Lawrence Berkeley Laboratory
University of California Berkeley, California 94720
(510) 486-4000 • FTS 451-4000

Jan 31, 1995

James Ziemba
U.S. Geological Survey
MS 425
Denver Federal Center
Denver, CO 80225

"PRELIMINARY DRAFT"

Dear Jim,

Please find enclosed a milestone report for activities under W.B.S. 1.2.3.11.2, Surface Geophysics, OB3B2L95A, B, and C, and the accompanying documentation per YMP-USGS QMP 3.04 to complete the milestone. Please process this report per the latest version of the USGS/LBL MOU on the Surface Geophysics work. We are concurrently sending an informational copy, for participant use only, to DOE/YMSCO. If you have any questions please give me a call at (510) 486-6709.

Best Regards,

Ernie Majer
Dept. Head, Subsurface Geosciences

cc: B. Bodvarsson/LBL

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WBS 1.2.3.11.2 LBL Surface-Based Geophysical Testing

FOR INFORMATION ONLY

LBL Principal Investigator - Ernest L. Majer

Narrative of work performed

PARTICIPANT USE ONLY

Objective of Work/Background

The work involved in the detection and mapping of lithology, structure, faults, and fractures at Yucca Mountain using surface geophysics is divided into four basic tasks, high resolution seismic imaging using surface reflection and VSP, gravity, electrical, and magnetics. LBL is responsible for the seismic, gravity, and electrical work in FY 95, and the USGS is responsible for some additional gravity and all of the magnetic work. LBL is also working with the USGS to synthesize the data into a geophysical model that will be used to constrain the geologic and site scale models. In FY 94, three seismic reflection profiles were acquired in the region of the WT2 (line Yucca-1, or Line-1, starting east of UZ16 and running up the road past WT2), NRG6 (line Yucca-2, or Line-2, starting at NRG7 and running down the road in Drill Hole Wash past NRG6 to the edge of the corporation yard) and a line along the crest of Yucca Mountain starting at UZ6 and extending approximately 3000 feet north along the crest road towards H-5 (line Yucca-3, or Line -3). Detailed VSP's, multicomponent using P-, and S-wave sources, were also acquired in WT-2 and NRG-6 to constrain and aid in the interpretation of the seismic reflection. The principal reason for the work was to image from the near surface to at least the repository horizon and below if possible. The objective was to provide information on faulting/fracturing and structure/lithology to provide input to ESF design activities. In addition these data would also provide information on geologic structure for input and control of the three-D site rock characteristics model. From this work the following conclusions were made:

Line 1

1. It seems that we have traversed a zone of faulting in this line that extends from just west of UZ-16 to the Ghost Dance Fault.

2. As seen in the VSP data and results, significant faulting extends to depth. No conclusions on dip or final extent of faulting can be reached from the data yet.

3. Preliminary interpretation indicates that the direction of dip of structure and faulting is consistent with known values.

Line 2

1. The reflections are discontinuous and indicate cross faulting along the line to a considerable depth, this is consistent with the VSP results at NRG-6

2. The complexity of faulting along Line 2 is greater than along Line 1, however, this may due to the oblique angle at which each line was run relative to the main structure.

In general we were pleasantly surprised on the ability of the seismic reflection methods to image the subsurface. Care must be taken to properly set survey parameters and in the processing of the data. It appears that in the region of these two lines there is significant faulting extending to well below the repository horizon. From the preliminary application and processing of the data, however, care must be taken not to over interpret the data or draw too strong a conclusion about the subsurface until greater experience and validation of the seismic reflection is obtained. There were also gravity data acquired along the WT-2 UZ-16 line by the USGS that confirmed the major faults detected by the seismic survey, and led to the conclusion that gravity data would be useful in the geophysical characterization effort.

Because of these conclusions and success, a larger scale seismic and gravity program was planned for FY 95, based on the work in FY 94. However, the work did show that the seismic and gravity data alone could not determine the hydrologic nature of the faults. For this reason the magnetic and electrical work were added for FY 95. Past electrical work at Yucca Mt. had mixed success at best. The Tuff is very resistive and difficult to resolve structure in using electrical methods. However, a new approach of using continuous profiling magnetotellurics (MT) could possibly resolve important conductive features. The approach is similar to seismic reflection, in that a continuous profile of stations at relatively close spacing (100 meters, which is close for MT) is acquired. Recent advances in interpretation and inversion methods allowed it to be performed. The approach in the MT work is to perform a preliminary profile on Line 3, Figure 1, over known features to determine its sensitivity and resolution. At that point a decision will be made on where to use the methodology. The technique is very expensive (two to three

times the cost of seismic coverage) and its use may not be justified in the same quantity as the seismic reflection. However, over critical features as the Ghost Dance fault and the sharp water table gradient, it may provide critical information on hydrogeologic parameters.

Plans for FY 95

The plans for FY 95 are to perform high resolution seismic reflection on Lines 1, 2, 3, 4, 5, 6, 7, 7a, (short cross line perpendicular to the Yucca Wash faulting) 8, 9, and 12. These lines sample a variety of geologic conditions and features of interest to the project. In addition four short lines on the pad of UZ-7a will be acquired at very high resolution (1 meter group spacing, using a hammer source) to determine the detailed fault structure in this region, hopefully to a depth of 500 meters, Lines 13, 13a, 14, and 14a, Figure 1. The electrical work will start on Line 3, across the Ghost Dance Fault region to determine the MT sensitivity and resolution. Depending upon the results of this line, the MT method may be employeed on some, or all of the other lines on which seismic was run. Gravity will be run on all lines shown in Figure 2, and on the regional seismic lines acquired by the USGS. The schedule is to have all gravity and seismic acquired by the end of February, 1995, and the MT acquired on Line 3 by the end of January, 1995.

Progress to Date:

OB3B2L95A South and North-South ESF Alignment, Gravity, Electrical, and Seismic

- All lines for the south portal were staked and laid out, (Lines 1, 10, and 11, Figure 1.). The test planning packages were completed, submitted and approved for all on-road and off-road work. The gravity meters were calibrated for proper operation and the exact locations of the lines were selected. The designed spacing of the gravity measurements is 50 meters. Surveying requirements were discussed with RSN and arrangements were made for the necessary surveying. RFQ's were sent out for the high resolution seismic and calibration of the instrumentation that will be used in the electrical work. The location of the surveys were selected. Vendors were selected and contracts awarded for the seismic work and calibration of the instrumentation to be used

in the electrical work. The data acquisition for the seismic reflection was completed in late January on Line 1. Preliminary gravity calibration loops were completed in prepartion for the gravity work on Lines 10 and 11.

OB3B2L95B Repository Region, Gravity, Electrical, and Seismic

- Work on this task focused on the seismic reflection and the electrical work. All test planning packages were submitted and approved for all on and off road work. The field work began in mid December with seismic acquisition along Line 2 with Digitec Inc. acquiring the data. The system being used is the Elastic Wave Generator (EWG) and a 144-channel 24 bit (OYO DAS-1) recording system. Six geophones per group at 12 meter intervals is being used for geometry. The shot point spacing is every other group, but in certain areas, over faults and in structurally complex regions, the shotpoints are every group. The maximum fold is 72.
- To date the seismic reflection has been performed on geophysics Lines 2, 3, 4, 5, 7, 8, 9, and 12, (see Figure 1.). Testing was performed before the survey began to optimize data collection procedures. This included source arrays, stacking parameters, and array lengths. The frequency content and signal to noise ratio of the data are much improved over last year's efforts. From the processing to date, the frequency content is acceptable up to 125 hertz. Also, it appears that there will be usable data up to the full three seconds of data recorded, which corresponds to a depth of approximately 5 kilometers.
- The electrical magnetotellurics (controlled source and natural) were carried out on Line 3 over the Ghost Dance Fault starting on January 27. The frequency range varied from 10 hertz (natural source) to 20,000 hertz for the controlled source. The work was completed on January 31. From the preliminary in-field processing, the Ghost Dance Fault does show up as an electrical anomaly.

OB3B2L95C Gravity on Regional Seismic Lines

- The gravity meters were checked for proper operation and the locations of the lines were selected. The designed spacing of the gravity measurements is 100 meters, except in known faulted regions where the spacing was selected to be every 50 meters. Surveying requirements were discussed with RSN and arrangements were made for the necessary surveying.
- In December all gravity measurements were acquired on Regional Seismic Lines 2 and 3 (the regional seismic lines, these are not the same lines 1 and 2 as shown in Figure 1). The data were acquired at 100 meters intervals along

these lines. In addition, the regional gravity calibration loops were performed before and after the gravity surveys. The drift rates were calculated and were within the tolerances specified in the technical procedures. Data processing is awaiting the completion of precision surveying by RSN.

Quality Assurance and Training

- All employees who had not completed GET, GERT, and QA orientation were trained and qualified. The necessary reading assignments were issued for the technical procedures and QA. A QA surveillance was performed by the USGS on the seismic work in December.

Operations

- Changes in Future Plans:

- Due to funding delays and delays in the approvals of the Test Planning Package the field work was delayed until December. However, once started the field work was completed within schedule.

- Problem areas:

- The surveying is lagging behind the geophysical work. The lack of survey coordinates for the regional seismic lines and repository seismic lines is delaying the processing of the gravity and seismic data.

GEOPHYSICAL SURVEY LINES

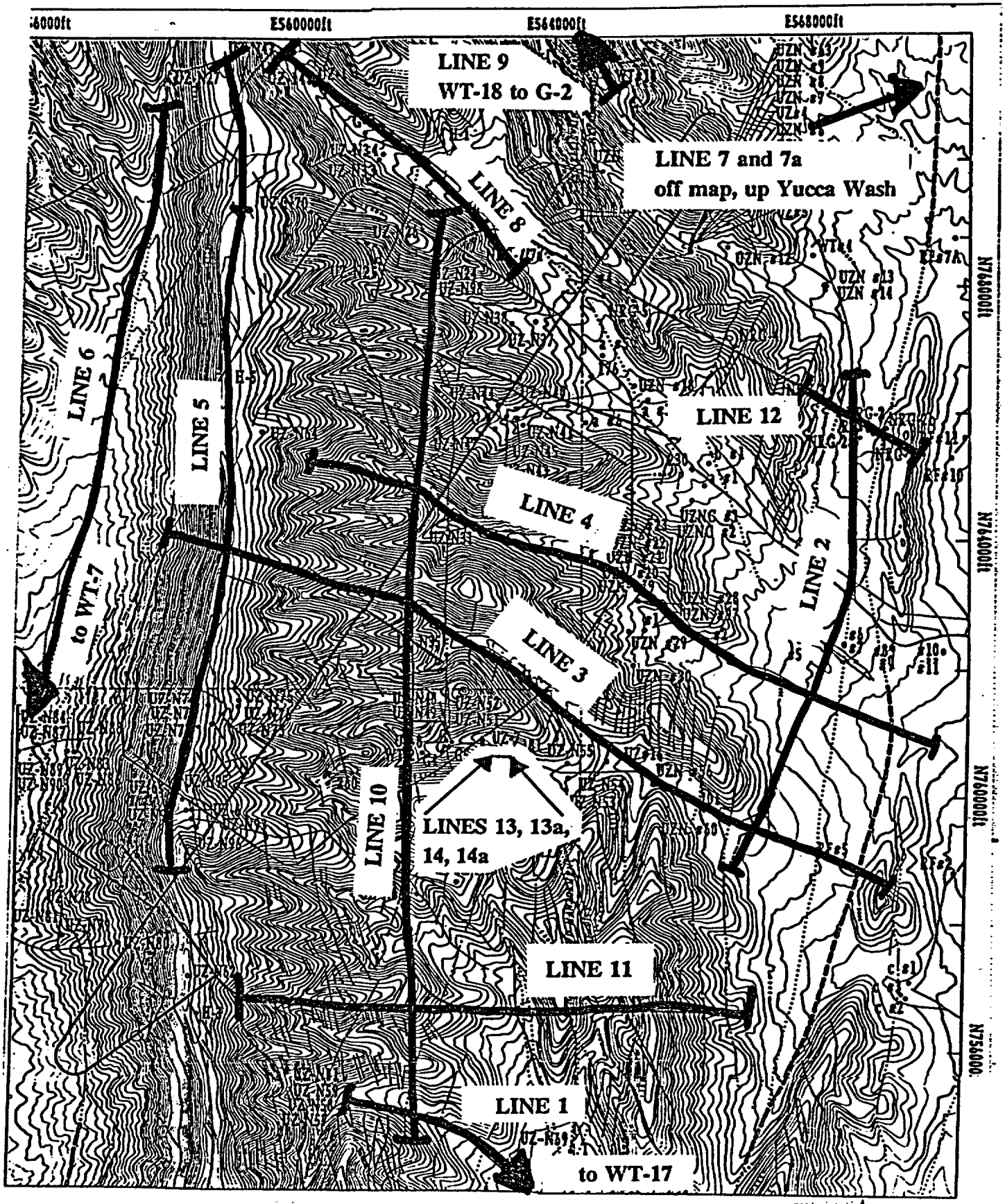

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FIGURE 1.