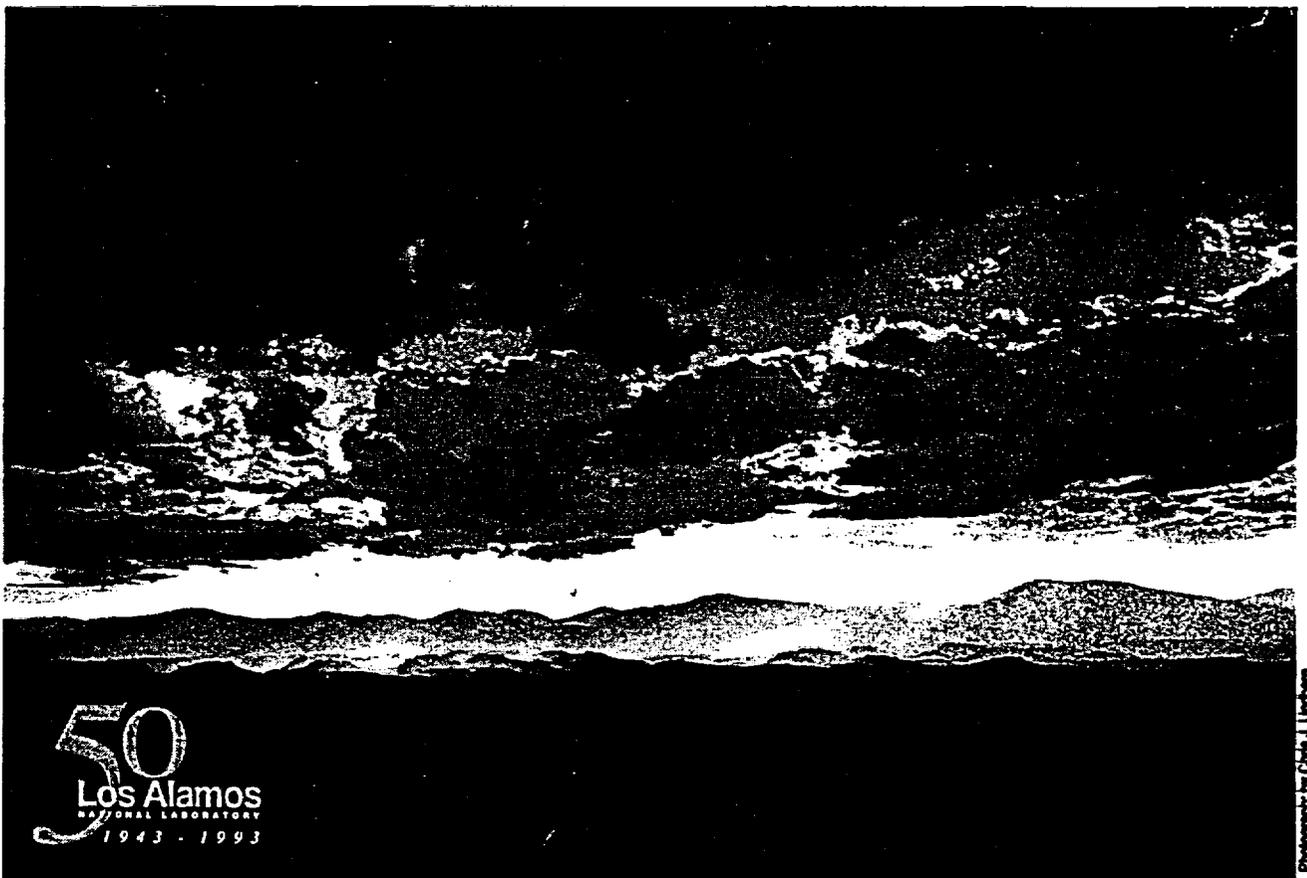


Yucca Mountain Site Characterization Project

Monthly Activity Report

May 1993



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Attachment to TWS-EES-13-07-93-024

CONTENTS

WBS 1.2.1	Systems Engineering (Canepa)	1
WBS 1.2.3.1.1	Site Investigation Coordination and Planning/Site Management (Canepa)	2
WBS 1.2.3.1.2/3	Site Investigation Coordination and Planning/Test Management and Integration (Oliver) ...	3
WBS 1.2.3.2.1.1.1	Mineralogy, Petrology, and Rock Chemistry of Transport Pathways (Bish)	4
WBS 1.2.3.2.1.1.2	Mineralogic and Geochemical Alteration (Levy)	7
WBS 1.2.3.2.1.2	Stability of Minerals and Glasses (Bish)	9
WBS 1.2.3.2.5	Postclosure Tectonics (Crowe)	10
WBS 1.2.3.2.8.1	Rock-Varnish Dating Support for USGS Neotectonic Studies (Harrington)	12
WBS 1.2.3.3.1.2.2	Water-Movement Tracer Tests (Fabryka-Martin)	13
WBS 1.2.3.3.1.2.5	Diffusion Tests in the ESF (Triay)	14
WBS 1.2.3.3.1.3.1	Site Saturated Zone Ground-water Flow System (Robinson)	15
WBS 1.2.3.4.1.1	Ground-water Chemistry Model (Ebinger)	17
WBS 1.2.3.4.1.2.1	Batch Sorption Studies (Triay)	18
WBS 1.2.3.4.1.2.3	Sorption Models (Rogers)	21
WBS 1.2.3.4.1.2.2	Biological Sorption and Transport (Hersman)	22
WBS 1.2.3.4.1.3	Radionuclide Retardation by Precipitation Processes (Morris)	24
WBS 1.2.3.4.1.4	Radionuclide Retardation by Dispersive, Diffusive, and Advective Processes (Triay)	28
WBS 1.2.3.4.1.5.1	Retardation Sensitivity Analysis (Zyvoloski)	31
WBS 1.2.3.4.1.5.2	Demonstration of Applicability of Laboratory Data (Springer)	33
WBS 1.2.5.2.2	Site Characterization Program (Canepa)	34
WBS 1.2.5.3.5	Technical Database Input (Hyer/Eckhardt)	36
WBS 1.2.5.4.6	Development and Validation of Flow and Transport Models (Springer)	38
WBS 1.2.5.4.7	Supporting Calculations for Postclosure Performance Analyses (Zyvoloski)	39
WBS 1.2.6	Exploratory Studies Facility (Elkins)	40
WBS 1.2.6.8.4	Integrated Data System (Elkins)	41
WBS 1.2.9.1.2	Technical Project Office Management (Canepa)	42
WBS 1.2.9.2.2	Project Control (Pratt)	43
WBS 1.2.11.2/3/5	Quality Assurance Program Development, Verification, and Engineering (Bolivar)	44
WBS 1.2.12.2/5 1.2.13	Local Records Center Operation/Records Management, and Documentation Control (Pratt)	45
WBS 1.2.15.2	Administrative Support (Pratt)	46
WBS 1.2.15.3	Training (Pratt)	47

LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Monthly Activity Report
May 1993

WBS 1.2.1

Systems Engineering

Objective

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

**Activities and
Accomplishments**

S. Levy met with other SCP Thermal Goals Working Group team leaders in Las Vegas. D. Bish prepared an evaluation of existing SCP thermal goals. Based on geochemical considerations, he recommended that some of the goals be modified.

May 1993

**WBS 1.2.3.1.1 Site Investigation Coordination and Planning/
Site Management**

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

Activities and Accomplishments Staff attended the International Colloid Workshop held 3-5 May in Santa Fe, NM. Staff supported the workshop by moderating a session on Performance Assessment and by participating in the concluding panel discussion.

Staff attended the Technical Advisory Group meeting on 14 May.

Staff was briefed by J. Poths on the progress of the Quaternary dating method of ^3He - ^4He , and the FY93 and FY94 plans were reviewed.

Staff worked with all principal investigators and technical coordinators to develop input for the FY94 Site Characterization Annual Plan.

**WBS 1.2.3.1.2/3 Site Investigation Coordination and Planning/
Test Management and Integration**

Objective	The objective of this task is to manage and integrate Exploratory Studies Facility (ESF) and Los Alamos site characterization test activities and to provide coordination for Los Alamos surface-based test planning and package development.
Activities and Accomplishments	<p>Surface-Based Test Coordination. Staff represented the Test Coordination Office at weekly surface-based testing meetings; developed an alternative version of AP-5.21Q, "Field Work Activation"; and provided working copies of AP-5.21Q to YMPO.</p> <p>Continued to support activities pertaining to the use of Tracers, Fluids, and Materials (TFM) at Yucca Mountain. Continued to develop of the Los Alamos TFM database and TFM evaluations for waste isolation impact and test interference impacts. Supported M&O-led effort on establishing/revising thermal goals for the repository.</p> <p>Continued support of sample collection in the SRG-5/SD-11 borehole by the Los Alamos Water-Movement Tracer Tests task.</p> <p>B. Carlos represented the principal investigators at the 5 May Sample Overview Committee meeting. All requests for existing core, including UE25 UZ-16 and USW NRG-6 were approved. Carlos attended an additional SOC meeting held in Las Vegas on 18 May to discuss proposed changes to AP-6.4Q.</p> <p>ESF Testing. Staff provided multi-shift field coordination and PI support for ESF north-ramp starter tunnel tests, including the newly approved test, Consolidated Sampling. Staff completed a test planning and job package for consolidated sampling in the ESF north-ramp starter tunnel. Staff initiated formal planning on Phase 3 ESF tests (Hydrochemistry, Radial Boreholes, and Hydrologic Properties of Major Faults).</p> <p>Construction of the ESF starter tunnel continued. Geologic mapping, consolidated sampling, and construction monitoring activities proceeded as planned; no perched water was identified this month.</p>
Planned Activities	Continue support of Los Alamos surface-based site characterization activities and ESF test coordination in response to Project programmatic requirements.
Problem Areas	None

May 1993

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

Work began on the 59 core specimens from UE-25 UZ-16, which we received from the Sample Management Facility; the first step will be to analyze bulk powders using XRD. These specimens originated at the surface down to the quartz-lattice caprock of the Topopah Spring Member, and from the basal vitrophyre of the Topopah Spring Member into the Calico Hills Formation. We have requested samples from the rest of the core and from Core NRG-6. Results of sample analyses from these two cores will provide us with necessary mineralogical information for sections associated with the eastern imbricate fault zone and the northern boundary of the potential repository, respectively.

Specimens were prepared for more detailed mineralogical and chemical study of the clays obtained from deep exposures at the portal for the ESF north-ramp starter tunnel.

B. Carlos examined fractures in the Tram Member of UE-25b #1h and USW G-3 at the SMF on 5-6 May.

R. Raymond continued SEM investigations of the cause of the bleached zones found adjacent to lithophysal fractures and cavities. He also obtained results of chemical analyses of clinoptilolite and stellerite from fractures and is analyzing additional samples to fill gaps in the data on XRD of fracture coatings.

A paper entitled "The Importance of Zeolites in the Potential High-Level Radioactive Waste Repository at Yucca Mountain, Nevada" by D. Vaniman and D. Bish was prepared for the Zeolite '93 Conference in Boise, Idaho, 21-25 June. The authors evaluated the role of zeolites in retardation of migrating radioactive waste, site thermal loading, and site hydrology. D. Bish, B. Carlos, and S. Chipera were also preparing papers for this conference. S. Chipera prepared an abstract on XRD analysis of zeolites and clays for presentation at the Clay Minerals Society annual meeting in September.

Planned Activities

Investigation of the alteration phenomena around lithophysal zones will continue in an attempt to understand the processes controlling the leaching and the potential for similar leaching of rocks adjacent to the potential repository horizon.

Crushing and separation of magnetic minerals for characterization of the trace mineral contents of Yucca Mountain tuffs will continue.

Several staff will complete papers for the Zeolite '93 meeting.

Preparation and analysis of the aeolian dust samples collected from the Yucca Mountain area in February will continue. Samples will be analyzed by XRD and SEM. Additional samples will be collected and analyzed.

Work planned within the next few months also includes the following activities:
(1) continue analysis of calcites to understand transport and precipitation mechanisms;
(2) examine drill core from USW UZ-14 as it becomes available at the SMF;
(3) analyze samples from UE-25 UZ-16 and USW NRG-6 for studies of stratigraphic variability in bulk mineralogy; (4) continue statistical evaluation of X-ray powder diffraction quantitative mineral analysis; (5) complete "field guide" to fracture-lining minerals.

Problem Areas None

Milestone Progress

3152
30 September 1993
Report on Statistical Analysis of Chemical and Mineralogical Data

3352
31 March 1993
Fibrous Minerals at Yucca Mountain
Submitted to TPO on 16 April 1993; preparing requested revisions.

3353
30 September 1993
Characterization of Airborne Minerals at UZ-16

3360
30 April 1993
Calcite Deposits in Fractures at Yucca Mountain, Nevada
Completed.

3364
30 September 1993
Distribution of Fracture-Lining Zeolites at Yucca Mountain, Nevada

3365
30 September 1993
Equilibrium Modeling of the Formation of Zeolites in Fractures at Yucca Mountain, Nevada

3369
30 September 1993
Field Guide to Fracture Lining Minerals at Yucca Mountain

4013
30 April 1993
Preliminary Description of Fracture-lining Minerals in Drill Cores UE-25 UZ-16
Completed.

Publications

D. L. Bish
The Importance of Zeolites in a Potential High-Level Waste Repository at Yucca Mountain, Nevada
Conference abstract, *Zeolites '93*
In press.

D. Broxton
Geological Evaluation of Six Nonwelded Tuff Sites in the Vicinity of Yucca Mountain, Nevada, for a Surface-based Test Facility for the Yucca Mountain Project. (3137)
LA-series report
In press.

B. Carlos, D. Bish, S. Chipera, and S. Craven
Fracture-Lining Manganese Oxide Minerals in a Silicic Tuff
Journal article, *Chemical Geology*
In press.

B. Carlos, S. Chipera, and D. Bish
Distribution of Fracture-Lining Zeolites at Yucca Mountain, Nevada
Conference abstract, *Zeolite '93*
In press.

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

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

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

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

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

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>A paper entitled "Pedogenesis of Siliceous Calcretes at Yucca Mountain, Nevada" by D. Vaniman, S. Chipera, and D. Bish was revised following external review and will appear in the journal <i>Geoderma</i>. This paper describes the use of mineralogy, geochemistry, and microfossil analysis in determining the origins of calcretes such as those exposed in Trench 14 near Yucca Mountain. An abstract entitled "Combined Quantitative-XRD and Chemical Evaluation of Soil Formation at Yucca Mountain, Nevada" by the same authors was prepared for the 1993 Clay Minerals Society annual meeting in September. The abstract summarizes progress in using data from quantitative XRD and chemical analysis to trace the dissolution reactions that have occurred in soils at the surface of Yucca Mountain, with implications for the evolution of recharge-water chemistry. G. WoldeGabriel is completing a paper on K/Ar dating of zeolites in the Southwest for <i>Zeolite '93</i>.</p> <p>S. Levy toured the N-Tunnel area at Rainier Mesa with Los Alamos staff and representatives of the ESF wall mappers. The purpose of the tour was to examine flowing fractures and faults—features that may be encountered in the ESF. We were also interested in examining fluid gels that had been observed in this tunnel in the past. It was not possible to visit any of the reported gel locations because they were in unstable areas that were sealed off.</p> <p>Levy also participated in a mapping and sampling session in the ESF north-ramp starter tunnel; samples were collected from the first 35 feet of the tunnel.</p>
Planned Activities	<p>We will be doing more work related to reformulation of SCP thermal goals and revisions to the draft paper on calcite-silica deposits. Sample collection from the north-ramp starter tunnel will continue on a periodic basis.</p> <p>The steam-heating experiments will continue, and the samples will be examined for mineralogical changes on a periodic basis. Chemical and mineralogical characterization of samples of bedrock breccias and hydrothermal deposits exposed at the surface will continue, as will calcite-silica laminated deposit studies.</p>
Problem Areas	None
Milestone Progress	<p>3138 30 September 1993 <i>Chemical Transport in Zeolitic Alteration</i> Research 60% complete; postponed because of attention to Milestone 3381.</p> <p>3142 31 January 1993 <i>K/Ar Dating of Clays and Zeolites</i> Submitted to TPO.</p> <p>3343 30 September 1993 <i>Zeolite Dating</i></p>

May 1993

**Milestone Progress
(cont.)**

- 3150
30 July 1993
*Final Report on Bedrock
Research 60% complete.*
- 3361
30 September 1993
Thermal Behavior of Natural Zeolites
- 3378
30 June 1994
Chemical Alteration of Calico Hills Tuff During Zeolitization (outside publication)
- 3381
30 September 1993
*Natural Alteration in Topopah Spring Tuff as an Analog to Waste-Repository
Hydrothermal Regime*
- 4012
30 September 1993
*Chemical Alteration of Calico Hills Tuff during Zeolitization
(letter report, input to Milestone 3378)*

Publications

- D. L. Bish and D. T. Vaniman
Thermal Behavior of Natural Zeolites
Conference abstract, *Zeolites '93*
In press.
- D. Bish and J. Aronson
*Paleothermal and Paleohydrologic Conditions in Silicic Tuff from Yucca Mountain,
Nevada*
Journal article, *Clay and Clay Minerals*
Submitted to *Clay and Clay Minerals*.
- S. Levy
*Surface-discharging hydrothermal systems at Yucca Mountain -- examining the
evidence (3341)*
Proceedings paper, *Materials Research Society Fall Meeting*
Published.
- 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.
- D. Vaniman, D. Bish, and S. Chipera
Dehydration and Rehydration of a Tuff Vitrophyre
Journal article, *Journal of Geophysical Research (3143)*
Approved by YMPO.
- D. Vaniman, S. Chipera, and D. Bish
Pedogenesis of Siliceous Calcretes at Yucca Mountain, Nevada (3141)
Journal article
Approved by YMPO.

WBS 1.2.3.2.1.2 Stability of Minerals and Glasses

Objective

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

Activities and Accomplishments

No activity reported during this period.

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

The revised version of Study Plan 8.3.1.8.1.2 was submitted to YMPO.

Staff continued to conduct field studies at the Lathrop Wells volcanic center. Shallow trenches were dug to permit tracing of tephra deposits exposed in the south quarry wall. We were able to trace a young sequence of reworked (aeolian reworking) tephra that overlies the southern spatter mounted at the base of the main cone. New exposures of fall deposits, which we infer are from the main cone, were also examined. We found that 1- to 2-meter-thick tephra deposits overlie bedrock exposures of the Topopah Springs member approximately 1 kilometer south of the main cone.

Field sites for trenching of the Quaternary basalt centers were examined at the Little Cones, Red Cone and Black Cone centers in Crater Flat and flagged for final environmental surveys.

Field work was conducted at the Lucero and Rio Puerco volcanic fields in west-central New Mexico to search for possible basalt centers for studies of the subsurface structure of feeder systems and the distribution and depth derivation of lithic fragments. Five candidate sites were identified for further study on the basis of suitability of underlying stratigraphy, range of eruptive mechanisms, and accessibility.

Work in Progress. Geologic samples stored at the University of New Mexico were packaged and shipped to the Sample Management Facility. Samples collected for Study Plan 8.3.1.8.1.2 were transferred, logged, and stored at a secure site at Los Alamos.

Comments on the "Volcanism Status Report" were received from several reviewers.

A planning meeting was held in preparation for the NRC Technical Exchange on 9 June in Las Vegas.

Exploratory statistical analyses of trace element data for the Lathrop Wells volcanic center continued. Cluster analysis of tephra samples indicated that the samples group into subclusters that correspond closely to the volcanic units classified from field and chronology studies.

Along with representatives of the DOE and support contractors, we examined the trench site at Hidden Cone. Those present decided that construction of a road to bring equipment to the site will not be necessary.

Planned Activities

We will participate in an NRC technical exchange on geophysics and volcanism studies in June 1993.

Staff will be preparing several talks for presentation at the Focus'93 meeting in Las Vegas in September.

Field mapping of the Q_s vents will be conducted at the Lathrop Wells volcanic center.

Problem Areas

We are concerned because we have not received results of XRF sample analyses for samples submitted early in FY 1992.

Milestone Progress 3075
30 September 1993
Preliminary Geologic Mapping of Volcanic Centers

3129
30 September 1993
Geochemistry of Lathrop Wells (part of 3252)

3252
30 September 1993
Volcanism Status Report
First draft in technical review.

Publications B. M. Crowe et al.
Volcanism Status Report
First draft in technical review.

WBS 1.2.3.2.8.1 Rock-Varnish Dating Support for USGS Neotectonic Studies

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

Activities and Accomplishments Field activities were carried out along the Windy Wash, Stagecoach Road/Paintbrush Canyon, and Solitario Canyon faults. These studies included: (1) mapping the prominent scarps occurring along the faults and associated Quaternary deposits and land forms, (2) reconstructing the Late Quaternary processes by which the scarps have evolved to their present form, and (3) determining if the length of time of their surface exposure may be able to be determined by cosmogenic dating of the scarps.

Planned Activities Continue the mapping of geomorphic features associated with the scarps that yield information as to the process and time of their formation. Continue the scoping study to ascertain the usefulness of cosmogenic dating to determine the age of these scarps.

Problem Areas None

Milestone Progress None

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

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, completed processing a suite of 19 cutting samples from UZ-16 for chlorine-36 analysis; these samples came from depths ranging from the surface down to 1171 ft below ground. Three ground-water samples from the Amargosa Desert were also processed for chlorine-36 analysis. Unfortunately, because of budget constraints, only about half of the samples will actually be submitted for chlorine-36 analysis this year; the remainder will be archived for analysis next fiscal year.</p> <p>J. Fabryka-Martin presented a talk to staff at the Sample Management Facility on an initial interpretation of results of the surface-based borehole sample analysis.</p> <p>A request was submitted to the Sample Overview Committee for collection of ream-bit cuttings from SRG-5.</p>
Planned Activities	Revise existing DPs; prepare new DPs; process soil samples for Cl/Br and chlorine-36/Cl ratios; process cutting samples from UZ-16 and neutron-access boreholes; participate in planning activities for sample collection from ESF; 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 Complete</p> <p>3362 30 September 1993 <i>Summary of Cl-36 Work</i></p>
Publications	None

May 1993

WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF

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

Activities and Accomplishments This task has been deferred because of lack of funding.

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

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

Activities and Accomplishments Software QA. B. Robinson continued to serve as CCB Chair, and Z. Dash continued to serve as a member of the CCB. A draft of the FEHMN SRS was completed and submitted for review.

Colloid Transport. We began testing dissolved tracers and microsphere tracers in a specimen of fractured Bandelier tuff as a precursor to experiments in C-Wells fractures. Preliminary results indicated that the microspheres chosen for their favorable transport characteristics indeed do move readily through the fracture sample. The fracture aperture is on the order of 25 μm ; microspheres of 0.3- and 1- μm diameters transported with nearly identical breakthrough curves. Furthermore, the microspheres exhibited a slightly earlier first-arrival time and significantly lower dispersed breakthrough curves than dissolved iodide and fluorescein dye tracers. This behavior may be caused by a lack of matrix diffusion of the spheres relative to the dissolved tracers, as would be predicted based on the low diffusion coefficient of micron-sized particles compared to dissolved species.

Planned Activities Contribute to the SQA effort by serving as CCB Chair (B. Robinson).
Complete documentation of batch sorption experiments with lithium bromide.
Continue modeling studies using FEHMN to support the design of field tests.
Begin lithium column sorption experiments.
Continue flow and transport tests on the Bandelier tuff fracture to develop techniques for the C-Wells fractures; carry out scoping calculations to understand the behavior of the first set of transport experiments.

Problem Areas None

Milestone Progress 3188
31 March 1993
Documentation for SORBEQ
Submitted to TPO.

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

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

May 1993

**Milestone Progress
(cont.)**

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

3201
Preliminary Modeling Using FEHM
Completed.

3367
30 April 1993
Aperture Characteristics, Saturated Fluid Flow, and Tracer Transport Calculations for a Natural Fracture
Complete.

Publications

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

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

B. A. Robinson
A Strategy for Validating a Conceptual Model for Radionuclide Migration in the Saturated Zone Beneath Yucca Mountain (3201)
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special Issue on the Yucca Mountain Project*
Submitted to YMPO.

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

P. Reimus, R. Glass, and B. Robinson
Aperture Characteristics, Saturated Fluid Flow, and Tracer Transport Calculations for a Natural Fracture (3367)
Conference paper, *1993 High-Level Radioactive Waste Management Conference*
Published.

WBS 1.2.3.4.1.1 Ground-Water Chemistry Model

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

Activities and Accomplishments **Study Plan.** Staff continued to address reviewers' comments on the Ground-Water Chemistry Model Study Plan, R0. The revision is due on 30 September 1993.

Other Activities. Modeling of different radionuclides using compositions of ground-waters from Yucca Mountain continued. The highest Np and U concentrations were predicted in waters with the highest bicarbonate concentrations. EQ3/6 modeling confirmed the expected result, but there is still significant discrepancy between modeled and measured Np and U solubility. Next month we plan to incorporate solubility data on solid phases that are different than those contained in the EQ3/6 data base, which should reduce this discrepancy.

Modeling of pH and Eh stability continued. Tuffaceous and carbonate waters at Yucca Mountain appear well buffered by bicarbonate or carbonate, and the Eh is well poised, within oxidizing conditions.

Planned Activities Continue to resolve comments on the study plan.

Complete letter report on most active ground-water.

Continue discussions concerning water chemistry, stable isotope constraints on water composition, and the ground-water chemistry model. Possible analogs related to reaction paths of water in the Los Alamos are currently being considered as test cases for modeling that will be conducted at Yucca Mountain. Continued collaboration with the USGS is expected.

Problem Areas None

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

Publications None

WBS 1.2.3.4.1.2.1 Batch Sorption Studies

Objective

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

Activities and Accomplishments

Using tuff GU3-1394 particles in the size range of 75 to 500 μm , we continued to measure sorption of Np onto tuffs and pure minerals as a function of Np concentration, ground-water composition, and temperature. (Tuff GU3-1394 is composed of 1% quartz, 1% Opal-CT, 3% feldspar, and 95% glass.) We pretreated the solid phases in ground-water (J-13 or UE-25p #1) for two weeks, used centrifugation to separate the solid phases from the ground-water, and equilibrated these solids with 20 ml of Np solution in ground-water (J-13 or UE-25p #1). Following a three-week sorption period, the phases were separated again using centrifugation and we determined the quantity of ^{237}Np in each phase using liquid scintillation counting. The experimental results may be seen in Table I.

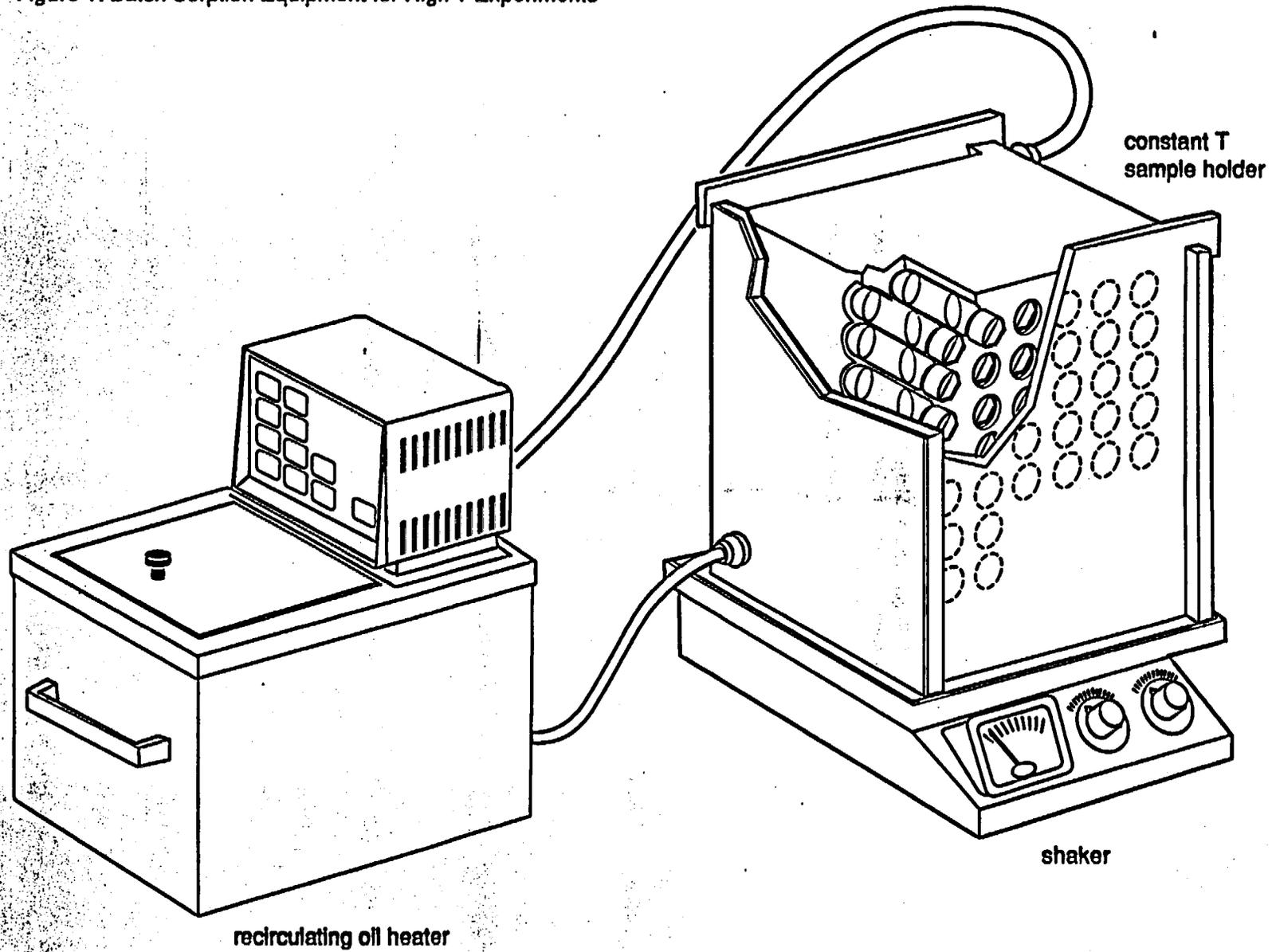
Table I. ^{237}Np Batch Sorption Coefficients (Kd, ml/g) in Tuff GU3-1394 at 20°C.

Ground-water type	Np Concentration			
	$6.0 \times 10^{-7} \text{ M}$	$6.8 \times 10^{-7} \text{ M}$	$1.3 \times 10^{-6} \text{ M}$	$1.4 \times 10^{-6} \text{ M}$
J-13		0.6	0.4	
UE-25p #1	0.8			1.

The results of these experiments seem to indicate that Np sorption onto tuff GU3-1394 is constant with Np concentration (which agrees with results reported for other tuffs in previous monthly reports). Glass doesn't appear to be a strong sorber for Np (which is consistent with our results for pure minerals presented in previous monthly reports). The sorption of Np onto GU3-1394 also seems to increase with an increasing amount of bicarbonate in the ground-water, which may indicate a surface complexation mechanism for Np sorption in which the neptunyl-carbonate complex participates.

We have designed new equipment to conduct batch sorption experiments at high temperature. (Fig. 1) This equipment consists of a metal rack kept at a constant temperature by a recirculating oil bath, which holds test tubes used for the batch sorption experiments. The rack is placed on top of a shaker that is used to equilibrate the solid and liquid phases. Next month, we will report on batch sorption experiments conducted at high temperature using this new design.

Figure 1: Batch Sorption Equipment for High T Experiments



Predecisional information—preliminary data—do not reference

May 1993

Planned Activities Continue work in all areas discussed above.

Problem Areas None

Milestone Progress

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

3345
30 June 1993
Neptunium Sorption onto Feldspar

3346
30 September 1993
Sorption as a Function of Temperature

Publications

P. S. Z. Rogers and A. Meijer
Dependence of Radionuclide Sorption on Sample Grinding, Surface Area, and Water Composition (3009)
Conference paper, 1993 *International High-Level Waste Management Conference*
Published.

WBS 1.2.3.4.1.2.3 Sorption Models

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

Activities and Accomplishments No activity reported this month.

Planned Activities No planned activity reported this month.

Problem Areas None

Milestone Progress 3347
30 September 1993
AFM Analysis of Hematite and Goethite

Publications None

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>Work continued on the mineral dissolution experiments at UC Berkeley. Growth curves for bacteria on various concentrations of ferric chloride were determined, and we found that concentrations of ferric chloride ranged from .016 μM to 10 μM. When compared to the growth curves of the same bacteria growing on hematite or goethite, those growth curves correspond to the growth curves obtained for a 2.0 μM ferric chloride concentration. This suggests that the organisms are able to solubilize Fe(III) at approximately that concentration. Experiments performed in 1991 demonstrated that the siderophore produced by this microorganism was by itself not capable of solubilizing Fe(III) from hematite.</p> <p>Another set of experiments has demonstrated that this bacteria (a <i>Pseudomonas</i> sp.) is not capable of using either Fe(III) or NO_3^- as a terminal electron acceptor, yet experiments performed last summer have shown that this bacteria produces extracellular reductases.</p>
Planned Activities	Continue dissolution experiments.
Problem Areas	None
Milestone Progress	<p>3080 30 September 1992 <i>Report on Chelation; Retitled Preliminary Evidence of a Siderophore Plutonium Complex</i> Completed; approved by YMPO on 18 April 1991.</p> <p>3092 30 September 1992 <i>Report on Colloidal Agglomeration</i> Draft completed. Milestone completion delayed until TPO decides on suitable publication vehicle. (Probably will be published as an LAMS report.)</p> <p>3176 30 September 1992 <i>Procedure for Determination of Formation Constants</i> Completed; submitted to QA Project Leader 26 February 1993. (Does not require DOE review.)</p> <p>3177 30 September 1992 <i>Procedure for Determination of Effects on Colloidal Agglomeration</i> Completed; submitted to QA Project Leader. (Does not require DOE review.)</p>

Publications

L. E. Hersman, P. D. Palmer, and D. E. Hobart
Preliminary Evidence of a Siderophore Plutonium Complex
Conference proceedings, *Proceedings of the Fall Meeting of the Materials Research Society*
Published.

L. E. Hersman
Report on Colloidal Agglomeration
LA-series report.
In preparation.

[The following text is extremely faint and largely illegible due to heavy noise and low contrast. It appears to be a technical report or abstract.]

[This section contains several lines of text, also illegible due to the same quality issues as the previous section.]

WBS 1.2.3.4.1.3 Radionuclide Retardation by Precipitation Processes

Objective

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

Activities and Accomplishments

Speciation. We began to study the stability constants of Np(V) and Np(VI) using Carbon-13 and Oxygen-17 NMR. New stock solutions of oxidation-state pure Np(V) and Np(VI) were prepared and characterized, and preliminary modeling of the Np solution was carried out to estimate an appropriate pH range. We also developed a working model for using carbonate/bicarbonate buffers to determine the true hydrogen ion concentration pH as a function of ionic strength, thereby removing the uncertainty associated with the need to know the activity coefficient in pH measurements. A more accurate determination of pH will allow direct curve-fitting and extraction of thermodynamic binding constants in Np experiments.

In our previous Uv/Vis absorption studies of the NpO_2^+ moiety, the solution systematically changed pH and (bi)carbonate concentrations at room temperature. This month, we extended at pH = 8.5 the bicarbonate concentration down to where only the putative singly coordinated species " $\text{NpO}_2(\text{CO}_3)^-$ " exists; this matches the upper end of the earlier study by Nitsche that reported the extremely low (bi)carbonate concentration reaction $\text{NpO}_2^+ \rightarrow \text{NpO}_2(\text{CO}_3)^-$. The Nitsche study indicates that the transition between the 980 nm NpO_2^+ and the 991 nm " $\text{NpO}_2(\text{CO}_3)^-$ " occurs at $[\text{HCO}_3^-] = 1 \times 10^{-3} \text{ M}$, while the present study indicates that the 991 nm " $\text{NpO}_2(\text{CO}_3)^-$ " to 996 nm " $\text{NpO}_2(\text{CO}_3)_2^{3-}$ " transition occurs at $[\text{HCO}_3^-] \approx 0.3 \text{ M}$ at pH = 8.5. Note that this latter transition previously had been reported to occur at $[\text{HCO}_3^-] \approx 0.03 \text{ M}$ in a solvent extraction experiment by Bidoglio (1985). The Np-carbonate species are shown in quotes to emphasize the possibility that they may exist as non-monomeric species.

We also began to examine the temperature dependence of the neptunyl-carbonate equilibria, initially with a pH = 8.5, $I = 1.0$, $[\text{HCO}_3^-] = 0.4 \text{ M}$, and $[\text{NpO}_2^+] = 40 \mu\text{M}$ sealed solution at 30, 55 and 80°C. To try to minimize the temperature-dependent absorbance of the O-H vibrational overtone at 974 nm, we remeasured the background at each temperature reading before taking the spectrum. Even this precaution yielded only marginal results, and we plan to try two further approaches: modification of the temperature control system to include the reference sample as well as the sample and the use of D_2O instead of H_2O , thereby red-shifting the overtone away from the spectral region of interest.

We are using PAS to measure the temperature dependence of the oxidation state and final $[\text{HCO}_3^-]$ of Pu-carbonate solutions.

Solubility. The Np undersaturation experiment at pH 6 in UE-25p #1 water was concluded this month. We found that the steady-state aqueous Np concentration was almost one order of magnitude lower than that obtained previously in the oversaturation experiment. We examined the soluble Np species using absorption spectrophotometry, and it appeared that a small fraction of the aqueous Np was complexed by carbonate. After examining the solids using XRD, we discovered that the solid obtained at the conclusion of the oversaturation experiment (i.e., the solid phase used to start the undersaturation experiment) was different from that obtained at the conclusion of this experiment, which may explain the lower solubility.

Activities and Accomplishments (cont.)

In the first undersaturation experiment at pH 6 (discussed in previous monthly reports), the aqueous Np concentration did increase to the steady-state obtained in the oversaturation experiment before the pH increased and the aqueous Np concentration decreased. When this happened, the undersaturation experiment was restarted by removing the solid phase and placing it in fresh UE-25p #1 water at pH 6. The x-ray powder pattern obtained from this second undersaturation experiment was different from both of those obtained in the pH 6 and 7 oversaturation experiments and contained almost twice as many diffraction lines.

Because the solid phase removed from the second undersaturation experiment remained in contact with UE-25p #1 water at pH 6 for nearly 600 days and exhibited lower solubility and a different powder pattern, we believe that a different, more crystalline solid phase was formed. We also believe that the solid may still be a ternary sodium neptunium carbonate, but with a more thermodynamically stable crystal lattice that would lead to lower solubilities in ground-waters.

Now that all undersaturation experiments in UE-25p #1 have been concluded, we are preparing new stock solutions of Pu and Am/Nd for use in oversaturation experiments in 0.1 M sodium perchlorate at 25°C. All experiments should be started by the end of June.

Conflict resolution according to LANL-YMP-QP-01.3, R1, is being sought in regard to Milestone 3329. An updated version of the revised report will be sent to a new, mutually agreeable reviewer as soon as this conflict is resolved. Attention continues to focus on submittal of historical scientific records from 1986-1989. Data reduction on these records has reduced the total page count from approximately 2000 pages to approximately 235 pages in six record packages. A complete list of accession numbers for Milestone 3329 has been compiled. Final corrections to Milestone 3030 were made and the milestone was sent to the Los Alamos TPO.

Planned Activities

Efforts in all above mentioned areas will continue.

Problem Areas

None

May 1993

Milestone Progress

3031

30 September 1992

Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies
Submitted to TPO.

3329

30 September 1992

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

3330

30 January 1993

Evaluation of Alternative Detection Schemes in Photoacoustic Spectroscopy
Submitted to TPO.

3344

30 September 1993

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

3350

30 September 1993

PAS Analysis of Pu(IV) Carbonate Systems
On schedule.

3351

30 September 1993

NMR Analysis of Np(V) and Pu(IV) Carbonate Systems
On schedule.

3363

30 April 1993

Radionuclide Solubility and Speciation Studies for the Yucca Mountain Site Characterization Project
Completed.

Publications

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

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

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

H. Nitsche, R. C. Gatti, E. M. Standifer, S. C. Lee A. Miller, T. Prussin,
R. S. Deinhammer, H. Maurer, K. Becraft, S. Leung, and S. A. Carpenter
*Measured Solubilities and Speciations of Neptunium, Plutonium, and Americium in a
Typical Ground-water (J-13) from the Yucca Mountain Region (3010)*

LA-series report
In press. (LA 12562 MS)

H. Nitsche et al.
*Radionuclide Solubility and Speciation Studies for the Yucca Mountain Site
Characterization Project*
Conference paper, *1993 International High-Level Waste Management Conference*
(3363)
Published.

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

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

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

Objective

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

Activities and Accomplishments

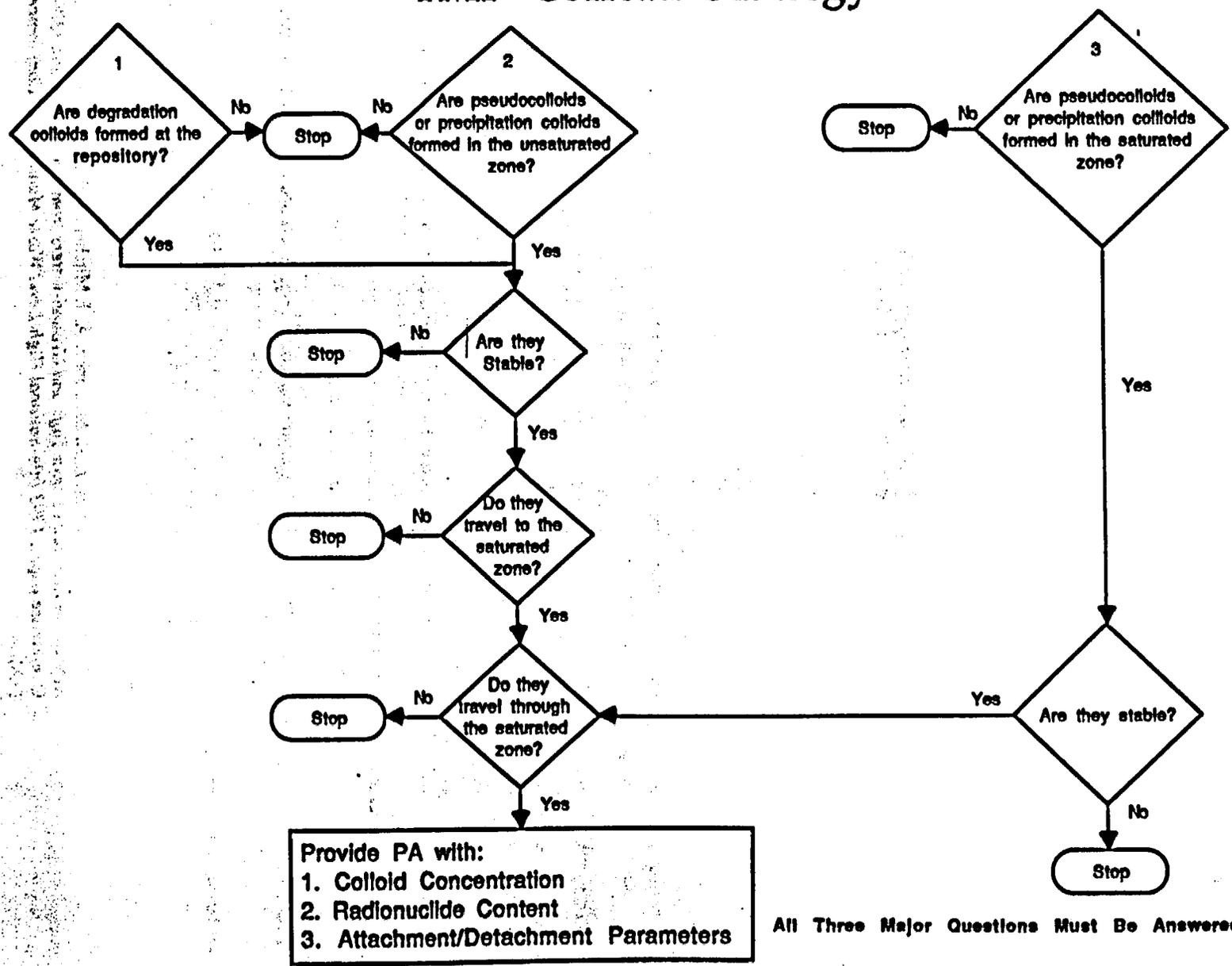
This month, along with the Geochemistry Integration Team, we refined our strategy for YMP colloid investigations and reviewed three pre-proposals on colloid work submitted by non-YMP investigators.

As part of our strategy refinement, we developed the following definitions for various types of colloids. We have defined *ground-water colloids* as colloids naturally occurring in aquatic systems; they consist of inorganic and/or organic molecular constituents or microorganisms. We have defined *anthropogenic colloids* as colloids produced by physical, chemical, or biological processes acting on materials introduced by humans; these include *radioactive-waste-derived colloids* and colloids derived from other materials and activities related to waste isolation. *Radioactive-waste-derived colloids* include (1) *pseudocolloids*, which are generated by the attachment of radionuclides (in soluble or colloidal form) to another colloid; (2) *precipitation colloids*, which are generated from solutions that are supersaturated with respect to actinide solid phases (They may include real actinide colloids, produced by the agglomeration of hydrolyzed actinide ions, which are traditionally referred to as radiocolloids.); and (3) *degradation colloids*, which are generated by disaggregation or spalling of actinide solid phases directly from the waste form.

Our derived colloid strategy (Fig. 1) addresses three major research areas: colloid formation, colloid stability, and colloid transport properties. Planned experiments will address the questions in Fig. 1, and focus on these three areas. (1) In colloid formation experiments we will test likely waste forms. Using sorption experiments, we will investigate formation of colloids by sorption of soluble radionuclides onto colloidal species at the Yucca Mountain site. (2) In colloid stability experiments, we will ascertain under what water chemistry conditions the radioactive-waste-derived colloids will remain in suspension. (3) To determine colloid transport properties, we will conduct laboratory and field-scale transport experiments to address the mobility of stable colloids under unsaturated and saturated conditions through fractured and porous media.

Staff also provided transport parameters on soluble radionuclides to Performance Assessment investigators.

YMP Colloid Strategy



Predictional information—preliminary data—do not reference

Planned Activities Work in all the above mentioned areas will continue.

Problem Areas None

Milestone Progress

3040
30 January 1993
Kinetics of Sorption on Columns of Pure Minerals
Completed on 30 October 1992; published in 1993 IHLRWM Conference Proceedings.

3044
30 October 1993
Measurement of Unsaturated Hydraulic Conductivity in Yucca Mountain Tuff
Completed as Level IV Milestone in 1992; TPO requested that it be published, and a TIP review was initiated.

3065
Techniques to Study Diffusion in Saturated Tuffs
30 October 1992
Completed on 30 October 1992; published in 1993 IHLWMC Proceedings.

3348
30 September 1993
Colloid Workshop Report

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

Publications

A. Meijer
Far-Field Transport of Carbon Dioxide: Retardation Mechanisms and Possible Validation Experiments
Conference paper, Focus '93 Site Characterization and Validation
Submitted to TPO.

J. Conca
Measurement of Unsaturated Hydraulic Conductivity in Yucca Mountain Tuff (3044)
Conference paper, Focus '93 Site Characterization and Validation
Submitted to TPO.

I. R. Triay, K. H. Birdsell, A. J. Mitchell, and M. A. Ott
Diffusion of Sorbing and Nonsorbing Radionuclides in Tuff (3065)
Conference paper, 1993 International High-Level Waste Management Conference
Published.

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

I. R. Triay, B. A. Robinson, R. M. Lopez, A. J. Mitchell, and C. M. Overly
Neptunium Retardation with Tuffs and Ground-waters from Yucca Mountain (3040)
Conference paper, 1993 International High-Level Waste Management Conference
Published.

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

Physical/Chemical Processes Affecting Transport. Work continued on developing software to automatically generate finite-element meshes for modeling of flow and transport at Yucca Mountain. The capabilities now working include generation of three-dimensional hexahedral mesh from a Yucca Mountain stratigraphy database, refinement of hexahedral mesh into a tetrahedral mesh, and the further refinement of tetrahedra into smaller tetrahedra. These capabilities work in both three dimensions and two dimensions (tetrahedra become triangles) so that exploratory calculations can be efficiently run in two dimensions.

Fracture/Matrix Coupling. We continued to compare explicit fracture modeling and the popular equivalent-continuum approach. We are still uncertain about when it is necessary to employ the double-permeability mode, which has two grids. We have some indications that the double-porosity model (one grid, but explicit fractures) may be a compromise that is useful for modeling high-heat-load repositories.

Modeling of Relative Permeability of Fractures. A simple-flow code to model single-phase, isothermal, steady-state flow on a rectangular mesh was developed. This code has been tested on a 200 x 200 (40,000 nodes) grid with uniform as well as randomly distributed permeabilities. The run times were on the order of 1.5 hours on a Spark station. Currently, a preconditioned orthomin-type matrix solver is being used (the same one as that used in FEHM). Work is under way to investigate how effective a conjugate gradient and a multi-grid solver will be for solving larger problems.

A code was developed to find the clusters of open nodes in a grid where some of the nodes are closed to flow. This code has been debugged on a 30 x 30 mesh with random permeabilities. The run times were on the order of 7 seconds on a Spark station. The next step is to couple this code with the flow code so that the flow problem can be solved more efficiently.

Calculations are being performed on 30 x 30 (the size of the grids used in work reported in literature at present) and on 200 x 200 grids using stochastically correlated permeability distributions. Effective permeabilities will be calculated by limiting flow to only those nodes allowed and accessible to the flowing phase under conditions of capillary pressure equilibrium.

Work is under way to test a three-dimensional, boundary-element code on a elliptical crack. In the future, attempts will be made to improve the efficiency of this code by using a mean field theory type approach.

Planned Activities

We are actively building grids for both two-dimensional and three-dimensional grids for isothermal and non-isothermal simulations.

Problem Areas

None

May 1993

Milestone Progress

3052

30 January 1993

Baseline Documentation for TRACRN

Received conditional certification; documentation is available from the Los Alamos Software Manager.

Completed.

3355

30 September 1993

Interim report- Update of Geophysical/Geochemical Models

Publications

K. Birdsell, K. Eggert, and B. Travis

Three-Dimensional Simulations of Radionuclide Transport at Yucca Mountain

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

Approved by YMPO.

WBS 1.2.3.4.1.5.2 Demonstration of Applicability of Laboratory Data

Objective

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

Activities and Accomplishments

This task has been deferred because of lack of funds.

WBS 1.2.5.2.2 Site Characterization Program

Objective

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

Management and Integration

Staff continued to support the "Calcite-Silica Topical Report." Staff continued to prepare for the June NRC technical exchange on the draft "Volcanism Status Report."

Study Plans

Water Movement Test, R1 (8.3.1.2.2.2). Review comments on Rev. 1 of the study plan were received from the YMPO in May 1992; they were addressed and returned to YMPO in December 1992. This study plan was approved on 10 February 1993 by the DOE. It was submitted to the NRC for a Phase I review and accepted on April 8, 1993.

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

Testing of the C-Hole Sites With Reactive Tracers, R0 (8.3.1.2.3.1.7). In February 1990, DOE/HQ issued the study plan (8.3.1.2.3.1) as a controlled document; it was then sent to the NRC for comments. The Los Alamos study plan (8.3.1.2.3.1.7) was approved. Staff reviewed NRC comments on the USGS study plan related to the first six C-wells activities and notified the DOE that they agreed with all NRC comments.

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

Mineralogy, Petrology, and Chemistry of Transport Pathways, R0 (8.3.1.3.2.1). In January 1992, we submitted revised NRC comments to T. Bjerstedt. In August 1992, YMPO requested that we word process the changes to be incorporated in the revision. That revision is in progress and staff is also responding to review comments from the State of Nevada received in January 1993.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). The YMPO approved the study plan on 18 December 1991 and submitted it to the NRC on 31 January 1992. No further action has been required.

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

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

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). A new draft of the study plan combining studies 8.3.1.3.4.1 and 8.3.1.3.4.3 was submitted to YMPO for review in October 1992. Review comments were returned to Los Alamos in February 1993; these comments are being incorporated in the study plan.

Biological Sorption and Transport, R0 (8.3.1.3.4.2). A revision addressing the Exploratory Shaft Design was submitted in September 1992. The study plan was approved by YMPO on 25 November 1992.

**Study Plans
(cont.)**

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

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. This study plan was revised, incorporating YMPO and DOE review comments. It was returned to YMPO in March 1993 for technical review.

Diffusion, R0 (8.3.1.3.6.2). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. The study plan was revised in response to YMPO comments and returned to YMPO in April 1993.

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

Demonstration of the Applicability of Laboratory Data to Repository Transport Calculations, R0 (8.3.1.3.7.2). This study plan is deferred because no funds were allocated.

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

Probability of Magmatic Disruption of the Repository, R0 (8.3.1.8.1.1). A detailed technical review was completed in July 1992 by the NRC. In August 1992, a one-day video conference was held with the NRC to discuss their technical review comments. In response to those comments, this study plan was revised and submitted to YMPO for review in February 1993. It was accepted and sent to the NRC in March 1993 for review.

Physical Processes of Magmatism and the Effects on the Repository, R0 (8.3.1.8.1.2). A draft study plan was submitted to DOE for review in October 1992. The review comments were returned in January 1993 for comment resolution. Those comments have now been addressed, and the study plan was sent to YMPO in May 1993.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). This study plan was accepted by NRC on 4 September 1990. A minor revision was added in March 1993; this revision does not require a review by YMPO and the DOE.

WBS 1.2.5.3.5 Technical Database Input

Objective

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

Activities and Accomplishments

Resolved discrepancies between what had been entered on the hard-copy TDIFs and what was present in the ATDT for the following items:

- DTN LA000000000003.002, TDIF 300480 (deleted incorrect data source from ATDT);
- DTN LA000000000004.002, TDIF 300486 (deleted incorrect data source from ATDT);
- DTN LA000000000005.001, TDIF 300232 (incorrect WBS # in ATDT);
- DTN LA000000000007.001, TDIF 300234 (incorrect WBS # in ATDT);
- DTN LA000000000012.001, TDIF 300234 (incorrect WBS # in ATDT); and
- DTN LA000000000034.001, TDIF 301091 (numbers transposed in DTN in ATDT).

All records currently in the Los Alamos Participant Data Archive were examined and compared for accuracy with the data entered into the ATDT, and all major discrepancies were corrected or resolved.

Staff entered information into ATDT and completed TDIF forms in order to create data tracking numbers for several reports. This exercise was undertaken so that work at Los Alamos could be identified by staff at other research institutions when appropriate, as being used to generate newly developed data. These included:

- LA-10929-MS, "Ground-water Chemistry at Yucca Mountain, Nevada, and Vicinity," which was assigned DTN LA000000000044.001 and TDIF #301441;
- LA-9652-MS, "Revised Volcanic Stratigraphy of Drill Hole J-13, Fortymile Wash, Nevada, Based on Petrographic Modes and Chemistry of Phenocrysts," which was assigned DTN LA000000000045.001 and TDIF #301451;
- LA-9255-MS, "Petrologic Studies of Drill cores USW G-2 and UE-256-1H, Yucca Mountain, Nevada," which was assigned DTN LA000000000046.001 and TDIF #301452;
- LA-10859-MS, "Fran Ridge Horizontal Coring Summary Report Hole UE-25h#1, Yucca Mountain Area, Nye County, Nevada," which was assigned DTN LA000000000047.001 and TDIF #301573;
- LA-9325-MS, "Status of Volcanic Hazard Studies for the Nevada Nuclear Waste Storage Investigations," which was assigned DTN LA000000000048.001 and TDIF #301542; and
- LA-8845-MS, "Geology and Petrology of the Basalts of Crater Flat: Applications to Volcanic Risk Assessment for the Nevada Nuclear Waste Storage Investigations," which was assigned DTN LA000000000049.001 and TDIF #301543.

Planned Activities

Resolve discrepancies between what was received by the Los Alamos RPC and what was recorded as sent by this office to the RPC.

Continue to determine if technical data needs to be logged into ATDT for current work on zeolites, saturated fluid flow, and other ongoing work of various principal investigators.

Problem Areas

None

WBS 1.2.5.4.6 Development and Validation of Flow and Transport Models

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

Activities and Accomplishments Work on preparing the caisson is progressing. It has been filled with 80 percent of the sand required. The following instrumentation has been installed: neutron-probe access tubes at each level, time-domain reflectrometry wave guides at each level, hollow fiber solution samplers, ceramic cup solution samplers, and temperature sensors. Final fabrication of the surface distribution system is almost complete.

Planned Activities Complete filling the caisson with sand and begin filling it with water.

Problem Areas None

Milestone Progress 3357
30 September 1993
Caisson Experiments to Test Flow and Transport Models

3368
30 April 1993
Testing models of flow and transport in unsaturated porous media
Completed.

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

WBS 1.2.5.4.7**Supporting Calculations for Postclosure Performance Analyses****Objective**

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

Activities and Accomplishments

Staff attended a meeting on thermal loading at the USGS Denver with representatives of INTERA, USGS, LBL, and SNL. The subject of the meeting was the new hydrologic data being generated by A. Flint of the USGS. S. Mishra of INTERA pointed out that this new data (Van Genuchten parameters) did not correlate well with porosity of the stratigraphic unit, but the older SNL data did correlate well. Discussion centered on the measuring techniques used by Flint because the new parameters were generated with a larger range of capillary data. In general, the group was not convinced that the new data was better. Hudson of the USGS presented a very interesting talk on the applicability of the two-parameter fit Van Genuchten model for very dry conditions. He presented data and fits that showed that a three-parameter fit was needed to get the dry and wet ends of the curves correct. At the present time we are continuing to use the older SNL data, while noting that a more accurate fit (three parameter) is needed in the future.

Planned Activities

No planned activities reported.

Problem Areas

None

Milestone Progress

4004
30 September 1993
Summary Report on Thermal Repository Calculations

Publications

None

WBS 1.2.6

Exploratory Studies Facility

Objective

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

Activities and Accomplishments

Staff continued planning for the LLNL large-block test; site selection at Fran Ridge for this test is underway and planning is complete for procuring an air-coring drill.

Staff reviewed four ESF tests for compliance with PSAR.

Staff continued to support ED&D with respect to monitoring in-progress ESF construction testing. Staff participated in weekly coordination meetings at Yucca Mountain. Staff met at Yucca Mountain with representatives of SNL, USGS, ED&D, M&O, and Los Alamos to discuss timely transfer of construction monitoring data to REECo construction. Staff met on 26 May with representatives of SNL, REECo, and M&O design and construction to discuss ongoing construction monitoring.

Staff met at LLNL on their "Large-Block Test Site Investigation Plan."

Planned Activities

Continue to focus on consolidating ESF thermal and mechanical testing. Work with CRWMS M&O to develop mechanical mining techniques for the main test area of the ESF. Work towards consolidating ESF thermal tests and developing integrated network. Continue to support Director of ED&D in ESF testing, in particular testing for WBS 1.2.2 and 1.2.4. Continue to gather information on TFM and to coordinate the ESF facility and IDS designs. Begin to prepare a network that integrates ESF testing, construction, design, and IDS.

Publications

N. Elkins

Prioritization of ESF Testing and Integration with Design and Construction
Conference paper, 1993 International High-Level Radioactive Waste Management Conference
Published.

N. Elkins

Planning and Implementation of Underground Testing in the ESF
Conference paper, Rock Mechanics Conference
Approved by YMPO.

H. Kalia

Control of Tracers, Fluids, and Materials for the Yucca Mountain Site Characterization Project
Conference paper, 1993 International High-Level Radioactive Waste Management Conference
Published.

Problem Areas

None

WBS 1.2.6.8.4 Integrated Data System

- Objective** The integrated data system (IDS) supports the Exploratory Studies Facility (ESF) test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purposes of the IDS are to assist the principal investigators (PI's) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PI's organizations for data management and analysis.
- Activities and Accomplishments** IDS design and development continued on schedule. The M&O has been responsible for designing and developing IDS for various principal investigators. Staff was briefed by the M&O on current status of the IDS design. Staff incorporated comments into the engineering plan and released the plan.
- Planned Activities** Continue to provide overview for YMPO design and development of the IDS by M&O. Develop IDS technical requirements documents as source of information for the IDS designers. Revise and update IDS Functional Requirements Document developed by Los Alamos. A meeting will be held on 3 June to discuss the IDS requirements of various principal investigators and current IDS design status. Continue to review design documents as they are developed by the M&O.
- Publications** H. Kalia
Acquisition of Test Data from the Exploratory Studies Facility for the Yucca Mountain Site Characterization Project
Conference paper, *Second International Symposium on Mine Mechanization and Automation*
Approved by YMPO.
- Problem Areas** None

WBS 1.2.9.2.2

Project Control

Objective

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

Activities and Accomplishments

Staff submitted the PACS status on 11 June.

Staff used the newly developed automated download software to report May status, and no problems were encountered. This new interface system has been tailored to match cost elements in the PACS participant workstation.

Planned Activities

We will continue to use the new download software to report June status. Further refinements to Los Alamos internal estimating and cost-performance reporting methods will be implemented.

Problem Areas

None

WBS 1.2.11.2/3/5 Quality Assurance Program Development, Verification, and Engineering

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

Program Development (WBS 1.2.11.2) We plan to implement the new QARD by August 1993; our major emphasis is on procedure revisions. A quarterly Q meeting was held in Las Vegas.

Personnel. F. Perry, one of the principal investigators for the Volcanism task, accepted a position at Los Alamos. He relocated from University of New Mexico in Albuquerque.

Travel. S. Bolivar and M. Clevenger attended workshops on assessment techniques sponsored by the Quality Management Special Interest Group, Knoxville, TN.

Procedure Revisions. Twenty-five quality administrative procedures are currently in revision, and an additional six are in formal review. Four procedures were completed and await entry into the RTN system.

Training. The Q team attended classes in root cause determination and conflict resolution in Las Vegas. They also critiqued the proposed class on records management. S. Bolivar attended the fourth class of a video conference training course entitled "Radioactive Waste Management." The training database software is still being tested.

Audits and Surveys (WBS 1.2.11.3) The audit plans for EES-13/LV (AR-93-04), Volcanism (AR-93-04), University of New Mexico (AR-93-05), and Ohio State University (AR-93-06) were approved. Audit report LANL-AR-93-02 (EES-5) was issued; no deficiencies were issued. The YMPO conducted DOE audit YM-93-11. Three corrective action reports were issued for minor infractions. Corrective actions for stop work order SWO-03 have been completed and SWO-03 will be sent to verification. The audit schedule was revised and distributed.

Quality Engineering (WBS 1.2.11.5) The revised four software procedures and software process guidebook are being evaluated. One CCB meeting was held to discuss the resolution of two internal deficiencies.

Planned Activities The training class for QP-17.6 will be revised. Our major effort will be directed at revising procedures to satisfy the new QARD. Corrective actions on stop work order SWO-03 will be verified. The audit of the University of New Mexico, Ohio State University, and the Los Alamos Volcanism task will be conducted. Compilation of the 1992 Quality Assurance Status Report will continue, and training files for active personnel will be entered into the new database.

Problem Areas None

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

**WBS 1.2.12.2
1.2.12.5
1.2.13**

Local Records Center Operations/Records Management and Document Control

Objective

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

Activities and Accomplishments

Forty-five records and/or record packages were received by the RPC; eight of these were rejected and returned to their originators for corrections.

Sixty-five records and/or record packages were submitted to the CRF, and all of them were accepted. One previously rejected record package was resubmitted to the CRF.

Staff assisted DOE auditors in their evaluation of Criterion 17, "Records." DOE determined that the Los Alamos records program was in compliance.

Two procedures were distributed: LANL-INC-DP-92-R1, "Sample Leaching to Extract Soluble Chloride and Bromide" and LANL-INC-DP-95-R1, "Preparation of Samples for Chlorine-36 Analysis."

Planned Activities

No planned activities reported.

Problem Areas

None

May 1993

WBS 1.2.15.2 Administrative Support

Objective The objective of this task is to provide administrative support for the Los Alamos YMP and the YMPO.

Activities and Accomplishments S. Klein, Los Alamos editor, reviewed and edited ten technical information products (TIPS); following TPO review and approval, she forwarded the TIPs to YMPO. She also prepared YMP weekly reports each week and monthly highlights for May. All reports were transmitted to the M&O and YMPO.

The February/March YMP Monthly Activity Report was published and distributed. The editor completed the first draft of the April YMP Monthly Activity Report.

The editor reviewed a concurrence draft of the 8th YMP Progress Report and transmitted comments to the M&O.

The FY 1993 TIP database was distributed to Los Alamos YMP management.

Planned Activities Continue work in all areas discussed above.

Problem Areas None

WBS 1.2.15.3

Training

Objective

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

Activities and Accomplishments

Staff toured Yucca Mountain and attended various training classes in Las Vegas from 9-12 May.

Staff participated in the DOE audit on 24-28 May.

Staff processed training records for May.

Planned Activities

No planned activities reported.

Problem Areas

None



Reynolds Electrical & Engineering Co., Inc.

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

9 10 34 AM '00

RPTS 1.2

IN REPLY REFER TO:
580-01-548

WBS 1.2.9.1
QA: N/A

August 5, 1993

I-345448

BMT

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 (SCP: N/A)

8-5-93

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

If further information is required, please contact Rene' R. Knott at 794-7193.

R.F. Pritchett

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

RFP:RRK:mab

Enclosure
Status Report (3 pages)

cy: See page 2

320
DIVISION

CC: *Bepko/Gertz*
 CC: *Wilson/H-ray*
 CC: *Williams, D*
 CC: *Parisi/Stucker*
 CC: *Stonick/Smith*
 CC: *Oyer/Blanchard*
 CC: *Brodeur*
 CC: *Jones, S/Dijm*
 CC: *Hampton*
 CC: *8/6/93 Harrison*
 CC: *Hutchinson*
 CC: *Petrel*

REECO
AN EGG COMPANY

TOTAL QUALITY IS OUR BUSINESS

ENCLOSURE 5

Carl P. Gertz
580-01-591
Page 2
August 5, 1993

cy w/encl.

Information Services Center, M/S 408
K. W. Powers, DOE/NV, M/S 505
M. B. Blanchard, DOE/YMP, M/S 523
W. R. Dixon, DOE/YMP, M/S 523
J. R. Dyer, DOE/YMP, M/S 523
C. E. Hampton, DOE/YMP, M/S 523
D. J. Harrison, DOE/YMP, M/S 523
B. D. Hutchinson, DOE/YMP, M/S 523
V. F. Iorii, DOE/YMP, M/S 523
S. B. Jones, DOE/YMP, M/S 523
E. H. Petrie, DOE/YMP, M/S 523
W. B. Simecka, DOE/YMP, M/S 523
D. R. Williams, DOE/YMP, M/S 523
W. A. Wilson, DOE/YMP, M/S 717
L. D. Foust, M&O, M/S 423
M. M. Martin, M&O, M/S 423
R. L. Robertson, M&O/Fairfax, VA
P. Justus, NRC/Las Vegas, NV
R. C. Furtek, REEC0, M/S 235
B. R. Gardella, REEC0, M/S 408
W. J. Glasser, REEC0, M/S 408
J. L. Henze, REEC0, M/S 751
S. L. Hughes, REEC0, M/S 408
D. L. Knight, REEC0, M/S 408
D. L. Koss, REEC0, M/S 408
R. B. Land, REEC0, M/S 585
T. M. Leonard, REEC0, M/S 751
K. L. Limon, REEC0, M/S 408
C. J. Mason, REEC0, M/S 751
S. O. Straub, REEC0, M/S 408
J. R. Trujillo, REEC0, M/S 590
M. Brodeur, SAIC, M/S 517/T-23
J. J. Brogan, SAIC, M/S 517/T-12
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

**REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
(REECo)**

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP)

JULY 1993 - STATUS REPORT

Reeco has no reportable Level 0 or Level 1 Milestones.

SITE (1.2.3)

WBS 1.2.3.5

Task: Soil & Rock Properties (Job Package 92-8)

Completed backfilling of test pits in Midway Valley.

Task: USW UZ-14 Drilling (Job Package 92-17)

Continued drilling/coring operations. Continuously cored the borehole to a depth of 1261.78 feet. The 12 1/4 inch reamed hole was advanced to 1261.78 feet. Commenced double shift operations (0800 hours to 2400 hours on July 26, 1993.

Task: UE-25 NRG-4 North Portal Ramp Borehole (Job Package 93-2A)

Completed drilling/coring operations on July 21, 1993, at a total depth of 726.01 feet.

Task: UE-25 NRG-2B North Portal Ramp Borehole (Job Package 93-09)

Completed drill pad and mobilized CME-850 Drill Rig and associated equipment July 23, 1993. Received Air Quality Permit and Notice to Proceed on July 30, 1993. Depth at period end was 13.71 feet.

REGULATORY (1.2.5)

WBS 1.2.5.2.4

Task: Site Characterization Plan (SCP) Reference Library and Database

Continued distribution and database maintenance for the SCP and Progress Reports. Ten copies of Progress Report #5 and five copies of Progress Report #7 were provided to the Technical Information Section for distribution at professional conferences.

EXPLORATORY STUDIES (1.2.6)

WBS 1.2.6.1

Task: Exploratory Studies Facility (ESF)

Continued administrative support for ESF activities to include planning, scheduling and management. Performed 90% Title II Design Review on Package 2A and submitted 91 comments. Performed environmental inspections.

Task: Technical Support and Underground Excavation for the ESF

Received DOE Headquarters programmatic approval on July 30, 1993. Notice of Award issued to the Subcontractor on July 30, 1993.

Task: Procurement Actions

Construction and Tunneling Services Inc. (CTS) submitted the first request for progress payment during this period. A site visit is planned in mid-August to the CTS facility in Washington.

Request for Proposal (RFP) for rental of a batch plant was issued on July 15, 1993 with a closing date of July 23, 1993. The low proposer is being reviewed for acceptability.

Conducted a site visit to Wulfenstein Construction Co. and verified that course aggregate is crushed and washed as required.

RFP 7-DH-93, Arch Structure, was cancelled on June 25, 1993.

RFP 1-VP-93 for Mine Rescue Equipment closes July 30, 1993, with an expected award of August 3, 1993. Equipment requirements include, but are not limited to; breathing apparatuses, stretchers, first aid, measurement instruments, etc.

Task: ESF North Portal Pad & Facilities (Job Package 92-20)

Drilled and blasted 16 rounds. Advanced full face from CS 1+36 to CS 1+97. Shot 193 bags of fibercrete. Pumped 539 cubic feet of grout for the permanent rockbolts. Installed 212 split set bolts and 205 permanent bolts. Supported mappers on two multi-shift mapping operations. Continued rework of the Portal Diversion Channel. Shot 70 bags of shotcrete. Completed surface site preparation at the concrete batch plant. Continued fencing of material control areas on the ESF pad.

TEST FACILITIES (1.2.7)

Task: Field Operations Support

Continued logistical and tour support for DOE Yucca Mountain Site (YMSO) staff. Eight tours and one Open House were held during this period. Support included but was not limited to arrangements for buses, registration of guests, coordination of lunches/beverages, medical service, furniture, and mechanical service. Continued preparations for upcoming tours.

Continued monitoring of portable chiller unit for Building 4015, Field Operations Center. Initial check by factory representative indicated unit is acceptable, but problems were experienced with circulation of condenser water. A new pump has been ordered and will be shipped on July 26, 1993.

Continued support services to participants and maintenance of YMP utilized facilities, utilities, equipment and roads in Area 25.

PROJECT MANAGEMENT (1.2.9)

WBS 1.2.9

Task: Technical Project Office Management/Project Control

Continued normal administrative level of effort support. Continued status and update of Planning and Control System (PACS); supported ESF Construction activities, drilling activities and completed cost estimates as required.

QUALITY ASSURANCE (1.2.11)

WBS 1.2.11

Task: Quality Assurance (QA)

Continued normal administrative level of effort support. Seven Corrective Action Requests (CARs) generated as a result of the DOE/YMP QA Division audit of REECo/YMP activities were issued. Responses are due August 4, 1993.

Conducted Audit REECo-008-93 of Processed and Special Process Control activities. The audit resulted in issuance of two Deficiency Notices concerning errors in Construction and Quality Control documentation.

Closed a REECo CAR which documented that training provided to Physical Standards & Calibration Laboratory (PSCL) personnel, per the DOE/YMP CAR corrective action plan, was ineffective based upon identification of a similar incident.

Completed required corrective actions for closure of DOE/YMP CAR YM-93-033 issued to the PSCL.

Completed Quality Assurance Requirements Document (QARD) Matrices identifying where OCRWM QARD requirements are met in REECo implementing procedures. The data has been entered into the YMP Requirements Traceability Network (RTN) mainframe for review by the DOE/YMP QA Division.

ENVIRONMENT, SAFETY & HEALTH (1.2.13)

WBS 1.2.13

Task: Safety & Occupational Health

Provided medical, occupational safety, industrial hygiene and fire protection support.

Environmental Technologies completed the bioremediation of approximately 1,884 tons of hydrocarbon stained soil removed from Area 25. The subcontract is in the process of being closed out.

SUPPORT SERVICES (1.2.15)

WBS 1.2.15

Task: Administrative Support and Training

Continued to provide procurement, logistical, and information management administrative level of effort support; continued support services to various YMP participants.

Formulated a plan to incorporate Study Plan references into the Records Management Systems through the use of the Technical Library Database, expediting study plan and open field report development for the scientific community.

Sandia National Laboratories

Albuquerque, New Mexico 87185

AUG 16 9 51 AM '00

AUG 10 1993

WBS:1.2.9

QA:NA

I-345749 BAH

Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
Nevada Operations Office
101 Convention Center Drive
Phase 2, Suite 200
Las Vegas, Nevada 89193-8518

Attn: V. F. Iorri

Subject: June 1993 Monthly Highlights and Status Report

Dear Carl:

Enclosed is the Monthly Highlights and Status Report for the month of June 1993.
If you have any questions, please call Leigh Lechel at (FTS) 844-4824. Thank you.

Sincerely,

L. E. Shephard
Technical Project Officer
YMP Project Management
6302

LES:6302:mt

Enclosure

327
DIVISION
CC: Sonecko / Gertz
CC: Oyer / Smith, L-w/6
CC: Boat / Williams, D
CC: Law / Lipin
CC: Grudsky / Petrus
CC: R.B. BC
CC: White, J
CC: Stuckler

REC'D IN YMP 8/16/93

ENCLOSURE 6

Copy to:

YMPO	D. Williams
YMPO	J. R. Dyer
YMPO	W. R. Dixon
YMPO	E. B. Pietrie
YMPO	J. Robson
YMPO	W. B. Simecka
YMPO	V. F. Iorri
YMPO	D. J. Harrison
NRC	P. S. Justus
M&O	S. J. Bodnar (2)
M&O	E. M. Fortsch (2)
M&O	R. K. St. Clair (2)
M&O	L. Wildman
M&O	L. D. Foust
ORNL	R. B. Pope
CCS	S. O'Connor
RSN	R. L. Bullock
LANL	J. A. Canepa
LLNL	W. L. Clark
USGS	L. R. Hayes
REECO	R. F. Pritchett
SAIC	M. D. Voegele
6300	D. E. Ellis
6302	L. E. Shephard
6302	D. Kessel
6302	F. J. Schelling
6312	F. W. Bingham
6313	L. S. Costin
6315	P. Davies
6319	R. R. Richards
6351	R. Thompson
6352	S. E. Sharpton
6352	B. J. Mathis
6352	31/12911/1.3/NQ
6352	YMP CRF