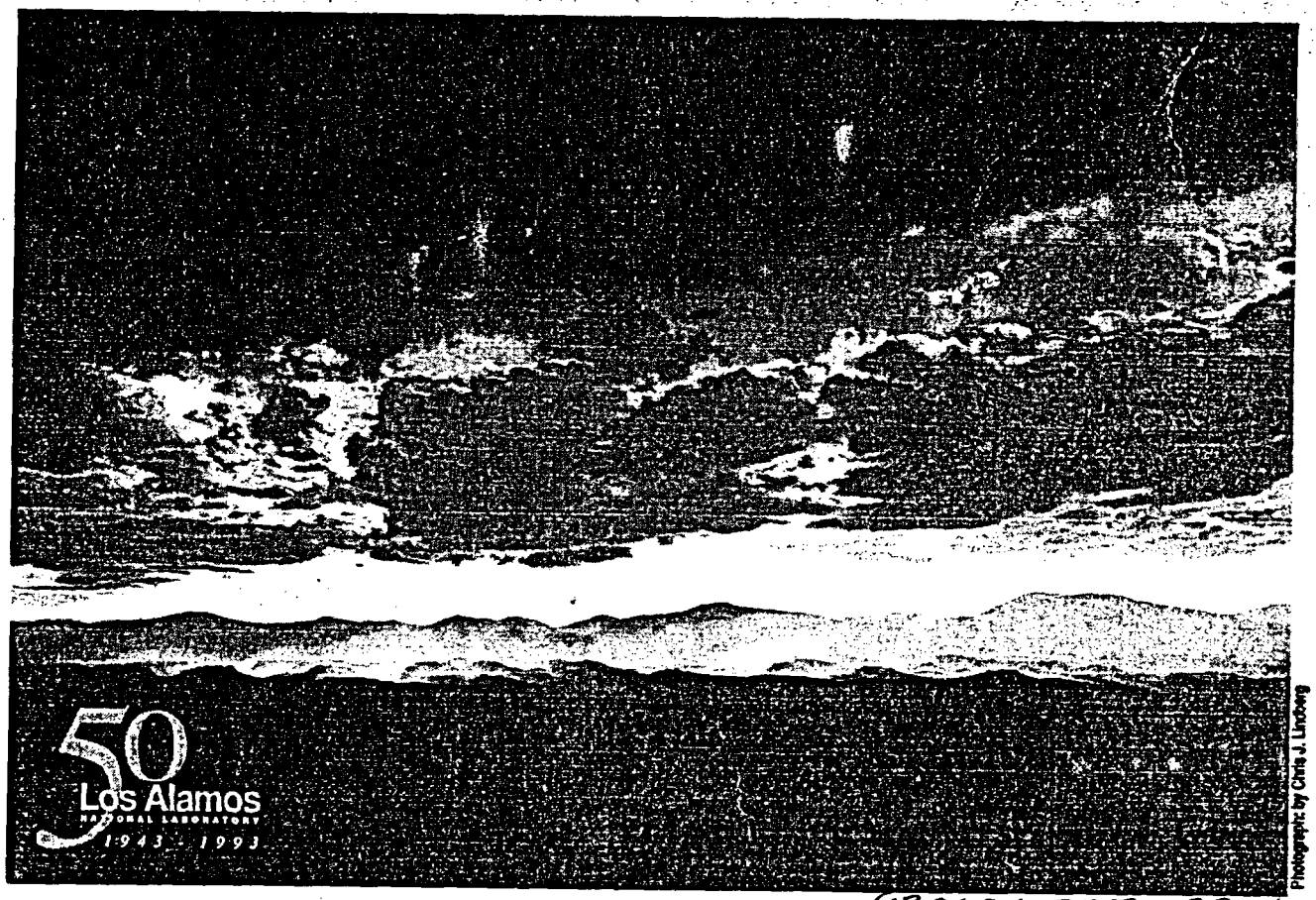
Yucca Mountain Site Characterization Project

Monthly Activity Report

April 1993



CONTENTS

WBS 1.2.3.1.1 Site Investigation Coordination and Planning/ Site Management

Objective

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

Activities and Accomplishments

A review of the USGS study plan "Characterization of the Yucca Mountain Unsaturated Zone in the Exploratory Studies Facility (ESF)" was completed.

Planned Activities

The TPO held a meeting of principal investigators to review the recent CASY meeting held in Denver and discuss the thermal loading issue.

A number of Los Alamos staff members attended the 1993 IHLRWM Conference in Las Vegas, NV.

The TPO held an internal program review.

The TPO held a planning meeting with the Dynamic Transport staff to prepare for the May Colloid Workshop.

The TPO reviewed Project and Laboratory documents and completed variance analyses.

Problem Areas

None

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

Objective

The objective of this task is to manage and integrate 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

ESF. Test Coordination Office staff attended weekly surface-based testing meetings and participated in review of Revision 4 of AP-5.21Q, "Field Work Activation." Staff provided field coordination and PI support for the following ESF north-portal starter tunnel tests: Geologic Mapping, Construction Monitoring, and Perched Water (a contingency test in the starter tunnel).

The Monthly Progress Report for April on ESF testing activities was prepared and appears in the Appendix to this document.

Surface-Based Testing. B. Carlos represented the principal investigators at the April Sample Overview Committee meeting.

Staff began planning sample collection activities in the SRG-5 borehole in support of the Water-Movement Tracer Test activity .

Planned Activities

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

Problem Areas

None

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

Objective

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

Activities and Accomplishments

D. Vaniman presented a paper entitled "Calcite Deposits in Fractures at Yucca Mountain, Nevada" on 30 April at the 1993 IHLRWM Conference in Las Vegas, Nevada.

D. Vaniman selected samples from UE-25 UZ-16 at the Sample Management Facility on 13-14 April and on 28 April. He also made initial sample selections from Core NRG-6. Together, these two cores will provide needed mineralogical information for sections associated with the eastern imbricate fault zone and the northern boundary of the potential repository, respectively.

Staff began analysis of calcites from UE-25 UZ-16. Calcite separates were prepared from this core and from USW G-1, USW G-4, USW GU-3, and UE-25 A-7 for instrumental neutron activation analysis. Included in this batch of samples are calcite and smectite separates from exposures at the north-portal starter tunnel, which are being analyzed for chemical information on the extent of transport through fractures. In addition, a smectite sample was separated from G4-159 for trace-element analysis.

In preparation for microautoradiography experiments to determine the potential effect of trace minerals on sorption of radionuclides, 25 polished one-inch rounds of devitrified, vitric nonwelded, and zeolitic tuff were prepared. These experiments will be conducted in conjunction with the Sorption task.

B. Carlos completed preliminary examination of fractures in UE-25 UZ-16 at the Sample Management Facility; she also examined the first 460 ft of USW NRG-6 and submitted a request for samples from these cores.

Members of this task have noted the need for a "field-guide" to fracture-lining minerals for well-site geologists and others mapping in the underground excavations in the area of Yucca Mountain; we have added a new milestone, which will consist of a short Los Alamos report on this topic.

R. Raymond continued to use SEM to investigate the cause of the bleached zones found adjacent to lithophysal fractures and cavities in samples USW G4-1132, G4-984, and G2-1505.0-.5. (What has in the past been referred to as a bleached zone is in fact a zone in which a mineral phase or phases have been removed.) Raymond found that porosity increases significantly within the bleached zones (9-13% increase) and Si is depleted relative to other elements, as shown by SEM energy-dispersive spectroscopy. Using XRD on sample USW G2-1505.0-.5, Raymond and S. Chipera demonstrated that the leached phase was predominantly cristobalite. Raymond performed additional chemical analyses of clinoptilolite and stellerite from fractures; additional samples will be analyzed to fill any gaps in our XRD data.

S. Chipera submitted a new detailed technical procedure for operation of the INEL microdiffractometer. The system has now been evaluated with numerous sub-milligram samples, including those that fluoresce in Cu radiation.

S. Chipera and D. Broxton conducted magnetic-mineral separations from G4-159 and G4-332. D. Bish's analysis demonstrated that the material in G4-159 is essentially end-member magnetite with little evidence of oxidation, whereas the separate from G4-332 was oxidized about 15-20% of the way toward maghemite. These results are in contrast to those of previously analyzed deeper samples, which showed considerable oxidation towards maghemite.

D. Bish, B. Carlos, S. Chipera, and D. Vaniman were preparing papers for the Zeolite '93 meeting, which will be held in June.

The preliminary report on UZ-16 fracture mineralogy is included in the Appendix to this monthly report.

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 also continue.

Collection of data on zeolites in fractures from "old" core will continue, with emphasis on microprobe and XRD analysis. Several staff members 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 using 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 SMF; (3) sample UE-25 UZ-16 for studies of stratigraphic variability in bulk mineralogy; (4) continue statistical evaluation of XRD quantitative mineral analysis; (6) complete "field guide" of 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

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

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

Milestone Progress (cont.)

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

Publications

D. L. Bish and D. T. Vaniman
Thermal Behavior of Natural Zeolites
Conference abstract, *Zeolites '93*
Approved by YMPO.

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

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*
Approved by YMPO.

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*
Approved by YMPO.

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

G. D. Guthrie
Distribution of Potentially Hazardous Phases in the Subsurface of Yucca Mountain
Los Alamos report (3352)
Submitted to TPO.

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 of Society of America.*

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

This task was the subject of an internal audit.

G. WoldeGabriel spent most of the month at Case Western Reserve University in Cleveland, Ohio, analyzing K/Ar ages of Lake Tecopah and Barstow feldspars, clays, and clinoptilolite (with or without mordenite), including material subjected to cation exchange at elevated temperatures.

S. Levy and D. Vaniman prepared responses to review comments on the Los Alamos-contributed sections of the draft working paper on calcite-silica deposits.

D. Vaniman, D. Bish, and S. Chipera completed revising a paper entitled "Dehydration and Rehydration of a Tuff Vitrophyre," which will be published in the *Journal of Geophysical Research*. S. Levy and G. Valentine submitted a summary of planned natural analog studies of hydrothermal effects at Yucca Mountain to Focus '93.

A paper by S. Levy entitled "Surface-Discharging Hydrothermal Systems at Yucca Mountain -- Examining the Evidence" was published in the *Proceedings of the Scientific Basis for Nuclear Waste Management XVI*.

Planned Activities

S. Levy will present a talk on natural gels and colloids at Yucca Mountain at the Colloid Workshop (3-5 May) in Santa Fe, NM.

Staff will continue to revise the draft working paper on calcite-silica deposits.

G. WoldeGabriel will analyze his K/Ar results.

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.

Problem Areas

None

Milestone Progress

3138
30 September 1993
Chemical Transport in Zeolitic Alteration
Research 60% complete; postponed because of attention to Milestone 3381.

3142
31 January 1993
K/Ar Dating of Clays and Zeolites
Submitted to TPO.

Milestone Progress (cont.)

3343
30 September 1993
Zeolite Dating

3150
30 July 1993
Final Report on Bedrock
Research 50% complete.

3361
1 April 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)

Publications

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

S. Levy
Surface-discharging hydrothermal systems at Yucca Mountain -- examining the evidence (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

Staff conducted a field study of basaltic intrusion forms. We examined an arcuate dike intrusion associated with the basalt of Nye Canyon and discovered a site with a preserved dike top. We also examined the conduit zone of the 10.5 Ma basalt at the south end of Crater Flat and briefly examined a Miocene basalt at Daylight Pass in which no basalt intrusions were noted.

Five task members attended a field conference in New Mexico on Quaternary dating methods.

A suite of new Ar-Ar whole-rock age determinations were obtained. Basalt samples from the Thirsty Mesa yielded ages of 4.68 +/-0.03 and 4.88 +/- 0.04 Ma; this is consistent with other results for this center. A sample of cuttings collected from an exploratory well drilled by a private company at the Amargosa Valley aeromagnetic anomaly yielded an age of 3.85 +/-0.05 Ma, which is consistent with the ages of the basalt of southeast Crater Flat and suggests the events are probably correlated. Three additional ages of about 3.7 Ma were obtained for basalt samples from the basalt of southeast Crater Flat. We now have consistent K-Ar and Ar-Ar results from multiple laboratories for multiple samples collected from this unit and consider the age of the event to be resolved with reasonable confidence. Replicate ages of 1.05 +/- 0.14, 0.96 +/- 0.15, 0.94 +/- 0.05, and 1.05 +/- 0.08 were obtained for the Black Cone center. Evaluations of the data for these Ar-Ar show that it was critically important to remove phenocrysts for sample preparation. Not removing phenocrysts for some age determinations may explain the scatter obtained from past results. An age of 1.02 +/- 0.10 was obtained for the Little Cones center. Replicate Ar-Ar analyses of the Ql_6 lava yielded discordant results ranging from 0.31 to 0.09 Ma, which is consistent with past experience; these measurements are not considered to be reliable indicators of the age of the lava flow. Step-heating analysis of feldspar separates obtained from partially fused tuff lithic fragments from the Ql_3 lava show that the lava can be no older than 100 ka, consistent with recent results from cosmogenic ^3He age determinations.

Work in Progress. Staff began risk simulation studies of the alternative models of E1 and E2. We will calculate distributions of the tripartite conditional probability.

Staff is completing final revisions to Study Plan 8.3.1.8.1.2, "Physical Processes of Magmatism and Effects on the Potential Repository."

Final details of a consultant contract with G. Thompson of Stanford University are being completed. Thompson will evaluate the completeness of the geophysical data used in the *Volcanism Status Report.*

Staff met with representatives of the DOE and the M&O to discuss the agenda for the NRC technical exchange scheduled for June.

Planned Activities

Revised geologic mapping will be conducted at Lathrop Wells and at the 3.7 Ma basalt centers of Crater Flat.

Field work will be conducted in New Mexico on the geometry of basalt intrusions and the depth of derivation of country rock fragments.

Volcanism staff will participate in a technical information exchange with the NRC in June.

Staff will prepare presentations for the upcoming Focus '93 meeting.

Problem Areas

Trench construction at basaltic centers in the Nellis Air Force Range may require a formal EIS before work may be started.

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 completed.

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

No activities reported this month.

Planned Activities

No planned activities reported this month.

Problem Areas

None

Milestone Progress

None

Publications

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

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

Hydro Geo Chem began processing a suite of 19 cutting samples from UZ-16 (surface to 1171 ft depth) for chlorine-36 analysis. The selected samples came from the fill dirt and alluvium; the Paintbrush nonwelded unit; and the base of the Topopah Spring welded unit, including the basal vitrophyre.

Three ground-water samples from the Amargosa Desert were received from J. Czarnecki of the USGS's Regional Saturated-Zone Hydrology activity. These samples are also being processed for chlorine-36 analysis.

Soil samples were collected from a shallow profile near Test Cell C (NTS Area 25) in order to test the hypothesis that high concentrations of chlorine-36 were produced in this area during the nuclear reactor engine tests that were conducted here in the 1960's.

Two technical detailed procedures (DPs) were issued: LANL-INC-DP-92, R1, "Sample Leaching to Extract Soluble Chloride and Bromide"; and LANL-INC-DP-95, R1, "Preparation of Samples for Chloride-36 Analysis."

J. Fabryka-Martin sponsored the Chloride and Chlorine-36 Studies in the Arid Southwest Workshop on 14-15 April in Las Vegas. Staff members from the USGS Characterization of Unsaturated Zone Infiltration activity, as well as representatives from LLNL, SNL, PNL, Desert Research Institute, REECo, New Mexico Institute of Mining and Technology, and Texas Bureau of Economic Geology participated in the workshop. The attendees presented overviews of their research activities as they pertained to estimating infiltration rates and discussed the strengths and limitations of infiltration estimates based on chloride and chlorine-36 measurements. A workshop summary is being prepared.

J. Fabryka-Martin attended the 1993 IHRLWM Conference in Las Vegas, NV, 26-30 April. J. Fabryka-Martin submitted a summary entitled "Distribution of Chlorine-36 in the Unsaturated Zone at Yucca Mountain: An Indicator of Fast Transport Paths" to the FOCUS '93 meeting.

Planned Activities

Revise existing DPs; prepare new DPs; process soil samples for Cl/Br and chlorine-36/Cl ratios; process cuttings 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

3191
Procedure for Chlorine-36 Analysis of Unsaturated Zone Samples
30 September 1992
Complete

3362
30 September 1993
Summary of Cl-36 Work

Publications

None

WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF

Objective

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

Activities and Accomplishments

This task has been deferred because of lack of funding.

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

Objective

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

Activities and Accomplishments

B. Robinson continued to serve as CCB Chair, and Z. Dash continued as a member of the CCB. A draft of the FEHMN SRS was completed and will be submitted for review. Review comments for the NONLIN_LSQ nonlinear least squares application were addressed.

Development of the computer code SORBEQ were completed. A Los Alamos report on the SORBEQ documentation was in review.

Calibration curves for measurement of the microsphere concentrations using the flow cytometer were made, confirming that the technique has a sensitivity of at least two orders of magnitude lower than fluorimetry.

B. Robinson and P. Reimus attended the 1993 IHLRWM Conference in Las Vegas, NV; Reimus presented a paper on aperture characterization, flow tests, and transport modeling for a fractured tuff laboratory specimen.

Planned Activities

Contribute to the SQA effort by serving as CCB Chair (B. Robinson).

Complete documentation of batch sorption experiments using lithium bromide.

Continue modeling studies using FEHMN to support the design of the field tests.

Pack column to be used in Li column tests and develop operating techniques for the experiments.

Start flow and transport tests on the Bandelier tuff fracture to develop techniques for the C-Wells fractures.

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 March 1993 because of personnel reassignment.

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

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
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special Issue on the Yucca Mountain Project* (3201)
Submitted to YMPO (Russell Dyer).

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

P. Reimus, R. Glass, and B. Robinson
Aperture Characteristics, Saturated Fluid Flow, and Tracer Transport Calculations for a Natural Fracture (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

Staff continued to address reviewer's comments on the study plan.

Modeling of various radionuclides in compositions of ground-waters from Yucca Mountain continued. As expected, the highest solubilities of U and Np were calculated in waters with highest bicarbonate concentrations. Modeling for "most active ground-water" should be completed in June.

Modeling of pH and Eh stability continued.

Planned Activities

Continue resolution of comments on the study plan.

Complete letter report on most active ground-water.

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 calcite, quartz, clinoptilolite, and hematite and tuffs G4-270 and G4-1506, we continued measuring sorption of Np as a function of Np concentration, ground-water composition, and temperature. The properties of the solid phases may be seen in Table I. (XRD results were provided by the Mineralogy/Petrology task.) We pretreated the solid phases in ground-water (J-13 or UE-25p #1) for two weeks, used centrifugation to separate out the solid phases, 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 using centrifugation, and we used liquid scintillation counting to determine the quantity of ^{237}Np in each phase.

Last month, we reported batch sorption coefficients using an initial Np concentration of 10^{-7} M at 20, 60, and 90°C in J-13 and UE-25p #1 ground-water. This month, we varied the concentration of Np in the ground-waters. (See Tables II and III.) In both J-13 and UE-25p #1 waters, we found that sorption of Np onto calcite decreased with increasing temperature, which was probably due a dissolution/precipitation reaction. For all other minerals and tuffs, sorption increased slightly or remained constant with increasing temperature. In J-13 water, sorption appeared to remain constant or decreased as Np concentration increased. This result is important because a constant K_d over the Np concentration range studied implies that in J-13 water, sorption of Np onto tuffs as a function of concentration is linear; consequently, using a K_d in performance assessment calculations now becomes a defensible approach. A decrease in K_d as a function of concentration (as in the case of calcite and hematite) implies a non-linear sorption isotherm. Np sorption onto the solid phase cannot be described using a K_d (probably because of multiple types of sorption sites on the solid phase); however, we believe that performing experiments close to the Np solubility limit in J-13 water and using the K_ds obtained for performance assessment calculations is a conservative approach to describing radionuclide transport.

In UE-25p #1 water, Np sorption coefficients appeared to increase as Np concentration increased, which may have been caused by oversaturated solutions or sorption co-precipitation mechanisms. All our sorption experiments included control samples (which involved contacting the Np solutions used with the container walls in the absence of a sorbing solid phase), and none of them showed evidence of Np precipitation or adsorption onto container walls. However, we should also consider the work of the LBL solubility group (Task 1.2.3.4.1.3), which suggests that the solubility of Np in UE-25p #1 at 25°C and pH of 8.5 is 7×10^{-6} M. Since Np solubility decreases with increasing pH, it is possible that the Np concentrations in UE-25p #1 at a pH of 8.7–9.0 exceeded the Np solubility limit. To address this problem, the next set of sorption experiments will be performed inside a glove box at a pH 8.5, which will be achieved by introducing CO_2 into the water.

Our next priority is to gather information on the sorption of U and Pu onto the minerals available in tuffs. To this end, the research group at Stanford University has already prepared albite and quartz for U sorption experiments.

Table I. Properties of Minerals and Tuffs

Solid	XRD	Surface Area, m^2/g	Size, mm	% Fe_2O_3	% FeO
calcite, synthetic	no impurities	0.09	39		
calcite	no impurities	0.1	86		
quartz	no impurities	0.18	200	<0.01	0.02
clinoptilolite	no impurities	16.	6.8	0.14	0.16
hematite, synthetic	no impurities	9.1	1.2	99.6	<0.01
G4-270 Topopah Spring	feldspar - 65% tridymite - 25% cristobalite - 7% hematite - 1%		75-500		
G4-275 Topopah Spring	feldspar - 61% tridymite - 24% cristobalite - 11% hematite - 1%	4.3	75-500	1.2	0.02
G4-1506 Calico Hills	clinoptilolite - 64% opal-CT - 16% mordenite - 7% quartz - 5% feldspar - 4%		75-500		
G4-1530 Calico Hills	clinoptilolite - 55% opal-CT - 16% mordenite - 12% quartz - 7% feldspar - 7%	4.3	75-500	0.53	<0.01

Minerals and tuffs have negative surface charges in J-13 and UE-25p #1 waters.

Table II. Results of Batch Sorption Experiments of Np in J-13 Water

	Initial Np Concentration = 7×10^{-7} M K_d (ml/g)			Initial Np Concentration = 1.3×10^{-6} M K_d (ml/g)		
Solid	20°C	60°C	90°C	20°C	60°C	90°C
calcite, synthetic	5×10^{1}	3×10^{1}		3×10^{1}	2×10^{1}	8×10^{0}
calcite	9×10^{1}	3×10^{1}	1×10^{1}	6×10^{1}	9×10^{0}	3×10^{0}
quartz	0	4×10^{-1}	3×10^{0}	0	0	
clinoptilolite	3×10^{0}	4×10^{0}	3×10^{0}	4×10^{0}	5×10^{0}	2×10^{0}
hematite, synthetic	2×10^{3}	2×10^{3}	3×10^{3}	2×10^{3}		
G4-270	1×10^{0}	1×10^{0}	1×10^{0}	1×10^{0}	9×10^{-1}	2×10^{0}
G4-1506	3×10^{0}	3×10^{0}	4×10^{0}	4×10^{0}	6×10^{0}	

No loss of Np due to adsorption to walls of containers or precipitation
pH of J-13 after sorption at 20 and 60°C is 8.4 - 8.6
pH of J-13 after sorption at 90°C is 8.4 - 8.9

Table III. Results of Np Batch Sorption Experiments at 20°C

Solid	Kd (ml/g) J-13 Initial Np Concentration (M)			Kd (ml/g) UE-25p #1 Initial Np Concentration (M)		
	7×10^{-7}	1.3×10^{-6}	2×10^{-5}	6×10^{-7}	3×10^{-6}	2×10^{-5}
calcite, synthetic	5×10^{1}	3×10^{1}		5×10^{1}		
calcite	9×10^{1}	6×10^{1}		6×10^{2}		
quartz	0	0		0		
quartz			3×10^{0}			4×10^{1}
clinoptilolite	3×10^{0}	4×10^{0}	2×10^{0}	1×10^{0}		2×10^{0}
hematite, synthetic	2×10^{3}	2×10^{3}	3×10^{2}	2×10^{3}		9×10^{2}
G4-270	1×10^{0}	1×10^{0}		1×10^{0}	3×10^{1}	
G4-275			1×10^{0}			5×10^{1}
G4-1506	3×10^{0}	4×10^{0}		1×10^{0}	3×10^{1}	
G4-1530			2×10^{0}			

pH of UE-25 p#1 after sorption at 20°C is 8.7 - 9.0

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

P. Rogers presented a talk entitled "Dependence of Radionuclide Sorption on Sample Grinding, Surface Area, and Water Composition" at the 1993 IHLRWM Conference 26–30 April.

P. Rogers and S. Chipera of Task 1.2.3.2.1 completed extensive technical corrections to a draft of a Los Alamos report entitled "Evaluation of Sample Preparation Methods and Pre-Treatment Conditions for Batch Sorption Studies."

Planned Activities

As soon as sample separation by D. Broxton and staff is completed, we will use the AFM to examine the surfaces of hematite crystals separated from Topopah Spring tuff for the presence of natural surface coatings.

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

Work continued on the first set of sterile control studies, and the second set is almost complete. The first set of studies clearly demonstrated that aseptic conditions could be maintained in vadose-zone columns for a extended period of time.

Work continued at UC Berkeley on microbial mineral dissolution. We reported earlier that microorgaisms promoted mineral dissolution under oxidizing conditions. We are now conducting a series of experiments to describe the mechanisms used by microorganisms to dissolve iron from a series of minerals.

A paper by L. Hersman entitled "Preliminary Evidence of a Siderphore Plutonium Complex" was published in the *Proceedings of the Scientific Basis for Nuclear Waste Management XVI.*

Planned Activities

Continue crushed-tuff column studies at Los Alamos. Columns will be inoculated with a pure culture of microorganisms, and the column conditions will be adjusted so that the population of the microorganisms can be controlled.

Continue mineral dissolution experiments at UC Berkeley. Microbial growth will be measured as a function of iron (ferric chloride) concentration. These results will allow us to determine the amount of iron being solubilized from hematite, goethite, etc.

Problem Areas

None

Milestone Progress

3080
30 September 1992
Report on Chelation; Retitled *Preliminary Evidence of a Siderphore Plutonium Complex*
Completed; approved by YMPO on 18 April 1991.

3092
30 September 1992
Report on Colloidal Agglomeration
Draft completed. Milestone completion delayed until TPO decides on suitable publication vehicle. (Probably will be published as an LAMS report.)

3176
30 September 1992
Procedure for Determination of Formation Constants
Completed; submitted to QA project leader 26 February 1993.
(Does not require DOE review.)

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

Publications

L. E. Hersman, P. D. Palmer, and D. E. Hobart
Preliminary Evidence of a Siderphore 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.

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. Previous studies of the NpO_2^+ moiety in carbonate have covered only sporadic regions of the log[carbonate] vs. pH predominance diagram at room temperature. From observation of systematic changes in conditions, several of these studies (often using disparate techniques such as solvent extraction or Uv/Vis spectroscopy) can be linked together to form a more coherent understanding of the system. We have previously reported our results from systematic pH changes, and we have now obtained results from conventional Uv/Vis absorption on the NpO_2^+ speciation vs systematic bicarbonate concentration change. Two species have been observed for 0.04 mM Np solutions at pH=8.47+0.05 and (bi)carbonate concentrations from 1.0 to 0.1 M, with characteristic peaks at 996 nm (high bicarbonate concentrations) and 988 nm (lower bicarbonate concentrations). We used sodium perchlorate as a non-coordinating ion source to keep the ionic strength constant during these experiments, but overtones from ClO_4^- (and HCO_3^-) masked some of this data, and we have subsequently switched to NaCl to keep ionic strength constant. Previous studies have found that Cl^- does not coordinate NpO_2^+ strongly, and the similarity between the results using ClO_4^- and Cl^- verify those results and imply that competition to NpO_2^+-CO_3 coordination from Cl^- is not significant. Furthermore, to minimize the HCO_3^- overtones, care must be taken to re-run the baseline with exactly the same HCO_3^- as will be used in the NpO_2^+ solution. Extensions to lower HCO_3^- concentrations are planned, and this information will then serve as a starting point for temperature-dependent Uv/Vis experiments and parallel NMR studies.

Work on Carbon-13 NMR experiments on U(VI) and Np(V) carbonates continued. Preparative work on ultra-high-purity Neptunium-237 stock solution was completed and shipped to I. Triay for sorption experiments. Thermodynamic binding constants and stability of U(VI) in carbonate solution as measured by Carbon-13 and Oxygen-17 NMR compares favorably to those reported in the NEA database, illustrating the utility of NMR as a species-specific probe for solution studies. We have initiated a stability constant study for Np(V) using Carbon-13 and Oxygen-17 NMR for comparison with ongoing UV-NIR solution studies.

Solubility. Pu undersaturation experiments at pH 8.5 in UE-25p #1 were completed following the oxidation state determinations on the supernatant. For the oversaturation experiments, following approximately 300 days of equilibration time, the predominant Pu species in solution at all pH values was PuO_2^{2+}, which was also the case for the undersaturation experiments. The Eh measurements, which were performed concurrently with the oxidation-state distribution determinations, indicated that the value was the same within experimental error for both under and oversaturation at each pH. The Pu solids isolated from the undersaturation experiments are being dried for subsequent XRD analysis.

Staff continued to address reviewer's comments on Milestone Report 3329, and this will be completed next month. A new report summarizing the undersaturation experiments using Np, Pu, and Am in UE-25p #1 at 60°C was begun.

Activities and Accomplishments (cont.)

C. Carnahan of LBL prepared a report describing the calculated solubility and speciation of NpO_2^+ in UE-25p #1 water under the same conditions used to determine solubility. Carnahan indicated that there was good agreement between calculated and measured values, with a slight adjustment of existing thermodynamic constants. It was determined that these adjustments are meaningful and consistent with our understanding of actinide speciation.

K. Roberts presented a talk entitled "Radionuclide Solubility and Speciation Studies for the Yucca Mountain Site Characterization Project" at the INHLWM Conference in Las Vegas, NV.

Regarding the LBL QA effort, four DP Action Request forms for detailed technical procedures are being submitted. Staff continued to submit historical scientific records (1986-1989) to the Los Alamos RPC. Approximately 3000 pages remain to be submitted. Technical data summaries for Milestone Reports 3010 and 3329 were verified.

Planned Activities

D. Clark, D. Morris, H. Nitsche, and D. Tait will participate in the upcoming Colloid Workshop in Santa Fe, NM. Morris will present a paper entitled "Review of Formation of Radiocolloids" and will serve as the moderator for the session "Potential Sources of Colloids at Yucca Mountain." Nitsche will serve as an expert panelist during this session.

Problem Areas

None

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.

Milestone Progress (cont.)

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
Submitted to TPO.

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)
In preparation.

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

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

Objective

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

Activities and Accomplishments

We continued to study the transport of Np through Yucca Mountain tuffs under advective and diffusive conditions. This month, using J-13 and UE-25p #1 water, we determined the hydrologic parameters for crushed- and solid-tuff columns made with tuffs from G4-270 and G4-1506 and began eluting Np through the J-13 columns.

Diffusion experiments using solid-tuff wafers were also completed. We suspended a tuff wafer in a Np solution prepared with UE-25p #1 water and removed small aliquots (0.1 g) from the solution phase to determine the Np concentration as a function of time. These experiments allow the study of kinetics of sorption onto solid tuff and address the issue of crushed vs. solid tuff for K_d determinations. The dimensions of the wafers used are given in Table I; the relative Np concentration remaining in solution as a function of time may be seen in Figure 1. The equilibrium Np concentration remaining in solution after 180 hours was used to calculate the Np K_d (Table I).

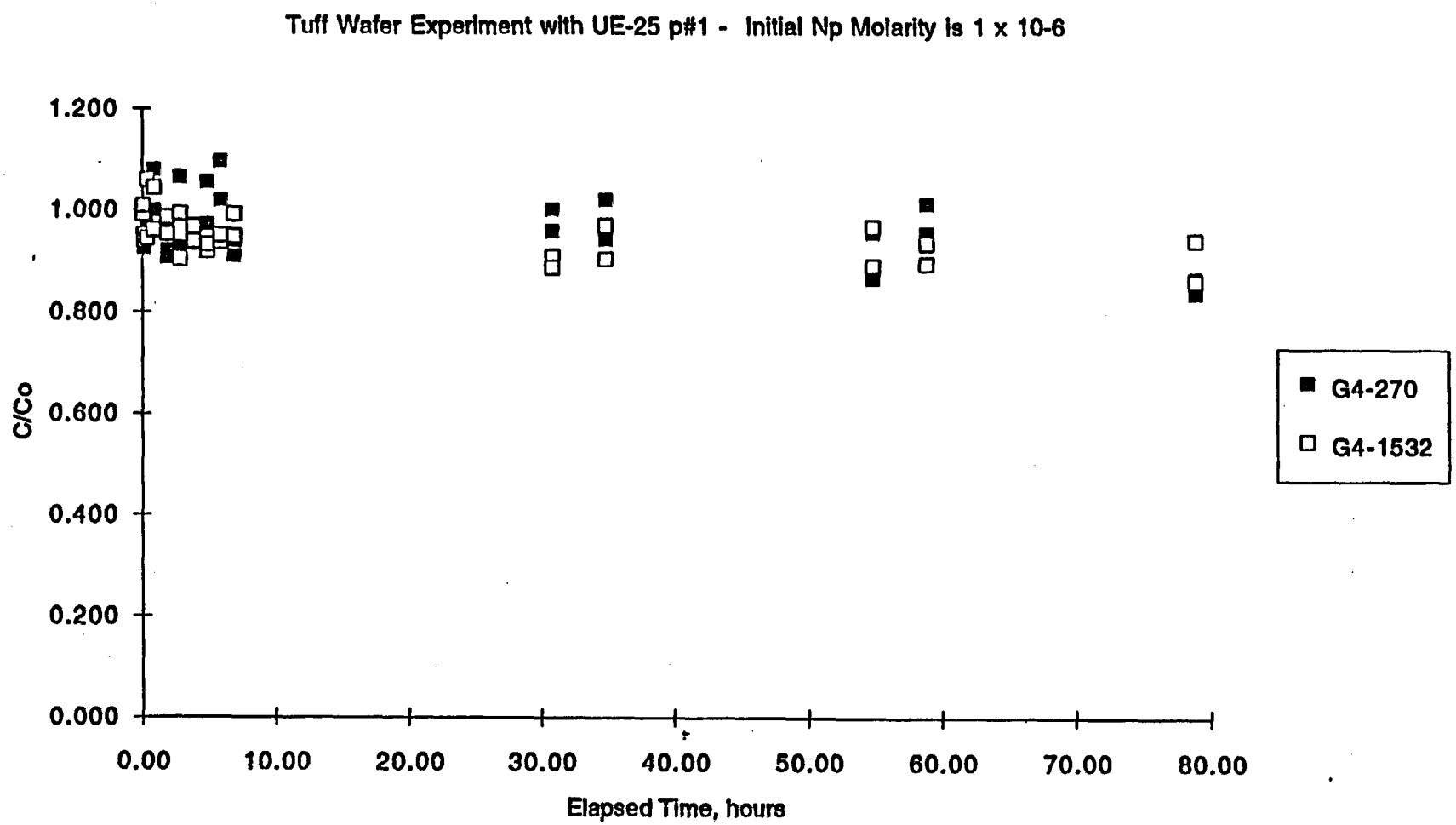
Table I. Description of Tuff Wafers

Tuff	G4-270	G4-1532
Diameter (mm)	13.4	12.8
Length (mm)	6.1	6.1
Np Solution Added (g)	40.	40.
K_d (ml/g)	4	5

These results indicate that the kinetics of Np sorption are very fast, which is an important finding because the use of K_ds in performance assessment calculations implies instantaneous sorption (as seems to be the case for Np). To improve counting statistics and decrease the scatter in Figure 1, future wafer experiments will be performed using higher concentrations of Np.

A paper by I. Triay et al. entitled "Transport of Np through Yucca Mountain Tuffs" was published in the *Proceedings of the Scientific Basis for Nuclear Waste Management XVI.*

I. Triay presented two talks, "Diffusion of Sorbing and Nonsorbing Radionuclides in Tuff and Neptunium Retardation with Tuffs" and "Ground-waters from Yucca Mountain," at the 1993 IHLRWM Conference. Both papers were published in the conference proceedings.


Tuff Wafer Experiment with UE-25 p#1 - Initial Np Molarity is 1 x 10-6
1.200
1.000
0.800
0.600
0.400
0.200
0.000
C/Co
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Elapsed Time, hours
G4-270
G4-1532

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*
In technical review.

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. Staff consulted with H. Trease of the Los Alamos Hydrodynamic Applications Group about the subroutine to generate meshes, and he determined that some reworking was necessary. We now can effectively deal with pinch-out zones and fairly radical grid changes.

Fracture/Matrix coupling. S. Kelkar has made significant progress on fracture-flow calculations. He is attempting to coordinate his theoretical work with laboratory studies to obtain information on relative permeability of fractures. The laboratory studies will probably be conducted at UC Berkeley.

Planned Activities

Begin calculations for ^{36}Cl transport. Perform near-field double permeability calculations to test the performance of various thermal load designs.

Build grids for isothermal infiltration and transport calculations.

Problem Areas

None

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

International Programs. A report for the quarter ending 31 March was prepared. It appears in the Appendix to this monthly report.

Publications

None

WBS 1.2.5.2.2 Site Characterization Program

Objective

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

Management and Integration

Staff responded to comments on the *Calcite-Silica Topical Report*. Staff began preparing 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. The Phase I Review by the NRC was completed on 8 April 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.

Study Plans (cont.)

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.

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.

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 November 1992.

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

Demonstration of the Applicability of Laboratory Data to Repository Transport Calculations, 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 are being addressed.

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 backlog issues on the following items previously submitted to both the SEPDB and the records center:

- Located the DTNs for report LA-11497-MS, submitted to and accepted by SEPDB 10/31/89 (LA000000000018.001, TDIF #300491) and for report LA-11787-MS, submitted to and accepted by SEPDB 3/31/92 (LA000000000002.001, TDIF #200185). Sent the appropriate information on these items to the YMP TDB and ATDT managers.

- Entered information on report LA-10927-MS, submitted to and accepted by the SEPDB on 5/25/87, into the ATDT (LA000000000039.001, TDIF #301155). Relayed the appropriate information on this item to the YMP TDB and ATDT managers and initiated records package.

- Entered report LA-10188-MS, submitted to and accepted by the SEPDB on 10/3/90, into the ATDT (LA000000000038.001, TDIF #301149). Relayed the appropriate information on this item to the YMP TDB and ATDT managers and initiated records package.

Worked with ATDT manager to resolve differences on TDIF forms (#300807 and #300933) and the information that was previously entered into the ATDT for LA000000000026, which was a submission to the TDB on LANL Rock Varnish Calibration work.

Entered information into ATDT and completed TDIF forms on several other reports. This was done to create data tracking numbers (DTNs) so that work at other laboratories being entered into the ATDT could identify these data, when appropriate, as being used to generate new developed data. These included:

- LA-10667-MS, which was given DTN LA000000000040.001 and TDIF #301230.
- LA-8840-MS, which was given DTN LA000000000041.001 and TDIF #301231.
- LA-9328-MS, which was given DTN LA000000000037.001 and TDIF #301242.
- LA-10960-MS, which was given DTN LA000000000042.001 and TDIF #301243

Planned Activities

Continue review of files to resolve inconsistencies and bring records up to date.

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 PIs.

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

The lower-boundary-condition device was installed, and staff has almost completed connecting it to the manifold of the 264 porous cups. Fabrication of the hollow-fiber solution samplers was completed.

E. Springer presented a talk entitled "Testing Models of Flow and Transport in Unsaturated Porous Media" at the 1993 IHLRWM Conference; the paper was published in the conference proceedings.

Planned Activities

Fill the caisson and install sampling equipment.

Problem Areas

Staff must revise and resubmit the special work permit for filling the caisson with sand.

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

Using a two-dimensional grid, we made some initial calculations, which were based on Covela data and canister heating loads developed by SNL. The run was on a section across the mountain.

Cartoons provided by D. Vaniman suggest that infiltration and bulk permeability in Solitario Canyon may be important for the thermal repository issue.

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 completed the following test planning and job packages: Geologic Mapping, Construction Monitoring, and Perched Water for the ESF north-portal starter tunnel. Staff began planning for the LLNL large-block test; site selection at Fran Ridge for this test is underway.

Staff continued to support issues that relate to tracers, fluids, and materials (TFM) at Yucca Mountain, with emphasis on FY 1993 and north-portal starter tunnel requirements. Staff continued to develop Los Alamos TFM database and to support TFM evaluations for waste isolation impact and test interference analyses.

Staff participated in weekly Field Engineering/PA/QA meetings and supported M&O-led effort on establishing/revising thermal goals for the repository.

The Monthly Progress Report for April on ESF testing activities was prepared and appears in the Appendix to this document.

Planned Activities

Staff will continue to focus on consolidating ESF thermal and mechanical testing and work with the M&O to develop mechanical mining techniques for the main test area of the ESF. Staff will work toward consolidating ESF thermal tests and developing an integrated network. Staff will continue to support Director of ED&D in the area of ESF testing in particular, testing for WBS 1.2.2 and 1.2.4., and construction monitoring testing. A meeting is scheduled for 3 May between ED&D and the U.S. Bureau of Mines to discuss to develop data acquisition system.

Publications

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

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 work continued on schedule. The M&O completed an Engineering Plan for IDS, which was reviewed by Los Alamos and released by M&O following ED&D signature. Staff visited Waste Isolation Pilot Plant (WIPP) at Carlsbad, NM, to become familiar with their data management system.

Staff met with representatives of the Denver branch of the U.S. Bureau of Mines, to discuss IDS concepts developed by this branch for the mining industry.

Staff requested that the M&O brief ED&D on the current status of IDS design.

Planned Activities

Staff will continue to provide oversight of design and development of the IDS by M&O and develop an IDS technical requirements document.

Staff will revise IDS Functional Requirements Document developed by Los Alamos. A meeting with IDS users and M&O will be scheduled in late May or early June to discuss specific requirements of each user. Staff will 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 1.2.9.1.2 Technical Project Office Management

Objective

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

Activities and Accomplishments

Management staff attended the April meeting of the Technical Advisory Group and reviewed the FY94 Annual Plan.

Management staff hosted a visitor from the Swedish Embassy.

The TPO attended the 1993 IHLRWM Conference (26-29 April) and the International Programs meeting; both were held in Las Vegas, NV.

The TPO presented an overview of the Laboratory at the Las Vegas OCRWM Fellowship meeting and conducted interviews with students.

The TPO presented an overview of Yucca Mountain Project to staff members from the Accelerator Technology Division at Los Alamos.

The TPO hosted an internal ES&H assessment of the program office space and held monthly ES&H meeting with key ES&H staff; actions for items to be brought up at DOE safety meetings were identified. A overview of Volcanism trenching operations by the Los Alamos independent safety officer was presented.

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

D. Holmes and M. Njegomir attended a one-week session of the Washington University Master's in Project Management program.

Staff continued to modify and debug software used for downloading information. This system has been tailored to match elements of cost in PACS Participant Workstation.

PACS status was submitted to the YMPO on 13 April.

Planned Activities

Download software to be used in the June status report. At that time further refinements to the Los Alamos internal estimating and cost-performance reporting methods will be implemented.

DOE/AL will conduct a Budget Book validation on the Los Alamos FY 1995 budget submission on 2 June.

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)

Staff submitted a revised Detailed Transition Plan (R3) and Impact Analysis (R2) to YMPO. We anticipate completion of activities for implementation of the new QARD by August; our major emphasis is revising the procedures. We are also looking at a more efficient method of displaying our organization chart. A quarterly Q meeting was held. The issues discussed included obtaining accession numbers and accessing the RIS.

Personnel. R. Morley's position description was changed to Information Services Specialist, reporting to the ACPL. M. Robinson's position description was changed to Database Administration Specialist, reporting to the software coordinator. M. Clevenger was appointed to the position of Deputy QAPL, reporting to the QAPL; Clevenger also will serve as DR Coordinator and EES-13 QAL.

Travel. S. Bolivar, P. Gillespie and D. Williams attended various sessions of the 1993 IHLRWM Conference; S. Bolivar and J. Day attended the Project Quality Assurance Committee meeting; C. Chavez and L. Sanders attended a records coordinator meeting; C. Mechels and L. Sanders attended a Information Resources Management Council quarterly meeting. All meetings were held in Las Vegas. C. Mechels also attended a Software Advisory Group function in Denver.

Procedure Revisions. Twenty-two procedures are currently being revised, and an additional seven are in formal review. Two procedures have been completed and await entry into the RTN system. Two technical detailed procedures (DPs) were issued: LANL-INC-DP-92, R1, "Sample Leaching to Extract Soluble Chloride and Bromide"; and LANL-INC-DP-95, R1, "Preparation of Samples for Chloride-36 Analysis."

Training. S. Bolivar attended the third session of a video conference training course on radioactive waste management. Training requirements for the new class on records management class were discussed at length; a pilot training class will be held 12 May. R. Morley and M. Robinson attended VAX classes in San Diego. J. Day and S. Bolivar received QARD training.

Audits and Surveys (WBS 1.2.11.3)

The audit plans for EES-1 and EES-5 were approved. The EES-1 audit was completed; three deficiency reports were issued. Audit report LANL-AR-93-01 (TCO) was approved and issued. The quarterly trend report was completed and distributed.

Quality Engineering (WBS 1.2.11.5)

The six software procedures were reduced to four; these four are now being edited. The Software Quality Assurance Manual will become a guideline document. The Software Management Status Report was issued; a part of a continuous quality improvement (CQI) exercise, this quarterly document was reformatted, which resulted in a substantial reduction in size.

Planned Activities

The pilot training class for QP-17.6 will be reviewed. The majority of efforts will be directed at revising procedures to satisfy the new QARD. Corrective actions on stop work order SWO-03 will continue. The audit of EES-5 activities will be conducted. Compilation of the 1992 Quality Assurance Status Report will continue. 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

Staff attended a record coordinators meeting and a record council meeting in Las Vegas, Nevada, on 26 April.

Eighty-four records and/or record packages were received by the RPC; twelve of these were rejected and returned to their originators for corrections.

Eighty-two records and/or record packages were submitted to the CRF. The CRF rejected one record package.

Planned Activities

No planned activities reported.

Problem Areas

None

WBS 1.2.15.2 Administrative Support

Objective

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

Activities and Accomplishments

S. Klein, Los Alamos editor, reviewed and edited three 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 April. All reports were transmitted to the M&O and YMPO.

The editor completed the first draft of the February/March YMP Monthly Activity Report.

The editor transmitted comments on the 8th YMP Progress Report to the M&O.

S. Klein attended the IHLRWM Conference in Las Vegas, NV.

The TIP database was revised, incorporating management suggestions.

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

The training database program is still undergoing testing.

S. Bolivar, E. Cole, and C. Chavez met with A. Anthony to review a class for QP 17.6 that Anthony is developing.

Training records for two Los Alamos divisions, Earth and Environment Sciences and Isotope and Nuclear Chemistry, were forwarded to C. Chavez for review. She will be responsible for maintaining all training records and ensuring dual storage of these records.

QP 2.13, R0, "Personnel Selection and Training Needs Assessment," is in internal review.

Planned Activities

No planned activities reported.

Problem Areas

None

Appendix

April 1993

Monthly Activity Report

Preliminary Description of Fracture-lining Minerals in Drill Core UE25 UZ-16

Barbara Carlos, EES-1

Introduction

The purpose of this preliminary report is to make general information on the distribution of fracture-coating minerals in UE25 UZ-16 available as soon as possible to other investigators on the Yucca Mountain Site Characterization Project. X-ray Diffraction and electron microbeam analyses have not yet been performed on samples from this core, and some of the mineral identifications in this report are subject to change upon further analysis. The report is intended for guidance to other investigators in selecting intervals that they may be interested in studying. A more complete report will be published when XRD and microbeam analyses of representative samples have been completed, and data will be submitted to the SEPDB at that time.

At Yucca Mountain, there is a general correlation between fracture coatings and stratigraphy. This also appears to be true in UE25 UZ-16. Therefore the following discussion is organized by stratigraphic unit.

Tiva Canyon Member

The drill core intersected the Tiva Canyon Member at 39.7 ft in a zone of flattened lithophysae. Fractures and breaks in the core from 39.7 to approximately 62 ft depth are coated with tridymite and abundant calcite and opal. Fine-grained white material is believed to be clay.
Starting at about 62 ft, manganese spots coat 5-10 % of fracture surfaces to about 80 ft depth. SiO_2 with no visible crystal morphology partially coats some fractures with manganese. Calcite is abundant, generally coating 100% of the surface (or sealing the fracture) where it occurs. Fine grained white material in this interval is probably clay, but may be crushed calcite in some cases.
Below about 92 ft depth, examination of the core in short-wave UV indicates frequent opal, although it is not always obvious without UV. From 92 to about 140 ft, small crystals that cannot be identified, but may be prismatic zeolites or tridymite, partially coat some fractures. Calcite is abundant, still coating 100% of the fracture surface where it occurs. Two generations of calcite may be present. A few fractures between 107 and 110 ft have up to 15 % Mn spots (under calcite on one fracture).
Below 140 ft calcite and opal cement fractures, some of which include brecciated matrix. A trace of fine-grained white coating at about 154 ft may be mordenite or clay.

From 154 ft, through a bedded interval, to 229 ft (in the upper Topopah Spring Member), the tuff is non- or partially-welded and contains no coated fractures.

Topopah Spring Member

Calcite and/or opal are the most abundant fracture coatings from the top of the densely welded quartz latite in the Topopah Spring Member to about 300 ft. The deepest opal in this interval (identified by UV response) is at 332 ft. Below 272 ft small vapor phase crystals of tridymite (gray in hand sample) become increasingly abundant. The gray appearance is probably caused by very small hematite blades intergrown with the tridymite and in the matrix just below it. Calcite is common over tridymite in lithophysal cavities and fractures to about 547 ft depth (approximately the base of the upper lithophysal zone). Euhedral quartz is present, but not common, in the lithophysal cavities and fractures. Within the lithophysal zone, from about 472-502 ft, some fractures have a 40-100% coating of prismatic crystals that are probably zeolites (heulandite or stellerite). Crusts of fine-grained white material coating 5-20% of the fracture surfaces at 362 ft and 472 ft are probably mordenite.

Below the upper lithophysal zone, from about 548-680, ft the dominant coatings are manganese-oxide spots and dendrites and prismatic crystals that are probably zeolites (stellerite or heulandite). Fine-grained white coatings may be mordenite or clay. Coverage by the different coatings varies, but Mn-oxides commonly are 5-15%, though they may get as high as 60% (551-553 ft). Prismatic crystals locally coat 100% of a fracture surface, but the distribution may vary over the length of a singe fracture, averaging 20-40% at the top of the interval, increasing to 100% with depth. Fine-grained white crusts are on only a few fractures and generally cover less than 5% of the surface. Lithophysal fractures (quartz or tridymite coatings and "bleached" margins along the fractures) cut the core at 560, 590, and 644-645 ft. Prismatic crystals are visible over the tridymite when the fractures are open. From 680-746 ft, prismatic crystals and manganese oxide spots both diminish in abundance to 5-10% surface coverage on fractures in which they occur.

Tridymite and hematite coat lithophysal breaks in the core (indicating proximity to the lower lithophysal zone) below about 729 ft, and occur in lithophysal cavities from about 746 to about 937 ft. Prismatic crystals, probably zeolites, coat non-lithophysal fractures (usually 100%) and sometimes overlie tridymite on lithophysal fractures. A few fractures below 905 ft have sparse(<5%) Mn spots, mostly under prismatic crystals. The fine-grained white coating on some fractures below 914 ft is probably mordenite. Calcite occurs over prismatic crystals on a fracture at about 924 ft. Probable mordenite overlies the prismatic crystals on one side of the fracture. Calcite overlies tridymite in an intersecting fracture.

Below about 937 ft, prismatic crystals are often large enough to be visually identified as stellerite. Sparse spots of manganese-oxide underlie prismatic crystals on some fractures. A fine-grained white coating, probably mordenite, occurs with and over the stellerite (stellerite 100%, mordenite 5-20%). These two zeolite minerals cement occasional brecciated fractures from about 942-1000 ft. In a few fractures below 981 ft, calcite coats prismatic crystals. From about 1065-1085 ft stellerite occurs with euhedral quartz. Spots of manganese oxide cover up to 30% of some fracture surfaces.

Between the lower extent of lithophysal cavities and breaks (about 1085 ft), and the basal vitrophyre, fracture coatings include stellerite and quartz, stellerite and possible mordenite over Mn spots, prismatic minerals that could be stellerite or heulandite, and sealed lithophysal coatings. Calcite occurs over stellerite and mordenite at about 1110 ft.

Fracture-coatings in the vitrophyre are fine-grained white to blue-white with desiccation cracks, and manganese-oxide dendrites. Based on previous analyses of other drill cores, the fine-grained white material is most likely to be smectite +/- a zeolite. Fine-grained blue-white material seen in this interval is similar to opal CT identified in previous drill cores. A fracture at 1114 ft contains crystals (unidentified) over probable quartz. Calcite cements a brecciated fracture from 1154-1157 ft (probably with opal-CT under the calcite).

There are few coated fractures in the Topopah Spring Member below the vitrophyre. The most likely minerals under the calcite in the fracture at 1183 ft are clinoptilolite and mordenite. From 1201-1202 ft the thin white coatings are probably mordenite.

Tuff of Calico Hills

Most of the coated fractures near the top of the tuff of Calico Hills contain thin coats of fine-grained white material, probably mordenite. Analyses of other drill core suggests that minor amounts of clinoptilolite may be present, but cannot be visually identified. Planar fractures at 1220, 1243 , and 1248 ft have a red-brown stain that probably contains hematite, and possibly quartz. Manganese appears to be present on the slickensided fracture at 1220 ft. From 1255-1315 ft, fractures are less abundant, and no coatings (other than drilling debris) were identified. Fractures from about 1319 to 1353 ft contain fine-grained, often satiny coatings, probably mordenite.
From 1353 to 1546 ft there are very few fractures not marked as being man-made, and almost all of the unmarked ones have no coating. A fracture at 1458 ft is mostly closed and probably contains mordenite.

Crater Flat Tuff

No coated fractures were observed in the Crater Flat Tuff above 1546 ft. From 1546 to about 1609 ft, fractures are not abundant, but all appear to contain Mn-oxides +/- hematite. The Mn-oxides often appear to be diffused into the matrix adjacent to (mostly closed) fractures and appear as staining rather than coatings. Fractures are often hairline and are traceable by their black discoloration and small air gaps. Fractures with continuous Mn-oxide coatings (rather than staining and patches) were identified in rubble at 1579 ft, and from 1602-1608 ft, where the fracture also contains hematite and white crystals that may be quartz pseudomorphs of tridymite.
From 1609-1622 ft much of the core had already been removed from the box as natural state samples, as about 1608 is the depth where water was first observed in the hole. Fractures on core remaining in the box had no coatings. Closed hairline fractures at 1622 and 1626 ft contain Mn-oxides and hematite. The next coated fracture in the core box is a calcite-coated vertical fracture intersected by the edge of the core from 1639-1641 ft. From 1646-1655 ft, fractures contain Mn-oxides and probable mordenite. The fracture from about 1649-1650 is 0.5-2.0 mm wide and contains fragments of matrix cemented by manganese oxides which are intergrown with ground matrix or silica. From 1655-1668 ft breaks in the core have no coatings other than drilling debris. From 1668 ft to TD (1686.2 ft) the tuff is non-welded, mostly unbroken, and has no fracture coatings.

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Isotope and Nuclear Chemistry Division

DATE April 1, 1993
IN REPLY REFER TO INC-6-93-257
MAIL STOP J514
TELEPHONE 667-4845

APR 19'93

Robert A. Levich
Project Director, DOE/AECL SA2
Department of Energy
Yucca Mountain Site Characterization Project Office
P.O. Box 986608
Las Vegas, NV 89193-8608

Dear Robert:

Subject: Report for Quarter Ending 03/31/93 of Cigar Lake-Analogue Study — Actinide and Fission Product Geochemistry Task of DOE/AECL Subsidiary Agreement Number 2

Current status and accomplishments: This report includes results of an integrated effort of Los Alamos National Laboratory personnel Ernest Bryant, David Curtis, Paul Dixon, June Fabryka-Martin, Richard Perrin, and Don Rokop, Carol Bruton at Lawrence Livermore National Laboratory, and Jan Cramer and his colleagues of AECL Research.

Groundwater Movement and Mass Transport at the Cigar Lake Ore Body

- Stable isotopes of noble gases, produced by nuclear reactions in uranium ore have the potential to provide information about groundwater residence times in uraniferous rock, and indicate water movement and mass transport away from such rock. Calculations indicate that krypton isotopes will probably not be useful for groundwater dating and tracing. However, ratios of $^{136}Xe/^{130}Xe$, $^{134}Xe/^{130}Xe$, $^{132}Xe/^{130}Xe$, and $^{21}Ne/^{20}Ne$ may be good qualitative indicators of groundwater residence times in the ore body. This work is not specifically identified as a milestone in the workplan.

- Analyses were started to determine noble gas isotope abundances in groundwater from the environs of the Cigar Lake ore body. This work is not specifically identified as a milestone in the workplan.

- LANL personnel are working with Jack Cornet at Chalk River to measure and interpret $^{36}Cl/Cl$ ratios with respect to radionuclide retention and transport at Cigar Lake. Calculated evaluations of pre-bomb atmospheric $^{36}Cl/Cl$ suggest that measured values of this ratio in groundwater samples from wells 239H and 71A reflect recent meteoric recharge with no significant postnuclear-testing chloride.

- Results of ^{129}I measurements in Cigar Lake groundwater were obtained from the Nuclear Structure Research Laboratory at the University of Rochester. Results show the smallest concentration in water upgradient from the ore zone (well 139 AL), the largest concentrations in samples from within the zone (wells 79BL and 220AL), and intermediate concentration in water upgradient from the ore (219BL). Preliminary interpretation suggests that ^{129}I is preferentially released relative to uranium from host minerals. It appears that measured concentrations represent release of a small fraction of ^{129}I produced in uranium minerals. We are presently unable to determine if the release was the result of natural processes, or drilling. This represents partial completion of milestone 6.

Radionuclide Retention in Spent Fuel Analogues — Uranium Minerals

We continue to work on the determination of ^{99}Tc and ^{239}Pu abundances in samples from Cigar Lake core 220 to understand processes of radionuclide release and retention from their uranium host minerals.

- ^{239}Pu has been measured in CS-604 and CS-615. Measured concentrations are much greater than predicted in these samples by the nuclear reaction model. Inconsistencies between multiple analyses on the same sample indicate a problem with the analytical procedure. Analysis of blanks does not indicate the presence of plutonium contamination. One of several possible explanations for the result is that processes in the Cigar Lake ore have enriched plutonium in these samples in the last hundred thousand years. Additional measurements and considerations of the nuclear process models will be required to verify and understand these results. This represents partial completion of milestone 6.

- ^{99}Tc has been measured in CS-620B, CS-604, and CS-609. Preliminary interpretations indicate that ^{99}Tc has not been fractionated from uranium in CS-620B, or CS-604. Surprisingly CS-609 contains a large excess of the radioactive fission product. One interpretation of this result suggests that processes active in the ore body in the last million years have resulted in preferential accumulation of technetium relative to uranium. Data will have to be carefully evaluated before the meaning of this result is understood. This represents partial completion of milestone 6.

Geochemical Modeling

- A letter report has been prepared describing geochemical controls on U concentrations in Cigar Lake groundwater. Interpretations of geochemical models suggest that U-silicates may be important controls on aqueous concentrations of U in a Si-rich environment such as that at Cigar Lake.

Status of Milestones and Problems

- A report titled *Geochemistry of ^{239}Pu, ^{129}I, ^{99}Tc, and ^{36}Cl* was submitted to the Australian Nuclear Science and Technology Organization for publication in the final report of the Alligator Rivers Analogue Project. This report represents the completion of milestone 9.

- The development of reliable procedures for measuring abundances of ^{99}Tc and ^{239}Pu in uraniferous rock continues to be a problem. Although we report preliminary results for these radionuclides, the analytical procedures are not reliable at this time, and the results of these efforts should be viewed with caution until they can be confirmed by more reliable procedures. It is likely that these difficulties will result in a delay in meeting milestone 15.

Programmatic Activities

- Bob Levich, the project manager, was briefed on program efforts at LANL on March 11.
- David Curtis provided an overview of Natural Analogue Project work to individuals attending the Yucca Mountain Project performance assessment information exchange at LANL on March 17.

Sincerely,

David B. Curtis

DBC:jh

cy: Jan Cramer, AECL Whiteshell Laboratory
Carol Bruton, Lawrence Livermore Laboratory
Henry Shaw, Lawrence Radiation Laboratory
Julie Canepa, LANL YMP Project Office, MS J521
Ernest Bryant, INC-6, MS J514
Paul Dixon, LANL, INC-6, MS J514
June Fabryka-Martin, LANL, INC-9, MS J514
Dick Perrin, INC-6, MS J514
Don Rokop, INC-6, MS J514
INC-6 File

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WBS 1.2.6.1.1, 1.2.3.1
"QA N/A"

memorandum

TWS-EES-13-LV-05-93-13

May 17, 1993
702/794-7095
M/S 527

TO: J. Dyer, DOE/YMPO
W. Simecka, DOE/YMPO

FROM: R. Oliver, LANL RO

SUBJECT: EXPLORATORY STUDIES FACILITY TESTING ACTIVITIES - APRIL 1993 - MONTHLY PROGRESS REPORT

GENERAL EXPLORATORY STUDIES FACILITY (ESF) ACTIVITIES

SITE CONSTRUCTION

Job Package (JP) 92-20 ESF North Portal Pad and Facilities

Construction of the ESF Starter Tunnel commenced on April 8, 1993, with a small "trim" blast to square up the face at the box cut. The first blast for the 12 ft by 13 ft center crown drift occurred on April 13, 1993. A total of 9 (6 ft), 1 (4 ft), and 2 trim blasts occurred during this month. The face of the center crown drift is at construction station (CS) 0+65 using Reynolds Electrical and Engineering Company, Inc. (REECo) stationing.

Underground work ceased for three shifts between April 29 and 30, 1993, awaiting resolution of concerns about ground movement. Survey of known photogrammetry targets showed no ground movement and REECo returned to work.

TEST PROGRAM

Final planning records for the first three ESF Site Characterization Plan Test activities to be deployed in the North Ramp Starter Tunnel were completed and controlled April 2, 1993 (See Table I). The general strategy for test planning and implementation is a function of starter tunnel construction progress, the tests, and associated records as illustrated by Attachment 1. A general ESF Test Event schedule is provided as Attachment 2. Geologic mapping and construction monitoring activities are proceeding as planned, no perched water was identified during the period. Progress by test is provided as appendices to this monthly progress report.

MAY 21 '93

TABLE I
ESF Testing Field Activities
North Ramp Starter Tunnel

SCP PROGRAM	STUDY NAME	SCP STUDY PLAN NUMBER	TEST NAME	TPP #	JP #	CONTROLLED	FIELD START
Rock Characteristic Program	Characterization of the Structural Features in the Site Area	8.3.1.4.2.2	Underground Geologic Mapping	TPP 92-10	JP 92-20A	4/2/93	4/8/93
Geohydrology Program	Characterization of YM Percolation in the Unsaturated-Zone ESF Investigation	8.3.1.2.2.4	Perched Water Testing in the ESF	TPP 92-11	JP 92-20B	4/2/93	4/8/93
Thermal and Mechanical Rock properties Program	In Situ Design Verification	8.3.1.15.1.8	Construction Monitoring	TPP T-93-2	JP 92-20D	4/2/93	4/8/93
Geohydrology Program	Water Movement Tests, Rev. 0 Water Movement Tests, Rev. 1 Characterization of the Percolation in the Unsaturated-Zone Surface-Based Study	8.3.1.2.2.2 8.3.1.2.2.3	Consolidated Sampling	TPP 92-14	JP 92-20C	Planned 5/10/93	Pending
Geochemistry Program	History of Mineralogic and Geochemical Alteration of YM	8.3.1.3.2.2	Consolidated Sampling	TPP 92-14	JP 92-20C	Planned 5/10/93	Pending

ENVIRONMENTAL, SAFETY, AND HEALTH (ES&H) ACTIVITIES

No unusual ES&H testing activities occurred during the period.

TRACERS, FLUIDS, AND MATERIALS (TFM)

Approximately 18,000 gallons of water with lithium-bromide tracer was reported used during the period by the constructor. Explosives and tunnel support materials were consumed and/or installed during tunnel construction. No significant TFM usage was reported by test organizations during the period.

TEST EXCLUSION AREAS AND TCO TURN OVER

Three samples were collected by the geologic mapping investigators during the period and numerous mapping targets were set, surveyed, and recorded.

None are considered permanent testing exclusion areas.

Nine test releases to construction were submitted for geologic mapping activities in conjunction with starter tunnel construction during the period (Attachment 3).

A release to construction letter was submitted to Engineering and Development Division to release the north ramp portal and highwall box cut to construction (Attachment 4).

Test Specific ESF Activities

Appendix I - Underground Geologic Mapping (JP 92-20A)
Appendix II - Perched Water (JP 92-20B)
Appendix III - Construction Monitoring (JP 92-20D)

Attachments

RDO:smw23

Cy w/o attachment 3 and 4:
D. Williams, DOE/YMPO, MS 523
D. Harrison, DOE/YMPO, MS 523
A. Girdley, DOE/YMPO, MS 717
R. Crawley, DOE/YMPO, MS 523
K. Skipper, DOE/YMPO, MS 523
E. Petrie, DOE/YMPO, MS 523
V. Iorii, DOE/YMPO, MS 523
R. Bullock, RSN, MS 403
B. Gardella, REECo, MS 408
R. McDonald, CRWMS/M&O, MS 423
L. Hayes, USGS, Denver, CO
D. Edwards, USGS/LV, MS 509
L. Shephard, SNL, Dept. 6302, Albuquerque, NM
D. Kessel, SNL/LV, MS 509
W. Clarke, LLNL, Livermore, CA
J. Blink, LLNL/LV, MS 527
J. Canepa, LANL, EES-13, MS J521
A. Mitchell, LANL, INC-9, MS J514
K. Dye, LANL/NTS, MS 735
R. Kovach, LANL/NTS, MS 735
N. Elkins, LANL, EES-13/LV, MS 527
D. Boak, LANL, EES-13/LV, MS 527
D. Weaver, LANL, EES-13/LV, MS 527
D. Rashid, LANL, EES-13/LV, MS 527
EES-13/LV, LANL, MS 527
CRMO, LANL, MS A150

TEST SPECIFIC ESF ACTIVITIES

UNDERGROUND GEOLOGIC MAPPING (JP 92-20A)

PROGRESS - MILESTONES AND DELIVERABLES

The geologic mapping data collection and observation activity started with starter tunnel construction.

SUMMARY OF FIELD ACTIVITIES

The US Bureau of Reclamation commenced mapping the back of the center crown drift of the ESF starter tunnel. Characterization comprised of placing photogrammetry targets every 4 ft taking photos, sketching (or Mapping) the ground conditions, and surveying (as building the photogrammetry targets) in three dimensions. Construction procedures consist of REECo blasting, barring down loose rock, installing rockbolts and wire mesh, cleaning the area, and then mapping. Because of ground conditions, REECo has shotcreted after characterization was complete. No area was covered with shotcrete prior to sketching (or mapping) and photos taken. The attached drawing titled "Crown Drift Geologic Mapping Illustration" is included and indicates sequence of mapping. During the characterization, if an area was unique, samples were taken. This occurred three times. Two samples were taken between CS 0+00 and CS 0+12, and a third sample was taken at CS 0+31.

DATA FLOW INFORMATION

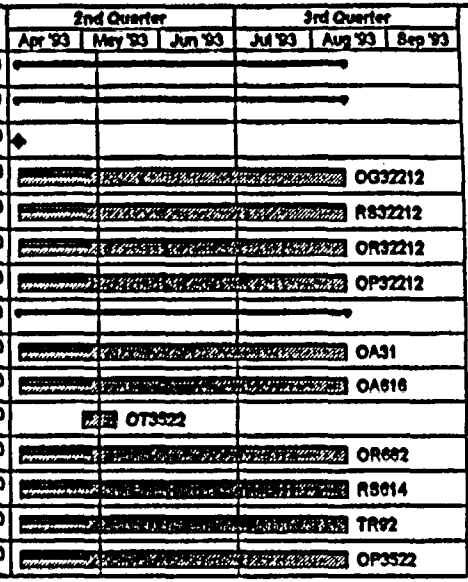
Geologic mapping data was recorded in a scientific notebook. Test-related photo and survey mission data is being submitted to the Job Package record file and the Principal Investigators (PIs).

COST & SCHEDULE SUMMARY

See illustrations for detailed cost and schedule information. The costs and progress on this activity are within the scope set by JP 92-20A.

Geologic Mapping (TPP 92-10/JP 92-20A)
Field Activity Working Schedule
LANL ESF Test Coordination Office

ID	Name	Duration	Scheduled Start	Summary Acct.	Cost Estimate	Estimated Prior Month Cost	Estimated Cost to Date
1	TEST IMPLEMENTATION - GEOLOGIC MAPPING	96d	4/5/93		$286,000	$62,830	$62,830
2	Test Implementation - Discreet	96d	4/5/93		$159,000	$34,760	$34,760
3	Start of Field Testing Activities	0d	4/5/93		$0	$0	$0
4	USGS/USBR Test Implementation	95d	4/5/93	OG3221293	$158,000	$34,760	$34,760
5	RSN Field Survey & Processing	95d	4/5/93		$0	$0	$0
6	REECo Test Construction & Procurement	95d	4/5/93		$0	$0	$0
7	JC Photography & Process	95d	4/5/93		$0	$0	$0
8	Test Implementation - Metrix Support Elements	96d	4/5/93		$127,000	$28,070	$28,070
9	Los Alamos TCO Coordination & Planning (Field Test Coordination Support)	95d	4/5/93	OA3108L3	$32,000	$7,040	$7,040
10	Los Alamos TCO Test Management (Project Engineer Support)	95d	4/5/93	OA616AL3	$16,000	$3,520	$3,520
11	T&MSS Direct Support Services (Photo Support)	10d	4/30/93	OT3522DL	$4,000	$1,200	$1,200
12	REECo Construction & Operations Support (Interim WBS) - (*1)	95d	4/5/93	OR662L3	$31,000	($2,226) $6,820	$6,820
13	RSN Survey Support / Capital Procurement (Interim WBS)	95d	4/5/93	RS614P92	$25,000	$5,500	$5,500
14	CRWMS M&O Networking & Baseline Planning Support (Network & Progress Repor	95d	4/5/93	TR922BA	$8,000	$1,680	$1,680
15	JC Photo Support (Interim WBS)	95d	4/5/93	OP3522L93	$11,000	$2,310	$2,310



Preliminary data—do not reference

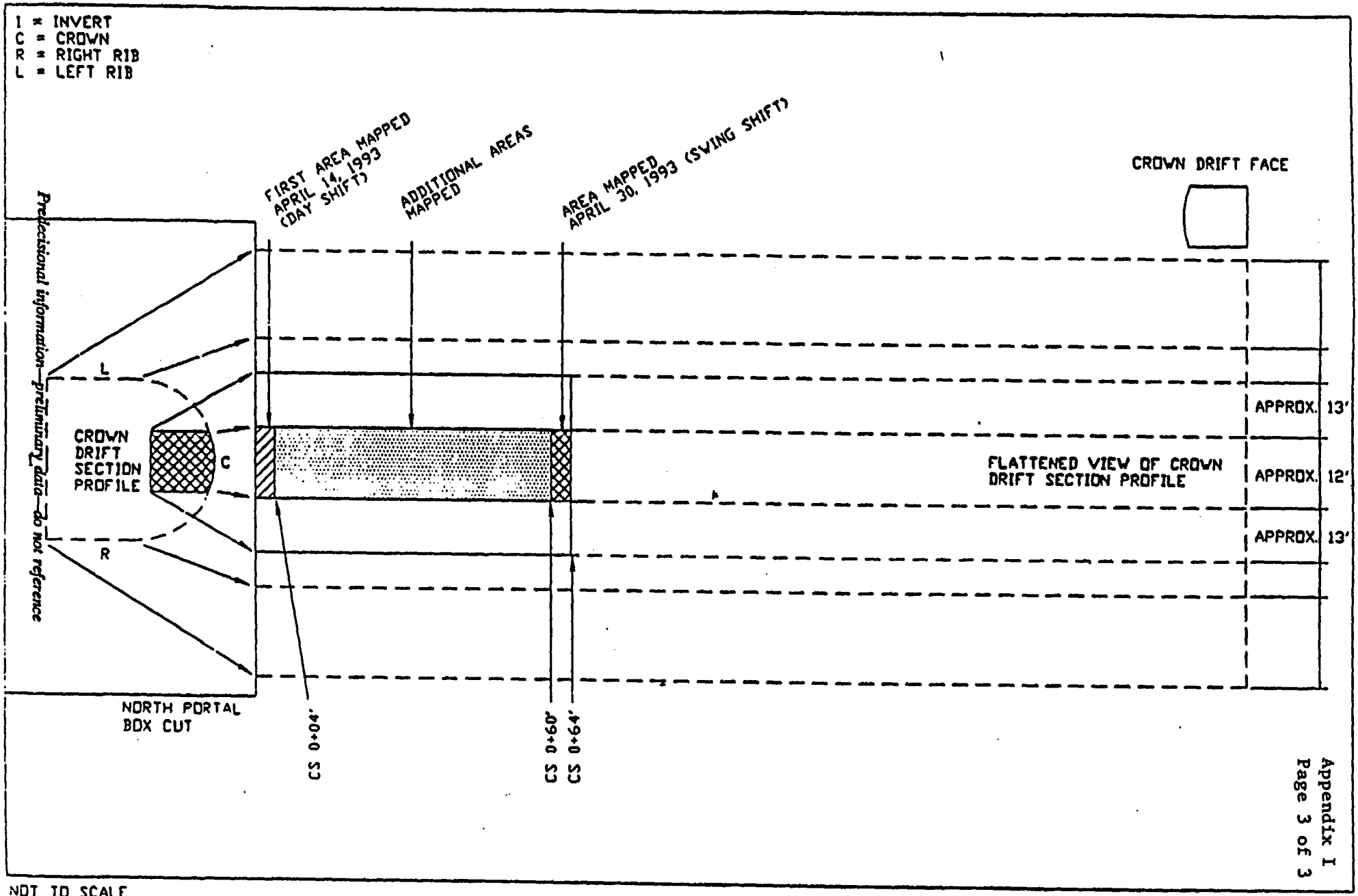
(1) Changed based on participant input.

Project: I-92-10
Date:5/6/93
Revision #0

Activity | Progress | Milestone ◆ | Summary | Rolled Up ◇

T9210TI.MPP

NORTH PORTAL AND CROWN DRIFT GEOLOGIC MAPPING ILLUSTRATION



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DRN. BY
D.J. WEAVER
STRTNCM4.DWG
5/3/93

PERCHED WATER (JP 92-20B)

PROGRESS - MILESTONES AND DELIVERABLES

The perched water data collection activity was ready to commence with starter tunnel construction.

SUMMARY OF FIELD ACTIVITIES

No water or samples were collected during the period. Equipment to collect samples, if identified, is on station.

DATA FLOW INFORMATION

Perched water sample data and observations will be recorded in a scientific notebook if encountered.

COST & SCHEDULE SUMMARY

See illustration for detailed cost and schedule information. The costs and progress on this activity are within the scope set by JP 92-20B.

Perched Water (TPP 92-11/JP 92-20B)
Field Activity Working Schedule
LANL ESF Test Coordination Office

ID	Name	Duration	Scheduled Start	Summary Acct.	Cost Estimate	Estimated Prior Month Cost	Estimated Cost to Date	2nd Quarter Apr '93	2nd Quarter May '93	2nd Quarter Jun '93	3rd Quarter Jul '93	3rd Quarter Aug '93	3rd Quarter Sep '93
1	TEST IMPLEMENTATION - PERCHED WATER	95d	4/5/93		$3,600	$500	$500						
2	Test Implementation - Discreet	95d	4/5/93		$2,000	$400	$400						
3	USGS Test Implementation	95d	4/5/93	OG33124G93	$2,000	$400	$400						OG33124
4	Test Implementation - Matrix Support	95d	4/5/93		$1,600	$100	$100						
5	Los Alamos TCQ Coordination & Planning (Field Test Coordination Support)	2d	5/4/93	OA310BL3	$500	$0	$0			OA31			
6	Los Alamos TCO Test Management (Project Engineer Support)	95d	4/5/93	OA616AL3	$0	$0	$0						OA616
7	T&MSS Direct Support Services (Photo Support)	2d	5/4/93	OT3522DL	$500	$0	$0			OT3552			
8	REECo Construction & Operations Support (Contingency) - (1)	2d	5/4/93	OR662L3	$0	$0	$0			OR662			
9	RSN Survey Support / Survey Procurement (Contingency)	1d	5/4/93	RS614P92	$0	$0	$0			RS614			
10	CRWMS M&O Networking & Baseline Planning Support (Monthly Cost & Progress	95d	4/5/93	TR922BA	$500	$100	$100						TR92

(1) Changed based on participant input.

Project: I-92-11
Date:5/6/93
Revision #0

Activity | Progress | Milestone ◆ | Summary | Rolled Up ◇

T9211TI.MPP

CONSTRUCTION MONITORING (JP 92-20D)

PROGRESS - MILESTONES AND DELIVERABLES

The construction monitoring data collection and observation activity began with starter tunnel construction.

SUMMARY OF FIELD ACTIVITIES

The PIs have been monitoring the blasting activity and provided REECo with peak particle velocity information. REECo fired a small charge to square up the face in preparation of tunneling. The geophones for this charge were located at GM #1 and GM #2 (see attached sketch for all geophone locations). Calculations indicated that GM #2 was too far away from the blast and relocated to GM #3. Stations GM #1 and GM #3 were used for blasts to CS 0+24 after that GM #3 and GM #4 were used to CS 0+60 and finally GM #4 and GM #5 were used to CS 0+64.

DATA FLOW INFORMATION

Construction monitoring data was recorded in a scientific notebook. Test related photo and survey mission data is being submitted to the job package record file and the PIs.

COST & SCHEDULE SUMMARY

See illustrations for detailed cost and schedule information. The costs and progress on this activity are within the scope set by JP 92-20D.

Construction Monitoring (TPP 93-2/JP 92-20D)
Field Activity Working Schedule
LANL ESF Test Coordination Office

ID	Name	Duration	Scheduled Start	Summary Acct.	Cost Estimate	Estimated Prior Month Cost	Estimated Cost to Date	2nd Quarter: Apr '93 / May '93 / Jun '93 — 3rd Quarter: Jul '93 / Aug '93 / Sep '93
1	TEST IMPLEMENTATION - CONSTRUCTION MONITORING	95d	4/5/93		$446,000	$89,000	$89,000	
2	Test Implementation - Discreet	95d	4/5/93		$280,000	$56,000	$56,000	
3	SNL Test Implementation	95d	4/5/93	OS42114L93	$280,000	$56,000	$56,000	OS42114
4	RSN Field Survey & Processing	95d	4/5/93		$0	$0	$0	RS42114
5	REECo Test Construction & Procurement	95d	4/5/93	OR42114L3	$0	$0	$0	OR42114
6	Test Implementation - Matrix Support	95d	4/5/93		$166,000	$33,000	$33,000	
7	Los Alamos TCO Coordination & Planning (Field Test Coordination Support)	95d	4/5/93	OA3108L3	$56,000	$11,200	$11,200	OA31
8	Los Alamos TCO Test Management (Project Engineer Support)	95d	4/5/93	OA618AL3	$28,000	$5,600	$5,600	OA618
9	T&MSS Direct Support Services (Photo Support)	95d	4/5/93	OT3522DL	$5,000	$1,000	$1,000	OT3552
10	REECo Construction & Operations Support (Contingency) - (*1)	95d	4/5/93	OR682L3	$55,000	($0) $11,000	$11,000	OR682
11	RSN Survey Support / Survey Procurement (Contingency)	95d	4/5/93	RS614P92	$5,000	$1,000	$1,000	RS614
12	Engineering Verification	10d	4/30/93	RS614P92	$2,000	$400	$400	RS614
13	CRWMS M&O Networking & Baseline Planning Support (Monthly Cost & Progress	95d	4/5/93	TR9228A	$14,000	$2,800	$2,800	TR92
14	CRWMS - M&O (Funding Transfer from WBS 12641 to WBS 1242114)	95d	4/5/93		$0	$0	$0	

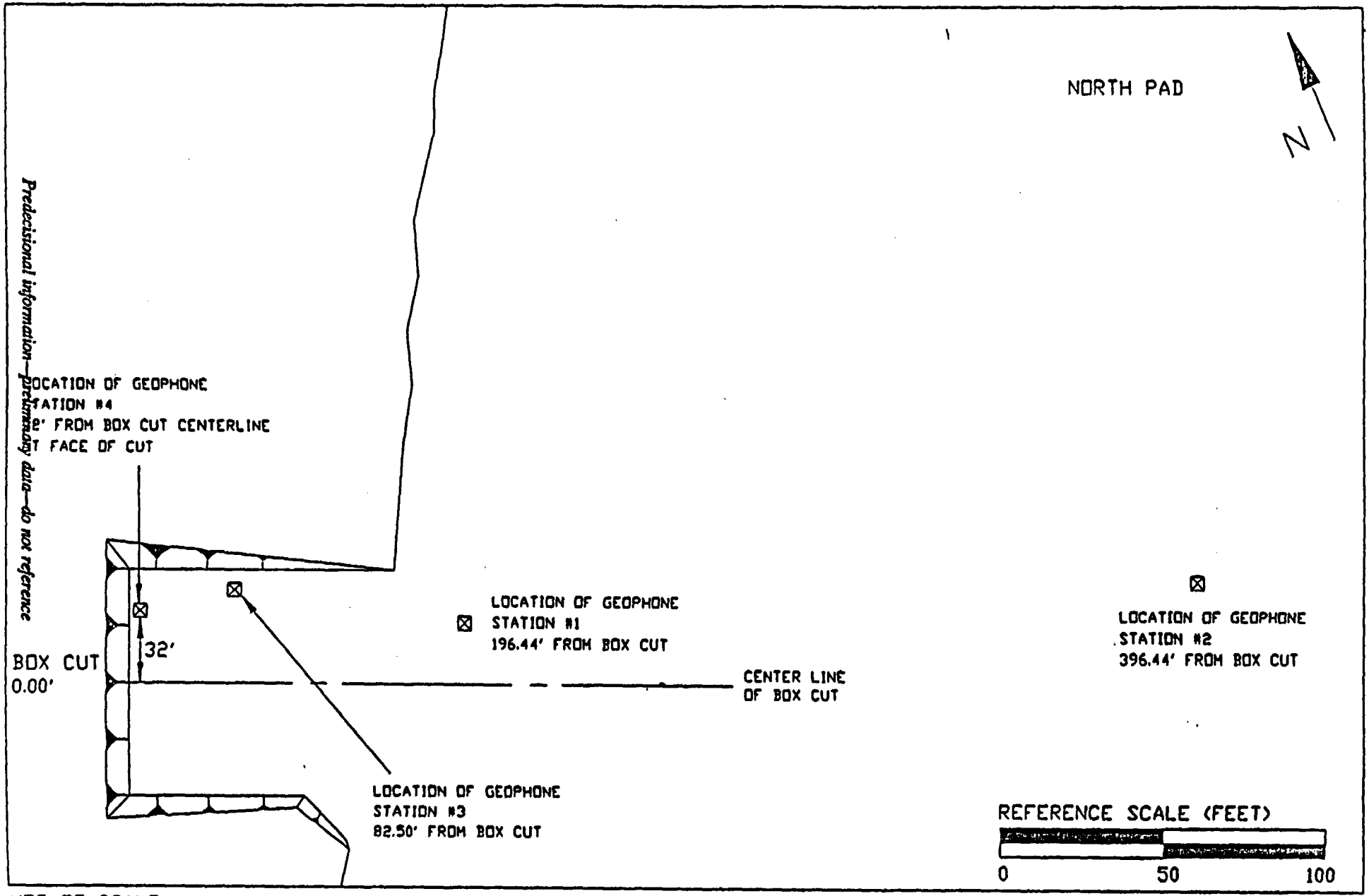
(*1) Changes based on participant input.

Project: T-93-2
Date:5/6/93
Revision #0

Activity ▨ Progress ——— Milestone ◆ Summary ——— Rolled Up ◇

T932TI.MPP

NORTH PORTAL BOX CUT
LOCATION OF GEOPHONES FOR BLAST MONITORING



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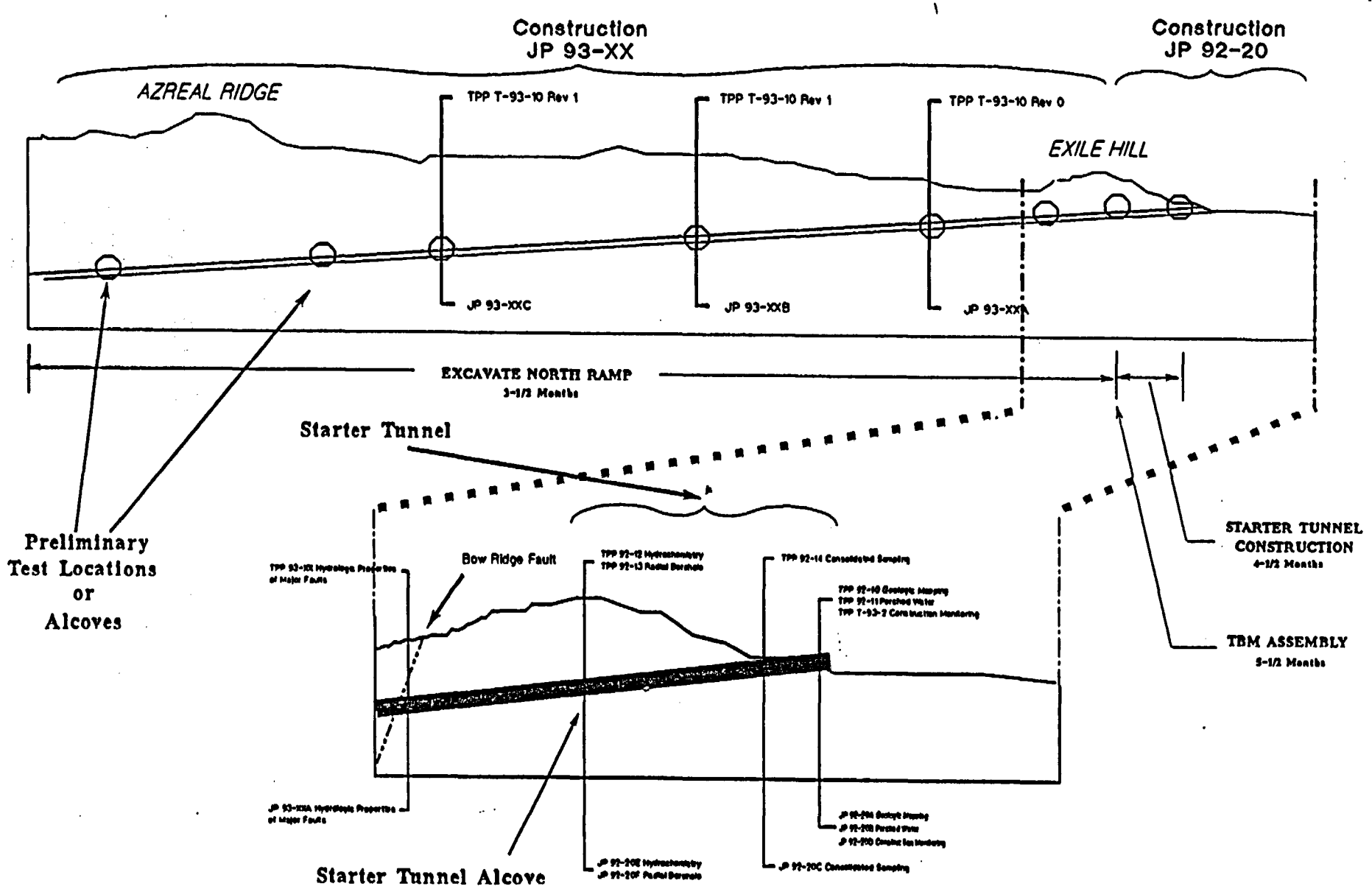
D.J. WEAVER

BOXCUT3.DWG
4/22/93

ESF TESTING – NORTH RAMP
JP & TPP Interactions



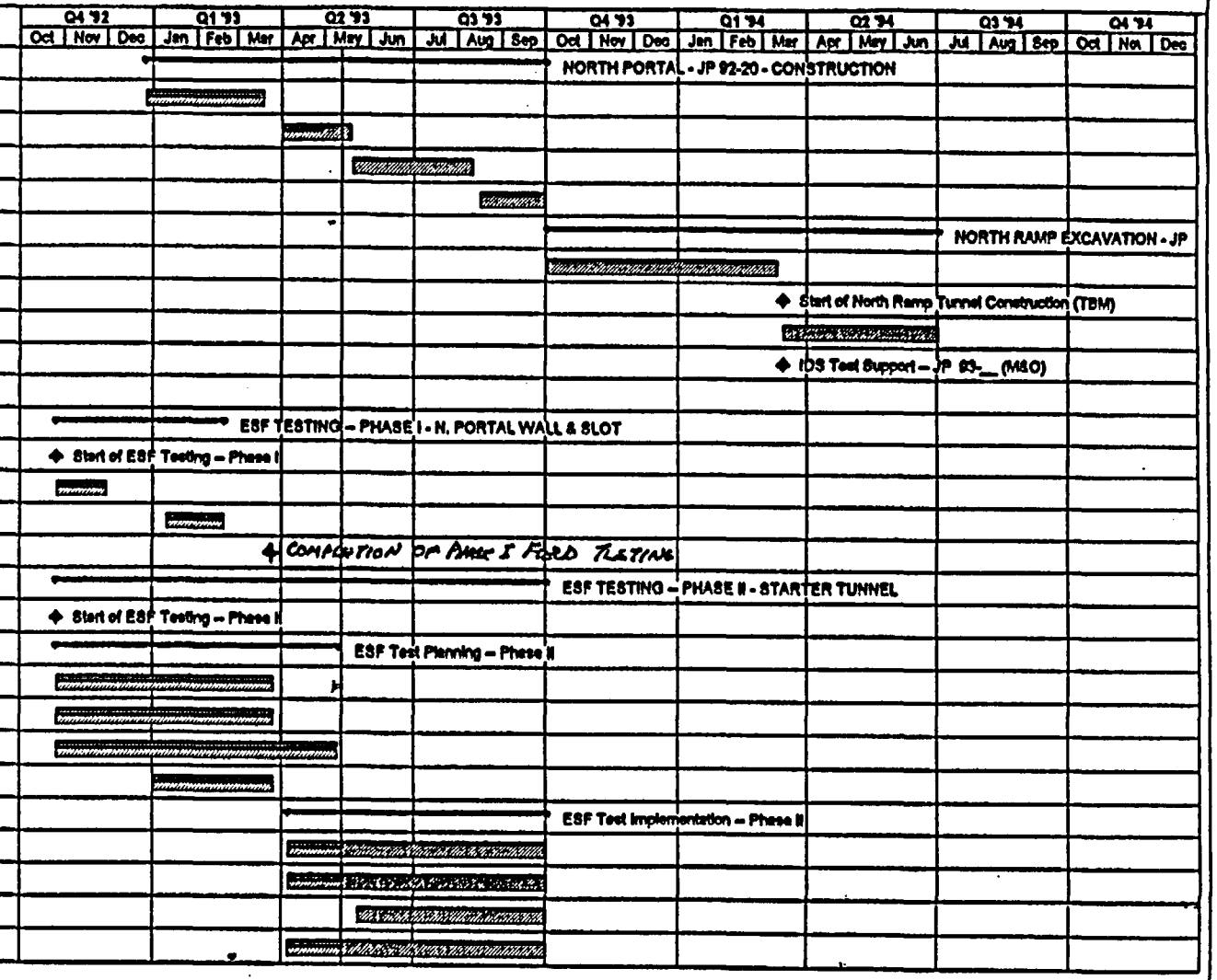
Predecisional information—preliminary data—do not reference

ESF Working Test Schedule

Planning and Field Activities

LANL ESF Test Coordination Office

ID	Name
1	NORTH PORTAL - JP 92-20 - CONSTRUCTION
2	Drill & Blast North Portal Wall & Slot – (621104)
3	Drill & Blast 100' Starter Tunnel – (64101)
4	Drill & Blast Remaining 100' of Starter Tunnel – (64104)
5	Drill and Blast Testing Alcove
6	NORTH RAMP EXCAVATION - JP 93-XX - CONSTRUCTION
7	Assemble and Set TBM
8	Start of North Ramp Tunnel Construction (TBM)
9	North Ramp Tunnel Construction
10	IDS Test Support – JP 93-__ (M&O)
11	
12	ESF TESTING – PHASE I - N. PORTAL WALL & SLOT
13	Start of ESF Testing – Phase I
14	Mapping Support Work Order - 3455-404
15	Wall & Slot Mapping (Phase I Testing Activity)
16	COMPLETION OF ESF TESTING - PHASE I
17	ESF TESTING – PHASE II - STARTER TUNNEL
18	Start of ESF Testing – Phase II
19	ESF Test Planning – Phase II
20	Geologic Mapping - Starter Tunnel (TPP 92-10/JP 92-20A)
21	Perched Water - Starter Tunnel (Contingency) – (TPP 92-11/JP 92-20B)
22	Consolidated Sampling - Starter Tunnel (TPP 92-14/JP 92-20C)
23	Construction Monitoring - Starter Tunnel (TPP T-93-2/JP 92-20D)
24	ESF Test Implementation – Phase II
25	Geologic Mapping - Starter Tunnel (TPP 92-10/JP 92-20A)
26	Perched Water - Starter Tunnel (TPP 92-11/JP 92-20B)
27	Consolidated Sampling - Starter Tunnel (TPP 92-14/JP 92-20C)
28	Construction Monitoring - Starter Tunnel (TPP 93-2/JP 92-20D)



Project: ESF Testing Event Schedule
Date:5/12/93
Revision #0

Activity Progress Milestone Summary Rolled Up

ESFSCHDB.MPP

Predecisional information - preliminary data - not reviewed