UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 9, 1996

MEMORANDUM TO: Central File

FROM: Sandra L. Wastler
Performance Assessment & HLW
Integration Branch
Division of Waste Management, NMSS

SUBJECT: SUBMITTAL OF DOCUMENTS

The following documents have been received from the U.S. Department of Energy, either directly or through the U.S. Nuclear Regulatory Commission's On-Site Representatives and should be placed in the High-Level Waste, Yucca Mountain Subject file:

1. Yucca Mountain Site Characterization Office Weekly Highlights for the week ending May 24 and June 3, 14, 21, 1996.

2. U.S. Department of Energy Field Test Coordination Report for the Weeks Ending May 31, June 14, 1996.

3. U.S. Geological Survey Progress Report for May, 1996.

4. Preliminary Draft data on DOE's Synthesis Reports.

5. Los Alamos National Laboratories' Monthly Management Analysis Report dated May, 1996.

6. Nye County, Nevada, Monthly Data Report for ONC #1, NRG-4, and Tunnel Instrumentation Boreholes dated February 23, 1996.

7. Report entitled "Thermal Loading Study for FY 1995", prepared for the U.S. Department of Energy by TRW Environmental Safety Systems, Inc., dated January 31, 1996.

Attachment(s): As stated

CONTACT: Sandra Wastler, NMSS/DWM
415-6724

Rec'd with letter dtd. 7/9/96 9607120013 450709

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WEEKLY HIGHLIGHTS REPORT FOR W/E JUNE 21, 1996

TO: Daniel A. Dreyfus, RW-1

FROM: Wesley E. Barnes, YMSCO

DATE: June 21, 1996

SUBJECT: Weekly Report

The following activities are provided as input from the Yucca Mountain Site Characterization Office for the Program Office Weekly Report.

Major Events

A U.S. Department of Energy/U.S. Nuclear Regulatory Commission Management Meeting is scheduled for July 1, 1996, via videoconference between Washington, D.C., Rockville, Maryland, Las Vegas, Nevada, and San Antonio, Texas. The purpose of this meeting is to provide a forum to discuss current activities, concerns, and for resolution of identified issues.

A U.S. Department of Energy/U.S. Nuclear Regulatory Commission teleconference is scheduled for July 8, 1996. The purpose of the teleconference is to schedule Department/Commission interactions for the remainder of 1996.

Key Accomplishments

The Tunnel Boring Machine progressed to Station 57+58.6 M or 18,893 ft. as of 08:00 June 21, 1996. Ground conditions are Category IV (Steel Sets). The drill/blast operations have advanced to station 1+36.2 M or 446.8 ft. in the Access/Observation Drift of the Thermal Test Alcove. The North Ghost Dance Fault Alcove advanced to station 0+14.7 M or 48.2 ft.

Staff members of the Assistant Manager for Environmental, Safety and Health completed a final topical report titled "Diet of Desert Tortoises at Yucca Mountain, Nevada, and Implication for Habitat Reclamation." This report documents tortoise studies conducted to ensure compliance with the U.S. Fish and Wildlife Service's Biological Opinion for the Yucca Mountain Site Characterization Project, and includes recommendations to facilitate reclamation of desert tortoise habitats disturbed by site characterization at Yucca Mountain.

The Civilian Radioactive Waste Management System Management and Operating Contractor delivered an addendum to its Fiscal Year 1996 Mitigation Analysis and Corrective Action Plan to the Department of Energy on June 18, 1996. The addendum provided the Department of Energy monthly cost-to-complete expenditure plans for the remainder of the fiscal year. The Management and Operating Contractor's Corrective Action Plan, when implemented, will bring costs within allocated budget for fiscal year 1996. A meeting was held with Yucca Mountain Site Characterization Office senior management to discuss the plan.

Emerging Issues

None to report

Secretarial Commitments

None to report

Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
P.O. Box 98608
Las Vegas, NV 89193-8608

JUN 05 1996

Dennis R. Williams, YMSCO, NV
Winfred A. Wilson, YMSCO, Mercury, NV, M/S 717

FIELD TEST COORDINATION REPORT FOR THE WEEK ENDING MAY 31, 1996
(SCPB: N/A)

Enclosure 2 lists site characterization field activities that are currently active. Many of these are ongoing monitoring and mapping activities; therefore, only those activities having significant status change are addressed below.

BOREHOLE USW G-2 AQUIFER TEST

Fluid level recovery from the pump test conducted in April 1996 continues to be monitored by an automated data collector. The data were downloaded on Wednesday, May 29, 1996, at which time the level had risen to 15 feet below the pre-test water level. It is expected to require several weeks to return to its pre-test level.

C-HOLE COMPLEX HYDRAULIC INTERFERENCE TESTING

Monitoring of tracer concentrations continued at C#3. Tracer that was injected May 15, 1996, was first detected in the monitoring well on May 18, 1996. Peak concentration of approximately 350 parts per million appears to have been detected about ten days after injection (May 25, 1996). The test was officially concluded on May 31, 1996, although water sampling and analysis will continue. Injection of sodium iodide tracer in C#1 is tentatively planned for Wednesday, June 5, 1996. This test and future tests using reactive (sorbing) tracers will yield data for modeling groundwater travel times for radionuclides.

BOREHOLE USW SD-12

Gas sampling to establish in-situ rock-gas compositions continues at SD-12. The samples are being collected by the U.S. Geological Survey.

EXPLORATORY STUDIES FACILITY (ESF) TESTING

The Tunnel Boring Machine progressed to station 55+56.3 meters as of 8 a.m., Friday, May 31, 1996. Instrument installation and data collection in support of construction monitoring continues. Geologic mapping and sampling were completed to approximate station 54+58 meters. Preliminary tunnel stratigraphy identified to date is summarized in Enclosure 1.

ESF Alcove 2 (Bow Ridge Fault Alcove):
Hydrochemistry testing continued.

ESF Alcove 3 (Upper Paintbrush Tuff [non-welded] Contact):
Air permeability (Air-K) testing continued this week. The testing will investigate pneumatic and hydrologic properties of the lithologic contact between the Tiva Canyon welded units and the Paintbrush bedded units.

ESF Alcove 5 (Thermal Testing Facility Access/Observation Drift):
Excavation (using drill/blast methods) of the Thermal Testing Facility Access/Observation Drift continued and had progressed to approximate station 1+12.9 meters from tunnel centerline as of 8 a.m., Friday, May 31, 1996. Total design length of the straight portion of the Thermal Testing Facility is 130 meters.

Lawrence Berkeley National Laboratory personnel completed air permeability testing in boreholes in the Thermomechanical block this week.

ESF Alcove 6 (Northern Ghost Dance Fault Alcove):
No activity was scheduled this week. The access drift remains at 0+11.4 meters.

If you have any questions, please contact Drew H. Coleman at 295-7926.

Drew H. Coleman

Drew H. Coleman
Field Test Coordination
Assistant Manager for Scientific Programs

AMSP:DHC-1886

Enclosures:
1. Tunnel Stratigraphy
2. Site Characterization Field
   Activities in Progress

ESF TUNNEL STRATIGRAPHY*

STATION	
0+00 to 0+99.5m	Tiva Canyon crystal poor upper lithophysal zone.
	Alcove #1 (centerline station intersection): 0+42.5
0+99.5 to 1+90m	Tiva Canyon crystal poor middle nonlithophysal zone
	Alcove #2 (centerline station intersection): 1+68.2
1+90 to 1+99.5m	Tiva Canyon crystal poor lower lithophysal zone.
1+99.5 to 2+02m	Bow Ridge fault zone (placing Pre-Ranier Mesa Tuff against Tiva Canyon Tuff)
2+02 to 2+20m	pre-Ranier Mesa Tuff
2+20	Fault (4.3m offset)***
2+20 to 2+63.5m	pre-Ranier Mesa Tuff
2+63.5 to 3+37m	Tuff "X"
3+37 to 3+49.5m	pre-Tuff "X"
3+49.5 to 3+59.5m	Tiva Canyon vitric zone
3+59.5 to 4+30m	Tiva Canyon crystal rich nonlithopysal zone
4+30m	Fault (~10m offset)***
4+30 to 4+34	Tiva Canyon crystal rich nonlithopysal zone
4+34 to 4+39m	Tiva Canyon crystal rich lithopysal zone
4+39 to 5+50m	Tiva Canyon crystal poor upper lithophysal zone
5+50m	Fault (~5m offset)***
5+50 to 5+53	Tiva Canyon crystal poor upper lithophysal zone
5+53 to 5+87m	Tiva Canyon crystal poor middle nonlithophysal zone

ENCLOSURE 1

ESF TUNNEL STRATIGRAPHY CONTINUED*

5+87 to 6+19m	Tiva Canyon crystal poor lower lithophysal zone
6+19 to 7+00m	Tiva Canyon crystal poor lower nonlithophysal zone
7+00m	Fault (~20m? offset)***
7+00 to 7+77m	Tiva Canyon crystal poor lower nonlithophysal zone.
	Alcove #3 (centerline station intersection): 7+54.
7+77 to 8+69m	Tiva Canyon crystal poor vitric zone
8+69 to 9+12m	Bedded tuffs (including thin Yucca Mountain member)
9+12 to 10+20m	Pah Canyon Member.
10+20 to 10+51.5m	Pre-Pah Canyon tuffs
	Alcove #4 (centerline station intersection): 10+27.8
10+51.5 to 11+93m	Topopah Spring crystal rich vitric zone
11+93 to 17+17m	Topopah Spring crystal rich nonlithophysal zone
17+17 to 17+97m	Topopah Spring crystal rich lithophysal zone
17+97 to 27+20m	Topopah Spring crystal poor upper lithophysal zone
27+20 to 35+93m	Topopah Spring crystal poor middle nonlithophysal zone
	Alcove #5 (centerline station intersection): 28+27
35+93m	Sundance fault (most prominent fault plane, minor fracturing reported between Stations 35+85 and 36+40)
35+93 to face	Topopah Spring crystal poor middle nonlithophysal zone

* All stations given are referenced to the right springline unless otherwise noted. Station 0+00 is located at coordinates N765352.7, E569814.4.

** Indicates that contact is preliminary and has not been verified.

*** Only faults with greater than 4 meters offset are noted on the table.

Site Characterization Field Activities in Progress

SCP ACTIVITY	TITLE	ACTIVITY
8.3.1.3.2.1	Mineralogy, Petrology, and Rock Chemistry of Transport Pathways	ESF Sampling, Borehole Sampling
8.3.1.3.2.2	Mineralogic and Geochemical Alteration	ESF Sampling, Borehole Sampling
8.3.1.4.2.2	Structural Features Within Site Area	Surface & ESF Mapping
8.3.1.17.4.3	Quaternary Faulting Within 100 km of Yucca Mtn.	Surface Mapping
8.3.1.17.4.4	Quaternary Faulting in NE-Trending Fault Zones	Surface Mapping
8.3.1.17.4.6	Quaternary Faulting Within Site Area	Trench Logging
8.3.1.2.1.1	Precipitation and Meteorological Monitoring for Regional Hydrology	Ongoing Measurements
8.3.1.2.1.2	Runoff and Streamflow	Ongoing Measurements
8.3.1.4.2.1	Characterization of Vertical/Lateral Distribution Stratigraphic Units in Site Area	Core Logging (all boreholes), surface of geophysical surveys
8.3.1.2.1.3	Regional Groundwater Flow System	Ongoing monitoring
8.3.1.2.2.1	Unsaturated Zone Infiltration	Shallow borehole neutron logging
8.3.1.2.2.2	Water Movement Tracer Tests	Cl^{36} measurements (SBT drillholes, ESF)

ENCLOSURE 2

Activities in Progress Continued

SCP ACTIVITY	TITLE	ACTIVITY
8.3.1.2.2.4	Characterization of Unsaturated Zone (ESF)	Hydrochemistry/Radial Boreholes testing
8.3.1.2.2.6	Gaseous Phase Movement in the Unsaturated Zone	Pneumatic pathways monitoring
8.3.1.2.3.1	Site Saturated Zone Groundwater Flow System	Ongoing monitoring, C-well testing
8.3.1.2.3.2	Saturated Zone Hydrochemistry	Ongoing monitoring
8.3.1.4.3.1	Systematic Acquisition of Site Specific Subsurface Information	Core logging
8.3.1.15.1.8	In Situ Design verification	Construction monitoring/testing
8.3.1.9.2.1	Natural Resource Assessment of Yucca Mountain	Rock sampling
8.3.1.3.4.2	Biological Sorption and Transport	Sampling in ESF
8.3.1.19.5.1	Engineered Barrier System Field Tests	Sampling in ESF

cc w/encls:
J. G. Jones, HQ (RW-45) FORS
C. J. Henkel, NEI, Washington, DC
R. W. Craig, USGS, Las Vegas, NV
C. J. Glenn, NRC, Las Vegas, NV
M. C. Brady, M&O/SNL, Las Vegas, NV
N. Z. Elkins, M&O/LANL, Las Vegas, NV
M. M. Mapa, M&O, Las Vegas, NV
R. E. Smith, M&O, Las Vegas, NV
L. J. Evans, M&O, Las Vegas, NV
J. H. Peck, M&O, Las Vegas, NV
C. L. Lugo, M&O, Las Vegas, NV
S. C. Smith, M&O, Las Vegas, NV
J. L. Woodruff, M&O, Las Vegas, NV
R. R. Schneider, M&O, Las Vegas, NV
L. S. Linden, M&O, Mercury, NV, M/S 719
P. A. Smallwood, ALPHA, Las Vegas, NV (2)
A. C. Williams, YMQAD, NV
W. R. Dixon, YMSCO, NV
R. C. Long, YMSCO, NV
J. T. Sullivan, YMSCO, NV
M. C. Tynan, YMSCO, NV
J. T. Gardiner, YMSCO, NV
R. S. Waters, YMSCO, NV
J. R. Summerson, YMSCO, NV
Record Processing Center

Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
P.O. Box 98608
Las Vegas, NV 89193-8608

JUN 21 1996

Dennis R. Williams, YMSCO, NV
Winfred A. Wilson, YMSCO, Mercury, NV, M/S 717

FIELD TEST COORDINATION REPORT FOR THE WEEK ENDING JUNE 14, 1996
(SCPB: N/A)

Enclosure 2 lists site characterization field activities that are currently active. Many of these are ongoing monitoring and mapping activities; therefore, only those activities having significant status change are addressed below.

BOREHOLE USW G-2 AQUIFER TEST

Fluid level recovery from the pump test conducted in April 1996 continues to be monitored by an automated data collector. The data were downloaded on Monday, June 10, 1996, at which time the level had risen to 10.4 feet below the pre-test water level. The pre-test water level elevation was 3346.3 feet. The borehole collar elevation is 5098.4 feet. Monitoring is expected to continue for a period of 30 to 60 days.

C-HOLE COMPLEX HYDRAULIC INTERFERENCE TESTING

Monitoring of tracer concentrations continued at C#3. Injection of sodium iodide tracer in C#1 remained on hold this week while repairs were made to a backup generator. Injection of the tracer in the borehole is now tentatively planned for early next week (week of June 17, 1996). This test and future tests using reactive (sorbing) tracers will yield data for modeling groundwater travel times for radionuclides.

EXPLORATORY STUDIES FACILITY (ESF) TESTING

The Tunnel Boring Machine progressed to station 56+77.9 meters as of 8 a.m., Friday, June 14, 1996. Instrument installation and data collection in support of construction monitoring continues. Geologic mapping and sampling were completed to approximate station 56+05 meters. Preliminary tunnel stratigraphy identified to date is summarized in Enclosure 1.

ESF Alcove 2 (Bow Ridge Fault Alcove):
Air permeability testing continues. The testing will investigate the hydrologic and pneumatic properties of the Bow Ridge Fault.

ESF Alcove 3 (Upper Paintbrush Tuff [non-welded] Contact):
Air permeability (Air-K) testing continued this week. The testing will investigate pneumatic and hydrologic properties of the lithologic contact between the Tiva Canyon welded units and the Paintbrush bedded units.

ESF Alcove 5 (Thermal Testing Facility Access/Observation Drift):
Excavation (using drill/blast methods) of the Thermal Testing Facility Access/Observation Drift (AOD) continued and had progressed to approximate station 1+36.2 meters from tunnel centerline as of 8 a.m., Friday, June 14, 1996. This completes the straight section of the AOD. Drilling to verify the location of the TSW2 hydrologic contact will begin next week. The information will be incorporated into the design of the remainder of the AOD and the Heater Drift. The walls of the AOD are being cleaned in preparation for geologic mapping.

ESF Alcove 5 (Thermomechanical Alcove):
Preparatory work required for installing the equipment needed in the planned testing continued all week in the alcove.

ESF Alcove 6 (Northern Ghost Dance Fault Alcove):
The access drift remains at 0+11.4 meters. Rock support was placed in the alcove this week in preparation for resumption of excavation.

If you have any questions, please contact Drew H. Coleman at 295-7926.

Drew H. Coleman
Field Test Coordination
Assistant Manager for Scientific Programs

AMSP:DHC-2017

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R. S. Waters, YMSCO, NV
J. R. Summerson, YMSCO, NV
Record Processing Center

WEEKLY HIGHLIGHTS REPORT FOR W/E JUNE 14, 1996

TO: Daniel A. Dreyfus, RW-1

FROM: Wesley E. Barnes, YMSCO

DATE: June 17, 1996

SUBJECT: Weekly Report

The following activities are provided as input from the Yucca Mountain Site Characterization Office for the Program Office Weekly Report.

Major Events

A U.S. Department of Energy/U.S. Nuclear Regulatory Commission teleconference is scheduled for June 18, 1996. The purpose of the teleconference is to schedule Department/Commission interactions for the remainder of 1996.

A U.S. Department of Energy/U.S. Nuclear Regulatory Commission Management Meeting is scheduled for June 1996, via videoconference between Washington, D.C., Rockville, Maryland, Las Vegas, Nevada, and San Antonio, Texas. The exact date has not been finalized pending the availability of RW-2. The meeting provides a forum to discuss current activities, concerns, and for resolution of identified issues.

Key Accomplishments

The Tunnel Boring Machine progressed 63.1 M or 207 ft. to Station 56+93.7 M or 18,680 ft. as of 08:00 June 17, 1996. The Tunnel Boring Machine is 1,602 M or 5,255 ft. ahead of schedule. In time, this equates to approximately 153 days ahead of schedule. Ground conditions are Category IV (Steel Sets). The drill/blast operations have advanced to station 1+36.2 M or 446.8 ft. in the Access/Observation Drift of the Thermal Test Alcove. The North Ghost Dance Fault Alcove advanced to station 0+13.6 M or 44.6 ft.

The Yucca Mountain Project Socioeconomic Monitoring Program Quarterly Employment Data report for period January 1996 through March 1996 was delivered to representatives of the State of Nevada and affected units of local government. This report describes the characteristics of workers associated with the Yucca Mountain Project, including residential distribution, immigration, occupation, etc.

The Yucca Mountain Site Characterization Office participated in a dry run/videoconference on June 10, 1996, to prepare for the Nuclear Waste Technical Review Board Summer Full Board meeting to be held July 9-10, 1996, in Denver, Colorado. The topics of discussion at the meeting will be Exploration and Testing Activities, Past and Future Climates, and Hydrology at Yucca Mountain.

The Yucca Mountain Site Characterization Office participated in an agenda-setting teleconference on June 10, 1996, in preparation for the U.S. Department of Energy/U.S. Nuclear Regulatory Commission Management Meeting scheduled for June 20, 1996. The meeting provides a forum to discuss current activities, concerns, and for resolution of identified issues.

The Office of Public Affairs staff conducted a tour of Yucca Mountain for Inyo County officials on June 12, 1996. The Inyo County officials that toured the site included Brad Mettam, Coordinator of the Inyo County Yucca Mountain Repository Assessment Office, Peter Chamberlin, Director, Inyo County Planning Department, and Randy Jackson, Hydrologist for Inyo County. The tour included stops at the Exploratory Studies Facility and the Tunnel Boring Machine. In addition, an overview of Nye County's oversight activities was presented by Nick Stellavato, Nye County's on-site representative, at Nye County's drill hole, ONC-1.

The "Fiscal Year 1996 Mitigation Analysis and Corrective Action Plan" was delivered to the Department of Energy on June 13, 1996. This plan details the action the Civilian Radioactive Waste Management System Management & Operating Contractor is taking to manage within the budget for Fiscal Year 1996.

Emerging Issues

None to report

Secretarial Commitments

None to report

cc:
L. H. Barrett, HQ (RW-2) FORS
J. C. Bresee, HQ (RW-10) FORS
H. H. Brandt, HQ (RW-15) FORS
R. A. Milner, HQ (RW-30) FORS
J. D. Saltzman, HQ (RW-30) FORS
M. A. Ferguson, HQ (RW-34) FORS
A. B. Brownstein, HQ (RW-36) FORS
Samuel Rousso, HQ (RW-40) FORS
David Langstaff, RL
W. L. Belke, NRC, Las Vegas, NV
Ron Pope, ORNL, Oak Ridge, TN
Wayne Cameron, White Pine County, Ely, NV
L. W. Bradshaw, Nye County, Tonopah, NV
P. A. Niedzielski-Eichner, Nye County, Chantilly, VA
V. E. Poe, Mineral County, Hawthorne, NV
Jason Pitts, Lincoln County, Pioche, NV
Lander County Board of Commissioners, Battle Mountain, NV
Eureka County Board of Commissioners, Eureka, NV
S. W. Dudley, Esmeralda County, Goldfield, NV
D. A. Bechtel, Clark County, Las Vegas, NV
Alan Kalt, Churchill County, Fallon, NV
B. R. Mettam, Inyo County, Independence, CA
Intertech Services Corp., Carson City, NV
A. C. Douglas, City of Las Vegas, Las Vegas, NV
Donald Schweitzer, BNL, Upton, NY
R. D. Dresser, Weston, Washington, DC
J. L. Smith, Occidental, CA
David Howell, IG, Las Vegas, NV
C. A. Johnson, NWPO, Carson City, NV
R. R. Loux, NWPO, Carson City, NV
C. J. Henkel, NEI, Washington, DC
Records Processing Center

MFR: AMSL:CLH-1986

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
Box 25046 M.S. 425
Denver Federal Center
Denver, Colorado 80225

IN REPLY REFER TO:

INFORMATION ONLY

June 14, 1996

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

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, May, 1996

Attached is the USGS progress report in the required format for the month of May, 1996.

If you have any questions or need further information, please call Raye Ritchey Arnold at (303)236-0516, ext. 282.

Sincerely,

Raye Ritchey Arnold
for Robert W. Craig
Technical Project Officer
Yucca Mountain Project Branch
U.S. Geological Survey

Enclosure:
cc: S. Hanauer, DOE/Forrestal
R. Dyer, DOE, Las Vegas
C. Fox, DOE, Las Vegas
A. Gil, DOE, Las Vegas
T. Hawe, DOE, Las Vegas
S. Jones, DOE, Las Vegas
R. Patterson, DOE, Las Vegas
R. Spence, DOE, Las Vegas
T. Sullivan, DOE, Las Vegas
M. Tynan, DOE, Las Vegas
D. Williams, DOE, Las Vegas
C. Glenn, NRC, Las Vegas (2 copies)
R. Wallace, USGS, Reston
P. Burke, M&O/TRW, Las Vegas
A. Haghi, M&O/Duke, Las Vegas
L. Hayes, M&O/TRW, Las vegas
M. Chornack, USGS, Denver
W. Day, USGS, Denver
L. Ducret, USGS, Denver

W. Dudley, USGS, Denver
D. Gillies, USGS, Denver
D. Hoxie, USGS, Las Vegas
R. Keefer, USGS, Denver
R. Luckey, USGS, Denver
B. Parks, USGS, Denver
Z. Peterman, USGS, Denver
R. Ritchey Arnold, USGS, Denver
D. Soeder, USGS, Las Vegas
R. Spengler, USGS, Denver
J. Whitney, USGS, Denver
R. Williams, USGS, Denver
T. Williams, USGS, Denver

U. S. GEOLOGICAL SURVEY

EXECUTIVE SUMMARY
May 1996

WBS 1.2.3.1 Coordination and Planning

U. S. Geological Survey - Yucca Mountain Branch is currently processing 176 scientific papers prepared by USGS authors. Of these, 58 are related to hydrologic studies and 118 to geologic studies. In addition, 28 abstracts by USGS authors are being processed, as well as 17 reports from LBL.

WBS 1.2.3.2 Geology

Geologic Framework

As part of the effort to assemble and analyze data for defining lithostratigraphic units to be used in 3-D geologic modeling of the potential site area, borehole geophysical logs are being examined to detect variations in log signatures that may correspond to lithologic differences and lead to a more accurate determination of formation and unit contacts in the subsurface. Comparison of contacts and log signatures for borehole SD-7 has indicated that several contacts within the Tiva Canyon Tuff and the Topopah Spring Tuff correlate well (to within 0.5 m stratigraphic thickness or less) with the geophysical log signatures. The geophysical log information and files are being translated to Excel worksheets, and a table of possible lithostratigraphic contacts that can be identified as input to the 3-D geologic model was prepared.

In support of the UZ North Ramp hydrogeologic report on perched water, borehole video logs, video and photographs of core, and lithologic logs were examined to determine dip of the Calico Hills Formation in boreholes SD-9 and UZ-14. It was noted that dips of 5°E-SE do not require faulting, but that dips slightly larger (2-5°) would require faulting. On the basis of 33 borehole contact observations, it is concluded that dips in the Calico Hills Formation near the two boreholes studied is 6°, and that appreciable dip-slip separation is therefore not likely.

Borehole video logs from SD-7, SD-9, SD-12, and UZ-16 were examined to determine the lithostratigraphic position and lateral extent of high-angle fractures in the Topopah Spring Tuff. Initial results indicate that the high-angle fractures are restricted to the middle nonlithophysal zone, but are well-developed only where this zone is thick and the lithophysae-bearing subzone (in the middle of the zone) is poorly developed or absent.

In support of the engineering design of the north Ghost Dance fault alcove, the contact between the upper lithophysal and middle nonlithophysal zones of the Topopah Spring Tuff in the small-diameter vertical borehole at the entrance to the alcove was determined to be at station 37+37, which was within 1 m of the position that was predicted based on the 3-D lithostratigraphic model. The determination was made by examining video of the borehole wall, core video, and core from the ESF main drift MPBX#12 vertical borehole.

Efforts to improve interpretation of the seismic reflection data continued, utilizing results of mapping activities in Crater Flat and from compilations of surface-rupture and aeromagnetic data. Superimposing aeromagnetic data on the fault activity map of Simonds and others (1996, USGS Map I-2520) allows close comparison to previously mapped fault locations, and is leading to new structural interpretations.

Field review of the central block bedrock geologic map was completed. After making necessary revisions, plans are to prepare and release a digital version of the map. Preparation of the synthesis report on fractures is nearing completion for technical review. The report includes interpretations of fracture characteristics in close proximity to, as well as away, from fault

zones, lithostratigraphic control of fractures (intensity and density), fracture connectivity, and observations as to the areal variability of fracture orientations. A report, "Characterizing the fracture network in the unsaturated zone at Yucca Mountain, Nevada, Part I: Collection and interpretation of geologic data: case studies", has been reviewed and revised, and will be submitted to the Rocky Mountain Association of Geologists for inclusion in a special publication on fractures.

Geologic mapping of the North Ramp ESF was accomplished as follows: (1) full periphery geologic mapping was completed to station 54+58; (2) detailed line survey was completed to station 54+73.87; and (3) stereophotography was completed to station 54+80.20.

Seismotectonic Studies

Logging activities in new trenches across northern and southern Crater Flat faults were completed, and revisions of logs resulting from field reviews are in progress. Compilation and revision of supporting trench logs on other faults on the west side of Yucca Mountain (e.g., the Windy Wash fault) continued, and preparation of final reports is in progress. The report, "Evaluation and characterization of Quaternary faulting -- Bare Mountain fault, Nye County, Nevada" was completed by U. S. Bureau of Reclamation staff and submitted to the USGS Reports Processing Unit.

All of the data on the geologic effects associated with 100 moderate-magnitude earthquakes in the western cordillera have now been compiled and summarized in a catalog, including the characteristics of 19 historical surface-rupturing earthquakes. Analyses to date show that different relations exist between surface rupture patterns and earthquake source parameters, such as the along-strike fault slip distributions, the across-strike width of the surface rupture zone, and the characteristics of distributed displacements as functions of earthquake magnitude and fault dip. For example, preliminary results indicate that distributed faulting in the Basin and Range province has occurred across zones as much as 15 km wide (commonly 2 to 10 km wide) with maximum secondary displacements of a few decimeters to nearly 1.5 m; these data will be useful in assessing possible distributed faulting at Yucca Mountain. Final stages of data analysis, documentation of data sources, and discussion of the results are nearing completion.

Work is in progress to make minor revisions and to provide additional supporting information to a report concerning alternative approaches for the characterization of fault displacement for probabilistic seismic hazard analysis. Preliminary results emphasize the implications of the historical rupture data for potential faulting scenarios and how the regional faulting analogs can be applied to an evaluation of the fault displacement hazards at Yucca Mountain. Data compilation and preparation of text continued for various chapters of the seismotectonic synthesis report.

A meeting was held at the Southwest Research Institute (SRI) in San Antonio, May 7-8, to share information and discuss tectonic models relevant to Yucca Mountain, based on current knowledge and results of ongoing research. Attendees included representatives of the USGS,

SRI, DOE, NRC, and the State of Nevada. Informal presentations by USGS and SRI staffs covered various aspects of data synthesis, field investigations, interpretations of geophysical data, and computer modeling techniques. A mechanized sandbox model of a pull-apart basin was demonstrated by SRI; models of this type have been greatly underutilized in the past. During the discussions, a consensus was reached as to the utility of certain tectonic models: (1) the caldera model and shallow detachment model were eliminated from further consideration; (2) strike-slip and deep to intermediate-depth detachment models have serious shortcomings, but may be useful; (3) the most promising models are those involving rift, pull-apart, or rhombochasm-type deformation.

WBS 1.2.3.3 Hydrology

Regional Hydrology

The meteorological monitoring activity continued to collect precipitation data and to process records for instrument calibration in order to close qualification of data for FY 1995. This work was delayed by the shut down of non-project supported, governmental work. Two major reports are in the final stages of approval: one on meteorological data from 1998 to 1994 and the other on regional precipitation and synoptic weather patterns for 1992 and 1993.

Runoff was neither observed nor reported during the month for the three gages at the site or for the Yucca Mountain area. Routine maintenance was made on the three streamflow-gaging stations located along Fortymile Wash.

The final phase of pumping on USW G-2 was concluded on April 25. Recovery, as expected, is taking several weeks. This time plus the time needed for final data analysis will likely cause a small delay in final report submittal, but there should be no delay in getting final data to those in the project who will need to use it.

The incorporation of 1995 flood data into the regional surface water section was started.

Review was completed for the report containing the vegetation map and the potentiometric-surface map. Revisions are in progress. Work continued on the report for the regional hydrologic model. The report will contain a larger-than-expected number of alternative models.

Unsaturated Zone

The U.S. Geological Survey Water Resources Investigation Report entitled, "Estimation of shallow infiltration and presence of potential fast pathways for shallow infiltration in the Yucca Mountain area, Nevada", has received final approval from its three technical reviewers. Seven data packages supporting this report have been completed and approved. Two other data packages are in the final stages of review and approval.

Preparation of the infiltration and fast paths maps for the TDB is complete and the supporting data package has been prepared and is in review.

All of the data associated with the Preliminary Surficial Materials Properties Map have been technically reviewed and approved.

Analysis of the spatial distribution of episodic and average infiltration rates is continuing using the simplified version of the infiltration model and the 100-year stochastic simulations of daily precipitation. Comparisons to the field data (neutron holes) with the remainder of the modeling domain being analyzed is continuing to determine what percentage of the site is represented by the field data. The effort to determine the representativeness of the 11 years of rainfall and neutron logging data relative to longer-term records and average infiltration rates also is continuing.

Calibration of the modified infiltration model which uses a finite difference approximation of Richards Equation for simulating infiltration, evapotranspiration, and redistribution was continued using the developed 16-year record of daily precipitation for Yucca Mountain. Inverse modeling of neutron moisture profiles was continued to evaluate the evapotranspiration component of the water balance and to determine the potential for near-surface fracture flow. A dynamic root-zone function was developed to better simulate the response of plants to moisture redistribution and to help account for differences between shallow and deep rooted plants as well as for differences in rooting densities and the percentage of bare soil evaporation. The function was also modified to allow for automatic adjustment of the root-zone depth as a function of both the thickness of alluvium cover and fractured versus unfractured bedrock. Efforts will now be concentrated on the calibration of the dynamic root-zone function and the development of an improved alpha coefficient function for simulating the response of plants to available moisture, time of year, and antecedent conditions (drought versus wet periods). This work will also be supported by studies of vegetation at Yucca Mountain conducted by the Environmental Program. The alpha coefficient function and the dynamic root-zone function will also be used to empirically account for possible contributions to evaporation caused by vapor flow through alluvium and fractures in the near-surface.

Writing of the manuscript for the Synthesis of UZ Infiltration is continuing with the inclusion of information gathered from the literature review. Work on the introduction section and on the development of tables and figures was continued. Results obtained from inverse modeling using the developed 16-year daily precipitation record for Yucca Mountain, the 12-year neutron logging record, and 16-year simulations of shallow infiltration have provided important results in terms of the timing and frequency of important infiltration events at Yucca Mountain and the characteristics of the timing, magnitude, and frequency of daily precipitation most conducive for initiating near-surface fracture flow, episodic infiltration, and runoff. Figures and maps showing the results obtained for the spatial distribution of average and episodic infiltration rates and for the temporal distribution of the simulated water content and water potential profiles at selected locations were developed. Preliminary results have indicated that average infiltration rates for

the modeling domain range from approximately 3.5 to 5.5 mm/year, depending on which realization was used for the 100-year precipitation simulation.

The technical review of data-base consisting of the FY95 neutron logging data was completed.

A short paper describing the analytical method and preliminary results for UZ #16 VSP was presented at the Seventh International Conference on High Level Radioactive Waste Management in Las Vegas, and staff presented results of polarization filtering and image processing to DOE/M&O and participant staff at a mid-month workshop in Denver. Documentation of the technical review packages for milestone on the VSP results is underway.

Several activities were undertaken and completed for UZ borehole instrumentation and monitoring. HRF prototype holes continued to be monitored on an on-going basis for the 55th month. Borehole data from these hole as well as NRG-7a, NRG-6, UZ#4, UZ#5, UZ-7a, and SD-12 were transferred to Denver, converted to engineering units, and archived to optical disk throughout the month.

Completed a psychrometer calibration run May 4th on Rack 2 and started another on May 13th. The current run has good results for 0.02, 0.1, and 0.4 molality. With the completion of this run all required sensors for SD-7 will be calibrated.

Technical reviews of the north ramp hydrology report were completed by four reviewers during the first week of May. Responses to mandatory comments were prepared during the 2nd and 3rd weeks of May. Revisions to the technical-review draft are in progress. Final compilation of this document will be completed by the third week of June.

Work on the in-situ borehole monitoring data report continued for NRG-6, NRG-7a, UZ#4 and UZ#5.

A reexamination of the NRG-6 pneumatic data, done in conjunction with preparation of the North Ramp Hydrology report, indicates that this borehole was affected by construction of the North Ramp. Pneumatic disturbance effects occurred on 10/01/95, when the TBM penetrated the northern limb of the Drill Hole Wash fault structure. This disturbance event was confirmed by the LBL Site Scale Model. Additional work is under way to determine if an interference may not have occurred before penetration of the Drill Hole Wash structure; perhaps as early as 8/21/95.

An analysis of the effects of the Ghost Dance Fault on pneumatic pressures in the lowermost two instrument stations at SD-12 (stations in the Calico Hills and basal vitrophyre of the Topopah Spring Tuff) were conducted. These analyses indicate short circuiting of the atmospheric pressure signal near the Ghost Dance Fault.

An error analysis incorporating core damage due to drilling and sample handling, instrument error and moisture retention curve fit errors has been completed. Finalization of new desorption

moisture retention curves has also been completed.Corrections to measured water potential data from borehole samples is being redone using new desorption moisture retention curves. Final composite moisture retention curves which incorporate hysteretic effects of field data are currently being done using corrected water potential and saturation field data. Predictions of saturated hydraulic conductivity from porosity for unmeasured core using regression equations is being done to complete matrix properties data set.

Monitoring of down-hole pneumatic pressure continues. As of 8 a.m. on 5/28 the TBM was at station 54+75 meters, the location of SD-7 along the trace of the ESF is approximately 55 +70 meters. No indication of ESF excavation effects were recognized in the record as of May 24, but it is expected that the effects will occur soon.

Pneumatic pressure monitoring and gas sampling was completed in borehole #2 of Alcove 2. The pneumatic pressure responses indicate that the fault has a high permeability connection to the atmosphere.

Pneumatic air-injection testing was completed in borehole #1 of Alcove 3. Permeability values of the Tiva Canyon crystal-poor lower nonlithophysal columnar zone average 2.0 darcy. Permeability values of the Tiva Canyon vitric zone range from less than 1.0 to 24.0 darcy.

The data package for the North Ramp Perched Water Testing has been completed and approval. Analyses of Borehole SD 7 perched water testing is ongoing. No perched water was encountered in May.

Core samples from alcove #2, #3, and #4 are being analyzed for bulk density, grain density, porosity, saturation and water potentials. A new drill for collecting core samples was tried in Alcove #3 with moderate success. Future samples for rock properties will be collected as bulk rock samples where possible and cored subsequently in the HRF rock processing room. Where bulk rock samples were not readily available in situ drilling will be used. Calibration of the heat dissipation probes is underway.

Detailed frequency analyses are being conducted on pressure data from several boreholes in order to determine the phase lag and amplitude of barometric pressure induced changes, both before and after the effects of the ESF were noticed. These analyses have quantified some of the ESF effects that have previously been identified only qualitatively. Comparative analysis of pneumatic data from NRG-6, NRG-5, NRG-7a, SD-9 SD-7, and SD-12 is ongoing to chart the effects if the TBM as it moves along the Ghost Dance Fault. A small-scale 3 dimensional model of the North Ramp and part of the Main Drift is being refined to analyze the horizontal permeability of the rocks effected by the ESF excavation. The model simulates the progress of the TBM by applying barometric stresses at the ESF horizon and will be calibrated against both pressure changes within each geologic unit and the time at which the borehole first began to be affected by the ESF.

The results of Carbon 14 dating of gasses collected from the Calico Hills Formation beneath perched water zones in SD-7 and SD-9 yield apparent ages from 5000 to 6000 years.

Nine stations of the down-hole sampling system at SD-12 were brought on-line and tested in support of UZ Hydrochemistry. The stations were pumped for one week to remove drilling air in the rock gas and were then sampled.

Thirty-one core samples from SD-12, SD-7, and ESF-AL#3 were extracted for pore-water and are in process for various chemical and isotopic analyses.

Fracture intensities have been calculated for units Tptrv, Tptrn, Tptrl, and Tptpul. For units stratigrapically lower, intensities will be calculated when ESF periphery maps (stations 28 to 40 m) become available. Mean thickness values have been calculated for Topopah Spring stratigraphic units, and subsequent fracture subunits, along the ESF north ramp. A mean fracture transmissivity has been determined from air-permeability distributions from boreholes NRG-6 and NRG-7a. In general, the transmissivity values for the Topopah Spring are about 1.5 orders of magnitude smaller than those for the Tiva Canyon. Work is underway to correct bias in the fracture orientation data sets in the directions parallel to the north ramp, and parallel to the north-south drift.

A computational grid was created to analyze the pneumatic pressure response at borehole SD-12. The lowermost stations at that borehole appear to be influenced by the nearby Ghost Dance fault, and so some inferences about the permeability of fault within the basal vitrophyre and Calico Hills units in the vicinity of SD-12 appear to be possible. The signals in the lower two stations were analyzed in terms of their component frequencies. Permeabilities are being estimated that would allow prediction of the principal harmonics of the measured signal.

Temperature data from instrumented boreholes UZ#4 and UZ#5 are being analyzed with one- and two-dimensional models to determine the percolation fluxes occurring at those boreholes. Percolation fluxes of 10 to 20 mm/yr appear to be the most consistent with the observed temperatures.

Saturated Zone

An interpretive report on the open-hole test in UE-25c #3, entitled "Analysis of a Pumping Test in Miocene Tuffaceous Rocks, May - June 1995, Yucca Mountain, Nye County, Nevada", had been completed. A data report, presenting the data from the 6/12/95 pumping test at the c-holes was submitted for review.

The USGS assisted LANL in initiating a partial-recirculation tracer test from UE-25c #2 to UE-25c #3 using the conservative tracer pentafluorobenzoic acid (PFBA). The purpose of the test is to determine if a similar tracer test, with Lithium (in the form of lithium bromide) as a sorbing tracer, is feasible.

An aquifer test was initiated by pumping borehole UE-25c #3 at the rate of 154 gpm from the Lower-Bullfrog geohydrologic unit, and monitoring the same unit in boreholes UE-25c #1 and UE-25c #2.

For the month of May 1996, 28 manual measurements of water level in 22 wells were completed. Seven zones in 5 wells were monitored on an hourly basis (transducer measurements). Wells WT #3, WT #14, and H-4, were instrumented with transducers and 21X data loggers so that potential water level change due to pumping at the C-hole complex could be measured. Continuous analog data were collected from two zones in one well (USW H-5 upper and lower zones) in order to monitor water-level responses to seismic events.

Field tests were completed for the single-well aquifer test conducted at well UE-25 WT #12, and the aquifer-test report is in preparation.

Work continued on the revision of the site scale hydrologic framework model and on preparation of the site SZ numerical flow model software and data to begin calibration of the site flow model. Staff continued working with the parameter-estimation software (PEST) to learn how to optimally use the code in conjunction with the FEHMN flow code. LANL staff continued working on creating new meshes for the FEHMN model, and at the end of the month appeared to have resolved the software problems that interfered with generating a grid.

WBS 1.2.3.6 Climatology and Paleohydrology

As previously reported, a comparison of surface water discharge data from the Owens River drainage system with historical precipitation records is being made for the purpose of developing transfer functions that will allow conversion of the paleolimnological record of Owens Lake to numerical estimates of past precipitation in the Sierra Nevada. Studies are still in progress, but preliminary results suggest that there is a continuous paleolimnological record of wet and dry climates in Owens Lake sediments that should serve as an excellent record of climatic conditions over the last 500 ky. Studies are also in progress to determine how this record of climate change can be adapted for use in climatic and hydrologic models.

Samples for thermoluminescence dating were collected at several sites near Yucca Mountain in an attempt to find surficial units that may be correlative with deposits in the high terrace of Fortymile Canyon. An abstract for the 1996 annual meeting of the Geological Society of America (Denver, Oct. 1996) was prepared, entitled "Thermoluminescence dating and associated problems, Yucca Mountain, southern Nevada, USA". Technical reviews of surficial deposit maps were completed for the Amargosa Valley 7½-minute quadrangle and for the eastern part of Crater Flat.

Analyses of pore salts from ream cuttings of UZ-14 continued in efforts to isotopically characterize the pore waters. Additional sample studies have confirmed that there is a distinct isotopic difference between the pore salts (waters), the host rocks, and the calcite fracture fillings. Such data have an important bearing on the degree and extent of water-rock interaction

and the concept of local saturation as a requirement of fluid flow. Chemical processing of an additional 25 samples of calcite from fracture filling, as well as new water samples from the c-hole complex, was begun.

Additional chemical and mass spectrometric analyses of U and Th isotope ratios of authigenic carbonate and silica materials from paleospring deposits at the Lathrop Wells diatomite locality (i.e., the Horse Tooth deposit) and from the Indian Pass deposit on the southwest side of the Amargosa Valley were conducted. Initial ratios for all analyses are found to be compatible with a ground water source and are similar to previously analyzed materials from the same sites. Data now available from five separate paleodischarge sites scattered throughout the Amargosa Valley and Crater Flat indicate that all sites were active during the last wet episode (12 to about 50 ka). Stratigraphically lower samples at several of the sites indicate that discharge was also active during the penultimate glaciation about 100 to 180 ka.

Thermoluminescence age determinations for materials collected at the Lathrop Wells diatomite site and the Indian Pass site were completed. These new age determinations, combined with previous dates obtained at the Stateline site and site 199 at the southern end of Crater Flat, are generally consistent with U-series ages determined for calcite samples from these sites.

Seven subsamples of opal and calcite for U-series disequilibrium dating were collected from sites in the ESF. All subsamples represent outermost materials available from free-face growth surfaces. Digestion and chemical separation of U and Th, as well as determination of isotopic ratios by mass spectrometry, were completed. Data have not yet been reduced; however, calcite from surfaces with no observed opal continues to present significant analytical challenges because of the extremely low concentration of U. Attempts to measure calcites with total U abundances of less than several nanograms continue to be met with mixed success, but larger sample sizes will be used in future analyses in efforts to obtain sufficient U and Th for more reliable analytical results.

WBS 1.2.13.4.7 Water-Resources Monitoring

In support of water-resources monitoring ground-water levels were measured at 28 sites and discharge was measured at one flowing well. The pressure-sensor was calibrated at site AD 6. Ground water data collected during April were checked and filed.

Reference points were installed at Texas Spring (Death Valley) and land surveys were conducted to assist in periodic verification of flume accuracy.

Staff from several of the USGS projects met with personnel from the National Park service for two days to discuss matters of mutual interest with regards to water resources.

USGS LEVEL 3 MILESTONE REPORT
OCTOBER 1, 1995 - MAY 31, 1996
Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
PRELIMINARY FRACTURE MODEL, TIVA CYN, YUCCA MTN Milestone Number: 3GUF105M	01/31/96	05/30/96	05/30/96	
SYNTHESIS OF HYDROGEOLOGIC UNIT/MATRIX PROPERTIE Milestone Number: 3GUP603M	05/30/96	09/10/96		
SUBSURFACE MINERAL RECORD OF PAST HYDROLOGY Milestone Number: 3GQH257M	05/31/96	06/14/96		
SYSTHESIS GAS PHASE CIRCULATION IN THE ESF Milestone Number: 3GGP605M	06/28/96	08/28/96		
SURFICIAL DEPOSITS MAP SHEETS 14-17, 23-24 29-30 Milestone Number: 3GCH201M	06/28/96	06/28/96		

Printed: 06/11/96 10:27

USGS LEVEL 4 MILESTONE REPORT
OCTOBER 1, 1995 - MAY 31, 1996
Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
DATA TO TDB/CRF: INFIL. & FAST PATHS FLUX MAPS Milestone Number: 3GUI610M	11/30/95	06/14/96		
DATA TO CRF: 3RD/4TH QTR FY95 PERCHED WATER DATA Milestone Number: 3GUS602M	12/29/95	05/17/96	05/17/96	
REVIEW DRAFT: AIR-K TESTING SB Bh FY95 Milestone Number: 3GUP618M	01/31/96	05/24/96	05/24/96	
LETTER RPT: RESULTS OF FY 93, 94, 95 MAG SURVEYS Milestone Number: 3GGU132M	02/15/96	06/28/96		
REVIEW DRAFT: IN-SITU MONITORING DATA PACKAGE Milestone Number: 3GUP661M	02/28/96	07/15/96		
REVIEW DRAFT: HYDROGEOLOGIC UNITS & MATRIX PROP Milestone Number: 3GUP602M	02/29/96	07/22/96		
DATA TO TDB/CRF:IN-SITU Bh MONITORING, 9/95-2/96 Milestone Number: 3GUP660M	03/28/96	08/13/96		
LTR RPT: SYSTHESIS OF TECTONICS MDLS FOR YM AREA Milestone Number: 3GTE610M	03/29/96	06/28/96		
DATA TO CRF: FY95 FORTYMILE WASH Milestone Number: 3GRG624M	03/29/96	06/28/96		
ADMIN RPT: AIR-K TESTING IN SB Bh THRU FY95 Milestone Number: 3GUP610M	03/29/96	07/30/96		
MEMO: SUMM OF FY1995 DATA Milestone Number: 3GWH608M	03/29/96	06/14/96		
ADMIN RPT: DEATH VALLEY HYDROCHEMISTRY Milestone Number: 3GWH609M	03/29/96	06/14/96		

Deliverable	Due Date	Expected Date	Completed Date	Comments
Compl Report: Surf Faulting in Basin/Range Milestone Number: 3GSS105M	04/29/96	06/28/96		
REV. DRAFT: PRELIM. SURFICIAL MTLS PROP MAP(S) Milestone Number: 3GUI605M	04/30/96	05/17/96	05/17/96	
DATA TO CRF: BOREHOLE MONITORING DATA Milestone Number: 3GUP655M	04/30/96	06/03/96		
REVIEW DRAFT: CONCEPTUAL MODEL OF UZ HYDRO SYS Milestone Number: 3GUM603M	04/30/96	07/12/96		
REVIEW DRAFT:GAS PHASE CIRCULATION IN VIC OF ESF Milestone Number: 3GGP604M	05/01/96	06/28/96		
REV DRAFT: SYNTHESIS RPT OF SELECT PALEO SITES Milestone Number: 3GQH670M	05/02/96	05/30/96	05/30/96	
ADMIN REPORT: NORTH RAMP HYDROLOGY Milestone Number: 3GUP667M	05/13/96	07/31/96		
LETTER REPORT: DETAILED ANALYSIS, UZ-16 VSP DATA Milestone Number: 3GUP622M	05/30/96	05/30/96	05/30/96	
Rpt: Comput of Porosity/Wtr Content Geophy Log Milestone Number: 3GGU245M	05/31/96	05/30/96	05/30/96	
Geophysical Log Analysis of H3-4-5,P1and A1/B-1H Milestone Number: 3GGU247M	05/31/96	05/30/96	05/30/96	
DATA TO CRF: FY95 SITE METEOROLOGY Milestone Number: 3GMM600M	05/31/96	07/31/96		
ADMIN RPT: STREAMFLOW & PRECIPITATION DATA, FY95 Milestone Number: 3GRS600M	05/31/96	06/28/96		
DATA TO CRF: FY95 STREAMFLOW DATA Milestone Number: 3GRS602M	05/31/96	06/28/96		

Deliverable	Due Date	Expected Date	Completed Date	Comments
REVIEW DRAFT: REGIONAL GROUND WATER FLOW Milestone Number: 3GRM601M	05/31/96	06/28/96		
SUMMARY MEMO: NET INFIL & FAST-PATHS FLUX MAPS Milestone Number: 3GUI611M	05/31/96	06/14/96		
DATA TO CRF: DATA FOR WELLS TESTED - 10/95-3/96 Milestone Number: 3GWF621M	05/31/96	05/14/96	05/14/96	
REVIEW DRAFT: PRELIM SITE SZ 3-D GW FLOW MODEL Milestone Number: 3GWM610M	05/31/96	06/28/96		
DATA TO CRF: REGIONAL HYDROLOGIC DATA SET Milestone Number: 3GRM622M	06/28/96	06/28/96		
INSTRUMENTATION PLAN FOR BOREHOLE USW SD-7 Milestone Number: 3GUP631M	06/28/96	06/28/96		
RVW DRAFT: INTERMEDIATE UZ HYDROCHEMISTRY AT YM Milestone Number: 3GUH606M	06/28/96	06/28/96		
REV DRAFT:MDLNG FLOW UZ FRAC NTWRKS TSw UNIT ESF Milestone Number: 3GUF603M	06/28/96	06/28/96		
REV DRAFT: LTR DESC HYDRAULIC PROP/SEL WT WELLS Milestone Number: 3GWF624M	06/28/96	06/28/96		
REVIEW DRAFT: PALEOCLIMATE SYNTHESIS REPORT Milestone Number: 3GCA101M	06/28/96	06/28/96		

 Printed: 06/11/96 10:27

Yucca Mountain Project
Variance Analysis Report

Entered on: 06/11/96 10:31 AM   Entered by: Raye Arnold
WBS: 1.2.3.1.2
WBS Title: Participant Management and Integration
AM: JONES S.   OM: STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 05/96

Data:

Cumulative Cost Variance: ($-151K / -26.2%)
Cause:

This negative cost variance is due largely to the budget and funding being at below the minimum level to manage the USGS site program. Initial budgets indicated a potential overrun of $426K. This account was not funded at a level adequate even for basic staffing requirements, leaving no funding for supplies & materials, office machine maintenance, secretarial support, publications, vehicle support, etc.

Impact:

There is a projected cost overrun in this P&S account of approximately $139K at this time. Cost underruns have been identified in P&S account 0G33131 to help offset this cost overrun.

Corrective Action:

All unbudgeted costs to this P&S account require TPO approval. Account is being closely monitored to minimize overruns. Staff time is being rebudgeted and charged to other WBS elements, as appropriate.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($-139K / -16.4%)
See "Cumulative Cost Variance"

Approved:
- ○ No
- ○ Tech. Mgr
- ● TPO
- ○ Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 06/11/96 10:42 AM Entered by: Raye Arnold
WBS: 1.2.3.6.2.2.1
WBS Title: Quaternary Regional Hydrology
AM: JONES S. OM: STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 05/96

Data:

Cumulative Cost Variance: ($118K / 15.7%)
Cause:

This positive cost variance results from new, unplanned work being added to the scope of this P&S account. Time-phasing of other budgets within this P&S account was not adjusted resulting in an artificially high spend rate in the earlier months of the fiscal year. This results in an apparent, but not real, underrun condition. Further, no invoices have been received from DRI for costs incurred and expenditures for laboratory analysis are very high in the fourth quarter of the fiscal year. Budgeted funds are expected to be costed by the end of the fiscal year.

Impact:

There is no impact resulting from this apparent underrun condition. Budget is not distributed appropriately to reflect spending, and there are delays in invoicing and costing from DRI. All budget is expected to be expended to complete the work.

Corrective Action:

Contact DRI to resolve invoicing problems.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($24K / 2.2%)
Variances are within tolerance.

Approved:
- ○ No
- ○ Tech. Mgr
- ● TPO
- ○ Yes

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey
Date Prepared 06/06/96 11:55

MONTHLY COST/FTE REPORT

Fiscal Month/Year MAY 1996

	CURRENT MONTH END						FISCAL YEAR		
WBS ELEMENT	ACTUAL COSTS	PARTICIPANT HOURS	SUBCON HOURS	PURCHASE COMMITMENTS	SUBCON COMMITMENTS	ACCRUED COSTS	APPROVED BUDGET	APPROVED FUNDS	CUMMULATIVE COSTS
1.2.3	1204	17900	3720	0	692	0	12378	0	7654
1.2.5	33	328	368	0	58	0	365	0	154
1.2.8	44	744	0	0	0	0	515	0	314
1.2.9	56	944	184	0	54	0	664	0	375
1.2.12	9	184	200	0	3	0	80	0	53
1.2.15	158	1720	368	0	39	0	1871	0	1287
TOTALS	1504	21820	4840	0	846	0	15873	0	9837

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/95 - 05/31/96

		OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
0G31196B	Scientific Programs Management and Integ	13.9	15.6	15.2	17.0	29.6	30.6	29.7	30.7	0.0	0.0	0.0	0.0	182.3
1.2.3.1.1		13.9	15.6	15.2	17.0	29.6	30.6	29.7	30.7	0.0	0.0	0.0	0.0	182.3
0G31296B2	U.S. Geological Survey Support	79.6	93.3	92.1	107.4	174.8	34.2	66.3	78.7	0.0	0.0	0.0	0.0	726.4
1.2.3.1.2		79.6	93.3	92.1	107.4	174.8	34.2	66.3	78.7	0.0	0.0	0.0	0.0	726.4
*1.2.3.1		93.5	108.9	107.3	124.4	204.4	64.8	96.0	109.4	0.0	0.0	0.0	0.0	908.7
0G32211D96	Compilation and Synthesis of Existing St	11.4	14.1	11.9	37.6	24.4	32.7	10.7	33.3	0.0	0.0	0.0	0.0	176.1
0G32211H96	Geophysical Investigations	3.5	0.1	0.0	0.0	0.8	-3.6	0.0	51.5	0.0	0.0	0.0	0.0	52.3
0G32211K96	Analysis of Pre 1985 Geophysical Logs	0.0	0.0	0.0	0.0	0.0	0.6	0.0	60.8	0.0	0.0	0.0	0.0	61.4
1.2.3.2.2.1.1		14.9	14.2	11.9	37.6	25.2	29.7	10.7	145.6	0.0	0.0	0.0	0.0	289.8
0G32212H96	Geologic Map of the Central Block of the	34.1	33.4	34.0	31.8	35.2	55.4	60.5	39.7	0.0	0.0	0.0	0.0	324.1
0G32212J96	Exploratory Studies Facility Mapping (US	111.3	100.7	135.7	183.3	192.8	244.4	157.1	165.7	0.0	0.0	0.0	0.0	1291.0
1.2.3.2.2.1.2		145.4	134.1	169.7	215.1	228.0	299.8	217.6	205.4	0.0	0.0	0.0	0.0	1615.1
0G32831A96	Summary of Geologic, Geophysical, and Se	5.9	6.3	5.9	6.5	6.9	5.9	6.8	40.6	0.0	0.0	0.0	0.0	84.8
1.2.3.2.8.3.1		5.9	6.3	5.9	6.5	6.9	5.9	6.8	40.6	0.0	0.0	0.0	0.0	84.8
0G32833A96	Coordination and Review of Ground Motion	0.0	11.5	24.0	14.0	24.1	-10.8	0.0	0.0	0.0	0.0	0.0	0.0	62.8
1.2.3.2.8.3.3		0.0	11.5	24.0	14.0	24.1	-10.8	0.0	0.0	0.0	0.0	0.0	0.0	62.8
0G32836A96	Seismotectonics Summary and Synthesis	7.8	16.6	14.2	16.7	16.9	12.4	10.7	17.8	0.0	0.0	0.0	0.0	113.1
1.2.3.2.8.3.6		7.8	16.6	14.2	16.7	16.9	12.4	10.7	17.8	0.0	0.0	0.0	0.0	113.1
0G32846A96	Quaternary Faulting at the Site	14.7	21.7	17.7	21.9	25.1	35.8	42.8	-0.2	0.0	0.0	0.0	0.0	179.5
0G32846K96	Trench Samp Dates Quat. Flts Hist GD, RV	0.0	0.0	0.0	0.0	3.8	0.0	0.7	10.1	0.0	0.0	0.0	0.0	14.6
1.2.3.2.8.4.6		14.7	21.7	17.7	21.9	28.9	35.8	43.5	9.9	0.0	0.0	0.0	0.0	194.1
0G3284CC96	Prepare Final Report on Tectonic Models	18.2	5.8	10.3	7.0	7.9	7.7	6.4	14.1	0.0	0.0	0.0	0.0	77.4
1.2.3.2.8.4.12		18.2	5.8	10.3	7.0	7.9	7.7	6.4	14.1	0.0	0.0	0.0	0.0	77.4
*1.2.3.2		206.9	210.2	253.7	318.8	337.9	380.5	295.7	433.4	0.0	0.0	0.0	0.0	2437.1
0G33111B96	Collection of Site Meteorological Data f	6.2	7.3	5.9	6.7	6.9	7.9	8.4	7.3	0.0	0.0	0.0	0.0	56.6
1.2.3.3.1.1.1		6.2	7.3	5.9	6.7	6.9	7.9	8.4	7.3	0.0	0.0	0.0	0.0	56.6
0G33112C96	Collection of Site Streamflow Data	7.0	19.4	9.6	10.2	8.3	4.4	1.1	3.3	0.0	0.0	0.0	0.0	63.3
1.2.3.3.1.1.2		7.0	19.4	9.6	10.2	8.3	4.4	1.1	3.3	0.0	0.0	0.0	0.0	63.3
0G33113A96	Assessment of Key Data/Modeling Problems	0.1	5.2	8.8	1.1	1.9	1.1	2.6	4.5	0.0	0.0	0.0	0.0	25.3
0G33113C96	Fortymile Wash Recharge	5.8	4.9	4.0	2.5	6.2	5.8	5.0	6.7	0.0	0.0	0.0	0.0	40.9
1.2.3.3.1.1.3		5.9	10.1	12.8	3.6	8.1	6.9	7.6	11.2	0.0	0.0	0.0	0.0	66.2
0G33114D96	Regional Saturated- Zone Numerical Model	7.1	6.2	1.5	2.7	10.4	24.6	6.0	28.9	0.0	0.0	0.0	0.0	87.4
0G33114E96	Regional Saturated- Zone Boundary Condit	5.0	12.5	12.2	15.5	4.3	3.4	-0.2	0.0	0.0	0.0	0.0	0.0	52.7
0G33114F96	Regional Saturated- Zone Framework Model	0.0	0.0	12.3	22.8	16.0	10.2	5.8	14.1	0.0	0.0	0.0	0.0	81.2
1.2.3.3.1.1.4		12.1	18.7	26.0	41.0	30.7	38.2	11.6	43.0	0.0	0.0	0.0	0.0	221.3
0G33121C96	Infiltration Distribution	7.8	9.5	9.0	11.3	11.2	8.2	9.7	5.7	0.0	0.0	0.0	0.0	72.4
0G33121D96	Infiltration Properties	5.7	6.7	5.7	9.9	11.0	5.8	6.2	10.0	0.0	0.0	0.0	0.0	61.0

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/95 - 05/31/96

	OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
0G33121E96 Infiltration Processes	15.4	18.1	16.9	20.3	23.7	20.0	16.2	19.2	0.0	0.0	0.0	0.0	149.8
1.2.3.3.1.2.1	28.9	34.3	31.6	41.5	45.9	34.0	32.1	34.9	0.0	0.0	0.0	0.0	283.2
0G33123C96 Vertical Seismic Profiling: Borehole UE-	17.5	20.0	13.2	32.7	21.1	10.1	9.5	19.9	0.0	0.0	0.0	0.0	144.0
0G33123D96 Unsaturated Zone Borehole Instrumentatio	74.8	82.1	66.5	38.2	57.3	41.1	49.5	55.1	0.0	0.0	0.0	0.0	464.6
0G33123G96 Integrated Analysis and Interpretation	0.0	0.0	12.4	12.9	15.3	16.7	17.1	16.1	0.0	0.0	0.0	0.0	90.5
0G33123H96 Matrix Properties of Hydrologic Units	12.2	9.3	9.4	7.2	7.7	7.2	6.1	14.4	0.0	0.0	0.0	0.0	73.5
0G33123K96 Temporary Instrumentation of SD-7	0.0	0.0	0.0	4.6	6.6	5.8	7.5	10.2	0.0	0.0	0.0	0.0	34.7
1.2.3.3.1.2.3	104.5	111.4	101.5	95.6	108.0	80.9	89.7	115.7	0.0	0.0	0.0	0.0	807.3
0G33124E96 Air-Permeability and Hydrochemistry Test	29.5	33.8	37.6	42.4	56.3	24.9	41.2	29.1	0.0	0.0	0.0	0.0	294.8
0G33124F96 Perched Water Testing in the Exploratory	0.9	0.0	2.8	4.3	3.0	1.0	12.4	22.0	0.0	0.0	0.0	0.0	46.4
0G33124K96 ESF Moisture/Dryout	0.0	0.0	0.0	0.0	7.0	7.5	12.9	18.3	0.0	0.0	0.0	0.0	45.7
1.2.3.3.1.2.4	30.4	33.8	40.4	46.7	66.3	33.4	66.5	69.4	0.0	0.0	0.0	0.0	386.9
0G33126B96 Gas Circulation and Pneumatic Pathways	9.6	11.5	9.0	13.7	9.6	8.9	8.7	10.3	0.0	0.0	0.0	0.0	81.3
1.2.3.3.1.2.6	9.6	11.5	9.0	13.7	9.6	8.9	8.7	10.3	0.0	0.0	0.0	0.0	81.3
0G33127B96 Unsturated-Zone Hydrochemistry	26.2	26.4	32.2	23.4	53.2	18.3	46.8	28.9	0.0	0.0	0.0	0.0	255.4
1.2.3.3.1.2.7	26.2	26.4	32.2	23.4	53.2	18.3	46.8	28.9	0.0	0.0	0.0	0.0	255.4
0G33128A96 Fluid Flow in Unsaturated-Zone Fractured	6.9	6.9	6.6	7.2	8.4	8.8	9.3	15.3	0.0	0.0	0.0	0.0	69.4
1.2.3.3.1.2.8	6.9	6.9	6.6	7.2	8.4	8.8	9.3	15.3	0.0	0.0	0.0	0.0	69.4
0G33129B96 Intermediate Site Unsaturated-Zone FlowM	7.3	8.6	15.2	30.5	6.3	16.6	17.7	23.0	0.0	0.0	0.0	0.0	125.2
1.2.3.3.1.2.9	7.3	8.6	15.2	30.5	6.3	16.6	17.7	23.0	0.0	0.0	0.0	0.0	125.2
0G33131A96 Conduct Hydraulic/Tracer Tests, C-Wells	39.6	40.5	40.7	49.0	57.6	7.2	10.1	8.6	0.0	0.0	0.0	0.0	253.3
0G33131F96 Site Potentiometric Levels Monitoring	11.7	17.5	17.2	0.4	3.7	10.3	10.8	16.8	0.0	0.0	0.0	0.0	88.4
0G33131G96 Pumping and Testing Existing Monitoring	11.8	14.0	5.4	20.7	20.8	21.4	31.8	17.6	0.0	0.0	0.0	0.0	143.5
0G33131K96 Enhanced C-Wells Hydraulic and Conservat	0.0	0.0	0.0	0.0	0.0	51.2	42.1	52.1	0.0	0.0	0.0	0.0	145.4
1.2.3.3.1.3.1	63.1	72.0	63.3	70.1	82.1	90.1	94.8	95.1	0.0	0.0	0.0	0.0	630.6
0G33132D96 Saturated-Zone Hydrochemical Sample and	6.7	6.9	6.3	8.7	6.9	6.9	7.4	7.0	0.0	0.0	0.0	0.0	56.8
1.2.3.3.1.3.2	6.7	6.9	6.3	8.7	6.9	6.9	7.4	7.0	0.0	0.0	0.0	0.0	56.8
0G33133D96 Site Saturated Zone Framework Model	14.9	10.2	4.6	0.1	0.1	0.7	11.2	16.7	0.0	0.0	0.0	0.0	58.5
0G33133E96 Site Saturated Zone Numerical Model	11.5	10.1	3.3	13.4	17.4	21.1	15.2	22.0	0.0	0.0	0.0	0.0	114.0
1.2.3.3.1.3.3	26.4	20.3	7.9	13.5	17.5	21.8	26.4	38.7	0.0	0.0	0.0	0.0	172.5
*1.2.3.3	341.2	387.6	368.3	412.4	458.2	377.1	428.1	503.1	0.0	0.0	0.0	0.0	3276.0
0G3521968 Tracer Gas Support	5.2	5.2	5.1	5.4	5.4	5.5	5.3	5.9	0.0	0.0	0.0	0.0	43.0
1.2.3.5.2.1	5.2	5.2	5.1	5.4	5.4	5.5	5.3	5.9	0.0	0.0	0.0	0.0	43.0
*1.2.3.5	5.2	5.2	5.1	5.4	5.4	5.5	5.3	5.9	0.0	0.0	0.0	0.0	43.0
0G36212B96 Paleoclimate Study of Lake, Playa and Ma	21.0	18.3	14.8	25.4	23.3	29.2	16.0	-29.7	0.0	0.0	0.0	0.0	118.3
1.2.3.6.2.1.2	21.0	18.3	14.8	25.4	23.3	29.2	16.0	-29.7	0.0	0.0	0.0	0.0	118.3
0G36214A96 Geochronological Studies of Surface Desp	22.4	16.3	17.1	3.4	0.9	-10.3	11.2	9.5	0.0	0.0	0.0	0.0	70.5

U.S. GEOLOGICAL SURVEY

ESTIMATED COSTS FOR 10/1/95 - 05/31/96

	OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
**1.2.8	40.6	34.3	34.4	35.6	39.7	38.7	47.3	43.6	0.0	0.0	0.0	0.0	314.2
OG912196B Participant Technical Project Office	27.1	29.1	29.7	25.2	24.4	22.6	15.8	34.4	0.0	0.0	0.0	0.0	208.3
1.2.9.1.2.1	27.1	29.1	29.7	25.2	24.4	22.6	15.8	34.4	0.0	0.0	0.0	0.0	208.3
*1.2.9.1	27.1	29.1	29.7	25.2	24.4	22.6	15.8	34.4	0.0	0.0	0.0	0.0	208.3
OG92296B Participant Project Control - USGS	19.9	20.9	19.7	20.5	27.0	18.8	18.1	22.0	0.0	0.0	0.0	0.0	166.9
1.2.9.2.2	19.9	20.9	19.7	20.5	27.0	18.8	18.1	22.0	0.0	0.0	0.0	0.0	166.9
*1.2.9.2	19.9	20.9	19.7	20.5	27.0	18.8	18.1	22.0	0.0	0.0	0.0	0.0	166.9
**1.2.9	47.0	50.0	49.4	45.7	51.4	41.4	33.9	56.4	0.0	0.0	0.0	0.0	375.2
OGC52196B Records Operation (USGS)	5.4	3.5	3.3	4.8	4.9	6.7	15.3	8.8	0.0	0.0	0.0	0.0	52.7
1.2.12.5.2.1	5.4	3.5	3.3	4.8	4.9	6.7	15.3	8.8	0.0	0.0	0.0	0.0	52.7
*1.2.12.5	5.4	3.5	3.3	4.8	4.9	6.7	15.3	8.8	0.0	0.0	0.0	0.0	52.7
**1.2.12	5.4	3.5	3.3	4.8	4.9	6.7	15.3	8.8	0.0	0.0	0.0	0.0	52.7
OGF23968I Support/Personnel Services	49.0	42.6	37.2	41.8	39.7	52.0	43.6	29.5	0.0	0.0	0.0	0.0	335.4
OGF23968Z Facilities Management - Space	85.4	57.6	71.0	71.3	71.3	71.3	71.3	71.3	0.0	0.0	0.0	0.0	570.5
OGF239683 Facilities Management - Computers/Phones	24.9	17.1	20.4	20.8	20.8	20.8	20.8	20.8	0.0	0.0	0.0	0.0	166.4
OGF239684 Facilities Management - Other	13.3	8.7	11.2	11.1	11.1	11.1	11.1	11.1	0.0	0.0	0.0	0.0	88.7
OGF239685 Procurement/Property Management - USGS	2.2	12.4	7.9	8.6	7.8	8.5	8.8	9.8	0.0	0.0	0.0	0.0	66.0
1.2.15.2.3	174.8	138.4	147.7	153.6	150.7	163.7	155.6	142.5	0.0	0.0	0.0	0.0	1227.0
*1.2.15.2	174.8	138.4	147.7	153.6	150.7	163.7	155.6	142.5	0.0	0.0	0.0	0.0	1227.0
OGF396B YMP Support For The Training Mission (US	5.6	5.0	4.0	3.6	7.7	4.3	14.2	15.1	0.0	0.0	0.0	0.0	59.5
1.2.15.3	5.6	5.0	4.0	3.6	7.7	4.3	14.2	15.1	0.0	0.0	0.0	0.0	59.5
*1.2.15.3	5.6	5.0	4.0	3.6	7.7	4.3	14.2	15.1	0.0	0.0	0.0	0.0	59.5
**1.2.15	180.4	143.4	151.7	157.2	158.4	168.0	169.8	157.6	0.0	0.0	0.0	0.0	1286.5
1.2 OPERATING	1018.8	1050.0	1093.3	1267.5	1440.2	1224.7	1239.0	1502.7	0.0	0.0	0.0	0.0	9836.2
CAPITAL EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0	16.0
GRAND TOTAL	1018.8	1050.0	1093.3	1267.5	1440.2	1224.7	1255.0	1502.7	0.0	0.0	0.0	0.0	9852.2
FTEs													
FEDERAL	118.1	125.4	123.4	133.7	118.8	121.9	112.7	127.9	0.0	0.0	0.0	0.0	
CONTRACT	7.9	8.6	11.1	15.4	17.4	21.5	22.7	28.0	0.0	0.0	0.0	0.0	
TOTAL	126.0	134.0	134.5	149.1	136.2	143.4	135.4	155.9	0.0	0.0	0.0	0.0	

* Fourth level WBS roll-up

** Third level WBS roll-up

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/95 - 05/31/96

		OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
0G36214B96	Surface Deposits Mapping	5.9	5.9	6.2	7.2	8.0	7.2	10.1	12.3	0.0	0.0	0.0	0.0	62.8
1.2.3.6.2.1.4		28.3	22.2	23.3	10.6	8.9	-3.1	21.3	21.8	0.0	0.0	0.0	0.0	133.3
0G36215A96	Paleoclimate/Paleoenvironmental Synthesi	9.1	9.1	15.4	3.3	13.8	8.9	13.5	33.0	0.0	0.0	0.0	0.0	106.1
1.2.3.6.2.1.5		9.1	9.1	15.4	3.3	13.8	8.9	13.5	33.0	0.0	0.0	0.0	0.0	106.1
0G36221E96	Subsurface Mineral Record of Past Hydrol	16.9	36.8	25.6	27.0	18.8	28.2	21.4	-3.4	0.0	0.0	0.0	0.0	171.3
0G36221F96		0.0	0.2	4.5	12.2	16.5	8.1	8.4	35.7	0.0	0.0	0.0	0.0	85.6
0G36221G96	Evaluation of Paleo Ground-Water Dischar	9.5	4.1	-0.7	0.0	1.7	4.2	14.9	60.2	0.0	0.0	0.0	0.0	93.9
0G36221K96	Dating of Fracture Coatings in ESF	0.0	0.0	24.3	50.5	86.9	53.0	31.3	34.4	0.0	0.0	0.0	0.0	280.4
1.2.3.6.2.2.1		26.4	41.1	53.7	89.7	123.9	93.5	76.0	126.9	0.0	0.0	0.0	0.0	631.2
*1.2.3.6		84.8	90.7	107.2	129.0	169.9	128.5	126.8	152.0	0.0	0.0	0.0	0.0	988.9
**1.2.3		731.6	802.6	841.6	990.0	1175.8	956.4	951.9	1203.8	0.0	0.0	0.0	0.0	7653.7
0G5249682	Regulatory Documentation	5.7	5.9	0.0	8.9	0.9	0.0	0.0	-5.0	0.0	0.0	0.0	0.0	16.4
1.2.5.2.4		5.7	5.9	0.0	8.9	0.9	0.0	0.0	-5.0	0.0	0.0	0.0	0.0	16.4
*1.2.5.2		5.7	5.9	0.0	8.9	0.9	0.0	0.0	-5.0	0.0	0.0	0.0	0.0	16.4
0G53596B	Technical Data Base Input	7.2	10.3	12.5	14.1	11.8	13.1	20.8	21.4	0.0	0.0	0.0	0.0	111.2
1.2.5.3.5		7.2	10.3	12.5	14.1	11.8	13.1	20.8	21.4	0.0	0.0	0.0	0.0	111.2
*1.2.5.3		7.2	10.3	12.5	14.1	11.8	13.1	20.8	21.4	0.0	0.0	0.0	0.0	111.2
0G54196B	Interact with Site Characterization and	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.2.5.4.1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0G54696B	Planning and Coordination of Flow- and-T	0.0	0.0	0.4	10.2	-3.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	7.8
1.2.5.4.6		0.0	0.0	0.4	10.2	-3.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	7.8
*1.2.5.4		0.0	0.0	0.4	10.2	-3.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	7.8
0G55396B		0.0	0.0	0.0	0.1	-0.1	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.5
1.2.5.5.3		0.0	0.0	0.0	0.1	-0.1	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.5
*1.2.5.5		0.0	0.0	0.0	0.1	-0.1	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.5
0G57968	Technical Evaluation	0.9	0.0	0.0	0.9	0.5	-0.2	0.0	15.9	0.0	0.0	0.0	0.0	18.0
1.2.5.7		0.9	0.0	0.0	0.9	0.5	-0.2	0.0	15.9	0.0	0.0	0.0	0.0	18.0
*1.2.5.7		0.9	0.0	0.0	0.9	0.5	-0.2	0.0	15.9	0.0	0.0	0.0	0.0	18.0
**1.2.5		13.8	16.2	12.9	34.2	10.0	13.5	20.8	32.5	0.0	0.0	0.0	0.0	153.9
0G82596B	Occupational Safety and Health	7.3	7.4	7.0	7.7	7.8	-7.5	7.5	10.8	0.0	0.0	0.0	0.0	63.0
1.2.8.2.5		7.3	7.4	7.0	7.7	7.8	7.5	7.5	10.8	0.0	0.0	0.0	0.0	63.0
*1.2.8.2		7.3	7.4	7.0	7.7	7.8	7.5	7.5	10.8	0.0	0.0	0.0	0.0	63.0
0G84596B	Radiological Studies	0.0	0.0	0.0	0.1	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
1.2.8.4.5		0.0	0.0	0.0	0.1	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
0G84796H	Water Resources Monitoring	33.3	26.9	27.4	27.8	31.9	31.6	39.8	32.8	0.0	0.0	0.0	0.0	251.5
1.2.8.4.7		33.3	26.9	27.4	27.8	31.9	31.6	39.8	32.8	0.0	0.0	0.0	0.0	251.5
*1.2.8.4		33.3	26.9	27.4	27.9	31.9	31.2	39.8	32.8	0.0	0.0	0.0	0.0	251.2

SYNTHESIS REPORTS SCHEDULED FOR FY96					
WBS #	*Part.*	*Deliverable #*	*Title*	*Baseline*	*Forecast*
1.2.3.2.1.1.1	M&O	3665	Synthesis of Mineralogy/Petrology Studies	01-Aug-96	30-Aug-96
~~1.2.3.2.2.1.1~~	~~USGS~~	~~3GGU102M~~	~~Stratigraphy, Structure, and Rock Properties of Yucca Mountain~~	~~30-Aug-96~~	~~30-Aug-96~~
1.2.3.2.5.1.1	M&O	3781M	Synthesis of Volcanism Studies	30-Aug-96	30-Aug-96
1.2.3.2.7.4	M&O	OS32741D1	Site Geotechnical Report	02-Sep-96	03-Sep-96
1.2.3.2.8.3.6	USGS	3GSH100M	Seismotectonic Framework for Yucca Mountain	01-Aug-96	01-Aug-96
1.2.3.4.1.2.1	M&O	3784M	Summary & Synthesis Report on Radionuclide Retardation	31-Aug-96	30-Aug-96
1.2.3.3.1.2.7	USGS	3GUH607M	Synthesis Report on UZ Hydrochemistry at Yucca Mountain	30-Aug-96	30-Aug-96
1.2.3.6.2.1.5	USGS	3GCA102M	Synthesis Quaternary Rsp YM Unsaturated & Saturated Zone Hydrologic Climate Changes	30-Aug-96	30-Aug-96
1.2.3.11.2	M&O	OB05M	Borehole and Surface Geophysics Synthesis Report	01-Aug-96	29-Aug-96
1.2.3.12.1	M&O	MOL305	Revision 1 of Vol II of the Near Field Environment Report Preparation	30-Aug-96	30-Aug-96

Note: Synthesis Report on Stratigraphy, Structure, + Rock Properties cancelled because this information to be presented in 1997 PISA. DOE added Synthesis Report on "Characterization of Fractures at Yucca Mountain" due 8/30/96

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M&O SYNTHESIS REPORT LEVEL 3 MILESTONES

Synthesis of Mineralogy/Petrology Studies: Milestone 3665 ✓ 01 Aug 96

This deliverable consists of a report that will describe the distribution, occurrence, and origin of important minerals in both fractures and matrix, the occurrence and distribution of erionite and associated health effects, the existing three-dimensional mineralogical model of Yucca Mountain and a description of existing mineral assemblages that are favorable for radionuclide retardation.

Stratigraphy Structure and Rock Properties of Yucca Mountain: Milestone 3GGU102M ✓ 30 Aug 96

Deleted for FY96 per change request

The deliverable consists of a synthesis report, based primarily on data available at the end of FY1995, describing the current level of understanding on the stratigraphy, structural geology, and rock properties of the site area.

Synthesis of Volcanism Studies: Milestone 3781M ✓ 30 Aug 96

This deliverable will include but not be limited to: Revision of estimates of the annual probability of a magmatic event affecting the repository using various structural models for volcanism in the Yucca Mountain region. This work will provide a mature evaluation of the probability of disruption of the repository area due to direct and indirect volcanic effects, and thereby the importance of the hazard to the site due to renewed igneous activity.

Site Geotechnical Report: Milestone 0S32741D1 ✓ 02 Sep 96

The deliverable will contain a synthesis of the geology, hydrology, geochemistry, geomechanics, Exploratory Studies Facility Observations, Seismic Design Basis, Engineering Geology of the North Ramp, Seals, and Appendices. In this report, various types or groups of data will be interpreted in the context of other related and relevant information and end use.

Seismotectonic Framework for Yucca Mountain: Milestone 3GSH100M ✓ 01 Aug 96

This deliverable will summarize and synthesize the available seismotectonic information for Yucca mountain and will contain the results of field studies of Quaternary faults, both at the site and in the region surrounding Yucca Mountain, with emphasis on their potential as seismic sources. This summary will include an assessment of the recency of displacement and Quaternary history of studied faults, including final results for the Ghost Dance fault, Rock Valley fault, and Crater Flat fault.

Summary and Synthesis Report on Radionuclide Retardation; Milestone 3784M ✓ 31 Aug 96

This deliverable will consist of the assembly of summary and synthesis activities of laboratory and modeling studies that investigate mechanisms by which radionuclide transport is retarded

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or enhanced by sorption, diffusion, microbial activity, solubility limits, and colloid transport. Results of analysis will be discussed with regard to quality/reliability of results, site characterization, current conceptual models and hypotheses, and recommended input to subsequent modeling efforts and performance assessment.

Report on UZ Hydrochemistry at Yucca Mountain: Milestone 3GUH607M 30 Aug 96

This deliverable will consist of analyses of water obtained from existing core samples from the Calico Hills and Paintbrush nonwelded units in selected boreholes, and these data will be compared to previously reported data will be compared to previously reported data from other boreholes. The synthesis also will include the results of past and ongoing rock-gas sampling from selected boreholes at the Yucca Mountain Site.

Synthesis Quaternary Response of Yucca Mountain Unsaturated and Saturated Zone Hydrol. to Climate Change: Milestone 3GCA102M 30 Aug 96

This deliverable will incorporate information from Terrestrial Paleoecology, lakes, playas, and marshes, Paleoenvironmental History, and Quaternary Regional Hydrology into a single report. The report will provide an initial assessment of local and regional climate change and the resulting response of infiltration, percolation, rise in water-table elevation within and past-discharge on, or near Yucca Mountain.

Borehole and Surface Geophysics Synthesis Report: 0BC5M ✓ 01 Aug 96

This deliverable will describe the geologic setting of Yucca Mountain and vicinity as determined from an interpretation and integration of surface-based and borehole geophysical data. Analysis of seismic data will include seismic reflection profiles across the Rock Valley fault and vertical seismic profile data collected to provide velocity information in support of seismic hazard assessment.

Revision 1 of Volume II of the Near Field Environment Report Prep.: Milestone MOL305 ✓ 30 Aug 96

This deliverable will include appropriate updates of the existing Near-Field Environment Report and any new or additional information that has been developed, in addition to new chapter(s) covering the Altered Zone.

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APPENDIX

Synthesis of Volcanism Studies

outline *(For information purposes only. The outline does not reflect contracted workscope and may not be used to judge suitability/acceptibility of the report)*

I. Abstract

II. Introduction to the volcanism issue (chapter 1)

A. Summary of major conclusions
B. Introduction to major issues regarding volcansim
   1. Risk vs. hazard
   2. Uncertainty and difficulties of predictions for Yucca Mountain
   3. Description of the contents of succeeding chapters

III. Geologic setting of basaltic volcanism (chapter 2)

A. Summary of geologic setting
B. Introduction
   1. Regional geologic setting at a variety of scales
C. Basaltic volcanism of the Yucca Mountain region
   1. Basalt of the silicic episode (>11 Ma)
   2. Post-caldera basalt (<11 Ma)
      a. Older post-caldera basalts (9-6.3 Ma)
      b. Younger post-caldera basalts (<4.8 Ma)

IV. Tectonic setting of Yucca Mountain and its relationship to basaltic volcanism (chapter 3)

A. Summary of the tectonic setting
B. Introduction to tectonic issues
C. Tectonics of the southern Great Basin
D. Tectonics of the Yucca Mountain region
E. Tectonics and the time-space distribution of basaltic volcanism
F. Summary of geophysical studies in the Yucca Mountain region
   1. Seismic studies (natural seismicity)
   2. Gravity studies
   3. Magnetic studies
   4. Geodetic studies
   5. Seismic studies (reflection, refraction, teleseismic)
G. Tectonic models of basaltic volcanism

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V. Petrologic and geochemical constraints on basaltic volcanism (chapter 4)

A. Summary of petrologic and geochemical constraints
B. Introduction to petrologic and geochemical constraints
C. Time-space-composition trends in basaltic volcansim from the western US
D. Mantle source components for volcanism
E. Evolution of basaltic volcanic fields
F. Geochemical evidence for polygenetic volcanism in the Yucca Mountain region

VI. 3. Magma System Dynamics (Chapter 5)

A. Summary of literature review
B. Recommendations for future research.

VII Eruptive Effects (chapter 6)

A. Description of analog eruptive centers in New Mexico and Arizona
B. Lithic data
   1. Measurement techniques
   2. Uncertainty
   3. Lithic data for different eruptive mechanisms
   4. Statistical treatment of lithic data
C. Implications for eruptive effects on a repository.

VIII. Subsurface Effects (chapter 7)

A. Controls on shallow intrusion geometry
   1. Desription of Paiute Ridge intrusion geometries
   2. Interpretation of emplacement mechanisms
   3. Implications for intrusions near repository.
B. Hydrothermal alteration of silicic tuffs around shallow basaltic intrusions.
   1. Paiute Ridge analog site
      a. Field descriptions
      b. Chemical and mineralogical data
      c. Interpretation of alteration processes
   2. Grants Ridge analog site
      a. Field descriptions
      b. Chemical and mineralogical data
      c. Interpretation of alteration processes
   3. Implcations for hydrothermal effects on repository.
C. Summary of theoretical and modeling studies of hydrothermal processes.

Intrusive effects

A. Temporal and spatial scale of disruption to a repository system
   1. Field studies
   2. Modeling studies

B. Anticipated contribution to releases

IX. History of volcanism studies (chapter 8)

A. Summary of volcanism studies
B. Introduction to volcanism studies
C. Progress before the site characterization plan (by year since 1979)
D. Progress since the site characterization plan (by year since 1988)

X. Probabilistic volcanic hazard assessment (PVHA; chapter 9)

A. Summary of PVHA
B. Introduction to PVHA
C. The probability models
D. Stragtegy for implementing PVHA at Yucca Mountain
E Revised probability calculations
   1. Definition of a volcanic event
   2. Temporal treatment of models
   3. Spatial and structural treatment of models
   4. Treatment of possible polygenetic volcanism
   5. Treatement of event distributions for various volcanic centers/clusters
   6. Recurrence rate calculations
   7. Estimates of the probability of disruption of the repository system
F. Comparison of probability calculations to those of the PVHA expert panel and others
   1. Comparisions of probability distributions
   2. Source and significance of differences in probability distributions

XI. Current status and recommendations for further needed work (Chapter 10)

XII Summary of conclusions from chapters 1 through 10 (chapter 11)

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MINERALOGY/PETROLOGY SUMMARY AND SYNTHESIS REPORT

Chapter 1: Mineralogy/Petrology of Transport Pathways

I. Geochemical Stratigraphy of the Yucca Mountain Site

A. The Background Bulk-Rock Chemistry of Yucca Mountain
- 1: Primary chemistry of the silicic volcanic units
- 2: Chemistry of altered tuffs

B. Mineral Chemistry
- 1: Abundances, distributions, and compositions of minerals at Yucca Mountain
  - a. Primary minerals (phenocryst, devitrification, and vapor-phase)
  - b. Secondary minerals

II. Geochemistry of the Potential Host Rock at Yucca Mountain

A. Geochemical/Textural Stratigraphy of the Topopah Spring Tuff

B. Bulk-Rock Chemistry in Reference to the Potential Repository Location

C. Mineralogy in Reference to the Potential Repository Location

III. Applications of Geochemistry to Flow and Transport Models

A. Mineralogy as a Factor in Sorption Experiments

B. Microautoradiography

C. Calcite as a Representative of Pleistocene(?) Deposits

IV. Fracture Mineralogy

A. The Importance of Fracture Minerals
- 1: Fractures as transport pathways (UZ)
- 2: Fractures as transport pathways (SZ)

B. Fracture Minerals of the UZ: chemistry, abundance, and paragenesis
1. Silica minerals (tridymite, cristobalite, quartz, and opal)
2. Zeolites (diversity)
3. Mn-oxides
4. Clays
5. Calcite

C. Fracture Minerals of the SZ: chemistry, abundance, and paragenesis
1. Quartz
2. Zeolites (equivalence to wall-rock)
3. Mn-oxides
4. Fe-oxides
5. Clays

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6. Calcite

D. Limitations and Needs in Applying Fracture Mineralogy to Site Transport Models

V. Minerals and Construction: Mineral Health Hazards

A. The Nature of Mineral Inhalation Hazards

B. Inhalation Hazards Specific to Yucca Mountain
1. Zeolites
   a. mordenite
   b. erionite
2. Chain clays
   a. palygorskite
3: Silica phases
   a. quartz, cristobalite, and tridymite
   b. opal

C. Hazard Rankings, Impacts, and Mitigation

VI. Statistical Considerations

A. Available Statistical Analyses

B. Needed Analysis

Chapter 2: History of Mineralogic and Geochemical Alteration of Yucca Mountain

I. Natural Alteration History

A. Overview of Alteration History Studies

B. Syngenetic Alteration of Pyroclastic Rocks
1. General Description
2. Devitrification and vapor-phase crystallization
3. Moderate-temperature hydrothermal alteration
   a. Alteration at the top of the Topopah Spring Tuff (Busted Butte, Yucca Mountain, ESF)
   b. Alteration in the lower Topopah Spring devitrified-vitric transition zone
   c. Alteration in the nonwelded Paintbrush Tuff
   d. Alteration in the Tiva Canyon Tuff
   e. Implications for Paleohydrology

C. Diagenetic Alteration
1. General Description
2. Occurrences of zeolitic rocks (emphasis on genetic aspects)
3. Geochronology
   a. K/Ar Studies
   b. Petrofabric Studies

4. Conceptual Model of Zeolitization at Yucca Mountain (including paleohydrology)
5. Chemical-Textural Studies of Zeolitization
   a. Chemical Changes Associated with the Vitric-Zeolitic Transition
   b. Distribution Patterns of Clinoptilolite Composition

D. Regional Hydrothermal Alteration
   1. General Description
   2. Paleogeothermal studies
   3: Geochronology
E. Surficial Alteration (trench studies)
F. Brecciation of the Topopah Spring and Tiva Canyon Tuffs (trench, outcrop, and ESF studies)
G. The Role of Colloids in Alteration and Transport
H. Present and Future Rates of Alteration Processes
I. Implications of Natural Alteration for Repository-Induced Processes
J. Remaining Uncertainties and Information Needs
K. Summary and Chronology of Alteration History of Yucca Mountain

II. Dehydration and Rehydration of Yucca Mountain Hydrous Phases

A. Overview of Dehydration/Rehydration Studies
B. Zeolites
   1. Long-term Clinoptilolite Dehydration (structural studies)
   2. Dynamic Heating
   3. Equilibrium and Calorimetric Studies of Clinoptilolite
C. Smectites
   1. Long-term Dehydration
   2. Dynamic Heating
D. Glasses
   1. Long-term dehydration and rehydration of Topopah Spring lower vitrophyre glass
   2. Dynamic heating
E. Contributions of hydrous minerals to repository heating effects and water budget
   1: Water released by hydrous minerals as a function of repository thermal history
   2. Thermal effects of hydrous mineral dehydration/rehydration as a function of repository thermal history
F Remaining Uncertainties and Information Needs

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Chapter III: Kinetics and Thermodynamics of Mineral Evolution

I. **Thermodynamic Stability of Minerals and Glasses at Yucca Mountain: Synthesis of thermodynamic data, field observations, and geochemical modeling on mineral and glass stability**

A. Description of present environmental conditions and possible extrapolation to repository conditions. From CMS paper.
   1. Zeolites present at Yucca Mountain
      a. Clinoptilolite, Mordenite, Analcime, Stellerite, Erionite, Minor Zeolites
      b. Why are we worried about zeolites?
   2. Ground water compositional trends
   3 Thermal trends (past and possibly the Buscheck stuff)

B. Analysis of Zeolite Stability
   1. Thermodynamic Data
      a. Description of estimation methods used to derive thermodynamic data.
      b. Comparison of estimated data with measured data for zeolites.
   2. Listing and description of representative chemical data for YM zeolites.
      a. List the representative chemical data and their sources.
      b. Describe the known chemical trends for phases to determine the representative compositions to be used in modeling. From Zeolite'93.
   3. Modeling of zeolite occurrences at Yucca Mountain.
      a. Observations of zeolite stability at Yucca Mountain
      b. Modeling of the conditions which result in stability of the primary zeolites (clinoptilolite, mordenite, analcime, and stellerite). From Zeolite '93, CMS paper.
      c. Modeling of the conditions which result in the stability of the rare zeolites (laumontite, chabazite, phillipsite, erionite). From Zeolite '93.
      d. Modeling specific to the formation of erionite at Yucca Mountain. From erionite letter report.
      e. Modeling addressing the clinoptilolite to analcime transition. From CMS paper
      f. Address the limited modeling on heulandite/stellerite stability.
      g. Compare and contrast field and modeling results on zeolite stability.

C. Analysis of illite/smectite stability
   1. Transformation to illite

D. Silica Polymorphs
   1. tridymite, opal-CT, or cristobalite to quartz transformation
   Knowing the kinetics of the transformation, cristobalite and quartz dissolution/precipitation kinetics, age of the formation, and the SiO2 abundance, can we calculate the temperature at various points in a drill hole (e.g., reproduce points on the geotherm of Bish and Aronson for the USW G-holes?). Estimate conversion of silica minerals under the thermal influence of a repository, effects on aqueous silica activity.

2. possible mobilization of silica in reflux zone, dissolution/precipitation affecting rock permeability.

E. Glass

F. Miscellaneous

Discussion of implications of mineral and glass transformation on the thermohydrologic history of Yucca Mountain

II. Kinetics of Mineral and Glass transformation at Yucca Mountain: Synthesis of experimental and field observations on kinetics of reactions.

A. Silica Polymorphs

1: Cristobalite to quartz transformation.

a. Knowing the kinetics of the transformation, age of the formation, and the SiO2 abundance, can we calculate the temperature at various points in a drill hole (e.g., reproduce points on the geotherm of Bish and Aronson for the USW G-holes?).

b. Can we model the amount of silica conversion that YM may encounter?

2. Transformation of opal-CT and tridymite

B. Feldspar dissolution kinetics, effects on aqueous silica activity.

C. Clinoptilolite/Analcime

1. Dissolution-precipitation kinetics

2. Prediction of clinoptilolite to analcime reaction rates

D. Glass-discussion of implications for mineral and glass transformations.

III. Summary of results: Implications for thermohydrology of Yucca Mountain, transport of radionuclides, integrity of the repository. Use of modeling to assess importance of thermal reactions.

APPENDIX A

CONDENSED OUTLINE AND WRITING ASSIGNMENTS FOR THE GEOTECHNICAL CHARACTERIZATION OF THE PROPOSED REPOSITORY SITE AT YUCCA MOUNTAIN

1.0 Introduction -- **The M&O will be responsible for writing all of Chapter 1.**

- 1.1 Purpose
- 1.2 Background
- 1.3 Scope
- 1.4 Quality Assurance
- 1.5 Report Organization

2.0 Geotechnical Summary -- **The M&O will be responsible for writing Chapter 2. Summary sections identified below will be written by SNL personnel.**

- 2.1 Introduction
- 2.2 Geology and Major Structural Features of the Proposed Site
  - 2.2.1 Known Geologic Features of Engineering and Construction Significance
  - 2.2.2 Potential Geological Features with Engineering and Construction Significance
- 2.3 Thermal/Mechanical Stratigraphy
- 2.4 Orientations of Joints and Fractures
- 2.5 Hydrology
- 2.6 Rock Structure Data
- 2.7 Laboratory Rock Properties Data -- **Nancy Brodsky**
  - 2.7.1 Physical Properties
  - 2.7.2 Thermal Properties
  - 2.7.3 Mechanical Properties of Intact Rock
  - 2.7.4 Mechanical Properties of Fractures
- 2.8 Rock Mass Quality Indices: RMR and Q -- **Steve Sobolik**
- 2.9 Rock Mass Thermal and Mechanical Properties Estimates -- **Steve Sobolik**
- 2.10 Availability of Naturally Occurring Construction Materials
- 2.11 Underground Opening and Borehole Sealing
- 2.12 Geochemistry and Health Concerns
- 2.13 Summary of Implications of Geotechnical Information

3.0 Geology of the Site -- **The M&O will be responsible for writing this chapter; SNL staff may provide input where noted (by **).**

- 3.1 Introduction
- 3.2 Lithologic Logging of the Core
- 3.3 Stratigraphy
  - 3.3.1 General Overview
    - 3.3.1.1 Ash-Flow Tuffs
    - 3.3.1.2 Bedded Tuffs and Other Volcanic Deposits

APPENDIX A

3.3.1.3 Alluvial Deposits
** 3.3.2 Geologic Cross Sections -- Chris Rautman
3.3.3 Thermal/Mechanical Stratigraphy
3.4 Major Structural Features
3.5 Hydrologic Features
** 3.6 In Situ Stress Measurements -- Mike Riggins

4.0 Rock Structure Data -- **The M&O will write this section, with SNL input where noted.**
4.1 Introduction
4.2 Rock Structural Logging
** 4.3 Borehole Rock Structure Data -- Chris Rautman
4.3.1 RQD Data
4.3.2 Rock Weathering and Hardness
4.3.3 Lithophysae Content
4.3.4 Fracture Data
4.3.5 Analysis of Rock Structural Character where Boreholes Intersect Faults
4.3.6 Correlation of Core Rock Structural Data with Downhole Video Logs
4.4 ESF Rock Structure Data
4.4.1 RQD Data
4.4.2 Fracture Data
4.4.x Additional subheadings as appropriate for USBR, etc.

5.0 Laboratory Rock Properties Data -- **Nancy Brodsky will write this chapter. She will get input from Mike Riggins, Bill Olsson, Steve Brown, NER, and Jim Connolly.**
5.1 Introduction
5.2 Physical Properties
5.2.1 Density and Porosity
** 5.2.2 Mineralogy --**Jim Connolly will assist Nancy.**
** 5.3 Thermal Properties -- **Mike Riggins will assist Nancy.**
5.3.1 Thermal Conductivity
5.3.2 Thermal Expansion
5.3.3 Heat Capacity
5.3.4 Correlations of Thermal Properties
** 5.4 Mechanical Properties of Intact Rock -- **NER will assist Nancy.**
5.4.1 Static and Dynamic Elastic Properties
5.4.2 Strength
5.4.3 Creep Properties
** 5.5 Fracture Mechanical Properties -- **Bill Olsson, Steve Brown will assist Nancy.**
5.5.1 Fracture Stiffness
5.5.2 Fracture Strength

APPENDIX A

6.0 Rock Mass Quality Data -- **Steve Sobolik will be responsible for this chapter except where noted (by **). For Sections 6.2 through 6.4, he will get input from Agapito personnel.**

- 6.1 Introduction
- 6.2 Rock Mass Quality Indices for the Rock Mass Rating System
  - 6.2.1 Data Analysis Procedures
  - 6.2.2 Strength Parameter
  - 6.2.3 Rock Quality Designation Rating
  - 6.2.4 Spacing of Discontinuities
  - 6.2.5 Condition of Joints
  - 6.2.6 Groundwater
  - 6.2.7 Distribution of Rock Mass Rating Values for the Thermomechanical Units
- 6.3 Rock Mass Quality Indices for the Q System
  - 6.3.1 Data Analysis Procedures
  - 6.3.2 Rock Quality Designation
  - 6.3.3 Joint Set Number
  - 6.3.4 Joint Roughness Number
  - 6.3.5 Joint Alteration
  - 6.3.6 Joint Water Reduction Factor
  - 6.3.7 Stress Reduction Factor
  - 6.3.8 Distribution of Q Values for the Thermomechanical Units
- 6.4 Evaluation of RMR and Q Results
  - 6.4.1 Correlation of RMR and Q Results
  - 6.4.2 Comparison of Q and RMR Determined in the ESF to SBT Core-Based Data
  - 6.4.3 Distributions of Q Values
- ** 6.5 Key Block Analysis -- **Mike Riggins of SNL is responsible for this section. He will receive assistance from Clinton Lum of SNL.**

7.0 Rock Mass Thermal and Mechanical Properties-- **Steve Sobolik will write this chapter except where noted (by **).**

- 7.1 Introduction
- 7.2 Data Analysis Procedures
- 7.3 Rock Mass Strength
  - 7.3.1 Yudhbir Criterion
  - 7.3.2 Hoek and Brown Criterion
  - 7.3.3 Design Rock Mass Strength
  - 7.3.4 Rock Mass Mohr-Coulomb Strength Parameters and Dilation Angles
- 7.4 Rock Mass Elastic Moduli
- 7.5 Rock Mass Poisson's Ratios
- 7.6 Rock Mass Thermal Conductivity and Heat Capacity
- 7.7 Rock Mass Thermal Expansion

APPENDIX A

** 7.8 Instrumentation Results from ESF -- Mike Riggins will be responsible for this section.

8.0 Implications of Geotechnical Information -- The M&O will write this section with SNL input as stated in Section 2.0.

9.0 References -- All authors will give references to the M&O, who will collate them.

Appendices as needed; e.g.: -- TBD by authors of preceding sections.

Technical Procedures - by reference
Development of Rock Mass Quality Estimates from Core Data
Racked Frequency of Occurrence Tables for Q, RMR, and RQD by Thermomechanical Unit
Rock Mass Quality; Indices for the Lithophysae-Rich and Nonlithophysal Tuff Rock
Core logs
Lab Properties, organized by property
RMQ data by data type
etc.

10/25/95 VERSION

Seismotectonic Framework of Yucca Mountain

A Synthesis Report by the

U.S. Geological Survey Tectonics Team

Executive Summary

Introduction

- Define purpose and scope of this synthesis report.
- Present a history of the tectonics program.
- Discuss relevant regulatory and design issues
- Discuss relevant technical issues and how they have been approached in this report
- Limitations of present work

1 Geologic Setting

- Miocene volcanic history
- Physiographic and climatic setting
- Evolution of the Great Basin

2 Neogene tectonic evolution of Yucca Mountain

- Pre-Neogene structural configuration
- Volcanotectonic evolution; calderas history and renewed volcanism (recurrent basaltic cones)
- Origin of major faults and other structures on Yucca Mountain
  - Discussion of faults on Yucca Mtn central block

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To Rich Quittmeyer	From John Whitney
Co. Rich - Here is revision	Co. - Any comments?
Dept.	Phone # 236 0516 x 275
Fax # 794 5378	Fax #

PRELIMINARY DRAFT
INFORMATION ONLY

Alternative tectonic models
- Tectonic domains
- Structural models and cross-sections
- Interpretation of geophysical data sets
  - seismic reflection, gravity, aeromagnetics, etc
- Vertical and horizontal deformation
- Discussion of coupled processes
- Discussion of regional and local stresses

3 Quaternary faulting in the Yucca Mountain Region

Distribution of Quaternary faults within 100 km
Brief description of all potential regional seismic sources
- Complete descriptions presented in an Appendix

Death Valley-Furnace Creek Fault System
Bare Mountain Fault System
Rock Valley Fault System

Modem deformation from so Great Basin GPS network

4 Quaternary faulting and paleoseismology at Yucca Mtn

Distribution of Quaternary deposits
- Quaternary stratigraphy

Geochronology of Quaternary sediments
- Dating paleo surface ruptures

Distribution of Quaternary faults and scarps at Yucca Mountain
- Relationship to Miocene structures
- Fault bifurcations and intersections
- Presence of basaltic ash in fault planes
- Scarp enhancement by erosion

Summary of Midway Valley Studies

Ghost Dance Fault Evaluation

Synthesis of paleoseismic studies of eight local faults
- (Detailed summaries in an Appendix)
- Displacements per events
- Recurrence intervals
- Fault slip rates: Quaternary through Neogene

5 Earthquake magnitude and recurrence at Yucca Mountain

- Fault segmentation models
- Distributed faulting scenarios
- Paleo-magnitude from displacement per event, fault length, and down-dip width
- Earthquake recurrence models

6 Seismotectonic models of Yucca Mountain faults

- Synthesis of faulting style, geometry, and dynamics
  - Critique tectonic models:
    - detachment
    - concealed detachment or strike-slip
    - high-angle planar or branching
    - volcanic
    - slide block
- Boundary element models of local faults (in cross-section and plan view)

7 Seismicity in the Great Basin

- Historical earthquake catalog (scrubbed version)
- Seismicity from 1978-1995
- Little Skull Mountain Earthquake of 1993
  - Discussion of triggered events
- Recent earthquakes in Rock Valley and near Yucca Mountain
- Precarious rock studies
- Background source zones in the Great Basin

8 Fault rupture hazard analysis: A summary of issues and information

Empirical data from Great Basin and global earthquakes
    Contrast regional data with Yucca Mtn data
Minimum magnitude for surface rupture in the Great Basin
Maximum background earthquake in the Great Basin
Alternative approaches for assessing fault rupture hazard

9 Ground motion hazard analysis: A summary of issues and information

Source Modeling studies and Scenario Earthquakes at Yucca Mountain
Ground motion attenuation
    Empirical relationships from California earthquakes in the western U.S.
    Empirical relationships from normal faulting earthquakes
Ground motion Site Response

10 Relevant earthquake sources

Define type I vs. relevant and potentially relevant sources)
    Distinguish relevancy *ɔ fault rupture vs. ground motion hazards
Seismic source characterization analysis
    Table of relevant and potentially relevant sources:
        use new empirical ground motion relationship

11 Discussion of the state of knowledge of tectonics of Yucca Mountain (?)

Discussion of studies that may increase confidence in the data and interpretations

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OUTLINE OF SYNTHESIS REPORT FOR RADIONUCLIDE RETARDATION

Chapter on: GROUNDWATER CHEMISTRY MODEL

Chapter on: SORPTION AND SORPTION MODELING STUDIES

I. Groundwater Chemistry (and its effects sorption)
II. Mineralogy Variability (and its effects on sorption)
III Sorption Data (determined by batch experiments)
  A. Sorption of Simple Cations
  B. Sorption of Simple Anions
IV Sorption of Actinides
V. Models that can explain the measured sorption data
  A. Ion Exchange
  B Surface Complexation
VI Recommended sorption data for PA

Chapter on: SOLUBILITY STUDIES

I. Introduction

  A. Solubility's Role in Multi-Barrier Approach
  B. Focus on Np, Pu, and Am
  C. Focus on OH- and CO32- Ligands
  D. Goals of Study: Short, Intermediate, and Long Term

II. Neptunium

  A. Summary of Bulk Solubility Experiments
  B. Summary of Solution Speciation
    1. Check on Consistency of Data Using SIT Analysis
  C. Summary of Solubility Limiting Solids
  D. Status of Solubility Modeling

III. Plutonium

  A. Summary of Bulk Solubility Experiments
  B. Summary of Solution Speciation
    1. Check on Consistency of Data Using SIT Analysis
  C. Summary of Solubility Limiting Solids
  D. Status of Solubility Modeling

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IV. Americium

A. Summary of Bulk Solubility Experiments
B. Summary of Solution Speciation
   1 Check on Consistency of Data Using SIT Analysis
C. Summary of Solubility Limiting Solids
D. Status of Solubility Modeling

Chapter on: DYNAMIC TRANSPORT STUDIES

I. Assessment of Validity of Kd under Advective Conditions

A. Crushed Rock Columns
   1 Using Water from the J-13 Well
      a. Vitric Tuff
      b. Zeolitic Tuff
      c. Devitrified Tuff
   2. Using Water from the UE-25 p# 1 Well
      a.. Vitric Tuff
      b. Zeolitic Tuff
      c. Devitrified Tuff
B. Saturated Solid Rock Columns
   1. Using Water from the J-13 Well
   2. Using Water from the UE-25 p# 1 Well
C. Unsaturated Solid Rock Columns
   1. Zeolitic Tuff
   2. Devitrified Tuff

II. Radionuclide Transport through Fractures

A. Conservative Radionuclides (tritium and pertechnetate)
B. Sorbing Radionuclides

III. Colloid-Facilitated Radionuclide Transport

A. Colloid Stability in Natural Groundwaters
B. Sorption of Radionuclides onto Colloids
C. Elution of Colloids through Fractures
   1. Saturated Systems
   2. Unsaturated Systems

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Chapter on: DIFFUSION STUDIES

I. Diffusion of Conservative Radionuclides through Saturated Tuff

A. Tritiated Water
  1. Diffusion Cells
  2. Rock Beakers
B. Pertechnetate
  1. Diffusion Cells
  2. Rock Beakers

II. Diffusion of Sorbing Radionuclides through Saturated Tuff

A. Tuff Wafers
B. Diffusion Cells
C. Rock Beakers

III Diffusion of Radionuclides through Unsaturated Tuff

Chapter on: BIOLOGICAL SORPTION AND TRANSPORT

I. INTRODUCTION

A. This will discuss subsurface microbiology and microbial effects on transport of radioactive wastes. This will reference pertinent literature and recent reviews including:
  1. Pedersen and Karlsson. 1995. Investigations of subterranean Microorganisms: Their importance for performance assessment of radioactive waste disposal. SKB Technical Report.
  2. Bachofen et al. 1990. Microorganisms in nuclear waste disposal. Experientia 46 and 47 (multi author review in two issues).
  3. Horn and Meike. 1995. Microbial activity in Yucca Mountain. LLNL report UCRL-ID-122256
  4. Hersman. 1996. Microbial activity in Yucca Mountain: Effects on radioactive transport. in "Subsurface microbiology". Holdeman and Amy, eds. CRC Press, Boca Raton, FL. in preparation.

II. MATERIALS AND METHODS

A. Describe the ESF and sampling techniques.
B. Describe sample collection methods, sample replication, and distribution to participating labs

C. Describe the materials and methods of each of the analysis performed at each of the participating labs:
   1. UNLV - CTC heterotrophs, nutrient limitations (PO4, S, carbohydrates), AODC counts, autotrophs (Fe, S, NH4 oxidizers), percent moisture.
   2. NM Tech - 14CO2 heterotrophs, nutrient limitations (amino acids, carbohydrates), AODC counts, water activity effects.
   3. U. Oklahoma - total anaerobes, MPN for SO4, NO3 reducers, methanogens.
   4. U. Tennessee - phospholipid fatty acid (PLFA) analysis which includes: 11 normal structure, 7 terminally branched saturates, 4 mid-branched saturates, 10 monoenoics, 2 branched monoenoics, and 1 polyenoic fatty acid analyses.

D. Describe the materials and methods of each of the analyses performed at Los Alamos - sorption of 239Pu(IV) by micro's, chelation of 239Pu(IV) by micro's produced siderophores, effects of micro's on colloidal agglomeration rates, siderophore/Fe(III) transport rates through unsaturated tuff columns, microbial dissolution of metal oxides.

E. Discuss correlation and regression analyses of the above experiments.

III. RESULTS

A. Figures and Tables.

B. Describe the results of each of the above experiments. Because of the volume of data, only significant results will be described (however, every data set will be mentioned).

IV. DISCUSSION

A. The significance of the data will be discussed. This discussion will also compare all of the experiments to one another, for example PLFA vs. total anaerobes. Significant correlations and regressions will be discussed. Performance assessment. The ESF and Los Alamos data will be combined to predict the microbial effect on transport.

V. LITERATURE CITED

Report Outline for Level 3 Milestone 3GUH607M:
Synthesis of UZ Hydrochemistry at Yucca Mountain
March 22, 1996
Revised May 15, 1996

INTERPRETATIONS OF CHEMICAL AND ISOTOPIC COMPOSITIONS AND GEOCHEMICAL MODELING (NETPATH) IN THE UNSATURATED ZONE, YUCCA MOUNTAIN, NEVADA, By Albert I.C. Yang

I. Introduction

This report will present new chemical and isotopic data obtained in FY 96 from boreholes SD-7, SD-9, SD-12, UZ-14, NRG-6, and NRG-7a. Data will be interpreted with respect to gaseous- and aqueous-phases residence times, flow paths, and flow types (matrix versus fracture flow). In addition, results of investigations on stable isotopic compositions (δD and $\delta^{18}O$) of pore water from UZ-14 with respect to water-extraction methods and significance of the isotopic data will be presented and discussed. Further, the results of geochemical modeling using the program NETPATH will be documented. Geochemical modeling will be used to evaluate chemical evolution of perched water and to correct ^{14}C ages of perched water.

II. Chemical and radioactive-isotopic compositions (^{3}H and ^{14}C) of pore water from unsaturated-zone cores

A. Boreholes from which data were collected

B. Sample collection and analysis
(Note: This section will be brief; reference to FY 95 milestone 3GUH105M.)

1. Gas samples from UZ-14 and SD-12
(CO_2, $^{14}CO_2$, and $^{13}CO_2$)

2. Pore-water samples from SD-7, -9, -12 and NRG-6, -7a
(Chemical compositions, ^{3}H and ^{14}C)

3. Gas and water sample analyses

C. Interpretations of chemical and isotopic data

1. Spatial variabilities in chemical and isotopic data

2. ^{3}H profiles in boreholes (limited samples; may not intercept all fast-flow paths)

3. Residence times of gaseous-phase $^{14}CO_2$ and pore water

4. Flux (qualitative) attributed to matrix or fracture flows.

III. Stable isotopic compositions (δD and $\delta^{18}O$) of pore water from UZ-14 (None of these data are in FY 95 milestone report)

A. Methods of pore-water extraction and analysis for δD and $\delta^{18}O$

1. Toluene distillation

2. Vacuum distillation

3. Compression extraction

4. Water analyses

B. Inconsistency in δD and $\delta^{18}O$ data with different extraction methods

1. Reviews of studies published in literature

2. Results of current studies

a. Isotopic data from toluene-azeotropic distillation

b. Comparison of vacuum distillation and compression-extraction methods

C. Laboratory tests

1. Imbibing dry core with known isotopic-composition water: imbibing test

a. Extracting imbibed water by vacuum distillation

b. Extracting imbibed water by compression

2. Exchange ability of matrix water with environmental water: column test

D. Applicability of the extraction methods to Yucca Mountain cores

1. Pah Canyon and Topopah Spring Tuffs: vacuum distillation method

2. Bedded tuff and Calico Hills Formation: Compression method

E. Interpretations of the stable-isotopic data

1. Source and nature of infiltrating water in UZ

(Note: UZ pore water in relation to precipitation water, perched water, and saturated-zone water)

2. Interactions of old matrix water with younger environmental water

3. Preglacial (> 10,000 years) or postglacial (< 10,000 years) pore water in Topopah Spring Tuff.
(Note: ^{14}C data were not obtainable from Topopah Spring Tuff because no water can be extracted by compression. However, water can be extracted by distillation. Distilled water is a pure water which contains no salts or carbon element for ^{14}C dating. But hydrogen and oxygen isotopes (δD and $\delta^{18}O$) can be measured on the pure water because hydrogen and oxygen are parts of the water molecule itself.)

IV. Geochemical modeling (NETPATH)

A. Modeling chemical evolution of perched water

1. Chemical speciation and mineral saturation of unsaturated-zone water

2. Conceptual model for water and mineral chemistry at YM

3. Selection of chemical-element constraints and mineral phases

4. NETPATH results

B. Models of ^{14}C age corrections on perched water

1. Various model performances

2. Sensitivity of isotopic input data to the corrected ^{14}C ages

3. Corrected ^{14}C ages of perched water

V. Summary and Conclusions

VI. References

CLIMATE AND QUATERNARY HYDROLOGY SYNTHESIS REPORT FY 96
(3GCA102M)

ABSTRACT

Climate cycles are 400 ky in duration. Those cycles are tied to changes in the earth's orbit which result in changes in the amount of heat (insolation) received by earth. Changes in insolation are well correlated with the major features of global climate change such as the waxing and waning of continental ice sheets. The well-dated record from Devils Hole shows southern Nevada climate changed in concert with those on the rest of earth. Long sedimentary records from basins such as Owens Lake provide an estimation of the magnitude and frequency of local climate change and therefore link changes in insolation to a climate response in the Yucca Mountain area. That linkage provides a way of using calculated changes in insolation over the next 100 ky or longer to estimate future-climate boundary conditions.

Sedimentary deposits from former wetlands and springs found in valleys near Yucca Mountain provide records of ground-water discharge during the last major wet-climate period. In particular deposits down the flow gradient from Yucca Mountain at Site 199 on Crater Flats, at the Lathrop Wells Diatomite, and at paleowetland sites near the Amargosa River show that discharge was initiated about 40 ka and persisted to about 8 ka. That discharge, at least in part, came from the regional aquifer when the water table rose a maximum of about 115m. Interpretation of plant macrofossils found in packrat middens suggest
mean annual precipitation (MAP) varied during the latter wet period, but exceeded modern levels by 200 to 300 percent. In particular, episodes with white fir and no limber pine likely had MAP levels above 25 inches,
whereas white fir and limber together likely had MAP levels between 20 to 25 inches and limber only indicate MAP levels below 20 inches.

Dating, isotopic, geochemical, and petrographic studies of calcite and opal minerals precipitated in fractures within Yucca Mountain provide a direct means of comparing regional climate changes to changes in hydrology within the unsaturated and saturated zones. Calcite and opal mineral precipitation within the unsaturated zone appears to have occurred throughout the period from more than 400 ka to about 100 ka.
During much, but not all of this time, regional climate records show an intermediate MAP level between the very dry modern condition and the wettest phases between 160 to 140 ka and between 40 to 8 ka. The few
minerals in both the ESF and drill holes dating from the wettest past climate phases, if upheld by new data, may indicate that the flow of water within Yucca Mountain may have changed in some fundamental way such as being dispersed along other fracture paths or passing through the mountain without leaving a mineral record, or, maybe the higher precipitation never gets into the mountain.

I. INTRODUCTION.

General comments will describe the linkages between climate and hydrology. Discuss the climate of the region and note that climate is not constant.

Link past synthesis reports to this one.

II. EXECUTIVE SUMMARY

This section will characterize Yucca Mountain paleoclimate and the response of paleohydrology to climate change.

The data will be placed within the framework of long (400 ky) climate cycles. In two areas deal with the long records spanning the entire 400 ky cycle and the high resolution records from the last 50 ky within the vicinity of the mountain.

III. CENTRAL HYPOTHESIS

The future climate patterns at Yucca Mountain can be projected by looking for patterns in the past that link climate and hydrological change to the cyclical change in the earth's insolation; the only parameter that can be reasonably estimated for the future. The hydrologic behavior of the mountain during the next 100 kY or more years should be similar to that which occurred for correspondingly similar insolation patterns in the past.

This section will also discuss the central problem of examining the hydrologic characteristics of Yucca Mountain during the current brief and unusually dry period in the region's climate history and relating these characteristics to those that are likely to occur in the future.

DATA COLLECTION, ANALYSES, AND INTERPRETATIONS

Paleoclimate data comes primarily from fossils of plants and animals that lived in aquatic and terrestrial environments as well as isotopic evidence derived from the fossils and other material. Site paleohydrology data comes primarily from the isotopes, geochemistry, and petrography of calcite and opal within the mountain and from deposits (including fossils) along the ground-water flow paths of Yucca Mountain. Additional paleohydrologic data comes from alluvial, fluvial, eolian, pedogenic, and related deposits on and near the mountain.

IV. CAUSATION OF CLIMATE AND HYDROLOGICAL CHANGE IN SOUTHERN NEVADA

A. THE NATURE OF THE CLIMATE SYSTEM

1. Modern climate varies due to factors such as the ENSO phenomena, ocean circulation, solar variability, volcanic eruptions, and so on. Those factors that produce climate variability operate within the climate boundary conditions established by the orbital parameters and commonly expressed in terms of insolation. As insolation changes on a millenial time scale the climate boundary conditions change and so does the average climate about which the variation and the degree of variation occurs.

2. The nature of climate when the insolation boundary conditions change will be discussed. What is the nature of insolation, how does it arise, what happens when it changes on a global scale? Key orbital parameters will be described; eccentricity (the shape of earth's orbit) and thus its distance from the sun; the obliquity (the tilt of the earth's axis towards or away from the sun); and precession (the relative wobble of earth on its axis) resulting in the orientation of the earth toward or away from the sun during northern hemisphere seasons. These orbital parameters vary in cyclic and predictable ways and hence their status for the next 100 k or more years is easily determined. Changes in orbital parameters produce changes in earth's upper atmospheric insolation. Insolation changes may or may not exhibit linear covariance with the tropospheric expression of climate. Note oceanic record of orbital changes represents a measure of the size of the earth's ice caps and that determines the position of the storm tracks relative to yucca mountain.

3. Discuss the Devils Hole record in the context of showing how this long, continuous, and well dated climate record shows that climate change in southern Nevada is closely

correlated with global climate change as recorded by, for example, stable isotopes of water from polar ice cores or from marine biogenic carbonate in oceanographic cores.

4. Orbital Parameters in the future.--Discuss orbital style and resulting insolation for the next 100 k. Identify orbital analogs from the past, noting for example, that the period from about 400 to 300 ka is in orbital terms nearly identical to the next 100 k years.

V. CLIMATE HISTORY OF YUCCA MOUNTAIN REGION

A. COMPARE ORBITAL RECORDS WITH THOSE FROM DEVIL'S HOLE--Discuss relationships between the two records, noting that the Devil's Hole record stops about 20 ka. Local climate records substitute for the gap in the Devil's Hole record.

B. LONG RECORDS-REGIONAL--Compare available lacustrine records from last 500 ky with orbital and insolation records. Note general response of lacustrine records with orbital parameters,especially eccentricity. Establish preliminary linkages between past and future orbital parameters
and response of lacustrine records.

(The information content from this comparison is dependent on technical assistance needed to assemble components of the database. Available samples need to be analyzed and the resulting data incorporated in the synthesis report.)

C. HIGH RESOLUTION RECORDS-LOCAL

1. Lakes, Playas, and Marshes--describe history of wetland development in Las Vegas Valley using new radiocarbon age data with the changes in insolation at 30 degrees north latitude. Data include ostracodes, mollusks, stable isotopes, radiocarbon, and stratigraphic components. Place resulting discussion in an orbital parameter context.

If available discuss middle and late Holocene climate history from the cores taken in Pahranagat Lake. (Detail of this comparison will be dependent on available technical assistance to assemble an adequate database for diatoms and ostracodes.) Pahranagat data from aquatic fossils, stable isotopes, and pollen provide a good estimate of climate variability within the present climate state.

2. Terrestrial Records--describe history of vegetation change revealed by the packrat midden data available from the literature and from the data collected over the last several years and interpreted by DRI. Place an emphasis on estimating the magnitude of past climate change. Compare
history of vegetation change with insolation at 30 degrees north latitude and place in orbital context.

3. Comparison of Aquatic and Terrestrial Records. Compare and contrast the local history of changes in surface and shallow ground water with those of the major vegetation types.

D. SITE RECORDS--Forty Mile Wash, Midway Valley--use field data of surficial deposits from map unit deposits associated with fluvial or ground-water discharge activity on or near the mountain as a record of surface water availability and local recharge sources. Estimations of ages by available techniques will allow assembly of the history of stream activity and shallow infiltration over the last 100 millennia. Compare
eolian history with site records of surface-water hydrology.

VI. QUATERNARY HYDROLOGY

A. OVERVIEW OF PRESENT-DAY REGIONAL HYDROLOGY--Discuss major features within the present-day hydrologic system, including hydrogeologic units, recharge areas, discharge areas, and ground-water flowpaths.

B. STABLE ISOTOPE AND MINERALOGY--UZ Place isotope and mineralogical datasets in a context of long term infiltration, percolation, and recharge history within yucca mountain. Discuss isotope data set from minerals with respect to thermal gradient and with respect to the possible range of del o18 values for input waters--considering arctic to subtropical air mass sources and minerals precipitated at temperatures consistent with the modern thermal gradient. If dataset permits recognition of general air mass sources, align those with long lacustrine records and orbital data.

B. RADIOGENIC ISOTOPE (STRONTIUM AND URANIUM) TRACER STUDIES--UZ--SZ Use strontium and uranium isotope data sets to identify solute sources for secondary minerals in fracture flow paths (paleohydrologic implications) and present-day ground waters (perched and SZ) within Yucca Mountain. Combine strontium and stable isotope data sets in an attempt to link air mass sources with flow paths within Yucca Mountain in order to identify linkage between orbital parameters and depth or path of percolation or recharge. Characterization of climate-controlled parameters is particuarly important for sub-surface materials dated by radiocarbon or uranium-series disequilibrium.

If data are available, consider using strontium isotope data from Devil's Hole record to describe changes in the elevation of the Devil's Hole recharge area as a function of climate change.

C. GEOCHRONOLOGIC STUDIES OF SUBSURFACE SECONDARY

MATERIALS--UZ--SZ Discuss the available uranium-series disequilibrium age estimates from vein and fracture-filling materials within Yucca Mountain in order to establish a preliminary subsurface history of past
hydrology. Place particular importance on paleohydrologic records obtained from ESF in repository block horizon to place constraints on values of paleo water flux of and near the present-day potentiometric surface to determine height of paleowater table fluctuations. Discuss any linkages between age and aqueous saturation information for secondary minerals to make a preliminary estimate of past water flux. Age
frequencies from dated materials will also be compared to regional and orbital climate framework to evaluate links between climate and paleohydrology. Ultimately, results will be synthesized as models of UZ aqueous flow that leave mineral precipitation as well as episodes of undersaturated water flux that leave no mineralogical record.

Use radiocarbon data to establish the fracture flow history in Yucca Mountain during the last hydrological cycle (40 to 20 ka). Compare radiocarbon data with insolation data in order to establish history of saturated versus unsaturated water flux.

D. PAST DISCHARGE--ISOTOPE AND PALEONTOLOGICAL STUDIES Utilize available data from stable and radiogenic isotopes, geochronology (thermoluminescence, radiocarbon, uranium-series disequilibrium), and fossils to describe the hydrologic origins (regional and or perched aquifers) and discharge history of ground-water deposits occurring down-gradient from Yucca Mountain. Synthesize discharge history into a climate framework that links surface-water availability determined from playa and terrestrial records to a ground-water fluctuation response. Determine if discharge history can be placed in an orbital context, so that likelihood of such discharge in the future can be assessed.

VII. DISCUSSION

A. CURRENT INTERPRETATIONS Integrate the implications of the data discussed above into current understanding of how climate has changed and what that change has meant to the hydrology in the mountain. Link ages of opal and calcite from within the moutain to climate outside the mountain. Describe the linkage of climate and past discharge during the last climate cycle. Suggest how the discharge from the regional aquifer down gradient from Yucca Mountain may have played out in earlier cycles. How many wet cycles may exist and, therefore, how frequently and for how long might discharge be similar to that of the last cycle.

B. SUPPORT FOR INTERPRETATION Describe similarity or dissimilarity of various climate proxies. Explain relationship or lack of relationship between hydrologic response and climate proxies, e.g. does discharge from regional aquifers occur during times when climate proxies say its wet, especially during the last climate hydrological cycle when we have the benifit of large well dated climate and hydrological datasets?

Do changes in insolation parameters serve as a good predictor of past climate and hydrological change. What other datasets are needed? What existing datasets need to be expanded??

How might climate vary in the future using insolation values as a predictor?? How might global warming affect the natural system?? Sustained or enhanced aridity? or acceleration of a glacial advance??

C. ALTERNATIVE HYPOTHESES How might changes in the Quaternary Geology of the mountain alter the climate hydrology couplets? Have the wet cycles during the past 200 ky changed the capacity of the mountain to receive infiltration?

Do the calcite-opal studies suggest climate related percolation pathways--e.g. fast paths during very wet climates, multiple paths during intermediate wet climates, and sporadic paths during dry climates?

Is the orbital insolation explaination for climate change the only mechanism--would others lead to a different view of future climate and hydrological change?

Others that arise.

VIII. ISSUES

Discuss adequacy of datasets, adequacy of understanding, ground-water travel time (GWTT), UZ-flux etc. The data sets noted above are in different stages of maturity. Some are nearly complete, while others are in their infancy. Further, whereas a general understanding now exists as to how the system behaves in climate and hydrological terms, the particulars, such as GWTT or UZ-flux, need to be sorted out and evaluated with existing or new data sets, and by presentation of interpretations in the project as well as general scientific arena.

IX. CONCLUSIONS

What do we know now and what do we need to know to support or refute the central or alternative hypostheses.

Draft Outline
Geophysics Synthesis Report

- E.L. Majer, LBNL -

I. Introduction

A. Scope and Purpose of Report (1 page)

B. Background (5-10 pages)

(a) Review of Status of Geophysical Information Prior to FY 1995

C. Objective of Recent (FY 1995) Geophysical Work (1-3 pages)

II. Regional Geophysics

A. Potential Methods

(a) Earth field "depth to basement" results from gravity/magnetic data
(b) Gravity results along regional seismic lines 2 & 3
(c) Magnetic results along regional seismic lines 2 &3
(d) Magnetotellurics (Midway Valley)

B. Seismic Methods

(a) Reflection (lines 2 & 3. Rock Valley)
(b) Refraction Amorgosa Desert lines
(c) P & S wave delay models (if available)

C. Presentation of Interpreted Model

(a) Cross-sections (where available and appropriate)
(b) Map view (where appropriate and available)

Note: Data will be presented at various scales depending upon resolution of data, spacing of data points and methods.

III. Repository Geophysics

A.	Seismic Reflection	YMP-1, 2, 3, 4, 5, 6, 7, 8, 9, 12, HR-1, HR-2, 13, 14, Line 1 (1994); Line 2 (1994).
B.	VSP	WT-2, NRG-6, UZ-16 (if available) SD-12, G-4, G-2.
C.	Magnetic Data	YMP-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12.
D.	Gravity Data	YMP-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.
E.	MT Data	YMP-3.

IV. Integration of Well-Log Data
(Note: This section is not intended to replace the well-logging synthesis report being developed by Bud Thompson)

A. Description of logs used and information derived from the logs. (UZ 16, G 2, ONC-1, UZ-14, UZ-4, UZ-5, UZ-7a, SD-7, SD-9, SD-12, WT-2, WT-10, WT-12, G-4, G-3, GU-3, G-1)

B. Use of statagraphic tops for correlation of well-log data with surface geophysics

C. Synthetic VSP and surface reflection results

D. Find input and constraints placed on models based on well-log data.

V. Synthesis of Geophysical Data

A. Models derived from each geophysical method. Presentation format will be in cross-section and map at scale dependent upon data type and resolution. However, efforts will be made to have a consistent scale and scales compatible with geologic and other information.

(a) Seismic - 2D cross-section
(b) Gravity - 3D model, residual and final interpretation of geologic structures
(c) Magnetic - 2D (hopefully 3D if provided by USGS)
(d) MT - 2D cross-section
(e) Well-logs 3D sections

B. Integrated Model - Presentations of alternative models derived from combined interpretations of the various geophysical data types. For example, depth to basement derived from seismic/gravity, Topopah top from well log, VSP, seismic, etc. The objective is to provide several plausible alternative repository block and regional models based on the available data and within the scope of the report.

VI. Conclusions and Recommendations

A. Final conclusions and interpretations of models

B. Discussion of "confidence intervals" of models and reliability of results

C. Recommendations for future work, priorities for work and recommendations on further integration activities

PRELIMINARY

SYNTHESIS REPORT ON BOREHOLE GEOPHYSICS
PROPOSED TABLE OF CONTENTS

CHAPTER	EST NO OF TEXT PAGES
Descriptive Abstract	1
Abstract (Executive Summary)	1
Area Map	1
Introduction	3 - 5
Purpose	
Scope (technical and aerial)	
Summary of Results	3 -8*
Core-to-log relationships	
Comparison to results from other methods	
Conclusions and Recommendations	5 -10
Observations derived from borehole geophysics	
Conclusions (With appropriate QA qualification status)	
Confidence in analytical models	
Recommendations for future work	
Borehole Geophysical Methods	8 - 15*
Field Methods	
Logging in empty boreholes	
Logging in volcanic rock environments	
Borehole geophysical measurements - (A generic description of the major measurements used. NOTE: This will not be a tutorial on geophysical logging!) NOTE: Investigations classified as prototype will not be discussed in detailed, that discussion will be included in the subsequent Log Analysis Report.	
Data Reduction and Analysis[1]	
Data Verification	
Forensic Evaluation	
Analytical Methods	
Porosity Evaluation	
Water Saturation Evaluation	
Fracture Evaluation	
Etc., Etc..	

[1] This section will be a brief overview and include reference to the detailed Log Analysis Report (a level four deliverable) which will be in production at the time this synthesis report is issued)

*These chapters will generate a significant number of additional pages of supporting tables, diagrams, charts, logplots, plates, maps, etc.

Proposed Table of Contents - **Synthesis Report on Borehole Geophysics** Jan 30, 1996

Data Integration 3 - 5

Supporting data used

Borehole geophysics feeds to other studies

Data Included (basic description) 3 - 5*

Boreholes; (acquired and developed data)

Modern Borehole Set

Historical Borehole Set

Core analysis

Outcrop

Fault

Topographic and Cultural

Qualification status of data

Description of the Digital Data Base - 5 - 10*

(To the extent the data provides support, the following will be in the digital data base, organized by borehole:

Borehole Stratigraphy -stratigraphic picks from all (surviving) sources in the Stratigraphic Compendium and from M&O Geophysics' log picks. (Cut off data about April 15, 1996)

Measurement, output, constant, and parameter averages over stratigraphic intervals

Rock Type from logs

Porosity from logs

Total Porosity

Effective Porosity

Density Porosity

Neutron Porosity

Acoustic Porosity

Bound water content (lumped zeolitic, clay content,)

Fracture indices

Permeability index

Water Saturation / fluid content

Total volumetric water

Rock Density

Rock Resistivity

Acoustic velocity (from acoustic logs where available, from synthetic analysis otherwise)

Mechanical Properties

Core data values

*These chapters will generate a significant number of additional pages of supporting tables, diagrams, charts, logplots, plates, maps, etc.

Proposed Table of Contents - Synthesis Report on Borehole Geophysics Jan 30, 1996

Cross Sections (discussion) 5 - 10*

Cross sections showing the spatial distribution of several boreholes will be presented as figures and discussed. To the extent the data set of acquired and developed data will provide support, the sections will contain:

Reference to map location, i.e., surface expression of section
Two or more boreholes showing some acquired and developed data in the form of log traces.
Stratigraphy and structure along the line(s) of section

Maps (discussion) 3 -10*

Planar maps of developed data will be included in the report. To the extent the data set of acquired and developed log data, fault data, outcrop data, and topography will provide support, we can supply the following for any group or subgroup of boreholes:

Structure maps on any selected horizon (surface)
Paleo topographic maps on any selected time horizon (surface)
Major stress/strain relationships
Isopach maps on any mappable parameter over any correlative interval
Isopach maps on differences or derivatives between two mappable parameters

3-D Perspective Drawings (discussion) 3 - 5*

Rotatable slices of pertinent parts of the mountain from any perspective based on any 3-D surface available through the data base.

Programmatic Issues Affecting Borehole Geophysics 5 - 10

SCP "Planned" activity vs. actual work that was done
Development of historical and modern borehole sets
QA pedigree for acquired and developed logging data
Qualification status of inputs and outputs
Qualification status of software employed

Traceability, Reproducibility, Genealogy 5 - 10*

This section will document the QA:L pedigree for the borehole geophysics synthesis report, and show the traceable, logical flow of acquired and developed data used as inputs and the development of data for outputs for the synthesis report. It will depend heavily on simply cross referencing similar sections in previous M&O Geophysics reports.

*These chapters will generate a significant number of additional pages of supporting tables, diagrams, charts, logplots, plates, maps, etc.

References - Cited and or Used 3 - 5

All pertinent M&O Geophysics Reports produced in FY'95 and FY'96
Many (if not all) borehole geophysics reports produced for the historical data set
Geophysics White Paper
Study plans supported and referenced
Techniques used for developing synthesis outputs
Software used

***These chapters will generate a significant number of additional pages of supporting tables, diagrams, charts, logplots, plates, maps, etc.**

NFER

ACRONYMS AND ABBREVIATIONS v

INTRODUCTION *(D. G. Wilder)* 1

1.0 HYDROTHERMAL MODELING *(T. A. Buscheck, other possible authors J. J. Nitao, and D. A. Chesnut)* xx
1.1 Introduction xx
1.1.1 Key Hydrological Issues in Site Suitability xx
1.2 Background and Available Data on Yucca Mountain xx
1.2.1 Matrix, Saturation, and Fracture Data xx
1.2.2 Recharge Flux Estimates Based on Saturation Distribution xx
1.3 Episodic Nonequilibrium Fracture-Matrix Flow xx
1.3.1 Matrix-Dominated and Fracture-Dominated Flow xx
1.3.2 Implications of Flow Regimes on Engineered Barrier System/Near Field Performance xx
1.3.3 Summary of Fracture-Matrix Interaction at Yucca Mountain xx
1.4 Preferential Flow Pathways xx
1.5 Spatial and Temporal Variability of Recharge Flux xx
1.6 Diffusion-Controlled Radionuclide Release xx
1.7 Impact of Repository Construction/Operational Activities xx
1.8 Thermohydrological Impact of Waste Package Emplacement xx
1.8.1 Role of In Situ Tests in Understanding Waste Package/Engineered Barrier System/Near Field Interaction xx
1.8.2 Results of the Prototype Engineered Barrier System Field Test xx
1.8.3 Long-Term Thermohydrological Performance of the Waste Package/Engineered Barrier System/Near Field xx
1.9 Summary: Key Aspects of the Hydrological System Affecting Site Suitability xx

2.0 HYDROLOGIC PROPERTIES *(W. Lin, possibly J. Roberts)* xx
2.1 Introduction xx
2.2 Preconstruction Conditions and Processes xx
2.2.1 Suction Potential at 20_C xx
2.2.2 Water Permeability at 20_C xx
2.3 · Perturbed Environment xx
2.3.1 Suction Potential at 70_C xx
2.3.2 Dehydration and Rehydration xx
2.3.3 Water Permeability of Topopah Spring Tuff at High Temperatures xx
2.4 Fracture flow properties and flow (lab measurements)
2.4 Conclusion xx

3.0 GEOCHEMISTRY *(W. Glassley, et ali)* xx
3.1. Introduction

Description of the requirements for describing NFE chemical and mineralogical properties.

A. Regulatory Issues

B. Waste Package Performance Issues

C. Repository Performance Issues

PRELIMINARY DRAFT
INFORMATION ONLY

3.2 Ambient Conditions xx
3.1.1 Mineralogical and Chemical Characteristics of the Host Rock xx
3.1.2 Water Composition of the Vadose Zone xx
3..3 Processes That Will Modify the Ambient Conditions within the Near-Field Environment xx
3.2.1 Excavation xx
3.2.2 Backfilling xx
3.2.3 Waste Emplacement xx

3..4 Results of Recent Geochemical Research xx
3.3.1 Rock-Water Interaction xx
3.3.2 Reaction Kinetics xx
3.3.3 Solid-Solution and Cation-Exchange Models xx
3.3.4 Geochemical Simulation of Rock-Water Interactions at Yucca Mountain xx
3.3.5 Radiation Effects xx
3.3.5 Summary of Results of Recent Geochemical Research xx

3.5 Equilibrium Chemical and Mineralogical Conditions

3.5.1 Identification of scenarios where chemical equilibrium may be achieved (heating rates are slow, fluid movement is minimal, and the duration of perturbed conditions is long).

3.5.2 Preliminary bounds on the chemical and mineralogical state of the system for these scenarios. Information will be based on already completed rock water interaction experiments, and EQ3/6 modeling,. These results will be summarized for studies completed since the Preliminary Near-Field Environment Report (PNFER).

3.6 Kinetically Controlled Chemical and Mineralogical Conditions

3.6.1 Identification of scenarios where kinetics rather than chemical and mineralogical equilibrium dominates. These will involve conditions in which fluid velocities are high, or changes in temperature are relatively rapid, or perturbation of the system is short.

3.6.2 Analyses of the chemical and mineralogical conditions as a function of time, and the rate of reaction (kinetics).

3.6.3 Laboratory and natural systems studies of reaction rates.

3.7 Testing Simulation Capabilities Using the New Zealand Process Natural Analogue

Extensive use has been made of the New Zealand geothermal site, where processes that will occur at Yucca Mountain, are occurring today under observable and measurable conditions. This work has focused on

evaluating simulations strategies, and testing databases. This work will be summarized.

3.8 Coupled Geochemical and Hydrological Processes

Movement of water at elevated temperatures will result in chemical and mineralogical changes that will also modify hydrological parameters. Preliminary studies of these processes have been conducted through both laboratory and numerical simulation approaches. These preliminary results will be summarized.

3.9 Summary

The chemical and mineralogical conditions that may evolve in the NFE will be bounded, summarizing the results presented in the previous sections. An description of the work necessary to refine these bounds will be provided. This will be an update of and addtion to the material reported in the Preliminary Near Field Environment Report and where that material is appropriate it will not be repeated in Rev. 1.

4.0 GEOMECHANICS *(S. C. Blair)* xx
4.1 Introduction xx
4.2 Ambient Conditions xx
4.2.1 Physical, Thermal, and Mechanical Properties of Near-Field Rock Mass and Intact Rock xx
4.2.2 Temperature and Stress xx
4.2.3 Cracks and Fractures
1. Studies on Core Samples
2. Studies on 0.5m Blocks
3. ESF Observations
4.3 Processes That Perturb the Waste Package Environment xx
4.3.1 Excavation of the Repository xx
4.3.1.1 Stress and Deformation
4.3.1.2 Rock Damage Due to Excavation
1. Results from ESF
2. Results from similar excavations and model simulations
4.3.2 Thermal Effects of Waste Emplacement xx
4.3.3 Time-Dependent Effects xx

4.3.3.1 Microcracking/Subcritical Crack Growth

4.3.3.2 Joint-Properties
1. Studies on Core Samples
2. Studies on 0.5m Blocks

4.3.4 Radiation Effects of Waste Emplacement xx
4.4 Seismic Loading xx

1 - New information obtained from excavation of the ESF will be added.

2 - New information will be added reflecting results of recent laboratory tests on core and 0.5m scale blocks of Topopah Spring tuff.

3 - Results of recent modeling studies will be added to the report.

5.0 RADIATION EFFECTS *(D. T. Reed and R. A. Van Konynenburg)* [NOTE: NO NEW WORK IN THIS AREA AND THEREFORE THIS SECTION WILL NOT BE REVISED) xx
5.1 Radiation Effects xx
5.2 Waste Package Environment xx
5.3 Radiolytic Yields in an Air-Water-Vapor System xx
5.3.1 Primary Yields of Bulk Components xx
5.3.2 Radiolytic Yield of Nitrogen Oxides and Acids xx
5.3.3 Radiolytic Yield of Ammonia xx
5.3.4 Radiolytic Formation of Atomic and Molecular Hydrogen xx
5.3.5 Radiolytic Formation of Ozone, Hydrogen, Peroxide, and Oxy-Radicals xx
5.4 Radiolytic Yields in the Pure-Water-Vapor and Dry-Air Limiting Cases xx
5.4.1 Radiolytic Yields in Water Vapor xx
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5.5 Radiolytic Waste Package Design Issues xx
5.5.1 Self-Shielding xx
5.5.2 Free Volume Outside the Waste Container xx
5.5.3 Overall Repository Temperature xx
5.6 Conclusions and Recommendations xx

6.0 MAN-MADE MATERIALS *(A. Meike)* xx
6.1 Ambient Conditions xx
6.2 Processes That Will Modify the Ambient Conditions in the Near-Field Environment xx
XXX MICROBES
6.2.1 Curing of Cementitious Material xx
6.2.2 Decomposition of Man-Made Materials xx
6.2.3 Coupled Interactions between Man-Made Materials xx
6.2.4 Interaction between Man-Made Materials and the Host Rock xx

6.3 Data Availability and Modeling Requirements Regarding Cementitious Materials xx

7.0 INTEGRATED TESTING (B. VIANI) xx

8.0 ELECTRICAL POTENTIALS *(A. Ramirez)* [NO NEW WORK HAS BEEN COMPLETED IN THIS AREA, THEREFORE THIS SECTION WILL NOT BE REVISED] xx
8.1 Introduction xx
8.2 Self-Potentials xx
8.2.1 Streaming Potential xx
8.2.2 Thermoelectric Potential xx
8.2.3 Electrochemical Potential xx
8.3 Summary xx

9.0 FIELD TESTS *IW. Lin et al.)* xx
9.1 Introduction xx
9.2 Re-analysis of G-Tunnel Experiments (J. Nitao)
9.3 Future Test concepts-integrated testing
9.3.1 Shake-down test
9.3.2 Drift scale test
9.3.3 Large scale-long duration tests
9.3.4 Confirmation monitoring
NOTE: THE FOLLOWING SECTIONS WILL BE DROPPED SINCE THEY NO LONGER APPLY
9.2 Engineered Barrier System Field Tests xx
9.3 Prototype Test xx
9.3.1 Parameters Measured xx
9.3.2 Test Description xx
9.3.3 Changes in Rock Mass Moisture Content xx
9.3.4 Temperature Measurements xx
9.3.5 Changes in Air Permeability xx
9.3.6 Steam Invading the Heater Emplacement Borehole xx
9.4 Summary xx
10.0 Altered Zone (W. Glassley et al)

I. Introduction

Description of the requirements for describing AZ chemical and mineralogical properties.

A. Regulatory Issues

B. Waste Package Performance Issues

C. Repository Performance Issues

II. Equilibrium Chemical and Mineralogical Conditions

Under some scenarios, chemical equilibrium may be achieved. This is likely to be the case where heating rates are slow, fluid movement is minimal, and the duration of perturbed conditions is long. For this case, rock water interaction experiments, and EQ3/6 modeling, have been completed that

provide preliminary bounds to the chemical and mineralogical state of the system. These results will be summarized.

III. Kinetically Controlled Chemical and Mineralogical Conditions

Under conditions in which fluid velocities are high, or changes in temperature are relatively rapid, or perturbation of the system is short, chemical and mineralogical equilibrium may not be achieved. The chemical and mineralogical conditions achieved will, therefore, be a function of time, and the rate of reaction. Several studies of reaction rates in laboratory and natural systems have been completed. The results of these studies will be summarized.

IV. Testing Simulation Capabilities Using the New Zealand Process Natural Analogue

Extensive use has been made of the New Zealand geothermal site, where processes that will occur at Yucca Mountain, are occurring today under observable and measurable conditions. This work has focused on evaluating simulations strategies, and testing databases. The work relevant for AZ studies will be summarized.

V. Coupled Geochemical and Hydrological Processes

Movement of water at elevated temperatures will result in chemical and mineralogical changes that will also modify hydrological parameters. Preliminary studies of these processes have been conducted through both laboratory and numerical simulation approaches. These preliminary results will be summarized.

VI. Summary

The chemical and mineralogical conditions that may evolve in the AZ will be bounded, summarizing the results presented in the previous sections. An description of the work necessary to refine these bounds will be provided.

REFERENCES.. xx

WEEKLY HIGHLIGHT REPORT FOR W/E MAY 24, 1996

TO: Daniel A. Dreyfus, RW-1

FROM: Wesley E. Barnes, YMSCO R, for

DATE: May 28, 1996

SUBJECT: Weekly Report

The following activities are provided as input from the Yucca Mountain Site Characterization Office for the Program Office Weekly Report:

Major Events

A U.S. Department of Energy/U.S. Nuclear Regulatory Commission Technical Meeting on the Exploratory Studies Facility is scheduled for June 3, 1996, via videoconference between Washington, D.C. and Las Vegas, Nevada. The purpose of the meeting is to discuss issues and open items related to the Exploratory Studies Facility construction and design.

Key Accomplishments

The deliverable (ALT6225) Probabilistic Evaluation of External Criticality will be issued on May 31, 1996. The deliverable (ALT6204) Waste Package Structural Performance Through Time Report will be issued on June 14, 1996.

The Tunnel Boring Machine progressed 97.2 M or 318.8 ft. to Station 54+75 M or 17,962.4 ft. as of 08:00 5/28/96. The Tunnel Boring Machine is 1,518 M or 4,979 ft. ahead of schedule. In time, this equates to approximately 164 days ahead of schedule. Ground conditions continued all week at Category 1. The drill and blast operations have advanced to Station 1+08.2 M or 355 ft. in the Thermal Test Alcove (TTA).

The Yucca Mountain Site Characterization Office participated in a U.S. Department of Energy/U.S. Nuclear Regulatory Commission Technical Exchange on May 22-23, 1996, in Las Vegas, Nevada. The purpose of the exchange was to discuss the U.S. Nuclear Regulatory Commission's review and comments on the U.S. Department of Energy's Total System Performance Assessment - 1995. Comments ranged from identifying areas of disagreement in modeling approach to identifying areas where the Nuclear Regulatory Commission staff felt the Total System Performance

Assessment - 1995 was difficult to interpret. The exchange was frank and constructive.

The Yucca Mountain Site Characterization Office participated in an initial scoping meeting on May 22, 1996, for the Nuclear Waste Technical Review Board Summer Full Board meeting scheduled for July 7-9, 1996, in Denver, Colorado. The proposed topics for the meeting are: past and future climate, hydrology, fracture studies, infiltration studies, update on Waste Containment and Isolation Strategy, and Exploratory Studies Facility and Scientific Programs updates.

A meeting was held on May 21, 1996, with Nevada Department of Transportation to review processes and schedules that would be applicable if heavy haul truck is chosen as a mode of transportation in Nevada. Nevada Department of Transportation presented a copy of a Preconstruction Engineering Management System example that was created by the Nevada Department of Transportation Operations Analysis Department. The outcome of discussions was that a 2-3 year preconstruction schedule would be realistic, and a 1-2 year construction schedule would be workable for a total of 4-5 year overall schedule prior to hauling.

Yucca Mountain Site Characterization Office submitted the Groundwater Monitoring Data Report to the Nevada State Engineer in compliance with water permit conditions for Yucca Mountain site activities. This permit requirement presents groundwater quantity, groundwater withdrawals and the withdrawal's impact on surrounding aquifers in the Yucca Mountain region for the period from January through March 1996.

<u>C-Hole Testing</u>: Pentafluorobenzoic acid tracer began being detected at the C-3 borehole on May 18, 1996. Tracer concentrations continued to rise, to a point of 204 parts per billion by May 21, 1996. The pump in the C-3 borehole continues to operate at 154 gallons per minute and approximately 3,079,620 gallons have been pumped during the current test as of May 21, 1996. The injection pump in the C-2 borehole continued to operate at approximately 5.1 gallons per minute during recovery to ensure flushing of the tracer from the borehole. It is anticipated that the peak of the tracer pulse will arrive during the weekend of May 25-26, 1996, and is hoped to be in the range of 1000 parts per billion. This is the second of a series of conservative and reactive tests which will be conducted at the C-wells to investigate general saturated zone hydrologic parameters and help determine potential radionuclide dilution factors.

Emerging Issues

None to report

Secretarial Commitments

None to report

NYE COUNTY

NUCLEAR WASTE REPOSITORY PROJECT OFFICE
P.O. BOX 1767 • TONOPAH, NEVADA 89049
(702) 482-8183 • FAX (702) 482-9289

February 23, 1996

NANCY PLEASE MAKE COPY AND SEND TO SANDI

Mr. Russell L. Patterson
Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 98608
Las Vegas, Nevada 89193-8608

Monthly Data Report for ONC #1, NRG-4, and Tunnel Instrumentation Boreholes

Dear Russ:

Please find enclosed the following report *"Monthly Data Report for ONC#1, NRG-4, and Instrumentation Boreholes"* dated December 20, 1995 to January 17, 1996, prepared by Multimedia Environmental Technology, Inc., for the Nye County Nuclear Waste Repository Project Office.

If you have any questions regarding this report, please call me at 295-6142.

Very truly yours,
NYE COUNTY, NEVADA

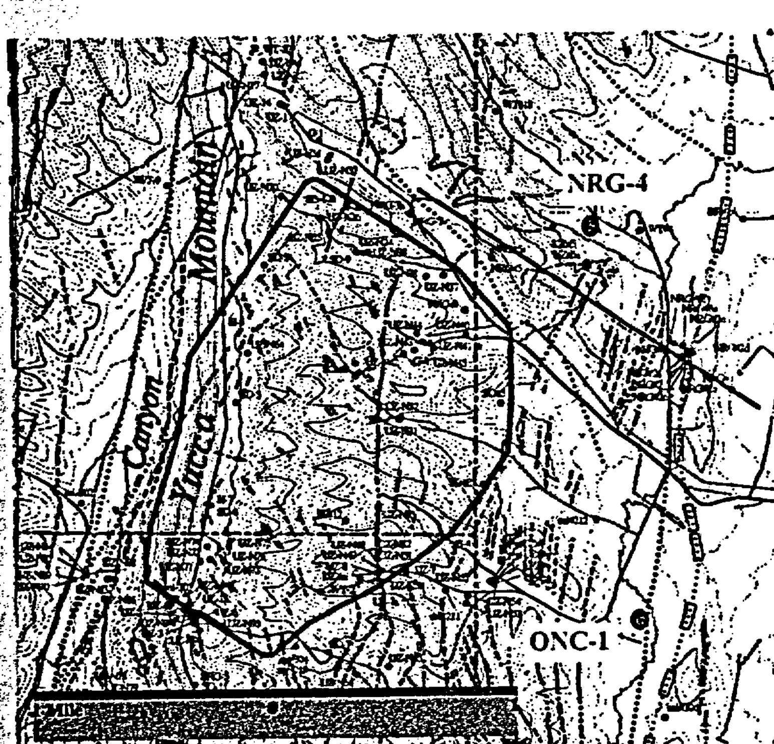
Janice Williams for
Nick Stellavato
On-Site Geotechnical Representative

Attachment

cc: Mr. Carl Johnson, Nevada Nuclear Waste Repository Office, w/summary
Mr. Bill Belke, Nuclear Regulatory Commission, w/summary
Mr. William Barnard, Nuclear Waste Technical Review Board, w/summary
Mr. Joe Wang, Lawrence Berkely Laboratory, w/summary + disk
Mr. Ned Z. Elkins, Los Alamos National Laboratory, w/summary + disk
Mr. Dwayne A. Chesnut, Lawrence Livermore national Laboratory, w/summary + disk
Mr. Alan Flint, U.S. Geology Survey, w/summary +disk
Mr. Lawrence McKague, SW Research Institute, w/summary + disk
Mr. Brad Mettam, Inyo County, w/summary
Mr. Dennis Bechtel, Clark County, w/summary
Mr. Phil Niedzielski-Eichner, Governmental Dynamics Inc., w/summary
Mr. Mal Murphy, Nye County, w/summary
Permanent File, w/att.

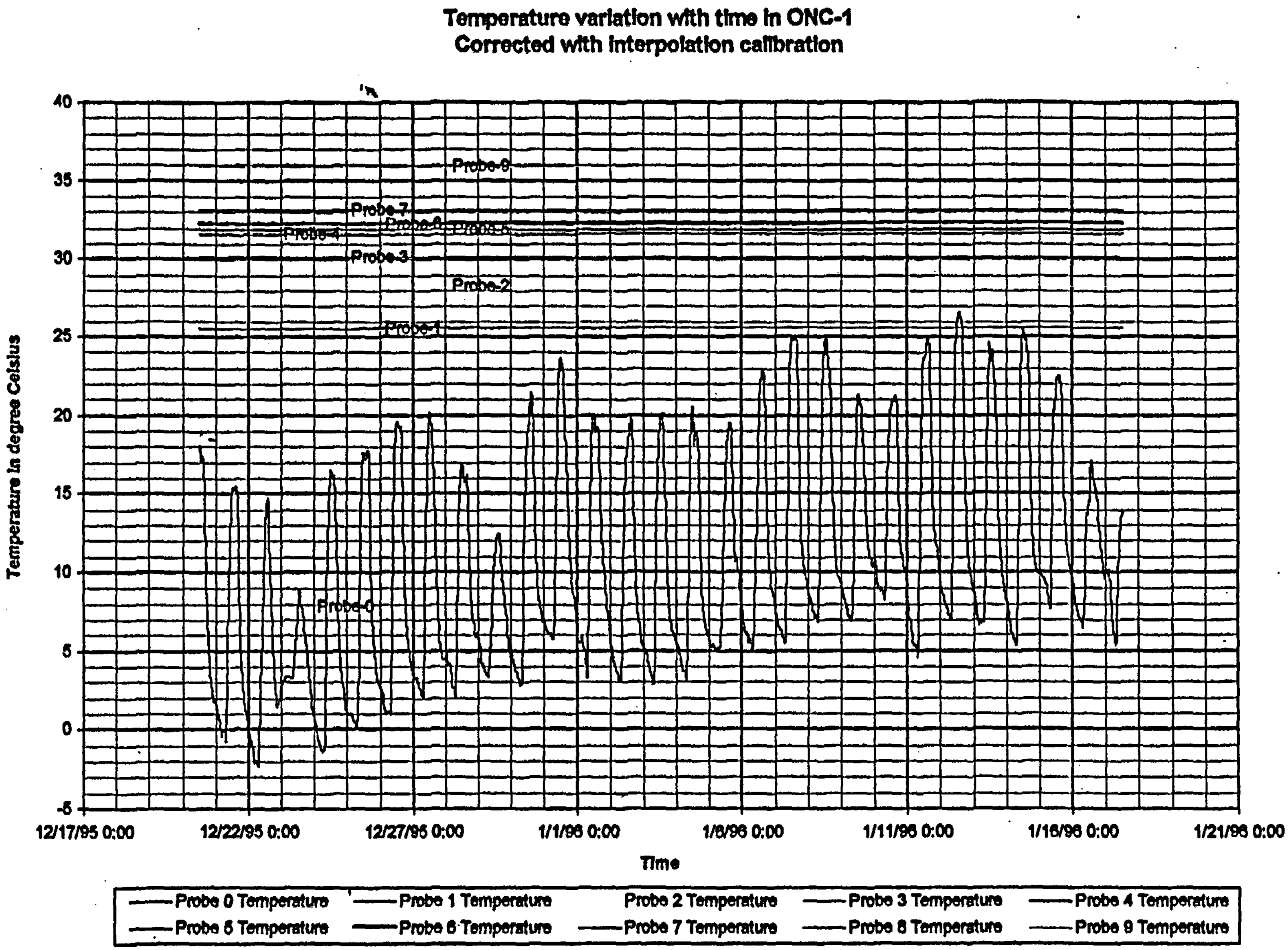
Monthly Data Report for ONC-1, NRG-4 and Tunnel Instrumentation Boreholes

Nye County Nuclear Waste Repository Project Office
Nye County, Nevada



December 20, 1995 to January 17, 1996

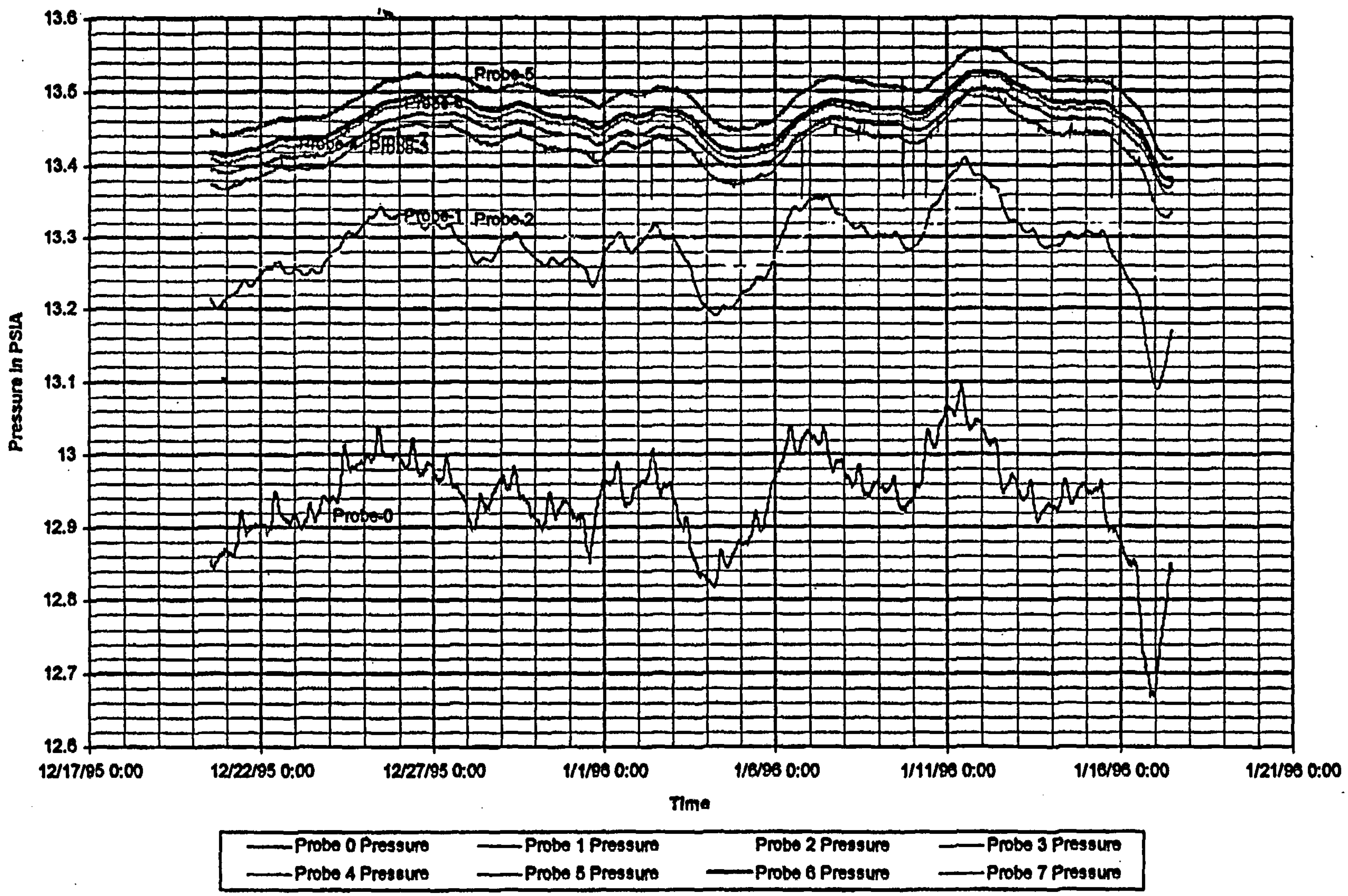
Prepared by:
Multimedia Environmental Technology, Inc.
Newport Beach, California



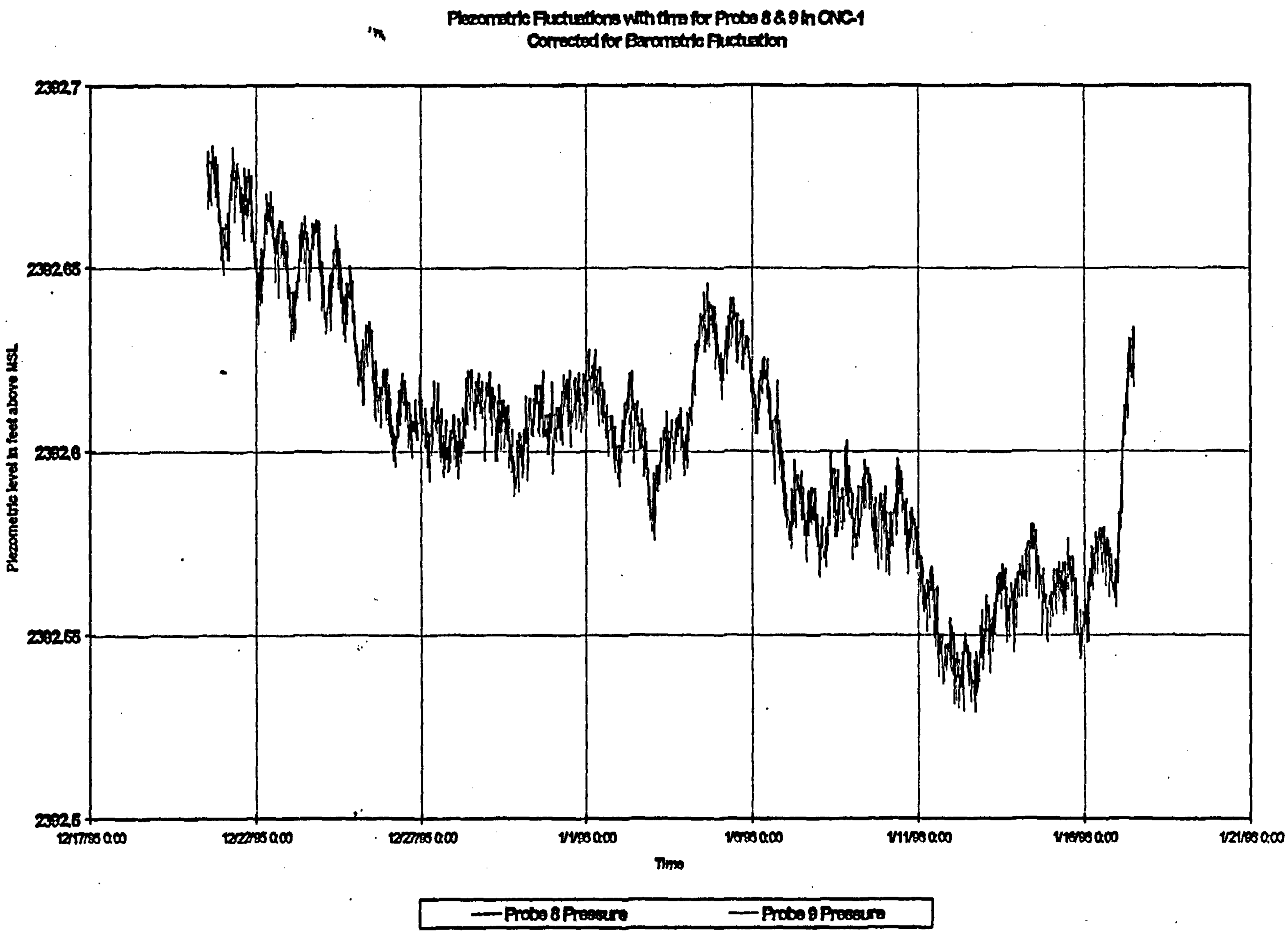
Temperature variation with time in ONC-1
Corrected with interpolation calibration
Temperature in degree Celsius
40
35
30
25
20
15
10
5
0
-5
Probe-9
Probe-7
Probe-8
Probe-4
Probe-5
Probe-3
Probe-2
Probe-1
Probe-0
12/17/95 0:00
12/22/95 0:00
12/27/95 0:00
1/1/96 0:00
1/6/96 0:00
1/11/96 0:00
1/16/96 0:00
1/21/96 0:00
Time
Probe 0 Temperature
Probe 1 Temperature
Probe 2 Temperature
Probe 3 Temperature
Probe 4 Temperature
Probe 5 Temperature
Probe 6 Temperature
Probe 7 Temperature
Probe 8 Temperature
Probe 9 Temperature

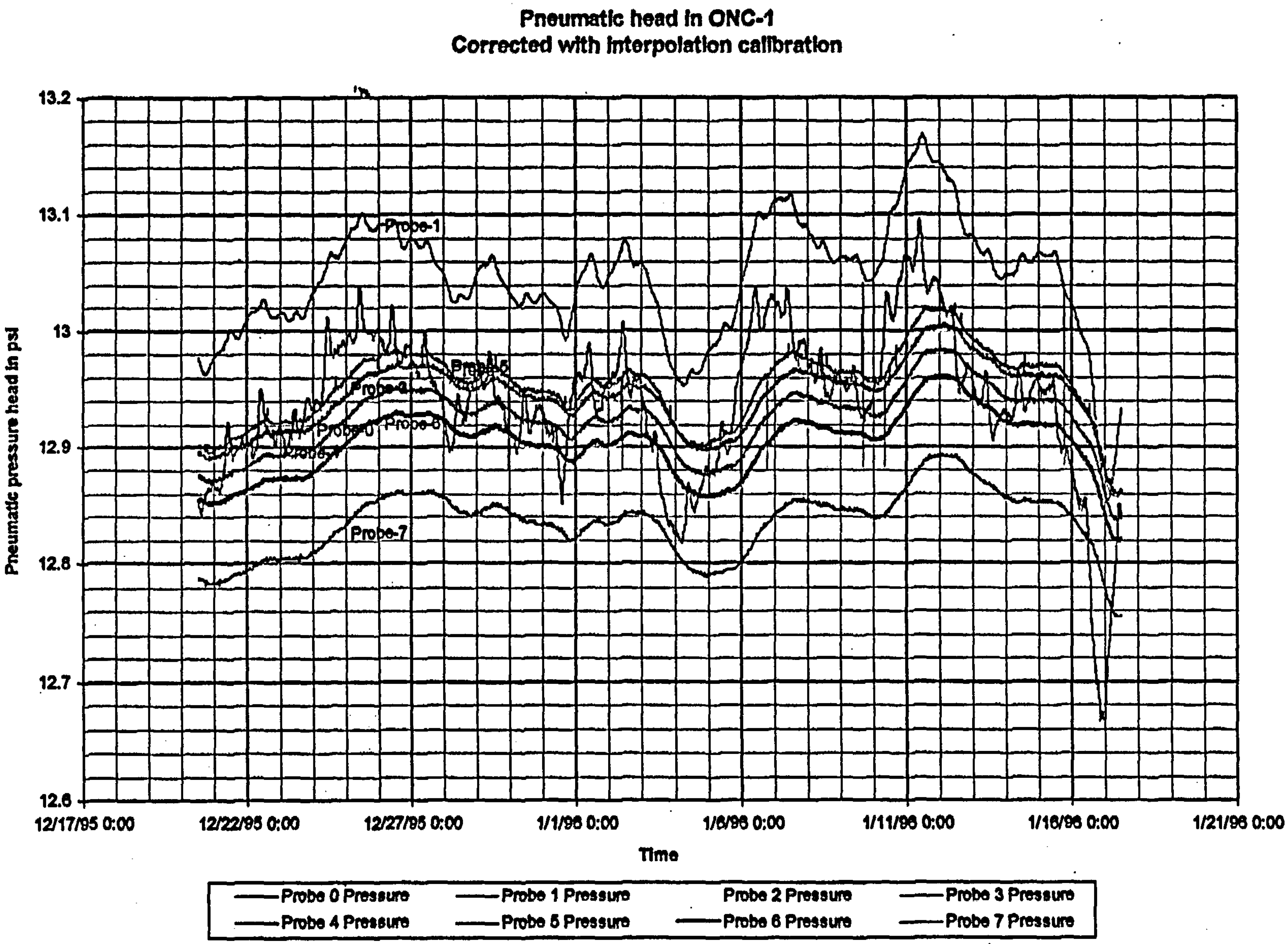
PRELIMINARY

Absolute pressure for ONC-1
Corrected with interpolation calibration

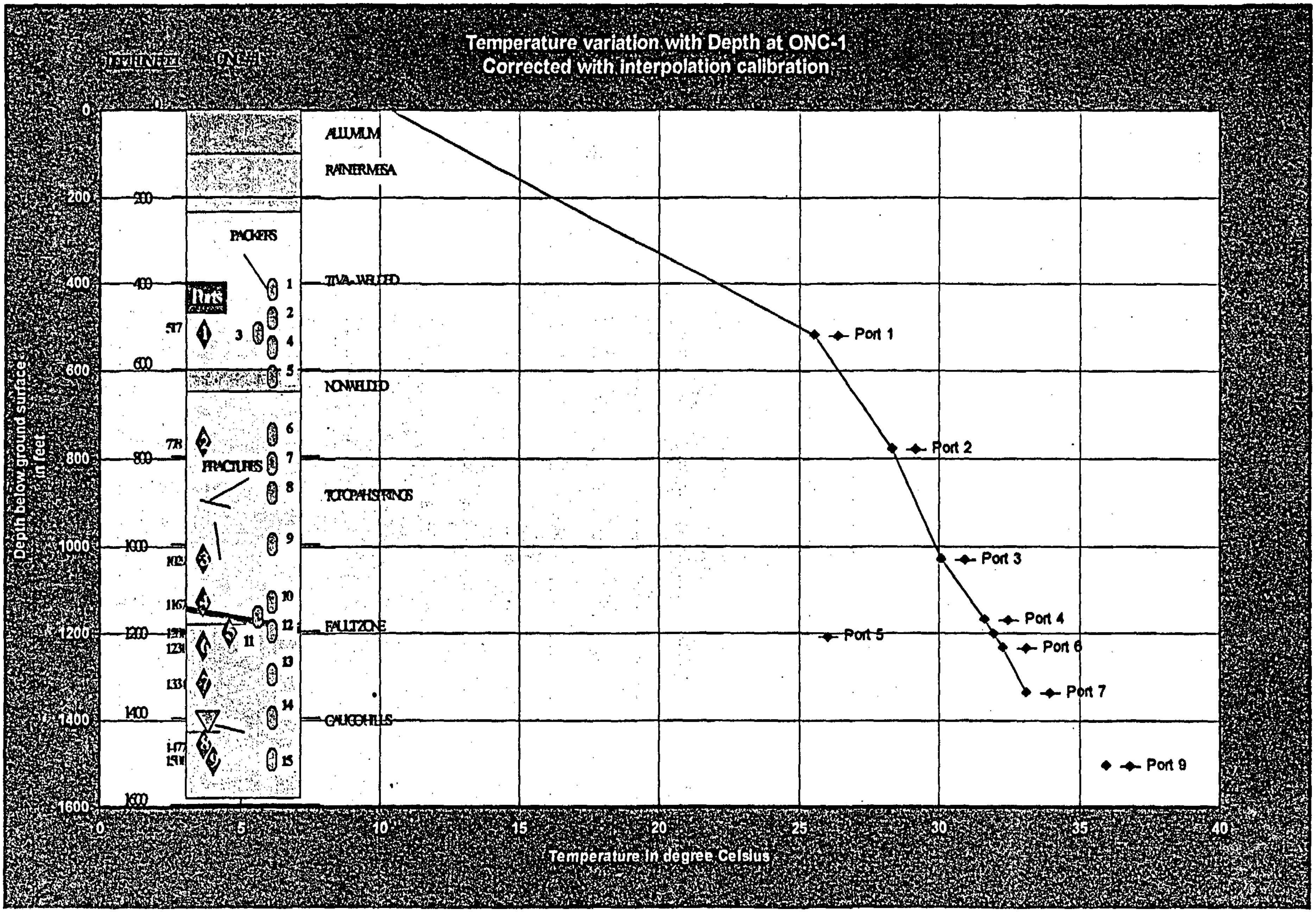


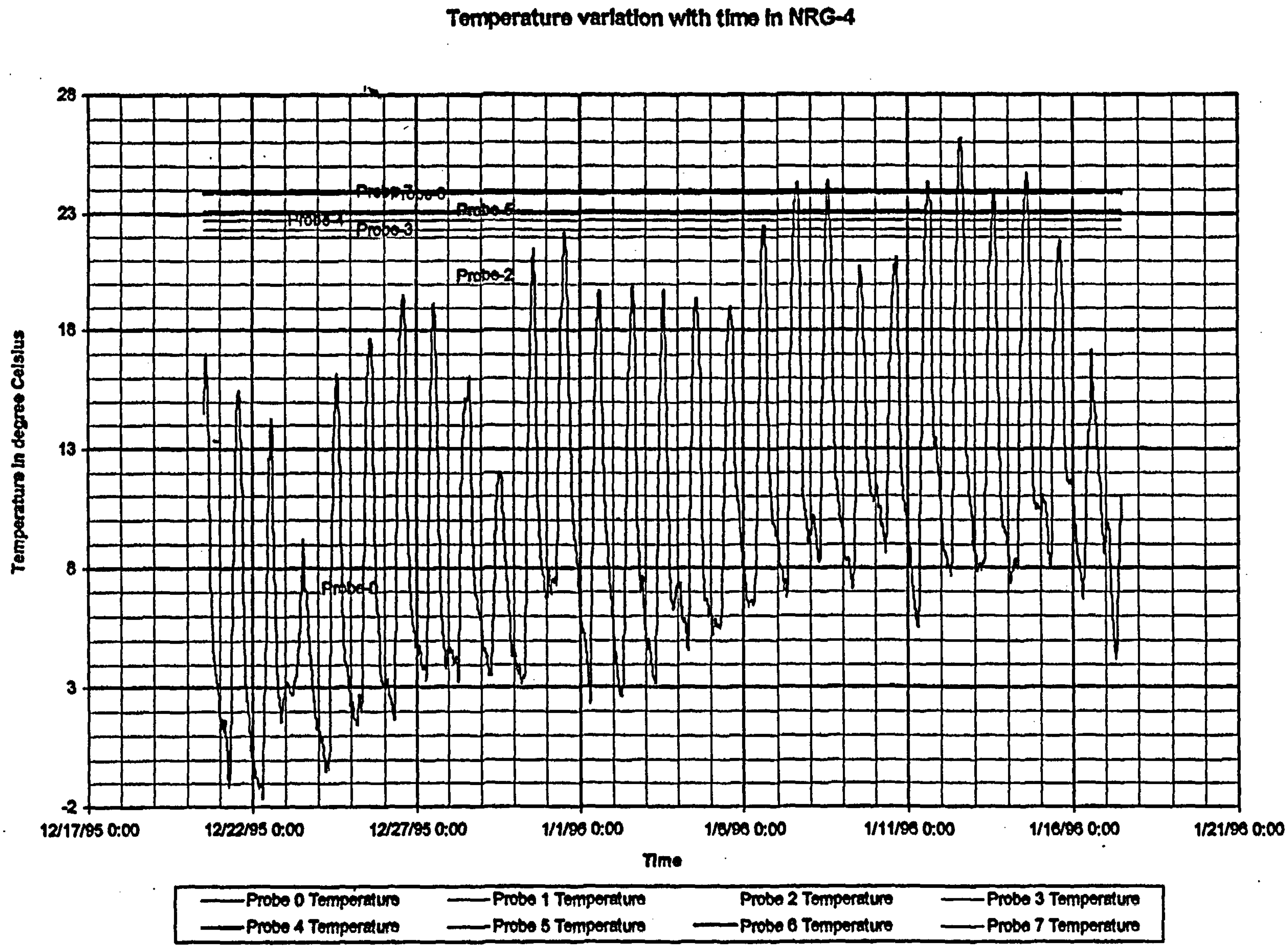
PRELIMINARY



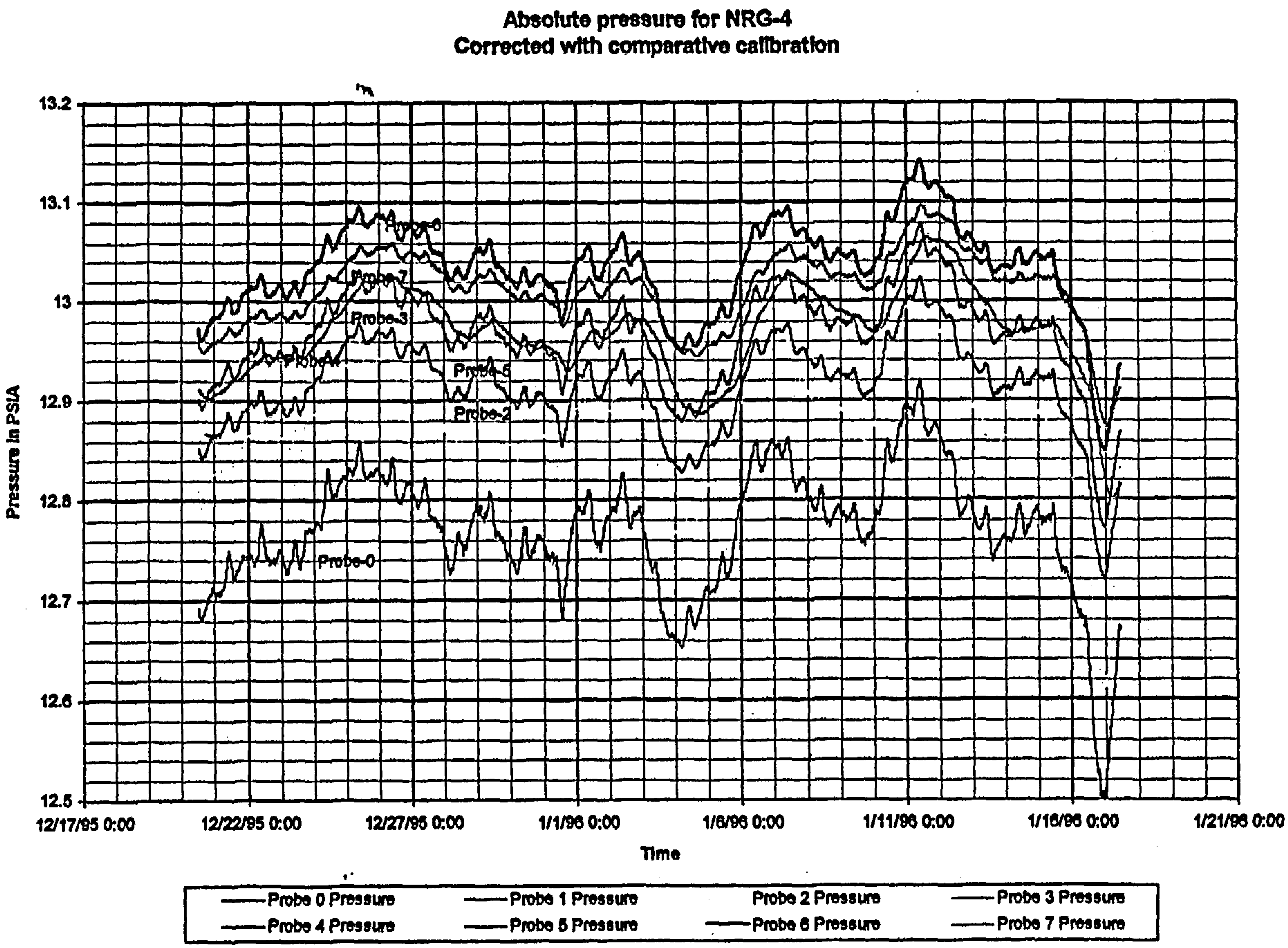

Pneumatic head in ONC-1
Corrected with interpolation calibration
13.2
13.1
13
12.9
12.8
12.7
12.6
Pneumatic pressure head in psi
Probe-1
Probe-5
Probe-3
Probe-0
Probe-6
Probe-4
Probe-7
12/17/95 0:00
12/22/95 0:00
12/27/95 0:00
1/1/96 0:00
1/6/96 0:00
1/11/96 0:00
1/16/96 0:00
1/21/96 0:00
Time
Probe 0 Pressure
Probe 1 Pressure
Probe 2 Pressure
Probe 3 Pressure
Probe 4 Pressure
Probe 5 Pressure
Probe 6 Pressure
Probe 7 Pressure

PRELIMINARY




Temperature variation with time in NRG-4
28
23
18
13
8
3
-2
Temperature in degree Celsius
Probe-7
Probe-6
Probe-5
Probe-4
Probe-3
Probe-2
Probe-0
12/17/95 0:00
12/22/95 0:00
12/27/95 0:00
1/1/96 0:00
1/6/96 0:00
1/11/96 0:00
1/16/96 0:00
1/21/96 0:00
Time
Probe 0 Temperature
Probe 1 Temperature
Probe 2 Temperature
Probe 3 Temperature
Probe 4 Temperature
Probe 5 Temperature
Probe 6 Temperature
Probe 7 Temperature

PRELIMINARY



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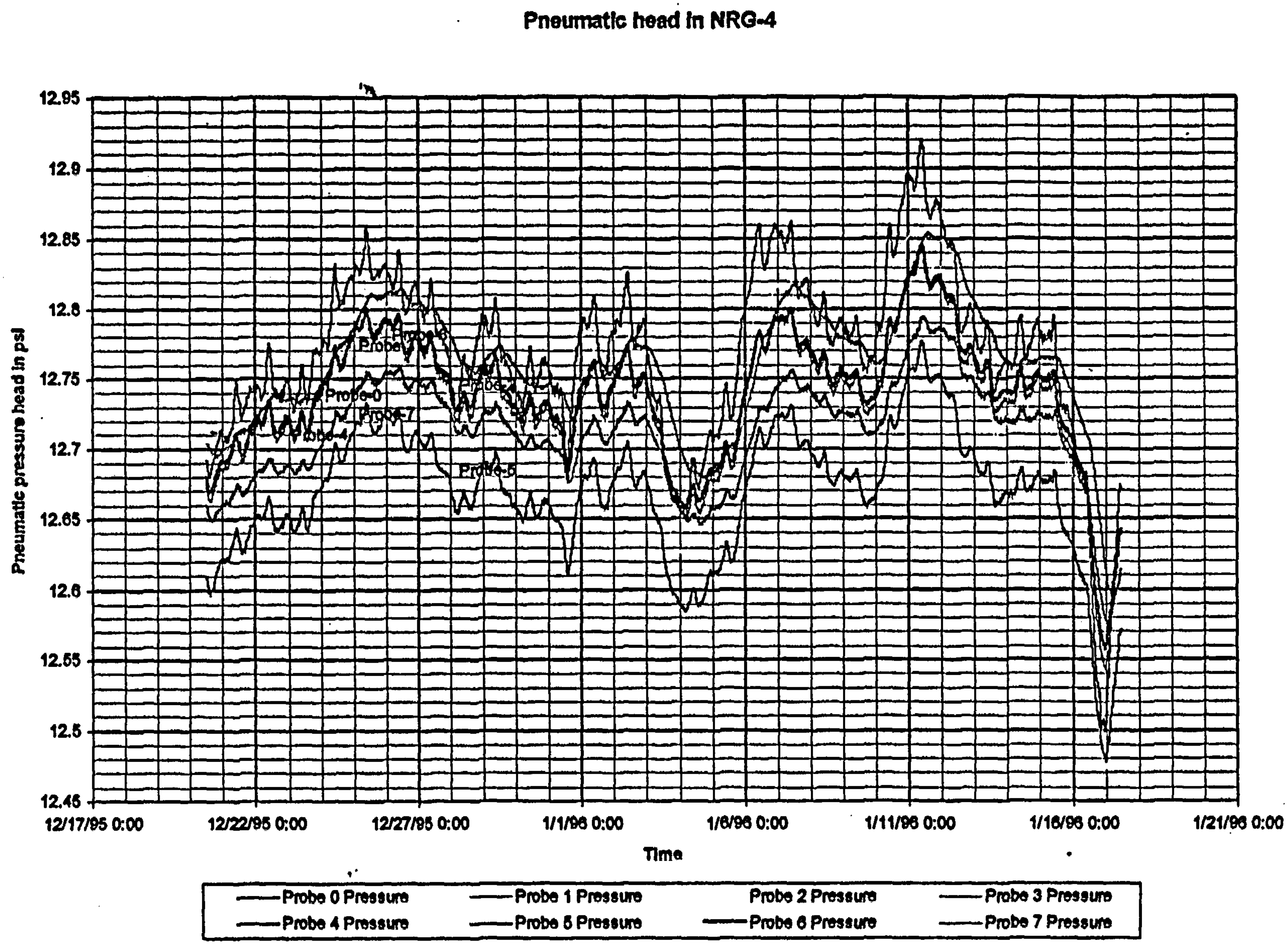

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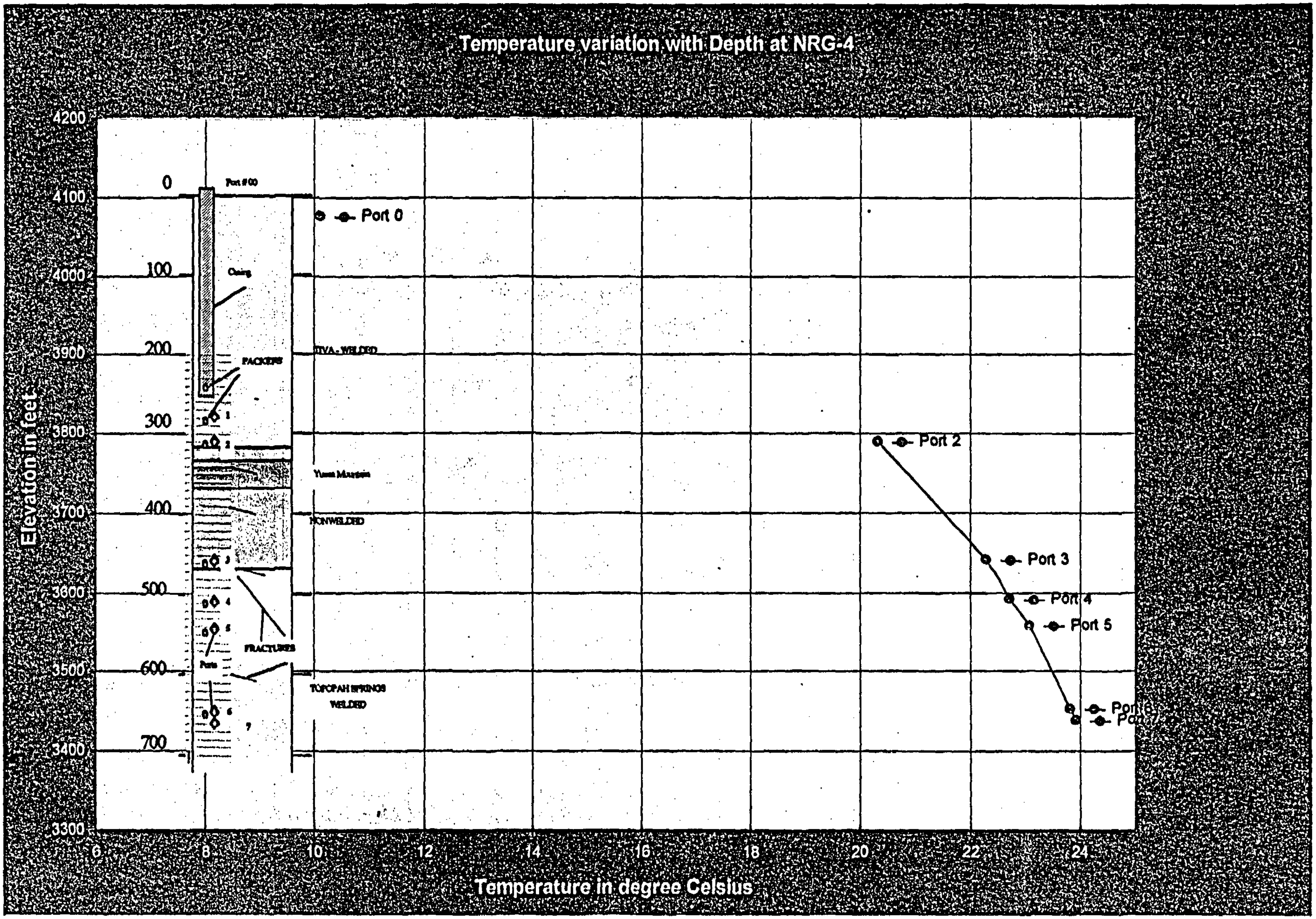

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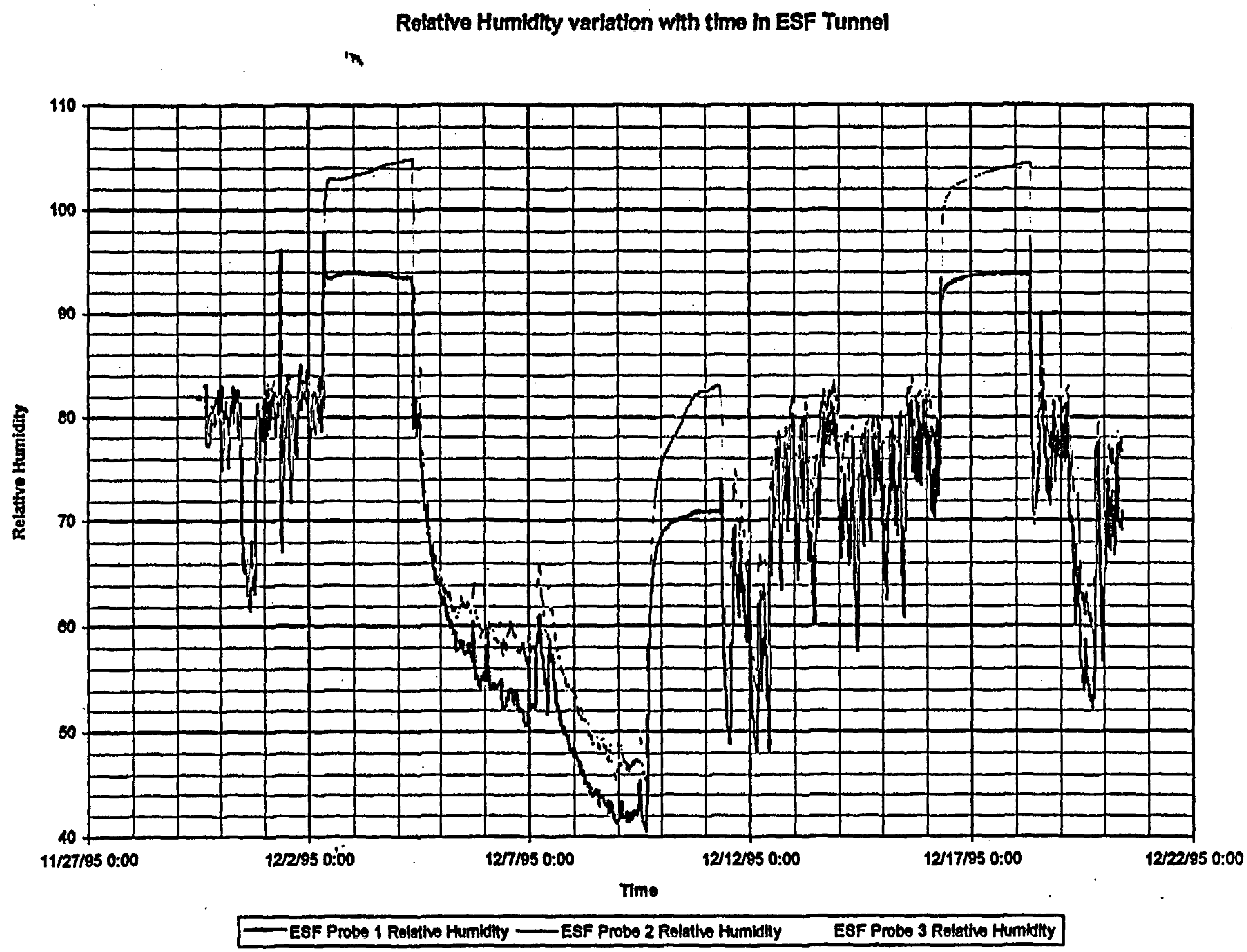

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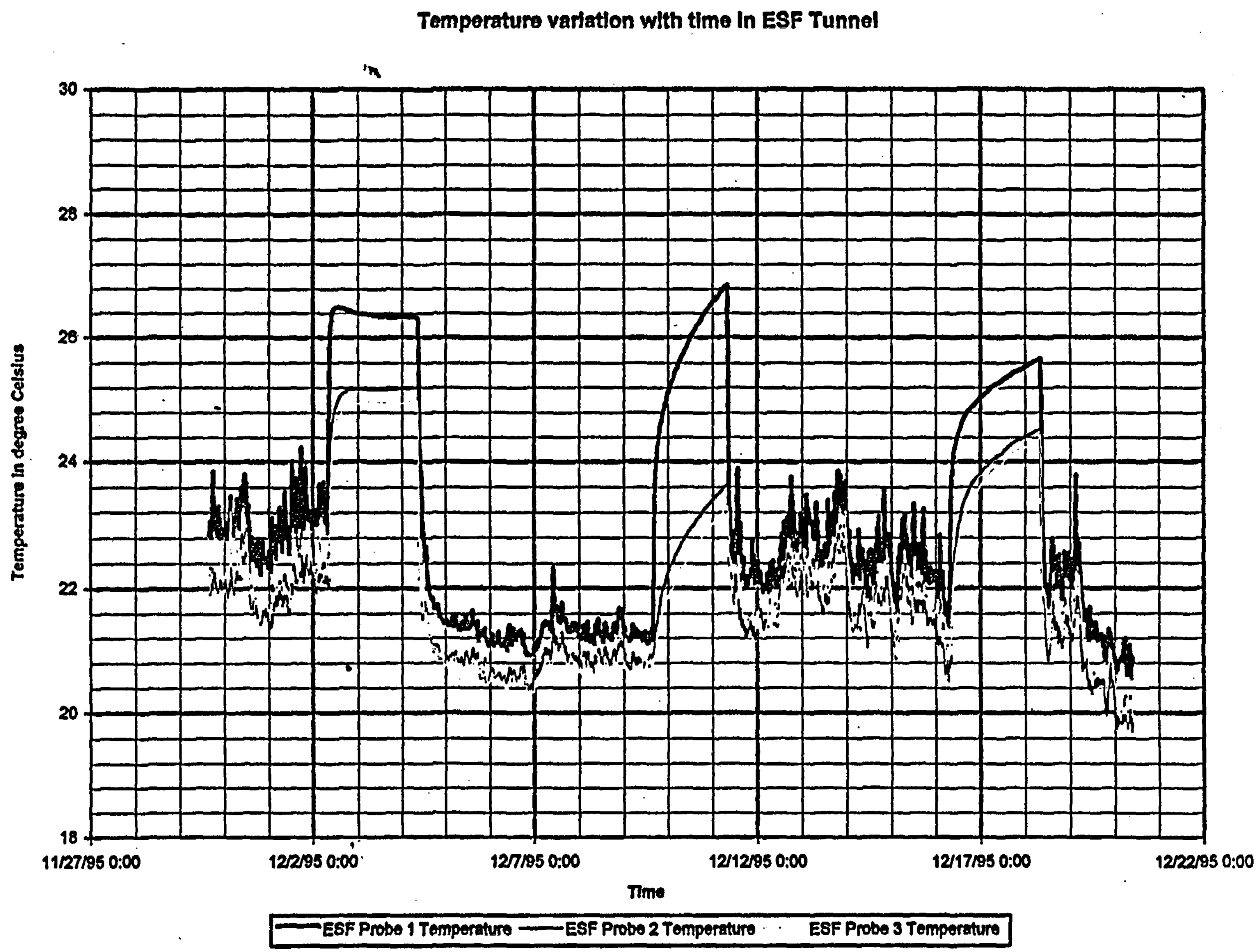

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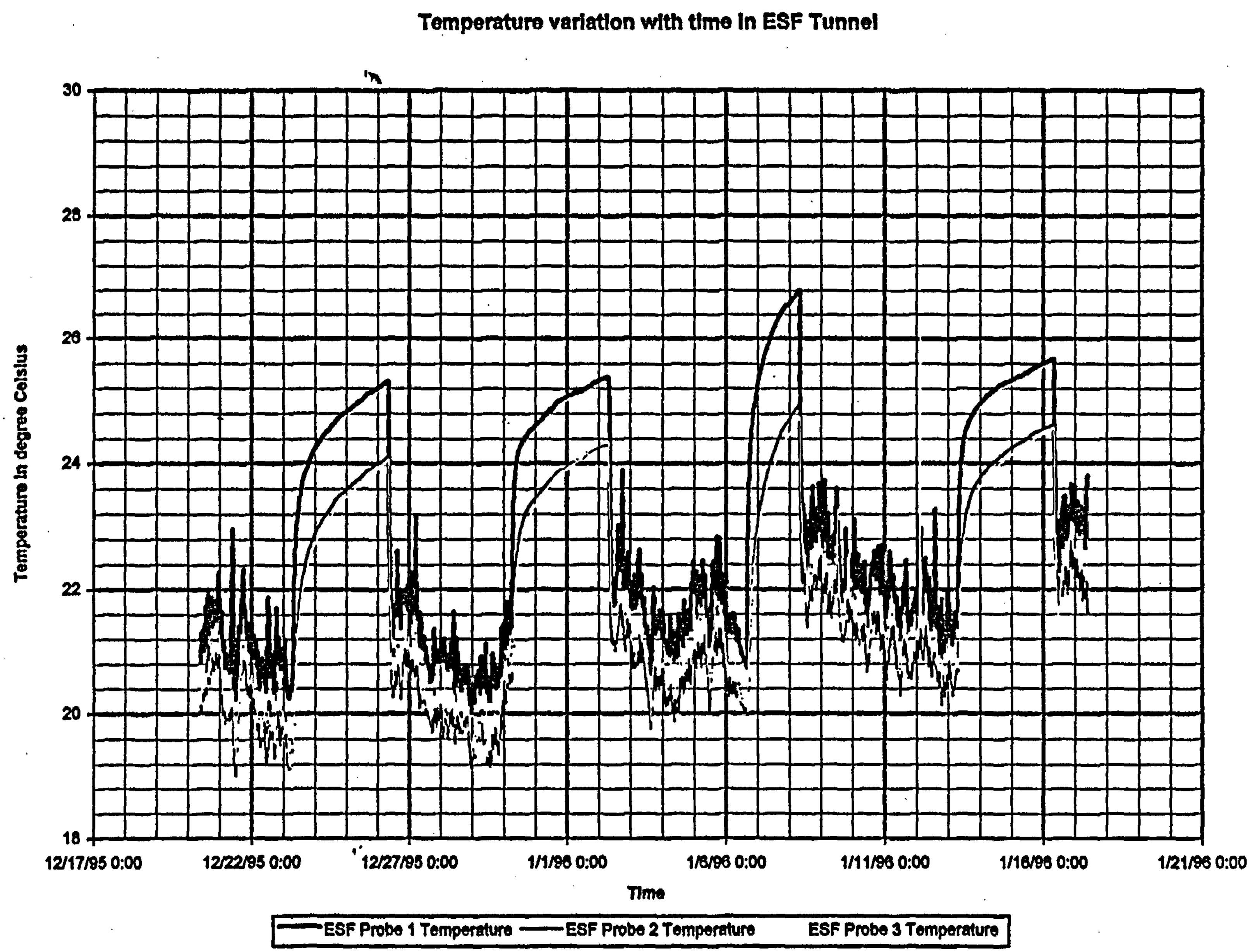

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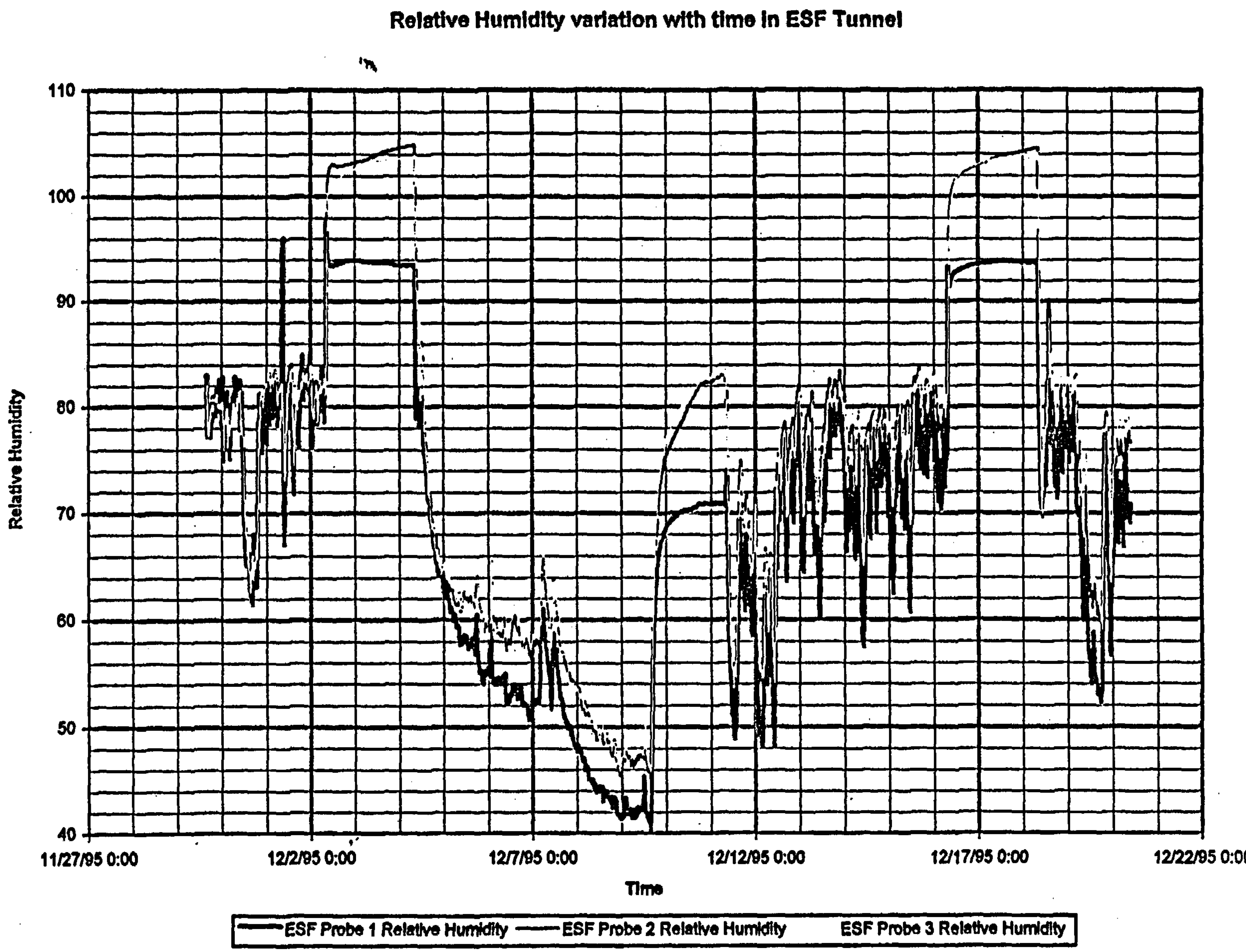
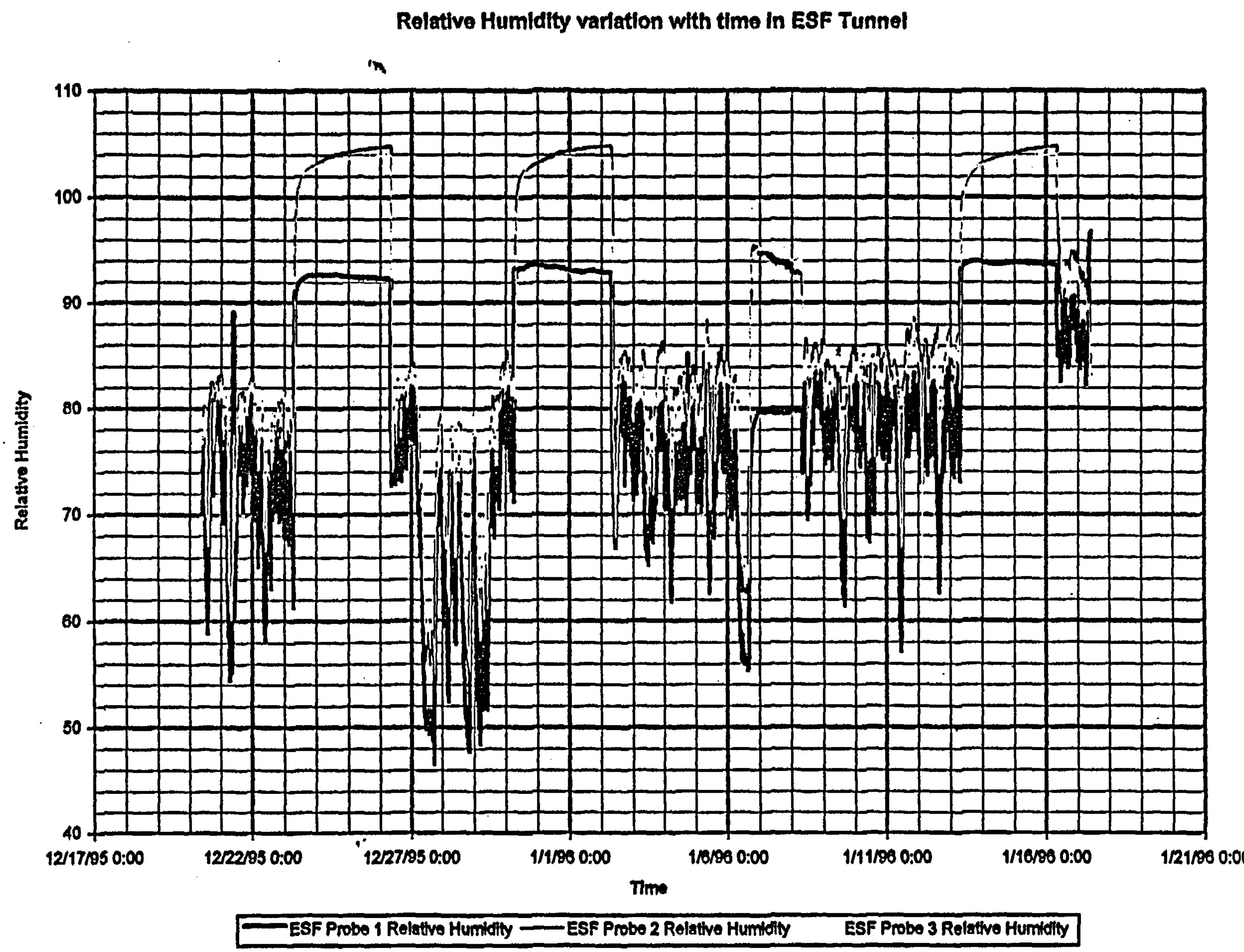
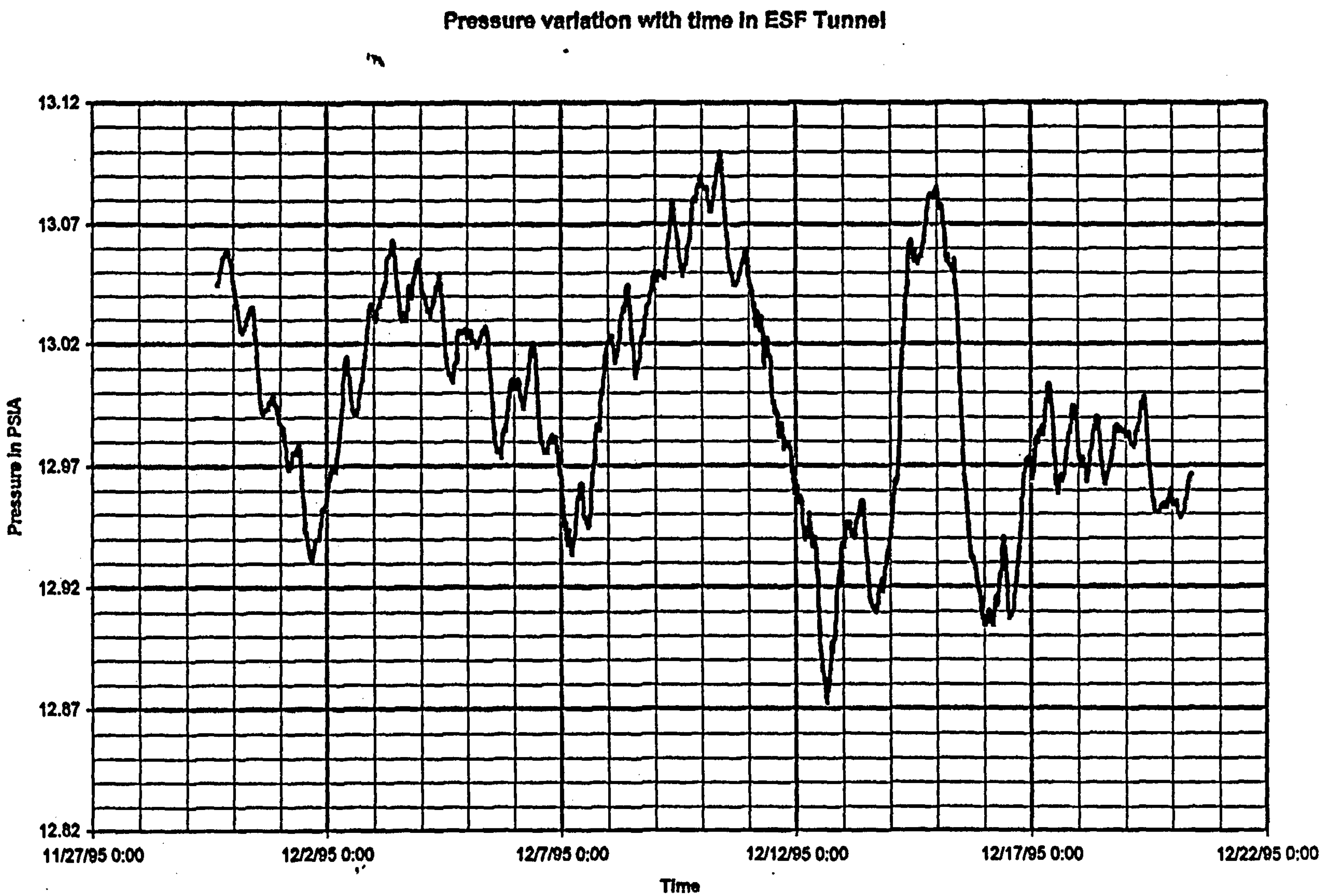
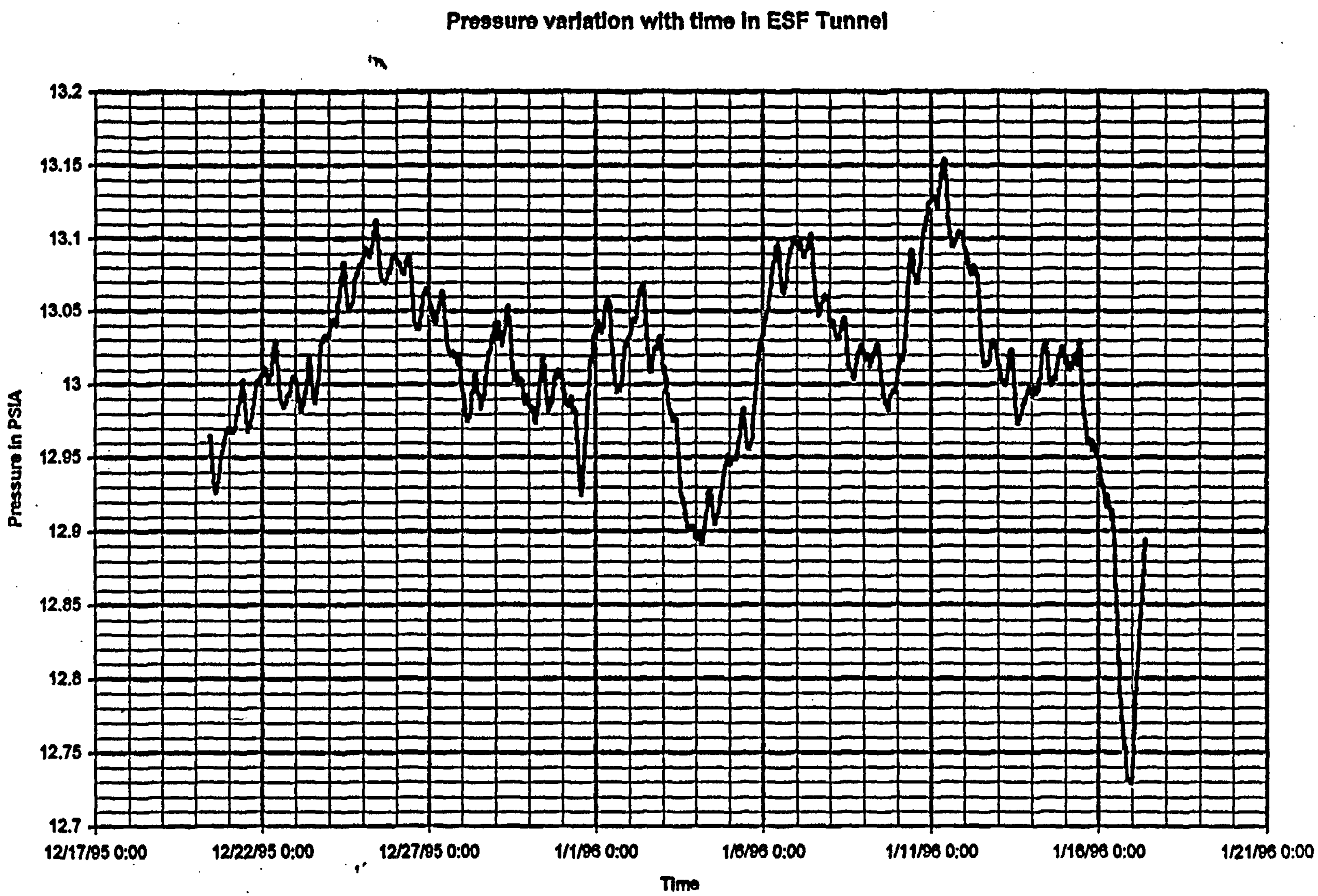



Relative Humidity variation with time in ESF Tunnel
110
100
90
80
70
60
50
40
Relative Humidity
12/17/95 0:00
12/22/95 0:00
12/27/95 0:00
1/1/96 0:00
1/6/96 0:00
1/11/96 0:00
1/16/96 0:00
1/21/96 0:00
Time
ESF Probe 1 Relative Humidity
ESF Probe 2 Relative Humidity
ESF Probe 3 Relative Humidity

PRELIMINARY



PRELIMINARY



WEEKLY HIGHLIGHT REPORT FOR W/E MAY 31, 1996

TO: Daniel A. Dreyfus, RW-1

FROM: Wesley E. Barnes, YMSCO Wes

DATE: June 3, 1996

SUBJECT: Weekly Report

The following activities are provided as input from the Yucca Mountain Site Characterization Office for the Program Office Weekly Report.

Major Events

A U.S. Department of Energy/U.S. Nuclear Regulatory Commission Technical Meeting on the Exploratory Studies Facility is scheduled for June 3, 1996, via videoconference between Washington, D.C. and Las Vegas, Nevada. The purpose of the meeting is to discuss issues and open items related to the Exploratory Studies Facility construction and design.

Key Accomplishments

The Tunnel Boring Machine progressed 97.3 M or 319.2 ft. to Station 55+72.4 M or 18,277 ft. as of 08:00 June 3, 1996. The Tunnel Boring Machine is 1,632 M or 5,354 ft. ahead of schedule. In time, this equates to approximately 164 days ahead of schedule. Ground conditions continued at Category 1 until Graveyard shift Friday (June 1, 1996) when category IV ground conditions were encountered. The drill and blast operations have advanced to station 1+15.3 M or 378 ft. in the Thermal Test Alcove (TTA). The North Ghost Dance Fault Alcove has advanced to station 0+11.4 M or 37 ft.

Tracer testing in the saturated zone continues at the C-Hole Complex. The tracer (pentafluorobenzoic acid) was injected on May 15, 1996 in C-2. Tracer was first detected in the discharge stream from the pumped well (C-3) on May 18, 1996 and the peak concentration of approximately 335 parts per billion (ppb) occurred on May 25, 1996. Data from the C-Holes testing will be used to refine models for transport of radionuclides in the saturated zone.

Staff members from the Assistant Manager for Scientific Programs, Assistant Manager for Suitability and Licensing, and Assistant Manager for Engineering and Field Operations met with board members

and staff of the Nuclear Waste Technical Review Board in an informal exchange on May 28 and 29, 1996. Topics of conversation were the thermal testing program, advanced conceptual design, thermal modeling and recent results of hydrologic investigations in the Exploratory Studies Facility.

Two staff members of the Assistant Manager for Scientific Programs accompanied the Nuclear Waste Technical Review Board members and staff into the Exploratory Studies Facility on May 29, 1996 and provided discussions on testing and construction activities within the tunnel. The group also received briefings on activities regarding surface and underground mapping, thermal testing, infiltration studies and age-dating of fracture coatings from selected United States Geological Survey and Lawrence Berkeley National Laboratory Principle Investigators in the Exploratory Studies Facility and at the Field Operations Center.

The Office of Public Affairs conducted a Nuclear Energy Institute tour of Yucca Mountain for 10 Congressional Staff members, and a tour for a guest from the Associated Press, Los Angeles, California.

The United States Geological Survey has installed the SEAMIST borehole liner in borehole USW UZ-6s to support gas phase circulation studies.

Emerging Issues

None to report

Secretarial Commitments

None to report

cc:
L. H. Barrett, HQ (RW-2) FORS
J. C. Bresee, HQ (RW-10) FORS
H. H. Brandt, HQ (RW-15) FORS
R. A. Milner, HQ (RW-30) FORS
J. D. Saltzman, HQ (RW-30) FORS
M. A. Ferguson, HQ (RW-34) FORS
A. B. Brownstein, HQ (RW-36) FORS
Samuel Rousso, HQ (RW-40) FORS
David Langstaff, RL
W. L. Belke, NRC, Las Vegas, NV
Ron Pope, ORNL, Oak Ridge, TN
Wayne Cameron, White Pine County, Ely, NV
L. W. Bradshaw, Nye County, Tonopah, NV
W. L. Offutt, Nye County, Tonopah, NV
P. A. Niedzielski-Eichner, Nye County, Chantilly, VA
V. E. Poe, Mineral County, Hawthorne, NV
Jason Pitts, Lincoln County, Pioche, NV
Lander County Board of Commissioners, Battle Mountain, NV
Eureka County Board of Commissioners, Eureka, NV
J. D. Hoffman, Esmeralda County, Goldfield, NV
D. A. Bechtel, Clark County, Las Vegas, NV
Cyril Schank, Churchill County, Fallon, NV
B. R. Mettam, Inyo County, Independence, CA
Intertech Services Corp., Las Vegas, NV
A. C. Douglas, City of Las Vegas, Las Vegas, NV
Donald Schweitzer, BNL, Upton, NY
R. D. Dresser, Weston, Washington, DC
J. L. Smith, Occidental, CA
David Howell, IG, Las Vegas, NV
C. A. Johnson, NWPO, Carson City, NV
R. R. Loux, NWPO, Carson City, NV
C. J. Henkel, NEI, Washington, DC
Records Processing Center

MFR: AMSL:CLH-1888

Los Alamos
NATIONAL LABORATORY

Earth and Environmental Sciences Division
EES-13 – Nuclear Waste Management R&D
Mail Stop J521, Los Alamos, NM 87545
Phone (505) 667-9768, Fax (505) 667-1934

WBS: 1.2.9.1
QA: N/A.

June 5, 1996

LA-EES-13-06-96-003

Dr. Colin A. Heath
CRWMS M&O Assistant General Manager for Program Integration
TRW Environmental Safety Systems, Inc.
2650 Park Tower Drive
Suite 800
Vienna, VA 22180

Dear Dr. Heath,

Submittal of Los Alamos Monthly Management Analysis Report for May 1996 (SCPB:NA)

Attached is the Los Alamos Monthly Management Analysis Report for May 1996. This report includes five sections:

(1) a summary of our technical efforts, including information on completion of contract deliverables and major problems;
(2) a summary of personnel changes;
(3) a list of any unusual current and/or anticipated financial performance problems;
(4) a list of programmatic issues that may impact the overall CRWMS M&O effort; and
(5) a summary of work planned for next reporting period.

The technical sections of this report have not received formal technical or policy review by Los Alamos or the YMP. Data presented in this document constitute predecisional information, should not be referenced, and are not intended for release from the U.S. Department of Energy as referenceable information.

If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

Julie A. Canepa

JAC/SHK/cmv

Attachment: a/s

Los Alamos Monthly Management Analysis Report for May 1996

(1) Summary of (a) Los Alamos' technical accomplishments, (b) deliverables completed, and (c) major problems that may impact future performance.

(a) Technical Accomplishments

WBS 1.2.3.1 Site Investigation Coordination and Planning. Staff represented the Los Alamos Site Characterization Project Leader at weekly surface-based testing meetings and Civilian Radioactive Waste Management System Management & Operating Contractor work scope consolidation meetings.

WBS 1.2.3.2.1.1.1 Transport Pathways. *Quantitative X-ray Diffraction Studies.* Staff completed collecting X-ray diffraction data and continued data reduction for samples from the lower Topopah vitrophyre to the water table in USW SD-7, SD-9, and SD-12. These data will be used in milestone 4240, "Analysis of the Vitric-to-Zeolitic Transition and of Zeolite Abundances in SD-7, 9, and 12," and they are needed to provide defensible transport models for the site. Preliminary analysis of data for bulk-rock samples at the top of the lower Topopah Spring Tuff vitrophyre and at the top of the zeolitized horizon in the Calico Hills Formation has revealed the presence of the zeolite chabazite. Chabazite has previously been identified at Yucca Mountain only in a limited number of fracture samples. The occurrence of chabazite in SD-7 once again emphasizes that we lack a complete understanding of mineral distributions at Yucca Mountain, even in close proximity to the host rock, and that "surprises" will still be encountered.

Chabazite in SD-7 occurs both above the lower Topopah Spring Tuff vitrophyre and within the nonwelded Calico Hills Formation. In a thermodynamic modeling study of the zeolites found at Yucca Mountain, S. Chipera modeled stability fields for erionite, phillipsite, and chabazite; these zeolites were stable phases only in groundwater compositions that were significantly more potassic than present Yucca Mountain groundwater. Decreases in aqueous silica and sodium activities and increases in temperature also enhanced the stability field for chabazite.

Preliminary results for USW SD-7 also indicate that the top of the abundantly zeolitized zone at the southern end of the exploration block is significantly higher than in the center of the exploration block. If this observation persists as the data are finalized, then the data will have important implications for transport modeling and particularly in providing more accurate site-performance calculations.

Calcite Studies. A paper titled "Paleo-transport of Lanthanides and Strontium Recorded in Calcite Compositions from Tuffs at Yucca Mountain, Nevada" (D. Vaniman and S. Chipera) was accepted for publication in the journal *Geochimica et Cosmochimica Acta*. This paper describes the evidence, recorded in calcite trace-element compositions, for the strong influence of trace minerals on groundwater chemistry at Yucca Mountain. In

particular, calcite compositions provide evidence that trace amounts of Mn oxides along fractures effectively modify the composition of UZ waters along all flowpaths greater than a few tens of meters. These results provide direct evidence that any radioactive wastes released in the UZ will encounter highly sorptive trace minerals. A presentation on this topic was made this month to the Los Alamos Earth and Environmental Sciences Division's external review committee; committee members who focus on the geosciences include H. Yoder (Carnegie Institution of Washington, Geophysical Laboratory) and L. Silver (California Institute of Technology).

Microautoradiography. Microautoradiography experiments will be completed this year on critical rock types, water compositions, and actinide species. Using electron microprobe analysis of Ag in the radiographic emulsions, test exposures to measure saturation limits and linearity of the emulsion used (Kodak NTB2 radiographic emulsion) in the microautoradiography experiments were completed. This experiment was only partially successful, because light scattering within the thin-section used partially exposed all of the test strips simultaneously. The experiment will be repeated with multiple, individually-exposed slides. The information from this work will be used to limit or to compensate for any nonlinearities in the response of the emulsions to exposure signals, thus allowing more quantitative measurements of mineral/mineral actinide distribution coefficients. These distribution coefficients for actinides are important data, and they will be used in the site transport models.

Summary and Synthesis Report. Work continued in data analysis and writing for the Mineralogy of Transport Pathways Summary and Synthesis Report.

Planning Activities. Staff participated in a teleconference with S. Nelson, A. Meijer, R. Henning, and B. Thompson to discuss combined activities at one of three drill holes (WT-17, WT-1, or USW H-3) near the southern end of Yucca Mountain. The Project does have access to some existing mineralogical data for WT-1 and H-3, although sample spacings in those two drill holes were relatively large. Because there is only a small amount of mineralogical information on the southeastern portion of Yucca Mountain, Min-Pet staff felt that, of the three holes discussed, additional effort would be best concentrated on WT-17 for FY97. Min-Pet staff also discussed the value of analyzing cuttings from WT-17 using X-ray powder diffraction methods; accurate mineralogic data for this hole would help define the mineralogy down-gradient away from Yucca Mountain. This data would also be used to provide "edge" information for the flow and transport site models. In addition, actual mineralogical data measured from cuttings would provide important ground truth for well-log information.

WBS 1.2.3.2.1.1.2 Alteration History. Staff expanded sections of the summary and synthesis report dealing with zeolitization from outline form. Preliminary versions of the data tables for zeolite chemical analyses were compiled. General considerations related to the definition of the vitric-zeolitic transition were described in this section. The boundary may be defined differently depending on the intended use for information about the

transition. The variety of possible uses includes paleohydrologic and other petrologic studies and mapping of sorptive, hydraulic, and thermal properties.

A report summarizing alteration history studies of Yucca Mountain natural self-analog studies, Yellowstone analog studies, and thermodynamic studies of zeolite stability and dehydration, pertinent to the evaluation of thermal loading goals, was completed.

WBS: 1.2.3.2.1.2. Kinetics and Thermodynamics of Mineral Evolution at Yucca Mountain. B. Carey continued analyzing thermodynamic data for clinoptilolite. His results this month include thermodynamic models for the energetics of cation-exchange, which allow the several thermodynamic measurements of the Gibbs free energy of formation of clinoptilolite to be evaluated for consistency. The models indicate that there is significant difference between calorimetric and solubility determinations of the Gibbs free energy of formation, and the calorimetric values are believed to be more reliable. In addition, Carey obtained accurate thermodynamic values (to within 0.1%) for both clinoptilolite and heulandite, allowing a single model for these structural pairs. The models also permit the calculation of the Gibbs free energy of formation of any compositional end-member with an improved and more quantifiable accuracy. These results will be included in the summary and synthesis reports.

B. Carey gave a presentation to the Los Alamos Earth and Environmental Sciences Division's external review committee on the potential for mineral reactions to occur at Yucca Mountain following emplacement of high-level radioactive waste. The talk focused on the mineral clinoptilolite and included a summary of the experiments characterizing the equilibrium and energetics of hydration and dehydration. These results were used in simulations that illustrated the effects of hydration and dehydration of clinoptilolite on saturation, temperature evolution, and the stability of clinoptilolite at Yucca Mountain. Other potential mineral reactions at Yucca Mountain including those involving clays, the silica polymorphs, and volcanic glass were briefly discussed. The external review committee made some suggestions for future work that included experiments designed to determine the water content of clinoptilolite at elevated pressure and experiments on the dissolution and precipitation behavior of minerals to better define the potential for redistribution of material at Yucca Mountain.

B. Carey, S. Chipera, and D. Bish prepared for presentations at the annual Clay Minerals Society meeting, which will be held 17-20 June in Gatlinburg, TN. The titles of the presentations are "X-ray Powder Diffraction And Thermogravimetric Analysis Of Clinoptilolite Dehydration Behavior" and "Hydration/Rehydration Hysteresis in Smectite: Equilibrium or Kinetic Effect?" Both talks will focus on kinetic and thermodynamic aspects of hydration in smectite and clinoptilolite, with a goal of accurately predicting the behavior of both minerals as a function of temperature and partial pressure of water.

A paper titled "Equilibrium Modeling of Clinoptilolite-Analcime Equilibria at Yucca Mountain, Nevada," was accepted for publication in the journal *Clays and Clay Minerals*. The authors were addressing reviewer and editorial comments before final submittal.

WBS 1.2.3.2.5 Volcanism. ***Probability Studies.*** Chapter 3, "Tectonic Settings of the Yucca Mountain Region: Relationship to Episodes of Basaltic Volcanism," of the summary and synthesis report was being edited and reviewed by co-authors at the USGS and Stanford University. Participants from the tectonics program at University of Nevada, Reno, have agreed to write sections on seismicity and teleseismic studies.

Staff continued to revise chapter 7, "Probabilistic Volcanic Hazard Assessment," of the summary and synthesis report.

Golder Associates was preparing results of their studies on simulation modeling of the probability of magmatic disruption of the Yucca Mountain site to be included in chapter 7.

Staff assessed all results to date on simulation modeling of the disruption probability. These results indicate that the uncertainty in the location of zone boundaries can be modeled for many zone boundaries by examining the disruption probability for different assumed values of the mean and standard deviation of dike lengths.

Staff evaluated the revised chronology data for the Lathrop Wells and Sleeping Center. This revised data indicate that the minimum repose interval for the Pliocene and Quaternary is 320,000 years, which is longer than the 200,000 years minimum repose interval estimated in the volcanism status report (Crowe et al. 1995). It is still, however, the shortest repose interval during the Pliocene and Quaternary.

Geochemistry of Eruptive Sequences. Staff focused on preparing for a DOE audit scheduled 3-7 June. The audit was later postponed indefinitely. Synthesis activities continued.

Subsurface Effects. Staff focused on preparing for a DOE audit scheduled 3-7 June. The audit was later postponed indefinitely. Other work included completion of a first draft of a mineral alteration study at the Paiute Ridge analog site and continued preparation of a manuscript on work at Grants Ridge site.

WBS 1.2.3.3.1.2.2 Water Movement Test. Staff collected 18 samples from the ESF tunnel for chlorine-36 analysis. Nine of these were associated with locations at which elevated chlorine-36 signals had previously been determined, near stations 2, 12, 21, and 26. At two of these locations, a single sample had previously been found to have elevated chlorine-36, and the objective was to resample these sites to confirm the earlier result as well as to determine the width of the zones with elevated chlorine-36. The remaining samples collected on this trip were systematic and feature-based samples from Alcoves 2 and 3 and from the main drift, between stations 41 and 50. Staff also participated in the collection of about 15 ESF samples for tritium analysis.

An alternative hypothesis to account for the elevated chlorine-36 in the ESF samples is natural production by cosmic rays impinging on calcite in surface soils. To test this concept, several soil samples were collected from YMP trenches and surface exposures this month.

The accelerator mass spectrometer used to analyze YMP samples for chlorine-36 has been inoperative for the past month, creating a backlog of approximately 70 samples. Staff continued processing additional ESF samples for chlorine-36 analysis.

Staff began processing a test suite of six samples for technetium-99, cesium-137, and plutonium, all of which are present as global fallout from atmospheric testing of nuclear devices in the 1950s and 1960s. The objective is to test the feasibility of using one of these nuclides as an independent indicator of fast paths, to corroborate the chlorine-36 results. Gamma-counting of raw sample material was insufficiently sensitive to detect cesium-137 in borehole and ESF samples containing bomb-pulse chlorine-36 (including an ESF sample from the Bow Ridge Fault) although cesium-137 was easily measured in surface soil samples. To improve sensitivity, chemical processing of these samples is necessary to isolate the cesium-137 as well as any plutonium from the matrix. However, it is likely that detectable levels of these elements will not be observed at depth, given their propensity to sorb strongly onto soil components.

WBS 1.2.3.3.1.3.1 Reactive Tracer Testing. A conservative tracer test involving injection of pentafluorobenzoic acid (PFBA) into well C#2 while producing water out of well C#3 was initiated on 15 May. The purpose of this test is to determine conservative tracer travel times, peak concentrations, and recoveries under partial recirculating (weak dipole) flow conditions in the most transmissive interval at the C-holes (the middle to lower Bullfrog unit). The results of the test are allowing project scientists to determine whether a reactive tracer test can be conducted in the same interval under the same conditions.

Ten kilograms of PFBA was injected as a 250 gallon slug (~10000 ppm) at ~5 gallons per minute (gpm) into the middle to lower Bullfrog formation in well C#2 at a depth of about 2290 ft below surface at 12:20 pm on 15 May. The linear distance between C#2 and C#3 is approximately 30 m, or 100 ft. The injection interval was 308 ft. long, extending down to 2598 ft. below surface. Tracer-free water produced from C#3 had been injected into C#2 at ~5 gpm starting at 3:45 pm on 14 May so that a steady-state weak dipole flow field was established prior to introducing tracer. The tracer solution was introduced without any disruption in the flow field, and water from C#3 was pumped at ~5 gpm into C#2 behind the tracer so as to maintain a steady flow field throughout the test. Water has been produced from C#3 at a nearly constant rate of 154 gpm since 8 May. As of 31 May, an upper bound for the mass of PFBA that has been reinjected into C#2 since the beginning of the test was about 80 g, or 0.8% of the total mass. This amount of reinjected mass should have no measurable effect on the breakthrough curve, although project scientists will ultimately account for this when doing the final interpretation of the test.

Fig. 1 shows the preliminary breakthrough curve as of about noon on 31 May (~385 hours since injection on 15 May). The curve contains nearly 500 data points representing analyses conducted in the field by UNLV and Los Alamos scientists. These data should be considered preliminary and should not be used outside the project until appropriate quality checks and reviews have been conducted. Over 800 samples have been collected during the test at intervals ranging from 15 minutes at the beginning of the test to 2 hours at the present time. The concentration of PFBA peaked at about 340-350 ppb on 25 and 26 May and has slowly declined since. The total recovery of PFBA at 385 hours since injection was about 25%. The apparent discontinuity in concentrations at about 350 hours in Fig. 1 is believed to be a problem associated with the field analyses and not an actual dip in concentrations. Samples collected near that time will be reanalyzed during the first week of June to test this hypothesis.

While the test results to date are still being analyzed, the preliminary results have indicated that, before proceeding with a reactive tracer test, it would be prudent to inject a conservative tracer into C#1 while pumping C#3 to determine if tracer response times and recoveries are shorter and higher, respectively, than from C#2. Modeling analyses have suggested that a reactive tracer test involving a 40 kg injection of lithium bromide (the current environmental permit limit) into C#2 would have a marginal chance of resulting in lithium concentrations that are significantly above background concentrations (70-80 ppb). Although C#1 is over two-and-a-half times the distance from C#3 than C#2, the possibility that the former well may yield a better tracer response cannot be ruled out. The pressure draw down in C#1 resulting from pumping C#3 is almost as great as the drawdown in C#2, and borehole videotapes indicate that fractures tend to be oriented more in the C#1-C#3 direction than the C#2-C#3 direction. Thus, the current plan is to inject 15 kg of sodium iodide into C#1 to determine if higher concentrations can be obtained from injections into this borehole. Staff was prepared to proceed with this injection during the last week of May, but the necessary approvals had not yet been obtained. Lithium bromide will ultimately be injected into whichever borehole (C#1 or C#2) results in a higher recovery/peak concentration of conservative tracer. In the meantime, approval for an 80 kg injection of lithium bromide is being pursued with the State of Nevada environment department in the event that C#1 does not have a significantly better tracer response than C#2. This approval would increase the chances of seeing a quantifiable lithium response from either C#1 or C#2.

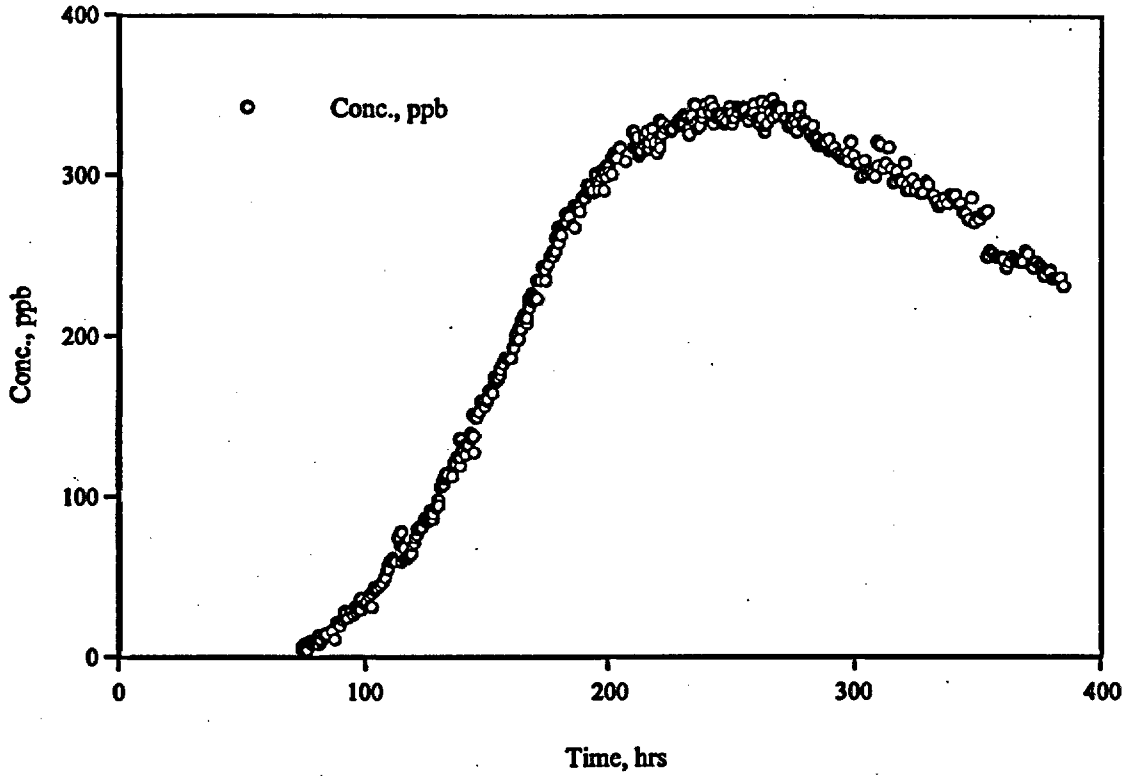


Fig. 1. Preliminary PFBA Breakthrough Curve (through 31 May 1996).

WBS 1.2.3.4.1.1 Groundwater Chemistry Model

Continued development of ground water chemistry model. Submitted estimates of long-term water compositions to sorption task for use in experiments on potential backfill materials.

WBS 1.2.3.4.1.2.1 Batch Sorption Studies. Staff completed summarizing the surface complexation work in the literature involving Np and relevant minerals and groundwater compositions at Yucca Mountain. This summary has been added to section IV, B. To date, staff completed sections I, III, and IV, A of this report and were currently working on section IV, B.

Outline for summary and synthesis report

I. Groundwater Chemistry (and its effects on sorption)

II. Mineralogy Variability (and its effects on sorption)

III. Sorption Data (determined by batch experiments)

- A. Sorption of Simple Cations
- B. Sorption of Simple Anions
- C. Sorption of Actinides

IV. Models that can explain the measured sorption data

A. Ion Exchange

B. Surface Complexation

V. Recommended sorption data for PA

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport. Staff continued writing the summary and synthesis report. The following sections have been completed:

Introduction (approximately 40 pages, 135 references)

Appendix - Colloidal Agglomeration

Siderophore Production

Siderophore/Plutonium Chelation

Siderophore promoted hematite dissolution Siderophore/Iron transport

WBS 1.2.3.4.1.3 Speciation/Solubility. Staff focused on data analysis and began writing the milestone. Data analysis includes using the SIT formalism to check for outlying data points from different sources.

WBS 1.2.3.4.1.4.1 Transport. Staff completed the summary and synthesis section on colloid stability in natural waters (see section III A of the transport outline). To date, they have completed sections I and III A of this report

Transport Report

I. Assessment of Validity of K_d under Advective Conditions
- A. Crushed Rock Columns
  - 1. Using Water from the J-13 Well
    - a. Vitric Tuff
    - b. Zeolitic Tuff
    - c. Devitrified Tuff
  - 2. Using Water from the UE-25 p# 1 Well
    - a. Vitric Tuff
    - b. Zeolitic Tuff
    - c. Devitrified Tuff
- B. Saturated Solid Rock Columns
  - 1. Using Water from the J-13 Well
  - 2. Using Water from the UE-25 p# 1 Well
- C. Unsaturated Solid Rock Columns
  - 1. Zeolitic Tuff
  - 2. Devitrified Tuff

II. Radionuclide Transport through Fractures
- A. Conservative Radionuclides (tritium and pertechnetate)
- B. Sorbing Radionuclides

III. Colloid-Facilitated Radionuclide Transport
- A. Colloid Stability in Natural Groundwaters
- B. Sorption of Radionuclides onto Colloids
- C. Elution of Colloids through Fractures
  - 1. Saturated Systems
  - 2. Unsaturated Systems

Staff also summarized the results of diffusion cells experiments (see Section II B in the diffusion outline). To date, they have completed sections I, II, A and II, B of the diffusion report.

Diffusion Report
I. Diffusion of Conservative Radionuclides through Saturated Tuff
  A. Tritiated Water
    1. Diffusion Cells
    2. Rock Beakers
  B. Pertechnetate
    1. Diffusion Cells
    2. Rock Beakers
II. Diffusion of Sorbing Radionuclides through Saturated Tuff
  A. Tuff Wafers
  B. Diffusion Cells
  C. Rock Beakers
III. Diffusion of Radionuclides through Unsaturated Tuff

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis. ***Drift-Scale Flow and Transport Calculations.*** A flow and transport model at the drift scale is being developed to simulate the movement of water and radionuclides in the vicinity of an emplacement drift and waste canister. Two- and three-dimensional finite-element grids were developed based on the latest designs proposed for the waste package/emplacement drift system. The calculations assume that the system has returned to the ambient hydrologic conditions (i.e., that the radioactive decay waste heat has dissipated). The hydrologic parameters of the system are based on measured properties of the Topopah Springs rock and recently measured unsaturated flow properties of the proposed backfill and invert materials. Measurements of the transport properties of the invert material (sorption coefficients) will be incorporated into the transport calculations when they are available.

Initial flow-model results indicate that a capillary barrier, which diverts water around the drifts, is set up at low infiltration rates. Consequently, the radionuclides must diffuse through the backfill and invert before migrating downward by advection with the flowing groundwater. However, at higher infiltration rates, advection occurs through the drift, increasing the rate of transport away from the drift area. The computational results will be compiled in the form of a time-dependent source term for radionuclide release, which will be used as input to site-scale radionuclide transport models.

Environmental Isotope Studies. A series of one- and two-dimensional calculations were initiated to explore the limits of applicability of certain model assumptions used in site-scale UZ transport calculations of ^{36}Cl. The first set of runs is to test the applicability of the dual-permeability model to simulate the interaction of fractures and matrix. The question addressed is whether the pressure gradients into the rock matrix from the fractures can be adequately represented using the dual-permeability approach, which effectively assumes a single pressure in the matrix for the reason of computational efficiency. The limits of this approach will be identified in this study. The other aspect of this work relates to the assumption of steady state, constant infiltration to represent what is, in effect, a series of rapid infiltration events, followed by periods of little or no infiltration. The transport response

of the system to periodic infiltration is being studied in this task as well. The results will be used to better interpret the isotopic measurements, including ^{36}Cl background and bomb-pulse data.

Grid Generation. Over the last 3 months, we have worked to produce a computational grid of the SZ for the USGS flow model (John Czarnecki) and the LANL flow and transport model. This has been an iterative process and to date, we have investigated 4 different versions of the Stratamodel SFM. A preliminary grid was produced for each of these Stratamodel's until a final version was identified and delivered April 4, 1996. Our close collaboration with the USGS has enabled us to quickly come to resolution on a model with the correct area of interest (AOI) and described by a computational grid of modest size (30,000 nodes) which allows the USGS to proceed with its flow calculations. We are now producing a computational grid for FEHM calculations.

The steps that have been carried out are as follows:

1) Conversion of the Stratamodel SFM to a hexahedral grid.
2) Removal of zero volume hexahedral elements which are part of Stratamodel.
3) Conversion of each hexahedral element to 24 tetrahedral elements.
4)Removal of all elements in bottom layer of model.
5) Addition of 465 nodes to grid the locations of water well water table measurements.
6)Identification and output of lists of nodes situated on the top, bottom, and four sides of the Stratamodel for application of boundary conditions.
7) Testing of the grid on simple heat flow and saturated flow problems prior to delivery to the USGS.
8) Addition of 239 nodes around the model perimeter to match water level of larger regional model. This step requires that the perimeter nodes as provided by USGS be translated 750m to the south and 750m to the west.

With the exception of the last item, all of these steps have been completed. We are working to modify the grid generation code to accomplish this last step. At this point 96 of the 239 nodes required have been added and a computational grid has been delivered to USGS. Computed flow solutions on the preliminary and final grids, complete with perimeter nodes will be delivered shortly.

This process has involved direct and efficient communication between the USGS and LANL to understand and develop SZ model requirements. New software was developed to handle some of the special cases that are part of this work. Stratamodel continues to be somewhat unreliable and does not always produce the expected geometries. For this reason, a completely new algorithm was implemented to identify and output the outside nodes for boundary condition inputs. We have also added the option of pinching out very thin layers that persist artificially in Stratamodel.

Code Development. The transport model options have been improved to include two new options. First, the diffusion coefficient can now be specified as a function of fluid saturation, in keeping with the experimental

measurements of Conca using the unsaturated flow apparatus. Second, a model consisting of a longitudinal and transverse dispersion has now been added. The former feature is being used for drift-scale transport calculations, and the latter will be useful in the SZ transport simulations to be performed later this year.

WBS 1.2.3.9.7 Special Studies: ESF Test Coordination. Staff provided multiple-shift field coordination and PI support for ESF north ramp, main, and alcove tests. Test installation for the single-element heater portion of the Thermal Test Program was in progress and planning for the FY97 heated room test continued. Geologic mapping and consolidated sampling activities were continuing using the mapping gantry.

Staff continued to assemble field records files for test activities conducted in the north ramp, main drift, and test alcoves. This effort includes the maintenance of an administrative database that identifies sample locations and their corresponding photo identifiers.

Administrative test management progress reports were generated to ensure that test requirements and issues are identified. Staff continued to support the Field Change Control Board and the Baseline Change Control Board.

Staff submitted a progress report (LA-EES-13-LV-05-96-007) on ESF testing activities for April 1996 to S.B. Jones and R.L. Craun.

WBS 1.2.5.7 Investment Decision Integration/Technical Evaluation. Staff attended the NWTRB meeting in Austin, TX, 30 AprilÐ1 May.

Staff attended a PR 14 review meeting in Las Vegas, NV.

Staff attended the 7th International meeting on Accelerator Mass Spectrometry in Tucson, AZ, 20–25 May.

Charles Harrington was appointed as a member of the committee that will prepare a new draft of the Waste Isolation Strategy. In connection with this responsibility, he attended a meeting in Las Vegas and participated in several teleconference calls. He also rewrote sections of the draft.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes. Staff extended the reduced-degree-of-freedom algorithms to dual-permeability simulations with air-water-heat. This extension should allow the first-time solution of mountain-scale simulations with this physics and fracture representation. The initial test results were very promising.

Staff continued testing of thermal problems using multiply-defined nodes. This technology allows excellent resolution near interfaces with coarser resolution than was required without this technique. Staff was currently also using it for drift calculations.

Grid Generation. Many grids were developed this month. They included drift-scale grids with multiply-defined interfaces and a new saturated-zone grid for John Czarnecki. The new saturated-zone grid contained additional points for observations, additional layers in the vertical direction, and new boundary nodes.

Carl Gable and Terry Cherry attended an X3D Workshop (on grid generation) at Los Alamos.

WBS 1.2.5.3.5 Technical Database Input. The following automated technical data tracking (ATDT) system submissions were completed:

- Stable chlorine isotope ratios measured for soils at Yucca Mountain, DTN LAJF831222AQ95.001
- Stable chlorine isotope ratios measured for USW UZ-1 rock cuttings, DTN LAJF831222AQ95.002
- Halide and chlorine-36 analyses of ground-waters from USW UZ-1, UE#25-P1, and UE25 UZN#2, DTN LAJF831222AQ95.004
- Halide and chlorine-36 analyses of soils from the UE25 NRG#5 drill pad, DTN LAJF831222AQ95.005
- Halide and chlorine-36 analyses of soils from Test Cell C, NTS Area 25, DTN LAJF831222AQ95.007
- Halide analyses of Topopah Spring tuff from UE25 UZ#16 (1111 ft), DTN LAJF831222AQ95.008
- Halide and chlorine-36 analyses of cuttings from borehole USW UZ-14, DTN LAJF831222AQ95.015
- Halide analyses of Paintbrush tuffs from Yucca Mountain, DTN LAJF831222AQ95.016
- Halide and chlorine-36 analyses of pore waters, groundwaters and surface runoff from Yucca Mountain and vicinity, DTN LAJF831222AQ95.017
- Halide and chlorine-36 analyses of drill core from USW UZ-N55, DTN LAJF831222AQ95.018

The following ATDT records packages have been transmitted to the Los Alamos Records Processing Center:

- Halide analyses of surface soils collected within the Perimeter Drift Boundary, DTN LA000000000063.002
- Halide and chlorine-36 analyses of ground-waters from the saturated zone, DTN LA000000000064.001
- Halide and chlorine-36 analyses of Rocks from the North Starter Tunnel, DTN LA000000000065.001

Staff continued to compare records transmitted to the RPC with the actual entries of the DTN database to verify that all entries were complete.

WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments. Staff attended weekly design and construction meetings. Staff continued to participate in discussions with DOE and the design team to merge future design activities into the existing 2C design package. Staff provided design

input to support field changes related to the thermal test alcove and north Ghost Dance Fault alcove construction Staff provided design input to support field changes related to the thermal test alcove construction. Staff developed weekly and monthly administrative management reports for testing activities and facilitated job package record development. Staff provided field test coordination and administrative support for ESF north ramp main drift and alcove activities.

WBS 1.2.6.1.2/3 Quality Assurance and Safety Analysis. Staff attended weekly design and construction meetings and routinely observed ESF field testing activities. Staff reviewed test planning records and test-related field change requests for compliance with QA and safety concerns. Staff developed and implemented a respirator program for scientific personnel working underground that meets Project requirements. Staff continued to coordinate all scientific tunnel access with the construction manager.

WBS 1.2.6.1.6 Exploratory Studies Facility (ESF) Test Management. Staff attended weekly design and construction meetings. Staff supported development of weekly and monthly administrative management reports for testing activities; staff facilitated job package record development. Staff provided field test coordination and administrative support for ESF north ramp, main drift, and alcove activities. Staff provided input for an M&O-initiated change in the WBS assignment for this effort from WBS 1.2.6.1 management category to WBS 1.2.6.14 performance category.

WBS 1.2.6.8.4 Integrated Data and Control System (IDCS). The design team was notified that the IDCS has been placed on indefinite hold because of budgetary constraints. The IDCS data acquisition equipment received in FY 1995 continued to be configured and deployed as temporary portable data acquisition stations. The ESF TCO completed the Draft Field Work Plan (FWP) document titled "ESF Data Collection Systems" to direct the QA configuration, deployment, calibration, and operation of the data acquisition systems in the ESF. This FWP will direct the data collection of the ESF testing organizations in FY 1996, 1997, and 1998.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. ***Program Development.*** Staff continued to place QPs, QP forms, and DPs on-line. They were also trying to identify the areas in which cuts can best be absorbed and functions still remain viable. Staff was also trying to determine areas in which to streamline processes without severely impacting technical areas. Staff was updating the RTN matrix and sent a prototype to the M&O. Paul Gillespie is heading this function. The matrix is now completely functional; it should be completely updated by 30 June.

Procedure Revisions. QPs-06.1, 06.2, 06.3, and 18.2 were placed on-line. QPs-02.5, 02.7, 02.11, 02.12, 02.15, 03.25, and 04.6 were approved; the next step will be to get these latest approved procedures to Document Control for distribution to file and WEB pages. The remaining QPs are in different stages of revision and review and are were being reviewed for process improvement and consolidation. P. Gillespie continued evaluation of QARD changes with respect to the RT matrix.

Travel. M. Clevenger and P. Gillespie attened QA managers meetings in Albuquerque on 22 and 23 May at which the Qualified Suppliers List Workshop was discussed.

M&TE. The Los Alamos standards and calibration group (ESH-9) is now conducting calibration activities for Los Alamos YMP researchers. QP-12.3, which describes control of M&TE, is presently being revised to eliminate the M&TE Coordinator activities.

Audits and Surveys. A performance-based audit of Post-closure Tectonics, which was scheduled for June 3, 1996, was canceled. It has been re-scheduled for the September 16, 1996. The compliance-based audit is still scheduled the last week of June and is currently focused on Cl-36 activities. RT Matrix and procedure revision activities were taking up local survey time.

Deficiencies. DR-YMQAD-95-D-015, which was issued by YMSCO and concerns one of our vendors (SIMCO), was still open. YMSCO is evaluating our revised resolution, and they will rule on closure by the end of May 1996.

Quality Engineering. B. Gundlach continued to work with investigators on FEHMN certification issues. He is also reengineered the draft home page on which we hope to make QA documents available on line.

(b) Deliverables Completed

Milestone T6545, "Users Manual for the FEHMN Application"

(c) Problem Areas

WBS 1.2.3.2.5 Volcanism. Digital terrain data for the Sleeping Butte center was previously archived with EG&G, which is no a longer participant in the YMP. The data cannot be retrieved with current volcanism resources. The revised Sleeping Butte geologic mapping is completed but cannot to transferred to a topographic base without access to the EG&G data.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. Budget reduction is causing surveillance personnel to work on things other than conducting surveys. Conversion of QPs from WordPerfect to Word is still having a major impact to the timeliness of procedure revision.

(2) Personnel Changes

NA

(3) Unusual Costs and Possible Financial Performance Problems

NA

WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways. The Peña Blanca study was approved on 3 April 1996. Because of problems at the TRW level, we have not been authorized to begin. According to the C/SCR, this work was supposed to have started on 1 March, and the draft report is due to TRW by 30 August. We have already lost several months, and further delays will jeopardize our ability to deliver the draft report by 30 August.

(4) Programmatic Issues that may Impact the Overall CRWMS M&O Effort

WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways. The possibly favorable impact of the occurrence of abundantly zeolitized rocks over 200 m above the water table in USW SD-7 is important. The occurrence of very thick UZ zeolitic sequences impinging on the southern end of the exploration block will have a significant impact on repository performance.

WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses. Staff now has thermodynamic models for the energetics of cation exchange in clinoptilolite. These models allow the several thermodynamic measurements of the Gibbs free energy of formation of clinoptilolite to be evaluated for consistency, showing that the calorimetric values are most reliable. The models also allow calculation of the Gibbs free energy of formation for any compositional end-member of clinoptilolite with an improved and more quantifiable accuracy, allowing more accurate thermodynamic models of mineral evolution under the thermal influence of a repository at Yucca Mountain.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. Communication between DOE and the M&O has been difficult. Staff has had to duplicate effort to satisfy both entities.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes. Staff was evaluating new fracture relative-permeability data made available by the USGS and using this data to help determine the applicability of dual-permeability models in a broad range of YMP applications.

(5) Worked Planned

WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways. Work planned for the coming months includes the following: (1) continue to provide input to mineralogic models for site transport evaluations and (2) support the project in preparation of synthesis and summary reports.

WBS 1.2.3.2.1.1.2 Alteration History. Staff will continue writing the Alteration History portion of the Mineralogy of Transport Pathways summary and synthesis report, in support of a site suitability analysis.

Sections on mineral dehydration and rehydration will be prepared for inclusion in the report. The work in support of the FY96 Thermal Loading Study Report will continue at a low level, mainly to provide guidance to the modelers, and will also be included in the Alteration History Summary and Synthesis report.

WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses. Summary and synthesis report writing will continue, and study plan comments will continue to be addressed. Several presentations related to kinetics and thermodynamics will be given at the annual meeting of the Clay Minerals Society.

WBS 1.2.3.2.5 Volcanism. Continue work described above.

WBS 1.2.3.3.1.2.2 Water Movement Test. Staff will process samples of surface calcite in order to evaluate this as an alternative source for the elevated ^{36}Cl levels seen in ESF samples. Staff will evaluate feasibility of alternative methods for corroborating the presence of bomb-pulse ^{36}Cl in subsurface samples. Staff will process critical ESF samples for ^{36}Cl. Staff will continue acquisition of halide data for bore holes to replace old data discarded as unreliable. Staff will continue acquisition of halide data for ^{36}Cl samples already submitted for isotope analysis. Staff will participate in activities for sample collection from ESF and bore holes. Staff will prepare for DOE audit scheduled for June 1996.

WBS 1.2.3.4.1.1 Groundwater Chemistry Model. Continue development of quantitative models for soil zone chemical processes. Continue to refine conceptual models for processes that could control groundwater chemistry at Yucca Mountain.

WBS 1.2.3.4.1.2.1 Batch Sorption Studies. Staff will complete section IV B of the sorption report.

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport. For the appendix section of the summary and synthesis report, staff will write a paper on bacterial growth on hematite and coordinate with Tom Kieft (NM Tech) and David White (U Tenn) for their contributions to the summary and synthesis report. Staff will also write the summary section of the report, which will discuss all of the information presented in the appendix.

WBS 1.2.3.4.1.3. Solubility/Speciation. Efforts in database collection and evaluation will continue.

WBS 1.2.3.4.1.4.1 Transport. Staff will complete Section III B of the transport report and section II C of the diffusion report.

WBS 1.2.3.4.1.5.1 Study: Retardation Sensitivity Analysis. Staff will continue code development on reduced-degree-of-freedom methods. Staff will continue drift-scale transport calculation study. Staff will complete a transient infiltration model study. Staff will continue grid development for UZ and SZ flow and transport calculations.

WBS 1.2.3.9.7 Special Studies: ESF Coordination. Staff will continue support of ESF test coordination site characterization activities in response to Project programmatic requirements.

WBS 1.2.5.3.5 Technical Database Input. Staff will continue to evaluate which technical data needs to be entered into the ATDT and/or the TDB (GENISES). Staff will continue to work the backlog of data submissions to the ATDT system.

WBS 1.2.6.1.1 ESF Management, Planning, and Technical Assessments. Staff will support finalizing of Title II Design Packages for the north portal surface facility and ESF excavations to meet the DOE's "temporary facility" guidance. Staff will continue field test coordination for construction monitoring, geologic mapping, consolidated sampling, perched water, radial boreholes, hydrologic properties of major faults, hydrochemistry, and thermal test facility activities being conducted in the north ramp, ESF main, and test alcoves.

WBS 1.2.6.1.6 ESF Test Management. Staff will continue management and implementation of test planning and field test activities.

WBS 1.2.6.8.4 Integrated Data and Control System. Staff will provide management for the Yucca Mountain Site Characterization Project Office to deploy ESF test data collection equipment to meet test requirements.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. Formal reports on surveys conducted in May will be issued at the end of June. Staff will continue placing Quality Administrative and Detailed Technical procedures on-line in an effort to address electronic document control. Staff will continue revising the remaining 18 QPs before working on the DPs. Staff will continue to provide the Los Alamos lab lead with monthly status of Software QA activities.