and precision?
   Yes__X__ No_____ N/A_____

<u>Staff comments on the remaining Study/Investigation Rationale topics:</u> Although the response to the following topics is in the affirmative there is nothing of substance for the staff to review were this study plan to be considered as a candidate for a detailed review. As far as the reviewer can determine, positive, acceptable words and phrases were inserted in the study plan, with no basis for such statements given in the plan itself.

7. In describing the constraints for the study, does the study plan consider the limits of analytical methods?
   Yes__X__ No_____ N/A______

8. In describing the constraints for the study, does the study plan consider the capability of analytical methods?
   Yes__X__ No_____ N/A_____

9. In describing the constraints for the study, does the study plan consider time required vs. time available?
   Yes__X__ No_____ N/A_____

   Staff Note: The above affirmative is to be caveated in that "timing" is mentioned in the study plan, but no details underlying the basis for such a statement have been provided.

   Suggestion: One item that is not addressed is the dependence of this study upon other studies that have been initiated as well as upon those that have not yet been initiated. This point deserves much more attention than has been devoted to it since the accomplishment of site characterization activities and the subsequent development of the License Application is directly dependent upon the completion and evaluation of all the identified studies. Non-completion of the studies would have an adverse impact on the timely submittal of the License Application. Such a potential delay bears "flagging".

10. In describing the constraints for the study, does the study plan consider the scale of phenomena and parameters?
    Yes__X__ No_____ N/A_____

11. In describing the constraints for the study, does the study plan consider interference among tests
    Yes__X__ No_____ N/A_____

12. In describing the constraints for the study, does the study plan consider interference between tests and exploratory shaft
    Yes__X__ No_____ N/A_____

III. DESCRIPTION OF TESTS AND ANALYSIS

1. For each type of test does the study plan describe the general approach that will be used?
   Yes__X___ No_____ N/A_____

2. For each type of test does the study plan describe the key parameters that will be measured in the test and experimental conditions under which the test will be conducted?
   Yes__X___ No_____ N/A_____

3. For each type of test does the study plan indicate the number of tests and locations?
   Yes__X__ No_____ N/A______

   Staff Comment: In the case of some tests, the number of specific locations for the particular test type is given but the number of samples for testing can not be stated definitively. This is dependent upon the presence (or absence) of appropriate samples at that particular location.

4. For each type of test does the study plan summarize the test methods if non-standard procedure, summarize steps of the test, how it will be modified, and reference technical procedure?
   Yes__X__ No_____ N/A_____

5. For each type of test does the study plan indicate the level of QA and provide the rationale for any tests not QA level?
   Yes__X__ No_____ N/A_____

6. For each type of test does the study plan reference the applicable specific QA requirements applied to test?
   Yes__X__ No____ N/A_____

7. For each type of test does the study plan specify the tolerance, accuracy, and precision required in the test?
   Yes__X__ No____ N/A______

8. For each type of test does the study plan indicate the range of expected results and the basis for those results?
   Yes__X___ No__X__ N/A_____

   NOTE: The anticipated ranges of expected results are given for mineralogies; isotopic and elemental analysis ranges are not given. Data concerning elemental and isotopic compositions for igneous rocks is available. Even though the data at Yucca Mountain may fall outside these ranges, they could have been stated.

9. For each type of test does the study plan list the equipment requirements, briefly describing special equipment?
   Yes____ No__X___ N/A_____

   NOTE: The study plan does not list the specific equipment requirements. However, this is not necessary for most of the analyses, since the methods/techniques (e.g., SEM) are generally independent of equipment model/make. It is not clear whether the X-ray fluorescence (XRF) work will be done on a spectrometer, or with an SEM. Based on the context it is suspected that the spectrometer will be used. The equipment needed for the analyses described in this study is generally available at laboratories that do petrologic and geochemical studies.

10. For each type of test does the study plan describe the techniques to be used for data reduction and analysis?
    Yes__X__ No_____ N/A_____

11. For each type of test does the study plan describe the representativeness of the test, indicating limitations and uncertainties that apply to use of results?
    Yes__X__ No_____ N/A_____

    NOTE: Representativeness of a geochemical or petrographic analysis is a function of the quality of sample, the sampling strategy, and the appropriate sample preparation techniques. The study plan outlines a reasonable sampling strategy with an appropriate number of samples to be collected and analyzed by standard methods. The authors of the study plan acknowledge the possibility of incomplete core recovery and the need to use the video log as a support for the data collected from well-cuttings.

12. For each type of test does the study plan provide illustrations of test locations?
    Yes__X__ No__X__ N/A_____

    Staff Comment: In the case of field tests this is done (see Figures 2-1, 3-1 and 3-2). In other cases, (e.g., where laboratory tests are conducted) no physical diagram of the laboratory facility is shown (or appropriate).

13. For each type of test does the study plan discuss the relationship of the test to set performance goals and confidence levels?
    Yes__X__ No_____ N/A_____

    NOTE; The following seven questions (Numbers 14 through 20) deal with analyses.The study plan does not address analyses of tests. Therefore, it is the staff's opinion that the study plan does not comply with the conditions of the Agreement. However, from the petrographic and geochemical aspects, the techniques to be used are well-established and need little description. The references given should provide appropriate documentation of the analytical procedures. A negative finding (with respect to the NRC/DOE agreement) by the staff relative to these questions is therefore considered not warranted.

14. For each type of analysis does the study plan state the purpose of analysis, indicate conditions to be evaluated and describe any uncertainty analysis?
    Yes_____ No__X__ N/A_____

15. For each type of analysis does the study plan describe the methods of analysis, including analytical expressions and numerical models to be used?
    Yes_____ No__X__ N/A_____

16. For each type of analysis does the study plan reference the technical procedures document that will be followed during analysis?
    Yes_____ No__X__ N/A_____

17. For each type of analysis does the study plan indicate the levels of QA applied?
    Yes_____ No__X__ N/A_____

18. For each type of analysis does the study plan identify data input requirements?
    Yes_____ No__X__ N/A______

19. For each type of analysis does the study plan describe the expected output and accuracy?
    Yes_____ No__X___ N/A_____

20. For each type of analysis does the study plan describe the representativeness of the analytical approach, indicating limitations and uncertainties that apply to results?
    Yes_____ No__X___ N/A_____

IV. APPLICATION OF RESULTS

1. Does the study plan briefly discuss where results from the study will be used for support of other studies?
   Yes__X__ No______ N/A______

2. Does the study plan refer to specific performance assessment analyses?
   Yes__X__ No______ N/A_____

3. Does the study plan describe where information from the study will be used in construction equipment and engineering system design and development?
   Yes__X__ No_____ N/A_____

Staff Comment: Section 4.0 identifies some studies that will use the information obtained in the present study, but does not specifically identify how the study will be used for the above stated purposes. However, Figure 1.1-2 indicates a linkage between the study and DOE Design Issue 1.11 (Configuration of the Underground Facility); Design Issue 2.7 (Repository Design criteria for Radiological Safety that comply with the Preclosure Design Criteria of 10 CFR 60.130 through 60.133), and Issue 4.4 (Repository Preclosure Design and Technical Feasibility). Using this rationale and assumptions, the staff has concluded that the response to the above query is affirmative.

4. Does the study plan describe where information from the study will be used in planning other characterization activities?

   Yes__X__ No_____ N/A_____

V. SCHEDULES AND MILESTONES

1. Does the study plan provide durations of and interrelationships among principal activities associated with this study?

   Yes__X__ No_____ N/A_____

2. Does the study plan list key milestones including decision points associated with study activities?

   Yes__X__ No_____ N/A_____

3. Does the study plan describe the timing of the study relative to other studies and other program activities?

   Yes____ No__X___ N/A_____

Staff Comment: The study does, in relative terms, identify the relative timing between the study's five activities (see Figure 5-1). The study however, does not present any information describing the relative timing either between information provided to other studies by this study or, more importantly, the timing existing between this study and other studies that provide it with information critical to its accomplishment. This is a major deficiency and leaves the reviewer with the sense that perhaps overall integration and the obvious inter-dependence of the myriad of activities may not have been fully considered. Lacking documentation of the activity inter-relationship, coupled with no awareness of the completion dates of activities contributing to the support of a given study, the staff has little assurance that this study (or any other study for that matter) can be accomplished within the DOE's current schedule for submittal of the License Application (by the year 2001).

4. Does the study plan provide dates for activities for the study plans.
   Yes__X__ No_____ N/A_____

   Staff Comment: Although the study plan suggests no actual dates, the timing and interrelationships of events (studies, activities and investigations) are expressed (see Figure 5-1) in terms relative to resumption of (site characterization) work. This approach is acceptable to the staff.

   Suggestion: Figure 5-1 should indicate the status of each activity relative to resumption of work*. To make this figure useful, DOE should indicate when work is to resume (or conversely, when it did actually resume).

   * It is assumed that resumption of work (beginning of site characterization and granting of necessary permits) has occurred. If not, identify when work was resumed. If not resumed, then when indicate when it will resume.

5. Does the study plan reference section 8.5 in the SCP?
   Yes ____ No __X__ N/A ____

   Staff Comment: This question is moot since DOE's schedules and milestones (SCP Section 8.5) have been revised (slipped) since publication of the SCP in 1988. There is therefore no necessity for reference to this section of the SCP. Nevertheless, DOE should provide an indication of the schedules and milestones under which it is currently operating.

ENCLOSURE C

Study 8.3.1.4.2.1: Characterization of the Vertical and Lateral Distribution of Stratigraphic Units within the Site Area

REFERENCES

AA Baedecker, P. A., ed., 1987, Methods for geochemical analysis: U. S. Geological Survey Professional Paper 1770.

RNP BARTOJER, 1983 (SEE P. 2-10; P. 3-15)

RNP BROCHER, ET AL, 1990 (SEE P. 3-14)

AA Byers, F. M., Jr., Carr, W. J., Orkild, P. P., Quinlivan, W. D., and Sargent, K. A., 1976, Volcanic suites and related cauldrons of Timber Mountain-Oasis Valley caldera complex, southern Nevada: U. S. Geological Survey Professional Paper 919, 70 pp.

AA Carr, M. D., and Yount, J. C., eds., 1988, Geologic and hydrologic investigations of a potential nuclear waste disposal site at Yucca Mountain, southern Nevada: U. S. Geological Survey Bull. 1790, 152 p.

RNP HOWARD, ET AL, 1990 (SEE P. 1-3)

AA Kirschvink, J. L., 1980, The least-square line and plane and the analysis of paleomagnetic data: Geophysical Journal of the Royal Astronomical Society, v. 62, pp. 699-718.

AA Larson, E. E., Hoblitt, R. P., and Watson, D. E., 1975, Gas-mixing techniques in thermomagnetic analysis: Geophysical Journal of the Royal Astronomical Society, v. 43, pp. 607-620.

IR AA Longman, I. M., 1959, Formulas for computing the tidal accelerations due to the moon and sun: Journal of Geophysical Research, v. 64, pp. 2351-2355.

AA Oliver, H. W., Hardin, E. L., and Nelson, P. H., eds., 1990, Status of data, major results, and plans for geophysical activities, Yucca Mountain Project: Department of Energy, YMP/90-38, 191 p.

SCP Rosenbaum, J. G., and Snyder, D. B., 1985, Preliminary interpretation of paleomagnetic and magnetic property data from drill holes USW G-1, G-2, GU-3, and VH-1 and surface localities in the vicinity of Yucca Mountain, Nye County, Nevada: U. S. Geological Survey Open-File Report 85-49, 73 pp.

AA Schlinger, C. M., Rosenbaum, J. G., and Veblen, D. R., 1988, Fe-oxide microcrystals in welded tuff from southern Nevada: Origin of remanence carriers by precipitation in volcanic glass: Geology, v. 16, pp. 556-559.

SCP Scott, R. B., and Castellanos, Mayra, 1984, Stratigraphic and structural relations of volcanic rocks in drill holes USW GU-3 and USW G-3, Yucca Mountain, Nye County, Nevada: U. S. Geological Survey Open-File Report 84-491, 121 pp.

AA = ASSUMED AVAILABLE

SCP = REFERENCED IN THE SCP

RNP = REFERENCED IN THE STUDY PLAN TEXT WITH NO CITATION PROVIDED IN REFERENCES

IR = IDENTIFIED IN REFERENCES; NOT CITED IN STUDY PLAN TEXT

AA Spengler, R. W., and Chornack, M. P., 1984, Stratigraphic and structural characteristics of volcanic rocks in core hole USW G-4, Yucca Mountain, Nye County, Nevada, with a section on geophysical logs by D. C. Muller and J. E. Kibler: U. S. Geological Survey Open-File Report 84-789, 77 pp.

AA U. S. Department of Energy, 1990, Review Record Memorandum: Geologic and geophysical evidence pertaining to structural geology in the vicinity of the proposed exploratory shaft, Rev. 0, YMP/90-2, Nevada Operations Office, Yucca Mountain Project Office, Las Vegas, Nevada.

IR AA Yilmaz, O., 1987, Seismic Data Processing: Society of Exploration Geophysicists, Tulsa, Oklahoma, 526 pp.

IR AA Zumberge, M. A., Harris, R. N., Oliver, H. W., Sasagawa, G. S., and Ponce, D. A., 1988, Preliminary results of absolute and high-precision gravity measurements at the Nevada Test Site and vicinity, Nevada: U. S. Geological Survey Open-File Report 88-242, 29 pp.

ENCLOSURE D

Study 8.3.1.4.2.1: Characterization of the Vertical and Lateral Distribution of Stratigraphic Units within the Site Area

Some of the data necessary to determine rock correlation and spatial variability in this study plan is similar to data being collected at Los Alamos National Laboratory (Study 8.3.1.3.2.1, Mineralogy, petrology and rock chemistry of transport pathways; Study 8.3.1.3.2.2, History of mineralogical and geochemical alteration of Yucca Mountain). Likewise, geological interpretations from this study are essential for adequate characterization of the transport pathways being investigated elsewhere. Therefore, we envision close communication and information exchange with scientists at Los Alamos in areas of potential overlap (mineralogy, petrology and diagenesis) so that data sets collected by each group are unique and complimentary.

The information obtained in this study will be used to produce a comprehensive, three-dimensional characterization of the spatial extent and variability of rock units within and around the proposed repository site. Much of the work in this study plan is directed toward identifying and predicting vertical and lateral variations in stratigraphic units and rock properties in areas of the repository block where relatively few subsurface samples will be collected. These data are critical to development of a "rock unit geometry and properties" model component (Fig. 1.1-2), which along with "fracture geometry and properties" and "fault geometry and properties" components (Study 8.3.1.4.2.2), will be used to develop an integrated three-dimensional geological model of the Yucca Mountain site (Study 8.3.1.4.2.3). A well-defined, three-dimensional stratigraphy also provides an essential geological context for concurrent mineralogical and alteration studies at LANL (Studies 8.3.1.3.2.1 and 8.3.1.3.2.2) in terms of ignimbrite eruption, deposition, cooling, devitrification and primary permeability interpretations. In addition, further hydrological, geochemical and thermal/mechanical property characterization investigations (SCP sections 8.3.1.2, 8.3.1.3, and 8.3.1.15, respectively) are strongly dependent on this geological framework in order to most accurately quantify parameters required in each of these fields, for instance, quantification of potential permeable-flow pathways, groundwater travel times, sorptive capacities of natural barriers, ambient temperature distributions, and appropriate subdivision of stratigraphy in terms of thermal and mechanical units. Results from each of these property characterization studies (geological, hydrological, geochemical and thermal/mechanical) will ultimately be integrated into a physical property model which is directly linked to repository performance assessment. In addition, rock property data determined in this study are directly applicable to development of design criteria for the underground facility. shaft and borehole seals and waste package configuration.

Previous geological and geophysical studies of the Yucca Mountain region are summarized in Chapter 1 of the SCP and a comprehensive review of geophysical activities is given by Howard, et al (1990). Although the stratigraphic, volcanological, structural, geophysical and tectonic interpretations included in these references are sufficient to provide a regional geological context into which the Yucca Mountain site can be placed, the quality of data for existing vertical and lateral distribution of stratigraphic units are inadequate to establish a three-dimensional model on a localized scale at the confidence level required by SCP be fired in 200-foot deep holes at one-mile intervals to generate a low-fold profile of the lower crust (8-20 seconds).

In addition to vibroseis and explosive sources, an array of 4 or 5 large air gun trucks will be tested as a seismic source during the two initial noise tests. The optional field trial of the shear wave reflection method may also be conducted during the noise tests, using shear wave sources and oriented horizontal seismometers.

Timing of source activation and seismograph recordings is provided by chronometers within seismographs and source systems that are calibrated by satellite time receivers. Locations are determined by surveys that employ either global positioning satellite receivers or electrical distance measuring devices.

3.2.1.2 Test Methods and Procedures

Procedures for conducting the seismic reflection surveys are explained in Technical Procedure SP-10 (Deep seismic reflection study of the tectonic environment) and SP-14 (Shallow reflection survey -- Mini-Sosie) (table 3.2-1).

3.2.1.3 QA requirements

See section 3.1.3.

3.2.1.4 Required tolerances, accuracy, and precision

No explicit requirements for tolerances, accuracy, or precision have been specified for this test. Table 3.2-3 lists the relevant tolerances, accuracies, and precisions that are standard for reflection surveys.

3.2.1.5 Range of expected results

Shallow seismic reflection methods have been demonstrated to produce useful reflections at depths corresponding to two-way travel times of about 0.3 to 1.0 seconds, depending on site conditions; however, the uppermost 50-150 m (depending on velocity) are not imaged. According to Oliver, et al (1990, p. 65), the previous experience gained in acquiring, processing, and interpreting shallow reflection data in southern Nevada is judged to be applicable to site characterization of Yucca Mountain.

An intermediate and deep seismic reflection survey in the Amargosa Desert, southwest of Yucca Mountain, shows that reflections can be observed as shallow as 25 meters and as deep as 33 km (Brocher, et al, 1990). These data provide clear images of the Tertiary basin fill, indicate that the fill is locally more than 1.5 km thick, and show where it is offset by subsequent faulting. Also in the Amargosa Desert, a shallow, widespread, subhorizontal low-frequency reflection about 100 m deep is interpreted as a basalt flow, an interpretation which is confirmed by nearby shallow drill data. This reflection line also images the pre-Tertiary/Tertiary contact as a series of tilted basement blocks, apparently bounded by high-angle normal faults (T. Brocher, personal commun., 1991). Prominent reflections are observed from the middle to lower crust, corresponding to two-way travel times of 5-10 seconds. Although more seismic profiling will be required, such as the test lines across Crater Flat and Yucca Mountain and along Yucca Wash as are being planned for this activity, the results relative to detecting buried faults, mapping the extent of fault zones and buried intrusive bodies, and investigating the subsurface geometry of fault zones are encouraging.

3.2.1.6 Equipment

Equipment used for the planned reflection surveys is listed in Technical Procedures SP-10 and SP-14 (Table 3.2-1).

3.2.1.7 Data-reduction techniques

Steps used in the processing of data obtained from shallow seismic reflection surveys typically include: common-depth-point (CDP) sorting, constant velocity analysis, normal movement correction, spectral whitening, deconvolution, bandpass filtering, datum and residual statics, and final CDP stage migration (Barbier, 1983; Carr and Yount, 1988).

Standard data-reduction techniques described in Technical Procedure SP-10 (Table 3.2-1) will be used to compile the field observations for the intermediate and deep reflection surveys. The recorded and processed data will be plotted on scale stable topographic base maps (scale 1:24,000 or other, as appropriate). The reflection data recorded on digital magnetic tapes will be processed using standard industry procedures. These procedures will include: sort to CDP geometry, bandpass filter, velocity analysis, application of elevation and refraction statics, application of normal-movement corrections, stack of CDP gathers, deconvolution, and migration.

3.2.1.8 Representativeness of results

Results of the planned reflection surveys should be representative of data collected from surveys in other parts of the area with similar geological environments (see section 3.2.1.5). However, limitations in the ability of the methods to provide useful seismic reflection data along the planned traverses will not be known until the surveys are completed.

REFERENCES

Baedecker, P. A., ed., 1987, Methods for geochemical analysis: U. S. Geological Survey Professional Paper 1770.

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