Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
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AUG 22 1997

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OVERNIGHT MAIL

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SUBMITTAL OF PARTICIPANTS' MONTHLY PROGRESS REPORT

As you have requested, the U.S. Nuclear Regulatory Commission is on distribution to receive a copy of the Yucca Mountain Site Characterization Project participants' monthly status report on a regular basis. Enclosed is the U.S. Geological Survey Progress Report for June 1997.

If you have any questions, please contact April V. Gil at (702) 794-5578.

Stephan J. Brocoum
Assistant Manager for Licensing

AML:AVG-1981

Enclosure:
Ltr, 07/14/97, Craig to Kozai, w/encl

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AUG 22 1997

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IN REPLY REFER TO:

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July 14, 1997

Wayne Kozai
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
P.O. Box 30307
Las Vegas, Nevada 89036-0307

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, June, 1997

Attached is the USGS progress report in the required format for the month of June, 1997.

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
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U. S. GEOLOGICAL SURVEY
EXECUTIVE SUMMARY
JUNE 1997

WBS 1.2.3.1 Coordination and Planning

U. S. Geological Survey - Yucca Mountain Project is currently processing 196 scientific papers prepared by USGS authors. Of these, 104 are related to geologic studies and 92 to hydro-geologic studies. In addition, 55 abstracts are being processed, as well as 17 reports by LBL personnel.

WBS 1.2.3.2 Geology

Geologic Framework

Verification and correlations based on core descriptions and photographs and on television camera observations continued. The process includes the geophysical identification of the 44 stratigraphic contacts that have currently been selected for incorporation in the future ISM3 geologic framework model. Present efforts are focusing on contacts in boreholes G-3/GU-3, G-1, G-4, A-1/B-1, and parts of the C-hole complex. Significant effort was also given to the testing of EXCEL-spreadsheet macros, which are designed to display segments of the suites of geophysical logs for purposes of documenting contact selection.

The Site Area Geologic Map (scale 1:24,000) has been prepared and submitted for review. Field reviews have been completed, and further technical reviews of both the map and accompanying text are currently underway. The bedrock geologic map of the Paintbrush Canyon area (scale 1:6,000) has also been completed and submitted for review.

A data package (Milestone SPG32M4) focusing on structural observations in the ESF in support of chlorine-36 (Cl-36) studies was submitted, including (1) maps depicting the location of Cl-36 sampling sites in relation to published surface and subsurface structural features; and (2) a tabulation of structural measurements taken at the sampling sites in the ESF, including orientation of structural features, joint origin (cooling vs. tectonic), and vertical and lateral connectivity with surrounding features. The data will be used in two summary reports (one by USGS and the other by LANL) scheduled for completion in August, 1997. Comparisons between surface geologic mapping, full-periphery mapping in the ESF, and detailed line survey data in the ESF are continuing for the purposes of obtaining additional information for evaluating structural controls on the distribution of Cl-36 and for integrating the model of spatially distributed infiltration.

Project personnel prepared four abstracts of papers to be given at the 1997 annual meeting of the Geological Society of America to be held in Salt Lake City. The general subject matter of the papers is the structural setting of Yucca Mountain, with individual topics covering: (1) geologic mapping and its role in site characterization; (2) the timing of crustal extension as recorded by deformation within the Rainier Mesa Tuff; (3) concepts of growth faulting in the Yucca Mountain area; and (4) controlling factors on the distribution of chlorine-36.

Geologic mapping in the ESF was accomplished as follows: (1) full-periphery geologic mapping, detailed line survey at the heading, and stereophotography were completed to station 78+76 (South Portal); (2) detailed line survey in Alcove #6 was completed to station 1+60; (3) full-periphery geologic mapping in Alcove #6 was completed to station 1+51; (4) detailed line survey in Alcove #7 was completed to station 1+33; and (5) full-periphery geologic mapping in Alcove #7 was completed to station 1+50.

Seismotectonic Studies

A Fault Displacement Workshop was held June 3 in Salt Lake City to review and discuss alternative methods for assessing fault displacements, discuss uncertainties in parameter values and models, and provide an opportunity for the expert teams to evaluate the pros and cons of alternative approaches, models, and submodels. Demonstration sites being used for analyzing fault displacement hazards include those with: (1) cumulative slips > 50m - Bow Ridge and Solitario Canyon faults; (2) cumulative slips 2 to 50 m - Ghost Dance and Sundance faults, Drill Hole Wash fault in the ESF, and an unnamed fault west of Dune Wash; and (3) fractures that show no measurable displacement in Quaternary alluvium - locality in Midway Valley east of the Bow Ridge fault. Personnel involved in probabilistic seismic hazard analysis continued to prepare reports that describe and document the formal elicitation process that was used to facilitate the development of seismic source and fault displacement interpretations and associated uncertainties, as well as the results of the several workshops that have been held.

WBS 1.2.3.3 HYDROLOGY

Regional Hydrology

Collection of site stream-flow data continued during June. Runoff was observed at several locations south and west of Yucca Mountain, but no runoff was observed or reported during the period for the three recording streamflow gages along Fortymile Wash. Streamflow and precipitation data collected through May have been compiled and stored in project files. Discharge and precipitation records for the streamgage sites on Fortymile Wash were submitted to the Nevada District Data Section for final tabulation and publication in the annual data report. Routine maintenance was performed on the gages along Fortymile Wash during the month.

Work continued on the regional saturated-zone synthesis report, with the authors responding to review comments and revising the report. A complete draft was prepared and submitted for editorial review.

In unscheduled work, staff attended a training class on use of borehole geophysics in hydrologic investigations. Software QA for Zonebudget, a post-processor module for MODFLOW and MODFLOWP, was completed and submitted to the USGS QA office. Staff also prepared a paper, based on one presented at the MODELCARE 96 symposium, which summarizes results of regional modeling. The paper was submitted for colleague review.

Unsaturated-Zone Hydrology

Hydrologic investigations of the UZ continued during June with monitoring of borehole instrumentation networks. Borehole data from NRG-7a, UZ#4, UZ#5, UZ-7a, and SD-12 were transferred to Denver, converted to engineering units, and archived to optical disk on a routine basis throughout the month. Daily EKES files were checked for any shelter activity. Sensor readings were checked daily as well for unusual occurrences. Several pieces of equipment were sent out for routine recalibration. Twenty trips were made to field sites for correcting generator, UPS, and chiller problems, including 14 visits for routine generator maintenance, four visits to correct instrument or power problems, and two visits to correct pump problems. Eight visits addressed data-acquisition problems, including data collection at UZ#4 and #5 and UZ-7a, and communications gear at SD-12. The two new generators for sites UZ-7a and SD-12 have been on site since April 1, although they still do not have instrument-grade governors.

Investigations of matrix properties continued during June with routine analysis of samples from the main drift on the high-pressure permeameter. Samples are being run in the centrifuge to collect moisture-retention data. The new rotating seal in the centrifuge is functioning well at both high and low flow rates. Samples are being run in the conductivity centrifuge using the new rotating seal. Data package preparation has begun. The filter-paper water-potential measurement technique is still being evaluated for measurement of properties of core samples from ESF alcoves, as problems were encountered with the technique. Samples from the two main drift niches, Alcove 6 and Alcove 7, have been received.

Studies of percolation flux across the repository horizon also continued, with focus on *in situ* field estimation of percolation flux rate. Data collection and analysis continued on the time-domain reflectometry (TDR) systems and heat-dissipation probes (HDP) installed in the ESF. The TDR and HDP instruments in the South Ramp were covered with plastic in an attempt to rewet the rock and calculate a sorption water-retention curve and to determine

current field water potential and water content. Plans were further developed for implementing an instrumentation scheme for the East-West drift to estimate the spatial variability of percolation flux. Rock samples, collected from the main drift at 20-m spacings, are still being analyzed in the laboratory to determine bulk properties and hydraulic conductivity.

Air-permeability and hydrochemical testing in the ESF continued with testing in Ghost Dance fault (GDF) alcoves. Air-injection testing was initiated in Northern Ghost Dance Fault Alcove borehole MF#1. Initial results indicate that the Topopah Spring middle nonlithophysal unit adjacent to the fault had permeability values of 4 darcies. This value is an order of magnitude larger than expected. Gas sampling and pneumatic monitoring also was conducted in the Southern Ghost Dance Access Drift borehole GTB#1. At this time no results are available.

Moisture monitoring in the ESF continued with collection of temperature and relative humidity data at six sites. Wind-speed data currently are being collected at five sites. Installation of four additional wind-speed monitors (plus relative humidity and temperature) has been completed. Barometric pressure, temperature, and relative humidity are being collected at one location. Data collection from heat-dissipation probes and TDR probes in Alcove 3 continued. Data collected between February 1, 1997, and July 1997 are being assembled for a data package. Possible locations for additional instrument stations are being investigated. Data from an evaporation pan located outside of Alcove 3 are being collected and assembled for a data package.

Investigation of South Ramp ESF hydrology continued with collection and processing of data from sets of tensiometers and heat-dissipation probes installed at ESF Stations 66+99 and 67+33. Water-content data were collected from the TDR instrumentation installed at Station 66+99. Areas around these instruments remain covered with plastic to monitor the recovery of the rocks from the drying effects due to tunnel ventilation and to interpret anomalies in the collected data. Data collection problems have been resolved, and no data were lost during June.

The locations of forty 2-m-deep boreholes were selected for study of South Ramp hydrology. These boreholes are located in and adjacent to faults in the South Ramp of the ESF, and sampled hydrogeologic layers include the welded Tiva Canyon Tuff, the nonwelded Paintbrush Tuff, and welded Topopah Spring Tuff exposed in the South Ramp. Hydrologic measurements for the rock core will include bulk properties, saturation and water potential. Chemical analysis will include tritium, stable isotopes (hydrogen, oxygen, carbon), cation/anion concentrations, ^{14}C, strontium isotopes, chloride (pore water), and ^{36}Cl. Field instrumentation will be used to monitor water potential and water content in and around several boreholes to determine existing hydrologic conditions. The 40 boreholes are located between ESF Stations 59+65 and 75+40. Thirty-five potential locations for instrumentation stations were selected to monitor the hydrologic conditions of the South Ramp and the role of faults in controlling those conditions, particularly in the nonwelded Paintbrush Tuff hydrogeologic unit. These stations will use heat-dissipation probes and/or tensiometers to monitor water potentials and in some locations will use TDR to monitor water content. These data will provide information on (1) hydrologic conditions due to the offset at faults and the resulting contrast in properties from dissimilar rock units, (2) whether there is field evidence indicating lateral diversion, and (3) potential pathways for water either to bypass or accumulate within particular rock units. The 35 potential instrumentation stations lie between ESF stations 66+41 and 75+40 and typically duplicate the locations of the 40 boreholes noted above.

Evaluation of data-collection methods continued. Evaluation of the filter-paper technique to determine the *in situ* water potential of cores was continued, but problems remain. Water-retention curves for the filter paper were measured in the laboratory, but the data indicate that this technique may be problematic. This technique seems very sensitive to small amounts of evaporation or condensation. The practicality of using heat-dissipation probes and/or tensiometers to measure *in situ* water potentials of collected cores is being investigated. The prototype packer installed in ESF-SR-MOISTSTD#1 collected data during June. Differences between the water potential measured with the tensiometer and the water potential measured with the heat-dissipation probe continue to be evaluated. A packer with a heat-dissipation probe, a tensiometer, and a psychrometer was built but has not yet been installed in the ESF.

Data collected from the heat-dissipation probes and tensiometers at stations 66+99 and 67+33 have been graphed, anomalies in the data have been identified, and technical problems with data collection are being resolved. Data

collected from the packer in borehole ESF-SR-MOISTSTD#1 have been graphed for analysis.

Investigation of lateral diversion in the Paintbrush nonwelded hydrogeologic unit (PTn) continued with laboratory experiments to evaluate methodology to measure water potential of core samples that will be collected from North Ramp boreholes. It is crucial that water-potential measurements be of high resolution, especially in the relatively high-potential rocks, as relative differences need to be discerned in order to calculate flux estimates through the various rock layers. Currently a filter-paper method is being evaluated along with rock-touch tensiometers and heat-dissipation probes used in the lab to measure the water potential of preserved rock samples. These measurements will be compared with data collected from *in situ* measurements using heat- dissipation probes and tensiometers with packer strings. The 21 planned North Ramp boreholes are being drilled. Molds and spacers were made to allow for centrifuge measurements of unsaturated hydraulic conductivity and water-retention data on the cores collected from the North Ramp boreholes. Preliminary measurements of water retention and hydraulic conductivity on samples collected from the North Ramp were made to test the centrifuge, and it appears that the centrifuge will work well. No data have been collected.

In the drift-scale flux and niche study, drilling of the seven boreholes at Niche #2 was completed. Moisture-content profiles from six of the seven boreholes were measured by neutron logging. Pneumatic testing of these Niche #2 boreholes is being conducted. Pneumatic testing of the three boreholes in Niche #1 was completed, and neutron logs of the boreholes were run prior to excavation of Niche #1. Excavation of Niche #1 was completed. The walls of the excavated niche were noticeably wet although some drying had occurred on most surfaces. The walls were mostly broken-up rock with two rubble zones and a reactivated cooling joint. The rubble zones and the reactivated cooling joint were obviously wet. Heat-dissipation probes and tensiometers were installed in the niche walls to monitor water potential in the competent rock as well as in the fractured areas. A relative-humidity/temperature sensor was installed in the niche. Analysis of the neutron logs has been initiated and will be compared to the core analysis to develop a neutron-probe calibration equation. Water-potential, relative humidity, and temperature data from the instruments installed in Niche #1 were collected and analyzed. Plans for additional instrumentation and boreholes in Niche #1 were completed.

Unsaturated-zone hydrochemical studies again continued through the period with multiple active efforts. Eighteen pore-water samples from ESF alcoves were prepared for tritium analysis and counted for tritium concentration, and the data were reduced. Water was distilled from two ESF core samples, and Arvada (Colorado) well water also was distilled. The extracted pore water will be analyzed for tritium, and the distilled Arvada well water will be used as background samples for tritium counting. Samples from the drift-scale test area were collected and analyzed; the task was completed on June 5. Water collection by compression and distillation methods during June was recorded in the water-collection database, and tritium concentrations measured in June were entered into the tritium database.

Pore water from four SD-12 core samples (three from the Calico Hills unit and one from the Pah Canyon Tuff) was collected using one-dimensional compression methods. Pore water was delivered to Huffman Laboratories for analysis of anions and cations and to Beta Analytic for carbon isotope analysis. Three SD-7 and three SD-9 pore-water samples were prepared for tritium analysis and counted for tritium concentration, and the data were reduced.

Dissolved CO_2 was collected from two SD-12 and two SD-7 core samples using CO_2 distillation and acidification-distillation collection methods. The extracted CO_2 was shipped to Beta Analytic for carbon isotope analysis. The extracted water will be analyzed for tritium and stable isotopes of oxygen and hydrogen. A digital vacuum gauge is being added to the dissolved-CO_2 distillation system to check for leakage and to measure sample volumes. The vacuum gauge was calibrated against a mercury manometer. Preparation of a technical procedure for extraction of dissolved CO_2 and water from tuffaceous samples by vacuum distillation was initiated.

Preparations for running the Dionex DX-100 ion chromatograph (IC) were begun, including a visit to the USGS National Water Quality Laboratory to observe analysis of anions with an ion chromatograph. Attempts to start up the USGS IC were unsuccessful due to air bubbles in the suppressor lines. Suppressors may be dried out and may require replacement.

Five data packages in support of the baseline hydrochemical measurements of the drift-scale test (Level 4 milestone **SPH37DM4 [Memo to TPO: Baseline Hydrochemical Measurements, Drift-Scale Test]**) were prepared and received technical, data-management, and quality-assurance reviews. These packages included (1) cation concentrations, (2) strontium isotopic composition, (3) uranium isotopic compositions, (4) stable isotopic compositions of deuterium and oxygen, and (5) tritium concentration. The first three determinations were conducted on the pore-water salts in core from the Thermal Alcove #5, and the last two determinations were made on distilled pore water in core from the Thermal Alcove #5. These data packages were accompanied by a memorandum on interpretations of the data dated June 10, 1997, to the USGS TPO, with a copy to the M&O/SPO Technical Lead for ESF Thermal Testing,. This constituted the completion of the Level 4 Milestone SPH37DM4, due June 13.

In unscheduled work, staff participated in radioactivity-safety audits required as part of the Radioactive Materials License for Central Region USGS Laboratories. Responses were prepared to a list of questions submitted by the State of Colorado regarding audit of Central Region WRD radioisotope laboratories and materials. Staff attended a meeting with State representatives and escorted meeting members through a pre-audit inspection of YMPB laboratories. In addition, staff worked on the geochemistry and isotope section of the PISA report. Efforts included consolidation of some of the figures and tables.

A second group of core samples was shipped to Dr. Gregg Davidson at the University of Arizona for vacuum extraction of dissolved carbon for ^{14}C activity and $^{13}C/^{12}C$ ratio measurements by Tandem Accelerator mass spectrometer. Those are all HQ-size cores from the ESF South Ramp. Dr. Davidson has finished most of the CO_2 extraction work but has not collected the CO_2 from acidification of the precipitated calcite in the vacuum-extracted cores. USGS staff has requested Dr. Davidson repack these cores in Protecore wrap so the UZ hydrochemistry lab can carry out remaining work in the future.

Staff presented a talk entitled "Conceptual water flux in the Topopah Spring Tuff and ^{14}C residence times of pore water" at the Yucca Mountain monthly meeting on June 3.

Saturated-Zone Hydrology

Convergent tracer testing in the Bullfrog aquifer continued during June with on-going pumping in the multiple-well Pyridone and 2,6 difluorobenzoic acid tracer test at the C-hole complex. The Pyridone breakthrough curve has shown a steady rise in concentration and appears to be reaching a broad peak of approximately 200 parts per trillion. Work continued on a letter report presenting the results from all hydraulic and tracer tests conducted at the C-hole complex, starting in May 1995, in the Bullfrog and Tram intervals. The draft is expected to be submitted to technical review in early July. The 1.66-inch tracer injection pipes were removed from boreholes UE-25 c#2 and UE-25 c#1 in preparation for the Prow Pass testing. Water samples were taken from the UE-25 c#1 pipe.

Preparation of the data packages containing information from the C-hole hydraulic tracer tests initiated in January 1997 was completed during June. The data packages cover concentrations of Pyridone and 2,6 difluorobenzoic acid as a function of time, and pressure and water-level data collected at the C-holes and nearby boreholes UE-25 ONC-1, USW H-4, UE-25 WT#14, UE-25 WT#3, and UE-25 p#1, respectively. Both packages have been submitted for review.

Monitoring of site potentiometric levels continued during June. Four zones in four boreholes (UE-25 WT#3, UE-25 WT#14, UE-25 p#1 and USW H-4, upper interval) were monitored hourly with transducer measurements. Data were downloaded from 21-X recorders at those holes.

Calibration of the SZ site flow model continued until June 6. Residuals were minimized through parameter-estimation procedures. Comparison of simulated boundary fluxes to those provided by the regional model was not completed due to problems in obtaining the information from FEHMN. Staff discussed calibration procedures and interpretation of output from PEST with Mary Hill, research hydrologist with USGS. The site flow model was submitted for technical review. Reviews were completed, and the model, including input/output files, was submitted to DOE on June 13, completing this activity and completing Level 3 milestone **SP24CBM3 [Site Saturated-Zone Flow Model]**. Comments concerning proper incorporation of the hydrogeologic framework model into the flow model will require some modifications to the present model mesh to insure that the framework

and flow models are consistent.

Work continued on preparation of the review draft of the site SZ synthesis report. A complete draft of the report was prepared and submitted to the SZ Modeling Unit Chief for supervisory review on June 27. A table of hydraulic characteristics for the rock units included in the flow model was reviewed, and staff revised the table in response to review comments.

Evaluation of sensitivity and uncertainty in the VA SZ flow model continued with a variety of efforts. Work continued on calculation of particle flow paths and fluxes for present, past, and future climatic conditions, based on regional flow-model output. Work also continued to incorporate data recently obtained by the USGS Nevada District concerning evapotranspiration from Ash Meadows into the regional flow model. This information will be used as part of the sensitivity analyses for TSPA-VA. An updated version of the site SZ flow model was delivered to DOE on June 16, and that version will be transferred to PA for their use.

Staff participated in the SZ flow-model expert elicitation. USGS climate and SZ staff participated in the first workshop for the Expert Elicitation Panel, June 4 to 6. Information documenting the types of data and known uncertainties in the data on which the flow and transport models are based was presented to the panel. The SZ Modeling Unit assembled and prepared documents for the panel to assist them in their evaluation of model uncertainty. Plans were initiated for the second flow-model workshop, which will be held in Las Vegas, July 20 and 21.

In unscheduled work, additional staff contributed to chapter 3.5 (Hydrologic Systems) of the PISA report and participated in the SZ expert elicitation workshop. Staff of the SZ modeling group continued work on analysis of frequency response of water levels at Yucca Mountain in order to estimate hydraulic characteristics of the aquifer.

WBS 1.2.3.6 CLIMATOLOGY and PALEOHYDROLOGY

Investigations of lakes and playas for details of climatic history continued during June. Staff assembled hydrologic and climatic data for the Owens Lake region to develop analog models for determining precipitation and temperature changes for the past 400 ky. The modern data sets are discussed in a manuscript detailing the relationship between modern climatology, hydrology and limnology of Owens Lake to serve as background for paleoclimatic studies. Staff prepared remaining samples from Owens Lake cores and from modern diatom analogs of hydroclimatic conditions in Owens Valley and other locations in the western United States. Work continued on evaluation of ostracode morphological change through long Quaternary lake records in order to document within-species range changes. Staff continued collection of ostracode data from the Las Vegas Valley and Indian Springs Valley deposits for stable isotope analysis and is working on a manuscript that discusses the climatic and hydrological states that existed in the Las Vegas and Indian Springs Valleys during the Pleistocene. Staff also participated in the SZ expert elicitation and presented an overview of the climate-program results.

Efforts to evaluate ground-water paleodischarge continued. Staff completed out-year planning for investigations of SZ response to past climatic change to construct a comprehensive model of past water-table elevation change and SZ flux down-gradient from the potential repository. Staff presented a summarization of paleohydrologic studies from past discharge sites that utilize isotopic data to document the response of SZ ground water to past climatic states; this presentation was made to the SZ expert elicitation.

Analytical efforts continued. A suite of subsamples from past discharge deposits at the state-line area in Amargosa Valley was prepared for U-series dating and Sr and U isotopic characterization. Samples were taken from two ~6-m sections that are believed to span the last two pluvial cycles. Strontium isotopes, in particular, should provide information on the relative importance of Fortymile Wash versus Amargosa Valley ground-water systems in supplying discharge at that site. The ^{13}C of sediment pore-gas carbon-dioxide samples collected from Jackass Flats was determined.

Studies of secondary mineral deposits and geochronology in the potential repository block continued. Out-year planning for investigations of subsurface secondary mineral records and their relation to UZ flux was completed,

with a goal of constructing a model of past flux on the basis of mineral records from the ESF, cross-drift and new boreholes, and ties to scenarios of past climatic change, hydrogeologic features, and hydrochemical evolution. A new shelf solution of mixed ^{238}U-^{235}U-^{232}Th isotopic tracers was prepared for use as a calibration standard for U-series mixed spike solutions. Use of the new mixed-isotope shelf solution will reduce uncertainties of future spike calibrations because separate weighing of U and Th shelf solutions is eliminated. Staff examined the petrography and paragenesis of secondary mineral occurrences from the ESF and sampled them for determination of ^{13}C and ^{18}O values of the calcite. Several samples from the ESF series were selected for determination of the U/Pb ages of contained opal. This technique provides age constraints for the older parts of the paragenetic sequence, and with coordinated sampling of the associated calcite for determination of ^{13}C values, offers an age-constrained record of past climate variability. Multiple splits of opal and calcite were prepared from a sample of the Tiva Canyon Tuff in efforts to provide a long and detailed climatic record.

Staff discovered spurious data from a calcite occurrence sampled from a depth of more than 700 m in borehole G-2. The occurrence was first analyzed in 1993, and the information survived data review to become part of the TDB. The data from this occurrence are within typical ranges but as the data set filled in with occurrences from other drill holes, the data became obvious as outliers. Resampling and analysis have verified that the submitted values are incorrect, and steps to remove the errant data from the TDB have been initiated.

Several papers described climatic studies. An extended abstract titled *Constraints on Quaternary unsaturated- and saturated-zone hydrology from geochronological and isotopic studies of calcite and silica, Yucca Mountain, Nevada, USA* (by J.B. Paces, Z.E. Peterman, L.A. Neymark, J.F. Whelan, and B.D. Marshall) was prepared in response to a request for participation in the OECD/NEA Coordinating Group on Site Evaluation and Design of Experiments Workshop on Use of Hydrogeochemical Information in Testing Groundwater Flow Models to be held in Borgholm, Sweden; September 1 to 3, 1997. The paper summarizes recent Yucca Mountain studies on U-Th, U-Pb, C, O, and Sr isotopic systems in subsurface minerals and past discharge deposits and their role in constraining paleohydrology. The paper has been submitted for final publications processing. A draft manuscript titled *Mixed $^{230}Th/U$ ages for subsurface opals due to slow rates of deposition, Yucca Mountain, Nevada, USA* (by L.A. Neymark and J.B. Paces) was completed for intended submission to the peer-reviewed journal *Earth and Planetary Science Letters*. The manuscript describes a subset of the opal U-Th isotope data from the ESF and from several boreholes and presents a conceptual and mathematical model of slow, continuous deposition that accounts for many of the observed trends.

Modifications were completed to *Applications of isotope geochemistry to the reconstruction of Yucca Mountain paleohydrology* (by J.F. Whelan, R. Moscati, S. Allerton, and B.D. Marshall) and *Origins and paleoclimatic implications of secondary calcite within the tuffs of Yucca Mountain, Nye County, Nevada* (by J.F. Whelan and R. Moscati) for release as USGS open-file reports.

Staff presented a paper entitled *Strontium isotopes in pore water from the unsaturated zone at Yucca Mountain, Nevada* (by B.D. Marshall, K. Futa, and Z.E. Peterman) on June 6 at the 7th Annual V.M. Goldschmidt Conference in Tucson. The abstract is available at <http://cass.jsc.nasa.gov/meetings/gold/pdf/2366.pdf>.

WBS 1.2.3.9 SPECIAL STUDIES

Work continued during the period on PISA synthesis reports. The USGS PI for chapter 2.3 (Geological Systems) met with M&O and DOE personnel in Las Vegas to discuss finalizing the draft sections of the Geology Chapter. A complete edit was performed on the Surficial Geology section, and the PI and others from the USGS provided comments on several other sections. Responses were also provided to questions raised on sections written by USGS authors. Staff continued to provide support for the Web-based effort for section 1 of the geology chapter. Drafts of the PISA climatic/meteorologic site description subchapters (PISA chapter 2.4) have been revised, and an annotated outline is nearly complete. In unscheduled work, three of the PISA Hydrology authors made presentations and participated in discussions with the SZ expert elicitation panel on June 5 and 6.

All figures originally planned for PISA section 3.5.3.3.1, Properties of Hydrogeologic Units, Unsaturated Zone

(Site), have been completed, and the accompanying discussion has been outlined. A decision was made to include the results of geostatistical studies of the spatial distribution of hydrologic properties, to be summarized from a recent Sandia National Laboratory milestone report authored by C.A. Rautman and others. Review of the fracture data included in the draft Geology chapter resulted in the decision not to repeat the data presentation in section 3.5.3.3.1, but discussion will be included with appropriate references to the earlier chapter.

Core data for specified hydraulic and physical properties for PISA section 3.5.3.3.2, Properties of Hydrogeologic Units, Saturated Zone (Site), have been compiled, and statistical analysis of the data sets is nearly complete. Structural features of the SZ units and borehole-geophysical data pertaining to hydraulic and physical rock properties have also been compiled and are being analyzed. Text and draft illustrations and tables presenting the results of hydraulic testing in individual boreholes have been completed, and definition of the spatial distribution of bulk hydraulic parameters is proceeding.

Coordination with M&O authors of PISA Section 3.4.1, Present Climate and Meteorology, was expanded to identify specific text and figures needed to support section 3.5.3.4.1, Site Infiltration, in the Hydrology chapter. General agreement on the content has been reached, and current efforts are directed at finalizing critical figures, tables, and text and at updating selected data sets. Sections concerning infiltration-studies core retrieval and processing as well as field instrumentation and measurements have been aggregated for inclusion in an earlier section on testing and baseline monitoring. Preparation of the section on infiltration modeling continued with modification of figures, tables, and text from existing milestone reports. Work also continued on further processing for publication of milestone reports that are extensively referenced in the Site Infiltration section.

The LBNL staff initiated preparation of the section on the UZ 3-D flow model and anticipates completing the draft section on schedule. The USGS staff recently met to assign technical responsibilities and to discuss how best to update the February version of the annotated outline to reflect the latest results reported in the recent UZ Model milestone report.

The USGS technical lead for the Site Characterization Progress Report discovered that several comments on the UZ site-scale flow model (section 3.1.13, activity 8.3.1.2.2.9.3) had not been properly addressed during the M&O/USGS interactive review. The comments were intended to ensure that more quantitative information on the calibration of the model would be added to the progress narrative, including infiltration rates applied to the model, calculated percolation flux at the repository horizon, and the quantification of any lateral flow calculated by the model in either the Paintbrush (PTn) or the Calico Hills (CHn) hydrogeologic units. The technical lead worked with M&O and LBNL staff to obtain the needed information and to insert it in the narrative. The technical lead also performed an informal "verification review" of the DOE Interactive Review Draft dated 5/23/97 and found six non-trivial errors affecting USGS activities, four in Chapter 3 and two in Appendix A. The technical lead also assisted the author of the Executive Summary with further revisions to the Unsaturated Zone section and participated in the DOE Interactive Review teleconferences on June 16 and 17.

About 12 significant technical comments were fielded by the technical lead as a result of the DOE Interactive Review. Eight of the comments addressed site investigations described in Chapter 3 and included comments on matrix hydrologic properties, UZ borehole monitoring, ESF dry-out and estimated flux rates, the UZ conceptual model, and the C-hole reactive-tracer tests. Three of the comments addressed Appendix A and involved canceled artificial infiltration tests, the UZ site-scale flow model, and site ambient thermal conditions. One question was received regarding references for USBR mapping of the ESF.

WBS 1.2.8.4.7 WATER RESOURCES MONITORING

Ground-water monitoring continued during June. Ground-water levels were measured at 28 sites, and ground-water discharge was measured at one flowing well. Data collected during May were checked and filed. Field measurements made during May sample collection were entered into the NWIS database. Review of preliminary analytical data received from the USGS National Water-Quality Laboratory continued during the period.

Staff completed and checked corrections to the NWIS database for sites included in the monitoring network (following merge of the USGS-NV District and USGS-ESIP databases). A project proposal for refining estimates of water use in the Amargosa Desert was prepared and discussed with National Park Service personnel. Staff discussed FY1998 plans for water-quality sample collection (in support of the M&O's Radiological/Environmental Field Programs) and environmental impact statement (EIS) support with M&O, USGS-YMPB, USGS-ESIP, and USGS-Nevada District managers.

Preparation of the data package for calendar year 1996 was completed and submitted to colleague review. Responses to those comments were prepared, and the data-records package was submitted to USGS-ESIP for further processing. Daily mean water levels at site JF-2a were obtained from USGS-ESIP personnel.

USGS Level 3 Milestone Report

October 1, 1996 - July 31, 1997

Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
LETTER REPORT **Milestone Number:** SSH13BM3	11/1/96	10/30/96	10/30/96	
LETTER REPORT **Milestone Number:** SSH13CM3	1/31/97	1/30/97	1/30/97	
Ltr Rpt: Geo S.R. Sta 55+00 to STA 63+47 **Milestone Number:** SPG42BM3	2/28/97	2/27/97	2/27/97	
Rpt Geo North/South Main Drft Sta 28+00 to55+00 **Milestone Number:** SPG42AM3	2/28/97	2/28/97	2/28/97	
Main Drift Hydrogeology Report **Milestone Number:** SPH223M3	3/14/97	3/14/97	3/14/97	
Initiate Soutn GDF Testing Geothermal Borehole **Milestone Number:** SP3505M3	4/18/97	4/10/97	4/10/97	
Complete Fracture Evaluation Report **Milestone Number:** SPG32M3	4/30/97	4/29/97	4/29/97	
LETTER REPORT **Milestone Number:** SSH13DM3	5/1/97	4/29/97	4/29/97	
Initiate North Gdf Alcove Testing **Milestone Number:** SP3500M3	5/16/97	5/15/97	5/15/97	

Deliverable	Due Date	Expected Date	Completed Date	Comments
Site Saturated-Zone Flow Model **Milestone Number:** SP24CBM3	6/16/97	6/16/97	6/16/97	

USGS Level 4 Milestone Report

October 1, 1996 - July 31, 1997

Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: SS Hazards Methodologies Wrkshop **Milestone Number:** SPG28FM4	10/25/96	10/24/96	10/24/96	
Memo to TPO: Jan-Jun96 Perio Wtr Lvl Data to RPC **Milestone Number:** SPH21CM4	10/31/96	10/30/96	10/30/96	
Memo to TPO: SS Hazards Method. Wrkshop Summary **Milestone Number:** SPG28GM4	11/15/96	11/14/96	11/14/96	
Memo toTPO: Seis. Src. Mdls & Proponents Wrkshop **Milestone Number:** SPG28HM4	11/27/96	11/26/96	11/26/96	
Memo to TPO: Comp Frac Data Coll:Cal. Hills,Prow **Milestone Number:** SPG34M4	11/27/96	11/27/96	11/27/96	
Memo to TPO: Comp Re-Eval Priority Strat Contact **Milestone Number:** SPG21M4	12/13/96	12/13/96	12/13/96	
Memo to TPO: Detailed Content Outline **Milestone Number:** SPH391M4	12/13/96	12/13/96	12/13/96	
Memo to TPO: SS Modls & Propnents Wrkshop Summry **Milestone Number:** SPG28IM4	12/19/96	12/19/96	12/19/96	
Report: Mod Flow In UZ Frac Ntwk TS W-U in ESF **Milestone Number:** SPH21AM4	12/31/96	12/19/96	12/19/96	
Memo to TPO: Monitoring Data Apr-Sep 1996 to RPC **Milestone Number:** SPH22GM4	12/31/96	12/23/96	12/23/96	
Memo to TPO: GM Models and Interpret. Workshop **Milestone Number:** SPG28AM4	1/17/97	1/13/97	1/13/97	
Memo to TPO: Seismic Source Interp. Wrkshop **Milestone Number:** SPG28JM4	1/17/97	1/13/97	1/13/97	

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: Clim Scenarios Recvd & Sim Started **Milestone Number:** SPH23AM4	1/30/97	1/13/97	1/13/97	
Memo to TPO: SS Interpretations Wrkshop Summary **Milestone Number:** SPG28KM4	2/4/97	2/3/97	2/3/97	
Memo to TPO: GM Modls & Interpret Wrkshp Summry **Milestone Number:** SPG28BM4	2/6/97	2/5/97	2/5/97	
Memo to TPO: Sub Bh Video Frac Db to GENISES **Milestone Number:** SPG211M4	2/28/97	2/27/97	2/27/97	
Memo to TPO: Jul-Dec96 Perio Wtr Lvl Data to RPC **Milestone Number:** SPH21BM4	2/28/97	2/7/97	2/7/97	
Memo to TPO: Annotated Outline Site SZ Synth Rpt **Milestone Number:** SPH23VM4	2/28/97	2/11/97	2/11/97	
Memo to TPO: Summary of Meetings with PA Mdlrs **Milestone Number:** SPH25CM4	2/28/97	2/13/97	2/13/97	
Memo to TPO: Rslts New Age & Iso Determinations **Milestone Number:** SPC23FM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: 1995 Water-Level Data **Milestone Number:** SPH21FM4	3/14/97	2/13/97	2/13/97	
Memo to TPO: Meteorlogical Data FY96 to RPC/TDB **Milestone Number:** SPH21IM4	3/14/97	3/14/97	3/14/97	
Publish Sel Streamflow & Precip Data for FY96 **Milestone Number:** SPH22CM4	3/14/97	7/31/97		
Memo to TPO: Subm FY96 Data to RPC/TDB **Milestone Number:** SPH22DM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Trans Funct Precip/Infil of Num Mdl **Milestone Number:** SPH22FM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Synth UZ Mont Data fm MD of ESF **Milestone Number:** SPH22IM4	3/14/97	3/14/97	3/14/97	

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: Reslt of Matrix-Hydro-Prop Determin **Milestone Number:** SPH22KM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Matrix-Hydro-Prop Compl Pkg to RPC **Milestone Number:** SPH22LM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Monitoring Data Thru Jan 97 to RPC **Milestone Number:** SPH22NM4	3/14/97	3/7/97	3/7/97	
Memo to TPO: Rslts Analyses/Interpret thru Jan97 **Milestone Number:** SPH22QM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Data Collected thru Jan 97 to RPC **Milestone Number:** SPH22RM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Rslts Chem Analysis Thru Jan 1997 **Milestone Number:** SPH22WM4	3/14/97	3/10/97	3/10/97	
Memo to TPO: Pkg of Chem Anal thru Jan 97 to RPC **Milestone Number:** SPH22XM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Final Hydrogeo Framewrk Data to RPC **Milestone Number:** SPH23DM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Test Data for July-Dec 1996 to RPC **Milestone Number:** SPH23MM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Results of Tests Comp Jul-Dec 96 **Milestone Number:** SPH23NM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Tech Anal/Interp Air-Perm & Hydroch **Milestone Number:** SPH35EM4	3/14/97	3/13/97	3/13/97	
Memo to TPO: Subm Air-Perm/Hydrochem Tstg to RPC **Milestone Number:** SPH35FM4	3/14/97	3/14/97	3/14/97	
Memo to TPO:Elicit of Experts Interpret Complete **Milestone Number:** SPG28LM4	3/20/97	3/20/97	3/20/97	
Memo to TPO: Comp QA Eval pre-1992 Bh Geo Logs **Milestone Number:** SPG212M4	3/28/97	3/26/97	3/26/97	

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: Draft Site Area Geol. Map to PISA **Milestone Number:** SPG222M4	4/18/97	4/17/97	4/17/97	
Memo to TPO: Ground Motion Feedback Workshop **Milestone Number:** SPG28CM4	4/21/97	4/21/97	4/21/97	
Memo to TPO: Seismic Source Feedback Workshop **Milestone Number:** SPG28MM4	4/25/97	4/21/97	4/21/97	
Memo to TPO: Updated Geohydro Frmwrk Sub for Rev **Milestone Number:** SPH24FM4	4/30/97	4/29/97	4/29/97	
Memo to TPO: Rev Dft Reg SZ Synth Rpt Clim Chng **Milestone Number:** SPH23BM4	5/1/97	5/1/97	5/1/97	
Memo to TPO: GM Feedback Workshop Summary **Milestone Number:** SPG28DM4	5/13/97	5/13/97	5/13/97	
Memo to TPO: SS Feedback Workshop Summary **Milestone Number:** SPG28NM4	5/19/97	5/19/97	5/19/97	
Memo to TPO: Regional Seismology **Milestone Number:** SPG39AM4	5/29/97	5/29/97	5/29/97	
Memo to TPO: Regional Struct Geology & Tectonics **Milestone Number:** SPG39BM4	5/29/97	5/29/97	5/29/97	
memo to TPO: Site Stratigraphy **Milestone Number:** SPG39CM4	5/29/97	5/29/97	5/29/97	
Memo to TPO: Regional Stratigraphy **Milestone Number:** SPG39DM4	5/29/97	5/29/97	5/29/97	
Memo to TPO: Site Seismology **Milestone Number:** SPG39EM4	5/29/97	5/29/97	5/29/97	
Memo to TPO: Site Struct Geology and Tectonics **Milestone Number:** SPG39FM4	5/29/97	5/29/97	5/29/97	
Memo to TPO: Rev Draft Site SZ Synthesis Report **Milestone Number:** SPH23WM4	5/30/97	7/7/97		

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: Reviewed Data Package to TDB **Milestone Number:** SPG32M4	6/10/97	6/9/97	6/9/97	
Memo to TPO:Baseline Hydchem Meas Drft Scale Tst **Milestone Number:** SPH37DM4	6/13/97	6/10/97	6/10/97	
Memo to TPO: GM Characterization Input to PSHA **Milestone Number:** SPG28EM4	6/30/97	7/15/97		
Memo to TPO: SS Characterization Input to PSHA **Milestone Number:** SPG28OM4	6/30/97	7/15/97		
Memo to TPO: Comp Geo Mapping of Thermal Tst Are **Milestone Number:** SPG42FM4	6/30/97	6/27/97	6/27/97	
Memo to TPO: Rev Drft Rslts Hydra&Tracer Tsts C- **Milestone Number:** SPH23SM4	6/30/97	7/7/97		

Participant USGS | Yucca Mtn. Site Char. Project-Planning & Control System | 01-Jun-97 to 30-Jun-97
Prepared - 07/08/97:16:11:44 | PACS Participant Work Station (PPWS) | Page - 1
WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

WBS No. - 1.2

WBS Title - Yucca Mountain Project

Parent WBS No. - 1.0

Parent WBS Title - Mined Geologic Disposal System

Element ID - 12

Statement of Work:

See the current WBS Dictionary

Cost/Schedule Performance

		Current Period					FY1997 Cumulative to Date					FY1997 at Completion		
Id	Description	BCWS	BCWP	ACWP	SV	CV	BCWS	BCWP	ACWP	SV	CV	BAC	EAC	VAC
1.2.3	Site Investigations	1109	1477	1059	368	418	9158	9441	8707	283	734	12283	12493	-210
1.2.5	Regulatory	44	44	32	0	12	362	362	304	0	58	504	474	30
1.2.8	Environment, Safety, and H	54	54	51	0	3	460	460	440	0	20	612	701	-89
1.2.9	Project Management	63	63	45	0	18	482	482	427	0	55	664	610	54
1.2.12	Information Management	8	8	5	0	3	60	60	38	0	22	80	70	10
1.2.15	Support Services	142	142	138	0	4	1290	1290	1224	0	66	1722	1720	2
Total		1420	1788	1330	368	458	11812	12095	11140	283	955	15865	16068	-203

Resource Distributions by Element of Cost

Fiscal Year 1997
Budgeted Cost of Work Scheduled

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	19540	19599	16166	20824	21557	21010	23147	23329	24443	24080	23010	21798	258503
LABOR	885	899	632	866	886	935	948	959	1009	996	950	918	10883
SUBS	139	143	87	148	145	145	225	150	159	163	161	143	1808
TRAVEL	25	43	34	45	43	53	43	43	50	50	53	47	529
PM&E	7	6	7	5	9	6	7	6	9	7	5	4	78
OTHER	197	201	179	206	293	241	248	253	193	185	187	184	2567
Total BCWS	1253	1292	939	1270	1376	1380	1471	1411	1420	1401	1356	1296	15865

Actual Cost of Work Performed

LBRHRS	19283	18578	18523	18723	17133	18725	19233	19288	17397	0	0	0	166883
LABOR	771	712	732	829	727	782	788	826	757	0	0	0	6924
SUBS	127	139	117	185	134	179	226	134	236	0	0	0	1477
TRAVEL	11	24	61	53	42	46	44	57	48	0	0	0	386
PM&E	43	16	88	85	89	110	60	192	95	0	0	0	778
OTHER	119	129	145	158	252	239	174	165	194	0	0	0	1575
Total ACWP	1071	1020	1143	1310	1244	1356	1292	1374	1330	0	0	0	11140

Inc. Dollars in Thousands

WBS No. - 1.2 -Yucca Mountain Project

Resource Distributions by Element of Cost

Fiscal Year 1997
Estimate to Complete

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	0	0	0	0	0	0	0	0	0	24142	23744	21905	69791
LABOR	0	0	0	0	0	0	0	0	0	1008	1036	927	2971
SUBS	0	0	0	0	0	0	0	0	0	204	190	161	555
TRAVEL	0	0	0	0	0	0	0	0	0	62	71	53	186
PM&E	0	0	0	0	0	0	0	0	0	14	17	27	58
OTHER	0	0	0	0	0	0	0	0	0	275	396	487	1158
Total ETC	0	0	0	0	0	0	0	0	0	1563	1710	1655	4928

Resource Distributions

Fiscal Year 1997	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
BCWS	1253	1292	939	1270	1376	1380	1471	1411	1420	1401	1356	1296	15865
BCWP	1195	1245	1131	1353	1329	1377	1367	1310	1788	0	0	0	12095
ACWP	1071	1020	1143	1310	1244	1356	1292	1374	1330	0	0	0	11140
ETC	0	0	0	0	0	0	0	0	0	1563	1710	1655	4928

Fiscal Year Distribution

	Prior	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	Future	At Complete
BCWS	15914	15865	9596	980	0	0	0	0	0	0	0	0	42355
BCWP	15609	12095	0	0	0	0	0	0	0	0	0	0	
ACWP	15908	11140	0	0	0	0	0	0	0	0	0	0	
ETC	0	4928	9596	980	0	0	0	0	0	0	0	0	42552

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey
Date Prepared 07/14/97 15:12

MONTHLY COST/FTE REPORT

Fiscal Month/Year JUNE 1997

	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.	1052	14311	3608	0	488	90	12260	10218	8669
1.2.5.	31	200	672	0	82	0	504	437	301
1.2.8.	51	558	0	0	0	0	612	542	440
1.2.9.	46	864	200	0	17	15	664	584	429
1.2.12	4	168	0	0	0	5	80	70	37
1.2.15	136	1296	336	52	72	30	1722	1526	1207
TOTALS	1320	17397	4816	52	659	140	15842	13377	11083

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/96 - 06/30/97

		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
OG311FA1	Scientific Programs Management & Integra	15.7	16.6	12.0	21.8	62.3	32.4	35.6	28.3	33.1	0.0	0.0	0.0	257.8
1.2.3.1.1		15.7	16.6	12.0	21.8	62.3	32.4	35.6	28.3	33.1	0.0	0.0	0.0	257.8
OG312FA1	Nevada Operations/Earth Science Investig	55.0	57.4	62.9	66.3	98.9	87.7	57.2	46.4	59.0	0.0	0.0	0.0	590.8
1.2.3.1.2		55.0	57.4	62.9	66.3	98.9	87.7	57.2	46.4	59.0	0.0	0.0	0.0	590.8
*1.2.3.1		70.7	74.0	74.9	88.1	161.2	120.1	92.8	74.7	92.1	0.0	0.0	0.0	848.6
OG32211FB1	Review & Revision of Lithostratigraphy B	14.1	13.4	50.3	23.9	8.6	14.0	2.4	6.6	-4.8	0.0	0.0	0.0	128.5
1.2.3.2.2.1.1		14.1	13.4	50.3	23.9	8.6	14.0	2.4	6.6	-4.8	0.0	0.0	0.0	128.5
OG32212FB2	Complete Site Area Geologic Map	36.9	24.9	34.2	12.0	21.2	50.7	18.6	25.8	52.8	0.0	0.0	0.0	277.1
OG32212FB3	Fracture Studies	6.3	16.8	14.9	12.2	9.9	9.7	10.8	5.7	10.6	0.0	0.0	0.0	[illegible]
OG32212FB4	Geologic Mapping of the Exploratory Stud	119.7	139.2	106.3	155.8	135.2	146.7	148.2	124.8	138.2	0.0	0.0	0.0	1214.1
1.2.3.2.2.1.2		162.9	180.9	155.4	180.0	166.3	207.1	177.6	156.3	201.6	0.0	0.0	0.0	1588.1
OG3252FB1	Evalute Tectonic Scenarios for PA	10.6	4.1	-4.1	2.3	0.0	2.5	0.6	0.1	0.0	0.0	0.0	0.0	16.1
1.2.3.2.5.2		10.6	4.1	-4.1	2.3	0.0	2.5	0.6	0.1	0.0	0.0	0.0	0.0	16.1
OG32836FB1	Conduct Probabilistic Seismic Hazards An	88.3	62.1	54.3	46.4	36.5	3.0	53.5	47.4	3.2	0.0	0.0	0.0	394.7
1.2.3.2.8.3.6		88.3	62.1	54.3	46.4	36.5	3.0	53.5	47.4	3.2	0.0	0.0	0.0	394.7
*1.2.3.2		275.9	260.5	255.9	252.6	211.4	226.6	234.1	210.4	200.0	0.0	0.0	0.0	2127.4
OG33111FB4	Collection of Site Meteor. Data for Hydr	7.8	8.8	12.2	17.5	14.3	29.6	0.4	5.9	-0.2	0.0	0.0	0.0	96.3
1.2.3.3.1.1.1		7.8	8.8	12.2	17.5	14.3	29.6	0.4	5.9	-0.2	0.0	0.0	0.0	96.3
OG33112FB1	Collection of Site Streamflow Data	5.6	5.1	5.3	7.4	5.7	7.1	0.0	0.0	0.0	0.0	0.0	0.0	36.2
OG33112FB2	Collection of Site Streamflow Data	0.0	0.0	0.0	0.0	0.0	0.0	6.8	6.0	6.9	0.0	0.0	0.0	19.7
1.2.3.3.1.1.2		5.6	5.1	5.3	7.4	5.7	7.1	6.8	6.0	6.9	0.0	0.0	0.0	55.9
OG33114FB3	Regional Saturated Zone Synthesis Report	7.6	7.6	0.0	12.5	29.1	11.6	55.4	15.7	56.2	0.0	0.0	0.0	195.7
1.2.3.3.1.1.4		7.6	7.6	0.0	12.5	29.1	11.6	55.4	15.7	56.2	0.0	0.0	0.0	195.7
OG33121FB1	Infiltration Processes	21.5	16.0	19.0	18.3	30.7	41.4	6.1	-6.8	0.9	0.0	0.0	0.0	147.1
1.2.3.3.1.2.1		21.5	16.0	19.0	18.3	30.7	41.4	6.1	-6.8	0.9	0.0	0.0	0.0	[illegible]
OG33123FB4	Integrated Analysis & Interpretation	14.5	5.4	14.5	20.9	38.8	10.6	-14.8	-0.2	17.4	0.0	0.0	0.0	[illegible]
OG33123FB5	Matrix Properties of Hydrologic Units	14.1	12.0	16.2	17.8	1.8	3.7	4.9	0.4	0.9	0.0	0.0	0.0	71.8
OG33123FBA	Unsaturated Zone Borehole Instrumentatio	31.9	36.3	32.6	32.3	34.2	-10.8	1.5	0.0	0.0	0.0	0.0	0.0	158.0
OG33123FBB	Unsaturated Zone Borehole Instrumentatio	0.0	0.0	0.0	0.0	0.0	11.0	24.4	21.5	25.4	0.0	0.0	0.0	82.3
OG33123FBC	Integrated Analysis & Interpretation	0.0	0.0	0.0	0.0	0.0	9.3	32.9	13.6	21.4	0.0	0.0	0.0	77.2
OG33123FBD	Matrix Properties of Hydrologic Units	0.0	0.0	0.0	0.0	0.0	0.0	16.5	15.6	14.7	0.0	0.0	0.0	46.8
1.2.3.3.1.2.3		60.5	53.7	63.3	71.0	74.8	23.8	65.4	50.9	79.8	0.0	0.0	0.0	543.2
OG33124E96	Air-K and Hydrochemisty Test - North Ram	5.5	3.1	6.4	6.1	1.4	5.8	0.1	0.0	10.9	0.0	0.0	0.0	39.3
OG33124FA1	Support E&I Design Basis Modeling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.1	0.0	0.0	0.0	4.2
OG33124FB7	Air Permeability & Hydrochem Testing ESF	46.1	40.6	40.9	68.9	62.7	21.6	-5.9	10.8	12.3	0.0	0.0	0.0	298.0
OG33124FB8	Percolation Flux across Repository Horiz	0.0	0.0	0.0	0.0	0.0	3.9	1.8	-0.9	0.0	0.0	0.0	0.0	4.8
OG33124FBA	Moisture Monitorning in the ESF	2.4	2.4	1.5	18.3	8.3	2.6	2.2	1.9	-14.2	0.0	0.0	0.0	25.4

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OG33124FBB	Air-Permeability & Hydrochem Testing ESF	0.0	0.0	0.0	0.0	0.0	14.5	56.6	62.1	34.7	0.0	0.0	0.0	167.9
OG33124FBD	Moisture Monitoring in the ESF	0.0	0.0	0.0	0.0	0.0	4.9	18.8	16.7	-21.8	0.0	0.0	0.0	18.6
OG33124FBF	South Ramp Hydrology	0.0	0.0	0.0	0.0	0.0	44.3	18.1	80.2	20.7	0.0	0.0	0.0	163.3
OG33124FBG	PTn Lateral Diversion (Phase I)	0.0	0.0	0.0	0.0	0.0	2.0	8.5	3.9	16.5	0.0	0.0	0.0	30.9
OG33124FBH	ESF Drift Scale Flux and Niche Study	0.0	0.0	0.0	0.0	0.0	2.0	10.8	8.8	32.9	0.0	0.0	0.0	54.5
1.2.3.3.1.2.4		54.0	46.1	48.8	93.3	72.4	101.6	111.0	185.6	94.1	0.0	0.0	0.0	806.9
OG33127B96	UZ Hydrochemistry	0.0	0.0	0.0	20.0	0.0	0.4	3.1	3.6	0.0	0.0	0.0	0.0	27.1
OG33127FBA	UZ Hydrochemistry	23.0	27.1	22.0	1.2	18.0	14.5	-14.3	-2.3	22.1	0.0	0.0	0.0	111.3
OG33127FBB	UZ Hydrochemistry	0.0	0.0	0.0	0.0	0.0	12.8	29.7	25.0	20.0	0.0	0.0	0.0	[illegible]
1.2.3.3.1.2.7		23.0	27.1	22.0	21.2	18.0	27.7	18.5	26.3	42.1	0.0	0.0	0.0	225.9
OG33128FBD	Fluid Flow in Unsaturated Zone Fractured	7.6	5.3	2.9	6.0	4.8	2.0	-0.4	0.0	0.0	0.0	0.0	0.0	28.2
1.2.3.3.1.2.8		7.6	5.3	2.9	6.0	4.8	2.0	-0.4	0.0	0.0	0.0	0.0	0.0	28.2
OG33129FBG	Site Unsaturated Zone Flow Model	7.8	6.4	8.3	25.5	-13.3	10.9	-0.8	7.0	-3.3	0.0	0.0	0.0	48.5
OG33129FBK	Support UZ Model Expert Elicitation	0.0	21.2	6.8	8.6	7.4	3.5	3.2	0.3	0.6	0.0	0.0	0.0	51.6
1.2.3.3.1.2.9		7.8	27.6	15.1	34.1	-5.9	14.4	2.4	7.3	-2.7	0.0	0.0	0.0	100.1
OG33131FBA	C-Well Complex Hydraulic & Conservative	46.5	42.2	46.6	74.2	58.5	31.3	4.0	0.3	-0.5	0.0	0.0	0.0	303.1
OG33131FBB	C-Well Complex Hydraulic & Tracer Test	0.0	0.0	0.0	0.0	0.0	22.2	49.4	52.0	52.6	0.0	0.0	0.0	176.2
OG33131FBC	Water-Level Monitoring	20.7	17.8	20.5	18.2	14.3	6.2	0.8	0.0	0.0	0.0	0.0	0.0	98.5
OG33131FBD	Water-Level Monitoring	0.0	0.0	0.0	0.0	0.0	6.0	12.0	8.8	4.5	0.0	0.0	0.0	31.3
OG33131FBF	WT Eh and Ph Measurements	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.7	1.2	0.0	0.0	0.0	6.2
1.2.3.3.1.3.1		67.2	60.0	67.1	92.4	72.8	65.7	68.5	63.8	57.8	0.0	0.0	0.0	615.3
OG33133FB3	Site Saturated Zone Flow Model	16.5	25.9	21.8	27.0	22.2	10.3	39.3	24.0	50.5	0.0	0.0	0.0	237.5
OG33133FB4	Site Saturated Zone Synthesis Report	1.3	0.0	2.5	0.3	11.0	6.2	10.4	23.6	16.7	0.0	0.0	0.0	72.0
OG33133FB5	Conduct VA SZ Flow Model Sensitivity An	4.0	2.0	2.6	8.5	8.9	12.9	22.0	16.2	17.3	0.0	0.0	0.0	94.4
OG33133FB6	Confirm SZ Hydrologic Flow Models	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
OG33133FB7	Support SZ Model Expert Elicitation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	15.6	0.0	0.0	0.0	[illegible]
1.2.3.3.1.3.3		21.8	27.9	26.9	35.8	42.1	29.4	71.7	65.0	100.1	0.0	0.0	0.0	420.7
*1.2.3.3		284.4	285.2	282.6	409.5	358.8	354.3	405.8	419.7	435.0	0.0	0.0	0.0	3235.3
OG3521FA1	Tracer Gas Support	5.7	5.1	6.0	6.8	5.4	9.5	6.4	2.9	5.8	0.0	0.0	0.0	53.6
1.2.3.5.2.1		5.7	5.1	6.0	6.8	5.4	9.5	6.4	2.9	5.8	0.0	0.0	0.0	53.6
*1.2.3.5		5.7	5.1	6.0	6.8	5.4	9.5	6.4	2.9	5.8	0.0	0.0	0.0	53.6
OG36212FB1	Confirmatory Aquatic Investigations	0.0	2.1	6.9	7.9	3.0	4.1	7.2	0.0	19.4	0.0	0.0	0.0	50.6
1.2.3.6.2.1.2		0.0	2.1	6.9	7.9	3.0	4.1	7.2	0.0	19.4	0.0	0.0	0.0	50.6
OG36215FB2	Paleoclimate/Paleoenvironmental Synthesi	40.1	38.6	31.7	62.4	37.8	19.5	9.6	30.1	2.1	0.0	0.0	0.0	271.9
1.2.3.6.2.1.5		40.1	38.6	31.7	62.4	37.8	19.5	9.6	30.1	2.1	0.0	0.0	0.0	271.9
OG36221FB1	Evaluation of Paleo Ground-Water Dischar	17.4	15.4	27.9	28.8	13.0	9.9	-34.8	30.2	0.1	0.0	0.0	0.0	107.9
OG36221FB2	Geo. Fract. Fill Mater, ESF & Est Past W	57.0	39.2	87.6	70.6	85.8	107.1	10.0	7.6	12.1	0.0	0.0	0.0	477.0

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OG36221FB3	Syn.Dist.&Anal Geochron. Age Dets Potent	0.0	0.0	0.0	0.0	0.0	24.4	66.4	73.0	49.8	0.0	0.0	0.0	213.6
1.2.3.6.2.2.1		74.4	54.6	115.5	99.4	98.8	141.4	41.6	110.8	62.0	0.0	0.0	0.0	798.5
*1.2.3.6		114.5	95.3	154.1	169.7	139.6	165.0	58.4	140.9	83.5	0.0	0.0	0.0	1121.0
OG395FB1	Update 3-D Geologic Model/Database	0.0	0.0	0.0	0.0	0.0	0.0	5.7	15.5	21.3	0.0	0.0	0.0	42.5
1.2.3.9.5		0.0	0.0	0.0	0.0	0.0	0.0	5.7	15.5	21.3	0.0	0.0	0.0	42.5
OG39BFA1D	Support Systems Engineering Reports & St	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
OG39BFA1F	Data & Del Mgt., QA Compl, Oversite Sup,	14.6	13.0	13.3	10.9	15.1	26.8	22.2	22.9	42.7	0.0	0.0	0.0	181.5
OG39BFB1	Support Development of PISA Ch 2.3 (Geol	30.1	29.7	43.9	50.1	55.5	50.1	69.2	69.3	48.1	0.0	0.0	0.0	4[illegible]
OG39BFB1C	Provide Support to LA Plan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
OG39BFB1E	Provide Input to SC Progress Report 16	9.9	11.0	10.9	5.6	13.1	9.1	9.5	10.0	11.2	0.0	0.0	0.0	90.3
OG39BFB2	Develop PISA Chapter 2.4 (Hydrology)	11.6	12.5	33.0	31.0	43.5	54.0	54.8	68.4	81.8	0.0	0.0	0.0	390.6
OG39BFB2E	Provide Input to SC Progress Report 17	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
OG39BFB4	Dev Climate/Meteorologic Sys Desc (PISA	0.0	0.0	0.0	0.0	0.0	16.1	51.3	35.3	31.0	0.0	0.0	0.0	133.7
1.2.3.9.11		66.2	66.2	101.1	97.6	127.2	156.1	207.0	205.9	214.8	0.0	0.0	0.0	1242.1
*1.2.3.9		66.2	66.2	101.1	97.6	127.2	156.1	212.7	221.4	236.1	0.0	0.0	0.0	1284.6
**1.2.3		817.4	786.3	874.6	1024.3	1003.6	1031.6	1010.2	1070.0	1052.5	0.0	0.0	0.0	8670.5
OG535FA1	Provide FY97 Technical Data Base Input	21.3	18.0	18.0	40.7	25.5	29.9	30.5	38.0	28.9	0.0	0.0	0.0	250.8
1.2.5.3.5		21.3	18.0	18.0	40.7	25.5	29.9	30.5	38.0	28.9	0.0	0.0	0.0	250.8
*1.2.5.3		21.3	18.0	18.0	40.7	25.5	29.9	30.5	38.0	28.9	0.0	0.0	0.0	250.8
OG541FA2	Viability Assessment Scenarios Developme	0.0	0.0	0.0	3.5	0.0	0.0	-0.1	1.3	0.0	0.0	0.0	0.0	4.7
1.2.5.4.1		0.0	0.0	0.0	3.5	0.0	0.0	-0.1	1.3	0.0	0.0	0.0	0.0	4.7
OG544FA1	UZ Flow Model Abstractions for VA	0.0	0.0	5.5	1.3	5.2	8.3	0.0	5.3	1.6	0.0	0.0	0.0	27.2
OG544FA2	SZ Flow Model Abstractions for VA	0.0	0.0	7.1	-0.4	-0.4	1.6	5.2	4.8	0.6	0.0	0.0	0.0	18.5
1.2.5.4.4		0.0	0.0	12.6	0.9	4.8	9.9	5.2	10.1	2.2	0.0	0.0	0.0	45.7
*1.2.5.4		0.0	0.0	12.6	4.4	4.8	9.9	5.1	11.4	2.2	0.0	0.0	0.0	[illegible]
**1.2.5		21.3	18.0	30.6	45.1	30.3	39.8	35.6	49.4	31.1	0.0	0.0	0.0	30[illegible]
OG825FA1	Federal Occupation Safety & Health	8.8	7.1	9.0	8.9	7.3	7.4	7.0	11.9	7.5	0.0	0.0	0.0	74.9
1.2.8.2.5		8.8	7.1	9.0	8.9	7.3	7.4	7.0	11.9	7.5	0.0	0.0	0.0	74.9
*1.2.8.2		8.8	7.1	9.0	8.9	7.3	7.4	7.0	11.9	7.5	0.0	0.0	0.0	74.9
OG845FA1	Radiation Protection	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
1.2.8.4.5		0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
OG847FA1	Water Resources Envir Impact Stmt Suppor	0.0	0.0	0.0	0.0	2.4	2.8	0.0	0.2	0.0	0.0	0.0	0.0	5.4
OG847FA2	Rad Water Quality Sample Collection	0.0	0.0	0.0	0.0	0.0	49.3	3.8	0.0	11.9	0.0	0.0	0.0	65.0
OG847FB1	Water Resources	30.4	29.6	30.3	48.3	17.0	37.6	32.8	36.7	31.5	0.0	0.0	0.0	294.2
1.2.8.4.7		30.4	29.6	30.3	48.3	19.4	89.7	36.6	36.9	43.4	0.0	0.0	0.0	364.6
*1.2.8.4		30.4	29.6	30.4	48.3	19.4	89.7	36.6	36.9	43.5	0.0	0.0	0.0	364.8
**1.2.8		39.2	36.7	39.4	57.2	26.7	97.1	43.6	48.8	51.0	0.0	0.0	0.0	439.7

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OG912FA1	Participant Technical Project Office	25.0	23.2	27.3	25.9	29.0	22.2	24.1	42.8	25.4	0.0	0.0	0.0	244.9
1.2.9.1.2		25.0	23.2	27.3	25.9	29.0	22.2	24.1	42.8	25.4	0.0	0.0	0.0	244.9
*1.2.9.1		25.0	23.2	27.3	25.9	29.0	22.2	24.1	42.8	25.4	0.0	0.0	0.0	244.9
OG922FA1	Participant Project Control - USGS	21.4	18.6	18.1	20.5	17.5	19.9	34.8	12.5	20.2	0.0	0.0	0.0	183.5
1.2.9.2.2		21.4	18.6	18.1	20.5	17.5	19.9	34.8	12.5	20.2	0.0	0.0	0.0	183.5
*1.2.9.2		21.4	18.6	18.1	20.5	17.5	19.9	34.8	12.5	20.2	0.0	0.0	0.0	183.5
**1.2.9		46.4	41.8	45.4	46.4	46.5	42.1	58.9	55.3	45.6	0.0	0.0	0.0	428.4
OGC522FA1	Satellite Records Operations	3.8	3.5	4.7	4.2	4.2	3.9	4.0	4.8	4.2	0.0	0.0	0.0	37.1
1.2.12.5.2.2		3.8	3.5	4.7	4.2	4.2	3.9	4.0	4.8	4.2	0.0	0.0	0.0	
*1.2.12.5		3.8	3.5	4.7	4.2	4.2	3.9	4.0	4.8	4.2	0.0	0.0	0.0	37.3
**1.2.12		3.8	3.5	4.7	4.2	4.2	3.9	4.0	4.8	4.2	0.0	0.0	0.0	37.3
OGF23FA1	Support/Personnel Services	32.4	28.7	35.4	25.6	22.5	27.7	25.9	35.2	29.9	0.0	0.0	0.0	263.3
OGF23FA2	Facilities Management - Space	61.7	61.7	61.7	61.7	61.7	61.7	64.0	59.3	61.7	0.0	0.0	0.0	555.2
OGF23FA3	Facilities Management - Computers/Phones	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	0.0	0.0	0.0	150.3
OGF23FA4	Facilities Management - Other	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	0.0	0.0	0.0	112.5
OGF23FA5	Procurement/Property Management - USGS	10.2	11.0	8.0	7.3	11.5	9.9	8.5	9.9	9.2	0.0	0.0	0.0	85.5
1.2.15.2.3		133.5	130.6	134.3	123.8	124.9	128.5	127.6	133.6	130.0	0.0	0.0	0.0	1166.8
*1.2.15.2		133.5	130.6	134.3	123.8	124.9	128.5	127.6	133.6	130.0	0.0	0.0	0.0	1166.8
OGF3FA1	USGS Training Support	4.5	4.2	3.7	4.8	4.2	4.2	3.8	4.6	6.5	0.0	0.0	0.0	40.5
1.2.15.3		4.5	4.2	3.7	4.8	4.2	4.2	3.8	4.6	6.5	0.0	0.0	0.0	40.5
*1.2.15.3		4.5	4.2	3.7	4.8	4.2	4.2	3.8	4.6	6.5	0.0	0.0	0.0	40.5
**1.2.15		138.0	134.8	138.0	128.6	129.1	132.7	131.4	138.2	136.5	0.0	0.0	0.0	1207.3
1.2 OPERATING		1066.1	1021.1	1132.7	1305.8	1240.4	1347.2	1283.7	1366.5	1320.9	0.0	0.0	0.0	11084.4
CAPITAL EQUIPMENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GRAND TOTAL		1066.1	1021.1	1132.7	1305.8	1240.4	1347.2	1283.7	1366.5	1320.9	0.0	0.0	0.0	1108
FTEs														
FEDERAL		112.7	108.9	108.0	109.3	99.7	109.6	112.6	113.0	102.0	0.0	0.0	0.0	
CONTRACT		17.0	17.8	19.2	26.5	22.1	25.9	29.0	29.6	27.8	0.0	0.0	0.0	
TOTAL		129.7	126.7	127.2	135.8	121.8	135.5	141.6	142.6	129.8	0.0	0.0	0.0	

* Fourth level WBS roll-up
** Third level WBS roll-up