Lawrence Livermore National Laboratory

MAY 25 12:53 PM '93

LLYMP9305060
May 19, 1993

WBS 1.2.9
"QA: N/A"

Carl Gertz, Project Manager
Department of Energy
Yucca Mountain Project Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

cc: Gertz
cc: Blanchard
cc: Boak
cc: Bryan / Simmons
cc: Dyer / Smistad
cc: Harrison / Gradsky
cc: Lani / Jones, S
cc: Sinecka / Smith, M

REC'D IN YMP 5/25/93

I-342/155
BAA

SUBJECT: Yucca Mountain Project Status Report - April 1993
SCP: N/A

Attached is the April Project Status Report for LLNL's participation in the Yucca Mountain Project.

If further information is required, please contact Elizabeth Campbell of my staff at 510-422-7854 or Jim Blink in Las Vegas at 702-794-7157.

5-19-93

Sincerely,

W. L. Clarke
LLNL Technical Project Officer
for YMP

WC/EC

cc:
Distribution

DISCLAIMER

1023.8

The LLNL Yucca Mountain Project 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.

ENCLOSURE 1

LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
MARCH 1993 TECHNICAL HIGHLIGHTS AND STATUS REPORT
TABLE OF CONTENTS

1.2.9 Project Management

WBS 1.2.9.1	Management and Coordination (Clarke)
WBS 1.2.9.1.2	Technical Project Office Management (Clarke)
WBS 1.2.9.2	Project Control (Podobnik)
WBS 1.2.9.2.2	Technical Project Office Management (Podobnik)

1.2.11 Quality Assurance

WBS 1.2.11.1	Quality Assurance Coordination and Planning
WBS 1.2.11.2	Quality Assurance Program Development
WBS 1.2.11.3	Quality Assurance Verification
WBS 1.2.11.3.1	Quality Assurance Verification - Audits
WBS 1.2.11.3.2	Quality Assurance Verification - Surveillance
WBS 1.2.11.5	Quality Assurance - Quality Engineering

1.2.12 Information Management

WBS 1.2.12.2.2	Local Records Center Operation (LRC) (Bryan)
WBS 1.2.12.2.5	Document Control (Bryan)

1.2.13 Environment, Safety and Health

WBS 1.2.13.1	Environment, Safety and Health Coordination and Planning (Blink)

1.2.15 Support Services

WBS 1.2.15.2	Administrative Support (Campbell)
WBS 1.2.15.3	YMSCP Support for the Training Mission (Bryan)

LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)
YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT

APRIL 1993

EXECUTIVE SUMMARY
(Items Proposed for Reporting in YMPO or OGD Reports)

1) **1.2.1.5 (Special Studies).** D. McCright is serving as the team leader for the focus on thermal goals affecting the engineered barrier system (EBS). Other team members are from SNL, LANL, M&O and LLNL. Some of the goals need to be changed to reflect the greater diversity of repository and waste package designs being considered in the ACD phase. The particular goals that the engineered barrier system team is taking the lead on for possible revision are:

1) the 350°C limit on spent fuel cladding,
2) the 500°C limit on glass,
3) the 275°C limit on the borehole wall,
4) maximizing the time the borehole wall stays above boiling, and
5) the design basis for a thermal load less than the allowable thermal load.

2) **1.2.2.2.1 (Chemical and Mineralogical Properties of the Waste Package Environment).** Work on the New Zealand natural analog site continued. A visit there by two LLNL scientists (C. Bruton and W. Bourcier) to evaluate potential sites for conducting validation activities using EQ3/6 was completed. Several sites were visited. From those, a prioritized list of site studies has been developed, and a draft memorandum describing the site work has been written.

3) **1.2.2.3.1.1 (Waste Form Testing - Spent Fuel).** The Thermogravimetric Apparatus units have been taken out of storage. Flow meters, thermocouples, and balances are being calibrated. Pumps and seals are being refurbished. Trial runs on unirradiated UO_2 will be conducted in May for equipment checkout.

4) **1.2.2.2.4 (Large Block Test).** A geomechanical numerical simulation of the Large Block Test (LBT) was initiated. The purpose of this work is to aid in the experimental design of the test and to provide a point of reference for evaluation of various thermal and material models for predicting the block response. The initial focus is on evaluation of options for the placement of heaters and the rate and duration of heating/cooling cycles, and to assist in the design of the type and location of diagnostic instrumentation, especially for the geomechanical measurements. Preliminary results for temperature, stress and displacement fields as a function of time from the start of heating should be available in mid May.

3) **1.2.2.2.2 (Hydrologic Properties of the Waste Package Environment).** In considering the sensitivity of mountain-scale, buoyant, vapor convection to k_b, the initial suite of calculations have assumed a uniform isotropic k_b throughout the UZ. Two thresholds were identified: The threshold k_b (called $k_{b\text{-}hyd}$) where mountain-scale, buoyant, vapor convection begins to dominate hydrological performance and the threshold k_b (called $k_{b\text{-}th}$) where this convection begins to dominate the thermal performance. J. Nitao also developed analytical expressions

for these thresholds and found very good agreement between the analytically determined values and those determined in the modeling study. It was found that $k_{b\text{-}th}$ is generally an order of magnitude larger than $k_{b\text{-}hyd}$.

5) **1.2.2.3.2 (Metal Barriers).** Recent authorization from YMPO will permit procurement of a high sensitivity thermogravimetric analysis unit. This unit will be used in an experimental study to discern at what point there is a transition between "dry" oxidation and "wet" corrosion. It is expected that the study will be conducted on a corrosion allowance material (such as carbon steel) with temperature, humidity, and surface condition as the principal variables. The transition between dry and wet conditions is very important with respect to performance of the container material and the design strategy for keeping the waste package in a "dry" condition for an extended period of time.

6) **1.2.5.3.4 (Geologic and Engineering Materials Bibliography of Chemical Species GEMBOCHS).** In the interest of mnemonics, two programs from the GEMBOCHS software library were renamed. DBAPP, an interactive FORTRAN/EQUEL code that facilitates review, modification, deletion and addition of GEMBOCHS data, has been renamed "FACET". D0OUT, a FORTRAN/EQUEL code that facilitates generation of GEMBOCHS-based thermodynamics datafiles for use with EQ3/6, GT, and other geomechanical modeling packages, has been renamed "JEWEL".

7) **1.2.5.4.2 (Waste Package Performance Assessment).** Work continues on the scoping study of cladding temperature history for various drift emplacement heat loadings, and of cladding creep endurance. Drift backfill 75 years after waste emplacement is assumed. Based on recent literature, the temperatures are somewhat higher than in the earlier parameterization of thermal results, but feasible repository loadings can meet both dryout and cladding goals. The cladding creep model was extended to incorporate reduced pressure load due to the progress of creep; non-inclusion is somewhat conservative.

8) **1.2.5.4.2 (Waste Package Performance Assessment).** LLNL is developing a summary model of the near-field environment of the waste packages. This will consider the thermal transient and dryout based on papers by J. Nitao, T. Buscheck and others. The product will be time histories, in table or algorithm form, of temperature, fractional saturation, fraction of waste packages wetted, and liquid water flux. In March, a calculational procedure was implemented to evaluate the distance of fracture flow penetration due to refluxing of condensate water above the repository. This procedure includes a spatial variability in water flux and in fracture sizes, and hence a spatial variability in distance of refluxing.

1.2.1 SYSTEMS ENGINEERING

1.2.1.1 Systems Engineering Coordination and Planning

No significant activities.

1.2.1.5 Special Studies

D. McCright and W. Clarke attended a meeting in Las Vegas on April 16 to discuss possible revision of the YMP thermal goals originally detailed in the SCP. D. McCright is serving as the team leader for the focus on thermal goals affecting the engineered barrier system (EBS). Other team members are from SNL, LANL, M&O and LLNL. A teleconference between team members was held on April 9. Some of the goals need to be changed to reflect the greater diversity of repository and waste package designs being considered in the ACD phase. The particular goals that the engineered barrier system team is taking the lead on for possible revision are:

1) the 350°C limit on spent fuel cladding,
2) the 500°C limit on glass,
3) the 275°C limit on the borehole wall,
4) maximizing the time the borehole wall stays above boiling, and
5) the design basis for a thermal load less than the allowable thermal load.

However, team members are free to comment on all of the thermal goals in other areas and members of other teams are free to comment on the EBS related goals. Following some preliminary recommended changes made at the April 16 meeting, the individual teams will continue to discuss the goals and report back to J. de la Garza of DOE on May 7 on their recommendations.

S. Saterlie (M&O) visited LLNL on April 22 to discuss the initiation of system studies work for the coming months.

1.2.1.6 Configuration Management

No significant activities.

1.2.2 WASTE PACKAGE

1.2.2.1 Waste Package Coordination and Planning

W. Lin attended the (SOC) Sample Overview Committee meeting at NTS on April 7.

B. Viani participated in the April Geochemistry Integration Task (GIT) teleconference meeting which focused primarily on the upcoming colloid workshop at LANL and on developing a project strategy for addressing the issue of colloidal mediated transport of radionuclides.

1.2.2.2 Waste Package Environment

D. Wilder and D. Chesnut visited Sweden for an International Program meeting on construction and grouting and then visited the Aspo Hard Rock Lab on March 29 - April 2.

The following papers were presented at the International High Level Radioactive Waste Conference held in Las Vegas, April 26-30:

1) "Alternative Strategies - A Means for Saving Money and Time on Yucca Mountain Project" by D. Wilder.

1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment

Work on the New Zealand natural analog site continued. A visit there by two LLNL scientists (C. Bruton and W. Bourcier) to evaluate potential sites for conducting validation activities using EQ3/6 was completed. Several sites were visited. From those, a prioritized list of site studies has been developed, and a draft memorandum describing the site work has been written.

Models of mineral evolution in the vicinity of waste packages were further developed. A reference set of computations that will be used as a comparison for calculations involving flow and transport has been initiated, using J-13 and rock systems idealized from the known stratigraphy. The current calculations do not consider the role of moving water. Computations have also been initiated in which the dissolution and precipitation kinetics of various silicates are used to bound estimates of the rates at which mineralogical and chemical equilibrium may be achieved in the vicinity of waste packages, and also in the areas surrounding the repository. Initial calculations indicate that local equilibrium will be achieved in periods of from a few months to a few years at the nominal SCP areal power density (APD), and at higher thermal loads.

Input was provided to the thermal goals panel, addressing specific geochemical and mineralogical issues.

W. Glassley attended the IHLRWM conference held in Las Vegas, April 26-30 and held discussions with several people regarding reaction progress rates and their implications for modeling with confidence evolution of the geochemical system around waste packages.

1.2.2.2.2 Hydrologic Properties of the Waste Package Environment

Model Calculations

Over the past months, the sensitivity of thermo-hydrological performance of the repository-Unsaturated Zone-Saturated Zone (UZ-SZ) system to a broad range of thermal loading design parameters, thermo-hydrological properties, and boundary conditions have been examined. It has been also demonstrated that because of the very small matrix permeability in most of the UZ, the only significant source of liquid water reaching a Waste Package (WP) and transporting radionuclides to the water table is from nonequilibrium fracture flow from three potential origins:

1) meteoric sources,
2) drainage of condensate generated under boiling conditions, and
3) drainage of condensate generated under sub-boiling conditions by either repository- or mountain-scale, buoyant vapor flow.

The first source of liquid water arises from the ambient system; the second and third sources are generated by repository heat. Analyses indicate that the third source of water can persist for tens of thousands of years. In addition to generating condensate flow, repository heat can also drive changes in the saturation distribution, including regions of net dry-out and regions of saturation buildup.

These changes in the saturation distribution can impact ambient fracture flow, possibly amplifying the effects of natural infiltration in regions of saturation buildup and attenuating those effects in regions of net dry-out. Analyses have indicated that repository-heat-driven changes in the saturation distribution can persist for more than 100,000 yr. In addition, a region of above-boiling temperatures can significantly mitigate the impact of fracture flow on WP performance and radionuclide migration for thousands of years.

The extent to which these three sources of fracture flow may impact WP performance and radionuclide migration is critically dependent on ambient site conditions and on the thermal loading strategy which will eventually be adopted for the Mined Geological Disposal System (MGDS) at Yucca Mountain. With respect to repository-heat-driven thermo-hydrological performance, there are three primary thermal loading strategies. These three strategies are best framed as the following three fundamental questions:

1) Under what conditions would a limited and distributed repository thermal load have a negligible impact on hydrological performance of the MGDS?

2) For intermediate thermal loads such as that described in the Site Characterization Plan - Conceptual Design Report (SCP-CDR), will the thermo-hydrological impacts and our understanding of those impacts allow demonstration that the performance of the MGDS meets regulatory requirements?

3) For higher thermal loads that have the potential of generating extended-dry conditions, will the thermo-hydrological impacts and our understanding of those impacts allow demonstration that the performance of the MGDS meets regulatory requirements?

The goal of the first thermal loading strategy is to minimize the hydrological impact of repository heat so that the primary concern in assessing hydrological performance is the ambient hydrological system. Therefore, this strategy requires that the ambient hydrological system and our understanding of that system allows demonstration that the performance of the MGDS meets regulatory compliance. For the second thermal loading strategy, we must demonstrate adequate understanding of both the ambient hydrological system and how heat perturbs fluid flow in the ambient system. The goal of the third thermal loading strategy is to dominate the ambient system with repository-heat-driven above-boiling conditions surrounding the repository. This would result in

1) the absence of liquid water in the vicinity of the WPs as long as boiling persists and

2) sub-ambient liquid saturation conditions for some time following the above-boiling period.

For all three thermal loading strategies, in situ heater tests at multiple locations in the unsaturated zone and (possibly) the saturated zone are critically important to demonstrating that our understanding and characterization of repository-heat-driven hydrothermal flow are sufficient to resolve the critical issues and hypotheses that provide the basis for the thermo-hydrological performance arguments.

T. Buscheck, with the support of S. Daveler and T. Quinn, continued analyzing the preliminary scoping calculations of the hydrothermal performance of the repository, using the new model which represents hydrothermal flow in the upper 1000 m of

the saturated zone as well as within the unsaturated zone. This month, calculations and analysis addressed three general effects:

1) the effect of bulk permeability, k_b, on mountain-scale, buoyant, vapor convection,
2) the effect of k_b layering on mountain-scale, buoyant, vapor convection, and
3) the size of the repository.

In considering the sensitivity of mountain-scale, buoyant, vapor convection to k_b, the initial suite of calculations have assumed a uniform isotropic k_b throughout the UZ. A wide range in k_b was considered in order to examine when boiling and buoyant convective effects dominate thermo-hydrological performance. In particular, two thresholds were identified: The threshold k_b (called $k_{b\text{-}hyd}$) where mountain-scale, buoyant, vapor convection begins to dominate hydrological performance and the threshold k_b (called $k_{b\text{-}th}$) where this convection begins to dominate the thermal performance. J. Nitao also developed analytical expressions for these thresholds and found very good agreement between the analytically determined values and those determined in the modeling study. It was found that $k_{b\text{-}th}$ is generally an order of magnitude larger than $k_{b\text{-}hyd}$. For example, for the reference SCP-CDR thermal load, $k_{b\text{-}hyd}$ is in the range of 1-5 darcy (10^{-12} to 5×10^{-12} m^2), while $k_{b\text{-}th}$ is approximately 50 darcy. For a lower areal mass loading (AML) of 27.1 MTU/acre, $k_{b\text{-}hyd}$ and $k_{b\text{-}th}$ are approximately 10 and 100 darcy, respectively. Both the modeling study and the analytical expressions also show that as long as boiling results in a significant gas pressure buildup, boiling tends to suppress the effects of mountain-scale, buoyant, vapor flow.

This month, k_b distributions that are horizontally uniform but vertically variable were considered. This was done in consideration of the unpublished k_b data of E. Weeks which indicate considerable layering of k_b. In particular, it appears that k_b may be considerably less in the nonwelded units (e.g., the nonwelded vitric PTn, the nonwelded vitric CHnv, and the nonwelded zeolitized CHnz) than it is in the welded units (e.g., the welded TCw, TSw1, TSw2, and TSw3).

The first suite of layered-k_b considered the case where the k_b of the PTn is substantially less than the other units in the UZ. For a low Areal Power Density (APD) of 20 kW/acre and 30-yr-old spent nuclear fuel (SNF), yielding an AML of 27.1 MTU/acre, a case with a k_b of 84 darcy throughout the UZ and a case with a k_b in the UZ of 84 darcy except in the PTn where k_b is 320 millidarcy were considered. For the uniform case, mountain-scale, buoyant gas-phase convection behaves as though it is in an "open" system with respect to the ground surface. In the open system, the gas-phase velocity vectors are orthogonal to the ground surface in the vicinity of the ground surface. Buoyant vapor flow substantially increases the liquid saturation from the repository horizon all the way to the ground surface. In the case where k_b is 320 millidarcy in the PTn, the PTn functions as a gas-phase flow barrier. Therefore, the gas-phase velocity vectors just below the PTn-TSw1 contact tend to become tangential to this contact. The PTn effectively isolates the repository-heat-driven gas-phase convection cells from the ground surface, thereby causing the mountain-scale, buoyant, gas-phase flow system to be "closed" with respect to the ground surface.

In general, hydrostratigraphic units (e.g., the PTn) which are found to have a substantially smaller k_b can function as "vapor caps" which limit the vertical extent and magnitude of repository-heat-driven saturation alteration. The role which the PTn may play in limiting these repository-heat-driven effects may prove to be more significant than its impact on limiting the infiltration of meteoric water.

The "size effect" (i.e., the areal extent of the repository) on the thermal behavior was also studied. For a high APD of 114 kW/acre and 30-yr-old SNF, yielding an AML of 154.7 MTU/acre, repository areas of 559 and 1747 acres were considered. For a 559-acre repository, the duration of boiling, t_{bp}, at the center of the repository is 11,400 yr. For a 1747-acre repository, t_{bp} is 13,300 yr at the center of the repository. The effect of more than tripling the area of the repository (and the total waste emplaced) is to only increase t_{bp} by 16%. It is planned to consider repository areas which are less than 559 acres in order to determine when the "size effect" begins to become more pronounced. These two 154.7 MTU/acre cases were reported on in "The Analysis of Repository-Heat-Driven Hydrothermal Flow at Yucca Mountain" by Buscheck and Nitao, Table 1 (page 854) of the Proceedings of the International High Level Radioactive Waste Management Conference. The second to last entry for t_{bp} in Table 1 is incorrectly given as 10,685 yr (for the 154.7 MTU/acre, 1747-acre repository). The correct value should be 13,286 yr.

Laboratory Experiments

Study Plan 8.3.4.2.4.2, Rev. 0, "Laboratory Study of Hydrological Properties of the Near Field Environment" was reviewed at LLNL, and the comment resolution was completed. The Study Plan will be submitted to YMPO in May.

Work continued to measure electrical resistivity as a function of moisture content of Topopah Spring Tuff samples from U3hg-1 and GU-3 holes at room temperature, using J-13 water as pore fluid. The purpose of following this experimental procedure is to determine the effect of the electrical conductivity of pore fluid on the relationship between the bulk electrical conductivity of a rock sample and the degree of saturation in it. The drying phase has been completed. The measured bulk resistivity using J-13 water as pore fluid at water saturation levels less than 80% is very similar to that when distilled water is used as pore fluid. When the saturation level is greater than 80%, the bulk electrical conductivity using J-13 water as pore fluid did not decrease with respect to increase of water saturation, as was observed when distilled water was used as pore fluid. The samples from GU-3 will be used for the experiment at high temperatures.

Disc samples from G-4 core have been prepared for the determination of electrical resistivity as a function of water saturation at room temperature. These disc specimens are machined both parallel and perpendicular to the axis of the core. Isotropy in electrical resistivity will be determined.

Work continued on an experiment to determine the effect of fracture surface coatings on the imbibition of water into the matrix. Eight Topopah Spring Tuff samples machined from outcrops from Busted Butte, NV were prepared for this

purpose. Work progresses to determine the mineralogy of the coating material, the pore size distribution in the coating layers, and the porosity of the samples.

Sample preparation for determining the moisture retention curve and one-dimensional imbibition using G-4 core has been completed. These samples are being used to obtain experimental data for calculating relative permeability as a function of water saturation. The determination of moisture retention curves has been started, and the one-dimensional imbibition experiment will be started next month.

The sample preparation of a fractured Topopah Spring tuff sample from the G-4 hole for the fracture healing study is about 90% complete.

Meetings and Publications

The following papers were presented at the International High Level Radioactive Waste Conference held in Las Vegas, April 26-30:

1) "The Analysis of Repository-Heat-Driven Hydrothermal Flow at Yucca Mountain" by T. Buscheck and J. Nitao,

2) "Large-Scale In Situ Heater Tests for Hydrothermal Characterization at Yucca Mountain", by T. Buscheck, D. Wilder and J. Nitao,

3) "Single-Hole In Situ Heater Tests for Hydrothermal Characterization at Yucca Mountain" by G. Danko and T. Buscheck.

The following papers were submitted as summaries to the FOCUS '93, Site Characterization and Model Validation, meeting to be held in Las Vegas on September 26-29, 1993:

1) "Determination of the Characteristic Curves of Topopah Spring Tuff" by W. Lin, J. Roberts and J. Nitao, and

2) "Electrical Resistivity of Topopah Spring Tuff as a Function of Water Saturation and Water Chemistry" by J. Roberts and W. Lin.

1.2.2.2.3 Mechanical Attributes of the Waste Package Environment

Work continued on Activity Plans for both laboratory and numerical studies of the geomechanics of the near field environment.

Set-up of laboratory facilities for geomechanics testing of rock samples continued. Emphasis was on apparatus to determine the effect of the cristobalite behavior at temperatures of 200 - 250°C on the mechanical properties of the rock. This apparatus may be ready for operation in June. The laboratory will be initially used to support the Large Block Test. A post doc candidate to support the laboratory measurements was interviewed.

1.2.2.2.4 Engineered Barrier System (EBS) Field Tests

ESF Field Tests

Study Plan 8.3.4.2.4.4, "Engineered Barrier System Field Tests" has completed review at LLNL. It will soon be submitted to YMPO.

Large Block Test (LBT)

The Scientific Investigation Plan for the Large Block Tests, SIP-NF-2 Rev. 0, has been reviewed by YMPO. Comment resolution will start next month.

The design of the loading frame has been finalized. The Mechanical Engineering Department (LLNL) personnel have prepared fabrication drawings of the frame. The procurement process for the frame will start next month. The process of removing the surface material of the site at Fran Ridge will also begin in May. Preparation work for laboratory tests on smaller blocks and quarry of the large block have been started.

A geomechanical numerical simulation of the Large Block Test (LBT) was initiated. The purpose of this work is to aid in the experimental design of the test and to provide a point of reference for evaluation of various thermal and material models for predicting the block response. The initial focus is on evaluation of options for the placement of heaters and the rate and duration of heating/cooling cycles, and to assist in the design of the type and location of diagnostic instrumentation, especially for the geomechanical measurements. Preliminary results for temperature, stress and displacement fields as a function of time from the start of heating should be available in mid May. An abstract describing this work was prepared as a summary for the FOCUS '93, Site Characterization and Model Validation, meeting to be held in Las Vegas on September 26-29, 1993. It is entitled "Geomechanical Analysis of the Large Block Test Using Numerical Techniques" by S. Blair and E. Kansa.

The numerical model used for the simulation is FLAC which is a time-dependent, finite difference model capable of treating both mechanical and thermally induced stresses and deformations. It is a two-dimensional code in which materials are represented by arbitrarily-shaped quadrilateral zones. FLAC is based on a Lagrangian scheme which is well suited for large material deformations and is capable of using several built-in material models, including the ubiquitous joint model, and is installed on a Sun Sparc workstation.

Review of specifications was initiated for several geomechanical diagnostic systems for the LBT. These include multiple point displacement extensometer (MPBX) systems, stress meters, acoustic velocity systems and a borehole scanner. This review led to the discovery the there may be two MPBX systems on site and efforts to locate them were initiated.

The following paper was submitted as a summary to the FOCUS '93, Site Characterization and Model Validation, meeting to be held in Las Vegas on September 26-29, 1993:

1) "Large Block Tests for the Coupled Thermal-Mechanical-Hydrological-Geochemical Processes" by W. Lin, S. Blair, J. Blink, T. Buscheck, Y. Chang, D. Chesnut, W. Glassley, J. Nitao, J. Roberts, J. Ueng and D. Wilder.

1.2.2.2.5 Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment

Investigation activities into the stability and reactivity of organic materials continue with lab facilities having been completed.

The potential for conducting studies on degradation of man-made materials in collaboration with New Zealand geothermal interests is being pursued as part of a geochemical analog project for the Yucca Mountain Project (see DOE trip report, March 26 - April 6, Drs. C. Bruton and W. Bourcier).

Revision of the draft Man-made Materials Study Plan 8.3.4.2.4.5 continues.

The following papers were submitted as summaries to the FOCUS '93, Site Characterization and Model Validation, meeting to be held in Las Vegas on September 26-29, 1993:

1) Proposed Experiments: Effects of Diesel Fuel on the Yucca Mountain Repository" by S. Carroll and K. Jackson,

2) "Colloids Derived from Materials Introduced into a Radioactive Waste Repository: A Report on the Current State of Knowledge" by A. Meike and C. Wittwer, and

3) "Chemical Concerns for the Use of Man-Made Materials in the Post-Emplacement Environment" by A. Meike.

1.2.2.3 Waste Form and Materials Testing

1.2.2.3.1 Waste Form

1.2.2.3.1.1 Waste Form Testing - Spent Fuel

Spent Fuel Dissolution

The remaining UO_2 dissolution experiments that are a part of the LLNL test matrix were started this month. They will be finished in May. These eight experiments are at temperatures of 50°C and 75°C, and at subatmospheric oxygen levels of 0.2% and 2%. This group includes three identical runs at mid-values of the variables to test for reproducibility of the runs. The early results of these three runs agree with each other quite well, indicating that the data are of good quality. The early results of all eight runs seem to follow the trends of the test matrix runs completed earlier. Detailed analysis of the final results of the full test matrix will be required before formal conclusions can be made.

Flow-through dissolution tests at PNL on ATM-106 fuel (PWR fuel with burnup ~48 MWd/kgM and fission gas release ~18%) in both oxidized (O/M ~2.4) and unoxidized forms are in progress. Another specimen of ATM-106 fuel was converted to U_3O_8 by heating in air overnight at 425°C. Flow-through dissolution tests on this material are also in progress. Preliminary results from these tests will become available in May.

The following paper was submitted as a summary to the FOCUS '93, Site Characterization and Model Validation, meeting to be held in Las Vegas on September 26-29, 1993:

1) "Uranium Dissolution Rates in Aggressive Water" by S. Steward, H. Weed and H. Leider.

Spent Fuel Oxidation

Dry Bath Testing

The loaded dry baths continue to run without incident. Empty bath 5, being tested at 255°C, ran for approximately one month before having unacceptable temperature fluctuations. The temperature controller operating mode was changed at the recommendation of the manufacturer, and the bath has remained stable (±1°C) for the last three weeks. If the temperature remains stable, it is planned to load the dry bath with spent fuel for a high temperature run in May.

Thermogravimetric Apparatus (TGA)

The TGA units have been taken out of storage. Flow meters, thermocouples, and balances are being calibrated. Pumps and seals are being refurbished. Trial runs on unirradiated UO_2 will be conducted for equipment checkout in May. B. Hanson has commenced preliminary operation of the TGAs. A revised test plan addendum will be completed prior to performing any quality affecting runs.

Materials Characterization Center (MCC) Hot Cell Activities

The report "Rationale for Determining MCC Spent Fuel Acquisitions" has been reviewed by LLNL and comments incorporated. The paper is now completing internal clearance at PNL.

1.2.2.3.1.2 Waste Form Testing - Glass

D-20-27 Unsaturated Testing of WVDP and DWPF Glass

The N2 tests (SRL actinide-doped glass) continue with no sampling period occurring this month. These tests have been in progress for 368 weeks. The N3 tests (ATM-10, a West Valley actinide-doped glass) continue and have been in progress for 286 weeks.

A QA surveillance on the N2/N3 activities has been scheduled for June 1993.

1.2.2.3.2 Metal Barriers

Revision of the Scientific Investigation Plan for the Metal Barrier Task (SIP-CM-01) has begun.

Degradation Mode Surveys

The review of the published literature on the corrosion and oxidation behavior of iron and steel is continuing.

Model and Test Development

G. Henshall met with personnel from the Performance Assessment Technical Area to discuss his previous work with pitting survivability models and how this work might be applicable to the performance of a corrosion resistant material under repository environmental conditions.

Recent capital funds authorization from YMPO will permit procurement of a high sensitivity thermogravimetric analysis unit. This unit will be used in an experimental study to discern at what point there is a transition between "dry" oxidation and "wet" corrosion. It is expected that the study will be conducted on a corrosion allowance material (such as carbon steel) with temperature, humidity, and surface condition as the principal variables. The transition between dry and wet conditions is very important with respect to performance of the container material and the design strategy for keeping the waste package in a "dry" condition for an extended period of time.

The statement of work from Principal Investigators at ANL was received and forwarded to YMPO to prepare a SANL (interlaboratory agreement) for resumption of support for the crack growth studies. Work continues on setting up a facility at LLNL that will complement the work being performed at ANL.

1.2.2.3.3 Other Materials

This WBS element has not been funded in FY93.

1.2.2.3.4 Integrated Testing

1.2.2.3.4.1 Integrated Radionuclide Release: Tests and Models

Determination of Elemental Profiles in Rocks, Minerals, and Glasses using the Ion Microscope

Samples of single crystals of clinoptilolite to be used for diffusion experiments were added to #1N, Na, K and Ca chloride salts, heated to 85°C, and are currently maintained at that temperature. These crystals will be removed over the next

Interactions of Actinide-bearing Solutions with Rock Core Samples

Flow testing of the saw-cut fracture at ambient temperature showed that the automatic flow monitoring system is working. Small oscillations in the differential pressure and consequent flow are readily detected using this system. These oscillations appear to be related to environmental factors and are not related to system "noise"; however, their exact cause has not been determined.

Rod shaped bacteria were again noted in the effluent from the core. At low differential pressures, the bacterial growth effectively shut down fracture flow.

Transmission Electron Microscopy (TEM) analysis of effluent showed the presence of iron (hematite) and silicon oxides (quartz) that may be related to the sawing process.

1.2.2.3.4.2 Thermodynamic Data Determination

No significant activities.

1.2.2.3.5 Nonmetallic Barrier Concepts

This WBS element has not been funded in FY93.

1.2.2.4 Design, Fabrication, and Prototype Testing

1.2.2.4.3 Container/Waste Package Interface Analysis

The following paper was presented at the International High Level Radioactive Waste Conference held in Las Vegas, April 26-30:

1.) "Drift Emplaced Waste Package Thermal Response" by D. Ruffner, T. Doering, G. Johnson, E. Platt, and J. Blink.

1.2.3 SITE INVESTIGATIONS

1.2.3.1 Site Investigations Coordination and Planning

This WBS element has not been funded in FY93.

LLNL has requested that the CCB approve addition of LLNL to the list of participants in the WBS Dictionary for this WBS element.

1.2.3.2 Geology

1.2.3.2.1.2.1 Natural Analogue of Hydrothermal Systems in Tuff

This WBS element has not been funded in FY93.

1.2.3.4 Geochemistry

1.2.3.4.2 Geochemical Modeling

Work continued on the Version 7.2 EQ3/6 package. Two new input file reformatters were created, one called xcon3 for EQ3NR and the other called xcon6 for EQ6. These presently support conversions among three version levels (6.0, 7.0 and 7.2). Conversions may be made from any supported level to any supported level, including to the same level. Conversions can also be made from the compact "W" format to the menu-style "D" format, and vice versa. These utilities replace older reformatters of less general capability. They are being used to facilitate testing Version 7.2 using the EQ3/6 test case library. They will be included in the Version 7.2 release package to allow users to convert their existing input files to Version 7.2. The Version 7.2 package will be released next month in both UNIX and PC forms. LLNL will update all YMP users.

The above input file reformatters are also being used as test beds for the development of the Version 8.0 EQ3NR and EQ6 modules for handling input files. The reformatters will thus also be extended to convert older input files (including the EQ3/6 test library) to Version level 8.0. Both the compact and menu-style formats will be preserved, though a few general changes are being made to each to better assist the code user.

1.2.3.5 Drilling

1.2.3.5.2.1 Common-to-Drilling Support

The WBS dictionary was updated to include LLNL in a geotechnical data collection support role. The CCB was requested to shift the work to 1.2.3.5.2.2 which has a more appropriate scope, and to add LANL since the NTS diagnostics group includes LANL personnel who may independently develop hardware.

1.2.3.10 Altered Zone Characterization

FY93 funding was received in this WBS element. PACS accounts were activated and work began.

1.2.5 REGULATORY

1.2.5.1 Regulatory Coordination and Planning

This WBS element has not been funded in FY93.

LLNL has requested that the CCB approve the addition of LLNL to the list of participants in the WBS Dictionary for this WBS element.

1.2.5.2 Licensing

1.2.5.2.2 Site Characterization Program

No significant activities.

1.2.5.3 Technical Data Management

1.2.5.3.4 Geologic and Engineering Materials Bibliography of Chemical Species (GEMBOCHS)

In the interest of mnemonics, two programs from the GEMBOCHS software library were renamed. DBAPP, an interactive FORTRAN/EQUEL code that facilitates review, modification, deletion and addition of GEMBOCHS data, has been renamed "FACET". D0OUT, a FORTRAN/EQUEL code that facilitates generation of GEMBOCHS-based thermodynamics datafiles for use with EQ3/6, GT, and other geomechanical modeling packages, has been renamed "JEWEL".

The development of a WINDOWS/4GL (mouse-driven) version of JEWEL continued. This program facilitates interactive point-and-click generation of thermodynamic datafiles for EQ3/6, GT, and other geoemechanical modeling packages. Beta testing of the prototype was completed, the prototype design was modified significantly on the basis of this testing, and work commenced on the final version of the code.

The CNGBOCHS system (Version 3.0) was installed on node s60 of the local sun network; this system is now available for use by local research groups (GEMBOCHS, EQ3/6, etc.) for error reporting.

Input was submitted for the Technical Data Catalog Quarterly for January - March 1993.

A. Simmons (YMPO), S. Bodnar, and R. Lewis ((M&O) visited LLNL on April 20 for an overview of the GEMBOCHS database and to discuss technical data management issues. J. Johnson presented the talk entitled "The GEMBOCHS Database and Software Library: Overview of Contents, Components and Applications".

The paper by S. Daveler, S. Lundeen and J. Johnson entitled "CNGBOCHS: An Integrated Ingres-Email-Interleaf System for Processing Change Requests Associated with the GEMBOCHS Database and EQ3/6" was submitted to YMPO for approval.

1.2.5.3.5 Technical Data Base Input

The transfer of an additional $60K by YMPO for this WBS element reported last month was delayed. The amount now being sent will be $35K of which $10K will be used to fund R. Silva's participation in the Solubility Working Group. The remainder will be used to input backlogged data.

1.2.5.4.2 Waste Package Performance Assessment

Cladding temperature history and creep endurance

Work continues on the scoping study of cladding temperature history for various drift emplacement heat loadings, and of cladding creep endurance. Drift backfill 75 years after waste emplacement is assumed. Based on recent literature, the temperatures are somewhat higher than in the earlier parameterization of thermal results, but feasible repository loadings can meet both dryout and cladding goals. The cladding creep model was extended to incorporate reduced pressure load due to the progress of creep. This effect had been included in some previous papers, but just examined and not included in others; non-inclusion is somewhat conservative.

The main contributors to elevated temperatures in the fuel cladding are the heating of the rock mass (dependent on the areal power density) and the temperature difference across the backfill (dependent on the package's heat generation rate at any given time and on the backfill's thermal conductivity). The container wall-to-center difference contributes only on the order of 10% of the total heat rise, assuming a 21-PWR-assembly container. The current analysis based on recent papers gives somewhat higher temperatures than reported in the February monthly report. There are still some feasible loading plans that will provide an APD of 90-100 kW/acre using 30-year-old spent fuel (AML of 122 to 136 MTU/acre) and still meet the cladding strain limit as calculated by a conservative approach. These loadings have 10 to 12 PWR assemblies per waste package, rather than 21 assemblies as in the preliminary analysis. Increasing the loading per package would require some other design choices affecting the heat transfer. The thermal calculation references are two papers from SNL (E. E. Ryder, "Results of Two-Dimensional Near-Field Thermal Calculations in Support of M&O Study on Repository Thermal Loading," SNL internal report, July 1992; and J. F. Holland, "The Results of Near-Field Thermal and Mechanical Calculations of Thermal Loading Schemes," International High Level Radioactive Waste Conference, Las Vegas, NV, April 26-30, 1993, p. 868) and one from LLNL (D. Ruffner et al., "Drift Emplaced Waste Package Thermal Response", International High Level Radioactive Waste Conference, Las Vegas, NV, April 26-30, 1993, Las Vegas, NV, p. 538).

The cladding creep rate is dependent on temperature and stress. Creep reduces the stress. In the initial analysis used above, this source of reduction was not included. Further analysis showed that including it makes an appreciable difference, with improved performance. The stress is generated by internal gas pressure in the fuel rod. The internal gas is a fill gas plus a small amount of fission gas released to the fuel rod's void space. During reactor operation, the fuel pellets swell, reducing the void volume by 30% to 50%. Gas pressure depends on temperature and volume. The cladding creep increases the volume progressively. Chin and Gilbert (Nucl. Tech., 85, p. 57, 1989) examined this but decided to include only the reduction in gas pressure resulting from decaying temperatures. This is somewhat conservative, and if the creep strain at the rupture threshold is low, this is not overly constraining on design temperature selection. The dependence of stress on accumulated strain was included in another paper by the Chin group (Nucl. Tech., 97, p. 316, 1992) and by

Mayuzumi and Onchi (J. Nucl. Materials, 175, p. 135, 1990 and Nucl. Tech., 93, p. 382, 1991). The creep model was extended to include the strain-dependent effects and it was found that it makes an appreciable difference in extending creep lifetime and a modest difference in increasing the allowable temperature. Analysis is continuing. Note that creep of cladding can occur mainly in two time periods: the first decade of temporary dry storage, if utilized, and the first few decades after backfill is emplaced in repository disposal. It is urged that there be coordination of creep allowables in these two design periods before changing any allowables to take the benefit of the finite-strain effect on creep.

Near-field environment model for a thermally dependent source term

LLNL is developing a summary model of the near-field environment of the waste packages. This will consider the thermal transient and dryout based on papers by J. Nitao, T. Buscheck and others. The product will be time histories, in table or algorithm form, of temperature, fractional saturation, fraction of waste packages wetted, and liquid water flux. In March, a calculational procedure was implemented to evaluate the distance of fracture flow penetration due to refluxing of condensate water above the repository. This procedure includes a spatial variability in water flux and in fracture sizes, and hence a spatial variability in distance of refluxing.

The paper by W. O'Connell, T. Ueng and L. Lewis entitled "Post-Closure Performance Assessment of Waste Packages for the Yucca Mountain Project" was submitted to YMPO for approval.

The PANDORA-1.1 users manual is in technical editing for reviewer's stylistic comments and for ease of use.

R. Stout and L. Lewis participated in a review meeting March 31 - April 1 in Richland, WA for the software requirements specification of the AREST code.

W. Halsey attended Performance Assessment Management meetings in Las Vegas on April 7 and April 29. The focus of the first meeting was to discuss TSPA-II schedule and content, and the focus of the second meeting was to discuss FY94 annual plan preparation.

W. Halsey and J. Gansemer visited SNL in Albuquerque, NM on April 21 to discuss Performance Assessment source term issues with Sandia staff.

W. Halsey gave a presentation to the OCRWM Student Fellows Conference in Las Vegas on April 26.

W. Halsey, W. O'Connell and A. MacIntyre attended the International High Level Radioactive Waste Conference, Las Vegas, NV, April 26-30, 1993, Las Vegas, NV. A. MacIntyre was a session chairperson.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management and Coordination

1.2.9.1.2 Technical Project Office Management

W. Clarke and J. Blink attended the TAG meeting in Livermore on April 14.

J. Blink presented lectures on fission and fusion to five classes at Valley High School in Las Vegas on April 12. He also presented hands-on science to three Burkholder Middle School classes (Henderson) on April 13, five Sandy Valley Elementary School classes on April 15, five Tonopah Elementary School classes on April 16, and five Charlotte Hill Elementary School (Las Vegas) classes on April 19. Finally, he presented a hands-on laser workshop to twenty Science Now high school students at the DOE Nevada Operations Office on April 22.

J. Blink attended the Quality Integration Group (QIG) meeting in Las Vegas on April 1 and the monthly management meeting in Las Vegas on April 12.

1.2.9.2 Project Control

1.2.9.2.2 Participant Project Control

The March cost/FTE report was submitted to YMPO. The March actual schedule progress and costs were submitted via the PACS workstation. The Cost Plan was updated to include March actuals. A variance analysis explanation was developed for several P&S accounts for activity undertaken in February.

A Change Control Request was submitted to modify budget and workscope for Metal Barriers, WBS 1.2.2.3.2. Changes accounted for an additional $100,000 to fund crack growth studies at ANL. The preparation of an additional SANL (interlaboratory agreement) with ANL to perform crack growth studies is in process.

LLNL staff met with YMPO staff to discuss current budget and costs for FY94 for WBS 1.2.9 and 1.2.15. DOE issued directions that the 1.2.9 account was not to be used to finance occasional, ad hoc activities for work in other third level WBS elements. Also, direction was received to transfer $30k from 1.2.9.2.2, Project Control, to 1.2.9.1.2, TPO management.

The automating of the transfer of data between laboratory financial systems and the PACS workstation has been placed on hold until staffing is completed in the Project Control group. Several candidates have been interviewed for two position openings: Project Control Coordinator to assist in the development and maintenance of the PACS database; and an Engineering/Scientific Coordinator to provide planning, programmatic and technical support for Technical Area Leaders. A candidate has been selected for the Engineering Scientific Coordinator position, and if the candidate accepts the position, training will begin immediately. The Project Control Coordinator position is still unfilled, and a suitable candidate has not been found. Supplemental labor will be used to fill this position until a permanent replacement can be found.

The LLNL FY94 IRM Long Range Plan which identifies computing resources acquisitions for next year was submitted. The plan addresses both software and hardware and includes major system initiative planning for components costing more than $25,000.

J. Podobnik attended the IRM council meetings in Las Vegas April 27-28. The meeting covered the direction the project is following for telecommunications, connectivity and information databases.

1.2.11 QUALITY ASSURANCE

1.2.11.1 Quality Assurance Coordination and Planning

R. Monks has accepted the position of Quality Assurance Manager and is expected to begin work at LLNL in May.

M. Revelli attended the Quality Assurance Managers Meeting in Las Vegas on April 20.

1.2.11.2 Quality Assurance Program Development

Work continued on the activities to implement the new QARD and completion of implementing documents. The following documents were completed and issued:

1 033-YMP-QP 2.8, Rev. 3, Quality Assurance Grading,
2) 033-YMP-QP 6.0, Rev. 4, Document Control,
3) 033-YMP-QP 2.9, Rev. 4, Indoctrination and Training, and
4) 033-YMP-QP 15.0, Rev. 3, Nonconforming Items.

Scientific Investigation Plan Change Notice SIP-CM-01-1-1 (Container Materials) was completed and transmitted to YMPO for approval. The CN was issued "For Interim Use".

Scientific Investigation Plan Change Notice SIP-07-0-1 (Revisions, Qualifications and Maintenance of Baseline Geohydrology Codes) was completed and transmitted to YMPO for approval. The CN was issued "For Interim Use".

A Change Notice (LLNL-QAG-L020-0-1) to the Grading Report for Activity E-20-16, "Metal Barriers Model Development", was completed and issued effective April 2.

A Change Notice (LLNL-QAG-L-042-0-1) to the Grading Report for Activity I-20-22, "Extend Pandora 1 to 1.1", was completed and issued effective April 5.

1.2.11.3 Quality Assurance Verification

1.2.11.3.1 Quality Assurance Verification - Audits

Representatives from YMPO visited LLNL on April 6 through April 8 to close CARs YM-92-064 and -065 resulting from Audit YMP-92-21.

1.2.11.3.2 Quality Assurance Verification - Surveillance

Representatives from YMPO verified the closure of CAR-YM-93-017 resulting from Surveillance YMP-SR-92-028 during their visit to LLNL on April 6 through April 8.

1.2.11.4 Field Quality Assurance/Quality Control

This WBS element has not been funded in FY93.

1.2.11.5 Quality Assurance - Quality Engineering

No significant activities.

1.2.12 INFORMATION MANAGEMENT

1.2.12.2 Records Management

1.2.12.2.2 Local Records Center Operation (LRC)

Five new revisions and five change notices were issued by Document Control.

1.2.12.2.3 Participant Records Management

A total of 228 items were logged into the LLNL-YMP tracking system. This includes 80 records/records packages that were processed through to the CRF. Three action items were closed.

Nearly all 1992 records have been cross referenced from the database to microfilm.

B. Bryan and T. Holmes attended the Records Coordinator Meeting in Las Vegas on April 26 and 27.

1.2.12.2.5 Document Control

LLNL received no funding under this WBS. Work performed to complete LLNL's obligation in this WBS is funded under WBS 1.2.12.2.2.

1.2.13 ENVIRONMENT, SAFETY AND HEALTH

1.2.13.1 Environment, Safety and Health Coordination and Planning

J. Blink provided input to the ALARA committee meeting on April 16.

1.2.15 SUPPORT SERVICES

1.2.15.2 Administrative Support

Verbal responses were made to additional questions regarding input to the PR 8, Site Characterization Progress Report: Yucca Mountain, Nevada.

1.2.15.3 Yucca Mountain Site Characterization Project (YMP) Support for the Training Mission

Three different self-study assignments were issued, and 24 people were trained to these assignments. Currently, there are 69 participants on the project who are to be trained and/or tracked.

LLNL PROJECT STATUS REPORT DISTRIBUTION

EXTERNAL

PRELIMINARY STAMP
Dr. J. Bates
Chemical Technology Division
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, Illinois 60439

H. Benton/D. Stahl
Ste P110
101 Convention Center Drive
Las Vegas, Nevada 89109

A. Berusch (RW-20)
OCRWM
Forrestal Building
Washington, DC 20585

M. Blanchard
Yucca Mountain Project Office
U.S. Department of Energy
P. O. Box 98518
Las Vegas, Nevada 89193-8518

T. Blejwas
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

J. Blink
LLNL/Las Vegas
101 Convention Center Drive,
Suite 820
Las Vegas, NV 89109

J. Boak
Yucca Mountain Project Office
U.S. Department of Energy
P. O. Box 98518
Las Vegas, Nevada 89193-8518

S. Bodnar
TRW, Mail Stop 423
101 Convention Center Drive
Las Vegas, Nevada 89109-2005

M. Brodeur
Science Applications Int'l Corp
101 Convention Center Dr. # 407
Las Vegas, NV 89109-2005

J. Canepa
Los Alamos National Laboratory
P.O. Box 1663/N-5, MS J521
Los Alamos, NM 87545

P. Cloke
Science Applications Int'l Corp
101 Convention Center Dr. # 407
Las Vegas, NV 89109-2005

W. Dixon
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

J. Dyer
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

PRELIMINARY STAMP
R. Einziger
Battelle-Pacific Northwest
P.O. Box 999/MS P714
Richland, WA 99352

R. Fish
Ste P110
101 Convention Center Drive
Las Vegas, Nevada 89109

L. D. Foust
Technical Project Officer
CRWMS M&O
101 Convention Center Drive
Phase II, Suite P110
Las Vegas, NV 89109

C. Gertz
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

D. Harrison
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

L. Hayes
U.S. Geological Survey
Box 25046/MS 425
Denver Federal Center
Denver, Colorado 80225

R. Hughey
Nuclear Energy Division
USDOE/SAN
1333 Broadway
Oakland, CA 94612

V. Iorri
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

C. Johnson
M&O
101 Convention Center Drive
Phase II, Suite P110
Las Vegas, NV 89109

P. Justus
Nuclear Regulatory Commission
301 E. Stewart Ave. #203
Las Vegas, NV 89101

H. Kalia
LANL/LV
101 Convention Center Drive #1024
Las Vegas, NV 89109-2005

PRELIMINARY STAMP
S. Marschman, P7-14
Battelle, Pacific Northwest
P.O. Box 999
Richland, WA 99352

M. Martin
TRW, Mail Stop 423
101 Convention Center Drive
Las Vegas, Nevada 89109-2005

J. Nelson
Science Applications Int'l Corp
101 Convention Center Dr. # 407
Las Vegas, NV 89109-2005

P. Osborne
Science Applications Int'l Corp
101 Convention Center Dr. # 407
Las Vegas, NV 89109-2005

R. L. Robertson
TRW-Metro Place
2650 Park Tower Dr.
Suite 800
Vienna, VA 22180

W. Simecka
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

A. Simmons
Yucca Mountain Project Office
U.S. Department of Energy
P.O. Box 98518
Las Vegas, Nevada 89193-8518

E. Smistad
Yucca Mountain Project Office
U.S. Department of Energy
P. O. Box 98518
Las Vegas, Nevada 89193-8518

L. Snow
Roy F. Weston, Inc.
955 L'Enfant Plaza, S.W.
Washington, DC 20024

H. Spieker
Nuclear Waste Mgmt System
M&O
101 Convention Center Drive
Suite #P110
Las Vegas, NV 89109-2005

Lawrence Livermore National Laboratory

LLYMP9305060
May 19, 1993

WBS 1.2.9
"QA: N/A"

Carl Gertz, Project Manager
Department of Energy
Yucca Mountain Project Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

SUBJECT: Yucca Mountain Project Status Report - April 1993
SCP: N/A

Attached is the April Project Status Report for LLNL's participation in the Yucca Mountain Project

If further information is required, please contact Elizabeth Campbell of my staff at 510-422-7854 or Jim Blink in Las Vegas at 702-794-7157.

Sincerely,

W. L. Clarke
LLNL Technical Project Officer
for YMP

WC/EC

cc:
Distribution

DISCLAIMER

The LLNL Yucca Mountain Project 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.

ENCLOSURE 1

I-33889

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

WBS 1.2.9.1
QA N/A

MAR 16 8 50 AM '00

March 3, 1993

TWS-EES-13-03-93-027

Mr. Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization Project Office
US Department of Energy
P.O. Box 98608
Las Vegas, NV 89193-8608

Dear Mr. Gertz:

Los Alamos Monthly Activity Report—January 1993

Attached is the Los Alamos Monthly Activity Report for January 1993. This internal document describes our technical work in detail; however, the report has not received formal technical or policy review by Los Alamos or the Yucca Mountain Site Characterization Project. Data presented in this document represent work progress, are not referenceable, and are not intended for release from the US Department of Energy. If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

JAC/SHK/elm

Attachment: a/s

Cy w/att:
M. B. Blanchard, YMPO, Las Vegas, NV
J. M. Boak, YMPO, Las Vegas, NV
R. L. Bullock, RSN, Las Vegas, NV
V. J. Cassella, HQ/Washington, DC
W. L. Clarke, LLNL, Livermore, CA
P. L. Cloke, SAIC, Las Vegas, NV
J. L. Cooper, YMPO, Las Vegas, NV
J. Docka, Weston, Washington, DC
J. R. Dyer, YMPO, Las Vegas, NV
L. D. Foust, CRWMS, M&O/TRW, Las Vegas, NV
L. R. Hayes, USGS, Denver, CO
C. Johnson, M&O/WCC, Las Vegas, NV
N. Jones, M&O/TRW, Las Vegas, NV
P. Justus, NRC, Las Vegas, NV
K. Krupka, PNL, Richland, WA
M. Martin, M&O/TRW, Las Vegas, NV
C. W. Myers, EES-DO, MS D446
C. M. Newbury, YMPO, Las Vegas, NV
R. F. Pritchett, REECo, Las Vegas, NV
R. L. Robertson, CRWMS, M&O, Fairfax, VA
L. E. Shephard, SNL, Albuquerque, NM
W. B. Simecka, YMPO, Las Vegas, NV
A. M. Simmons, YMPO, Las Vegas, NV
R. K. St. Clair, M&O/TRW, Las Vegas, NV
J. T. Sullivan, YMPO, Las Vegas, NV
M. Voegele, SAIC, Las Vegas, NV
D. R. Williams, YMPO, Las Vegas, NV
RPC File (2), MS M321
TWS-EES-13-File, MS J521

Cy w/o att.:
J. A. Canepa, EES-13, MS J521
S. H. Klein, IS-11, MS J521
CRM-4, MS A150

9303220276 66pp.

ENCLOSURE 2

CONTENTS

LOS ALAMOS NATIONAL LABORATORY

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Monthly Activity Report

January 1993

WBS 1.2.1 Systems Engineering

Objective

The objective of this task is to integrate systems with the Geologic Repository Program, to describe the Yucca Mountain Site Characterization Project Mined Geologic Disposal System, and to evaluate the performance of the natural, engineered barrier, and total systems for meeting regulatory standards.

Activities and Accomplishments

No significant activity this month.

Planned Activities

None

Problem Areas

None

WBS 1.2.3.1.1 Site Investigation Coordination and Planning/ Site Management

Objective

The objective of this task is to manage and coordinate site characterization activities.

Activities and Accomplishments

A meeting of principal investigators was held to discuss the extended- dry concept. G. Zyvoloski presented summaries of two DOE meetings on modeling aspects of the concept. D. Bish brought the staff up to date on the mineral stability interactions with LLNL. S. Levy discussed her proposed field analog studies, which have been developed to test the extended-dry concept.

Technical coordinators provided quarterly update information to the TPO. Variance analyses were also provided and actions were taken by technical coordinators to correct identified inconsistencies.

Staff participated in a Q-list workshop on natural barriers. Workshop participants identified the natural barriers important for site performance that could be compromised during site characterization activities.

Planned Activities

Problem Areas

None

WBS 1.2.3.1.2 Site Investigation Coordination and Planning/ Test Management and Integration

Objective

The objective of this task is to manage and integrate ESF and Los Alamos site characterization test activities and to provide coordination for Los Alamos surface-based test planning and package development.

Activities and Accomplishments

Surface-based Test Coordination. Staff submitted Los Alamos sample collection requirements for the remaining neutron-access borcholes to the Project Office.

Staff continued to develop an administrative data base, which will be merged with the YMP GIS, to identify and track Los Alamos interfaces with other participant and Project surface-based testing activities.

B. Carlos represented the principal investigators at the Sample Overview Committee meeting.

ESF Testing. Staff coordinated geologic mapping with construction at the North Portal.

Staff began Phase II of the ESF testing program, which includes preparing test and job record packages for field tests in the North Portal starter tunnel.

Staff continued to work on merging the administrative database with the YMP GIS so that Los Alamos ESF testing activities will be merged with those of other participants.

R. Oliver represented the Test Coordination Office at the Sample Overview Committee meeting.

Planned Activities

Continue evolution and support of the Los Alamos surface-based and ESF activities in response to the Project program directives.

Problem Areas

None

Publications

None

WBS 1.2.3.2.1.1.1 Mineralogy, Petrology, and Rock Chemistry of Transport Pathways

Objective

The purpose of this activity is to define the important mineralogical and geochemical variables along fracture and rock-matrix transport pathways at Yucca Mountain, in support of performance assessment and to evaluate the impact of repository construction on natural waste-transport barriers.

Activities and Accomplishments

D. Vaniman replaced D. Broxton as technical coordinator of mineralogy/petrology studies, and D. Bish replaced D. Vaniman as principal investigator for this task.

The study plan is still being revised to reflect planned tests; we have also responded to some comments by the state of Nevada.

We received the first fracture samples from UE-25 UZ-16 on 27 January. J. Whelan (USGS Denver) and E. Roedder (Harvard University) traveled to Los Alamos to prepare samples for fracture calcite studies and to discuss fluid-inclusion results.

D. Vaniman participated in the Natural Barriers Evaluation Workshop in Las Vegas 19-21 January.

S. Levy discussed ESF starter-tunnel integrated sample program needs at a meeting in Las Vegas, and, as a result of information presented at the meeting, we are re-evaluating our sampling needs.

S. Chipera successfully separated a large amount of pure tridymite, which will be used as a pure mineral standard for quantitative x-ray diffraction analyses, from a sample of Bandelier Tuff.

A letter report on the fracture-lining minerals in the Paintbrush Tuff in existing drill core (USW G-1, G-2, GU-3, G-4 and UE25a #1) may be found in the Appendix.

Planned Activities

Work planned for the next few months includes the following: (1) continue analysis of fracture-coating minerals in existing drill core and prepare paper on distribution of fracture-lining zeolites at Yucca Mountain for inclusion in the proceedings volume for Zeolite '93; (2) continue analysis of calcites to understand transport and precipitation mechanisms; (3) sample UE-25 UZ-16 for studies of stratigraphic variability in bulk mineralogy; (4) continue statistical evaluation of x-ray powder diffraction quantitative mineral analysis; (5) begin analysis of fracture coating minerals in UE-25 UZ-16.

Problem Areas

None

Milestone Progress

3120
Calcite in Fractures
Completed.

3123
Fracture-Lining Manganese Oxide Minerals in a Silicic Tuff
Completed; revised and resubmitted for publication.

3130
15 December 1993
Fracture Mineralogy of the Paintbrush Tuff
Expanded scope.

Milestone Progress (cont.)

3135
Mineralogy as a Factor in Radioactive Waste Transport Through Pyroclastic Rocks at Yucca Mountain, Nevada
Completed; submitted to *Bulletin of the Geological of Society of America.*

3137
30 September 1992
Mineralogy of Calico Hills for Adit Development
Submitted to TPO.

New Level III Milestones

Thermal Behavior of Natural Zeolites
Completed.

Distribution of Fracture-Lining Zeolites at Yucca Mountain, Nevada
Completed.

Equilibrium Modeling of the Formation of Zeolites in Fractures at Yucca Mountain, Nevada
Completed.

Publications

D. L. Bish
Thermal Behavior of Natural Zeolites
Conference paper, *Zeolites '93*
Submitted to YMPO.

D. L. Bish and D. T. Vaniman
The Importance of Zeolites in the Potential High-Level Radioactive Repository at Yucca Mountain
Conference paper, *Zeolites '93*
In preparation.

D. Broxton
Geological Evaluation of Six nonweleded tuff sites in the vicinity of Yucca Mountain, Nevada, for a surface-based test facility for the Yucca Mountain Project. (3137)
LA-series report
Submitted to TPO.

B. Carlos, D. Bish, S. Chipera, and S. Craven
Fracture-Lining Manganese Oxide Minerals in a Silicic Tuff
Approved by YMPO.

B. Carlos, S. Chipera, and D. Bish
Distribution of Fracture-Lining Zeolites at Yucca Mountain, Nevada
Conference paper, *Zeolite '93*
Approved by YMPO.

Publications (cont.)

S. J. Chipera, D. L. Bish, and B. A. Carlos
Equilibrium Modeling of the Formation of Zeolites in Fractures at Yucca Mountain, Nevada
Conference paper, *Zeolites '93*
Submitted to YMPO.

G. D. Guthrie, D. L. Bish, and B. T. Mossman
Quantitative Analysis of Zeolite-Bearing Dusts Using the Rietveld Method
Journal article, *Science*
Submitted to *Science*.

D. Vaniman
Calcite Deposits in Fractures at Yucca Mountain, Nevada
Conference paper, *International High-Level Waste Management Conference*
Approved by YMPO.

D. Vaniman, D. Bish, D. Broxton, B. Carlos, S. Chipera, and S. Levy
Mineralogy as a Factor in Radioactive Waste Transport Through Pyroclastic Rocks at Yucca Mountain, Nevada
Journal article, submitted to *Bulletin of the Geological of Society of America.*

D. T. Vaniman
Calcite Deposits in Drill Cores USW G-2 and USW GU-3/G-3 at Yucca Mountain, Nevada
LA-series report
Submitted to TPO.

WBS 1.2.3.2.1.1.2 Mineralogical and Geochemical Alteration

Objective

The objective of this task is to characterize past and present natural alteration processes that have affected the potential geologic repository and to predict future effects of natural and repository-induced alteration.

Activities and Accomplishments

S. Levy discussed sampling needs in the Exile Hill starter tunnel with the ESF test coordinator in Las Vegas. Based on these discussions, researchers will now sample on their own in the tunnel and request samples from the integrated sampling program.

We began using the new electron microprobe. We had good quantitative results from standards, but we must do additional fine-tuning of background settings and devise a setup file for zeolite analysis.

G. WoldeGabriel continued to revise milestone 3142 in response to reviewer's comments. The revisions to this paper, which deals with the preliminary K/Ar dating of clinoptilolite should be complete by early February.

We have determined the Cl, N, P, S, and oxalate content of ashed plant roots from the vicinity of Trench 14 and from pinon-juniper woodlands. We will use this data, along with INAA data on trace-element content of the roots, to help characterize the chemical contents of the plant material.

Planned Activities

In early February, D. Bish and S. Levy will participate in a LLNL-hosted workshop on the geochemical aspects of coupled geochemical/hydrological processes in the post-emplacement period.

A field orientation session for ESF wall mappers and Mineralogy/Petrology principal investigators has been tentatively set for March.

Steam-heating experiments will continue, and we will examine the samples for mineralogical changes on a periodic basis. We will continue chemical and mineralogical characterization of surface samples of bedrock breccias and hydrothermal deposits. We will continue K/Ar and calcite-silica laminated-deposit studies.

Problem Areas

None

Milestone Progress

3138
30 September 1993
Chemical Transport in Zeolitic Alteration
60% complete.

3141
31 March 1992
Laminated Zone in Trench 14
Completed on 3 August 1992.

3142
31 January 1993
K/Ar Dating of Clays and Zeolites
In technical review.

Milestone Progress (cont.)

3143
16 March 1992
Experimental Dehydration of Volcanic Glasses
Completed on 3 August 1992.

3341
30 October 1992
Surface-discharging hydrothermal systems at Yucca Mountain -- examining the evidence
Completed.

3150
15 April 1993
Final Report on Bedrock
37% complete.

3342
30 September 1993
Letter report on *Analyses of Core for Alteration*
On Schedule.

3343
30 September 1993
Report on *Zeolite Dating* (for Zeolite 93 Conference Proceedings)
On schedule.

Publications

D. Bish and J. Aronson
Paleothermal and Paleohydrologic Conditions in Silicic Tuff from Yucca Mountain, Nevada
Journal article, *Clay and Clay Minerals*
Submitted to *Clay and Clay Minerals.*

S. Levy
Surface-discharging hydrothermal systems at Yucca Mountain -- examining the evidence
Proceedings paper, *Materials Research Society Fall Meeting*
Approved by YMPO; submitted.

S. Levy and C. Naeser
Bedrock Breccias Along Fault Zones near Yucca Mountain, Nevada
Chapter in USGS Bulletin on Yucca Mountain studies
In USGS editorial review.

S. Reneau
Maganese Accumulation in Rock Varnish in a Desert Piedmont, Mojave Desert, California, and Application to Evaluating Varnish Development
Journal article, *Quaternary Research*
Accepted for publication.

D. Vaniman, D. Bish, and S. Chipera
Dehydration and Rehydration of a Tuff Vitrophyre
Journal article, *Journal of Geophysical Research* (3143)
Approved by YMPO.

D. Vaniman, S. Chipera, and D. Bish
Pedogenesis of Siliceous Calcretes at Yucca Mountain, Nevada (3141)
Journal article
Approved by YMPO.

WBS 1.2.3.2.1.2 Stability of Minerals and Glasses

Objective

The objective of this activity is to produce a model for past and future mineral alteration in Yucca Mountain. The model is intended to explain the natural mineral evolution resulting from the transformation of metastable mineral assemblages to more stable assemblages and the effects of a repository emplacement.

Activities and Accomplishments

This activity has been deferred.

WBS 1.2.3.2.5 Postclosure Tectonics

Objective

The objective of these volcanism studies is to determine the hazards of future volcanic activities with respect to siting a high-level radioactive waste repository at Yucca Mountain.

Activities and Accomplishments

We calculated the distribution centroid for older and younger post-caldera basalt in the Yucca Mountain region and found (at a 95% level of confidence) that they have spatially distinct, northwest-trending centroids. Following analyses of the younger post-caldera basalt in the Crater Flat volcanic zone, we found that the volume-location surface for the basalt vents parallels the volcanic zone.

We completed collecting paleomagnetic data for the lava-flow units of the Lathrop Wells volcanic center and found the data on monogenetic versus polycyclic models to be nondiscriminatory.

Staff completed $^{232}U/^{232}Th$ isotopic analyses on samples from the $Ql4_a$ lava at Lathrop Wells and from a lava flow at Little Black Peak.

Work in Progress. Trenches LW-3 and LW-4 were infilled; the southernmost section of Trench LW-1 was infilled, and the remaining parts were fenced. The northern and central sections of LW-1 were left open so that further soil, stratigraphic, geomorphic, and paleomagnetic studies may be conducted.

We examined the southwest flanks of the main cone of the Lathrop Wells center, which has recently been exposed. We found no sequences of young tephra and soil in this section, which is consistent with Wells interpretation (based on petrologic data) that the tephra units are local and not derived from the main cone (1990; 1991).

Planned Activities

The $^{40}Ar/^{39}Ar$ ages of lithic fragments from the $Ql3$ lava at Lathrop Wells should be completed in February.

We will resume trenching studies at Lathrop Wells in late February as soon as we receive authorization from Los Alamos management. We will trench beneath the $Ql3$ lava in an attempt to obtain samples for the TL age determinations. We will also continue stratigraphic, soil, and petrology studies at the southern part of the cone.

Problem Areas

All concerns about trenching safety have been resolved, and no violations were identified.

Milestone Progress

3034
30 September 1992
Report on Magma System Dynamics
Complete

3109
30 September 1992
Report of Subsurface Effects
Complete

3111
30 April 1993
Preliminary Geologic Mapping of Volcanic Centers

Milestone Progress (cont.)

3164
30 March 1993
Progress Report on Thermoluminescence

R482
30 October 1992
Volcanism Status Report
First draft complete; revised draft due 1 March 1993.

Publications

B. M. Crowe, *et al.*
Volcanism Status Report
First draft complete; revised draft due 1 March 1993.

WBS 1.2.3.2.8.1 Rock-Varnish Dating Support for USGS Neotectonic Studies

Objective

This activity will provide rock-varnish dating support in various areas of surface site characterization activities including erosion, neotectonics, and paleoclimate.

Activities and Accomplishments

Staff met to plan FY93 rock-varnish dating support and field activities to identify potential sites for rock-varnish dating.

The Erosion Topical Report was renamed "The Potentially Adverse Condition: Evidence of Extreme Erosion during the Quaternary Period at Yucca Mountain." C. Harrington continued to modify this report in response to reviewer comments.

Planned Activities

As soon as "The Potentially Adverse Condition: Evidence of Extreme Erosion during the Quaternary Period at Yucca Mountain" is complete, we will begin field work.

Problem Areas

None

Milestone Progress

None

Publications

None

WBS 1.2.3.3.1.2.2 Water-Movement Tracer Tests

Objective

The objective of the water-movement tracer tests is to obtain measurements of chlorine isotope distributions to help quantify the percolation of precipitation in the unsaturated zone.

Activities and Accomplishments

We received results of ^{36}Cl analyses for nine samples from USW UZ-N-54 and N-55 from LLNL. They showed that the extremely high ^{36}Cl levels previously observed in the Paintbrush nonwelded (PTn) unit in N-55 (see June 1992 monthly report) also extended into the welded units above and below the PTn, all the way to the bottom of the hole, 256 ft below ground. The results confirmed that ^{36}Cl levels observed in the PTn unit in N-54, only 200 feet away, are at background levels. The high ^{36}Cl levels and their pervasive distribution in N-55 cannot be explained easily by any natural hydrologic process; the most likely explanation is that the separator was contaminated when it was used to drill several shallow holes near Test Cell C immediately before drilling N-55. Calculations by the J. Fabryka-Martin indicated that extremely high levels of ^{36}Cl (about six orders of magnitude above natural background) would have been produced near Test Cell C during testing of nuclear-powered rocket engines in the early 1960's, which could easily account for those measured in the N-55 cuttings samples. Several experiments are planned to test this hypothesis.

C. Eastoe (University of Arizona, Laboratory of Isotope Geochemistry) analyzed seven soil samples from five Midway Valley soil pits for variability in the stable Cl isotope ratio of meteoric Cl. His results indicated a stable chlorine isotope., and the $^{36}Cl/Cl$ and Cl/Br ratios clustered tightly about the expected meteoric averages. (Assuming that meteoric Cl derives predominantly from sea salts, we expected the stable Cl isotope ratios to cluster about an average of 0 per mil; however, these ratios did not tend toward average but ranged from -1.4 to +0.8 per mil.) A correlation with Cl concentration is suggested by the data. We believe that mixing between two different sources is unlikely in light of the $^{36}Cl/Cl$ and Cl/Br ratios, and we are considering mechanisms for fractionation, such as plant root activity, as a possible cause.

Bromide analytical sensitivity was improved by more than an order of magnitude following installation of the Dionex AI-450 chromatography package last month. Hydro Geo Chem is now able to routinely analyze samples at levels of 0.5 ppm for chloride and 0.005 ppm for bromide with uncertainties on the order of 5% or better, and they are re-analyzing many samples. Collection of cutting samples from UZ-16 for ^{36}Cl analysis continued.

The SMF sent to Hydro Geo Chem a shipment of 31 barrels containing 221 cuttings samples from UZ-16 and from neutron holes USW UZ-N-11, N-27, N-37, and N-53.

J. Fabryka-Martin summarized results of ^{36}Cl study at two meetings, the Unsaturated Zone Modelers meeting in Las Vegas and the University of Arizona's Hydrology and Water Resources Workshop on flow and transport through unsaturated fractured rock in Tucson. She presented a preliminary interpretation of the ^{36}Cl data and estimates of the magnitude of and extent of contamination of surface soils by the ^{36}Cl , which was produced by NTS activities between 1950 and 1969. She also participated in the Consolidated ESF Sampling meeting in Las Vegas.

Planned Activities

Revise existing detailed technical procedures (DPs); prepare new DPs; process soil samples for Cl/Br and ^{36}Cl /Cl ratios; process cuttings samples from UZ-16 and neutron-access boreholes; collect additional soil samples from Yucca Mountain area as opportunities arise.

Problem Areas None

Milestone Progress 3191
Procedure for Chlorine-36 Analysis of Unsaturated Zone Samples
30 September 1992
98% complete

Publications None

WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF

Objective

The objective of this task is to determine *in situ* the extent to which the nonsorbing tracers diffuse into the water-filled pores of the Topopah Spring welded unit.

Activities and Accomplishments

This task has been deferred because of lack of funding.

WBS 1.2.3.3.1.3.1 Site Saturated Zone Ground-water Flow System (Reactive Tracer Testing)

Objective

Experiments will be conducted at the C-Well complex (holes UE-25c #1, UE-25c #2, and UE-25c #3) and other wells in the vicinity of Yucca Mountain using reactive tracers to characterize retardation and transport properties at a larger scale than currently used in laboratory experiments.

Activities and Accomplishments

Software Certification. B. Robinson continued to serve as CCB Chair, and Z. Dash continued to serve as a member of the CCB. A Los Alamos report on the computer code SORBEQ was prepared and is in review.

Lithium Batch Sorption Experiments. We continued to document the latest suite of batch sorption experiments.

Lithium Column Sorption Experiments. D. Linzey was trained to the detailed technical procedures (DPs) used in column sorption experiments. Staff began to assemble equipment for these experiments.

Colloid Transport. P. Reimus was trained to DPs to be used in his laboratory activities. The C-Wells cores containing fractures were cut to a shape appropriate for installing flow manifolds for hydraulic and tracer testing.

Planned Activities

B. Robinson will continue to contribute to the SQA effort by serving as CCB chair .

We will complete documentation of batch sorption experiments with lithium bromide.

Using FEHMN, we will continue modeling studies to support the design of the field tests.

We will begin Li column transport studies.

Problem Areas

Because the Project has decided not to drill a fourth C-Well, we will be unable to pursue our strategy for qualifying sorption experiments using existing core samples, and we must plan an alternative approach.

Milestone Progress

3188
30 September 1992
Documentation for SORBEQ
Rescheduled to March 1993 because of personnel reassignment.

3194
30 September 1992
Batch Sorption Experiments with Lithium
Rescheduled to March 1993 because of personnel reassignment.

T112
22 June 1992
Final Documentation for FEHM
Rescheduled to June 1993 because of personnel reassignment.

3196
27 July 1992
FRACNET Documentation
Rescheduled to August 1993 because of personnel reassignment.

Publications

B. A. Robinson
FRACNET—Fracture Network Model for Water Flow and Solute Transport (3196)
LA-series report
In preparation.

B. A. Robinson
SORBEQ—A One-Dimensional Model for Simulating Column Transport Experiments (3188)
LA-series report
In preparation.

B. A. Robinson
A Strategy for Validating a Conceptual Model for Radionuclide Migration in the Saturated Zone Beneath Yucca Mountain
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project*
Submitted to YMPO (Russell Dyer).

W. L. Polzer and E. H. Essington
The Use of Selectivity Coefficients to Estimate Modified Langmuir Isotherm Parameters as a Function of Experimental Conditions
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project*
Submitted to YMPO (Russell Dyer).

P. Reimus, R. Glass, and B. Robinson
Aperture Characteristics, Saturated Fluid Flow, and Tracer Transport Calculations for a Natural Fracture
Conference paper, *1993 High-Level Radioactive Waste Management Conference*
Approved by YMPO.

WBS 1.2.3.4.1.1 Ground-water Chemistry Model

Objective

The goal of this investigation is to provide conceptual and mathematical models of the ground-water chemistry at Yucca Mountain. These models will explain the present ground-water composition in relation to interactions of minerals and ground-water and will be used to predict ground-water compositions as a result of anticipated and unanticipated environments.

Activities and Accomplishments

Study Plan. Staff continued to review comments and revise the study plan for this task. We are giving special attention to the sensitivity analysis and redox sections, as well as to the section on stable isotope constraints on water composition.

Other Activities. Staff continued modeling related to "most active ground-waters." Our goal is to categorize ground-waters using the compositional variables that affect radionuclide solubility and/or sorption properties. The letter report on this subject due 30 September 1992 has been delayed until after a 2 March meeting with task members from Sorption, WBS 1.2.3.4.1.2.1, and Solubility, WBS 1.2.3.4.1.3.

Modeling of pH and Eh stability is underway.

QA Activities. We will restart the IMOU between LLNL and Los Alamos.

Planned Activities

Continue resolution of comments on study plan.

Continue "most active ground-water" modeling with radionuclide and sorption input. Staff continued to collaborate with the USGS on water chemistry, stable isotope constraints on water composition, and the ground-water chemistry model.

Continue support of QA efforts and tracking of IMOU with LLNL.

Problem Areas

None

Milestone Progress

3415
30 September 1993
Letter report on Most-Active Ground-water Chemistry
(input to Milestone 3349 [Dynamic Transport])

Publications

None

WBS 1.2.3.4.1.2.1 Batch Sorption Studies

Objective

The objective of this task is to provide sorption coefficients for elements of interest to predict radionuclide movements from the repository to the accessible environment.

Activities and Accomplishments

This month, we conducted batch sorption experiments to address the role of trace minerals in tuff in the retardation of Np. We pre-conditioned solid phases (tuffs from the Calico Hills [G4-1530]) with ground-water (1g to 20 ml) for two weeks, added a solution of ^{237}Np in ground-water from Well J-13 (1 g of solids to 20 ml of solution), and equilibrated the entire solution for three weeks. Following sorption, we separated the two phases using centrifugation and determined the quantity of Np in each phase using gamma spectrometry. The composition of the tuffs from G4-1530 is 55% clinoptilolite, 16% opal-CT, 12% mordenite, 7% quartz, 7% feldspar, and 2% smectite; the tuff particles ranged in size from 75 to 500 μm, and the surface area of the tuff is 4.3 m^2/g.

To address the role of trace minerals, we used a magnetic separator to enrich a fraction of the crushed tuff and thus increase their iron oxide content. The composition of G4-1530 and of the two fractions is given in Table I.

Table I. Composition of Tuff from G4-1530 and from two Magnetically Separated Fractions

	G4-1530	Fraction #1	Fraction #2
% SiO_2	70	69	71
%TiO_2	0.08	0.1	0.2
%Al_2O_3	11	12	12
%Fe_2O_3	0.5	0.5	1.5
%MnO	0.06	0.02	0.3
%MgO	0.04	0.03	0.09
%CaO	0.8	0.8	0.6
%Na_2O	2.8	2.7	3.2
%K_2O	4.1	4.1	4.4
%H_2O (-)	1.3	1.5	0.8
%H_2O (+) +CO_2	8.6	9.2	5.2
%P_2O_5	0.005	0.001	0.03
%BaO	0.02	0.01	0.04
%SrO	0.003	0.003	0.003

We conducted batch sorption experiments using the two magnetically separated fractions and the original tuffs from G4-1540. The batch sorption coefficient for G4-1530 was 2 ml/g, and those for Fractions #1 and #2 were 1 and 2 ml/g, respectively. It is not clear from these preliminary results whether there is a correlation between the quantity of trace metal oxides in the tuff and the tuff's Np sorption capacity. No correlation between the two could indicate passivation of the trace minerals in the tuff, which may be caused by mineralogical reactions or chemical competition (sorption sites already occupied by other metals that are present in the groundwater which has flowed through the tuffs).

Planned Activities

We plan to collaborate with the Mineralogy and Petrology task (1.2.3.2.1.1.1) to further address the role of trace minerals in radionuclide sorption by tuff.

Problem Areas

None

Milestone Progress

3218
30 September 1993
Effects of Water-Rock Ratios on Sorption Coefficients

3345
30 June 1993
Neptunium Sorption onto Feldspar

3346
30 September 1993
Sorption as a Function of Temperature

Publications

None

WBS 1.2.3.4.1.2.3 Sorption Models

Objective

The objective of this task is to provide sorption models for elements of interest to predict radionuclide movements from the repository to the accessible environment.

Activities and Accomplishments

Using the atomic-force microscope (AFM), we continued to study natural goethite samples. To provide smoother surfaces for higher resolution imaging, we attempted to etch the sample surfaces with dilute HCl; unfortunately, the image resolution did not improve, and the sample crumbled. Our next approach is to have some sample surfaces laser-milled.

J. Leckie and C. Ong (Stanford University) submitted a list of planned experiments for studying the adsorptive behavior of uranyl ion. Initially they will study the adsorption of uranyl onto quartz and albite and the influence of competing ligands and metal ions on sorption. To determine the type of surface or surface coating, Leckie and Ong will perform a preliminary study of the stability of albite at basic pH.

Planned Activities

Our long-term objective is to determine the sorption site density of hematite and goethite for radionuclides, and how it is changed by reaction of the mineral surface with ground-water, which is a necessary input parameter for most sorption models. We believe that understanding the factors important to surface adsorption on the atomic scale is also important for developing improved models.

Next month we will obtain images of freshly laser-milled goethite surfaces so that we may prepare and characterize surface samples to test their reaction with adsorbates in solution.

We will continue to try to improve our analysis of AFM images.

Problem Areas

None

Milestone Progress

None

Publications

P. S. Z. Rogers
Dependence of Radionuclide Sorption on Sample Grinding, Surface Area, and Water Composition
Conference paper, *1993 International High-level Waste Management Conference*
Approved by YMPO.

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport

Objective

The purpose of this research is to determine whether microbial activity can influence the movement of plutonium in tuff. Because fluids are used extensively in the exploration of locations for a nuclear repository, those micro-organisms capable of utilizing drilling fluids as growth substrates are of special interest.

Activities and Accomplishments

U. C. Berkeley. We continued mineral dissolution experiments, comparing the rate of microbial growth on hematite (a pure iron oxide) to the growth rate on ferric chloride. Unlike published research, we are conducting these experiments aerobically. Reductive dissolution of hematite is well documented; however, we have seen no results on the effects of aerobic dissolution even though most microbial mineral interactions occur in oxydizing environments.

Los Alamos. We continued crushed-tuff column studies.

All milestones (3080, 3177, and 3092) were reviewed.

Planned Activities

Continue column and mineral dissolution experiments.

Problem Areas

We are still having problems ensuring long-term column sterility in our crushed-tuff column experiments. Although the crushed tuff is sterile when first packed into the columns, microbial growth can be detected (by plate counts and growth in broth culture) after several days of incubation. We hope to resolve this problem quickly.

Milestone Progress

3080
30 September 1992
Report on Chelation,
Retitled *Preliminary Evidence of a Siderphore Plutonium Complex*
Approved by YMPO.
Submitted to *Proceedings of the Fall Meeiting of the Materials Research Society*

3092
30 September 1992
Report on Colloidal Agglomeration
Draft completed. Milestone completion delayed until TPO decides on suitable publication vehicle.

3176
30 September 1992
Procedure for Determination of Formation Constants
Completed, Submitted to QA project leader 26 February 1993.

3177
30 September 1992
Procedure for Determination of Effects on Colloidal Agglomeration
Completed, Submitted to QA project leader (does not require DOE review).

Publications

L. E. Hersman, P. D. Palmer, and D. E. Hobart,
Preliminary Evidence of a Siderophore/Plutonium Complex
Journal article, *Journal of Applied and Environmental Microbiology*
In preparation.

WBS 1.2.3.4.1.3 Radionuclide Retardation by Precipitation Processes

Objective

The objective of the solubility determination task is to determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository into the accessible environment.

Activities and Accomplishments

Speciation. Using PAS, we determined the oxidation states of 250 nM Pu / bicarbonate solutions at pH 8.5–9 at elevated (75°C) temperatures. As reported last month, solutions originally made with Pu(IV) in $NaHCO_3$ solution retain the Pu^{4+} oxidation state from 1 M to 3 mM bicarbonate concentration at room temperature. Our results now suggest that even elevated temperatures do not cause an oxidation state change. Unfortunately, this study was cut short, and it is necessary to continue to observe long-term behavior.

We prepared Np(V) stock solutions in carbonate media for study using UV-VIS-NMR, PAS, and NMR spectroscopic techniques. We ordered an ultra-pure Np solution to prepare Np(V) stock for use in sorption studies.

We began our UV/VIS absorption study on NpO_2^+ species in (bi)carbonate media. At least three species were observed for 0.4 mM Np at 0.9 M (bi)carbonate concentrations between pH 8.4 and 13. These results will serve as a starting point for parallel NMR studies, as well as bicarbonate-concentration and temperature-dependent UV/VIS experiments.

We believe that our results of oxygen-17 and carbon-13 NMR experiments on the U(VI) carbonate system, within the pH range of 6–10 and temperature range of 0–25°C, indicate that there are only two observable uranyl-containing species present in solution under these conditions. The NEA-OECD database predicts three species, all at significant concentration, should be observable. This discrepancy may exits because the NEA data is based on model-fitting, whereas our data is based on results using a species-specific spectroscopic probe. These studies have provided the necessary groundwork so that we may proceed with similar studies of Np(V) in carbonate solution.

The milestone report (3330) entitled "Evaluation of Alternative Detection Schemes for Actinide Speciation using Photoacoustic Spectroscopy" by Tait et al., which describes the development phase of our PAS system, was completed and is in internal technical review. We continued to incorporate review comments on Milestone 3031, "Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by PAS and NMR Spectroscopies" by Clark et al.

Solubility. Work continued on the current undersaturation experiments in UE-25p #1 well water. The Np undersaturation experiment at pH 6 has not yet reached the steady state value determined in the oversaturation experiment; therefore it will continue. We determined the oxidation states of the Pu undersaturation experiments at pH 6 and 7. We found Pu(VI) and Pu(V) in the supernatant of both experiments, with Pu(IV) polymer, Pu(IV), and Pu(III) in insignificant quantities. The Eh values agreed with those measured in our earlier oversaturation experiments (~ 310 mV vs NHE in both cases). We isolated the solids for x-ray diffraction analysis. The Pu undersaturation experiment at pH 8.5 will be concluded in early February, when we will also complete the americium/neodymium undersaturation experiments at 60°C.

Staff submitted 1000 pages of scientific records from 1986-1988 to the RPC. Two DP revisions, "X-ray Powder Diffraction by the Debye-Scherrer Method," LANL-LBL-DP-03, R1, and "Operating and Calibrating a Low-energy Gamma-ray Counting System," LANL-LBL-DP-02, R1, and two new DPs, "Operating and Calibrating the Mettler H6T Analytical Balance," LANL-LBL-DP-14, R0, and "Concentration Determination of Soluble Radionuclides from Data Provided by a Low-energy Gamma-ray Counting System," LANL-LBL-DP-01, R0, were submitted..

All LBL YMP staff was trained to QP-3.5, R1, and open notebooks were submitted. A paper entitled "Radionuclide Solubility and Speciation Studies for the Yucca Mountain Site Characterization Project" was submitted to the TPO. This paper will be presented at the 1993 International High-Level Radioactive Waste Management Conference to be held April 26-30, 1993 in Las Vegas, NV.

Planned Activities

Efforts in all above mentioned areas will continue.

Problem Areas

None

Milestone Progress

3031
30 September 1992
Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies
In preparation.

3329
30 September 1992
Measured Solubilities and Speciations from Oversaturation Experiments of Neptunium, Plutonium, and Americium in UE-25p #1 Well Water from the Yucca Mountain Region
Technical review completed; reviewer comments returned to LBL.

3330
30 January 1993
Evaluation of Alternative Detection Schemes in Photoacoustic Spectroscopy
In review.

3344
30 September 1993
Report on Comparison of Solubilities of Np, Am, and Pu Between J-13 and UE-25p #1 Waters
On schedule.

3350
30 September 1993
PAS Analysis of Pu(IV) Carbonate Systems
On schedule.

3351
30 September 1993
NMR Analysis of Np(V) and Pu(IV) Carbonate Systems
On schedule.

Publications

D. L. Clark, D. E. Hobart, P. D. Palmer, J. C. Sullivan, and B. E. Stout
Carbon-13 NMR Characterization of Plutonyl(VI) Aqueous Carbonate Complexes
Journal article, *Journal of the American Chemical Society*
In preparation.

D. L. Clark, C. D. Tait, D. E. Morris, D. E. Hobart, S. A. Ekberg, and P. D. *Palmer*
Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies (3031)
LA-series report
In preparation.

D. L. Clark, J. G. Watkin, D. E. Morris, and J. M. Berg
Molecular Models for Actinide Speciation
LA-series report
In preparation.

H. Nitsche, R. C. Gatti, E. M. Standifer, S. C. Lee A. Miller, T. Prussin, R. S. Deinhammer, H. Maurer, K. Becraft, S. Leung, and S. A. Carpenter
Measured Solubilities and Speciations of Neptunium, Plutonium, and Americium in a Typical Ground-water (J-13) from the Yucca Mountain Region (3010)
LA-series report
Approved by YMPO; accession numbers being obtained; camera-ready.

H. Nitsche
Radionuclide Solubility and Speciation Studies for the Yucca Mountain Site Characterization Project
Conference paper, *1993 International High-Level Waste Management Conference*
Submitted to YMPO.

C. D. Tait, D. E. Morris, J. M. Berg and W. H. Woodruff
Evaluation of Alternative Detection Schemes in Photoacoustic Spectroscopy
Journal article, *Analytical Chemistry* or *Reviews of Scientific Instrumentation* (3330)
In preparation.

C. D. Tait, S. A. Ekberg, and P. D. Palmer, and D. E. Morris
Plutonium (IV) Carbonate Speciation Changes
Journal article, *Inorganic Chemistry* (3350)
In internal review.

WBS 1.2.3.4.1.4 Radionuclide Retardation by Dispersive, Diffusive, and Advective Processes

Objective

The objectives of this task are to determine the rate of radionuclide movement along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movements in the flow geometries and hydrologic conditions expected to exist along the flow path to the accessible environment in the scenarios used for perform assessment.

Activities and Accomplishments

This month we began radionuclide migration studies through a column of fractured tuff from drill hole USW G-1, at a depth of 1,941 feet. The two halves of the fractured core were sealed with epoxy, confined in a vessel filled with J-13 water, and placed in a constant-temperature enclosure (25 ± 0.2°C). We established a constant flow (0.3 ml/hr.) of J-13 water through the column. Next month, we will begin to determine the hydrological parameters of the column by eluting tritiated water through it. See Fig. 1.

A majority of our time this month was spent organizing the Colloid Workshop to be held 3-5 May in Santa Fe, NM. Workshop participants will evaluate whether colloids will significantly increase radionuclide release to the accessible environment at Yucca Mountain. There will be six sessions: Colloid Transport Calculations, Evidence of Colloids from Sampling Studies, Evidence of Colloids Transport at the Field Scale, Potential Sources of Colloids at Yucca Mountain, Laboratory and Field Experiments Relevant to Yucca Mountain, and Future Direction of Colloid Studies in YMP. Each session will consist of a formal presentation followed by a panel discussion.

(1) FRACTURE CORE

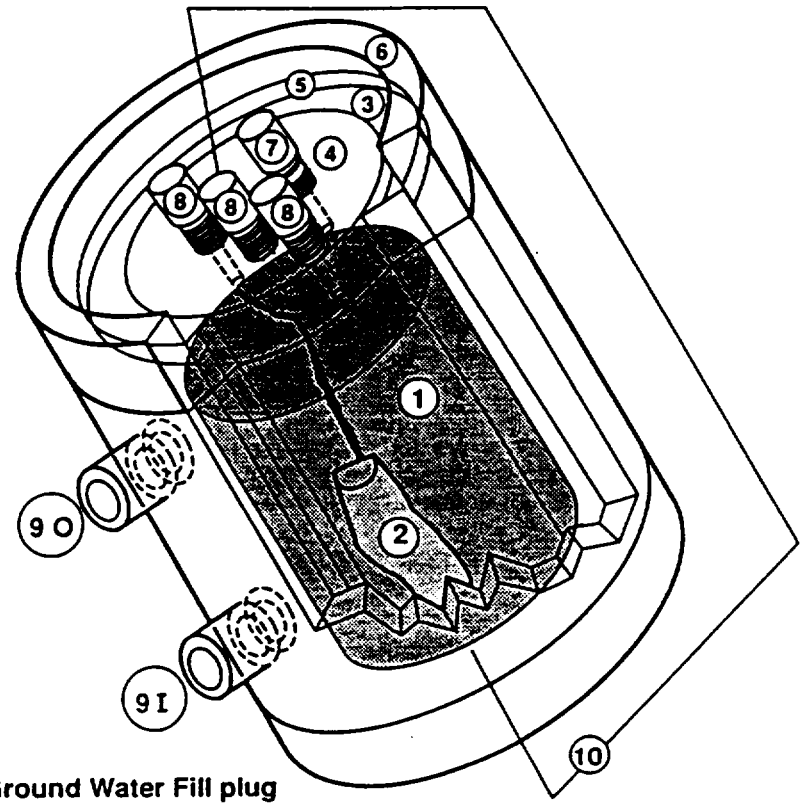
(2) Epoxy Sealing Fracture

(3) Ground Water Containing Jacket

(4) End Cap, Containing Core and Ground Water

(5) Constant Temperature Water

(6) Constant Temperature Water Containing Jacket



(7) Ground Water Fill plug

(8) Fracture Outlet

(9O) Constant Temperature Water Outlet

(9I) Constant Temperature Water Inlet

(10) Fracture Inlet (cap same as #4)

FIGURE 1

Planned Activities

Work in all the above mentioned areas will continue.

Problem Areas

None

Milestone Progress

3040
30 January 1993
Kinetics of Sorption on Columns of Pure Minerals
In internal review.

3044
30 January 1993
Measurement of Unsaturated Hydraulic Conductivity in Yucca Mountain Tuff
In internal technical review.

3065
Techniques to Study Diffusion in Saturated Tuffs
30 October 1992
In internal review.

3348 (Level IV)
Colloid Workshop Report
30 September 1993

3349
Summary Report on Np Transport through Yucca Mountain Tuffs
30 September 1993
On schedule.

Publications

A. Meijer
Far-Field Transport of Carbon Dioxide: Retardation Mechanisms and Possible Validation Experiments
Los Alamos letter report
In internal review (publication vehicle to be determined).

J. Conca
Measurement of Unsaturated Hydraulic Conductivity in Yucca Mountain Tuff (3044)
LA-series report
In internal review.

I. R. Triay, A. J. Mitchell, and M. A. Ott
Diffusion of Sorbing and Nonsorbing Radionuclides in Tuff
Conference paper, *1993 International High-level Waste Management Conference*
Submitted to YMPO.

I. R. Triay, R. M. Lopez, A. J. Mitchell, C. M. Overly, and M. A. Ott
Neptunium Retardation with Tuffs and Groundwaters from Yucca Mountain
Conference paper, *1993 International High-level Waste Management Conference*
Submitted to YMPO.

I. R. Triay, M. A. Ott, A. J. Mitchell, and C. M. Overly
Transport of Np through Yucca Mountain Tuffs
Conference paper, *Proceedings of the fall meeting of the Materials Research Society, November 30 - December 4, 1992* .
Submitted to YMPO.

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis

Objective

The objectives of this task are to construct a geochemical/geophysical model of Yucca Mountain and to use this model to examine the physical and chemical controls on radionuclide transport along flow paths to the assessable environment.

Activities and Accomplishments

Using FEHM, we continued to develop a three-dimensional, finite-element mesh for use in flow and transport calculations. This code includes an automatic mesh refinement in which any element can be flagged based upon geometric criteria, material property gradients, fine structure, or any other criteria defined by the user. We are using AVS as the graphical interface, which allows the user to interactively choose regions of the grid for refinement or to extract subregions of the grid for high-resolution calculations.

Fracture/Matrix Coupling. Using FEHM, we continued to investigate the equivalent continuum model for unsaturated flow. We are investigating the relative flow through the fracture and matrix portions of the media under different layering conditions as found at Yucca Mountain.

The dual permeability model was running with a traditional (six-degree-of-freedom) solver, and we continued work on solution algorithms. This work will directly affect the DOE-directed hot-repository modeling.

QA and Programmatic. TRACRN submitted for certification to the CCB chair. Certification should be final on 15 February.

Planned Activities

We plan to add the following capabilities to our three-dimensional finite-element mesh: (1) fault offsets (2) tabular features which crosscut stratigraphy (dikes and sills), (3) permit input of general data input formats (well log data, isopach maps, USGS topography, (4) improved user interface.

Begin calculations for ^{36}Cl transport.

Perform near-field double-permeability calculations to test the performance of various thermal-load designs.

Implement air/water diffusion for thermal calculations.

Complete certification of TRACRN.

Problem Areas

None

Milestone Progress

3052
30 January 1993
Baseline Documentation for TRACRN
Submitted to the CCB chair for software quality assurance.

Publications

K. Birdsell, K. Eggert, and B. Travis
Three-Dimensional Simulations of Radionuclide Transport at Yucca Mountain
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project*
Approved by YMPO.

WBS 1.2.3.4.1.5.2 Demonstration of Applicability of Laboratory Data

Objective

The purpose of this study is to design and conduct experiments to evaluate the applicability of laboratory data and to test models used in the radionuclide transport program to determine far field radionuclide transport. Both intermediate- and field-scale experiments and natural analogs will be assessed for their potential to provide the required data.

Activities and Accomplishments

This task has been deferred because of lack of funds.

Publications

None

WBS 1.2.5.2.2 Site Characterization Program

Objective

The purpose of this task is to coordinate the regulatory Project requirements within the Los Alamos programmatic structure. The focus of this coordination effort is on the integration of the technical work within the regulatory framework.

Topical Report Support

Staff supported completion of the topical report on Erosion, which is now entitled "The Potentially Adverse Condition: Evidence of Extreme Erosion during the Quaternary Period at Yucca Mountain." C. Harrington continued to modify this report in response to reviewer comments.

Staff continued an intense effort to prepare the Volcanism topical report for mid-March delivery to the DOE.

Study Plans

Water Movement Test, R1 (8.3.1.2.2.2). Review comments on Rev. 1 of the Study Plan were received from the YMPO in May 1992; they were addressed and returned to YMPO in December 1992.

Diffusion Test in the Exploratory Studies Facility, R0 (8.3.1.2.2.5). In April 1992, this study plan was accepted by DOE. In June 1992 it was submitted to the NRC for review.

Testing of the C-Hole Sites With Reactive Tracers, R0 (8.3.1.2.3.1.7). In February 1990, DOE/HQ issued the study plan as a controlled document; it was then sent to the NRC for comments. In January 1992, we were requested by DOE to review revised NRC comments addressed by the USGS. The revision was completed and all comments were accepted by Los Alamos.

Ground Water Chemistry Modeling, R0 (8.3.1.3.1.1). This study plan was returned in May 1992 from YMPO review; comments are now being addressed.

Mineralogy, Petrology, and Chemistry of Transport Pathways, R0 (8.3.1.3.2.1). In January 1992, we submitted revised NRC comments to T. Bjerstedt. In August 1992, YMPO requested that we word process the changes to be incorporated in the revision; that revision is in progress.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). The YMPO approved the study plan on 18 December 1991 and submitted it to the NRC on 31 January 1992.

Natural Analog Hydrothermal System in Tuff (8.3.1.3.3.1). This is an out-year activity.

Kinetics and Thermodynamics of Mineral Evolution and Conceptual Model of Mineral Evolution, R0 (8.3.1.3.3.2; 8.3.1.3.3.3). No progress during the recording period because of funding.

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). A new draft of the study plan was submitted to DOE for review in October 1992.

Biological Sorption and Transport, R0 (8.3.1.3.4.2). A revision addressing the Exploratory Shaft Design was submitted in September 1992.

Dissolved Species Concentration Limits, and Colloid Formation and Stability, R0 (8.3.1.3.5.1; 8.3.1.3.5.2). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. Rev. 0 was submitted to YMPO for comment resolution, verification, and approval on 9 October 1992.

Study Plans (cont.)

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. Rev. 0 will be submitted to YMPO for comment resolution, verification, and approval.

Diffusion, R0 (8.3.1.3.6.2). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. Rev. 0 was submitted to YMPO on 30 November 1992.

Retardation Sensitivity Analysis, R0 (8.3.1.3.7.1). This study plan was approved by the DOE and sent to the NRC for review in July 1992.

Demonstration of the Applicability of Laboratory Data to Repository Transport Calculations, RO (8.3.1.3.7.2). This study plan is deferred because no funds were allocated.

Gaseous Radionuclide Transport Calculations and Measurements, (8.3.1.3.8.1). This study plan is deferred because no funds were allocated.

Probability of Magmatic Disruption of the Repository, R0 (8.3.1.8.1.1). A detailed technical review was complete in July 1992 by the NRC. In August 1992, a one-day video conference was held with the NRC to discuss their technical review comments. These comments are now being addressed.

Physical Processes of Magmatisim and the Effects on the Repository, R0 (8.3.1.8.1.2). A draft study plan was submitted to DOE for review in October 1992. The review comments were return on January 1993 for comments resolution. These comments are now being addressed.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). This study plan was accepted by NRC on 4 September 1990.

WBS 1.2.5.3.5 Technical Database Input

Objective

The objective of this task is to coordinate input of technical data to the Project Technical Database (TDB) and the Automatic Technical Data Tracking System (ATDT).

Activities and Accomplishments

Submitted Erosion data to the TDB.

Submitted data on Fran Ridge water use to the TDB.

Staff reviewed AP 5.1Q/Rev3/Draft C and AP 5.2Q/Rev4/Draft C.

Staff submitted data from Activities 8.3.1.6.1.1.3, 8.3.1.8.5.1.2.2, 8.3.1.3.4.1.1 and 8.3.1.4.2.2 to the ATDT.

Planned Activities

Submit data from Activities 8.3.1.3.2.2.1 and 8.3.1.3.2.1.2 to the TDB.

Submit calcite data to the TDB.

Problem Areas

None

WBS 1.2.5.4.6 Development and Validation of Flow and Transport Models

Objective

Model testing is necessary to assess performance at Yucca Mountain. This task will conduct an experiment in a caisson facility to provide a baseline of confidence in models for transport.

Activities and Accomplishments

A special work permit for installation of sampling equipment in the caisson was prepared and is in review.

E. Springer prepared a paper entitled "Testing Models of Flow and Transport in Unsaturated Porous Media" for the International High-Level Waste Management Conference.

Planned Activities

Install lower-boundary-condition apparatus as soon as special work permit is approved and weather conditions are favorable.

Complete filling of the caisson.

Problem Areas

None

Milestone Progress

No FY93 milestones.

Publications

E. P. Springer, M.D. Siegel, P. L. Hopkins, and R. J. Glass
Testing models of flow and transport in unsaturated porous media
Conference paper, *1993 High-Level Radioactive Waste Management Conference*
In preparation.

WBS 1.2.5.4.7 Supporting Calculations for Postclosure Performance Analyses

Objective

This task will provide documentation and results of calculations used in analyses of postclosure performance that supports design of repository, seals, and waste package and perform calculations of postclosure performance needed to support activities carried out under other performance assessment WBS elements.

Activities and Accomplishments

G. Zyvoloski attended two meetings on thermal loading. They were held on 6 January at LLNL and on 22 January in Las Vegas, NV. These meeting were summarized in a memo included in the Appendix to this report.

Planned Activities

No planned activities reported this month.

Problem Areas

None

Milestone Progress

None

Publications

None

WBS 1.2.6 Exploratory Studies Facility

Objective

These Exploratory Studies Facility (ESF) tasks address the issues and information needs associated with the ES-based characterization of Yucca Mountain to determine the suitability of permanently isolating high-level nuclear waste from biosphere in a geologic repository.

Activities and Accomplishments

Staff continued to gather information on the use of tracers, fluids, and materials (TFM) at Yucca Mountain with emphasis on FY 1993 ESF-related activities. Waste isolation impact and test interference analysis for the TFMs were requested from the M&O.

Staff met with LLNL staff about their heater test and attended a meeting on Performance Analysis calculations as they relate to the heater test.

Staff prepared briefings and attended weekly ESF management meetings and participated in weekly Field Engineering/PA/QA meetings.

N. Elkins and H. Kalia submitted papers on TFM and on ESF test prioritization and coordination to the 1993 High-Level Radioactive Waste Management Conference.

Planned Activities

Staff will continue to focus on ESF thermal and mechanical testing. We will develop the integrated network for IDS and support Director of ED&D as required.

Staff will participate in ED&D weekly ESF management review meetings.

Staff will participate in weekly Field Engineering/PA/QA meetings.

Publications

N. Elkins
Prioritization of ESF Testing and Integration with Design and Construction
Conference paper, *1993 International High-Level Radioactive Waste Management Conference*
Approved by YMPO.

H. Kalia
Control of Tracers, Fluids, and Materials for the Yucca Mountain Site Characterization Project
Conference paper, *1993 International High-Level Radioactive Waste Management Conference*
Approved by YMPO.

Problem Areas

None

WBS 1.2.6.8.4 Integrated Data System

Objective

The integrated data system (IDS) supports the Exploratory Studies Facility (ESF) test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purposes of the IDS are to assist the principal investigators (PI's) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PI's organizations for data management and analysis.

Activities and Accomplishments

No significant activities reported this month.

Planned Activities

No planned activities reported.

Publications

H. Kalia
Acquisition of Test Data from the Exploratory Studies Facility for the Yucca Mountain Site Characterization Project
Conference paper, *Second International Symposium on Mine Mechanization and Automation*
Approved by YMPO.

Problem Areas

None

WBS 1.2.9.1.2 Technical Project Office Management

Objective

The objective of this task is to manage the Los Alamos Yucca Mountain Project Site Characterization Program.

Activities and Accomplishments

The TPO supported the Technical Advisory Group meeting.

The TPO visited the Harry Reid Center at the University of Nevada, Las Vegas, to discuss current support provided to Los Alamos by K. Stetzenbach and other possible collaborations. She also toured the facility.

The TPO reviewed seven technical information products.

WBS 1.2.9.2.2 Project Control

Objective

The objective of this task is to support management's efforts in planning, scheduling, and controlling the technical work. This task will develop, implement, and maintain computerized cost, schedule, and technical milestone data bases and develop strategies to meet management information requirements.

Activities and Accomplishments

On 12 January, D. Holmes attended a Project meeting on resources required to complete site characterization . On 29 January, D. Holmes and R. Oliver met with J. Carlson and T. Perrigo of SAIC to follow-up on the resource requirements exercise.

Staff submitted the PACS status report on 14 January.

Planned Activities

Staff will completion the resource requirements request by 19 February.

Staff will complete a computerized download of actual costs and forecasts from the Los Alamos accounting system .

Staff will submit the FY1995 DOE Unicall budget.

Problem Areas

The BOY was recast by DOE into B&R DB102124 and DB0104070; however, both DBs were eliminated in the latest B&R classification report, and, as a result, this money is not available to Los Alamos.

WBS 1.2.11.2/3 Quality Assurance Program Development, Verification, and Engineering

Objective

The Quality Assurance (QA) Program supports Los Alamos Yucca Mountain Site Characterization Project participants and ensures that their efforts provide data and evidence admissible for the repository-licensing process.

WBS 1.2.11.2 Program Development

Program Development One Q meeting was held during which the group conducted a self-assessment. Based on input from this exercise, a charter for Q meetings will be developed. Performance in 1992 was discussed and found to be satisfactory. We established goals for 1993, the major one being to implement the QARD as soon as possible. Activities for implementation of the QARD were identified and a draft transition schedule developed. Outstanding action items were addressed. New Project personnel were identified, the organization chart revised, and distributed for review.

Personnel. Lynn Sanders is the new records coordinator and will be the primary liaison with the Project Office.

Travel. S. Bolivar, J. Day, and P. Gillespie attended a meeting of the Rio Grande chapter of the ASQC in Albuquerque on 19 January.

Procedure Revisions. Twenty-one quality administrative procedures (QPs) were in various stages of revision.

Training. S. Bolivar and P. Gillespie attended the Requirements Traceability Network (RTN) training in Las Vegas on 25-26 January.

WBS 1.2.11.3 Audits and Surveys

Audits and Surveys Six audit reports are in various stages of completion. A QA planning meeting on audit philosophy was held and a draft 1992 audit schedule issued for review. The fourth quarter trend report was completed. Corrective actions for CAR-YMP-92-058 have been completed. The Project Office approved our proposed actions for CARs-YMP-93-018 and 019. CAR-YMP-93-019 has subsequently been closed by the Project Office.

WBS 1.2.11.5 Quality Engineering

Software. One CCB meeting was held. Richard Morley is the new software configuration control manager.

Planned Activities

The training coordinator will continue development of training classes for QP-17.4 and -17.5. Outstanding 1992 audit reports will be completed. The majority of efforts will be directed at completing documents that outline our transition to the new QARD. Corrective actions for stop work order SWO-03 will be completed. We will address how resident files will be handled in the revision of the records procedures. The quarterly QA information brochure will be issued. We will continue to compile the 1992 Quality Assurance Status Report.

Problem Areas

None

Publications

S. Bolivar and J. Day
The Quality Assurance Liaison—Combined Technical and Quality Assurance Support
Conference abstract
Approved by YMPO.

WBS 1.2.12.2/.5 1.2.13 Local Records Center Operations/Records Management and Document Control

Objective

The objective of this task is to satisfy the records management requirements of the YMP and NQA-1.

Activities and Accomplishments

Eighty-three records and/or records packages were received by the RPC; ten of these were rejected and returned to the originators for corrections.

Fifty-three records and/or record packages were submitted to the CRF; the CRF did not reject any records and/or records packages this month.

Staff submitted the end-of-year report to S. Bolivar.

Record staff attended the YMP Records Conference in Las Vegas, NV, 11-13 January.

Staff attended a QA meeting on 28 January.

Planned Activities

No planned activities reported.

Problem Areas

None

WBS 1.2.15.2 Administrative Support

Objective

The objective of this task is to provide administrative support for Group EES-13 and the YMPO.

Activities and Accomplishments

S. Klein reviewed and edited seven technical information products (TIPS) and following TPO review and approval, forwarded them to YMPO.

S. Klein prepared YMP weekly updates for January and monthly highlights for December and transmitted them to the M&O and YMPO. Editorial support staff completed the YMP Monthly Activity Report for November.

S. Klein designed the TIP database.

Planned Activities

S. Klein will train support staff to enter data into the TIP database.

Problem Areas

None

WBS 1.2.15.3 Training

Objective

The objective of this task is to fulfill the training requirements of the Yucca Mountain Project and maintain appropriate training records.

Activities and Accomplishments

Training staff attended a QA meeting on 28 January.

Staff began to learn new database software.

Staff prepared the end-of-year report and submitted it to S. Bolivar.

Staff submitted thirty-one records packages to the RPC.

Staff prepared material for the Los Alamos YMP Orientation, which will take place on 25 February.

Planned Activities

Training staff will attend a meeting for training representatives 23-25 February in Las Vegas. The meeting will include two days of performance-based training.

Problem Areas

None

APPENDICES

Yucca Mountain Site Characterization Project Colloid Workshop
May 3-5, 1993
Santa Fe, New Mexico

Co-Chairs: Ines R. Triay, Los Alamos National Laboratory
Ardyth M. Simmons, Department of Energy, Yucca Mountain Project

Organizer: Alan J. Mitchell, Los Alamos National Laboratory

Host: Los Alamos National Laboratory

Objective: to evaluate whether colloids will significantly increase radionuclide release to the accessible environment at Yucca Mountain.

REGISTRATION:

Sunday May 2, 1993	5:00-7:00 PM	Refreshments will be served
Monday May 3, 1993	7:00-8:00 AM	

PROGRAM:

Monday May 3, 1993
Morning Session: Colloid Transport Calculations
Moderator: Everett Springer, LANL

8:00-8:10	Welcome	Julie Canepa, LANL
8:10-8:30	Statement of Workshop Goal	Ardyth Simmons, DOE/YMP
8:30-9:00	Colloids: A Performance Assessment Perspective	Malcolm Siegel, SNL
9:00-9:30	Colloid Transport Calculations with CTCN	H. Eric Nuttall, UNM
9:30-10:00	Colloid Modeling Studies	Thomas Pigford, LBL
10:00-10:15	Break	
10:15-12:00	Panel Discussion Moderator: Everett Springer Panelists: Malcolm Siegel, H. Eric Nuttall, and Thomas Pigford	

Question to be answered by the panel:
Can we bound the potential significance of colloid transport at Yucca Mountain?

12:00-1:00 Hosted Lunch

1/25/93

Monday May 3, 1993
Afternoon Session: Evidence of Colloids from Sampling Studies
Moderator: Bill Steinkampf, USGS

1:00-1:30	Humic Materials in Well J-13 Water	Greg Choppin, FSU
1:30-2:00	Suspended Solids in Well J-13 Water	Jerry Kerrisk, LANL
2:00-2:30	Colloids in Waters at the NTS and Vicinity	Michael Whitbeck, DRI
2:30-3:00	Characterization of Colloids from the NTS	Brian Viani, LLNL
3:00-3:15	Break	
3:15-5:00	Panel Discussion Moderator: Bill Steinkampf Panelists: Greg Choppin, Allen Ogard, Michael Whitbeck, and Brian Viani	

Questions to be answered by the panel:
Do we have sufficient data to establish an upper limit on the amount of suspended solids in the groundwater at Yucca Mountain?
What is the most likely nature of the colloids in the groundwater at Yucca Mountain?
How should future colloid sampling studies be conducted?

Tuesday May 4, 1993
Morning Session: Evidence of Colloid Transport at the Field Scale
Moderator: Bruce Robinson, LANL

8:00-8:30	Radionuclide Migration at the NTS	James Hunt, UC, Berkeley
8:30-9:00	Actinide Mobility Through an Aquifer in a Semi-Arid Region	Wilfred Polzer, LANL
9:00-9:30	Colloid Natural Analog Studies at Cigar Lake	Peter Vilkes, AECL
9:30-10:00	Migration From a Transuranic Waste Disposal Site in the Vadose Zone	Jim Wolfram, INEL
10:00-10:30	Colloid Distribution at the Koongarra Uranium Deposit	Tim Payne, ANSTO
10:30-10:45	Break	
10:45-12:00	Panel Discussion Moderator: Bruce Robinson Panelists: James Hunt, Wilfred Polzer, Peter Vilkes, Tim Payne, and Jim Wolfram	

Question to be answered by the panel:
Does the evidence support the likelihood for significant transport of radionuclides by colloids at Yucca Mountain?

12:00-1:00 Hosted Lunch

1/25/93

Tuesday May 4, 1993

Afternoon Session: Potential Sources of Colloids at Yucca Mountain

Moderator: David Morris, LANL

1:00-1:30	Review of Formation of Radiocolloids	David Hobart, LANL
1:30-2:00	Colloids From Waste Form Reactions	John Bates, ANL
2:00-2:30	Colloid Formation From Spent Fuel Dissolution	Walt Gray, PNL
2:30-3:00	Gels and Colloids around Yucca Mountain	Schon Levy, LANL
3:00-3:15	Break	
3:15-5:00	Panel Discussion Moderator: David Morris Panelists: David Hobart, John Bates, Walt Gray, and Schon Levy	

Questions to be answered by the panel:

Can we bound the total mass of colloidal material that may be present in the repository environment?

Can we bound the relative contributions to the total colloidal mass from the major sources?

6:00- No host dinner at Rancho De Chimayo
Transportation provided - 6:00 pm departure time.

Wednesday May 5, 1993

Morning Session: Laboratory and Field Experiments Relevant to Yucca Mountain

Moderator: Arend Meijer

8:00-8:30	Review of LANL Colloid Transport Experiments	Ines Triay, LANL
8:30-9:00	Colloid Transport Field Experiments	John McCarthy, ORNL
9:00-9:30	Review of Colloid Transport Investigations in the NAGRA and SKB Programs	Robert S. Rundberg, LANL
9:30-10:00	Review of the Canadian Transport Experiments	Peter Vilkes, AECL
10:00-10:30	Break	
10:30-12:00	Panel Discussion Moderator: Arend Meijer Panelists: Paul Reimus, John McCarthy, Robert Rundberg, and Peter Vilkes	

Questions to be answered by the panel:

To what extent are experiments conducted in other media pertinent to Yucca Mountain?

Can the physico-chemical behavior of colloids be predicted from laboratory data?

What are the most critical experiments needed to address the issue of colloid transport at Yucca Mountain?

12:00-1:00 Hosted Lunch

Wednesday May 5, 1993
Afternoon Session: Future Direction of Colloid Studies in YMP
Moderator: Ines Triay, LANL

1:00-1:45	Observations and Conclusions Relevant to Colloid Transport at Yucca Mountain	J. I. Kim, TUM
1:45-2:05	Colloid Strategy for the Yucca Mountain Project	Ines Triay, LANL
2:05-2:15	Break	
2:15-4:50	Panel Discussion Moderator: Ines Triay Panelists: J. I. Kim, Ardyth Simmons, Julie Canepa, Bill Steinkampf, Brian Viani, Malcolm Siegel, H. Eric Nuttall, David Morris, and Bruce Robinson	

Question to be answered by the panel:
Relative to the objective of the workshop, what are the priorities for future colloid studies in the Yucca Mountain Project?

4:50-5:00	Closing Remarks	Ardyth Simmons, DOE/YMP
5:00	Adjourn	

1/25/93

FRACTURE-LINING MINERALS IN THE PAINTBRUSH TUFF

Barbara Carlos and Steve Chipera EES-1

Introduction

Drill cores from USW G-1, G-2, GU-3, G-4 and UE-25a#1 have been examined as part of ongoing fracture mineralogy studies. This report provides an overview of the fracture-lining minerals in the Paintbrush Tuff intersected by these drill cores. A more inclusive discussion of the manganese oxide minerals in fractures at Yucca Mountain will be found in Carlos et al. (in press), and a more detailed description of the fracture-lining zeolite minerals will be presented in Carlos et al. (in prep). Additional work is continuing on calcite in fractures, and preliminary results are presented in Vaniman (in press).

The Paintbrush Tuff comprises (from the top down) the Tiva Canyon, Yucca Mountain, Pah Canyon, and Topopah Spring Members. The stratigraphy has been described by Spengler et al. (1979), Spengler et al. (1981), Maldonado and Koether (1983), Scott and Castellanos (1984), Spengler and Chornack (1984), and Byers (1987). Cores of the Tiva Canyon Member exist only for USW G-4, UE-25a#1, and USW GU-3, and the Yucca Mountain and Pah Canyon Members have been identified only in USW G-2 and USW G-4. The unequal representation of the upper three Members of the Paintbrush Tuff is partly the result of variations in deposited thickness and post-depositional erosion, and partly because coring did not always start with the first tuff unit encountered in a hole.

Minerals in Fractures

The dominant minerals lining fractures in the Paintbrush Tuff are SiO_2 polymorphs, calcite, opal, manganese-oxide minerals, iron oxides, clays, and zeolites.

The silica polymorphs tridymite, cristobalite, and quartz line lithophysal cavities and fractures. These fractures and cavities formed during vapor phase alteration of the tuff, and are the earliest set of fractures in the Paintbrush Tuff. The coatings have characteristic tridymite morphology and twinning, and the matrix adjacent to the fractures is bleached. In some intervals, the tridymite morphology is retained, but the tridymite has been transformed to cristobalite or quartz. In others, euhedral quartz crystals occur on or instead of the tridymite morphology. Subhorizontal "fractures" with lithophysal coatings usually represent cavities intersected by the drill core, and often contain bladed hematite crystals, calcite (sometimes in several generations), opal, and, less commonly, fluorite or zeolites. Minor amounts of other vapor phase minerals, too small to be identified by present X-ray powder diffraction methods, may occur.

Lithophysal fractures occur in both the Tiva Canyon and Topopah Spring Members, but bleaching of the adjacent matrix is more developed in the Topopah Spring Member.

Calcite also occurs in non-lithophysal fractures (those that have no tridymite or bleached selvedges) but less frequently. It may occur alone, with opal, particularly in brecciated zones, or, less often, with zeolites. When calcite occurs with opal, opal is usually the last mineral deposited. In fractures that contain calcite and zeolites, calcite is usually the last mineral.

Manganese oxides form small (up to 2 mm) crusts and larger (up to 1 cm) dendrites on fractures in all units, commonly on planar or curviplanar cooling fractures, generally alone or with granular quartz or clay minerals, but sometimes under zeolites. The abundance of manganese oxides in fractures is variable. Spots and dendrites of manganese oxides also occur in the matrix of less welded intervals. To date, rancieite and lithiophorite are the only manganese-oxide minerals identified in the Paintbrush Tuff (above the water table), although other manganese-oxide minerals occur below the static water level.

Iron oxides occur as red-brown staining on bare rock and in fine-grained quartz coatings. Hematite crystals are common in lithophysal cavities and fractures.

The chain clays palygorskite and sepiolite have been identified in fractures in the Tiva Canyon Member and the upper Topopah Spring Member in core from USW GU-3 and USW G-4. Smectite is more widely distributed, especially in the deeper parts of the Topopah Spring Member, both in the densely welded devitrified intervals and in the lower vitrophyre, where it is a common fracture-lining mineral. Kaolinite has been identified in fractures from the Topopah Spring Member in USW G-1, and may be present in the Yucca Mountain Member in USW G-2.

The most variable minerals in the Paintbrush Tuff are the zeolites. Prismatic heulandite and stellerite are common, but variable in abundance, above the lower vitrophyre of the Topopah Spring Member. They also occur in the zeolitic portion of the Pah Canyon Member in USW G-2. Prismatic heulandite ranges in size from a few microns to 75 microns, stellerite may be as long as 150 microns. Heulandite also occurs as tabular crystals 50-200 microns in diameter over approximately the same intervals as the prismatic zeolites. Prismatic zeolites occur continuously in fractures above the top of the lower vitrophyre in all drill cores, but the interval in which they first appear varies above the lower vitrophyre varies from one drill hole to another. They occur from near the top of the Topopah Spring Member in USW G-1, from 90 m above the lower vitrophyre in UE-25a#1, near the top of the Topopah Spring Member and then again from 60 m above the lower vitrophyre in USW G-2, from 15 m above the lower

vitrophyre in USW G-4 and from less than 3 m above the lower vitrophyre in USW GU-3. Mordenite is ubiquitous in the lower half of the Topopah Spring Member. It occurs as fine-grained crusts as small as 2 mm in diameter and the crusts increase in size and abundance with depth in the core. Longer fibers are often intergrown with prismatic zeolites. Erionite has been identified within or just above the lower vitrophyre in 2 holes (UE-25a#1 and USW GU-3). Phillipsite has been identified in isolated occurrences within the vitrophyre in the same two holes. Below the lower vitrophyre in the Topopah Spring Member, prismatic crystals of clinoptilolite (structurally isomorphous with heulandite, but containing more K and maintaining its structure to higher temperature upon heating) occur with cristobalite or opal CT, and mordenite.

Discussion

The most outstanding feature of the fracture mineralogy in the Paintbrush Tuff above the lower vitrophyre is the calcic nature of all but the vapor phase minerals, from the relatively early rancieite to the latest calcite. Although the amount of K in the tuff matrix is much greater than that of Ca , recent water chemistry from the unsaturated zone indicates that present pore waters from shallow depths in the Paintbrush Tuff, though dilute, contain up to 8 times as much Ca as K (Yang, 1992). There is insufficient data as yet to determine the present source of the Ca in the pore waters, but fracture-lining mineral chemistry suggests that Ca has been dominant over K in the unsaturated zone for most of the history of the mountain.

Zeolites and smectite are widespread in fractures, though laterally variable in distribution across Yucca Mountain; they are abundant in fractures although the tuff matrix may be devitrified and may contain no zeolites and little smectite. This suggests that many of the fracture coatings were deposited by flow along the fractures rather than by porous flow through the matrix. Factors controlling the lateral distribution of zeolite deposition are unknown. Distance from the Timber Mountain Caldera may have had an effect, but was certainly not the most important factor, as the prismatic zeolites are more abundant in USW G-1 than in USW G-2. Proximity to Drill Hole Wash may be a factor; as the prismatic zeolites are most abundant in USW G-1 and UE-25 a#1. Mordenite is ubiquitous in the middle and lower Paintbrush tuff, but is not equally abundant in all core. In USW G-1 prismatic zeolites may occur in fractures with or without mordenite. The underground workings of the ESF should provide additional information on lateral distribution of the zeolites. In addition, geochemical modeling may help us to understand conditions that control deposition of the various zeolites.

There are few constraints on the time of deposition of the fracture-lining minerals. Tridymite, hematite, and minor amounts of other vapor-phase minerals were deposited in lithophysal cavities and connecting fractures early in

the cooling of the tuff. Some of the calcite deposited in these cavities and fractures may also have been early. Fluorite and opal came later than the first calcite, but often earlier than another episode of calcite deposition. Either opal or calcite may be the last mineral in the sequence in fractures containing both. We are studying the petrography and trace chemistry of the calcites, and the USGS is determining isotopic composition and performing U-series dating to determine the times and conditions of calcite precipitation. In fractures containing zeolites and calcite, calcite is usually the last mineral to be deposited, and these calcites are included in the trace element and isotope studies. Other than the relationship with calcite, and the fact that the prismatic zeolites have not been affected by slickensiding, there are no time constraints on the deposition of zeolites. Manganese oxides often occur on planar or curviplanar cooling fractures. Many have been smeared by slickensides. This suggests that manganese, and the sometimes-slickensided mordenite crusts occurring with it may have been deposited early in the history of Yucca Mountain. Manganese oxides are often covered by later mordenite, clay, or prismatic zeolites. In the lower vitrophyre they appear to be intergrown with other coatings, particularly smectite. Levy (1989) has postulated that the mineral deposition in fractures in the vitrophyre took place during cooling and incipient devitrification along the fractures, based on textural relationships between the vitrophyre and fractures, and on temperatures calculated from $\delta^{18}O$ in quartz lining the fractures. Many of the fine-grained coatings are slickensided, which supports the idea that they were deposited early in the history of the mountain during faulting. There are few occurrences of visibly crystalline zeolites in the vitrophyre. Again, geochemical modeling may help us to constrain the conditions present during deposition of fracture-coatings in the vitrophyre.

In the Topopah Spring Member below the vitrophyre, in USW G-4 (the only core to date for which mineral chemistry and results of heulandite heating are available), fracture-coatings more closely resemble those in the tuffs of Calico Hills and the Crater Flat Tuff, suggesting that the vitrophyre may have provided a barrier between the fluids depositing the suites of minerals above and below it. Below the vitrophyre, clinoptilolite (K dominant) rather than heulandite (Ca dominant) is the prismatic zeolite. Stellerite has not been identified in fractures below the vitrophyre. Changes in mordenite chemistry laterally or with depth have not been determined.

References

Byers, F., M., Jr., and Moore, L. M., 1987. Petrographic Variation of the Topopah Spring Tuff Matrix Within and Between Cored Drill Holes, Yucca Mountain, Nevada. Los Alamos National Lab. Report LA-10901-MS, 72 pp.

Carlos, B. A., Chipera. S. J. Bish, D., L., and Craven, S., J., in press Fracture-lining manganese oxide minerals in silicic tuff, Yucca Mountain, Nevada. Chem. Geol.

Carlos, B. A., Chipera, S. J., and Bish, D. L., in prep Distribution of fracture-L lining zeolites at Yucca Mountain, Nevada. Proceedings of Zeolite '93, the 4th International Conference on the Occurrence, Properties and Utilization of Natural Zeolites.

Levy, S., S., and O'Neil, J., R., 1989. Moderate-temperature zeolitic alteration in a cooling pyroclastic deposit. Chem. Geol., 76:321-326.

Maldonado, F., and Koether, S., L., 1983. Stratigraphy, structure, and some petrographic features of Tertiary Volcanic rocks at the USW G-2 Drill Hole, Yucca Mountain, Nye County, Nevada. U.S. Geol. Survey Open-File Report 83-732, 83 pp.

Scott, R., B., and Castellanos, M., 1984. Stratigraphic and structural relations of volcanic rocks in Drill Holes USW GU-3 and USW G-3, Yucca Mountain, Nye County, Nevada. U.S. Geol. Survey Open-File Report 84-491, 121 pp.

Spengler, R., W., and Chornack, M., P., 1984 Stratigraphic and structural characteristics of volcanic rocks in Core Hole USW G-4, Yucca Mountain, Nye County, Nevada. U.S. Geol. Survey Open -File Report 84-789, 77 pp.

Spengler, R., W., Byers, F., M., Jr., and Warner, J., B., 1981. Stratigraphy and structure of volcanic rocks in Drill Hole USW G-1, Yucca Mountain, Nye County, Nevada, U.S. Geol. Survey Open-File Report 81-1349, 50 pp.

Spengler, R., W., Muller, D., C., and Livermore, R., B., 1979. Preliminary report on the geology and geophysics of Drill Hole UE25a-1, Yucca Mountain, Nevada Test Site. U.S. Geol. Survey Open-File Report 79-1244, 43 pp.

Vaniman, D. T., in press. Calcite deposits in fractures at Yucca Mountain, Nevada. Proceedings of the Fourth Annual High-Level Radioactive Waste Management Conf., Las Vegas, Nevada.

Yang, I. C., 1992. Flow and transport through unsaturated rock--data from two test holes, Yucca Mountain, Nevada. Proceedings of the Third Annual High-Level Radioactive Waste Management Conf, Las Vegas, Nevada, 732-737.

January 6, 1993 Livermore California
Report by George Zyvoloski

This meeting, chaired by Bill Simeka, dealt primarily with the extended-dry (hot repository) concept advocated by Tom Buscheck and others. The meeting started by reviewing the link between waste canisters and repository design. The approach, proposed by Simeka, was that the canisters are safe, but if they fail, the hot repository will be the ideal backup. He stressed the urgency of proving this, and his task of defending the budget allocations that would support this approach. Topics discussed included the effect of a hot repository on a MRS system (generally negative), characterization of fault zones that intersect the repository, episodic rainfall events, and repository design (to the extent that it could lead to non-uniform heating). I also talked to Steve Blair of LLNL, who expressed concern over the stress effects of the hot repository design.

My list of concerns regarding the hot repository design are as follows:

1) What are the relative permeability and capillary curves at high temperatures? Is scaling with surface tension good enough?

2) Is the equivalent continuum approach valid for this application?

3) Do we need to go to 3-d calculation to realistically identify fast paths and incorporate topographic and stratographic effects? This question is particularly important if convection in the saturated zone is important.

4) How does thermal stress affect fracture permeability?

5) Can we generate high-vapor pressure zones caused by fracture closing from thermal stresses? This would inhibit boiling and provide a flow path (albeit a slow one).

6) How important is the 6% dip of the units? With faulting, this could result in perched water. This is not accounted for in the 2-d radial calculations

7) How important is episodic influx? This results in much more fracture flow than averaged influx.

If we were to point to one aspect on the hot repository that is critical, it would be the role of thermal diffusion properties vs. hydrologic diffusion properties. Buscheck points out that the thermal wave wins the

battle. If there are zones where convection of heat (heat carried by flow) is much greater than conduction of heat, then the method would fail because the dry umbrella could not be maintained for a sufficient amount of time.

January 22, 1993 Las Vegas, Nevada

This was a follow-up meeting to the one described above. The meeting was called to distribute the data used by Buscheck in his hot repository calculations. Buscheck gave a very short description of the problem and summarized and major findings. This meeting was attended by Bo Bovardsson of LBL and Ed Kwicklis and Alan Flint of the USGS. They generally agreed that the hot repository was interesting and worth pursuing. However, they advocated the approach that the uncertainty of the hot repository didn't allow one to take any shortcuts in regards to characterization. Additionally, Kwicklis suggested that the hot repository concept might severely impact the MRS system affecting the hot repository through fast flow paths to the surface. Furthermore, he believes that it is necessary characterize at high temperatures. It was suggested by the USGS that future calculations use the latest USGS data on hydrologic data. This means that this data will be distributed to the groups (including LANL) who will be doing numerical simulations of Yucca Mountain. It appears that the USGS and LBL will pursue a 3-d infiltration model (low resolution), Buscheck will possibly pursue some 2-d slice models along with the 2-d radial calculations, and LANL might do some dual permeability work.

Los Alamos National Laboratory
Los Alamos, New Mexico 87545