

# MONTHLY HIGHLIGHTS AND STATUS REPORT



July 1993

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CHARACTERIZATION  
PROJECT

# Monthly Status Report

July 1993

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## July Highlights

SNL staff identified a final surface location for drill hole SD-12.

See **1.2.3.2.2.1 Systematic Acquisition of Site-Specific Subsurface Information** on page 4.

SNL and USGS staff held several strategic planning meetings to discuss integrating site characterization and three-dimensional modeling activities. Ongoing efforts by both participants enhance synergistic and collaborative activities while avoiding potential duplications or overlaps.

See **1.2.3.2.2.2 Three-Dimensional Rock Characteristics Models** on page 6.

SNL staff prepared structural and lithologic logs for the NRG-5 borehole and surveyed the location of proposed borehole NRG-7.

See **1.2.3.2.6.2.1 Surface Facilities Exploration Program** on page 7.

SNL staff submitted mechanical properties data from NRG-2 core to the Central Records Facility.

See **1.2.3.2.6.2.2 Surface Facilities Laboratory Tests and Material Property Measurements** on page 7.

## July Highlights, Continued

SNL staff developed a technique to replicate rough fractures to study topographic correlation.

See **1.2.3.2.7.1.4 Laboratory Determination of Mechanical Properties of Fractures** on page 11.

SNL staff completed the Transition Plan to consolidate climate modeling work at SNL.

See **1.2.3.6.2.1.6 Future Regional Climate and Environments** on page 13.

SNL staff performed construction monitoring activities at the ESF starter tunnel. Collected information is provided to the M&O design and construction management team.

See **1.2.4.2.1.1.4 In Situ Design Verification** on page 16.

SNL staff completed three-dimensional thermal/structural analyses assessing the impact of potential repository thermal loading on the ESF drifts.

See **1.2.4.2.1.2 Rock Mass Analyses** on page 17.

SNL staff received a draft memorandum from LLNL describing the hydrothermal-effects model to be used in TSPA-II. Results of the gas flow calculations performed by DSI were also submitted. Transport calculations for the saturated zone were completed.

See **1.2.5.4.1 Total System Performance Assessment** on page 21.

SNL staff has nearly completed the input parameter distribution operation for TSPA-II. Three indicator geostatistical simulations run for the East-West INTRAVAL cross sections show promising results.

See **1.2.5.4.4 Site Performance Assessment** on page 24.

The annual internal audit was conducted, and a site surveillance of geotechnical field logging of borehole samples was performed.

See **1.2.11 Quality Assurance** on page 34.

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### **DISCLAIMER**

Quality assurance checks on data contained in this report have been performed only to determine that the data have been obtained and documented properly. The SNL Project Department cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly. Milestones have not been baselined and are included only to show status.



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**YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT  
EXECUTIVE SUMMARY**

**1.2.3.2.2.1 SYSTEMATIC ACQUISITION OF SITE-SPECIFIC SUBSURFACE INFORMATION**

- SNL staff held a formal staking party on July 14 and identified a final surface location for drill hole SD-12. The location (to the west of the Ghost Dance Fault) was selected to provide design information for the ESF main-test-level drift, which runs from north to south under recently modified plans. Logistical considerations regarding drill pad construction and road access and engineering concerns vis-a-vis providing design input were discussed with other participants in the field prior to the final decision.

**1.2.3.2.2.2 THREE-DIMENSIONAL ROCK CHARACTERISTICS MODELS**

- SNL staff attended several strategic planning meetings with USGS staff to discuss integration between site characterization and three-dimensional modeling activities. This review indicated that the modeling efforts are largely synergistic, mostly due to ongoing development efforts by staff from both organizations. Under the idealized scenario, the geometric model developed by the USGS using the Lynx GMS software package will be used to constrain geostatistical modeling of material properties.

**1.2.3.2.6.2.1 SURFACE FACILITIES EXPLORATION PROGRAM**

- Structural and lithologic logs were prepared for the NRG-5 borehole. The location for an additional North Ramp borehole designated NRG-7 was located and surveyed.

**1.2.3.2.6.2.2 SURFACE FACILITIES LAB TESTS AND MATERIAL PROPERTY MEASUREMENTS**

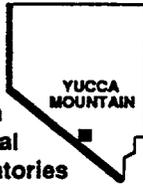
- Mechanical properties data for core from NRG-2 from depths of 150 ft. to 200 ft. were submitted to the YMP Central Records Facility.

**1.2.3.2.7.1.4 LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES**

- A technique for making gypsum cement replicas of rough fractures in the welded Topopah Spring Member tuff was developed to study the effect of topographic correlation.



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**YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT  
EXECUTIVE SUMMARY (Continued)**

#### **1.2.3.6.2.1.6 FUTURE REGIONAL CLIMATE AND ENVIRONMENTS**

- SNL has completed all actions associated with the Transition Plan for consolidating future climate modeling work at SNL. The Transition Plan is expected to be issued as a Yucca Mountain Site Characterization Project (YMP) Controlled Document shortly.

#### **1.2.4.2.1.1.4 IN SITU DESIGN VERIFICATION**

- SNL staff continued construction monitoring activities at the ESF starter tunnel under Study Plan 8.3.1.15.1.8. In the past month, seismic records from construction blasting were recorded, rock mass quality estimates for the first 200 ft. of tunnel were developed, locations for the first two stations of rock bolt load cells were selected, and bolts were installed. The holes for the two multiple point borehole extensometers were also located and drilled. The information collected during this investigation is being provided to the Management and Operations (M&O) design and construction management team so that real-time evaluations of the performance of the excavations, construction techniques, and ground support can be made.

#### **1.2.4.2.1.2 ROCK MASS ANALYSIS**

- SNL staff continued work on a series of analyses in support of the design of the ESF north ramp. Three-dimensional thermal/structural analyses of the repository to assess the impact of the potential repository thermal loading on the ESF drifts has been completed. These results will support two-dimensional analyses of several cross sections of the ESF north ramp to evaluate long-term stability.

#### **1.2.5.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENT**

- A draft memorandum describing the hydrothermal-effects model to be used in TSPA-II was completed and submitted for comment by LLNL. The hydrothermal-effects model will use the number of containers outside the boiling isotherm and the volume of the boiling isotherm to determine the amount of water displaced by the repository's thermal perturbation and the containers that will be subject to it. Container-wall (from LLNL) and fuel-rod (from the M&O) temperatures will be used as parameter inputs to YMIM to calculate container corrosion and uranium alteration.



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**YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT  
EXECUTIVE SUMMARY (Continued)**

#### **1.2.5.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENT (Continued)**

- The results of gas flow calculations performed by Disposal Safety Inc. (DSI) were processed. The calculations are similar to the ones used in the previous TSPA (and documented in SAND 91-7034), but with a major improvement: gas flow and heat flow are now coupled, and the calculations are time-varying rather than steady-state.
- Transport calculations for the saturated zone have been completed. Curves showing the breakthrough of nuclides at the 5 km accessible environment were generated based on this information. The data set was also transmitted to Intera for inclusion in their version of the TSPA.

#### **1.2.5.4.4 SITE PERFORMANCE ASSESSMENT**

- The input parameter distribution generation for TSPA-II has been essentially completed. All matrix, bulk, and fracture properties that could be produced were finalized. Initial distributions of the site-specific data had been generated and upscaled to the TSPA stratigraphy; however, a modification was required due to changes in the stratigraphic realizations (columns) generated to cover the repository area based on results of thermal output analyses.
- Three indicator geostatistical simulations were run for the East-West INTRAVAL cross section. The results were converted to porosities, and GAG was applied to generate a grid. Then the unsaturated flow code DUAL was run on the three cases. The saturations, porosities, and volumetric water content at the location of UZ-16 were generated and sent to Golder Associates. The current model is only minimally calibrated but shows promising results for capturing heterogeneous flow.

#### **1.2.11 QUALITY ASSURANCE**

- The SNL YMP QA Annual Internal Audit was completed as well as a site surveillance of geotechnical field logging of borehole samples.



## 1.2.1 SYSTEMS ENGINEERING

The objective of the Systems Engineering element is to apply the systems engineering discipline to transform the regulatory requirements into functional needs to the MGDS design, system configuration, and site characterization activities. The Systems Engineering element is comprised of four tasks: Systems Engineering Coordination and Planning (1.2.1.1), Program-Level Requirements Document Development (1.2.1.2.1), Project-Level Requirements Documents Development and Maintenance (1.2.1.2.2), and Special Studies (1.2.1.5), which includes development of items important to safety/waste isolation.

### **1.2.1.1 SYSTEMS ENGINEERING COORDINATION AND PLANNING**

No significant activities this reporting period.

### **1.2.1.2.2 PROJECT-LEVEL REQUIREMENTS DOCUMENTS DEVELOPMENT AND MAINTENANCE**

No significant activities this reporting period.

### **1.2.1.2.1 PROGRAM-LEVEL REQUIREMENTS DOCUMENT DEVELOPMENT**

No significant activities this reporting period.

### **1.2.1.5 SPECIAL STUDIES**

No significant activities this reporting period.

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## 1.2.2 WASTE PACKAGE

The objective of the Waste Package element includes support to the Container/Waste Package Interface Analysis element (1.2.2.4.3) in the conduct of thermal and structural analysis of the near-field environment that will support evaluations of emplacement orientation, the effects of backfill properties and timing, as well as other thermal loading issues related to waste package design.

### **1.2.2.4.3 CONTAINER/WASTE PACKAGE INTERFACE ANALYSIS**

#### Major Accomplishments

No significant activities this reporting period.

## 1.2.3 SITE INVESTIGATIONS

The objective of the Site Investigations element includes work scope related to site data collection and analysis to support site suitability evaluation, design, licensing, performance assessment requirements, and the natural barrier system component of the multiple barrier system described in the physical system. The Site Investigations element is comprised of twelve tasks: Site Investigations Coordination and Planning (1.2.3.1), Systematic Acquisition of Site-Specific Subsurface Information (1.2.3.2.2.1), Three-Dimensional Rock Characteristics Models (1.2.3.2.2.2), Surface Facilities Exploration Program (1.2.3.2.6.2.1), Surface Facilities Laboratory Tests and Material Property Measurements (1.2.3.2.6.2.2), Surface Facilities Field Tests and Characterization Measurements (1.2.3.2.6.2.3), Laboratory Thermal Properties (1.2.3.2.7.1.1), Laboratory Thermal Expansion Testing (1.2.3.2.7.1.2), Laboratory Determination of Mechanical Properties of Intact Rock (1.2.3.2.7.1.3), Laboratory Determination of the Mechanical Properties of Fractures (1.2.3.2.7.1.4), Ground Motion From Regional Earthquakes and Underground Nuclear Explosions (1.2.3.2.8.3-3), and the Future Regional Climate and Environments (1.2.3.6.2.1.6).

### 1.2.3.1 SITE INVESTIGATIONS COORDINATION AND PLANNING

#### Significant Meetings Attended

Sandia National Laboratories (SNL) staff attended the July 14 Sample Overview Committee (SOC) meeting to discuss sample allocation requests and planning for FY94 drill holes. Significant discussion focused on incompatible core-preservation requests by the U.S. Geological Survey (USGS) and Los Alamos National Laboratory (LANL) personnel. After presentations and defenses by all concerned Principal Investigators (PIs), a compromise agreement was reached to dedicate samples from one entire drill hole (exclusive of "primary" samples) to each study. Specific preservation instructions will be incorporated into the test planning packages. Three holes from the Systematic Drilling Program are scheduled for FY94, in addition to a number of holes to support design and construction of the south ramp access to the Exploratory Studies Facility (ESF). The next SOC meeting is scheduled for August 4.

### 1.2.3.2.2.1 SYSTEMATIC ACQUISITION OF SITE-SPECIFIC SUBSURFACE INFORMATION

#### Major Accomplishments

A formal staking party was held on July 14 and a final surface location for drill hole SD-12 was identified in the field. The location, to the west of the Ghost Dance Fault, was selected to provide design information for the ESF main-test-level drift, which runs from north to south under recently modified plans. Logistical considerations regarding drill pad construction and road access and engineering concerns vis-a-vis providing design input were discussed with other participants in the field prior to the final decision. SNL staff also accompanied Project Office personnel to the tentative location of drill hole SD-10, which is intended to provide additional information regarding the ESF main test level further to the north. Logistical constraints will be more significant in this region of steep topography and narrow drainages. (SCP Activity 8.3.1.4.3.1.1)

Sandia Technical Procedure (TP) 0162, "Geologic Description and Core Logging," was approved and issued as an SNL controlled document. Completion of this technical procedure was a prerequisite for initiating the Systematic Drilling Program. (SCP Activity 8.3.1.4.3.1.1)



### Significant Meetings Attended

Several strategic planning meetings have been held with USGS staff to discuss interrelationships and integration among several site characterization and three-dimensional modeling activities. This Technical Project Officer (TPO)-level review and discussion indicated that the modeling efforts described under Work Breakdown Structure (WBS) element 1.2.3.2.2.2 are largely synergistic, mostly due to ongoing but informal staff efforts. Questions regarding potential duplication and overlap of characterization activities were also laid to rest with several agreements-in-principle that expand the collaborative activities previously reported under this section. Increasing emphasis on ESF design requirements predicated upon ramp access rather than on earlier shaft concepts have markedly increased the importance of the site-oriented Systematic Drilling Program. This change in user emphasis has led to a larger role of the Systematic Drilling Program in this early stage of overall site characterization, rather than to an expansion of plans for the drilling program. (SCP Activity 8.3.1.4.3.1.1)

### Status Report on Ongoing Activities

The paper entitled "Spatial Variability of Hydrologic Properties in Volcanic Tuff," intended for publication in the journal *Groundwater*, has completed USGS review, but other commitments of SNL staff delayed the SNL review. The paper, an expansion of work originally presented at the International High-Level Radioactive Waste Management Conference in April, includes a test of the hypotheses developed by the original work. (SCP Activity 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

SNL staff normally assigned to this activity continued to be heavily involved in providing geologic support for WBS element 1.2.3.2.6.2, "Soil and Rock Properties of Potential Locations of Surface Facilities." (SCP Activity 8.3.1.14.2.1) Geologic logging of core being performed under the scientific notebook procedure in use for the Soil and Rock Properties Study is virtually identical to that anticipated for the Systematic Drilling Program. (SCP Activity 8.3.1.4.3.1.1)

Draft data reports tentatively entitled "Physical and Hydrologic Properties of Outcrop Samples from a Nonwelded to Welded Tuff Transition,

Yucca Mountain, Nevada" and "Physical and Hydrologic Properties of Surface Outcrop Samples at Yucca Mountain, Nevada," containing the laboratory results of the outcrop sampling studies that have been conducted at Yucca Mountain over the past several years under this activity, remained in deferred status during the month. In late July, staff determined that excessive deterioration of friable nonwelded samples during imbibition testing will render 105°C oven drying of questionable value. Preparation of the reports will resume, but without determination of the oven-dried bulk properties. (SCP Activity 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

### Major Activities Upcoming Next Three Months

Drafts of reports in preparation will be finalized and reviewed as appropriate. Principal emphasis will be placed on completing all procedures and other prerequisites for initiating the Systematic Drilling Program with hole SD-12 in the October 1 time frame. (SCP Activity 8.3.1.4.3.1.1)

Budget preparation for FY94 will continue when guidance is received from the Project Office. (SCP Activity 8.3.1.4.3.1.1)

Geologic support will be provided to the Soil and Rock Properties Study (SCP Activity 8.3.1.14.2.1) through logging core from the north ramp boreholes. Remaining TPs to support the Systematic Drilling Program will be finalized as quickly as possible. (SCP Activity 8.3.1.4.3.1.1)



### **1.2.3.2.2.2.2 THREE-DIMENSIONAL ROCK CHARACTERISTICS MODELS**

#### Significant Meetings Attended

A proposal for a software development effort to allow explicit integration of the USGS-developed geometric model of Yucca Mountain with numerical material properties modeling at SNL was presented to Project Office staff. The intended methodology is probabilistic in nature, yet it makes use of geologically based deterministic correlations between the statistical distribution of important hydrologic properties and the micro-stratigraphic or zonal subdivisions of the thick ash-flow tuff sequences at Yucca Mountain. The use of observed correlations allows abundant soft information from the geologic setting to be incorporated in a theoretically rigorous manner that will reduce excessive uncertainty in modeling of material properties away from measured control points. The result will be more tightly constrained "numerical rocks" for use in performance calculations without unduly proscribing the residual uncertainty that is inherent in any geologic investigation. (SCP Activity 8.3.1.4.3.1.1)

Several strategic planning meetings have been held with USGS staff to discuss interrelationships and integration among several site characterization and three-dimensional modeling activities. This TPO-level review and discussion indicated that the modeling efforts are largely synergistic, mostly due to ongoing development efforts by staff from both organizations. Under the idealized scenario, the geometric model developed by the USGS using the Lynx GMS software package will be used to constrain geostatistical modeling of material properties. This latter activity will continue to be tightly focused on the "performance" uses of those models in both detailed "process" modeling and more limited "total systems" assessments. Increased consistency in interpretation of site characterization data is anticipated as a result. (SCP Activity 8.3.1.4.3.1.1)

#### Status Report on Ongoing Activities

Several GSLIB software routines were modified to better meet requirements for postprocessing replicated simulations and checking the

successful completion of the simulations. A copyrighted, public domain PostScript utility (Ghostsript) to display and print GSLIB output on the personal computer (PC) was obtained during July. This will allow migration of much geostatistical modeling to the PC from the workstation environment. Although display would appear to be a minor issue in a sophisticated modeling activity, PC software programs to serve with the powerful graphics of the Postscript language are almost nonexistent. (SCP Activity 8.3.1.4.3.2.1)

Draft text sections for the 1993 Total System Performance Assessment (TSPA) summary document describing the construction of the repository-scale three-dimensional indicator simulations of lithology are being revised. (SCP Activity 8.3.1.4.3.2.1)

Preparation of the study plan for the Three-Dimensional Rock Characteristics Models study continues at a low level using the revised U.S. Department of Energy/U.S. Nuclear Regulatory Commission (DOE/NRC) level-of-detail agreement for study plans. Higher-priority items and limited staff resources are delaying completion of the study plan. (SCP Activity 8.3.1.4.3.2.1)

#### Major Activities Upcoming Next Three Months

Work will commence on attempting to modify the simulation codes to accommodate the soft information provided by the microstratigraphic units known at Yucca Mountain. (SCP Activity 8.3.1.4.3.2.1)



### **1.2.3.2.6.2.1 SURFACE FACILITIES EXPLORATION PROGRAM**

#### **Major Accomplishments**

Structural and lithologic logs were prepared for the NRG-5 borehole. The location for an additional North Ramp borehole designated NRG-7 was located and surveyed. The section map of the north ramp was implemented on computer and extended through the NRG-3 borehole. Criteria for the engineering (design) use of data from borehole SD-12 has been established, and the hole has been located and surveyed. A QA surveillance of the Scientific Notebook Procedure for Geotechnical Core Logging was performed by SNL QA personnel. No serious deficiencies were noted. A QA audit of the Soil and Rock Properties study was performed by SNL QA personnel. Results are anticipated in August.

#### **Status Report on Ongoing Activities**

Drilling has been completed on NRG-4 and structural and lithologic logs are being prepared.

#### **Major Activities Upcoming Next Three Months**

Structural and lithologic logs will be prepared for NRG-4 and NRG-2A. Borehole NRG-2B will be drilled in August. The M&O ESF design group is investigating the possibility of a change in the ESF design. This change has been designated the "Enhanced" ESF design. SNL will continue to investigate borehole requirements to support the "Enhanced" ESF design.

### **1.2.3.2.6.2.2 SURFACE FACILITIES LABORATORY TESTS AND MATERIAL PROPERTY MEASUREMENTS**

#### **Major Accomplishments**

Mechanical properties data (ultrasonic velocities, static elastic properties, and unconfined strength) for core from NRG-2 from depths of 150.0 ft to 200.0 ft were submitted to the YMP CRF.

#### **Status Report on Ongoing Activities**

Mechanical properties testing is underway on core samples from NRG-6, NRG-2, and NRG-3.

Samples from NRG-6 to 416.0 ft are being tested. Samples for thermal properties testing below this depth need to be obtained from the Sample Management Facility (SMF).

#### ***Thermal Conductivity Testing***

Thermal conductivity testing on air-dry samples have been completed at 30°C, 50°C, and 70°C. The scientific notebooks for these tests are being reviewed. These thermal conductivity data will be submitted to the Project database after review of the scientific notebooks is completed and data summary sheets are prepared.

Thermal conductivity measurements are being conducted on saturated samples. For these samples, measurements will be made at 30°C, 50°C, 70°C, 110°C, 155°C, 200°C, 245°C, and 290°C. Additional samples are being oven-dried and will be tested at the same temperatures.

#### ***Thermal Expansion Testing***

Thermal expansion testing on air-dry samples have been completed for temperatures to 110°C.

Review of the scientific notebooks for these tests has been completed. The data have been submitted to the YMP Central Records Facility under Technical Document Information Form No. 301783.

Thermal expansion testing on saturated samples was delayed so that parts for the saturation test apparatus can be cloned. After repairs to one of the temperature controllers is completed, the dilatometer will be reassembled and calibrated.



Thermal expansion testing on saturated samples will resume after the dilatometer calibration is completed. For these measurements, the atmosphere surrounding the sample during testing will be controlled (i.e., high humidity) in a saturation test apparatus to minimize sample dehydration at temperatures below the nominal boiling point of 100°C. When this temperature is reached, the temperature will be held constant for 30 hours and the sample allowed to dehydrate until the length stabilizes. Heating will be restarted and will continue until 300°C is reached, then the sample will be cooled to ambient temperature.

#### *Mineralogy*

Work Agreements WA-0087, "Polished Thin Section Preparation of Samples from NRG-6," and WA-0088, "Laboratory Petrologic Determination of Samples from NRG-6," were issued. Polished thin sections are being made on 17 samples from depths of 22.2 ft to 416.0 ft. A 100 gram to 1 milligram weight set is being calibrated. The weight set will be used to check balances for whole-rock chemical analysis. Mineralogic, petrologic, and whole-rock chemistry of samples will be used to interpret data from thermal and mechanical tests and to determine if correlations exist between these values and the physical properties of the rock.

#### Major Activities Upcoming Next Three Months

Core samples from NRG-2A, NRG-2B, NRG-4, and NRG-5 will be submitted for mechanical properties testing.

Provided that samples from NRG-6 below 416 ft are obtained from the SMF in a timely manner, thermal properties testing will be completed and reported to the Project Office.

#### Other Items to Report

Priority has been given to thermal properties testing on samples from NRG-6. Additional test equipment has been brought on line so that studies can establish baseline test conditions for site characterization. (See WBS 1.2.3.2.7.1.1, "Laboratory Thermal Properties," and WBS 1.2.3.2.7.1.2, "Laboratory Thermal Expansion Testing," for discussion on these activities.)

#### **1.2.3.2.6.2.3 SURFACE FACILITIES FIELD TESTS AND CHARACTERIZATION MEASUREMENTS**

#### Status Report on Ongoing Activities

The SNL Geophysics Department is investigating the potential for using geophysical methods to investigate the Bow Ridge Fault and the Ghost Dance Fault.

#### Major Activities Upcoming Next Three Months

Initiate feasibility study for geophysical investigation of the Bow Ridge Fault area and the Ghost Dance Fault.

### **1.2.3.2.7.1.1 LABORATORY THERMAL PROPERTIES**

#### **Status Report on Ongoing Activities**

Priority has been given to thermal conductivity testing on samples from NRG-6 (see WBS 1.2.3.2.6.2.2, Surface Facilities Exploration Program). Until additional test equipment is brought on line, the studies to establish baseline test conditions for thermal conductivity measurements have been delayed.

The thermocouple calibration for the new low temperature (LT) instrument has been completed and is being reviewed. A system calibration will be completed after the thermocouple calibration is approved.

Samples for the study on the effects of sample saturation on thermal conductivity are ready for testing. These experiments are necessary to determine whether thermal conductivity has a predictable dependence on the saturation state of the sample and, if so, to describe the nature of the relationship. Results from these experiments will be used to determine the optimal baseline test conditions for thermal conductivity characterization. (SCP Activity 8.3.1.15.1.1.3)

The comparative instrument has been calibrated and is ready for the study on fracture effects on thermal conductivity of Unit TSw2. Samples have been sent to New England Research, Inc. (NER) for machining to be completed in the first part of August. If fractures are observed to have a significant effect, samples containing natural fracture will be obtained and tested. (SCP Activity 8.3.1.15.1.1.3)

The rock crushing laboratory at the University of New Mexico (UNM), including installation of the shatterbox, jaw crusher, and hood for dust control, is complete. Bracket extensions for the sample hopper on the jaw crusher are being machined. These brackets will make routine cleaning of the removable jaws easier. Safety items for the laboratory have been ordered.

A petrographic photograph album of Yucca Mountain rocks is being assembled. This album will be used for training and as a visual reference for evaluating welding, devitrification, and alterations observed in thin sections.

#### **Major Activities Upcoming Next Three Months**

After calibration of the new LT instrument is completed, testing activities for the scoping study on the effects of saturation on thermal conductivity will begin. Three samples of welded devitrified tuff and three samples of nonwelded zeolitic tuff will be used for this study. The thermal conductivity of each sample will be measured at nominal temperatures of 30°C, 50°C, and 70°C, at five different saturation states (fully saturated, oven-dry, air-dry, and two other intermediate states). A moisture containment cell will be used to control the test environment. (SCP Activity 8.3.1.15.1.1.3)

After test samples are machined and inspected, the study on the effects of fractures on thermal conductivity will be initiated. The thermal conductivity of two air-dry samples from Unit TSw2 will be measured using the comparative method. A nominal temperature of 30°C and stress levels of 0, 2.5, 5, 7.5, and 10 MPa will be used. After the samples are tested, they will be cut in half and the fracture surface roughened. The halves will be rejoined, and the thermal conductivity measurements will be repeated. (SCP Activity 8.3.1.15.1.1.3)

Technical and safety procedures for using the rock crushing and grinding equipment at UNM will be developed.

### **1.2.3.2.7.1.2 LABORATORY THERMAL EXPANSION TESTING**

#### Status Report on Ongoing Activities

Priority has been given to thermal expansion testing on samples from NRG-6 (see WBS 1.2.3.2.6.2.2, Surface Facilities Exploration Program). Until additional test equipment is brought on line, the studies to establish baseline test conditions for thermal expansion measurements have been delayed.

Parts for the saturation test apparatus for the additional dilatometer are being fabricated. These parts, along with the computer for the data acquisition system, are expected to be delivered in the first week in August.

Most of the samples for the study on the effects of sample size on thermal expansion have been conditioned (i.e., saturated or dried) and are ready for testing. Results from these experiments will be used to determine the optimal baseline test conditions for thermal expansion characterization. Machining of the remainder of the samples will be completed during the first half of August. (SCP Activity 8.3.1.15.1.2.1)

#### Major Activities Upcoming Next Three Months

After the new dilatometer is brought to operational status, experiments to study the effects of sample size on thermal expansion will be initiated. Five samples of each of four different lithologies (welded devitrified, welded vitric, nonwelded vitric, and nonwelded zeolitic) will be tested for each sample size. The samples will be right cylinders of two sizes: 0.25-in. (0.6-cm)-diameter x 1 in. (2.54 cm) and 1-in. (2.54-cm)-diameter x 4 in. (10.2 cm) nominally. The samples will be fully saturated before experiments are started. The samples will be heated, and the atmosphere surrounding the sample during testing will be controlled (i.e., high humidity) in a saturation test apparatus to minimize sample dehydration at temperatures below the nominal boiling temperature of 100°C. When this temperature is reached, temperature will be held constant and the sample allowed to dehydrate until the length stabilizes. Heating will be restarted and continued until the temperature reaches 300°C; the sample then will

be cooled to ambient temperature (25°C). (SCP Activity 8.3.1.15.1.2.1)

After the study of the effects of sample size on thermal expansion is completed, the study of the effects of sample saturation will be initiated. Five samples of each of four different lithologies (welded devitrified, welded vitric, nonwelded vitric, and nonwelded zeolitic) will be tested. Three initial saturation states will be examined: fully saturated, air-dry, and oven-dry. The atmosphere surrounding the sample during testing will be controlled (i.e., high humidity) in a saturation test apparatus to minimize sample dehydration at temperatures below the nominal boiling point of 100°C. When this temperature is reached, the temperature will be held constant and the sample allowed to dehydrate until the length stabilizes. Heating will be restarted and will continue until 125°C is reached; the sample then will be cooled to ambient temperature. (SCP Activity 8.3.1.15.1.2.1)



**1.2.3.2.7.1.3 LABORATORY DETERMINATION  
OF MECHANICAL PROPERTIES  
OF INTACT ROCK**

Status Report on Ongoing Activities

NER is conducting a study of the mechanical properties of tuff samples from a series of north ramp geology (NRG) drill holes. These holes are located along the length of the planned position of the north ramp of the ESF. The samples are machined, dried, and saturated prior to testing at uniaxial and triaxial conditions. Other samples are tested in indirect tensile (Brazil) experiments and for average grain densities. Sample porosity is calculated from dry bulk density and average grain density values, and compressional and shear wave velocities are measured on both the dry and saturated samples. In addition to experiments on samples from the upper half of USW NRG-6, a series of 8 unconfined experiments, 9 Brazil tests, and 20 measurements of average grain density from samples of UE25 NRG-2 (ranging in depth 150 to 200 ft) have been completed. The data are being analyzed, including the plotting and fitting of strength-porosity and moduli-porosity data for comparison with previous fits on data from smaller samples. (SCP Activities 8.3.1.15.1.3.1 and 8.3.1.15.1.3.2)

Major Activities Upcoming Next Three Months

In the study of the mechanical properties of NRG drill hole samples at NER, samples from the lower portion of USW NRG-6 are being tested and will be completed early in August. Testing of samples from UE25 NRG-3 will follow. Data analysis will be continuous as the data are collected. (SCP Activities 8.3.1.15.1.3.1 and 8.3.1.15.1.3.2)

Two members of the NER staff will be in Albuquerque, NM on August 11 through 13, to visit staff at SNL. The discussions will center on the plans for and results from core recovered from the series of NRG drillholes. (SCP Activities 8.3.1.15.1.3.1 and 8.3.1.15.1.3.2)

**1.2.3.2.7.1.4 LABORATORY DETERMINATION  
OF THE MECHANICAL  
PROPERTIES OF FRACTURES**

Status Report on Ongoing Activities

Work is continuing on the development of a computer program to model the dilation, normal stiffness, and shear stiffness of single fractures in rock. An early version of the code is being used to study the changes in the aperture of a fracture under normal stress. (SCP Activity 8.3.1.15.1.4.2)

SAND93-1466A, an abstract entitled "Simple Mathematical Model of a Rough Fracture Using the Concepts of Fractal Geometry," has been submitted for presentation at the Geological Society of America (GSA) national meeting in Boston, MA in October 1993. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

Several studies have produced data relating to the time-dependent mechanical properties of fractures and to the effect of roughness on the mechanical properties. Software that generates dynamic simulations of fractures with measured constitutive properties was acquired and is being applied in the fracture studies. (SCP Activity 8.3.1.15.1.4.2)

The technique for making gypsum cement replicas of rough fractures in the welded Topopah Spring Member tuff was developed, and several replicas have been cast to study the effect of topographic correlation. Experiments will begin following calibration of the laboratory equipment. (SCP Activity 8.3.1.15.1.4.2)

SAND92-2333, "The Effect of Sliding Velocity on the Mechanical Response of Artificial Joints in Topopah Spring Member Tuff," has been submitted for management review. (SCP Activity 8.3.1.15.1.3.2)

Major Activities Upcoming Next Three Months

A comment resolution meeting for Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," will be held in Las Vegas, NV on August 19. All three authors of the plan will respond to comments

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from the Project Office review. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

SAND92-2216J, a journal article entitled "Simple Mathematical Model of a Rough Fracture," is being drafted and will be submitted for review in August. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

The draft of a new standard test method, "Standard Test Method for Normal and Shear Stiffness of Rock Fractures Using a Compression/Rotary Shear Apparatus," completed the first review and vote by American Society for Testing and Materials (ASTM) Subcommittee D18.12 on Rock Mechanics. The review was discussed at the committee meetings in Atlanta, GA on June 22 and 23. The draft was well received, with relatively few technical comments raised. The draft will be revised in the next two to three months. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

**1.2.3.2.8.3.3 GROUND MOTION FROM REGIONAL EARTHQUAKES AND UNDERGROUND NUCLEAR EXPLOSIONS**

Status Report on Ongoing Activities

Revisions to the study plan entitled "Ground Motion From Regional Earthquakes and Underground Nuclear Explosions" are ongoing.

Major Activities Upcoming Next Three Months

Work on the study plan will continue.



#### **1.2.3.6.2.1.6 FUTURE REGIONAL CLIMATE AND ENVIRONMENTS**

##### **Major Accomplishments**

The nine open Corrective Action Requests (CARs) identified in an audit of the National Center for Atmospheric Research (NCAR) have been closed. SNL has completed all actions associated with the Transition Plan for consolidating future climate modeling work at SNL. The Transition Plan is expected to be issued as a Yucca Mountain Site Characterization Project (YMP) Controlled Document shortly.

##### **Significant Meetings Attended**

Staff met with Pacific Northwest Laboratory (PNL) staff on July 7 in Richland, WA to discuss the transition and resolution of Quality Assurance (QA) concerns.

Staff met with NCAR personnel June 23 and 24 to define and perform corrective actions needed to close out nine CARs.

##### **Status Report on Ongoing Activities**

Study Plan and readiness review preparation continue.

##### **Major Activities Upcoming Next Three Months**

Procurement of a replacement contract with NCAR has been initiated.

Completion of a draft Study Plan and a readiness review are expected before the end of FY93.

## 1.2.4 REPOSITORY

The objective of the Repository element includes work scope related to the repository component of the physical system including the repository operations system, the underground facility component of the engineered barrier system, the access/borehole seals, and the monitoring system component of the performance evaluation system. The Repository element is comprised of nine tasks: Repository Coordination and Planning (1.2.4.1.1), Excavation Investigations (1.2.4.2.1.1.1), In Situ Thermomechanical Properties (1.2.4.2.1.1.2), In Situ Mechanical Properties (1.2.4.2.1.1.3), In Situ Design Verification (1.2.4.2.1.1.4), Rock Mass Analyses (1.2.4.2.1.2), Certification of Design Methods (1.2.4.2.3.1), Design Analysis (1.2.4.2.3.2), and Sealing and Design Requirements (1.2.4.6.1).

### 1.2.4.1.1 REPOSITORY COORDINATION AND PLANNING

#### Status Report on Ongoing Activities

Work on the initial drafts of Study Plans 8.3.1.15.1.6, "In Situ Thermomechanical Properties," and 8.3.1.15.1.7, "In Situ Mechanical Properties," continued.

SNL staff continued work on a series of analyses in support of the design of the ESF north ramp. Three-dimensional thermal/structural analyses of the repository to assess the impact of the potential repository thermal loading on the ESF drifts has been completed. These results will support two-dimensional analyses of several cross sections of the ESF north ramp to evaluate long-term stability. Geotechnical data from the NRG holes will be incorporated into the analyses. The analyses are expected to provide input for the 90% design review in August 1993. This month, the analyses for design of the tunnel section from the starter tunnel to the Bow Ridge Fault were completed and the results transmitted to the Project Office for inclusion in the 90% design review.

SNL continued construction monitoring activities at the ESF starter tunnel under Study Plan 8.3.1.15.1.8. In the past month, seismic records from construction blasting were recorded, rock mass quality estimates for the first 200 ft of tunnel were developed, locations for the first two stations of rock bolt load cells were selected, and bolts were installed. The holes for the two multiple point borehole extensometers were also located and drilled. The information collected during this investigation is being provided to the

Management and Operations (M&O) design and construction management team so that real-time evaluations of the performance of the excavations, construction techniques, and ground support can be made.

#### Major Activities Upcoming Next Three Months

Significant effort will be required to complete the instrument installation for the geotechnical monitoring effort in the starter tunnel. (Study Plan 8.3.1.15.1.8)

ESF design analyses for the north ramp section to the repository horizon will be completed.

#### Other Items to Report

SNL staff is continuing temporary monitoring of rock mass movement as the ESF starter tunnel is excavated. Several sets of tape extensometer pins have been installed to monitor closure of the pilot heading. This work is not part of the design verification study plan (8.3.1.15.1.8), but it is similar in nature to the more permanent monitoring that will be installed under the study plan. This temporary monitoring is being conducted under WBS 1.2.6.1.1.



#### **1.2.4.2.1.1.1 EXCAVATION INVESTIGATIONS**

##### Status Report on Ongoing Activities

Staff began incorporating changes to Study Plan 8.3.1.15.1.5, "Excavation Investigations," in response to comments received from Project Office reviewers.

##### Major Activities Upcoming Next Three Months

Staff will work with Project Office reviewers to finalize the Study Plan 8.3.1.15.1.5, "Excavation Investigations."

#### **1.2.4.2.1.1.2 IN SITU THERMOMECHANICAL PROPERTIES**

##### Significant Meetings Attended

A presentation detailing plans and objectives of the experiments contained in Study Plan 8.3.1.15.1.6, "In Situ Thermomechanical Properties," was presented at the Nuclear Waste Technologies Review Board (NWTRB) meeting held on July 13 and 14.

##### Status Report on Ongoing Activities

Staff continued work on the rough draft of Study Plan 8.3.1.15.1.6, "In Situ Thermomechanical Properties."

The SAND report "Test Instrumentation for the ESF In Situ Thermomechanical Experiments" was submitted for SNL management review.

##### Major Activities Upcoming Next Three Months

Staff will continue drafting Study Plan 8.3.1.15.1.6.

Staff will produce a final draft of the SAND report "Test Instrumentation for the ESF In Situ Thermomechanical Experiments" that incorporates comments from management review.

Under LANL coordination, staff will work with Lawrence Livermore National Laboratory (LLNL) staff to consolidate SNL's ESF thermomechanical testing with LLNL's hydrothermal testing, if possible.

#### **1.2.4.2.1.1.3 IN SITU MECHANICAL PROPERTIES**

##### **Status Report on Ongoing Activities**

Staff continued work on the rough draft of Study Plan 8.3.1.15.1.7, "In Situ Mechanical Properties."

##### **Major Activities Upcoming Next Three Months**

Staff will continue drafting Study Plan 8.3.1.15.1.7, "In Situ Mechanical Properties."

#### **1.2.4.2.1.1.4 IN SITU DESIGN VERIFICATION**

##### **Status Report on Ongoing Activities**

Staff continued construction monitoring of the ESF north ramp starter tunnel. The monitoring plans include seismic monitoring for blasting, rock quality determination, ground support system performance evaluations, and excavation closure monitoring for stability assessment. In this reporting period, seismic blast monitoring and rock quality determination activities were conducted, and installation of load cells to be used to monitor rock bolts used as ground support continued.

An SNL report summarizing the rock quality determination of the top heading of the first 200 ft of the starter tunnel was drafted and submitted for technical review.

As an activity separate from construction monitoring, staff performed additional monitoring activities in the north ramp starter tunnel to address safety concerns. Convergence monitoring of the tunnel and support girders was conducted, and rock bolt load cells for evaluating ground support were monitored.

##### **Major Activities Upcoming Next Three Months**

Staff will continue to field construction monitoring activities, and to procure and design instrumentation and a data acquisition system needed for future monitoring activities.

Staff will field additional monitoring activities in the north ramp starter tunnel to address safety concerns as an activity separate from construction monitoring.



### **1.2.4.2.1.2 ROCK MASS ANALYSES**

#### Status Report on Ongoing Activities

Work related to laboratory testing of small, layered polycarbonate models continued in July. This month the data from four tests were analyzed. The tests were a far-field view of loading normal to the plates, a close-up view of loading normal to the plate, a far-field view of loading at 10 degrees to the plate, and a close-up view of loading at 10 degrees to the plate. For the first two experiments, the displacements around the hole are nearly symmetrical, as expected.

Next month, SNL will draft a report describing the tests and data.

A study of the surface characteristics of natural fractures and how to relate these to the frictional data gathered on replicas on the surfaces is continuing. This study will place special emphasis on determining whether the fitting parameters in the so-called "Barton Model" for frictional behavior have physical significance. This is being accomplished by investigating the effect on fracture shear strength and dilation with variation in three parameters: normal stress, roughness, and the strength of the rock material. A draft SAND report is being prepared. The report was sent to SNL from the University of Colorado (CU) and has been returned to CU with comments.

A series of experiments designed to study the effects of a nonstandard loading conditions on frictional properties were conducted at CU in 1992. SAND92-1853, entitled "Effect of Boundary Conditions on the Strength and Deformability of Replicas of Natural Fractures in Welded Tuff: Data Report," detailing the experiment techniques and the resulting data, has completed management review and been sent to the Project Office. The first of two analysis SAND reports (SAND92-2247), "Effect of Boundary Conditions on the Strength and Deformability of Replicas of Natural Fractures in Welded Tuff: Comparison Between Predicted and Observed Behavior," has also finished management review and been sent to the Project Office.

SNL's support of the M&O's design efforts for the north ramp continued in July. Late in June, SNL

became aware of new possible alignments for the north ramp. Given the changes, most of the analyses performed over the last two months are of limited utility. In July, SNL performed analyses of a typical tunnel cross section in the region between the starter tunnel and the Bow Ridge Fault. The analyses show that the seismic loads are clearly the dominant loads. Furthermore, large-scale rock crushing is not expected. A significant amount of tension, though, should be accounted for in the design. This work was transmitted to the Project Office in July.

#### Major Activities Upcoming Next Three Months

Testing, data reduction, and analysis will begin for a set of layered plate experiments. Design support analyses will be performed for the second section of the north ramp.

### **1.2.4.2.3.1 CERTIFICATION OF DESIGN METHODS**

#### Status Report on Ongoing Activities

Work at CU at Boulder in developing joint constitutive models is continuing. CU conducted a literature search to identify the "best" available joint constitutive model in the literature. Experimental data developed under WBS element 1.2.4.2.1.2 has been fitted to Plesha's joint constitutive model. This month the model was being incorporated into a finite element code, and a report was being prepared.

In other work at CU, modifications to the discrete element code DDA are being performed to implement an augmented Lagrangian approach for enforcing the contact constraints and a sub-block concept. This month, CU staff worked on an augmented Lagrangian method to handle block-to-block contact. A variable penalty number was incorporated into the method that improves the convergence rate. At SNL, staff implemented the augmented Lagrangian approach to explore the sub-blocking concept in a two-dimensional research code. Sub-blocking was attained, but the convergence rate was not satisfactory as the number of sub-blocks was increased. Next month staff will explore using a classical Lagrange multiplier method for tying the sub-blocks together.

In a separate activity, the coupled finite element—boundary element research is continuing. In June, the first successful test case in which nonlinear finite elements were coupled to linear boundary elements was conducted. The test case involved pressurizing a thick wall cylinder and allowing the plastic front to move in from the inner surface. This result is a significant accomplishment for this activity. July was spent planning additional test cases to be run to show compatibility with a variety of constitutive models.

B. J. Thorne (SNL) has been working to improve SNL's continuum joint model. SNL staff has identified a number of desired improvements to the model, such as increasing the number of joint sets, allowing for joint sets at arbitrary angles, and joint dilation. Work will progress toward these improvements through the remainder of the FY93. These improvements were identified as

missing desired features in the two-dimensional model and are desired features for the three-dimensional model.

This month the JAC2D manual was drafted and will enter review next month.

#### Major Activities Upcoming Next Three Months

Testing of a discrete element code sub-blocking concept will continue.

Implementation of the sub-blocking concept into the DDA code will continue.

Development of a coupled finite element—boundary element technology will continue to assess how to couple nonlinear finite elements to linear boundary elements.



#### **1.2.4.2.3.2 DESIGN ANALYSIS**

##### **Status Report on Ongoing Activities**

A memo entitled "Static Analysis of a Representative North Ramp Cross-Section in Tiva Canyon" was transmitted to DOE and the M&O. This memo documents a series of linear, static plane strain elastic analyses conducted for a horseshoe-shaped opening between the north ramp starter tunnel and the Bow Ridge Fault. Transmittal of this memo represents completion of Milestone T655.

#### **1.2.4.6.1 SEALING AND DESIGN REQUIREMENTS**

##### **Major Accomplishments**

SAND93-1184, a draft report describing the proposed strategy for sealing boreholes, has been completed and submitted for SNL internal review. The report develops a strategy for sealing boreholes based on evaluations of the current and planned borehole system, the potential impacts on performance that the borehole system could have, and the available technologies to seal boreholes.

##### **Significant Meetings Attended**

Staff attended a meeting with DOE personnel in Las Vegas, NV to discuss UZ-16, the borehole sealing strategy, and other sealing issues.

##### **Status Report on Ongoing Activities**

SAND93-1184 is being revised based on peer review comments.

##### **Major Activities Upcoming Next Three Months**

SAND93-1184 will be completed and submitted to DOE.

##### **Other Items to Report**

SNL Staff is reviewing material information on the Y-7 grout mix planned to be used in the UZ-16 geophone emplacements.



## 1.2.5 REGULATORY

The objective of the Regulatory element is to assure site-related compliance with Nuclear Regulatory Commission agreements, requirements, and policies; evaluate the performance of the natural barriers, engineered barriers, and total systems for meeting regulatory standards; and manage, maintain, and accumulate technical data and information produced by site characterization, design development, and performance assessment activities for the project. The Regulatory element is comprised of 11 tasks: Regulatory Coordination and Planning (1.2.5.1), Site Characterization Program (1.2.5.2.2), Technical Database Input (1.2.5.3.5), Total System Performance Assessment (1.2.5.4.1), Repository Performance Assessment (1.2.5.4.3), Site Performance Assessment (1.2.5.4.4), Interactive Graphics Information System (1.2.5.4.5), Development and Validation of Flow and Transport Models (1.2.5.4.6), Support Calculations for Postclosure Performance Analyses (1.2.5.4.7), Development and Verification of Flow and Transport Codes (1.2.5.4.9), and Special Projects (1.2.5.5).

### ***1.2.5.1 REGULATORY COORDINATION AND PLANNING***

#### Significant Meetings Attended

Several SNL staff attended a Performance Assessment (PA) planning meeting in Denver, CO on July 12. Items discussed included the status of the PA Management Plan and the progress of the various elements of TSPA-II. The current schedule of the TSPA-II includes a meeting of the principal investigators to discuss preliminary results in mid-September, a general meeting to present results in the late September-to-early October time frame, and preparation of a final report for policy review on December 30, 1993.

#### Status Report on Ongoing Activities

A number of comments were provided to the M&O on the contents and format of the PA Management Plan.

### ***1.2.5.2.2 SITE CHARACTERIZATION PROGRAM***

#### Status Report on Ongoing Activities

Staff participated in a number of all-day meetings for the Integrated Test Evaluation (ITE) effort, which is aimed at prioritizing Site Characterization Plan (SCP) activities with respect to design needs. This phase of the ITE is expected to be completed in FY93.



### 1.2.5.3.5 TECHNICAL DATABASE INPUT

#### Major Activities Upcoming Next Three Months

The FY94 budget needs for WBS 1.2.5.3.5 will be determined.

#### Issues/Potential Problems Needing Resolution and Potential Impacts

Modification of TDIFs is required to facilitate TDIF usage by technical personnel.

### 1.2.5.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENT

#### Major Accomplishments

SAND 93-0852, "The Appropriateness of One-Dimensional Yucca Mountain Hydrologic Calculations," by R. Eaton, has completed internal review and has been submitted to YMP for policy review.

A rough draft of the document "Scenarios Constructed for Nominal Flow in the Presence of a Repository at Yucca Mountain and Vicinity" (Sand 92-2186) was completed, sent to external co-authors, and prepared for internal review.

#### Significant Meetings Attended

SNL staff attended the Hydrology Integration Task Force meeting in Las Vegas, NV on July 26 and the Groundwater Characterization Project Information Exchange Meeting on July 27.

#### Status Report on Ongoing Activities

#### Total System Performance Assessment II (TSPA-II)

Source term and near field: The stand-alone version of LLNL's YMIM source program is now running. SNL is now working on coupling YMIM with the SNL flow and transport programs. Some inconsistencies have been identified within YMIM, and a meeting has been planned at LLNL in early August to discuss the problems.

A draft memorandum describing the hydro-thermal-effects model to be used in TSPA-II was completed and submitted for comment by LLNL. The hydrothermal-effects model will use the number of containers outside the boiling isotherm and the volume of the boiling isotherm to determine the amount of water displaced by the repository's thermal perturbation and the containers that will be subject to it. Container-wall (from LLNL) and fuel-rod (from the M&O) temperatures will be used as parameter inputs to YMIM to calculate container corrosion and uranium alteration.



Aqueous and gaseous flow: The results were received from the gas flow calculations performed by Disposal Safety Inc. (DSI). The calculations are similar to the ones used in the previous TSPA (and documented in SAND 91-7034), but with a major improvement: gas flow and heat flow are now coupled, and the calculations are time-varying rather than steady-state. SNL staff has transmitted this information to Intera so that they may also use it in their TSPA.

A draft of the minutes of the Expert Elicitation of Sorption Data for TSPA-II meeting, which took place on June 1, was completed by SNL staff. Copies of the draft were sent to the geochemists who participated in the exercise. The minutes of this meeting will be used to form the basis of the section of the TSPA on geochemistry data that is to be written by LANL.

Work continued on the equations to define the fracture characteristics to be used in TSPA-II. An adequate characterization of the fractures requires a knowledge of the distributions of the fracture aperture, spacing, porosity, saturated conductivity, and van Genuchten parameters. However, the only data available is bulk permeability (sparse) and fracture frequency. Therefore, the equations developed for use in the TSPA are based on the parallel-plate analog.

Modifications to TOSPAC have been incorporated to allow changes in flux, mesh, and water-table height during a single calculation. This will simulate macro-climatic cycles. Miscellaneous bugs in the TRANS and OUTPLOT modules of TOSPAC have been corrected. In all, 66 TOSPAC subroutines have been modified since Version 2.1 was released.

On July 1, staff distributed a memorandum for comment concerning the groundwater flux distributions being considered for use in TSPA-II. The most important difference from TSPA-1991 is that SNL intends to incorporate climate change in the TSPA-II calculations. TSPA-1991 considered a time period of 10,000 years and used a groundwater flux selected from an exponential distribution with a mean of 1 mm/yr for all realizations. For TSPA-II, a time period of 1,000,000 years was considered. This period was broken into a series of dry interpluvial periods (current conditions) and wet pluvial periods. The groundwater flux for the dry periods will be characterized by an exponential distribution with a

mean of 0.5 mm/yr; the wet-period flux will be selected from an exponential distribution with a mean of 10 mm/yr. Two letters have been received in response to the memo. A reviewer from the USGS sent several papers on deciphering paleoclimates. Workers from Raytheon and USGS in Mercury, NV provided "Maxey-Eakin" information and suggested that calcite fracture fillings at Yucca Mountain are indicative of significant evapotranspiration over long periods of time and would preclude high infiltrations in the past. SNL staff will incorporate this information in the TSPA-II section on infiltration flux.

Transport calculations for the saturated zone have been completed. Curves showing the breakthrough of nuclides at the 5 km accessible environment were generated based on this information. The data set was also transmitted to Intera for inclusion in their version of the TSPA.

Disturbed analyses: Work continued on the TSPA analysis. The thermal analysis has been completed for the volcanic problem. Now the range of temperatures in rock surrounding a basaltic intrusion can be approximated. This calculation will be combined with a modified version of the TSPA-91 VOLCAN program to calculate conditions for waste-package failures.

The baseline human-intrusion drilling analyses have almost been completed; however, information to estimate waste-package lifetimes for the near-miss calculation must be included. Lifetimes are being determined using YMIM.

Auxilliary calculations: A dual-porosity material characteristic model has been developed for the SNL version of the multiphase integrated finite-difference code, TOUGH2. This material property formulation attempts to account for water flow in fractures in unsaturated geologic media. The equivalent continuum model uses a look-up table to area-weight the fracture and matrix properties according to the Van Genuchten formulation. This modification of the TOUGH2 code allows improved hydrologic modeling of Yucca Mountain.

Computations are underway to determine the effect of fracture aperture and fracture spacing on repository dryout. Preliminary results show that a considerable amount of repository dryout is calculated using the fracture model, while no

dryout is calculated if the composite model is not used in the calculations.

A method-of-lines (MOL) code has been written to obtain numerical solutions to a model of barometric pumping in a discrete fracture/matrix system. The code is still undergoing testing; however, some preliminary simulations of barometric pumping have been performed. For conditions thought to be representative of the Topopah Springs geologic unit, results of the model indicate some sensitivity to the amount of vapor diffusion. There has been discussion in the literature regarding suitable values for coefficients in the vapor diffusion term. The preliminary results show a factor of more than two difference in net moisture respiration using two different but plausible values for the effective vapor diffusion coefficient. The analysis is continuing, and results will be reported as they come available.

#### **1.2.5.4.3 REPOSITORY PERFORMANCE ASSESSMENT**

##### Significant Meetings Attended

SNL personnel gave presentations on thermal modeling, testing, and performance assessment to the NWTRB on July 13 and 14 in Denver, CO.

##### Status Report on Ongoing Activities

Due to questions regarding the applicability of smeared two-dimensional models for lower thermal loadings, three-dimensional analyses of the in-drift emplacement cases are being examined in the next iteration of TSPA. If the three-dimensional results differ significantly from the two-dimensional calculations already completed, updated boundary conditions will be provided to the M&O's waste package design team for use in simulating characteristic waste form temperatures.

Two of the required four far-field thermal models have been completed for use in the next iteration of TSPA. The thermal profiles from these cases are being reduced into requested formats and should be available within the next two weeks. The remaining two cases are currently being run and should be completed within a week. The goals of these far-field thermal analyses are to provide PA with estimates of the number of packages protected by a boiling front as a function of time and estimates of volumetric dry-out.

Work continued on defining analyses required to support Phase II of the M&O's thermal loading systems study. Specific analyses should be defined and partially completed by the end of the upcoming reporting period.

Three nonisothermal flow visualization experiments have been completed. Numerical modeling of these experiments continues; however, progress has been delayed due to other Project priorities.



#### 1.2.5.4.4 SITE PERFORMANCE ASSESSMENT

##### Status Report on Ongoing Activities

Database and GIS Management: The Performance Assessment Data Base porosity data was provided to the YMP M&O at their request to support their PA exercise. Preparations continued for a briefing to DOE on the SNL approach to data management scheduled for August.

Additional digital information on Yucca Mountain topographic and porosity data was provided to Dynamic Graphics, Inc. (DGI) for use in preparing a demonstration of the surface and subsurface modeling software. The information clarified the data set nomenclature defining the stratigraphy.

Geohydrologic Data Analysis: The input parameter distribution generation for TSPA-II has been essentially completed. All matrix, bulk, and fracture properties that could be produced were finalized. Initial distributions of the site-specific data had been generated and upscaled to the TSPA stratigraphy; however, modification was required due to changes in the stratigraphic realizations (columns) generated to cover the repository area generated using the newest information on thermal output. The columns for the TSPA were relocated and reduced from ten columns to eight. The corresponding stratigraphies for the ten geostatistical simulations were regenerated, and the tables reprinted for the stratigraphy section.

Documentation has begun on data retrieval, data reduction, numeric analysis, statistical analysis, and parameter distribution generation. A check of the database distributions and an initial compilation of the reference material cited is currently underway. The documentation will be incorporated in the TSPA-II report.

Fracture properties were tabulated from four representative drill holes: USW G-1, G-3, G-4, and UE 25a#1. The basic raw data referenced was the fracture count (1/m) down each bore hole and the orientation (dip angles) of the fractures. From this raw data, volumetric values for fractures were derived using the relationship of aperture width with the fracture density ( $1/m^3$ ). Subsequently, as derivative values from the basic fracture count, orientation and bulk conductivity, values, fracture porosity, fracture

conductivity and fracture air entry parameters have been generated and provided to the modelers.

The program APERTURE was updated several times to generate fracture parameter distributions based on fracture frequency, bulk conductivity, and fracture orientation data. By sampling these distributions, data for derivative distributions are produced for fracture aperture, fracture spacing, fracture air entry parameter, fracture porosity, and fracture conductivity.

The Geostatistical Adaptive Grid (GAG) program has been updated to improve and calibrate the generation of material properties. The correlation between mean pore size and porosity was changed from log scale to linear scale to allow linear averaging for the upscaling of the mean pore size to be used.

INTRAVAL: Three indicator geostatistical simulations were run for the East-West INTRAVAL cross section. The results were converted to porosities, and GAG was applied to generate a grid. Then the unsaturated flow code DUAL was run on the three cases. The saturations, porosities, and volumetric water content at the location of UZ-16 were generated and sent to Golder Associates. The current model is only minimally calibrated but shows promising results for capturing heterogeneous flow.



#### **1.2.5.4.5 INTERACTIVE GRAPHICS INFORMATION SYSTEM**

##### **Major Accomplishments**

The computer network at the new facility is installed and operational. Network servers and systems are being configured for the upcoming move.

##### **Status Report on Ongoing Activities**

Project participants are still requesting Calma products and are expected to continue needing the Calma thermal/mechanical model for the immediate future. Plans to shut down the Calma system at the end of FY93 are now on hold. The system will not be moved to the new facility, but it will continue to be operational in the existing location.

Development is continuing on a series of coverages showing the starter tunnel, alcoves, and instrument locations. The plan of the starter tunnel is nearly complete, while the information regarding instrument locations are not yet available.

One Calma job was completed during this period.

##### **Major Activities Upcoming Next Three Months**

Staff will relocate the existing computer systems and Local Area Network (LAN) to the BDM building in a manner that will minimize downtime and disrupted services.

Staff will find alternate sources for three-dimensional model products and eliminate the Calma software.

Staff will plan and begin the implementation of a user environment that provides access to data obtained from instruments placed in the tunnels at Yucca Mountain. This tool will enable users to manipulate, visualize, and output the data as needed.

The following jobs are in progress:

- Job 397 for D. L. Eley - Convert GTMs to ARC/INFO
- Job 398 for D. Guerin - Hydrogeologic drill holes
- Job 401 for L. H. Skinner - Contours of Yucca Mountain
- Job 405 for C. A. Rautman - Rebuild TSw1 model per new input
- Job 407 for M. L. Jones - Add new data coverages
- Job 408 for L. E. Shephard - Profile through USW G-4
- Job 409 for P. B. Davies - SD drill hole products



#### 1.2.5.4.6 DEVELOPMENT AND VALIDATION OF FLOW AND TRANSPORT MODELS

All activities addressed in this monthly status report support SCP Section 8.3.5.12.2.1.1. Activities supporting SCP Section 8.3.5.12.2.2.2 are not scheduled for FY93 and hence are not addressed.

#### Major Accomplishments

All accomplishments have been included in the Status Report on Ongoing Activities for the sake of brevity and completeness.

#### Significant Meetings Attended

D. Freed from the Massachusetts Institute of Technology (MIT) visited SNL to discuss design of reactive transport cells compatible with the laser phosphorescence analysis technique currently under development at MIT. Professor Valery A. Mironenko, Corresponding Member of the Russian Academy of Sciences, St. Petersburg Mining Institute, visited SNL and met with staff involved with the validation of flow and transport models.

M. Siegel attended the first workshop of the Russian-American Center for Contaminant Transport Studies at Lawrence Berkeley Laboratory (LBL). The purpose of the workshop was to allow American and Russian scientists studying contaminant transport to exchange information about programs in their respective countries and to identify areas of potential collaboration in model validation in a format similar to that of the INTRAVAL program. The focus of this meeting was contaminated sites in the Mayak (Chelyabinsk-65) region in Russia.

#### Status Report on Ongoing Activities

General: A significant portion of this month's activity was directed toward QA-related tasks. The internal SNL QA audit required attendance at several meetings and preparation for the audit, as well as participation in the actual audit.

Caisson test: Systematic studies of sorption of Ni by the Wedron 510 sand under atmospheric conditions at 2 different Ni concentrations

(100 ppb and 200 ppb) in the presence and absence of LiBr (17 ppm Li and 200 ppm Br) were completed. The results showed no dependence of Ni sorption on Ni concentration over the range studied and decreased Ni sorption in the presence of Li, and suggest that Ni sorption under atmospheric CO<sub>2</sub> conditions is equivalent or slightly higher than under CO<sub>2</sub>-free conditions. Nickel sorption experiments using the batch sorption techniques described in LANL Detailed Technical Procedures TWS-INC-DP-05-R2 and IANL-INC-DP-86-RO were completed; the Ni analyses are in progress.

Two LiBr pulses were eluted from saturated Wedron 510 sand columns (5 cm diameter by 30 cm tall). Analysis of Br by ion selective electrode and Li by flame atomic absorption and fitting of the breakthrough curve by CXTFIT determined retardation factors of 1.06 and 0.96 for Li and Br, respectively. Dispersion coefficients were 0.017 and 0.0023, respectively, for Li and Br. The two runs differed in the way the sand columns were packed, the first with microlayering and the second homogeneously. The results indicated that these differences in the packing method did not significantly affect the breakthrough curve. The retardation factor of less than 1 for Br is consistent with anion exclusion, causing the Br to flow in the center of the pores where the velocity is higher than average. Kinetic batch sorption experiments were conducted for Li with Wedron 510 sand. Preliminary results show that there is a finite sorption rate that would effect breakthrough curves. Staff is currently modeling column breakthrough data with a kinetic sorption expression with the CXTFIT code to compare the extracted reaction rate constant with the rate constant measured in the batch experiments.

Reactive transport model development: Technical editing of the revised draft of the report "User's Manual for LEHGC: A Lagrangian-Eulerian Model of Hydrogeological Transport in Saturated-Unsaturated Media - Version 1.0" was completed. Formal technical review of the manual will begin in August.

Reactive Transport Experimentation: A new 250-ml reactor vessel has been prepared for the autotitrator, permitting titrations to be performed on smaller load sizes, typically 100 ml electrolyte + 100 g sand. This factor-of-four decrease conserves specially treated (e.g., carbonate-stripped or acid-washed) sand required for the



experiments. Three alkalimetric titrations of acid-washed Wedron 510 sand have been performed at ionic strengths of 0.0018, 0.0030, and 0.012. It was been determined that of leakage of filling solution through the ceramic frit of the pH electrode is significant when titrating systems of low ionic strength. At high ionic strength ( $<0.01$ ) such a change is negligible, but at lower ionic strength this effect must be explicitly accounted for to obtain precise surface acidity constants. Titrations at ionic strengths of 0.03, 0.1, and 0.3 will be performed during August.

An internal audit of this task was carried out during the week of July 12 through 16. Actions required by the Corrective Action Requests (CARs) resulting from the QA audit held at MIT in March were carried out.

Flow and transport through single fractures: The purpose of this task is to challenge existing conceptual models of fracture flow and explore possible rapid transport mechanisms that may be relevant to performance assessment at Yucca Mountain.

The following data was submitted to the Data Records Management System (DRMS) for entry into the 51/L19/-1/159 data set (activity 2: Unsaturated Fracture Flow): Log book for the Full-Field Instability in a Natural Fracture Experiment.

First drafts of experimental procedures and data sheets were prepared for evaluating the effects of wetted structure on fracture permeability, and a scientific notebook was submitted to the DRMS (see above).

Preliminary experiments exploring the effects of air entrapment on fracture permeability and tracer migration were used to develop a plan for subsequent experimentation. The data necessary to characterize the structure of both phases (air and water) was considered, as were means of obtaining such data (commercial software, dedicated software, qualitative visual analysis). This evaluation led to first drafts of both experimental procedures and data sheets. Final drafts will be completed in August and experimentation begun. Training of a new technician to run this experiment continued.

Work continued to further improve manufacture of analog fractures. Evaluation of various casting

compounds continued. The technique used to manufacture cast replicas of natural fractures was refined; it is expected that additional care taken during the casting process will simplify implementation of controlled boundary conditions. The improved methodology will be tested in August. Numerically controlled milling techniques may be used to directly manufacture analog fracture surfaces to predetermined specifications. Two such surfaces may then be used to create a controlled analog aperture field. The ability to replicate a specific aperture field is limited by the physical dimensions of the cutter and the increment between cutting centers. An exploration of these physical limitations was initiated in July and will continue in August in preparation for subsequent fracture manufacture.

Fracture-matrix interaction: The purpose of this task is to challenge existing conceptual models describing the transfer of fluids and solutes between fractures and the host matrix (fracture-matrix interaction) and to explore the impact of fracture-matrix interaction on rapid transport mechanisms.

Mock fracture-matrix interaction investigations were conducted this month to optimize the boundary conditions to be used in subsequent investigations. This required defining the fluid flow rate to the top of the fracture and the aspiration strength to be applied to the lower drip point of the fracture. With these parameters defined, staff is prepared to initiate experimentation. Plans have also been made to deliver the USGS block to SNL for use in future fracture-matrix experiments.

A suite of x-ray images have been acquired using the new Philips industrial x-ray unit. These images, comprising a collection of dummy test objects representing a suite of material types and densities, will be used as a baseline for comparison and evaluation of various real-time x-ray analysis equipment.

Refinement of experimental apparatus allowing observation of fracture wetted structure as a function of matrix pressure continued. The experiment was slightly reconfigured to allow a greater range of pressure variation. A relay to shut off the camera if flow of cooling fluid ceases was fabricated and will be installed in August. Software controlling data acquisition and pressure variation was refined and tested. First drafts of



the experimental procedure and data sheets for the scientific notebook were written. The utility of the IP-Laboratory software package by Signal Analytics for image analysis was explored. Additional light shielding was added to attenuate spurious data resulting from internal reflections and light leaks.

Field, laboratory, and numerical experimentation to determine scaling laws for effective-media properties in heterogeneous media: The purpose of this task is to challenge existing conceptual models for the scaling of effective media properties that are critical to PA at Yucca Mountain.

The automated gas permeameter test system is fully operational. Tests have been completed to evaluate permeameter sensitivity, measurement repeatability, and temporal stability. Data collected to date indicate that measurement sensitivity and repeatability are within the specifications of the electronic permeameter equipment (0.5% full scale). Calibration of the mass flowmeters and pressure transducers has also been accomplished. Measurement of gas permeability at multiple scales has been initiated on tuff slabs to be used in the fracture-matrix interaction studies described above.

#### Major Activities Upcoming Next Three Months

Staff will obtain surface complexation constants of Br, Li, and Ni by sand to be used in caisson or in supporting laboratory studies, carry out Li-Ni ion exchange studies with sand, continue isotherm experiments to determine the linear range of sorption of tracers and continue surface potentiometric titration of sand, implement LEHGC code on massively parallel architecture, continue development of method of unsaturated  $K_d$  measurements with Turbula mixer, and optimize method for laser fluorescence measurements of U in sand and fractured media.

#### **1.2.5.4.7 SUPPORTING CALCULATIONS FOR POSTCLOSURE PERFORMANCE ANALYSES**

##### Status Report on Ongoing Activities

A new ESF PA Analysis (#14) investigating the sensitivity of previous analyses to uncertainty in the hydrologic properties of the nonwelded Paintbrush Tuff has been initiated. Summer student Walter Cruz (Universidad del Turabo, Puerto Rico) has performed preliminary calculations and is documenting them in a report to the Science and Technology Alliance at SNL. This PA analysis has been identified as a potential activity with Level III Milestones for FY94.

Documentation of ESF Analysis #13 is continuing. Additional calculations assuming a higher fracture permeability have been performed to assess water imbibition in the TSw2 sections of the north ramp and main test level of the ESF. The results of these calculations will be included in SAND93-1182; a preliminary draft of this report should be ready for technical and editorial review in early August.

##### Major Activities Upcoming Next Three Months

FY94 budget and milestone planning for WBS 1.2.5.4.7 will be completed.

Documentation of ESF Analysis #13 will continue, with a SAND report (SAND93-1182) to complete technical and management review by the end of FY93 (Level III Milestone OS14).

The report SAND92-2248 will be published when it completes Project Office review.

Testing and numerical simulations using TOUGH-2 for the nonisothermal experiments planned with WBS element 1.2.5.4.3 will continue.

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Other Items to Report

S. Sobolik was to participate in a DOE-NRC Technical Exchange on the ESF Title II Design. This exchange was postponed indefinitely. Presentation materials concerning the underground water analysis (ESF Analysis #13) specifically relating to fire suppression are ready when the exchange is rescheduled.

An SNL Internal Audit (SNL-A93-1) was held. The auditors had very complimentary comments on how the analyses performed under WBS element 1.2.5.4.7 are documented under the SNL QA system.

**1.2.5.4.9 DEVELOPMENT AND VERIFICATION OF FLOW AND TRANSPORT CODES**

Status Report on Ongoing Activities

Staff is continuing to work with the Software Quality Action Team (QAT) to rewrite QAIP 3-2, to process software QA records, and to qualify the code TOUGH2.

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#### **1.2.5.5.2 ENERGY POLICY ACT SUPPORT**

##### **Significant Meetings Attended**

J. Schelling is continuing to attend meetings to support the ITE.

##### **Status Report on Ongoing Activities**

SNL staff have been requested by representatives of the National Academy of Sciences to give an overview on TSPA-91 at a meeting in August. Some time has been spent this month getting that information ready for presentation.



## 1.2.6 EXPLORATORY STUDIES FACILITY

The objective of the Exploratory Studies Facility element includes work scope related to the design, construction, and operation of the Exploratory Studies Facility. The Exploratory Studies Facility element includes the Exploratory Studies Coordination, Planning, and Technical Assessment (1.2.6.1.1) task.

### ***1.2.6.1.1 ESF COORDINATION, PLANNING, AND TECHNICAL ASSESSMENT***

#### Major Activities Upcoming Next Three Months

Under LANL coordination, staff will work with LLNL staff to consolidate SNL's ESF thermomechanical testing with LLNL's hydrothermal testing, if possible.

Staff will support development of tracer requirements for testing in the ESF facility.

Staff will supply a preliminary estimate of support needed from the Integrated Data System (IDS) by the SNL in situ field experiments to aid the designers of the IDS system in developing the system.



## 1.2.9 PROJECT MANAGEMENT

The objective of the Project Management element includes work scope related to project-level planning and control, and management of contract activities. The Project Management element includes two tasks: Technical Project Office Management (1.2.9.1.2) and Project Control (1.2.9.2.2).

### 1.2.9.1.2 TECHNICAL PROJECT OFFICE MANAGEMENT

#### Significant Meetings Attended

Staff participated in a number of Project meetings in Las Vegas, NV. Topics included budget, planning, design, technical data, and license application development.

### 1.2.9.2.2 PROJECT CONTROL

#### Major Accomplishments

To date, a total of 22/52 milestones have been completed.

#### Significant Meetings Attended

SNL YMP Project Control staff met with other YMP schedulers in Las Vegas, NV on July 2 to kick off the initial meeting of the Planning and Control System (PACS) Workstation Working Group. The group will address workstation planning and implementation issues.

Project Control staff met with selected members of the YMP Project Control Steering Committee on July 8 in Albuquerque, NM to discuss concerns regarding Project control processes and problems.

Training and Project Control staff attended the PACS orientation pilot training session, held in Las Vegas, NV on July 29.

SNL and contractor staff responsible for tasks under 1.2.9 attended a monthly meeting to provide updates on activity status, accomplishments, and future plans for work in these elements.

#### Status Report on Ongoing Activities

SNL YMP Project Management staff are developing new reports to aid Project technical staff in their tracking and analysis of Project costs. The new reports include additional graphics reports depicting costs broken out by labor/subcontracts/other, as well as additional detailed tabular reports on labor, travel, and purchases.



The migration of the Administrative Information Management System (AIMS) to a new SUN platform was initiated. To date, the new operating system and the INFORMIX database software has been loaded and configured. Efforts to load the database programs and data files will commence in August.

A "Worker Classification" exercise for the Government Accounting Office (GAO) was completed and forwarded to W. Kozai. The exercise was intended to count and categorize SNL YMP staff and their fields of investigation.

The FY93 capital equipment budget and expenditures are being reconciled.

Work continues in preparation for the FY94 budget exercise. Preliminary work scopes have been extracted for the SNL input to the Site Characterization Annual Report.

Analysis continued on the SNL/YMP Baseline Configuration Management Plan.

#### Major Activities Upcoming Next Three Months

The budget planning exercise is expected to begin during the first week of August. SNL Project Control staff is continuing to prepare for this activity. Preliminary work scopes have been extracted from the SNL input to the site characterization plan.

The SNL Baseline Configuration Management Plan will be completed.

Project Management staff will complete the initial FY94 budget exercise after receiving guidance from the Project Office.



## 1.2.11 QUALITY ASSURANCE

The objective of the Quality Assurance element includes work scope related to the development and maintenance of project participants' assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository and monitored retrievable storage facility will be met and complies with Federal regulations.

### 1.2.11 QUALITY ASSURANCE

#### Major Accomplishments

The SNL YMP QA Annual Internal Audit was conducted. Eleven CARs will be issued: five deviations and six observations.

A site surveillance of geotechnical field logging of borehole samples and relevant documentation was performed.

#### Status Report on Ongoing Activities

Staff continues to implement procedure improvement and transition to the new Quality Assurance Requirements and Description (QARD). Two procedures remain to be revised. The following list summarizes the status of particular procedures.

- QAIP 2-5, Training (Revised). In review
- QAIP 3-2, Software QA Procedure "draft."  
Working with technical staff
- QAIP 6-3, Conducting and Documenting  
Reviews of Documents. Issued

Final resolution, verification, and close out of all ten open CARs from the October 1992 QA Audit of NCAR were completed during this reporting period.

Final resolution, verification, and close out of the four open CARs from the March 1993 QA Audit of MIT were completed during this reporting period.

#### Major Activities Upcoming Next Three Months

A surveillance is planned in the areas of laboratory thermal properties and laboratory thermal expansion tests.

#### Other Items to Report

The QARD matrix will be input into the YMP QAD database.



## 1.2.12 INFORMATION MANAGEMENT

The objective of the Information Management element includes work scope related to the project-level establishment of systems to facilitate organization, storage, and retrieval of information/documents. The Information Management element is comprised of four tasks: Information Management Coordination and Planning (1.2.12.1), Local Records Center Operation (1.2.12.2), Participant Records Management (1.2.12.2.3), and Document Control (1.2.12.2.5).

### **1.2.12.1 INFORMATION MANAGEMENT COORDINATION AND PLANNING**

#### Status Report on Ongoing Activities

Services for the support of WBS element 1.2.12 activities were maintained as needed.

### **1.2.12.2 LOCAL RECORDS CENTER OPERATION**

SCP Sections/Activities - according to the WBS Dictionary, this WBS element includes no SCP activities.

#### Major Accomplishments

Ten boxes of the 22 Series "Procurement" proprietary non-program records and YMP nonrecords were reviewed for submittal to SNL microfilming.

Six Cited References (167 pages), for publications, were copied and submitted to the CRF.

One hundred and sixty-six records (4,143 pages) were processed. Sixty-two records (987 pages) were prepared and submitted to the CRF. One hundred and four records (3,156 pages) were Limited Value and Information Copies retained by SNL.

Two (2) TDIFs were prepared and submitted to the RMS.

Three (3) TDIFs were entered into the YMP Automated Technical Data Tracking System (ATDT).

#### Significant Meetings Attended

ES&H Training was attended as required by staff members on July 7th and 21st.



Staff members attended the SNL/YMP Internal Audit opening and closing meetings on July 12th and 16th.

#### Status Report on Ongoing Activities

Project and SNL Microfilmed records/documents (12,100 pages) were verified and sent to SNL storage.

The "backlog" technical data review and processing method has been designed for submittal of backlog technical data to ATDT, GENISES, and finally the Records Management System.

One (1) new data set was opened.

#### Major Activities Upcoming Next Three Months

The QAT to assess and redesign the current Local Record Center filing system is on hold pending issuance of QARD required rescissions to SNL YMP Program procedures.

"Participant Data Archives" desk guidance was completed.

Staff reviewed eighteen (18) three ring binders (36 inches of paper, 9,000 pages), which contain SEPDB records, against microfilm. The verified hardcopy was either destroyed with approval or sent to the SNL Archives.

Development of a Disaster Preparedness and Recovery Plan for the YMP Records Management Program continues, with concentration on electronic records and computer systems.

The review process for the preparation and submittal of technical data from published SAND reports has been developed and will be folded into the processing of backlog technical data over the coming months.

The establishment of a technical data team to evaluate SNL YMP processes and integrate requirements, technical efforts, and support efforts for improved efficiency of personnel has been delayed due to "backlog" processing efforts.

#### **1.2.12.2.3 PARTICIPANT RECORDS MANAGEMENT**

##### Major Accomplishments

A new Records Management Supervisor for the YMP Records Management Support efforts began work on July 7.

##### Significant Meetings Attended

On July 20 and 21, the Records Manager and Supervisor attended the Office of Civilian Radioactive Waste Management (OCRWM) Records Inventory and Disposition Schedule (RIDS) Seminar in Las Vegas, NV. Also in attendance was guest S. Tonnesen, Org. 7145, Recorded Information Management. Her attendance marked the emphasis within the DOE Records Management community (and within SNL) to share information where topics are of mutual interest.



### **1.2.12.2.5 DOCUMENT CONTROL**

#### **Major Accomplishments**

The Document Control staff participated in the development of a configuration management form that will be used to capture information for the Document Control, Training, Person Table, Property, and PACs systems.

#### **Status Report on Ongoing Activities**

Work continued on integrating the Document Control database with the Training database.

#### **Major Activities Upcoming Next Three Months**

Work will begin on eliminating obsolete records from the Document Control system to significantly reduce the number of records that will have to be re-coded before integration with the Training database. Hard copies of these records will be made and stored for future reference.

Document Control staff will work on a comprehensive update of the Person Table to verify and update data in the Document Control system prior to integration with the Training database.

Integration of the Document Control and Training databases will be completed.



## 1.2.15 SUPPORT SERVICES

The objective of the Support Services element includes work related to project-level general administrative and project support activities. The Support Services element is comprised of three tasks: Support Services Coordination and Planning (1.2.15.1), Administrative Support (1.2.15.2), and YMP Support for the Training Mission (1.2.15.3).

### **1.2.15.1 SUPPORT SERVICES COORDINATION AND PLANNING**

#### Significant Meetings Attended

SNL and contractor staff responsible for tasks under WBS element 1.2.15 attended a monthly meeting to provide updates on activity status, accomplishments, and future plans for work in these elements.

#### Status Report on Ongoing Activities

Services for the support of WBS element 1.2.15 activities were maintained as needed.

### **1.2.15.2 ADMINISTRATIVE SUPPORT**

#### Major Accomplishments

During the month of July, four SAND reports were printed and distributed. One SAND report was sent to the printer.

#### Status Report on Ongoing Activities

Work on the Procurements database design continued. Efforts were concentrated on developing queries that will provide downloaded financial information from SNL's financial system. The database will be designed to provide detailed procurement information as required by the YMP socioeconomic monitoring plan and will perform three major functions: procurement tracking, financial data downloads, and reporting.

All SNL YMP property that is in storage has been inspected by S. Carter, Property Management, DOE, in visits to Albuquerque, NM during the weeks of July 19 and July 26. Desirable excess equipment will be shipped to the University of Nevada, Reno. Other miscellaneous items will be examined by SNL personnel for possible use, after which all remaining excess property will be sent for SNL reapplication.

The Quarterly Worker Data Report was compiled and submitted to the YMP. SNL staff responded to a new socioeconomic exercise requesting the distribution and completion of a worker data survey. Results were forwarded to J. Carlson, SAIC.



### **1.2.15.3 YMP SUPPORT FOR THE TRAINING MISSION**

#### Major Accomplishments

The Training database has been converted to the Administrative Information Management System (AIMS).

Concurrence has been achieved with the TPO, QA organization, and Training organization on assigning procedural training based on the procedures cited in the Work Agreement the individual works on. This training assignment method will create a closer and more direct link between the training the individual receives and the work the individual performs.

SNL QAIP 2-5 has been revised and submitted to the TPO for final approval.

#### Significant Meetings Attended

The Training Manager attended a PACS Orientation at the Project Office on July 29. Discussions were held with the Project's training staff on the possibility of modulating the presentation material and adding appropriate detail to each segment to convert the material to in-depth training. The Project's training staff agreed to explore this direction. SNL agreed to be an alpha site for this PACS Training and to videotape the training sessions conducted at SNL for use throughout the Project.

The Training Manager met with DOE's Training Officer, C. Rehkop, and the YMP Training Officer, R. McCarthy, on July 29, in Las Vegas, NV. The purpose of the meeting was to share information on SNL's expanded training, to provide an update on SNL's current training efforts, and to obtain guidance on resources sharing to avoid duplication of efforts.

#### Status Report on Ongoing Activities

Staff continues to use parallel entry into FoxPro and Informix while the effort continues to develop a relational database integrating the Training and Controlled Document databases.

#### Major Activities Upcoming Next Three Months

Work will begin on eliminating inactive training records from the database prior to integrating the Training database with the Controlled Document database. Hard copies of the inactive records will be made and stored for future reference.

SNL will finalize the integration of the Training and Controlled Document databases.

Work will begin on assigning procedural training to participants based on procedures cited in the relevant Work Agreement.

Professional development programs will be sought out and evaluated for inclusion in the training program.

Training will investigate the feasibility of conducting field training through a one-day field trip to the Jemez Mountains for SNL YMP participants.

The Training Manager will work with the Project Office's training staff to have PACS, General Employee Training (GET), and Underground Worker training conducted at SNL by Project Office staff.

Editing of the "Geology for Non-Geologists" course tapes will resume.

The Training Newsletter will resume publication.



# United States Department of the Interior



GEOLOGICAL SURVEY  
BOX 25046 M.S. 425  
DENVER FEDERAL CENTER  
DENVER, COLORADO 80225

IN REPLY REFER TO:

September 10, 1993

WBS: 1.2.9.2.2  
QA: N/A

Carl P. Gertz, Project Manager  
Yucca Mountain Site Characterization Project Office  
U.S. Department of Energy  
P.O. Box 98608  
Las Vegas, Nevada 89193-8608

SUBJECT: U.S. Geological Survey Yucca Mountain Project Monthly Summary for August 1993

Dear Carl:

In compliance with Yucca Mountain Project monthly reporting procedures, following is the YMP USGS input for August 1993. If you have any questions, please contact Raye Ritchey at (303)236-0517.

## WBS 1.2.1 - SYSTEMS ENGINEERING

### 1.2.1.6 - Configuration Management

Impact assessments were performed and Affected Document Notices (ADNs) completed for seven change requests.

## WBS 1.2.3 - SITE INVESTIGATIONS

### 1.2.3.1 - Coordination and Planning

The HIP is currently processing 47 hydrologic procedures and scientific notebook plans. They also are processing 78 YMP-HIP scientific publications, 55 YMP-GSP scientific publications, 8 YMP-LBL scientific publications, and 58 abstracts.

#### 1.2.3.2.2.1.1 - Surface and Subsurface Stratigraphic Studies of the Host Rock and Surrounding Units

Partial and preliminary description of core from UZ-14 continued between the depths of 241-1292 feet (deepest core examined). This interval is in the Topopah Spring Tuff and includes the lower nonlithophysal zone and the lower vitrophyre. Detailed logging continued; depth interval from 300-1292 feet is in review. Partial and preliminary description of core from NRG-5 continued between the depths of 690 to 996 feet. NRG-5 was cored only from 690-996 feet; therefore, there is little stratigraphic context in which to identify units. Partial and preliminary description began of core from NRG-2b between the depths of 0-128 feet. Detailed log of NRG-2a, from 80-265 feet total depth (0-80 feet was not cored), was completed and is in review.

The north ramp geologic cross section was revised and updated, based on

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current borehole data, a review of the original north ramp cross section, and changes in the ramp alignment. New isopach maps were created of Yucca Mountain Tuff, Pah Canyon Tuff, Topopah Spring Tuff, and the Rhyolite of Calico Hills. These maps, based on the latest borehole and surface mapping data for the cooling sub-units and bedded tuffs, will aid in developing the 3-D stratigraphic model and in determining pre-eruptive topography for each of the major eruptive units.

Isotope and geochemistry group work in support of stratigraphic studies and mapping of zonal features consisted of final data compilation, entry and verification of the analytical data base containing all available major-element, trace-element, and radiogenic isotope data for Tertiary volcanics and Paleozoic sediments at Yucca Mountain and surrounding areas. This work is directed toward meeting the FY93 milestone to supply a report on the Geochemical Data Base by the end of September. Additional samples from the Tiva Canyon member of the Paintbrush Canyon Tuff were collected for petrographic, geochemical and isotopic analysis in order to help assess the lateral variations within this unit. A visiting Russian geochemist, Dr. Leonid A. Neymark will assist the isotope and geochemistry group in developing new analytical techniques focusing initially on U-Th disequilibrium dating of calcites associated with Ghost Dance fault veins by mass spectrometry.

#### **1.2.3.2.2.1.2 - Structural Features within the Site Area**

Mapping continued of stratigraphic and structural features on the East and West Wings of the Ghost Dance Fault study area at Antler Ridge. Sample locations were located in WT-2 Wash. Analysis of fracture data around and along the Ghost Dance Fault system continued. Thirty-five rock samples were collected from the southeastern flank of Whaleback Ridge and 40 additional samples of drill core from USW GU-3 for thin section and geochemical analysis.

Mapping of the North Ramp starter tunnel continued throughout August with excavation still in the upper lithophysal zone of the Tiva Canyon Tuff. The lower bench of the starter tunnel was mapped to station 0+89 including stereophotography, full-periphery mapping, and detailed line surveys. Geologists collected 19 samples as part of the Consolidated Sampling Program. The samples were collected between stations 0+00 and 0+89 and included fracture fillings, representative lithologic samples, smectite from lithophysae, contaminated and uncontaminated wall rock, a sample of both walls of a fracture, and a sample of lithophysal filling.

#### **1.2.3.2.8.3.1 - Relevant Earthquake Sources**

A fault parameter table for relevant earthquake sources continues through final review and revision. Quaternary Fault Compilation was reviewed. Methodology has been identified and discussions are continuing to evaluate and revise deterministic seismic hazards. Meetings are ongoing to formulate earthquake ground motion methodology; a preliminary model is nearly complete.

#### **1.2.3.2.8.3.3 - Ground Motion from Regional Earthquakes and Underground Nuclear Explosions**

The study plan has been delayed indefinitely because the principal author is awaiting the final position paper from the DOE seismic hazards methodology group; the study plan must reflect DOE's position on ground motion methodology.

#### **1.2.3.2.8.3.4 - Effects of Local Site Geology on Surface and Subsurface Motions**

Work continued on analysis of the Midway Valley experiment; 150 useable seismograms have been assembled.

#### **1.2.3.2.8.4.1 - Historical and Current Seismicity**

Additional records at CalTech relating to earthquakes near Yucca Mountain were photographed. Surveys were conducted for precarious rocks near the San Andreas Fault and near Eureka, Nevada.

Three temporary broad-band stations were installed near Beatty to improve traveltimes curves for earthquake location. Approximately 75% of the UNR data report for the Little Skull Mountain earthquake data acquisition was completed. Approximately two man-months were expended to prepare for the upcoming NPE shot at the Nevada Test Site and Sierra "corner shot" in Amargosa Valley.

#### **1.2.3.2.8.4.4 - Quaternary Faulting within Northeast Trending Fault Zones**

Field work in Rock Valley continued. A field trip was conducted for USGS and DOE personnel to assess field exposures (including trenches and scarps) relevant to Quaternary faulting and seismic hazard evaluation. Map and air photo data were reviewed in light of field data. Information needed for the report on the Rock Valley fault zone was assembled.

#### **1.2.3.2.8.4.5 - Detachment Faults**

Most recent versions of the Calico Hills map were reduced for incorporation into other small-scale maps of the region. Field work was compiled. Analysis continued of structures in Paleozoic rock; structural and stratigraphic data and colored versions of the map were compiled. The "Geologic map of the East of Beatty Mountain quadrangle, Nye County, Nevada" is nearly complete.

#### **1.2.3.2.8.4.6 - Quaternary Faulting within the Site Area**

The Quaternary fault map and report were revised following review. Map and text were prepared for formal USGS review. Versions of the map were reduced for incorporation into the 1:100,000-scale Beatty geologic map.

Geomatrix personnel completed excavation of subsidiary fault to the east of the main trace on Busted Butte wall #4. They also reanalyzed displacements on the main fault in detail and began descriptions of units and soils on exposed wall. Excavation of new trenches on the Solitario Canyon fault were completed, including extending pit (SCR-71A) on SCR-T1; digging new trenches SCR-T2, SCR-T3, and SCR-T4; and cleaning one natural exposure (SCR-E1). Rock samples were collected from bedrock scarps along Solitario Canyon fault and Windy Wash fault, and submitted for cosmogenic dating.

#### **1.2.3.2.8.4.12 - Tectonic Models and Synthesis**

Data on faults within 100 km radius of Yucca Mountain were reviewed; preliminary analysis was made of NE-trending faults in the Rock Valley area.

Material collected during June field work was compiled. Preliminary boundary element modeling for Yucca Mountain continued.

#### **1.2.3.3.1.1.1 - Precipitation and Meteorological Monitoring for Regional Hydrology**

August was an abnormally dry month as the summer drought continued; however, during the last week of August, the monsoon did reach southern Nevada. On the 27th, thunderstorms developed in the Yucca Mountain region, with one storm hitting the southern half of the mountain. The storm lasted 43 minutes and dropped 16.5 millimeters in the wedge at N-77. Lesser amounts were recorded at other locations. A lightning strike pattern was documented, as well as time-lapse video and satellite imagery.

An NCR was prepared for relative humidity data collected between April 15 and

April 19, 1993. Relative humidity sensors at the five weather stations were out-of-calibration following closing calibrations on March 25, 1993. Calibrated sensors were not received in time to meet the one-year replacement requirement; therefore, data from sensors are under a hold tag until the data can be verified and adjusted. This means that the open file report of weather station data will be delayed until data are corrected, which is expected to be October 31, 1993.

#### **1.2.3.3.1.1.2 - Runoff and Streamflow**

Reduction of FY1986-1990 runoff and streamflow data was completed. An initial draft of the report was completed for colleague review.

#### **1.2.3.3.1.1.3 - Regional Ground-Water Flow System**

Several wells in the Amargosa Desert were monitored as part of the periodic water level monitoring program. Depths to water in several wells on Franklin Lake playa were measured.

Data collection activities, associated with the rainfall, streamflow, and ground-water recharge in FY1993, has resulted in delays in the Fortymile recharge data report. Completion of this report will take precedence over new upcoming publication avenues, e.g. the Fall '93 AGU meeting and the '94 high level waste meeting. The report should be ready for submittal to DOE by December 31, 1993.

#### **1.2.3.3.1.1.4 - Regional Hydrologic System Synthesis and Modeling**

Staff engaged in a two-day meeting with representatives from GeoTrans Inc., a company conducting a remedial investigation of the NTS for the DOE Environmental Restoration program. The GeoTrans staff has developed an investigation of the NTS very similar to that being conducted of the entire Death Valley region by the 3-D modeling group. Methods, logistics, and modeling problems were discussed, and efforts made to coordinate data management and review of previous work.

#### **1.2.3.3.1.2.1 - Unsaturated Zone Infiltration**

Monthly sampling of surficial materials at each of the neutron boreholes continued. All of the moisture information was placed in a data base, allowing a review of changes in water content with time at each of the measured locations. Sampling and data collection continued at the tensiometer transects located in WT-2 Wash. Eight water content and moisture potential samples were collected along the three transects. Particle size analysis of bulk density samples was completed for N-53, -54, and -55. Neutron, natural gamma, and gamma-gamma tools were run in N-85. The natural gamma and gamma-gamma logs differentiated in the caliche and boulder layers found in the alluvial profile. Further refinement of these techniques should allow determination of depth to caliche in all of the alluvial washes. Neutron hole N-39 was drilled; drive core samples to a depth of 60 feet were collected.

#### **1.2.3.3.1.2.3 - Percolation in the Unsaturated Zone, Surface-Based Study**

In support of matrix properties testing, all LEXAN samples from UZ-16 have been requested from the SMF, and a portion of them have been delivered. Core preparation has begun which consists of subsampling the LEXAN sample using a 1" drill to provide a 1" core plug. These samples will be used for saturated permeability, air permeability, gas pycnometry determined particle density, and sorptivity at RH dryness. A slice will be taken off the end of the core plug which will be used for moisture retention and the remaining portion of the plug will be tested in the steady state centrifuge to determine unsaturated hydraulic conductivity.

In preparation for instrumenting existing boreholes, staff prepared design for a template that will be used in orienting geophones that will be installed at UZ-16; coordinated with a local metals fabrication shop on design and fabrication of DISA holders that will be used in instrumenting small diameter UZ boreholes; sent dry mix samples of grout (prepared for use in UZ borehole stemming and instrumentation program) to SNL for analysis and evaluation; coordinated with Smith Fiberglass Products on specifications for the axial scribe line that is to be traced onto the fiberglass pipe being manufactured by Smith; completed punch-list of requirements for refurbishing two prototype instrument shelters built by REECO in 1988/1989 (to be used in support of small diameter borehole instrumentation program in FY1994); and continued cleaning and bench testing DISAs.

Two zero offset and two "walkaway" vertical seismic profiles were conducted at UZ-16. Several thousand source-receiver combinations were recorded. Source and seismic detectors were multiple component. Maximum source-receiver distance was over 5,000'. Preliminary examination indicates that data quality is excellent. Coherent seismic energy was detected in the UZ-16 borehole, even at the 5,000' offset distances. Processing and interpretation of data tapes is in progress.

In support of air permeability testing, the 4-packer system was assembled, connected to the support trailer, and tested at Test Cell C. All components of the data acquisition system operated perfectly, as did the pneumatic system. The surface-based air permeability testing system will be ready for field testing at the c-hole complex on September 7, 1993. All equipment and required technical procedures for conducting air permeability tests in UZ-16 will be field ready by the scheduled test date of October 4, 1993.

Drilling operations at UZ-14 were monitored closely throughout August. The borehole was advanced in stages to test and evaluate various water producing zones. Water was first encountered at a depth of 1254 ft. Three water zones were encountered as the borehole was advanced to a temporary TD of 1282 ft. (contact with the basal vitrophyre was at 1278 ft). Several moist/damp zones also were encountered between depths of 1200 to 1254 ft., before encountering free flowing water between 1254 and 1258 ft. Three bailer tests and three pump tests were conducted. Water samples also were collected during each of the pumping tests. Water sample chemistry is being analyzed. An attempt will be made to seal the water-bearing zones below a depth of 1234 ft. by injecting (squeezing) grout into the borehole. This activity is scheduled for September 1, with drilling to resume on September 7 if the squeeze-job is successful. Results of the first three bails tests have been analyzed, indicating that most of the water was produced from the middle zone (1265-1271 ft.), which is 100 times more permeable than the lower zone. Preliminary chemistry tests indicate that the upper water zone does contain a trace of the polymer used to drill G-1; the middle zone shows only a trace of the polymer; the lower zone has no indication of polymer. The chemistry of the lower zone water is markedly different from the upper two zones.

#### **1.2.3.3.1.2.4 - Percolation in the Unsaturated Zone - ESF Study**

Completion of the analytical report on imbibition experiments has been delayed until September 30, 1993, because some extra tests were required on the large fractured welded tuff block. This delay is not expected to affect progress of the ESF test. An experiment with a fractured core was conducted to study the effect of bacterial growth on the variability of the water flow rate through a fracture. Bacterial counts are expressed in CFU/cm<sup>3</sup>, where CFU = colony-forming units. Initial counts of the water used with this experiment were 50-60. After 20 days of continuous testing, counts exceeded 10,000,000. No known nutrients exist in the water used for this experiment. The variability of the water flow rate through the fractured sample changed by more than one order of magnitude under the same boundary conditions.

#### **1.2.3.3.1.2.6 - Gaseous-Phase Movement in the Unsaturated Zone**

Staff met to formulate plans for conducting divergent tracer tests at UZ-6s and Hilti holes in October. Another set of gas concentration samples was collected from UZ-6s and Hilti holes; results were similar to past results.

#### **1.2.3.3.1.2.7 - Unsaturated Zone Hydrochemistry**

Gaseous phase chemical investigations staff prepared for sampling UZ-16 by getting together equipment and preparing a schedule. The packer string was constructed and tested. The packer handling system was assembled over the hole, and the packer was installed downhole. As the fifth packer was prepared for insertion into the hole, it was noted that the weight of the packer string changed as it was raised or lowered several feet. A borehole camera was lowered into the hole and determined that the wire rope had come off the sheave. The packers were raised slowly, and the problem was corrected. The packer string could not be raised to inspect packer #4, but could be lowered. The hole was viewed with the borehole camera to a depth of about 400 feet, and no obstructions were found. It was decided that the best way to proceed would be to lower the string about 40 feet, inflate the packers, and pump and collect gas from four zones rather than five. Gas samples are being collected. Five out of eight CO<sub>2</sub> gas samples collected at borehole UZ-16 were degassed for C<sup>14</sup> analysis. Upon degassing, it was discovered that the sample volumes are too small. Resampling for a longer period of time after packer emplacement will be required.

In support of aqueous phase chemical investigations, analyses were done on seven perched water samples from UZ-16, and four from various collection sites at UZ-6 and UZ-6s. The ion chromatograph was calibrated for anions. Four perched water samples from UZ-14 were analyzed for chloride, bromide, nitrate, and sulfate. Three partially welded or nonwelded cores were compressed by the high-pressure one-dimensional compression method. Quantities of pore water extracted ranged from 22.1 ml to 36.0 ml.

#### **1.2.3.3.1.2.8 - Fluid Flow in Unsaturated Zone Fractured Rock**

Golder Associates is advising the USGS on fracture network modeling. Initial discussions have defined strategies and goals. As part of the conceptual design of this activity, data and information about fracture orientation, dip, frequency, density, orientation and flow rates in differential stress regimes, and fracture characterization at different scales, will continue to be compiled. To date, fracture information for UZ-6, NRG-1, NRG pavement area, and G-4 have been compiled. The fracture data sets are being loaded into FracMan code. Information will be used in the formulation of the fracture network model. Work has begun on compiling information on bulk permeabilities and/or transmissivities of fracture rock reservoirs on a world wide basis. Most of the data comes from analyzing production and pressure changes with time (in years). Three of the six reservoirs researched are in fractured volcanic tuffs. The objective is to determine some possible ranges of bulk permeabilities/transmissivities in fractured rock using very long term "pump" tests.

Analysis began by LBL on the effect of block-size distribution on matrix block shape factors and equilibration times at Yucca Mountain. Using both a Warren-Roof and a more exact treatment of fracture/matrix interactions, the appropriate method of averaging the shape factors will be found in terms of the moments of the block-size distribution function.

#### **1.2.3.3.1.2.9 - Site Unsaturated Zone Modeling and Synthesis**

In preparation for the two-dimensional cross sectional simulation of Pagany Wash, a one-dimensional model was constructed with stratigraphy representative

of UZ-4 and UZ-5 in the upper 120 m. Derived statistical correlations between porosity and hydraulic parameters were used in conjunction with porosity profiles to estimate the hydraulic properties at these boreholes. Attempts to numerically simulate the measured saturation profiles at UZ-5 with the TOUGH code have so far suggested the following: 1) the measured profiles do not appear to be consistent with steady 1-D flow; 2) saturation and capillary pressure profiles for steady 1, 2.5 and 5.0 mm/yr percolation fluxes are nearly identical, suggesting that while it would be difficult to accurately estimate fluxes in this range from measured profiles, it is relatively straightforward to predict the observed saturation and water potential profiles during past pluvial events since these are relatively insensitive to flux; 3) hysteresis resulting from the distribution of nonwelded and fractured welded stratigraphic layers causes a fundamental asymmetry in time-scales required to establish steady-flow under conditions of wetting and draining. Drainage from a high-flux to gravitational equilibrium profile requires time periods on the order of a hundred thousand years or more, whereas for wetting conditions, steady flow may be established in ten-thousand years or less if significant fracture flow is involved; 4) the vitric caprock of the Topopah Spring Member, although assumed to be significantly fractured, restricts the drainage of water from layers above it, causing the capillary pressure profile above it to approach a gravity equilibrium profile; 5) due to the slow drainage above the vitric caprock, some of the water in the upper unsaturated zone probably dates to the last (and even previous) ice age; and 6) capillary barrier effects caused by the relatively large openings in the fractures of the Topopah Springs Member, will significantly delay any increase in recharge flux due to climate change from entering this unit.

#### **1.2.3.3.1.3.1 - Site Saturated Zone Ground Water Flow System**

An interim plan was developed to conduct non-pumping tests at the c-holes until the discharge pipeline is completed, and the power cable issue is resolved. The interim plan involves monitoring for hydraulic effects of barometric pressure changes with open-holes, and for the hydraulic effects of barometric pressure changes and earth tides with packer-string-instrumented holes. This work is being referred to as Phase-I and a specific Work Program has been written for it by RSN and reviewed by the USGS. The Work Program was finalized in July and the YMPO issued a "Notice to Proceed" to YMSO in August.

A tracer test was performed at the Raymond quarry site (being used to prototype the c-hole bound packer strings), where deuterium, bromide, fluorescein, and fluorescent microspheres were injected into one well, and pumped out of another well 100 feet away.

Routine water-level measurements were suspended this month, and probably part of next month, while repairs are being made to measuring equipment in Denver. Only wells requiring water-level measurements associated with transducer replacement were measured, using equipment borrowed from the Weapons Program.

Reduction of all 1992 periodic water-level data has been completed, and checked. Water-level altitudes were recomputed for VH-1, based on revised measuring points. Water-level altitudes were also computed for wells J-11 and J-12, based on new information on reference point altitudes provided by environmental monitoring program personnel.

#### **1.2.3.3.1.3.2 - Saturated Zone Hydrochemistry**

A suite of fluid samples for chemical and isotopic analyses were collected at borehole USW UZ-14.

#### **1.2.3.6.2.1.2 - Paleoclimate Study of Lake, Playa and Marsh Deposits**

Staff participated in drilling of lacustrine sediments from the Sevier Lake

Basin that could provide long term regional climate records for model validation and climate parameter reconstruction. Available water quality data from the Northeast and upper Midwest were entered into a spreadsheet for preliminary analysis and general check of cation and anion balances. Preliminary stable isotope data was examined for various bivalves, gastropods, and ostracodes.

#### 1.2.3.6.2.1.3 - Climatic Implications of Terrestrial Paleoecology

C-14 analysis was completed for 36 samples collected by DRI.

#### 1.2.3.6.2.1.4 - Paleoenvironmental History of Yucca Mountain

The map report on the northern 1/3 of Yucca Mountain was submitted for colleague review. Airphoto interpretation and field checking of surficial deposits for the central 1/3 of Yucca Mountain continued.

#### 1.2.3.6.2.2.1 - Quaternary Regional Hydrology

In support of regional paleoflood studies, Arc/Info drainage basin maps of the Death Valley watershed, and storm volume runoff tables of the upper Amargosa River drainage basin that depict modern-day runoff conditions in the Yucca Mountain site area, were completed. Work began on assembly and analysis of numerical data of regional paleoflood and annual streamflow conditions. These materials will characterize probable peak discharge rates, storm volumes, and streamflow frequencies of runoff events that would have occurred during the latter half of the Holocene, about 2,000 to 5,000 years ago. The numerical correlations between regional precipitation and peak discharge and storm runoff volumes for individual drainage basins of the watershed are important because they quantitatively characterize regional paleoflood conditions and provide a means of establishing the potential magnitudes and frequencies of large-scale floods and debris flows that may occur due to storms in the Yucca Mountain area.

Staff supporting the evaluation of past discharge areas completed the report on Amargosa Desert vegetation mapping; final figures are being redrafted.

Isotope and geochemistry group work in support of paleoclimate studies focused primarily on evaluation of past discharge. Available isotopic and geochemical data on waters from both the Oasis Valley and Ash Meadows flow systems were compiled and evaluated with regard to determining multi-component mixing dynamics and flow path reactions and assessment. Sr isotopic data was collected from travertine veins and massive limestone units in Rock Valley in an attempt to assess whether the two types of calcite deposits are genetically linked. Preliminary results suggest that the two occurrences (subterranean versus surficial) are unrelated. Stratigraphic relationships in cross sections of the Quaternary discharge sites near the southern end of Crater Flat were examined and additional samples were collected for U-Th disequilibrium and thermoluminescence dating. Samples of young rhizoliths (19 ka) from one of these deposits were prepared for  $^{14}\text{C}$  dating by accelerator mass spectrometry in order to verify previously determined by U-Th disequilibrium ages. Calcite silica studies were supported primarily by installation of new electronic equipment on one of the mass spectrometers. The new magnetic field controller will allow faster peak jumps and enhanced digital scanning of the magnetic field.

In support of arid-zone geochemistry studies, 109 ion chromatograph measurements were made of chloride concentration from Organ Pipe Cactus National Monument soils. Preparation for the IC measurements included leaching the chloride from the soils and filtering the leachate twice. Forty-three chlorine concentration measurements were made of surface boulders and calcrete samples. Most of these were reanalyses, deemed important because

calculated cosmogenic CL-36 age is quite sensitive to the Cl concentration in the sample.

In support of calcite silica studies, staff extracted CO<sub>2</sub> from 81 soil gas samples for mass spectrometer analysis; analysis was completed. Approximately 110 samples were entered into the soil gas data base. Approximately 20 samples were analyzed using a coulometer for organic, inorganic, and total carbon content. Staff petrographically described and sampled: 11 samples from the c-hole complex to test for evidence of recent saturated zone calcite deposition; 7 samples of cobble undercoatings from soil profiles at Fortymile Wash and Fran Ridge; 14 samples from the PIA soil gas site on the flank of Rainier Mesa to test for isotopic systematics from the base of the thin soil down a thin fracture exposure of about 30 meters; 18 samples from Trench 5a on the eastern flank of Exile Hill to test for variation in calcified soil from a colluvial to alluvial environment; 32 samples from a vertical column sampling of Trench 14c to test for long-term climate record in a sequence of calcified soils; 38 samples from buried calcified soils at Busted Butte to test for long-term climate record in a sequence of calcified soils; 10 samples from the ESF excavation of sparry calcite hosted by faults, fractures and lithophysal cavities for comparison with the data from overlying calcified soils; and 4 samples from the Tiva Canyon Pavement.

#### **1.2.3.7.2.1 - Natural Resource Assessment**

Staff visited the Nevada Bureau of Mines and Geology (NBMG) to collect additional cuttings/samples of Chainman Shale and Sheep Pass Formation occurrences in wells throughout Railroad Valley in support of the Yucca Mountain petroleum model. USGS wells in Fish Lake Valley also were sampled for recent peat which may be an analog to the Neogene peat found in Area 8 of the NTS. Coal samples also were provided by NBMG as additional possible analogs to the Area 8 peats. A first draft was completed of "Source rocks and thermal maturity history of the Yucca Mountain region, Southern Nye County, Nevada".

Isotope and geochemistry group work in support of potential mineralization studies at Yucca Mountain included preparation of a summary abstract titled "Isotopic tracers for gold mineralization in Paleozoic limestones of southern Nevada" to be submitted to the ANS High Level Radioactive Waste Management meeting. In the process of producing this document, Sr data from mineralized and unmineralized Paleozoic carbonates throughout the Yucca Mountain vicinity were compiled and evaluated. Results indicate that unmineralized carbonates retain their original marine Sr isotopic compositions, whereas mineralized carbonates reflect addition of radiogenic Sr, probably through interaction with hydrothermal fluids migrating upwards from the Precambrian basement. Thus, this isotopic approach appears to provide promise as a very useful tool for evaluating mineral potential of carbonate terrains.

#### **WBS 1.2.5 - REGULATORY**

##### **1.2.5.3.5 - Technical Data Base Input**

Twelve current TDIFs were received into the PDA, 8 new entries into the ATDT system were quality checked, 20 new TDIFs were created for backlog publications, and 21 previously completed TDIFs were corrected to meet minimum current standards.

#### **WBS 1.2.9 - PROJECT MANAGEMENT**

##### **1.2.9.2.2 - Project Control**

The FY1994 planning exercise, based on DOE funding targets, was completed and uploaded to Las Vegas.

**1.2.11 - QUALITY ASSURANCE**

**1.2.11.2 - Quality Assurance Program Development**

An effort was initiated to identify potential improvements for the vendor qualification component of the procurement program.

**1.2.11.3 - Quality Assurance Verification**

Supplier audits/evaluations were completed for Storage Technology; Air Products and Chemical; Druck, Inc.; Ocala Water Quality Laboratory; and REECO. It was recommended that Air Products be removed from the Approved Suppliers List; the rest were recommended for retention.

Auditing management personnel visited the Yucca Mountain site to become familiar with field considerations and related issues. Plans are being established to significantly increase the level of field surveillances.

**WBS 1.2.12 - INFORMATION SYSTEMS**

**1.2.12.2.2 - Local Records Center Operation**

The LRC received 181 individual records, 45 current criteria packages, and 15 publications packages. Corrective actions were required on 3% of the records received. Current material transmitted to the CRF included 101 individual records and 47 criteria packages (1,368 pages). Backlog material included 5 publications packages and 18 other criteria packages.

**WBS 1.2.13 - ENVIRONMENT, SAFETY, AND HEALTH**

**1.2.13.4.7 - Water Resources**

Ground-water levels were measured at 26 sites. Discharge data were collected at six sites. Ground-water data collected during July were checked and filed.

Sincerely,

*Ray E. Ritchey*  
for Larry R. Hayes  
Technical Project Officer  
Yucca Mountain Project  
U.S. Geological Survey

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