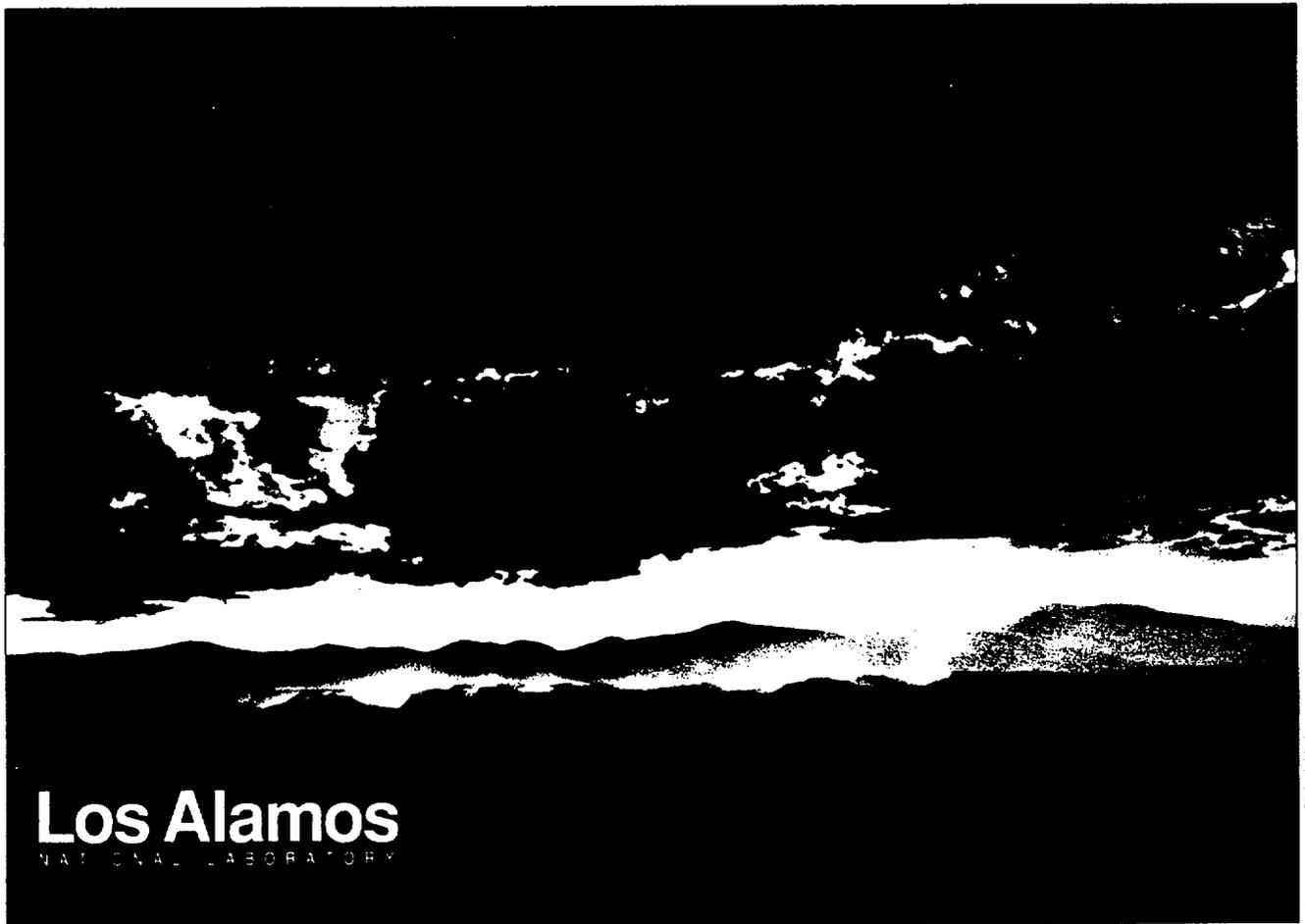


Yucca Mountain Site Characterization Project

Monthly Activity Report

July 1992



Attachment to TWS-EES-13-08-92-043

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LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Monthly Activity Report

July 1992

WBS 1.2.1 Systems

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.

Technical Data (WBS 1.2.1.3.5)

Activities and Accomplishments Finalized quality administrative procedure 8.3, "Transfer of Data."

Entered information into the Automated Technical Data Tracking System for the following activities: 8.3.1.3.2.1.2., "Calcite Deposits In Drill Cores USW G-2 and USW GI-3/G-3 at Yucca Mountain, Nevada"; 8.3.1.3.2.2.1, "Pedogenesis of Siliceous Calcretes of Yucca Mountain, Nevada"; and 8.3.1.3.2.2.2, "Dehydration and Rehydration of a Tuff Vitrophyre."

Staff submitted our parameter list and parameter screens to G. Heitland of SAIC.

Planned Activities Input information into the Automated Technical Data Tracking System for Activity, 8.3.1.3.2.2.1, "Bedrock Breccias Along Fault Zones Near Yucca Mountain, Nevada."

Submit data from Activities 8.3.1.8.1.3.2, 8.3.1.3.6.1.1, and 8.3.1.3.2.1.3 to the Technical Data Base.

Caisson Experiment (WBS 1.2.1.4.6)

Activities and Accomplishments Filling of the caisson is awaiting a NEPA categorical exclusion from DOE Albuquerque Operations Office.

Fabrication of the lower-boundary condition apparatus was started.

Staff discussed hydrologic characterization of the porous material in the caisson at a 10 July meeting in Albuquerque with representatives of Daniel B. Stephens and Associates and staff from Sandia National Laboratory. This group mandated a series of tests using both silica-sand and limonite mixtures to determine if limonite has an impact on the hydrologic properties of the porous material. One

Activities and Accomplishments (continued)

concern is the possible migration of limonite from the layer in which it was initially placed to sites throughout the caisson; this has become an important issue in the experiment, as migration would negate the concept of a layer. In addition, the issue of the relative influence of the limonite versus the expected variability of hydrologic properties of the sand must be resolved so that we may test the impact of limonite on various rates of chemical retardation. The percentage of limonite introduced will be 2-3%, which may not affect the K_d sufficiently to distinguish the limonite layer from the sand. Further analysis is needed to resolve this issue.

Planned Activities

Prepare the caisson for filling.

Continue to fabricate lower-boundary condition apparatus as material becomes available.

Write manuscript for special issue of *Radioactive Waste Management*.

Publications

E. P. Springer and M. D. Siegel

An Integrated Intermediate-Scale Caisson Experiment to Validate Models of Fluid Flow and Contaminant Transport in the Unsaturated Zone

Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project*

In preparation.

Performance Assessment Computational Support (WBS 1.2.1.4.7)

Activities and Accomplishments

G. Zyvoloski is further developing the dual porosity/dual permeability (DP/DP) capability of FEHMN in order to add a heat component; it will be used to study the effects of fractures that intersect the repository block have on performance assessment. He has also designed a probable solution scheme to solve this three-degrees-of-freedom problem (air/water/heat).

Planned Activities

Continue code development to add the heat component to the DP/DP model in FEHMN.

WBS 1.2.3.1 Site Management and Integration

Site Management (WBS 1.2.3.1.1)

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

Activities and Accomplishments Staff attended Mission 2001 meeting to review schedules, identify constraints, and make corrections, if possible.

Staff attended Integrated Test Evaluation (ITE) meetings in Las Vegas on 1-2 and 16-17 July and in Albuquerque on 29 July.

Staff attended the DOE audit of Los Alamos. Site management and integration staff were interviewed.

Staff presented the "YMP perspective" on locating Nuclear Rocket programs in the ERAD facilities near Yucca Mountain at a joint Los Alamos/Sandia meeting at DOE/NVD .

Test Management and Planning (WBS 1.2.3.1.2)

Objective The objective of this task is to provide coordination for Los Alamos surface-based test planning and package development.

Activities and Accomplishments E. Springer made a presentation at the Testing and Performance Assessment meeting in Las Vegas on 14-15 July. The presentation, which covered Los Alamos tests primarily for the ESF, discussed expected analyses to evaluate test-to-test, construction-to-tests, and waste-isolation interferences.

Staff developed design and test related information submissions and transmitted them to YMPO for the USW UZ-14 test planning and job package.

Staff continued to work on merging an administrative data base with the YMP GIS to track Los Alamos interactions with other Project participants and other site characterization surface-based testing activities.

Staff developed a preliminary sample collection and core field log to provide summary information to principal investigators and SOC members.

Several sample requests were evaluated and approved by the SOC.

Staff completed test planning package 92-07, "Fran Ridge Test Pit Mapping," and its associated job package, 92-7.

R. Oliver attended the July meeting of the Sample Oversight Committee. The YMPO has decided to archive 10% of the future core, contrary to SOC recommendations.

July 1992

**Activities and
Accomplishments
(continued)**

Staff attended a YMP geophysical logging workshop for surface-based testing activities.

Staff continued to participate in Test Integration Group (TIG) meetings. We have started developing test information for tests to be performed in north portal area, and started preparing test planning packages for launch chamber tests. Staff planned agenda for Exploratory Studies Test Coordination (ESTC) meeting on 18 August.

Planned Activities

Staff will continue support of the Los Alamos surface-based site characterization activities in response to Project program directives.

Prepare test planning packages for launch chamber tests.

Continue gathering TFM information from participants and establish TFM data files.

Prepare Title II test planning packages.

Continue with ESF sample and test coordination efforts.

Attend ASCE-sponsored symposium entitled "Dynamic Analysis and Design Consideration for High-Level Nuclear Waste Repositories."

Conduct ESTC meeting on 18 August.

Continue to support ITE and Mission 2001 efforts.

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	<p>We continued work on operating procedures and software for the INEL microdiffractometer.</p> <p>“Calcite deposits in fractures of drill cores USW G-2 and USW GU-3/G-3 at Yucca Mountain, Nevada” (milestone 3120) was reviewed and revised. This paper summarizes bulk chemical, electron microprobe, and petrographic data for samples from which 12 calcite separates were analyzed by instrumental neutron activation analysis (INAA). Data indicate major chemical differences between deep and shallow calcites at Yucca Mountain, in accord with results from USGS stable and radiogenic isotope studies. In addition, the data from chemical studies indicate differences between the shallow fracture calcites in USW G-2 and USW GU-3. These differences will be compared with other shallow calcites to investigate the chemical environments of the most recent fracture transport and deposition at Yucca Mountain.</p> <p>“Geologic evaluation of six nonwelded tuff sites for a surface-based test facility for the Yucca Mountain Project” (milestone 3137) was completed and is in internal technical review. This report summarizes a large amount of petrographic and chemical data to recommend that nonwelded vitric tuffs at Busted Butte and/or zeolitic tuffs at Prow Pass provide the best localities for siting a surface-based test facility for investigating rock analogous to the tuffaceous beds of Calico Hills beneath Yucca Mountain.</p> <p>D. Broxton presented a paper, “Chemical Changes Associated with Zeolitization of the Tuffaceous Beds of Calico Hills, Yucca Mountain, Nevada,” at the Seventh International Symposium on Water-Rock Interaction (Park City, Utah, 17 July). He presented information about zeolitic rocks closest to the Timber Mountain-Oasis Valley caldera complex that are notably K-rich and Na- and U-poor, reflecting probable higher temperatures of zeolitization nearer the caldera complex.</p> <p>In fracture mineralogy studies, B. Carlos visited the Sample Management Facility to examine and sample fractures in core intervals not previously sampled. Data on fractures containing zeolites are being compiled for a paper to be written for the Zeolite '93 Conference (Idaho, June 1993). “Fracture-lining manganese oxide minerals in silicic tuff, Yucca Mountain, Nevada” received YMPO approval and was submitted to <i>Chemical Geology</i>.</p>
Planned Activities	Work planned within the next few months includes the following activities: (1) continue analysis of fracture fillings in the Paintbrush Tuff to determine mineral distribution and factors controlling that distribution and (2) continue analysis of calcites to understand transport and precipitation mechanisms.
Problem Areas	None

July 1992

Milestone Progress

3120

30 June 1992

Calcite in the Upper Paintbrush Tuff
Complete.

3130

17 August 1992

Fracture Mineralogy of the Paintbrush Tuff

3137

30 September 1992

Mineralogy of Calico Hills for Adit Development
In technical review.

Publications

D. E. Broxton

Chemical Changes Associated with Zeolitization on the Tuffaceous Beds of Calico Hills at Yucca Mountain, Nevada

Conference paper, *Proceedings of the 7th Water-Rock Interactions Symposium*, July 1992

Published.

B. Carlos, D. Bish, S. Chipera, and S. Craven

Fracture-Lining Manganese Oxide Minerals in a Silicic Tuff

Journal article, *Chemical Geology*

Approved by YMPO; submitted for publication.

G. D. Guthrie, D. L. Bish, and B. T. Mossman

Quantitative Analysis of Zeolite-Bearing Dusts Using the Rietveld Method

Journal article, *Science*

Submitted.

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, *Journal of Geophysical Research*

Policy review completed by 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	<p>D. Vaniman and G. WoldeGabriel attended the Seventh International Symposium on Water-Rock Interaction in Park City, Utah. Vaniman presented a paper, co-authored by M. Ebinger, D. Bish, and S. Chipera, on precipitation of calcite, dolomite, sepiolite, and silica from evaporated carbonate and tuffaceous waters in southern Nevada. Following is a brief summary of the paper: Petrographic observations and modeling indicate that in both types of water calcite and/or dolomite precipitate first, followed by sepiolite and silica phases. They found that relative proportion of dolomite among the precipitates initially increases in both waters, but later decreases among precipitates from the carbonate-source waters and disappears from precipitates of tuff-source waters. Equilibrium precipitation would produce opal rather than sepiolite in both waters, but the common occurrence of sepiolite suggests that silica precipitation is suppressed. Modeling results suggest late precipitation of abundant but poorly ordered silica phases from tuff-source waters and rarer but more ordered silica phases from carbonate-source waters.</p> <p>Woldegabriel's presented a preliminary assessment of clinoptilolite K/Ar results from Yucca Mountain altered tuffs (co-authors are D. Broxton, D. Bish, and S. Chipera). To summarize: The K/Ar dates fall into at least three distinct groups. Older dates may be crystallization ages, whereas the younger dates may reflect the effects of continued diagenetic reactions of older clinoptilolites with percolating fluids. The K/Ar dates increase with depth, and this pattern has been documented in four drill holes. The results suggest that dating of K- rich zeolites may provide useful information for assessing the zeolitization and zeolite-groundwater interactions at Yucca Mountain.</p> <p>Several samples of altered rock from Busted Butte and Yucca Mountain, which have been cited by various researchers as possible examples of recent hydrothermal spring deposits, were analyzed by electron microprobe. Our examination of the thin sections indicates no evidence of constructional features that might be expected in a deposit built up from repeated discharge of solute-laden fluid.</p> <p>Comments on the final report by the Natural Analog Review Group were provided to the TPO.</p>
Planned Activities	Chemical and mineralogical characterization of samples from hydrothermal deposits exposed at the surface will continue. We will complete our responses to comments made by the National Academy of Science peer-review panel report, "Groundwater at Yucca Mountain: How High Can it Rise?" We will also provide additional input to the YMP topical report on calcite-silica and breccia deposits.
Problem Areas	None

Milestone Progress

3138

30 October 1992

Chemical Transport in Zeolitic Alteration

60% complete.

3141

31 March 1992 (delayed due to participation in the issue resolution process)

Laminated Zone in Trench 14

63% complete. (Technical review complete.)

3142

31 July 1992

K/Ar Dating of Clays and Zeolites

In technical review.

3143

30 April 1992

Experimental Dehydration of Volcanic Glasses

In program review.

3150

15 April 1993

Final Report on Bedrock

28% complete.

Publications

D. Bish and J. Aronson

Paleothermal and Paleohydrologic Conditions in Silicic Tuff from Yucca Mountain, Nevada

Journal article, *Clay and Clay Minerals*

Revision sent to YMPO.

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

Manganese Accumulation in Rock Varnish in a Desert Piedmont, Mojave Desert, California, and Application to Evaluating Varnish Development

Journal article, *Quaternary Research*

In YMPO policy review.

D. Vaniman, D. Bish, and S. Chipera

Dehydration and Rehydration of a Tuff Vitrophyre

Journal article, *Journal of Geophysical Research*

Policy review completed by TPO.

D. Vaniman, et al

Precipitation of Calcite, Dolomite, Sepiolite, and Silica from Evaporated Carbonate and Tuffaceous Waters of Southern Nevada

Conference paper, *Proceedings of the 7th Water-Rock Interactions Symposium*, July 1992

Published.

D. Vaniman, S. Chipera, and D. Bish

Pedogenesis of Siliceous Calcretes at Yucca Mountain, Nevada

Journal article, *Science*

Policy review completed by TPO.

**Publications
(continued)**

G. WoldeGabriel, *et al.*
*Preliminary Assessment of Clinoptilolite K/AR Results from Yucca Mountain,
Nevada: a Potential High-Level Radioactive Waste Repository Site*
Conference paper, *Proceedings of the 7th Water-Rock Interactions Symposium*, July
1992
Published.

July 1992

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 completed our response to the NRC review of Study Plan 8.3.1.8.5.1.1, "Probability of Magmatic Disruption of the Repository," and it is now in YMPO review.

The revised draft of Study Plan 8.3.1.8.1.2, "Physical Process of Magmatism and Effects on the Repository," is in review.

We completed responses to two comments in the volcanism section of the National Academy of Science's report on coupled processes; they are being integrated with the program-wide responses.

We processed six field notebooks for volcanism studies dating back to 1977; they will be submitted to the RPC.

We inventoried field notebook entries for volcanism studies covering activities described in a RIB submittal. They are studies of the 3.7 Ma centers of Crater Flat, the basalt of Buckboard Mesa, the Quaternary basalt of central Crater Flat, the basalt of Sleeping Butte, and the Lathrop Wells basalt.

Olivine was separated from four samples of Q13 lava to analyze for the isotopic composition of helium, part of surface exposure age determinations.

We received a copy of a letter from the USGS to the Nuclear Technical Review Board that described results of new K-Ar age determinations of the aeromagnetic anomaly south of the town of the Lathrop Wells (4.0 Ma) and a lava mesa east of the Sleeping Butte center (4.5 Ma). These results are significant new additions to the Pliocene volcanic history of the Yucca Mountain region as both sites are located on the previously described Crater Flat volcanic zone and provide new support of northwest trending structural models for the controls of sites of Pliocene and Quaternary volcanism.

A comment by S. Wells, B. Crowe and L. McFadden to a paper by Turrin *et al.* (1992) was published in the 24 July issue of *Science*. Wells, Crowe, and McFadden discussed alternative interpretations of the stratigraphy, K-Ar geochronology and paleomagnetic data of the Lathrop Wells volcanic center.

Staff discussed Yucca Mountain site issues with an NBC national news producer and with the editorial review board of the *Las Vegas Review Journal*.

Work in Progress. We continued writing the Issue Resolution Report for volcanism. We submitted the first three sections of the report for informal technical review.

We are establishing the U-Th disequilibrium age of the Q15 lava at the Lathrop Wells center.

We are obtaining duplicate surface exposure ages on the Q13 lava, directly above a site dated by the TL, and the KAr methods.

The software certification process is continuing for ^3He mass spectrometry studies.

- Planned Activities**
- A video conference with the NRC on the volcanism project is planned for August.
 - A special volume on volcanic chronology and risk assessment with special emphasis on studies of the Lathrop Wells volcanic center is planned for a 1993 volume of the *Journal of Volcanology and Geothermal Research*.
 - A meeting with the NWTRB subpanel on tectonics is scheduled for 14-16 September in Las Vegas.
 - Trenching at the Lathrop Wells volcanic center is planned for the first and third weeks of September.
- Problem Areas**
- Field mapping of the 3.7 Ma basalt centers of Crater Flat will be delayed in order that we may complete the Issue Resolution Report.
- Milestone Progress**
- 3174
8 January 1992
Effects of Magmatic Disruption on the Repository (Study Plan 8.3.1.8.1.2, R0)
 - 3034
30 September 1992
Report on Magma System Dynamics
 - 3109
30 September 1992
Report of Subsurface Effects
 - 3111
30 September 1992
Preliminary Geologic Mapping of Volcanic Centers
 - 3164
30 September 1992
Progress Report on Thermoluminescence
 - R482
31 August 1992
Issue Resolution Report
- Publications**
- B. M. Crowe, *et al.*
Issue Resolution Report
In preparation.
 - S. G. Wells, *et al.*
Multiple Eruptive Events at Small Volume Basaltic Centers: Evidence From the Cima and Crater Flat Volcanic Fields
Journal article
In preparation.

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	<p>The subcontractor, Hydro Geo Chem, began processing 14 additional samples from USW N54 and N55 to assess the reproducibility and distribution of the elevated signal seen earlier in the nonwelded units underlying the Tiva Canyon welded unit. Hydro Geo Chem determined the Chloride and Cl/Br profiles for the alluvial samples from USW N37 found between the surface and 36.5 feet below the surface; they began processing 7 samples for ³⁶Cl from this interval. These 21 samples, plus associated replicates and blanks, will be submitted to the University of Rochester next month for ³⁶Cl analysis.</p> <p>Hydro Geo Chem continued investigating alternative methods to improve the detection limit for bromide.</p> <p>Collection of cutting samples for ³⁶Cl analysis from UZ-16 continued. A criteria letter for sample collection was submitted for inclusion in the job package for UZ-14.</p>
Planned Activities	Complete additional DPs; process soil samples for Cl/Br and chlorine-36/Cl ratios; process cuttings samples from neutron-access bore holes; and collect additional soil samples from Yucca Mountain area as opportunities arise.
Problem Areas	None
Milestone Progress	<p>3191 <i>Procedure for Chlorine-36 Analysis of Unsaturated Zone Samples</i> 30 September 1992 92% complete</p>
Publicatlons	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 No significant activity in this study.

Milestone Progress No Level II milestones are planned for this fiscal year.

**WBS 1.2.3.3.1.3.1 Site Saturated Zone Groundwater 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 Qualification.** Z. Dash and B. Robinson began serving as temporary Software Configuration Manager and CCB Chair, respectively. Z. Dash submitted implementation-phase baseline for the plotting routine GENPLOT for review.
- Lithium-Bromide Studies.** Lithium batch adsorption and desorption experiments were completed at solid/liquid ratio of 1:1 at 38°C. Measurements were made at initial lithium concentrations of 0–1000 ppm. We are currently interpreting the results, which will be incorporated in an upcoming report..
- Planned Activities** Continue to contribute to the SQA effort by serving as temporary Software Configuration Manager (Z. Dash) and temporary CCB Chair (B. Robinson).
- Complete documentation of batch-sorption experiments with lithium bromide.
- Continue developing techniques for measuring the concentration of polystyrene microspheres in solution
- Complete paper that presents a validation strategy for the matrix-diffusion conceptual model.
- Continue modeling studies using FEHMN to support the design of field tests.
- Problem Areas** We were unable to make significant progress on our modeling efforts this month because of the large amount of time we devoted to the SQA effort.
- Milestone Progress** 3188
30 September 1992
Documentation for SORBEQ
- 3194
30 September 1992
Batch Sorption Experiments with Lithium
- T112
22 June 1992
Final Documentation for FEHMN
Delayed due to personnel reassignment.
- 3196
27 July 1992
FRACNET Documentation
Delayed due to change of assignment for principal investigator.
- R529
Evaluation of Preliminary Application of FEHMN to Yucca Mountain
Completed.

Publications

B. A. Robinson

FRACNET—Fracture Network Model for Water Flow and Solute Transport

LA-series report

In preparation.

B. A. Robinson

SORBEQ—A One-Dimensional Model for Simulating Column Transport Experiments

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*

In preparation.

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*

In preparation.

W. L. Polzer, M. G. Rao, H. R. Fuentes, and R. J. Beckman

Thermodynamically Derived Relationships Between the Modified Langmuir Isotherm and Experimental Parameters

Journal article, *Environmental Science and Technology*

Accepted.

WBS 1.2.3.4.1.1 Groundwater Chemistry Model**Objective**

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

Activities and Accomplishments

Study Plan. M. Ebinger continued to address review comments and revise the study plan for this task.

Other Activities. We defined the matrix for investigating most-active groundwaters. Our goal is categorize groundwaters using compositional variables that affect radionuclide solubility and/or sorption properties. Variables of interest presently are measured Eh potential, pH, and bicarbonate content. EQ3/6 will be used to conduct simulations using the different kinds of groundwater compositions.

M. Ebinger attended the Seventh Water-Rock International Symposium in Park City, Utah, in July. He presented a paper on water-rock interactions and the pH stability of ground waters from Yucca Mountain.

QA Activities. No additional progress to report on the IMOU between LLNL and Los Alamos. IMOU is in review at YMPO.

Planned Activities

Resolve comments on study plan; collaborate with USGS; support QA efforts; and track IMOU mentioned above.

Problem Areas

We are concerned about delays in material and equipment for the USGS down-hole sampler as this could slow progress on testing of conceptual models of groundwater chemistry at Yucca Mountain.

Milestone Progress

3006
31 August 1992
Eh and pH Buffering Capacity

3415
30 September 1992
Most-Active Groundwater Chemistry

Publications

M. Ebinger
Water-Rock Interactions and the pH Stability of Ground waters from Yucca Mountain, Nevada
Conference paper, *Proceedings of the 7th Water-Rock Interactions Symposium*, July 1992
Published.

D. Vaniman, D. Bish, M. Ebinger, S. Chipera
Precipitation of Calcite, Dolomite, Sepiolite, and Silica from Evaporated Carbonate and Tuffaceous Waters of Southern Nevada
Conference paper, *Proceedings of the 7th Water-Rock Interactions Symposium*, July 1992
Published.

WBS 1.2.3.4.1.2.1/3 Batch-Sorption Studies and Sorption Models

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	<p>K. Kung prepared a required standard operating procedure (SOP) for sorption measurements; it is now in review. Because the filters specified for sorption measurements in detailed technical procedure (DP) INC-DP-005 are no longer manufactured, Kung will test potential replacements.</p> <p>J. Schense tested the BET surface-area analyzer and achieved acceptable results. He found the results to be extremely sensitive to sample degassing time and temperature; for example, degassing tests on a YMP sample of zeolitized tuff showed a 17% increase in surface area after the sample was degassed for 15 hours versus 3 hours. Since we do not have the facilities to degas samples overnight, they have been sent to Quantachrome for commercial-grade analysis. We expect results back by 21 August.</p>
Planned Activities	<p>P. Rogers will continue preparation of the September milestone reports.</p> <p>K. Kung will begin testing new filters for sorption measurements as soon as appropriate laboratory preparations are complete and the SOP is approved.</p>
Problem Areas	None
Milestone Progress	<p>3009 30 September 1992 <i>Variation of Water-Rock Ratio Sorption Coefficients on Zeolitic Tuff</i></p> <p>3212 30 September 1992 <i>Progress Report on Single Mineral Experiments</i></p>
Publications	<p>A. Meijer <i>A Strategy for the Derivation and Use of Sorption Coefficients in Performance Assessment Calculations for the Yucca Mountain Site</i> Conference proceedings, <i>Proceedings of the DOE/Yucca Mountain Site Characterization Project Radionuclide Adsorption Workshop at Los Alamos National Laboratory September 11-12, 1990</i>. (LA-12325-C, 1992) In press.</p>

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	<p>The dissolution rate of hematite by the <i>Pseudomonas</i> sp. is being determined. These experiments are being performed to aid in determining the effect(s) of micro-organisms on actinide oxides and to better understand the activities of micro-organisms in a subsurface environment.</p> <p>Unsaturated-flow columns are now being constructed to study microbial activities in unsaturated environments.</p> <p>Work has continued on writing milestones 3080, "Report on Chelation," and 3092, "Report on Colloidal Agglomeration."</p>
Planned Activities	<p>Continue plutonium K_d experiments.</p> <p>Continue colloidal agglomeration experiments.</p>
Problem Areas	None
Milestone Progress	<p>3080 30 September 1992 <i>Report on Chelation</i> In preparation.</p> <p>3092 30 September 1992 <i>Report on Colloidal Agglomeration</i> In preparation.</p> <p>3176 30 September 1992 <i>Procedure for Determination of Formation Constants</i> In progress.</p> <p>3177 30 September 1992 <i>Procedure for Determination of Effects on Colloidal Agglomeration</i> In preparation.</p>
Publications	<p>L. R. Hersman, D. E. Hobart, and T. W. Newton <i>Preliminary Evidence of Siderophore/Plutonium Complexation</i> Journal article, <i>Journal of Applied and Environmental Microbiology</i> Resubmitted.</p>

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

We continued to address mandatory comments to the study plan for this task; we hope to complete this process by 15 August.

Speciation Studies. PAS experiments this month focused on determining the extent to which the spectrum of Pu(IV) colloid (~20 mM) in dilute carbonate /bicarbonate solutions (~ 5 mM, i.e., J-13 levels) is temperature-dependent. Specifically, we wanted to assess the kinetic stability of the colloid at low Pu concentrations in dilute carbonate. We have previously shown that Pu(IV) is stable as dissolved species under J-13-like conditions when the solutions are prepared from dissolved species. In our current experiments, we are looking for evidence of dissolution of Pu(IV) colloid to dissolved Pu(IV) species. This work will tie up the few remaining loose ends with respect to Pu(IV) before we begin Np(V) experiments.

We repeated the C-13 NMR experiments to characterize carbonate-ligand exchange processes with Am(III) and found that the new pulse sequence method to determine rate constants does not work for Am(III) because of lifetime incompatibilities. We may be forced to adopt the more conventional line width method for this system. We also investigated H₂O exchange on Am(III) using O-17 NMR; these results are still being worked up.

Several new Np(V) solution samples were prepared for use in tuff sorption experiments by the Sorption Task.

We continued to work on U(IV) and Th(IV) model complexes.

We began work on Milestone Report 3031, "Plutonium(IV) and Plutonium(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies."

Solubility Studies. X-ray powder diffraction patterns for the solids produced in the Np oversaturation experiments are still being matched to known solids and results from previous Np studies in UE-25 p#1 at 25°C and in J-13 water.

We performed oxidation state determinations for two experiments in UE-25p #1 at 60°C, Pu at pH 6 and Am/Nd at pH 6. The Pu experiment was analyzed on day 258, and the Am/Nd experiment on day 260. The methods we used to determine different oxidation states in solution are listed in Table I. These two methods have undergone extensive testing with very favorable results in aqueous solutions that range from 1 M in acid to acidified brines up to 8 M in ionic strength.

Activities and
Accomplishments
(continued)

Table I. Methods That Determine Oxidation States in Solution		
Method	Oxidation State Distribution	
	Organic Phase	Aqueous Phase
PMBP Extraction at pH = 0	(+4)	(+3, +5, +6, p) ^a
PMBP Extraction at pH = 0 w/ Cr ₂ O ₇ ⁺	(+3, +4)	(+5, +6, P) ^a
LaF ₃ Coprecipitation ^b	(+3, +4, p) ^a in precipitate	(+5, +6) in supernatant
HDEHP Extraction at pH = 0	(+4, +6)	(+3, +5, p) ^a
HDEHP Extraction at pH = 0 w / Cr ₂ O ₇ ²⁻	(+3, +4, +5, +6)	(p) ^a

(a) (p) = Pu(IV) polymer

(b) Method with "holding oxidant"

Our first Pu(IV) / J-13 experiment at pH 6 at 60°C contained the highest amount of Pu(VI) yet at steady state, 72%. (The 25°C and 90°C experiments at pH 6 in J-13 water contained 29% and 7% Pu(VI) respectively.) The results of Pu oxidation state determinations at 60°C at pH 6 may be seen in Table II; the presence of 94% Pu(VI) was similar to our findings in J-13 water.

Table II.
Plutonium Oxidation-State Distribution
in UE-25p #1 water at 60°C and pH 6

Pu(III)	0%
Pu(IV)	(1.3 + 0.4)%
Pu(IV) polymer	(0.4 + 0.1)%
Pu(V)	(4.2 + 0.6)%
Pu(VI)	(94.1 + 11.1)%

The Pu experiments at pH 7 and 8.5 will be completed next month. Following this, experiments from undersaturation will be restarted.

The results of the Am/Nd oxidation state distribution determination in UE-25p #1 water at 60°C and pH 6 shows that *all* Am exists as Am(III). Only two separations were needed for this determination: one LaF₃ co-precipitation and one PMBP extraction. The co-precipitation separates oxidation states III and IV from V and VI. The precipitate contained 100% of the americium; therefore, the americium can only be in the trivalent or tetravalent oxidation state. The PMBP extraction then separates the tetravalent ions from trivalent ions, and it showed no extraction of the americium; this proves that all the americium is in the trivalent oxidation state. We are currently working up the results for the Am/Nd experiment at pH 8.5 and will report them next month. We are also starting a new Am/Nd oversaturation experiment at pH 7 to run concurrently with the recently restarted undersaturation experiment at pH 7.

Activities and Accomplishments (continued)	Quality Assurance. With respect to the LBL QA effort, a draft detailed technical procedure, "Concentration Determination of Soluble Radionuclides from Data Provided by a Low-Energy Gamma-Ray Counting System" (LANL-LBL-DP-01,R0) has been completed. We are beginning to prepare for the QA Audit scheduled for 19-21 August.
Planned Activities	Efforts in all above mentioned areas will continue.
Problem Areas	None
Milestone Progress	3010 30 June 1991 <i>Report on Measured Solubilities of Pu, Am, and Np in J-13 Groundwater from Oversaturation Conditions</i> Submitted 7/29/91 In revision.
	3031 30 September 1992 <i>Plutonium(IV) and Plutonium(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies</i> On schedule.
	3329 30 September 1992 <i>Report on Neptunium, Plutonium, and Americium Solubility Experiments in UE-25p #1 Water from Oversaturation.</i> On schedule.
	3330 1 January 1993 <i>Evaluation of Alternative Detection Schemes in Photoacoustic Spectroscopy</i> Early completion anticipated.
Publications	D. L. Clark, D. E. Hobart, P. D. Palmer, J. C. Sullivan, and B. E. Stout <i>Carbon-13 NMR Characterization of Plutonyl(VI) Aqueous Carbonate Complexes</i> Journal article, <i>Journal of the American Chemical Society</i> In preparation.
	D. L. Clark, C. D. Tait, D. E. Morris, D. E. Hobart, S. A. Ekberg, and P. D. Palmer <i>Plutonium(IV) and Plutonium(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies</i> LA-series report In preparation.
	D. L. Clark, J. G. Watkins, D. E. Morris, and J. M. Berg <i>Molecular Models for Actinide Speciation</i> LA-series report In preparation.
	L. E. Hersman, P. D. Palmer, and D. E. Hobart, <i>Preliminary Evidence of a Siderophore/Plutonium Complex</i> Journal article, <i>Journal of Applied and Environmental Microbiology</i> In preparation.

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

D. E. Morris and D. L. Clark
Spectroscopic Studies of the Hydrolysis of UCl_4 : Spectral Effects of Ligand Exchange
LA-series report.
In preparation.

D. E. Morris, C.D. Tait, S. A. Ekberg, and P. D. Palmer
Speciation of Plutonium in Carbonate Media
Conference abstract, *Materials Research Society*
In YMPO policy review.

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 Groundwater (J-13) from the Yucca Mountain Region*
LA-series report
Returned to TPO for policy review.

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*
In preparation.

C. D. Tait, D. E. Morris, S. A. Ekberg, and P. D. Palmer
Plutonium Carbonate Speciation Changes
Journal article, *Inorganic Chemistry*
In preparation.

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 continued Np transport work using crushed-tuff columns made from tuffs G4-1530.3 and G4-275. We prepared three new columns (two from G4-1530.3 and one from G4-275), which were packed wet. The dimensions and column parameters are given in Table I.

Table I.

Identifier	Tuff	Diameter (mm)	Length (mm)	Flow Rate (ml/hr)
G4-1530.3K	G4-1530.3	4.72	1816.1	~ 1
G4-1530.3L	G4-1530.3	6.35	1828.8	~ 1
G4-275E	G4-275	4.72	1816.1	~ 1

We characterized these columns by eluting tritiated water through the tuff. The elution curves are given in Figures 1-3, where A/At represents cumulative activity eluted.

We began transport studies using three solid rock columns made with tuff G4-1530. Because the initial parameters we chose for tritium elution yielded a large dispersion, we adjusted them, and eluted tritiated water through the columns a second time.

We continued Np batch-sorption experiments with tuffs G4-1530 and G4-275 with USWH-3, UE-25p #1, and J-13 waters to support our transport experiments. We are also conducting batch-sorption experiments using Np solutions and pure mineral separates (hematite, montmorillonite, clinoptilolite, and quartz) found in the tuffs. This month we prepared the Np solutions in USWH-3, UE-25p #1, and J-13 waters. To ensure that the solutions were free of microbial activity, we autoclaved all equipment and filtered the Np solutions through a 0.2 micrometer cellulose nitrate filter.

Staff continued to organize the colloid workshop to be held in early 1993.

M. Ott revised four detailed technical procedures; three were submitted for approval.

Staff developed parameter screens for the SEPDB data for all tasks in the dynamic transport and diffusion studies.

Planned Activities Continue all work discussed above.

Problem Areas None

Figure (1)

HTO Elution Through Column G4-1530.3K

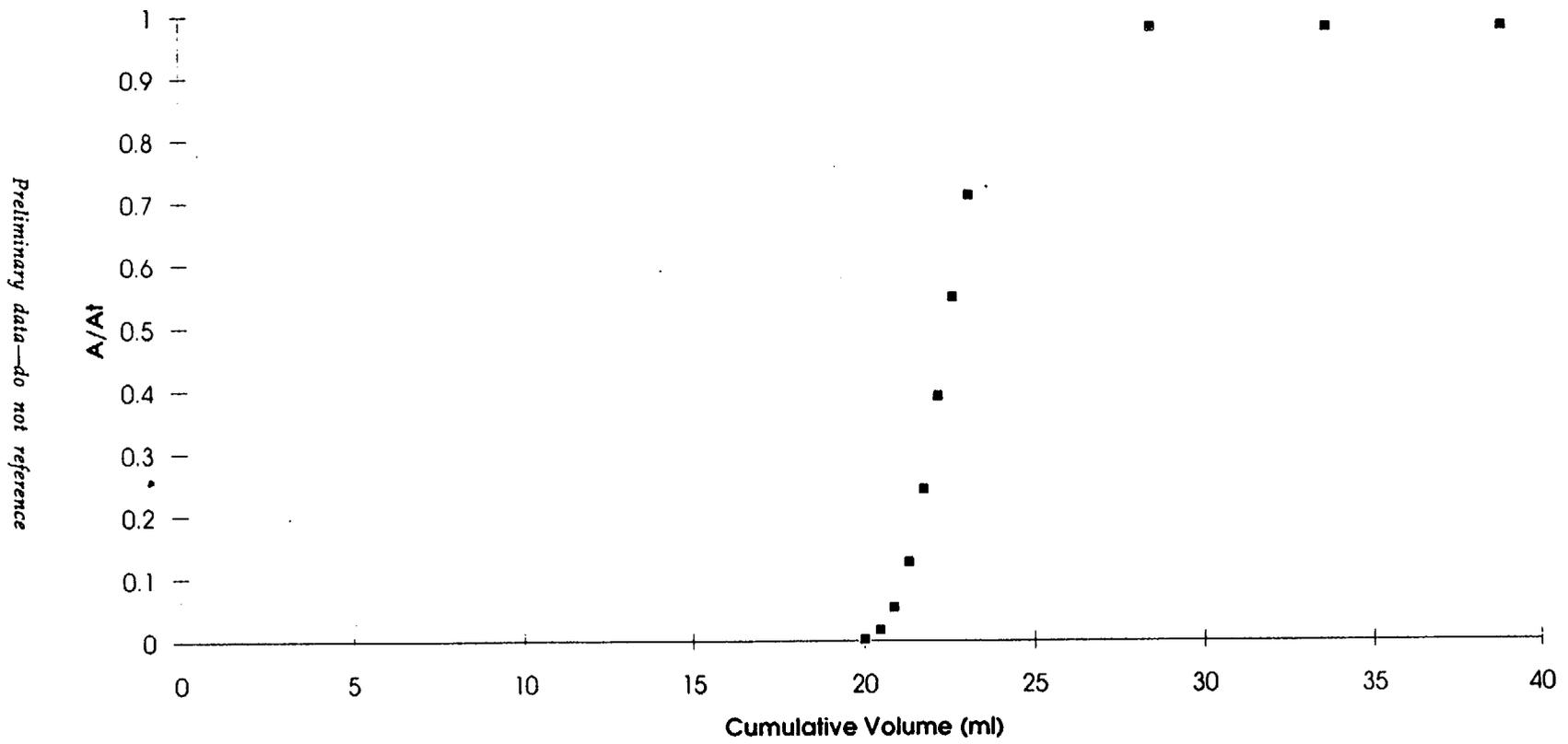


Figure (2)

HTO Elution Through Column G4-1530.3L

Preliminary data—do not reference

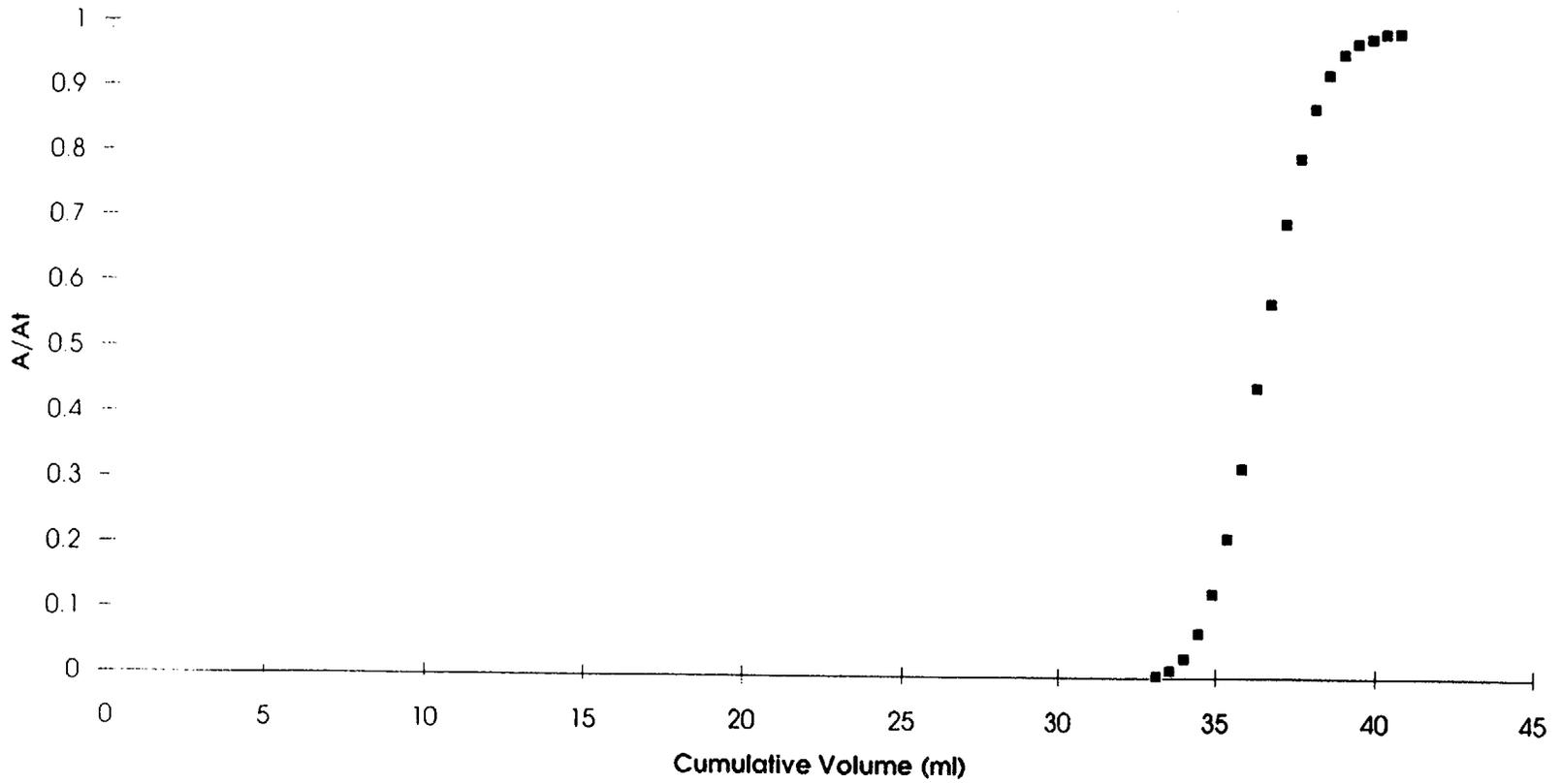
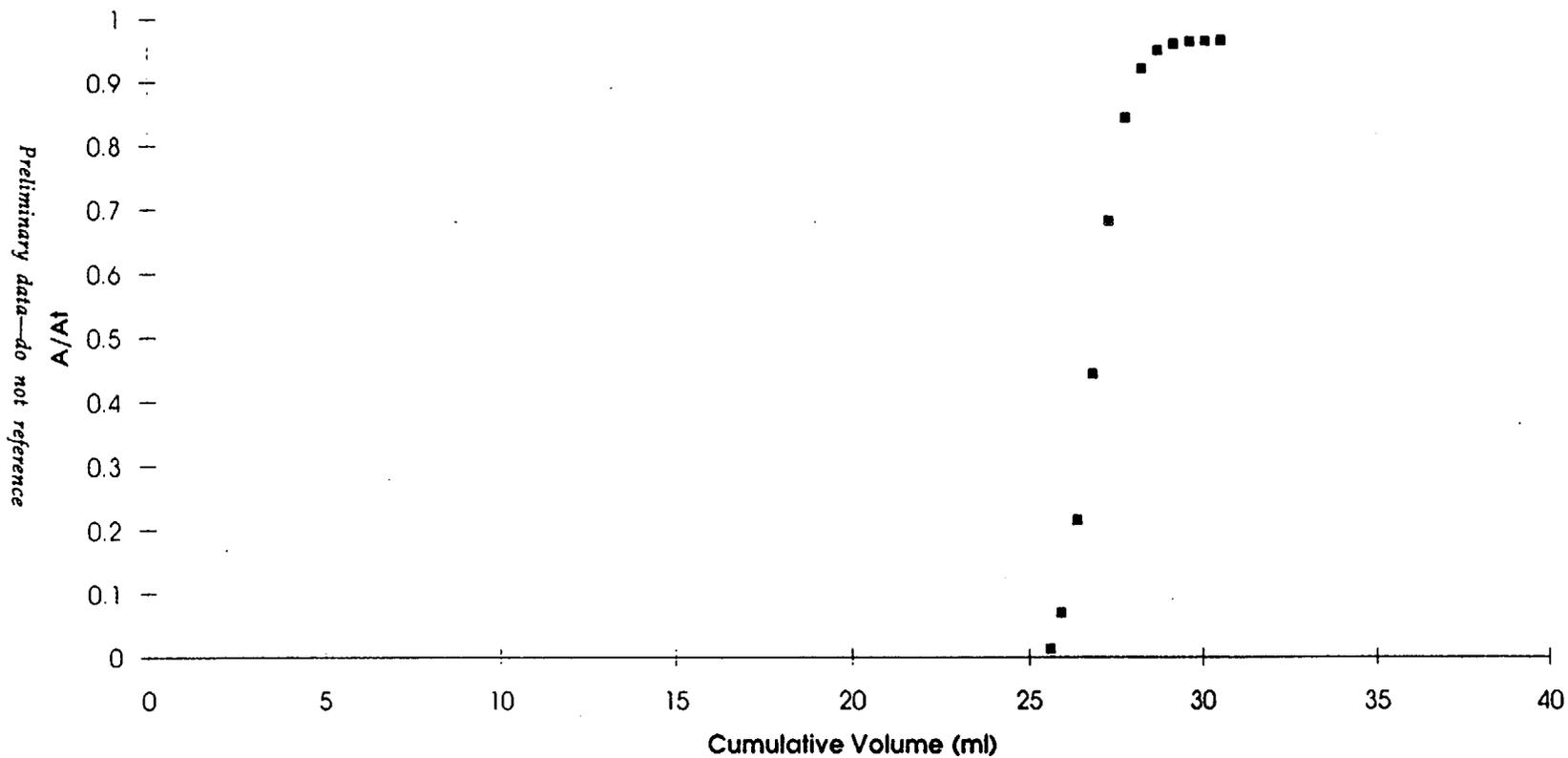


Figure (3)

HTO Elution Through Column G4-275E



Milestone Progress

3040

30 September 1992

Kinetics of Sorption on Columns of Pure Minerals

3044

31 August 1992

Letter Report on Assessment of Available Techniques for Unsaturated Column Transport Experiments

In preparation.

3027

31 March 1992

Report on Sorption by Batch and Column Techniques

Publications

I. R. Triay

Radionuclide Migration in Tuff under Diffusive Conditions

Conference Paper, *Proceedings of the Migration '91, Jerez de la Frontera, Spain, 14-18 October 1991*

In preparation.

I. R. Triay, A. J. Mitchell, and M. A. Ott

Radionuclide Migration Studies for Validating Sorption Data—Past, Present, and Future

Conference paper, *Proceedings of the DOE/Yucca Mountain Site Characterization Project Radionuclide Adsorption Workshop at Los Alamos National Laboratory September 11-12, 1990. (LA-12325-C, 1992)*

Approved by YMPO; in press.

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	<p>QA and Programmatic. Certification of TRACRN continued. Modifications were made to the Software Design Document, the Models and Methods Summary, and some software prologs in response to RIDS generated as part of the design phase baseline.</p> <p>Verification of TRACRN continued. The code compares well with analytic and other numerical solutions we used for the verification exercise, and these comparisons are being documented in the Verification and Validation Report. The user's manual is nearly complete.</p> <p>Certification of FEHMN and GZSOLVE continued. G. Zyvoloski is working with B. Robinson and Z. Dash (C-Wells Reactive Tracer Task) on documentation and verification of these software applications.</p>
Planned Activities	Continue certification of TRACRN. The design phase baseline will be resubmitted in early August.
Problem Areas	None
Milestone Progress	<p>3052 31 July 1992 <i>Baseline Documentation for TRACRN</i></p>
Publications	<p>K. Birdsell, K. Eggert, and B. Travis <i>Three-Dimensional Simulations of Radionuclide Transport at Yucca Mountain</i> Journal article, <i>Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project</i> Revised version submitted to YMPO.</p> <p>K. Birdsell, K. Campbell, K. Eggert, and B. Travis <i>Sensitivity Analysis of Integrated Radionuclide Transport Based on a Three-dimensional Geochemical/Geophysical Model</i> Conference proceedings, <i>Proceedings of the DOE/Yucca Mountain Site Characterization Project Radionuclide Adsorption Workshop at Los Alamos National Laboratory September 11-12, 1990.</i> (LA-12325-C, 1992) In press.</p>

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	<p>E. Springer reviewed a draft report of the June meeting of Joint Geochemistry Integration Team and Hydrology Integration Task Force (HITF) on 9 July in Denver.</p> <p>E. Springer attended the HITF meeting on 28 July in Albuquerque, NM. The task force made a recommendation concerning testing in the large hydraulic gradient area at Yucca Mountain, which will be formally submitted to the Project Office.</p> <p>E. Springer provided input from this study for a presentation at a meeting on performance assessment and testing.</p>
Planned Activities	Continue to develop study plan.
Problem Areas	None
Milestone Progress	No FY91 milestones.
Publications	<p>C. Loeven <i>A Summary and Discussion of Hydrologic Data from the Calico Hills Nonwelded Hydrogeologic Unit at Yucca Mountain, Nevada</i> (LA-12376-MS, 1992) LA-series report In press.</p>

WBS 1.2.5**Regulatory and Institutional****Objective**

The purpose of this task is to coordinate the regulatory and institutional 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 and institutional framework.

Management and Integration

Grading package for Groundwater Chemistry Modeling was submitted as a result of the DOE audit. Other change requests for rock varnish dating were processed.

Staff made a significant effort to prepare the Erosion topical papers. The "old" data was reviewed by DOE contract staff and was found to be in conformance with applicable Los Alamos QA and technical procedures. It appears that this review will provide sufficient evidence that these data are qualified.

Study Plans

Water Movement Test, R1 (8.3.1.2.2.2). R1 has been approved by DOE but not by NRC. A revision incorporating NRC and State of Nevada comments was submitted to the YMPO on 17 October 1991. Comments are being addressed.

Diffusion Test in the Exploratory Studies Facility, R0 (8.3.1.2.2.5). This study plan was approved by the YMPO and DOE/HQ in May 1992.

Testing of the C-Hole Sites With Reactive Tracers, R1 (8.3.1.2.3.1.7). In February 1990 DOE/HQ issued this study plan as a controlled document; it was then sent to the NRC for comments. In January 1992 we were requested by DOE to revise NRC comments. The revision is in progress.

Groundwater Chemistry Modeling, R0 (8.3.1.3.1.1). In March 1991 this study plan was submitted to the project office for review. Comments were returned 31 July 1992, and are now being addressed.

Mineralogy, Petrology, and Chemistry of Transport Pathways, R3 (8.3.1.3.2.1). In August 1990 the NRC approved the study plan. In October 1991 we were asked to revise the study plan; in January 1992 we submitted revised comments to T. Bjerstedt.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). The Project Office approved the study plan in December 1991 and submitted it to the NRC in January 1992 for comments.

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). A comment resolution meeting for DOE/HQ and Project Office comments was held in March 1990; revision on this activity has been deferred because funds have not been allocated.

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). A new study plan has been issued for internal review.

Biological Sorption and Transport, R1 (8.3.1.3.4.2). Revisions incorporating DOE/HQ and Project Office comments were submitted in May 1991. Additional revised text were submitted in August 1991.

Dissolved Species Concentration Limits, and Colloid Formation and Stability, R0 (8.3.1.3.5.1; 8.3.1.3.5.2). In November 1990 the project office submitted comments to Los Alamos to revise; that revision is in progress.

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). A comment resolution meeting for DOE/HQ and Project Office comments was held in August 1990; revisions are in progress and are expected to be completed by June 1992.

Diffusion, R0 (8.3.1.3.6.2). A comment resolution meeting for DOE/HQ and Project Office comments was held in August 1990; revisions are in progress and are expected to be completed by August 1992.

Retardation Sensitivity Analysis, R0 (8.3.1.3.7.1). A revision incorporating DOE/HQ and Project Office comments was submitted in June 1991. In October additional comments were received from SAIC, P. Cloke. The comments have been addressed and were submitted to the P. Cloke in March 1992.

Demonstration of the Applicability of Laboratory Data to Repository Transport Calculations, R0 (8.3.1.3.7.2). This study plan is in preparation.

Gaseous Radionuclide Transport Calculations and Measurements, (8.3.1.3.8.1). Funds have not been allocated.

Probability of Magmatic Disruption of the Repository, R0 (8.3.1.8.1.1). This study plan was approved by the Project Office in September 1990 and by the NRC in October 1991.

Physical Processes of Magmatism and Effects on the Potential Repository, R0 (8.3.1.8.1.2). Study plan is complete and has been issued for internal review.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). Accepted by NRC in September 1990.

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

Continued to develop Tracers, Fluids, and Materials (TFM) information program consistent with plan issued by Project (YM 91-23).

Supported M&O efforts to develop a position paper on prototyping; developed input for the position paper and participated in meetings.

Prepared briefings for biweekly ESF management meeting. Attended biweekly ESF division meetings. Participated in ESF excavation and testing planning meeting.

Reviewed Title II design, Package 1A.

Planned Activities

Continue to develop design-related information for launch-chamber tests.

Continue to support integration meetings with representatives of ESF design, TIG, Sample Management Facility, and surface-based testing.

Support ESF division effort to develop rationale and justification for the need to have a prototype test facility for Yucca Mountain.

Support ESF budget options and strategies.

Develop interfaces for testing and the ESF design.

Revise and update PSAR as required.

Begin to identify YMPO integrated data system planning.

Develop new networks for ESF testing.

Prepare abstract for waste management conference.

Problem Areas

None

Milestone Progress

No milestones for FY91.

Publications

None

July 1992

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**

This activity has been deferred.



Reynolds Electrical & Engineering Co., Inc.

Post Office Box 98521 • Las Vegas, NV 89193-8521

9 9 25 AM '00

I-331650

IN REPLY REFER TO:
580-01-649

WBS 1.2.9.1
QA: N/A

September 4, 1992

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

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP) STATUS REPORT

Attached is the August YMP Status Report for Reynolds Electrical & Engineering Co., Inc.'s participation in the YMP.

If further information is required, please contact Sandra L. Hughes at 794-7192.

R. F. Pritchett, Manager
Yucca Mountain Project Division
YMP Technical Project Officer

RFP:SLH:mab

Enclosure
Status Report (3 pages)

cy: See page 2

*See Gertz (e)
See Distribution
List (YMP)
Brodsky
Jones, S.
Waters
Stuckert*

9/9/92

TOTAL QUALITY IS OUR BUSINESS

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Carl P. Gertz
580-01-649
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September 4, 1992

cy w/encl.

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~~L. M. Smith, DOE/NV, M/S 505~~
~~M. B. Blanchard, DOE/YMP, M/S 523~~
~~U. S. Clanton, DOE/YMP, M/S 523~~
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B. R. Gardella, REECo, M/S 408
W. J. Glasser, REECo, M/S 408
J. L. Henze, REECo, M/S 751
R. B. Land, REECo, M/S 585
T. M. Leonard, REECo, M/S 408
K. L. Limon, REECo, M/S 408
C. J. Mason, REECo, M/S 751
S. O. Straub, REECo, M/S 408
J. R. Trujillo, REECo, M/S 590
R. A. Adams, SAIC, M/S 517
M. Brodeur, SAIC, M/S 517/T-23
R. D. Hutton, SAIC, M/S 517
S. C. Smith, SAIC, M/S 517/T-10
J. W. Teak, SAIC, M/S 517
J. E. Therien, SAIC, M/S 517
R. S. Saunders, W, M/S 517/T-24



REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
(REECO)

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP)

AUGUST 1992 - STATUS REPORT

Reeco has no reportable Level 0 or Level 1 Milestones.

SITE (1.2.3)

WBS 1.2.3.2

Task: Fran Ridge Test Pits (Job Package 92-7)

Began field activities in the north pit by mobilizing, mucking, scaling, rock bolting, and drilling the first vee-cut round.

WBS 1.2.3.5

Task: Capital Equipment to support Drilling Programs

Procurement is in process for the following drilling support equipment: Cuttings/handling system, hydraulic casing jacks and bag house, drill rig to replace the Joy 1. The Request for Proposal (RFP) 3-DH-92 for the replacement drill rig was sent out to eleven prospective offerors with a closing date of August 13, 1992. No proposals were received. The RFP was amended with a closing date of September 16, 1992. Received Sutorbilt blower during this period.

Task: Neutron Access Holes (Job Package 91-9)

Commenced operations on August 3, 1992, on Phase II of the Neutron Access Boreholes. To date, three of the twelve holes, UZ-N63, UZ-N33 and UZ-N34 have been completed. Initiated preparation of UZ-N31 and UZ-N32 drill pads and access. Access road to UZ-N31 and UZ-N32 is tentatively scheduled for completion on September 1, 1992.

Task: North Portal Drill Hole and Surface Facility Test Pits (Job Package 92-2)

Resumed activity with mobilization and commenced pavement clearing up slope of drill pad.

Task: UZ-16 Drilling and Testing (Job Package 92-3)

Drilling operations were temporarily suspended on August 27, 1992, due to equipment failure. The #1 Allison transmission on the LM-300 drill rig has been removed and transported to the Detroit Diesel/Allison facility in Las Vegas for repairs or replacement. Turnaround time for repairs or replacement has not been determined at this time. Present depth of the core hole is 673 feet; depth of the 12 1/4-inch reamed hole is 639 feet.

Overheating of the Haz-Vac unit's engine continues to present a problem on warmer days. Efforts to obtain a larger radiator have been unsuccessful. A 16,000 cfm evaporative cooler for auxiliary cooling has been ordered to eliminate downtime.

Task: Midway Valley Trenching (Job Package 92-5)

No field activity during this period.

Task: Quaternary Faulting (Job Package 92-12)

Mobilized and began field activities. Completed pavement clearing on the west flank of Busted Butte; excavated trenches in Crater Flats.

EXPLORATORY STUDIES (1.2.6)

WBS 1.2.6.1

Task: Exploratory Studies Facility (ESF)

Source Evaluation Board continued evaluation of the proposals submitted for the Technical Support and Underground Excavation for the ESF.

FIELD OPERATIONS (1.2.7.4)

Task: Administrative & Maintenance Support

Earthquake damage in July to the Site Office, Building No. 4015, was extensive; because of funding limitations, only minor cleanup was accomplished to meet minimum safety requirements.

Continued support to W. A. Wilson, Yucca Mountain Site Manager, to include: processing of purchase requisitions for Field Operations Center (FOC) Site Office requirements; providing support services to participants and maintenance on YMP utilized facilities, equipment and roads in Area 25; and providing logistical and support services to management contractor.

Provided support for the Yucca Mountain Site Office open house and public tours. Nine tours were held during this period with 177 people attending. Support included but was not limited to; arrangements for buses, registration of guests, coordination of lunches/beverages, medical service, furniture, mechanical service and grading of access road. Continued preparations for upcoming tours.

PROJECT MANAGEMENT (1.2.9)

WBS 1.2.9.1

Task: Management and Administrative Support

Continued coordination and staffing of YMP displays at meetings, exhibits, conferences and tours; staffed and supported the Public Reading Room of the Research and Study Center.

Task: Site Characterization Plan (SCP) Distribution

Two SCP sets were distributed during this period.

Task: Long Range Planning (LRP)

Continued status and update of Planning and Control System (PACS); reviewed output data for Mission 2001 schedule; completed cost estimates as required.

WBS 1.2.9.3

Task: Quality Assurance (QA)

Received and accepted an action plan from the YMP Division to correct significant document control deficiencies identified on Correction Action Report (CAR) CA-92-002. The CAR identified the following problems:

- 1) outdated and superseded documents were not removed and destroyed;
- 2) subsequent revisions were not transmitted to the original document holder;
- and 3) no procedure existed to control the internal distribution of Job Packages, Drawings and Specifications. Actions to correct the CAR are scheduled to be completed by November 1, 1992.

Received guidance from DOE/YMP regarding establishment and implementation of a first line Quality Control Inspection Program for ESF by REECo/YMP.

Significant training deficiencies documented on CAR CA-92-001 were successfully resolved and verification completed as scheduled.



Lawrence Livermore National Laboratory

LLYMP9209044
September 15, 1992

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

GERTZ (2)
DYER (BLANCHARD)
SIMONKA/HARRISON
JOHNSON/SIMMONS
JOHNSON - 2/0
BLUDSKY
BUAK
SUNES-S
DIXON

WBS 1.2.9
"QA: N/A"

I-332151

9-15-92

SUBJECT: Yucca Mountain Project Status Report -August 1992
SCP: N/A

Attached is the August 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 FTS 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.

LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
AUGUST 1992 TECHNICAL HIGHLIGHTS AND STATUS REPORT
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LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)
YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT

AUGUST 1992

EXECUTIVE SUMMARY

(Items Proposed for Reporting in YMPO or OGD Reports)

- 1) **WBS 1.2.1.4.2 (Waste Package Performance Assessment)**. A revised algorithm for checking compliance with NRC radionuclide release rate limits was implemented and tested. This algorithm implements the 10 CFR 60 peak annual release limits.
- 2) **WBS 1.2.2.2.1 (Chemical and Mineralogical Properties of the Waste Package Environment)**. Scoping calculations are being conducted that link the results of thermal-hydrological calculations to fluid-rock interaction. Specific regimes were identified in which particular equilibrium conditions could be recognized. These early calculations suggest that chemical equilibrium will be approached in regions near the waste package.
- 3) **WBS 1.2.2.3.1.1 (Spent Fuel Testing)**. A series of short term oxidation scoping experiments on Gd-doped unirradiated UO_2 and spent fuel were performed to determine the parameters for next year's dry bath tests. The Gd bearing fuel oxidized to U_4O_9 similar to spent fuel (not to U_3O_7 like unirradiated UO_2). The rate of oxidation decreased with increasing Gd content. The amount of Gd used in these experiments ranged from the amount of fission products in current spent fuel to the higher values expected from future high-burnup fuels that use burnable poisons. These scoping experiments support the earlier evidence that suggests fission products may be responsible for the stabilization of the UO_2 matrix against oxidation.
- 4) **WBS 1.2.2.2.2 (Hydrologic Properties of the Waste Package Environment)**. Thermal-hydrological calculations have been conducted for comparison with prior calculations using LLNL-Engineering and SNL codes. For comparison purposes, these calculations apply the thermal conductivity (K_{th}) value of the TSw2 to the entire unsaturated zone. Since this value is much larger than the value of adjacent far-field units, their insulating value is less than in these simplified calculations, and the duration of boiling is reduced about 50% from the more realistic calculations. Comparison with similar calculations at SNL and LLNL-Engineering indicate that the three codes agree within about 10% for both peak temperatures and duration of boiling. These calculations also point out that, for long term boiling performance, the depth of the repository appears to be optimal, with the highest thermal conductivity in the near-field (limiting peak temperatures) and lower thermal conductivity in the far-field (insulating the repository).

5) **WBS 1.2.2.2.2 (Hydrologic Properties of the Waste Package Environment).** Sensitivity analyses have been conducted for hydrothermal calculations of repository performance at Areal power densities (APDs) of 20 to 114 kW/acre and spent fuel ages of 30 and 60 yr. The independent variables were thermal conductivity, bulk permeability, recharge flux, and the treatment of the saturated zone. For thermal conductivity, the calculations were updated using values from RIB Version 4, and boiling durations increased by 17 to 30% while peak temperatures did not change significantly. For permeability, boiling was suppressed for a non-fractured value, and conduction was dominant (vapor buoyancy was not a significant factor) when a value of $2.8 \times 10^{-13} \text{m}^2$ (3-100 μm fractures per meter) was used. For recharge values of 0 mm/yr (initial repository saturation of 68%) and 0.132 mm/yr (initial 95% saturation), the boiling duration did not change, but the peak temperatures decreased for the higher recharge value due to the heat capacity of the initial saturation. Finally, when conduction and convection (including buoyancy flow) were included in the upper 1000 m of the saturated zone, the boiling durations nearly doubled while peak temperatures were not affected.

6) **WBS 1.2.2.2.2 (Hydrologic Properties of the Waste Package Environment).** Refluxing of water has been suggested as a mechanism that can heal fractures and alter the hydrology of the mountain. Refluxing was examined at low heat loads and for extended dry scenarios. At the lowest thermal loading (20 kW/acre, 30-yr old fuel), the refluxing at the repository horizon is about five times higher than the ambient refluxing driven by the existing geothermal gradient. At 36 kW/acre of 30-yr old fuel (the same waste distribution as the SCP-CD reference case of 57 kW/acre of 10-yr old fuel), the refluxing is about 90 times higher than ambient refluxing. For extended dry scenarios, post-boiling refluxing at the repository horizon will be precluded by lack of moisture until late times, when the temperature gradients are substantially reduced.

1.2.1 SYSTEMS

1.2.1.1 Management and Integration

1.2.1.2 Systems Engineering

1.2.1.2.4 Systems Engineering Implementation

D. Ruffner and T. Buscheck provided input to and reviewed the Phase I draft of the thermal loading study being led by M&O-Vienna. J. Blink attended a meeting of the report authors in Las Vegas on August 19.

1.2.1.2.5 Configuration Management and Plans and Procedures Control

No significant activities.

1.2.1.2.6 YMP Support to Management Systems Improvement Strategy

No significant activities.

1.2.1.3 Technical Data Base Management

1.2.1.3.5 Technical Data Base Input

No significant activities.

1.2.1.4 Performance Assessment

1.2.1.4.2 Waste Package Performance Assessment

A revised algorithm for checking compliance with NRC radionuclide release rate limits was implemented and tested. This algorithm implements the 10 CFR 60 peak annual release rate limits.

A draft of the PANDORA theoretical manual was completed.

The Individual Software Plan (ISP) for PANDORA Version 1.1 development was released as an LLNL-YMP controlled document.

1.2.1.4.5 Geochemical Modeling and Data Base Development

The first of the four geochemical code user manuals entitled "EQ3/6, A Software Package for Geochemical Modeling of Aqueous Systems: Package Overview and Installation Guide, Version 7.0, Part I" by T. Wolery has completed technical review and was sent to YMPO for programmatic approval on July 30. The second and third geochemical code user manuals are being revised by the author to incorporate the technical review comments. Review is underway for the last user manual.

The structural modification of the GEMBOCHS database was completed and all data were transferred into the new table structure. This update facilitates significantly improved performance of dependent software such as DBAPP and D0OUT. Modification of D0OUT was initiated as required by structural modification of GEMBOCHS.

Local beta testing of CNGBOCHS continued, and several modifications were incorporated as a consequence of this testing.

The most recent version of the EQ3/6 software package and a set of the pre-release code manuals were transmitted to Dr. A. Meijer of LANL. Problems identified with the version of EQ3/6 ported to the Iris Indigo workstation at LLNL were resolved.

An Individual Software Procedure (ISP) was completed and approved for Maintenance, Code Release and Documentation of EQ3/6 Version 7. A separate ISP was completed and approved for Initial Qualification of EQ3/6 Version 7. An ISP will be prepared next month for all activities pertaining to Version 8. If the necessary funding is received, development of Version 8.0 will begin at the start of FY93.

Input was provided to G. Heitland (SAIC) for the GEMBOCHS chapter of the YMP-TDB handbook which is to be published this fall.

The OCWRM audit of LLNL-YMP on August 10-14 reviewed geochemical code maintenance and the supporting database. The audit evaluated a variety of issues related to record management of changes and developments. No findings were issued in this area. J. Johnson presented a talk entitled "The GEMBOCHS Database and Software Library: Overview of Contents, Components, and Applications" to the auditors and observers from the NRC, NV, and OCRWM.

Corrective action in response to CAR-LLNL-16 was completed by incorporating all known bug fixes regarding EQ3/6 Version 7.0 into a Version 7.1, using the approved configuration management system. A letter concerning this matter and a set of floppy disks containing Version 7.1 have been transmitted to all YMP parties who earlier received Version 7.0 or Version 7.0x. Version 7.0x was the major focus of the CAR. Version 7.1 also contains the new set of data files (R15).

Corrective action in response to CAR-LLNL-17 was completed by inventorying records and submitting all inactive records to the LRC. Active records not submitted are less than one year old.

1.2.1.4.7 Supporting Calculations for Postclosure Performance Analyses

This WBS element has not been funded in FY92.

1.2.2 WASTE PACKAGE

1.2.2.1 Management and Integration

W. Halsey, D. Wilder, W. Clarke, R. Stout, J. Blink, T. Buscheck and D. Ruffner participated in the Thermal Workshop held in Las Vegas on August 20-21.

T. Quinn consulted with the LLNL-YMP QA manager on proposed changes to the Software Quality Assurance Plan and several Technical Implementing Procedures (TIPs). Comments on the latest proposed YMP software requirements were submitted to the LLNL-YMP QA manager.

1.2.2.2 Waste Package Environment

Conceptual design began for a large-block (3-5 m sides) laboratory test of coupled thermal-hydrological-mechanical-geochemical-corrosion phenomena. A proposal for this test will be submitted to YMPO next month.

1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment

Attempts to model the coupling of fluid-rock interaction with hydrological properties continued, with emphasis on identifying specific regimes within which particular equilibrium conditions could be recognized. These early calculations suggest that chemical equilibrium will be approached in regions near the waste

package. Initial runs with EQ3/6 to consider precipitation and dissolution effects on pore and fracture properties were started.

The review comments for the geochemistry Study Plan were fully incorporated in the text of the Study Plan. However, although a draft of the revised Study Plan is near completion, consideration is being given to preparing a more thoroughly revised version that more accurately reflects the current plans for the work in this task. The Study Plan, originally written in 1986, is incomplete and out-of-date, and needs to be thoroughly overhauled.

A paper by B. Viani and C. Bruton entitled "Modeling Fluid-Rock Interaction at Yucca Mountain, Nevada: A Progress Report" was approved by YMPO and will soon be published.

1.2.2.2 Hydrologic Properties of the Waste Package Environment

Model Calculations

Code-to-Code Comparisons:

Repository thermal calculations using heat conduction models have been conducted by three groups (LLNL-Hydrology, LLNL-Engineering and SNL). The LLNL-Engineering and SNL groups have assumed that the thermal conductivity (K_{th}) for TSw2 can be applied to the entire unsaturated zone (UZ). However, K_{th} (both wet and dry values) for TSw2, are twice as large as the wet K_{th} value for the nonwelded PTn and CHnv units and the welded CHnz, and nearly four times larger than the dry K_{th} value of the CHnz. Therefore, assuming the TSw2 K_{th} can be applied to the entire UZ substantially under-represents the insulating effect of the lower K_{th} values of the far-field units. LLNL-Hydrology calculations (assuming that the TSw2 K_{th} values apply to the entire UZ) found that the duration of boiling decreases by 50% relative to the case with the RIB Version 4 K_{th} distribution. For 30-yr old fuel and an Areal power density (APD) of 114 kW/acre, the duration of boiling decreases from 6500 to 3200 years. The three most similar calculations (114, 102 and 100 kW/acre) by the three groups agreed within about 10% for both peak temperature and boiling duration when the temperature rise was scaled to the heat load. For long-term boiling performance, the depth of the repository appears to be optimally located with the highest K_{th} being in the near-field (providing for limiting peak temperatures), and the lowest K_{th} being in the far-field (insulating the repository, thereby extending the duration of boiling).

Sensitivity Analyses:

Several suites of scoping calculations were conducted that systematically examined the sensitivity of the hydrothermal performance of the UZ to four drivers: thermal conductivity (K_{th}), bulk permeability (k_b), recharge flux, and the treatment of hydrothermal flow in the saturated zone (SZ). APDs of 20 to 114 kW/acre were used with 30 and 60-yr old fuel.

In past calculations, the thermal conductivity values were used from the Reference Information Base (RIB) Version 3. In the latest calculations, a suite of cases was run using RIB Version 4 values of K_{th} . Because Version 4 values are generally lower, all of the Version 4 cases have longer boiling periods. For example, the calculated duration of the boiling period (t_{bp}) for 30-yr old fuel with an APD of 57 kW/acre increases from 1800 to 2100 years. For 30-yr old fuel and an APD of 114 kW/acre, t_{bp} increases from 5000 to 6500 years and for 60-yr old fuel and an APD of 114 kW/acre, t_{bp} increased from 10,000 to 13,000 years. While the duration of boiling increases, the peak temperatures for the Version 4 cases do not increase. Although K_{th} for many of the units (the nonwelded units in particular) are smaller in Version 4, the dry K_{th} of the TSw2 (the repository horizon), is significantly greater than in Version 3. Therefore, the relative changes in K_{th} (Version 4 versus Version 3) tend to reduce the far-field heat loss outside of the boiling zone (thereby prolonging the duration of boiling), but allowing for greater heat dissipation within the dry-out zone (thereby reducing the peak temperatures in the near-field).

The sensitivity of hydrothermal performance was examined at a range in bulk permeability from $1.9 \times 10^{-18} m^2$ (no fractures) to $2.8 \times 10^{-13} m^2$ (3-100- μm fractures per meter). When no fractures are present, there is no significant boiling because the small matrix permeability results in very large gas-phase pressure gradients, resulting in an elevated boiling point. Therefore, matrix-only flow is associated with completely conduction-dominated flow with no boiling effects, resulting in somewhat higher peak temperatures than the case with fracture flow and significant boiling effects. In contrast, if buoyancy does not significantly affect the mass flow of vapor (see last month's report), the duration of boiling is insensitive to the presence or absence of fractures. When buoyancy dominates vapor flow, both peak temperatures and the duration of boiling conditions are somewhat reduced. For $k_b = 2.8 \times 10^{-13} m^2$, the local boiling pressure gradients dominate far-field buoyancy, resulting in conduction-dominated heat flow for both 57 and 114 kW/acre of 30-yr old fuel using RIB Version 4 values of K_{th} .

The sensitivity of hydrothermal performance was examined at a range of net recharge flux from 0 mm/yr (resulting in an initial repository saturation of 68%) to 0.132 mm/yr (95% initial saturation) using the RIB Version 4 values of K_{th} . In spite of the much wetter initial saturation distribution in the high net recharge case, the duration of boiling is the same as the zero net recharge case. The high net recharge case is associated with lower peak repository temperatures due to the higher initial heat capacity of the partially saturated rock.

In all of the calculations to date, the water table has been treated as being at a fixed depth and at a constant temperature. This assumption causes the saturated zone to act both as a heat sink and a reservoir of liquid for rewetting the dry-out zone. The impact of this assumption was examined by including the upper 1000 m of the SZ in the model. Heat conduction as well as convection, including buoyancy flow, are modeled in the SZ. For all of the cases considered (20 to 114 kW/acre, 30 and 60-yr old fuel), the treatment of the water table and SZ has very little impact on peak repository temperatures. Beyond 1000 years (after temperatures have peaked), the SZ begins to heat up, thereby becoming less of a heat sink. Consequently, the

duration of boiling substantially increases, particularly for higher thermal loading conditions. For 30-yr old fuel and an APD of 57 kW/acre, t_{bp} increases from 2100 to 3500 years. For 30-yr old fuel and an APD of 114 kW/acre, t_{bp} increases from 6500 years to 11,500 years.

Calculations for low thermal loads which do not result in boiling are also affected by the treatment of the SZ. For 30-yr old fuel and an APD of 20 kW/acre, hydrothermal flow in the SZ extends the duration of time the repository is above 50°C from 2200 to 3600 years and extends the duration of time the repository is above 40°C from 5060 to 14,150 years.

Refluxing:

The impact of low thermal loads (resulting in sub-boiling conditions) on repository-heat-drive refluxing was examined. Even for sub-boiling conditions, repository-heat-driven refluxing will be significant for tens of thousands of years. Under ambient conditions, the geothermal gradient drives ambient refluxing even if the net flow of moisture is zero. Depending on what is assumed for naturally-occurring net recharge flux, repository-heat-driven condensate drainage (and the ambient refluxing) will probably be the dominant sources of liquid flux in the UZ.

For 30-yr old fuel and an APD of 36 kW/acre (the same waste package spacing as the reference SCP-CDR case of 57 kW/acre with 10-yr old fuel), the average temperature at the center of the repository peaks at 90°C. Although boiling temperatures never occur, repository-heat-driven refluxing results in as much as 1 mm/yr of liquid flux at the repository horizon (90 times the ambient refluxing). For 30-yr old fuel and an APD of 20 kW/acre, repository-heat-driven refluxing is at least five times larger than ambient refluxing. Therefore, boiling conditions are not required to generate significant vapor-phase and liquid-phase flux due to repository heating. Because sub-boiling conditions will also not mitigate the occurrence of episodic meteoric sources of deep nonequilibrium fracture flow, hydrologic assessments of low thermal loading conditions must account for the superposition of naturally-occurring episodic fracture flow and repository-heat-driven refluxing for essentially all the time of regulatory concern.

In general, two conditions are required to generate sub-boiling refluxing: Liquid water and sufficient thermal gradients. There are significant differences between refluxing which occurs under thermal loading associated with sub-boiling conditions and refluxing in an extended dry scenario. Because of the long lag in rewetting of the dry-out zone subsequent to long-term boiling, the repository horizon will have minimal liquid saturation for tens of thousand of years. By the time enough liquid water returns to the repository horizon to allow refluxing, the temperature gradients will have declined, and the potential for repository-heat-driven refluxing will be substantially reduced. However, because low thermal loads are associated with negligible dry-out, sub-boiling refluxing will be facilitated by the availability of liquid water during the time that temperature gradients are steepest. Therefore, at the repository horizon, post-boiling period refluxing for high thermal loads (which generate substantial dry-out) will probably be much less than the sub-

boiling refluxing associated with low thermal loads (which generate negligible dry-out).

Impact of Heat on the Saturated Zone:

Work began to examine the impact of repository-heat-driven hydrothermal flow on the hydrology and geochemistry of the SZ. It was found that there is a significant temperature rise in the upper SZ even for the lowest thermal loads. For 30-yr old fuel and an APD of 20 kW/acre, the upper SZ peaks at 46.9°C (16.5°C above ambient) at 6900 years and remains above 40°C for 26,350 years. Therefore, there is the potential for repository-heat-driven hydrothermal-geochemical alteration of the upper SZ even for low thermal loads. Work will soon begin to conduct preliminary scoping calculations of the potential of such alteration. For 30-yr old fuel and 114 kW/acre, the upper SZ peaks at 90°C at 830 years, remains above 90°C for 670 years, and remains above 70°C for 12,400 years.

Laboratory Experiments

The determination of the characteristic curves of the eight disc-type Topopah Spring tuff samples from the U3hg-1 hole at a depth of 1312 feet and the five Grouse Canyon tuff samples from G-Tunnel continued. A room-temperature constant humidity chamber was used. Measurement for the imbibition phase up to 98% relative humidity at 20°C has been completed. The samples are in the draining phase at a relative humidity of 85%.

The feasibility study to measure relative humidity in laboratory rock samples continued with the calibration of the resonant cavity.

The feasibility test of measuring suction potential vs saturation in rock at high temperature by the gas displacement method continued. Work continues to improve the experimental setup.

A sample holder was designed for measuring electrical resistivity as a function of moisture content at elevated temperatures. The purpose of the measurement is to generate calibration curves of electrical resistivity of Topopah Spring tuff samples with respect to moisture content so that the laboratory and field determined resistivity can be interpreted with respect to degree of water saturation. Four specimens of Topopah Spring tuff have been machined, and the porosities of the specimens have been determined. The ends of the specimens are being coated with gold to be used as electrodes for the electrical resistivity measurement.

Model Development & Documentation

S. Daveler made several enhancements to EXTPOOL including the addition of a new macro button which displays a window with two new command buttons. The first new capability maps the duration of time for which certain threshold conditions are exceeded. Data are examined between successive snapshots at a location to determine if a specified threshold is exceeded, and the time of threshold crossing is calculated. When the value at that location drops below the threshold, the second

crossing time is calculated. For instance, if one is interested in the duration of fracture flow conditions which are generated by condensate drainage during repository-heat-driven boiling and dry-out, the duration of fracture flow conditions throughout the unsaturated zone can be contoured to indicate the potential for hydrothermal-geochemical alteration of fracture pathways. The second new command added to EXTOOL allows scaling of specified time history data by addition, subtraction, multiplication and division.

T. Quinn has been assisting in conducting calculations on the Open Computing Facility (OCF) IBM workstations and the National Energy Research and Supercomputing Center (NERSC) Crays. Because of frequent difficulties with both of these timesharing systems, considerable time and effort have been required to achieve throughput. The NERSC Crays, in particular, have provided intolerable turnaround time due to the ineffective timesharing algorithm in their UNICOS operating system. Purchase of dedicated workstations is being considered to improve throughput.

T. Quinn completed the Individual Software Plan (ISP) to qualify the V-TOUGH code for quality affecting activities. The ISP was modified to reflect recent changes in the Software Quality Assurance Plan (SQAP). The ISP has been signed by the LLNL-YMP Software Quality Assurance manager and is now being processed by the LLNL-YMP QA manager.

Meetings

T. Buscheck attended the INTRAVAL meeting at LBL on August 24 to discuss the model validation test case using data from neutron holes N54 and N55.

1.2.2.2.3 Mechanical Attributes of the Waste Package Environment

A final draft was prepared for Study Plan 8.3.4.2.4.3, "Characterization of the Geomechanical Attributes of the Waste Package Environment" with all comments being resolved from both YMPO and OCWRM. This draft was submitted to YMPO and several other changes were suggested by the M&O. These changes are being incorporated.

Input was provided for the Large Block Testing proposal.

1.2.2.2.4 Engineered Barrier System (EBS) Field Tests

D. Wilder, W. Lin and J. Blink participated in the ESFTC meeting in Las Vegas on August 18.

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

This WBS element has not been funded in FY92.

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

Work has been completed on the month-long uranium dissolution experiments which test using single crystal UO_2 at room temperature in buffer solutions saturated with 20% oxygen in argon. The results show good agreement with PNL's spent fuel data and with the UO_2 powder experiments performed at both PNL and LLNL.

Guidance was received by PNL from DOE-RL to provide spent fuel Approved Test Materials (ATMs) to ANL. DOE-NV had previously committed the funds to perform the transfer. The confirmation of NEPA compliance requirements is proceeding for the requested work.

Flow-through testing of the approved test matrix is progressing normally. Some of the tests use spent fuel specimens at reduced oxygen fugacities, and other tests use partially oxidized spent fuel fragments approximately 1 mm in size. The latter tests were completed.

Installation of BET surface area apparatus in the hot cell has been placed on hold until next year (FY93).

Spent Fuel Oxidation

An interim examination was conducted of the dry bath testing at PNL. A preliminary examination of the data revealed no surprises. The part time maintenance and calibration of the system is being conducted prior to restart.

A series of short term oxidation scoping experiments on Gd-doped unirradiated UO_2 and spent fuel were performed to determine the parameters for next year's dry bath tests. The Gd bearing fuel oxidized to U_4O_9 similar to spent fuel oxidation (not to U_3O_7 like unirradiated UO_2). The rate of oxidation decreased with increasing Gd content. The amount of Gd used in these experiments ranged from the amount of fission products in current spent fuel to the higher values expected from future high-burnup fuels that use burnable poisons. These scoping experiments support the earlier evidence that suggests fission products may be responsible for the stabilization of the UO_2 matrix against oxidation.

Materials Characterization Center (MCC) Hot Cell Activities

The report "Spent Fuel Acquisition Plan" has been reviewed by LLNL, and comments are being incorporated into the final draft.

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 336 weeks. The N3 tests (ATM-10, a West Valley actinide-doped glass) continue and have been in progress for 254 weeks.

1.2.2.3.2 Metal Barriers

A draft summary of the corrosion of weathering steels was prepared and provided to the M&O design team. LLNL is leading a task team on corrosion; the team is one several discipline-oriented teams summarizing issues needing to be resolved in order to make a thermal loading decision.

1.2.2.3.3 Other Materials

This WBS element has not been funded in FY92.

1.2.2.3.4 Integrated Testing

1.2.2.3.4.1 Integrated Radionuclide Release

B. Viani attended a meeting on August 24 in Las Vegas and presented a summary of work related to characterization of natural colloids in Nevada Test Site (NTS) waters. Other presentations by B. Delakowitz (Technical University of Munich, Germany), I. Triay and E. Springer (LANL), E. Nuttall (UNM), and W. Steinkampf (USGS) also focused on colloids and their role in radionuclide transport. Other attendees were H. Nitsche and C. Carnahan (LBL), J. Stuckless (USGS), R. Levich and A. Simmons (YMPO).

On August 26, B. Viani met with I. Triay, (LANL), A. Simmons, (YMPO), M. Siegel (SNL) and W. Steinkampf (USGS) to plan and organize a workshop to focus on the role of colloids in the transport of radionuclides in a potential repository at Yucca Mountain. A tentative agenda was developed, and prospective speakers are being invited.

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

Work continued on the exposure of alpha particle sensitive film to core wafers.

Interactions of Actinide-bearing Solutions with Rock Core Samples

The plumbing of the flow-through system in Bldg. 281 was completed. The flow-through apparatus was tested at room temperature using a core with a "saw cut" fracture. A two order of magnitude decrease in permeability occurred and may be due to bacterial fouling during storage of the wet core. Samples were taken of the

outflow fluid to look for evidence of bacterial growth. The core will be disassembled, and further examination will continue. The upstream and downstream teflon valves proved to be too pliable to maintain a steady flow rate in the system. Gold-plated stainless steel valves will be used in the next test. The tests will be continued next month at elevated temperatures.

Source Term Development

Work continued on adsorption of uranium on goethite at elevated temperatures.

1.2.2.3.4.2 Thermodynamic Data Determination

This WBS element has not been funded in FY92.

1.2.2.3.5 Nonmetallic Barrier Concepts

This WBS element has not been funded in FY92.

1.2.2.4 Design, Fabrication, and Prototype Testing

1.2.2.4.1 Waste Package Design

This WBS element has not been funded in FY92.

1.2.2.4.2 Container Fabrication and Closure Development

This WBS element has not been funded in FY92.

1.2.2.4.3 Container/Waste Package Interface Analysis

D. Ruffner, W. Clarke, W. Halsey, D. Wilder, R. Stout, T. Buscheck and J. Blink attended the YMPO Thermal meeting in Las Vegas on August 20-21 to define the method and time table to settle thermal issues. Many of the issues addressed tie very closely with the thermal calculations being done at LLNL. Several task teams were formed to summarize issues needing resolution prior to specifying repository thermal loading.

A code-to-code verification exercise was completed. One run from SNL, one run using the LLNL-Engineering code TOPAZ, and one run using the LLNL-Hydrology V-TOUGH code were compared. The runs used 30-yr old spent fuel, thermal loadings of 100 and 114 kW/acre, and homogenous rock properties (the entire mountain at TSw2 properties). After the results were scaled to a common thermal loading of 100 kW/acre, the temperature was plotted as a function of time, and the results were within a 10% band. The agreement is even closer at late times.

1.2.5 REGULATORY AND INSTITUTIONAL

1.2.5.2 Licensing

1.2.5.2.1 NRC Interaction Support

W. Clarke, J. Blink and R. Stout attended the planning meeting in Las Vegas on August 21 for the October NWTRB meeting.

1.2.5.2.2 Site Characterization Program

LLNL staff continued to support the Integrated Test Evaluation (ITE) task. M. Revelli participated in the August 5-6 ITE meetings in Las Vegas, during which presentation materials were completed and reviewed for a YMPO briefing to OCRWM on the ITE task. The core team completed a formal assessment of trade-off weights for Criterion #1 (Suitability of the Site), Criterion #2 (Regulatory Compliance), and Criterion #3 (Scientific Confidence). Most efforts focused on the preparation and review of a draft report/notebook documenting the approach and results of the ITE task. M. Revelli also participated in the August 26-27 meeting where this material was discussed.

1.2.5.2.4 Technical Support Documentation

No significant activities.

1.2.5.2.5 Study Plan Coordination

No significant activities.

1.2.5.2.6 Semi-Annual Progress Reports

No significant activities.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management and Integration

1.2.9.1.1 Management

LLNL-YMP received a plaque from YMPO recognizing its safety program accomplishments.

The LLNL provided a response to the GAO audit to YMPO. Specific examples of Internal Research and Development-funded products directly benefiting nuclear waste-fund activities were cited.

The LLNL TPO's response to the LLNL-YMP Management Assessment was provided to the LLNL-Energy Program Leader and YMPO.

LLNL and YMPO conducted a (LESSON) workshop for 19 Clark County teachers August 3-13. LESSON is a program to train K-8 teachers to present science in an inspirational hands-on style. The workshop culminated in a tour of the NTS and Yucca Mountain. Instructors and coordination were provided by LLNL, YMPO, SAIC, RSN, and B&W/M&O.

J. Blink attended an Advanced Communications Workshop conducted by D. Valentine in Las Vegas on August 26. J. Blink completed the GET-1.5 refresher test on August 31.

J. Blink and J. Maduell (an LLNL technical artist) visited Yucca Mountain and the NTS P-Tunnel on August 27 to gather information for a new repository rendering.

R. Sandifer and H. Benton of the M&O visited LLNL on August 27 and were briefed on LLNL's technical activities.

1.2.9.1.4 Records Management

Document Control issued eleven new documents and thirteen Change Notices under controlled distribution. Routine follow-up for receipt acknowledgments continues.

A total of 204 items were logged into the LLNL-YMP tracking system. This includes 47 records/records packages that were processed through to the CRF. Fourteen action items were closed.

Records staff personnel are conducting a records inventory and expect completion by September 18. All on and off-site controlled documents are also being inventoried to complete a Correction Action.

1.2.9.2 Project Control

The July FTE report was submitted to YMPO. The July actual schedule progress and costs to the PACS reporting system was submitted via PACS workstation.

The August cost plan was prepared. Inputs were completed for the Information Resources Long Range Plan.

A cost-to-close report by 5th and 6th level WBS was produced. The analysis is continuing to refine and update year end costs and budgets. Recommendations were made to the LLNL TPO for adjusting budgets, and a request was made to YMPO to redistribute funds among the current WBS budgets.

Efforts were initiated to convert LLNL activities to the new WBS structure. Conversion of old cost accounts, PACS accounts and worksopes are being coordinated with internal systems and YMPO. The effort will be completed during the last week of September.

The OCWRM audit of LLNL-YMPO on August 10-14 examined the procurement process within the Project Control area. No findings or recommendations were recorded within the procurement area.

D. Stahl and R. Fish of the M&O visited LLNL on August 17-18 to continue the Mission 2001 budget scrubbing process. Corrections were made to several WBS elements.

1.2.9.3 Quality Assurance

LLNL-YMP was audited by OCWRM Office of Quality Assurance (YMP-92-21) during the week of August 10-14. The audit team found the LLNL QA Program to be effectively implemented in the areas examined. Five minor CARs were issued.

Surveillance Reports S92-07 "Flow-through Dissolution Tests on Spent Fuel and UO2", S92-08 "Hydrologic Properties of the Waste Package", and S92-010 "Activities Associated with the Development of the PANDORA Computer Code" were issued.

Responses to CARs YM-92-048 and YM-92-049 resulting from the YMPO Surveillance YMP-SR-92-018 were transmitted to YMPO.

LLNL-CARs-015, -016, and -017 were verified, closed, and transmitted to YMPO. LLNL-CARs-020, -021, -022, -023, and -024 were issued.

Responses were sent to YMPO on comments to the sections of the Qualified Suppliers List (QSL) that pertain to LLNL.

SIP-NF-1, Rev. 1 "Initial Engineered Barrier System Field Tests" was resubmitted to YMPO for review and approval. It replaces an earlier submission that had not completed the review cycle. This document was resubmitted to correct terminology and to separate the grading package from the plan.

Quality Assurance Program Plan Change Notice R 2-0-4 "Quality Assurance Program" was issued and transmitted to YMPO for review and approval.

The following Individual Software Plans were issued:

- 1) ISP-NF-01,
- 2) ISP-NF-07, and
- 3) CN-SP-NF-06-0-1.

The following procedures/revisions were issued:

- 1) 033-YMP-QP 2.1, Rev. 4 "Preparation, Approval, & Revision of Procedures, Requirements, Plans, and the Quality Assurance Program Description",
- 2) 033-YMP-QP 4.1, Rev. 2 "Preparation of QA Requirements Specifications and Approval of Subcontractor QA Programs",
- 3) 033-YMP-QP 12.0, Rev. 3 "Control of Measuring and Test Equipment", and
- 4) 033-YMP-QP 18.2, Rev. 2 "Qualification of Quality Assurance Audit Personnel".

Quality Procedure Change Notices 2.8-2-3 "Quality Assurance Grading", 3.0-2-3 "Scientific Investigation Control", and 4.0-3-1 Procurement Document Control" were issued. CN-SQAP-0-2 was issued.

LLNL PROJECT STATUS REPORT DISTRIBUTION

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