P-E-719

# MAPPING GEOTHERMAL SEISMIC SOURCES NEAR LEACH HOT SPRINGS, NEVADA

May 26, 1978

Submitted To:

U.S. DEPARTMENT OF ENERGY
Nevada Operations Office
P.O. Box 14100
Las Vegas, NV 89114

Submitted By:

ENSCO, INC.
Earth Sciences and Systems Division
5408A Port Royal Road
Springfield, VA 22151

ENSCO, INC. 5408A Port Royal Road Springfield, Virginia 22151 (703) 321-9000

May 30, 1978

U. S. Department of Energy
Nevada Operations Office
P. O. Box 14100
Las Vegas, Nevada 89114

Attention: Mr. Joseph N. Fiore, Chairman
Source Evaluation Panel

Reference: RFP No. ET-78-R-08-0003

Gentlemen:

ENSCO, Inc. is pleased to submit its Technical Proposal and Fixed Price, Level of Effort, Term, Cost Proposal in response to subject RFP.

This proposal offers a new passive seismic survey technique, developed under U.S.G.S. contracts and applied commercially in several geothermal regions, to investigate the geothermal system near Leach Hot Springs, Nevada. Results obtained to date have been very encouraging, an example of which is included in the proposal, and promise to give a more detailed location of the possible geothermal reservoir at Leach Hot Springs and the associated faulting.

The survey will be carried out at this investigation site by ENSCO's Earth Systems and Sciences (ESS) Division in conjunction with a consultant from EDCON Corporation, Denver, Colorado, for aid in the geophysical interpretation of results. The ESS Division is primarily involved in the research, development and application of various geophysical survey techniques and has particular interest in establishing this seismic activity mapping survey as a useful tool in geothermal exploration.

We, therefore, assure that every effort will be made to successfully complete the proposed survey.

This proposal is valid for a period of 120 days.

Mr. Thomas L. Herb, Senior Vice President, Finance and Administration; and Mr. Robert Howard, Executive Administrator; are authorized to conduct negotiations and commit ENSCO, Inc. to all provisions of this proposal.

Should you require further information regarding the technical aspects of this proposal, please contact Dr. Edward Page. For costing or contractual matters, contact Mr. Robert Howard.

Very truly yours,

Hal P Demuth

Hal P. Demuth
Vice President

TABLE OF CONTENTS

# A. PROPOSER'S NAME AND ADDRESS

ENSCO, Inc.
5408A Port Royal Road
Springfield, VA 22151

# B. TECHNICAL PROPOSAL

## B.1 INVESTIGATION SITE

The selected investigation site is the Leach Hot Springs area located in Grass Valley, Nevada, approximately 30 miles south of Winnemucca. The proposed survey will cover the 5x5 mile region outlined in Figure B.1.1, and is accessible for locating seismic arrays for the survey. This area is definitely prospective as a potential geothermal reservoir and there is fairly extensive geologic and geophysical reconnaissance of the area reported in "Preliminary Open File Report, Geological and Geophysical Studies in Grass Valley, Nevada," (U.S. ERDA Contract No. W-8405-ENG-48). The Leach Hot Springs is located on a fault identified by a 10 meters by 15 meters high scarp trending northeast. Water temperatures at depth are estimated to be 155°C to 170°C, based on silica and alkali-element geothermometers (Mariner, et. al., 1974). Use of mixing model equations (Fournier, et. al., 1974) indicates that the temperature at depth may exceed 200°C.

Existing geophysical data over Leach Hot Springs include heat flow, gravity, magnetic, self potential, electrical resistivity, electric field ratio, tellurics, magnetotellurics, and various seismic surveys. Particularly relevant is a ground noise survey described by Liaw (1977), which made use of both conventional ground noise and F-K techniques. This survey detected only surface waves, and consequently, responded only to alluvium thickness and did not locate any actual geothermal ground noise sources. Our technique is designed to optimize detection of body waves as well as surface waves, and is more likely to detect and locate sources of body wave energy.

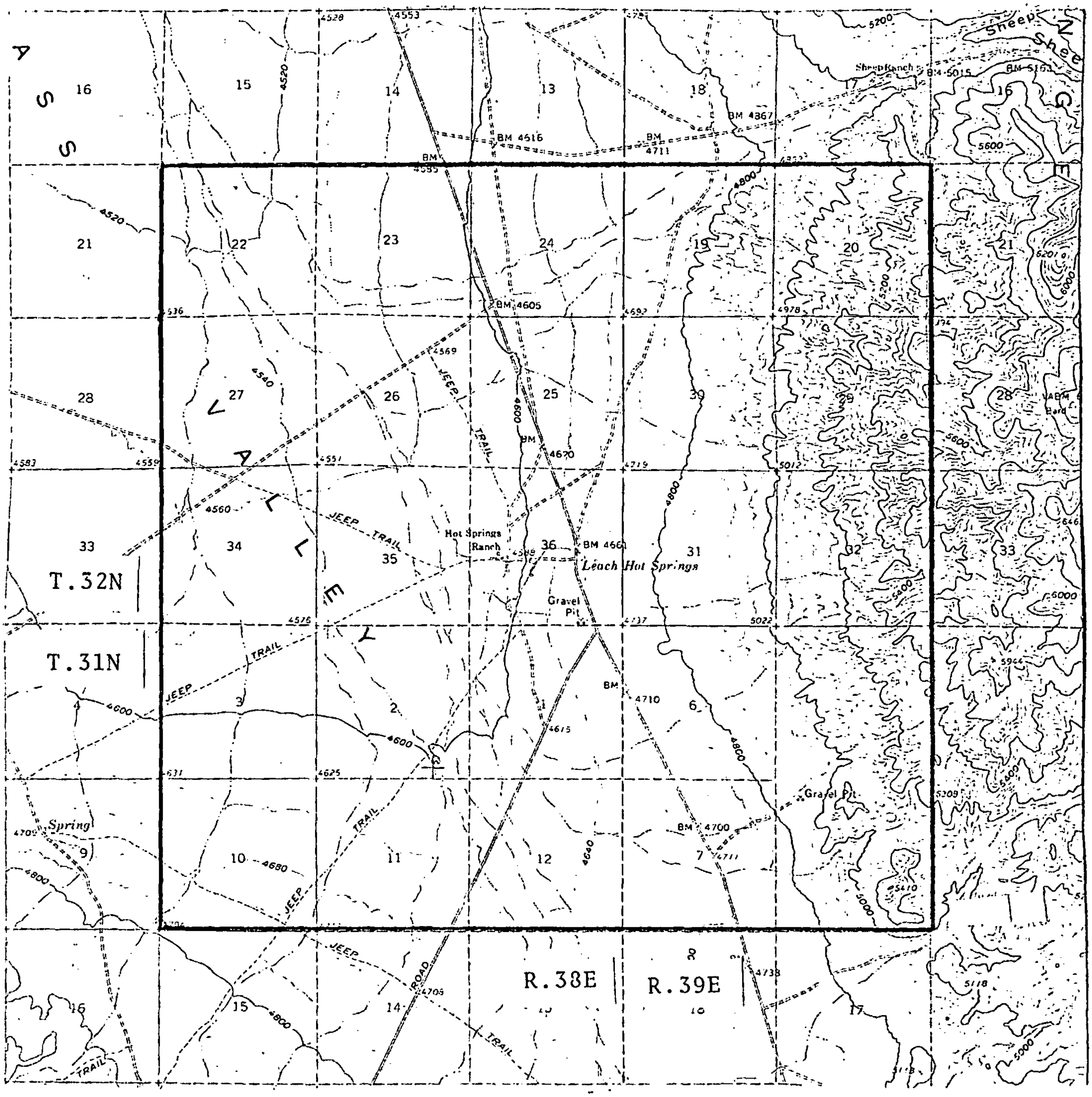



Figure B.1.1. Region of Grass Valley
Selected for Seismic Activity
Mapping

This is an excellent site in which to apply the proposed Seismic Activity Mapping Survey, the results of which would supplement existing information and provide more detailed information on the subsurface location of the possible geothermal reservoir at Leach Hot Springs and the associated faulting. The results of the Seismic Activity Mapping Survey would then be evaluated in light of the existing geologic and geophysical data in this area, and a complete report will be written describing the correlation between the Seismic Activity Mapping and the existing geology and geophysics. In addition, the future potential of this new passive seismic method would be further evaluated.

## B.2 PROGRAM DATA OFFERED

The data being offered consists of seismic activity maps indicating locations of body wave and surface wave emissions in the geothermal site, the time dependence of these emissions, and their frequency wavenumber composition. The array processing techniques to be utilized allow the location of seismic sources without requiring visually detectable, discrete microseismic events as in microearthquake surveys, yet allows improved detection and accurate location of these sources beyond that capable of conventional ground noise surveys. The data should be extremely valuable in delineating features of the geothermal system, since the dynamics of hot fluids, vapors, and active faults are likely to be the dominant source of ground noise in these regions.

The seismic activity maps will be computed to cover a 5x5 mile region at depths of 1000' to 7000', at 1000' increments, for the body wave sources. The field work will consist of simultaneously recording two 6-element arrays for overnight periods of five hours at a minimum of four sites. The arrays will be laid out as shown in Figure B.2.1. The body wave array consists of six geophone clusters (4.5 Hz geophones); five clusters uniformly spaced 1200' from a central cluster. Each geophone cluster will consist of 108 geophones covering a circular region of approximately 160' radius, according to the observed noise characteristics. The geophone output will be amplified and low-pass filtered (15 Hz cutoff), and transmitted through cables to be recorded near the center of the array by a Honeywell 5600C 14-channel analog tape recorder. The surface wave array has the same basic geometry but has a 200' inter-element spacing, and uses six individual HS-10 1 Hz seismometers. The array output is amplified, filtered, and recorded on the Honeywell unit.

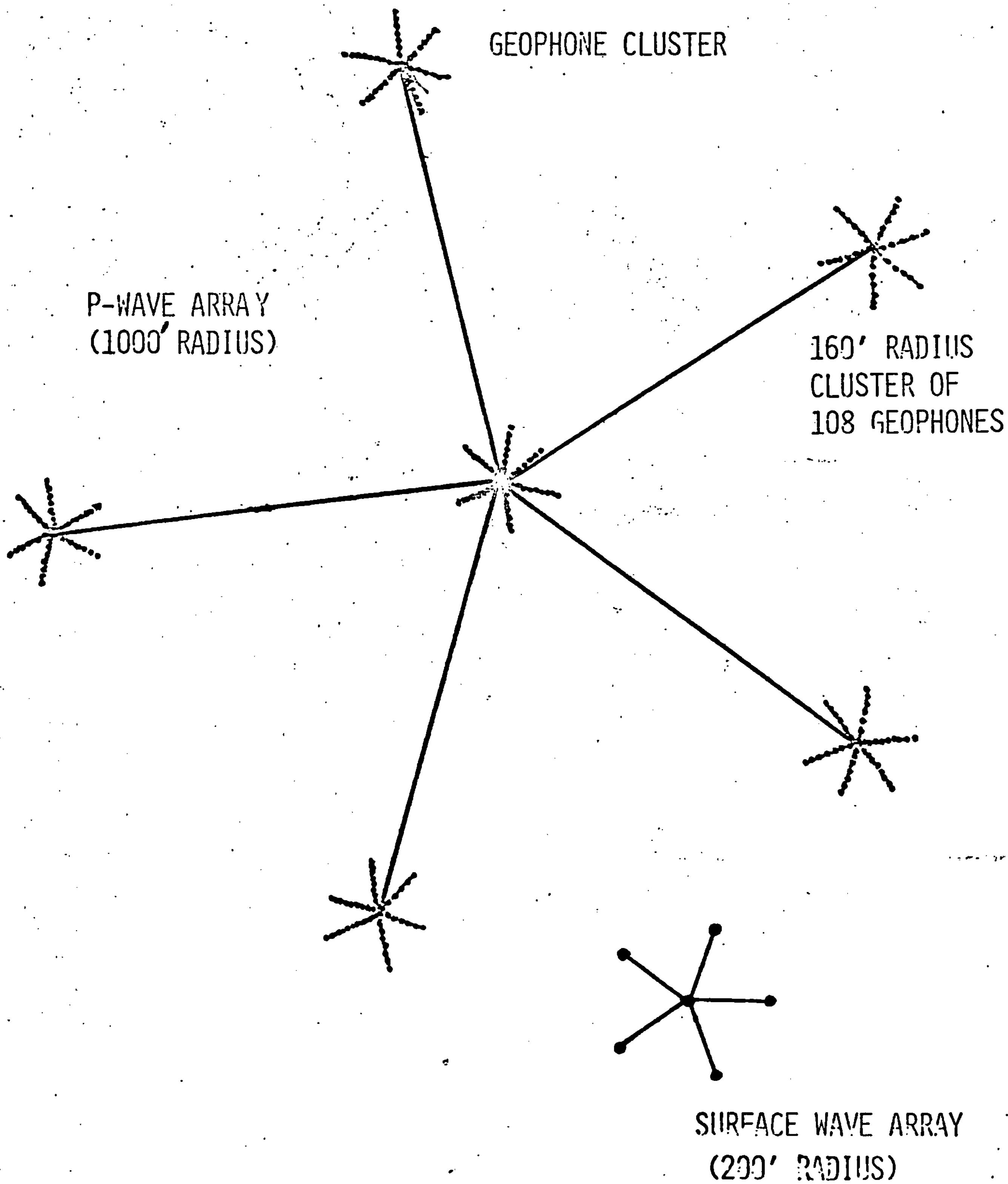



Figure B.2.1. Body Wave and Surface Wave Array Geometry

Data will be recorded for at least five hours during quiet periods of the night and drum recordings will be made for selected elements of both arrays to aid in the selection of good ground noise data. All instrumentation will be battery powered to eliminate generator noise.

The following is a description of the seismic activity mapping technique and an example of results from a survey in Roosevelt Hot Springs, Utah.

## DESCRIPTION OF THE SEISMIC ACTIVITY MAPPING TECHNIQUE

The technique involves correlating ground noise recorded over an array of geophones and using inter-phone correlations to determine the location of noise sources.

The physical layout of the array geophones, the seismic arrivals originating from a volume element centered at R, and their propagation through a region with a specified velocity profile is illustrated in Figure B.2.2. Figure B.2.3 is a flow chart of the computational steps involved in obtaining the average normalized array correlation for spatial locations of interest. The result is a ground noise seismic activity map. The first step in this analysis procedure is to specify the regional velocity profile, the coordinates of the geophones, and the spatial locations to be scanned for ground noise emission. At present, the HYPO 71 ray tracing program is used to compute the seismic travel times from each spatial element, located at R, to each geophone, assuming a two-dimensional layered earth model. Geophone data is then pre-processed and aligned according to the computed travel time delays for the space element located at R. The average normalized array correlation is computed using multistation correlation procedures. The magnitude of this correlation estimate is directly related to the degree that the seismic wave pattern at all geophones matches that expected for seismic emissions originating at a given location. This procedure is repeated for each space element being analyzed.

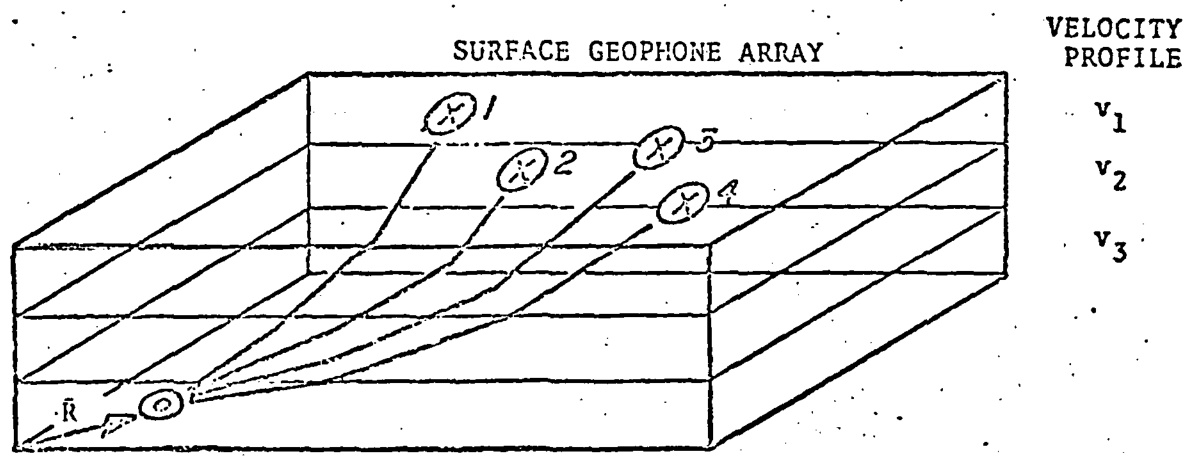



Figure B.2.2. Seismic Array Analysis

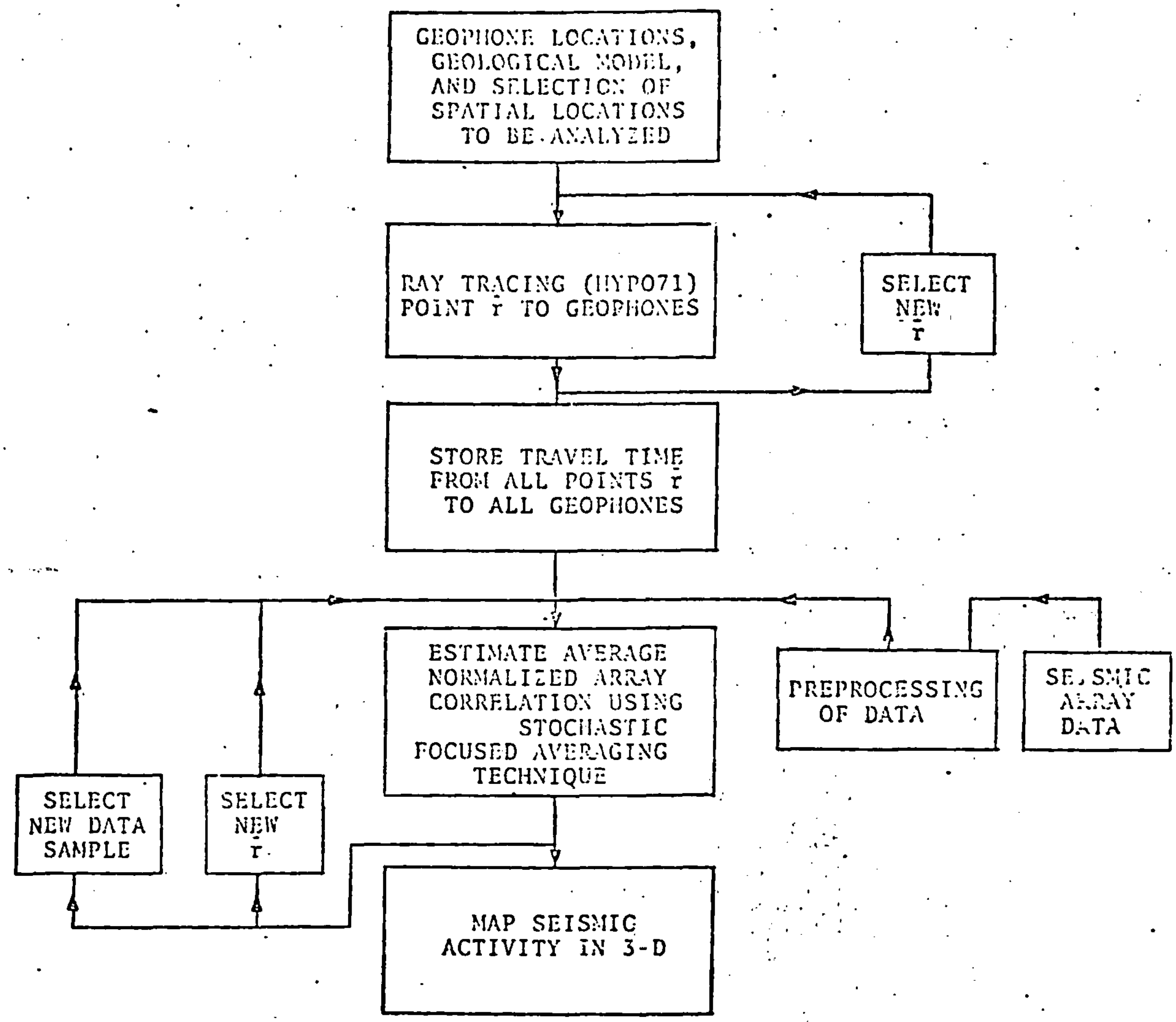



Figure B.2.3. Flow Chart For Ground Noise Seismic Array Analysis

As an example, the spatial elements may be of the dimensions 1000'x1000', and 20x20 grids of these elements may be used in mapping the geothermal region. Figure B.2.4 is a sample output map generated using synthetic data for a circular source region as recorded by a 6-element geophone array. This map covers a vertical plane of 20,000'x20,000'. The darkness of each spatial element is proportional to the normalized average array correlation for waveforms originating at that element.

## RESULTS FROM A GEOTHERMAL EXPLORATION SURVEY IN ROOSEVELT HOT SPRINGS, UTAH

In the Roosevelt Hot Springs survey, data was collected using four 5-phone arrays having inter-phone spacing of 1000' at the locations shown in Figure B.2.5. The data was recorded using a separate digital tape recorder for each geophone and had a sample rate of 100 pts/sec and a dynamic range of 60 dB. To insure accurate time alignment of the data recorded at the independent recording sites, an electronic timing mark, sent by cable from a central clock, was superimposed on the data each hour. This provided a check on the drift of the crystal clocks and insured the timing accuracy of <10 msec required for this analysis. Approximately 20 hours of data were recorded for each array. In addition to the digital tape recordings, smoked drum records of the ground noise and the wind speed were made. These records were used to locate 15 minute time periods with minimum interference from cultural and environmental noise sources, including microearthquakes.

Figures B.2.6 through B.2.9 are the seismic activity maps generated from data recorded at the individual array sites indicated in Figure B.2.5. These maps cover a 20,000'x20,000' region at a depth of 2000' with each square representing a

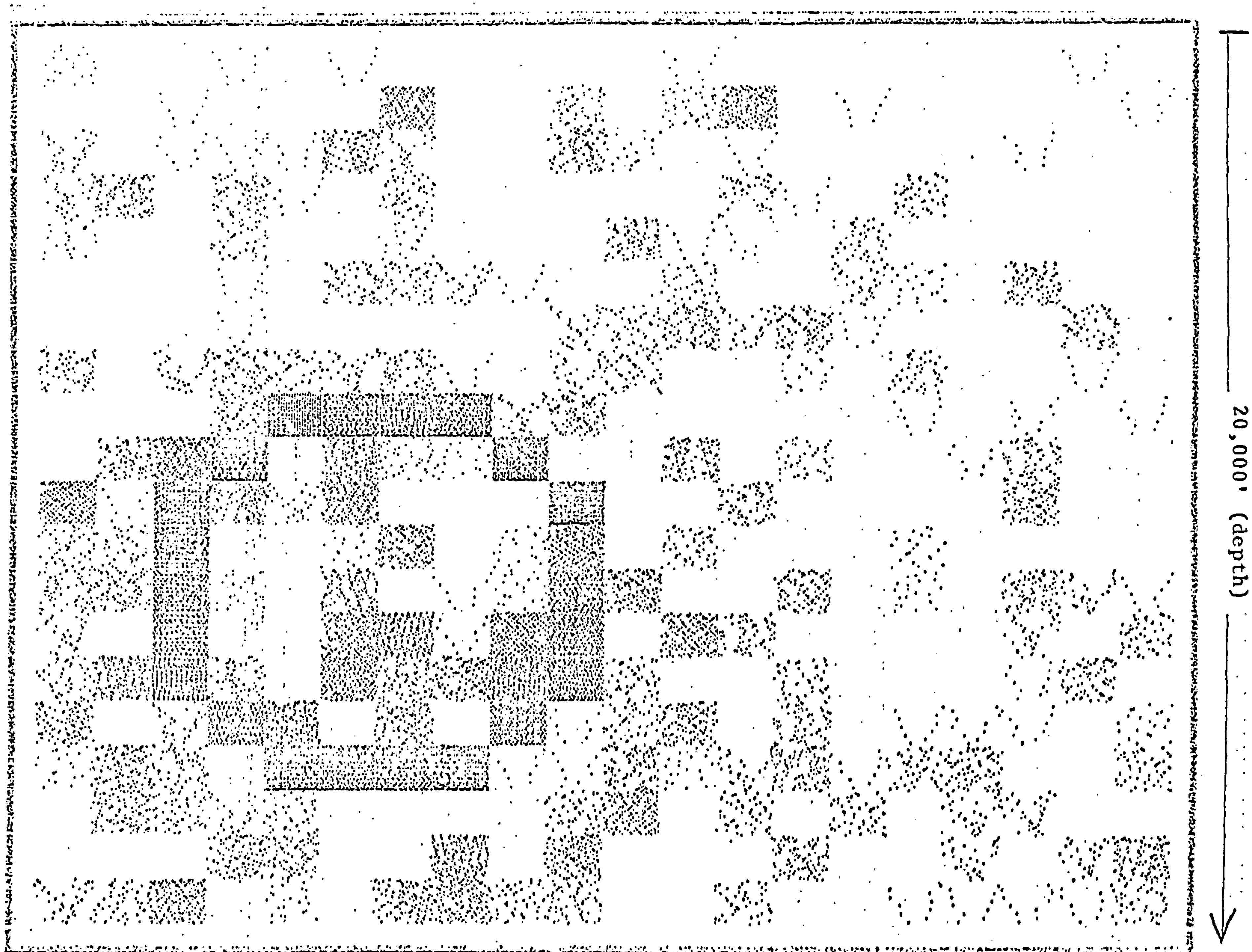



Figure B.2.4. Seismic Activity Map for A Synthetic Continuously Emitting Source

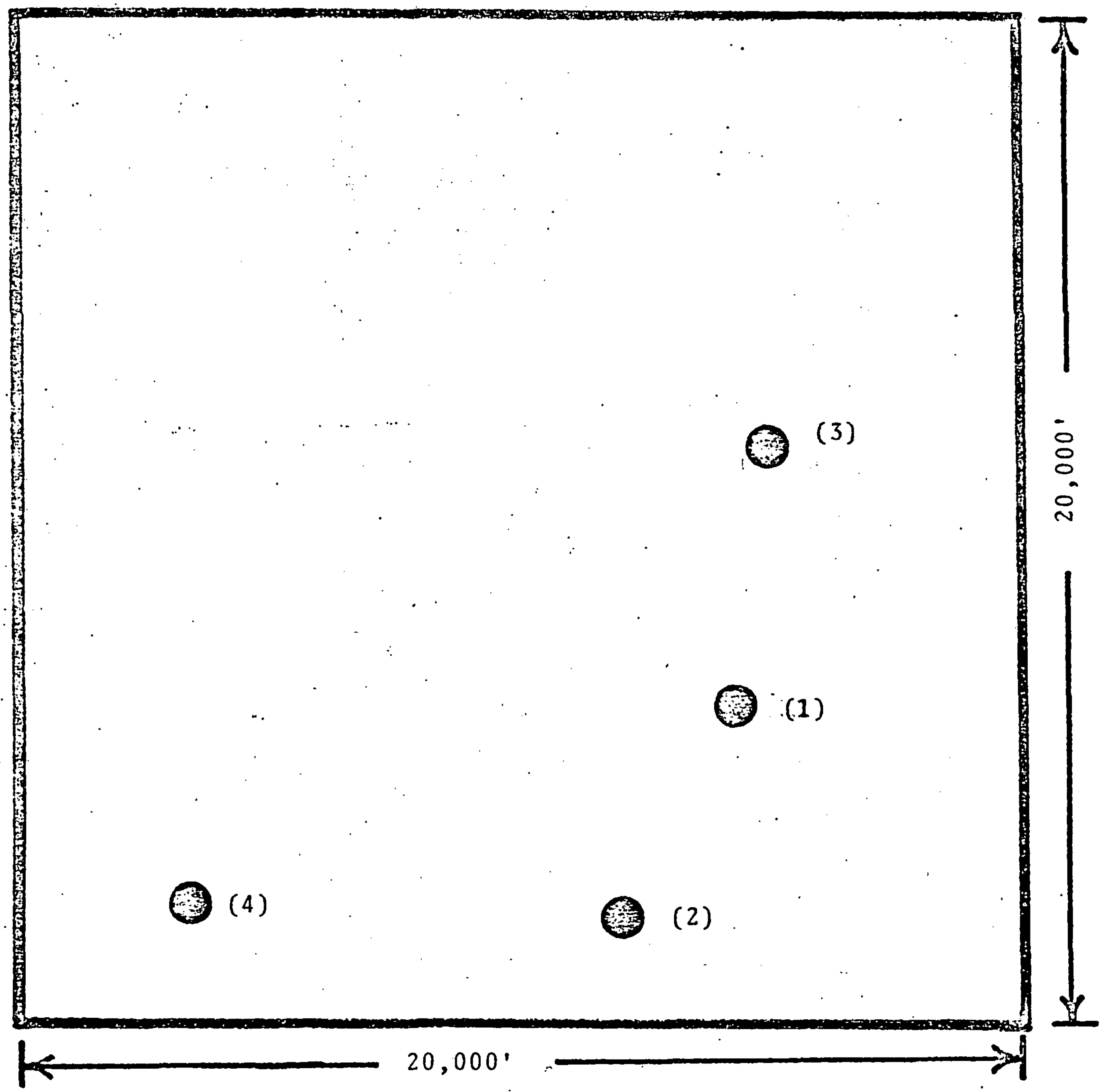



Figure B.2.5. Array Locations

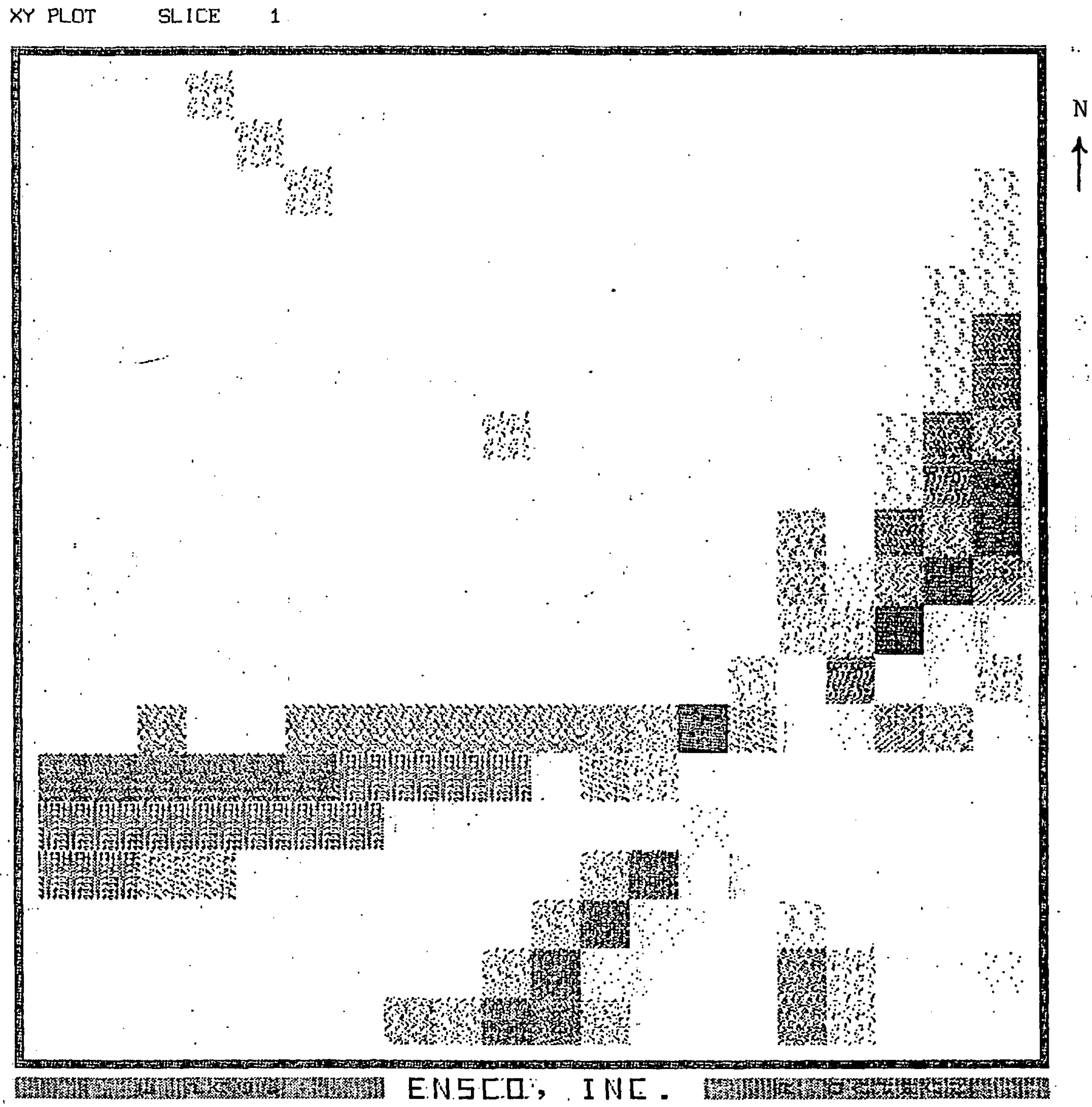



Figure B.2.6. Array 1, Seismic Activity Map

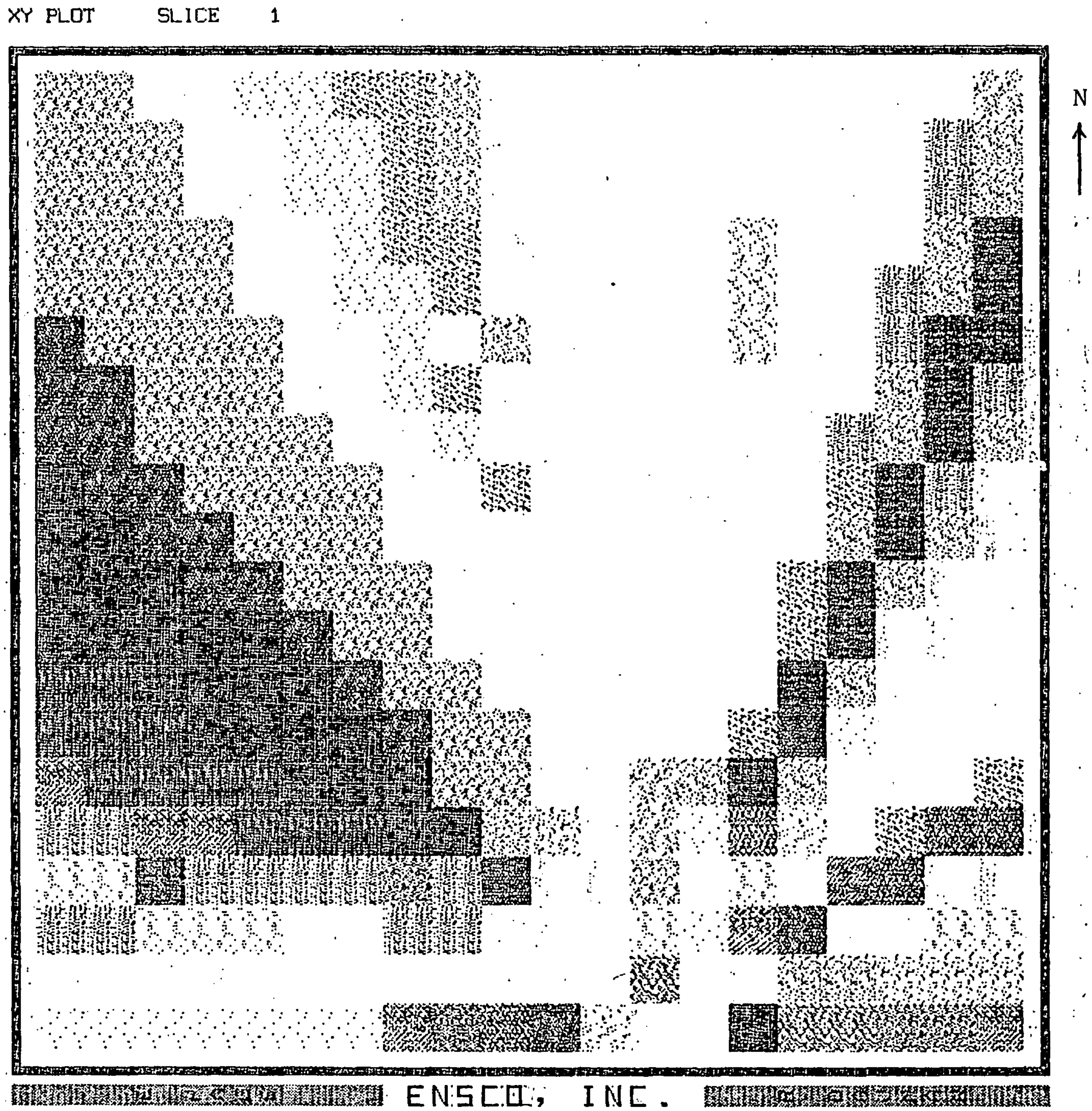



Figure B.2.7. Array 2, Seismic Activity Map

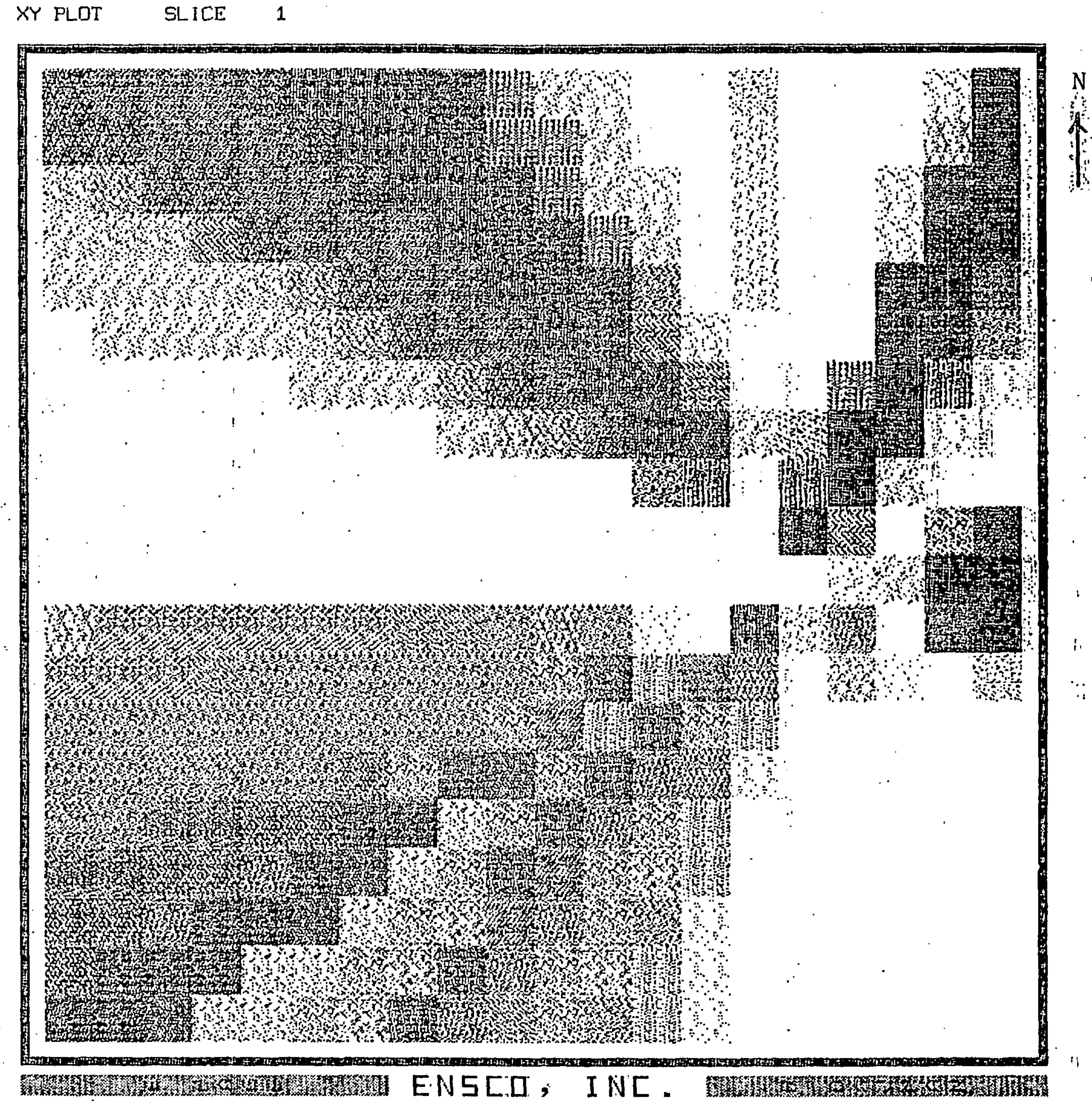



Figure B.2.8. Array 3, Seismic Activity Map

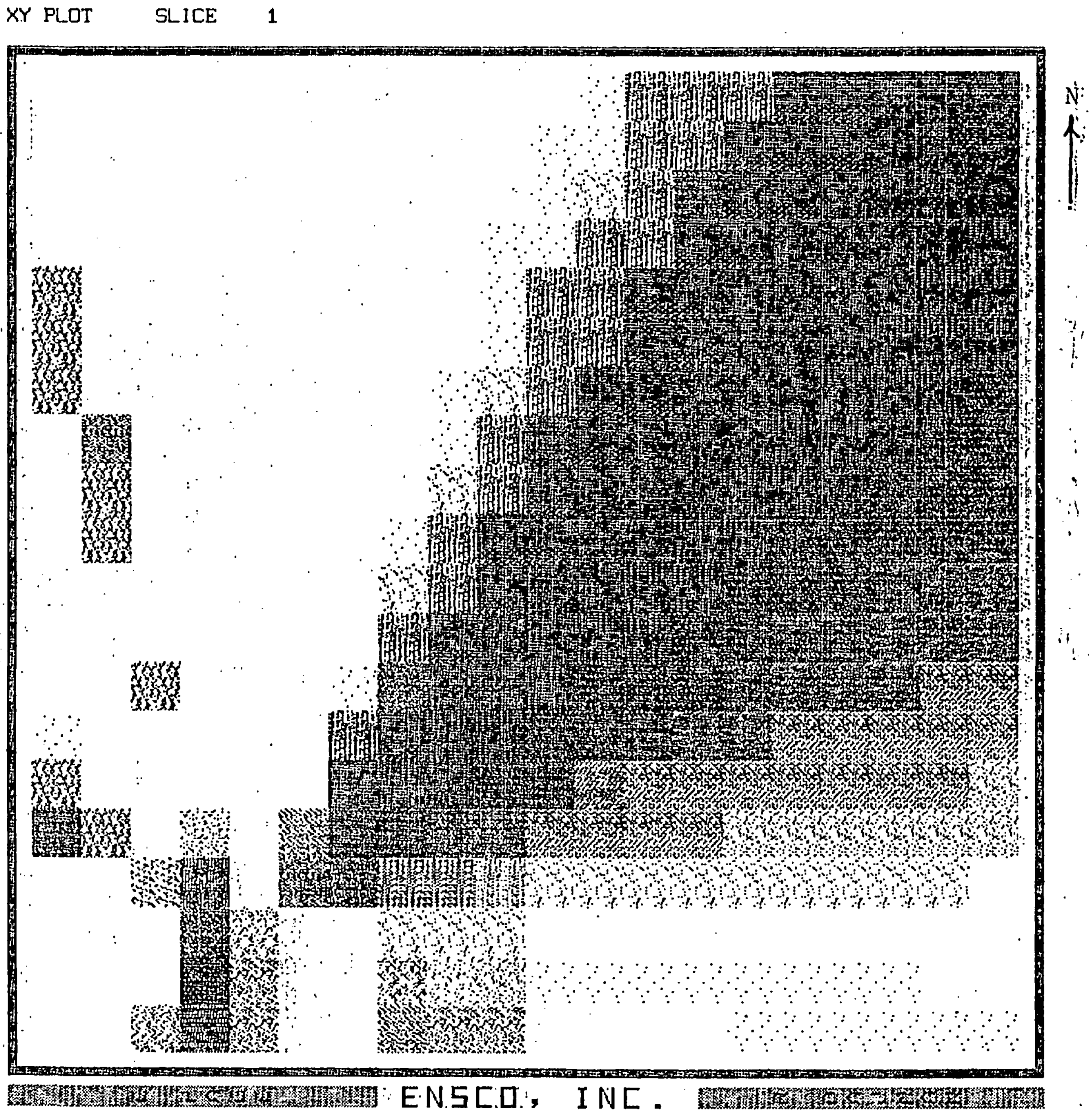



Figure B.2.9. Array 4, Seismic Activity Map

1000'x1000' area. The darkness of each square is related to the degree that seismic emissions correlate over the array for that source location.

In interpreting these maps, one must keep in mind the location of the recording array relative to the map feature. Depending on many factors, such as bandwidth of emissions, velocity profile, etc., the resolution of a source decreases as one moves radially from the array, and in many cases only the direction of the source can be determined. In such cases the source can be located only by the combined use of additional arrays. For this reason, surveys are always conducted with a minimum of three arrays placed to give good cross coverage of the area of interest.

In Figure B.2.6 one observes noise sources to the northeast and west of Array 1. In Figure B.2.7, sources are also observed to the northeast and west of Array 2, which was recorded on a different day approximately one mile from Array 1. In Figure B.2.8 (Array 3), noise sources are again observed to the northeast, although other secondary features differ. In Figure B.2.9 the seismic activity, as observed by Array 4, indicates a dominant northeast source, observed with lower resolution due to the greater distance from source to array.

Figure B.2.10 is an equally weighted composite of the four previous maps and clearly defines the seismically active regions in this portion of the Roosevelt Hot Springs.

The agreement among maps from four different arrays is quite impressive when one considers the different source-to-array spacings, possible time dependence of the sources, and the possibility of weaker sources close to a given array. In addition, analysis was performed on this data to verify that the observed features are statistically meaningful. The results indicate that it is extremely unlikely that they could have originated by chance correlation or surface wave energy.

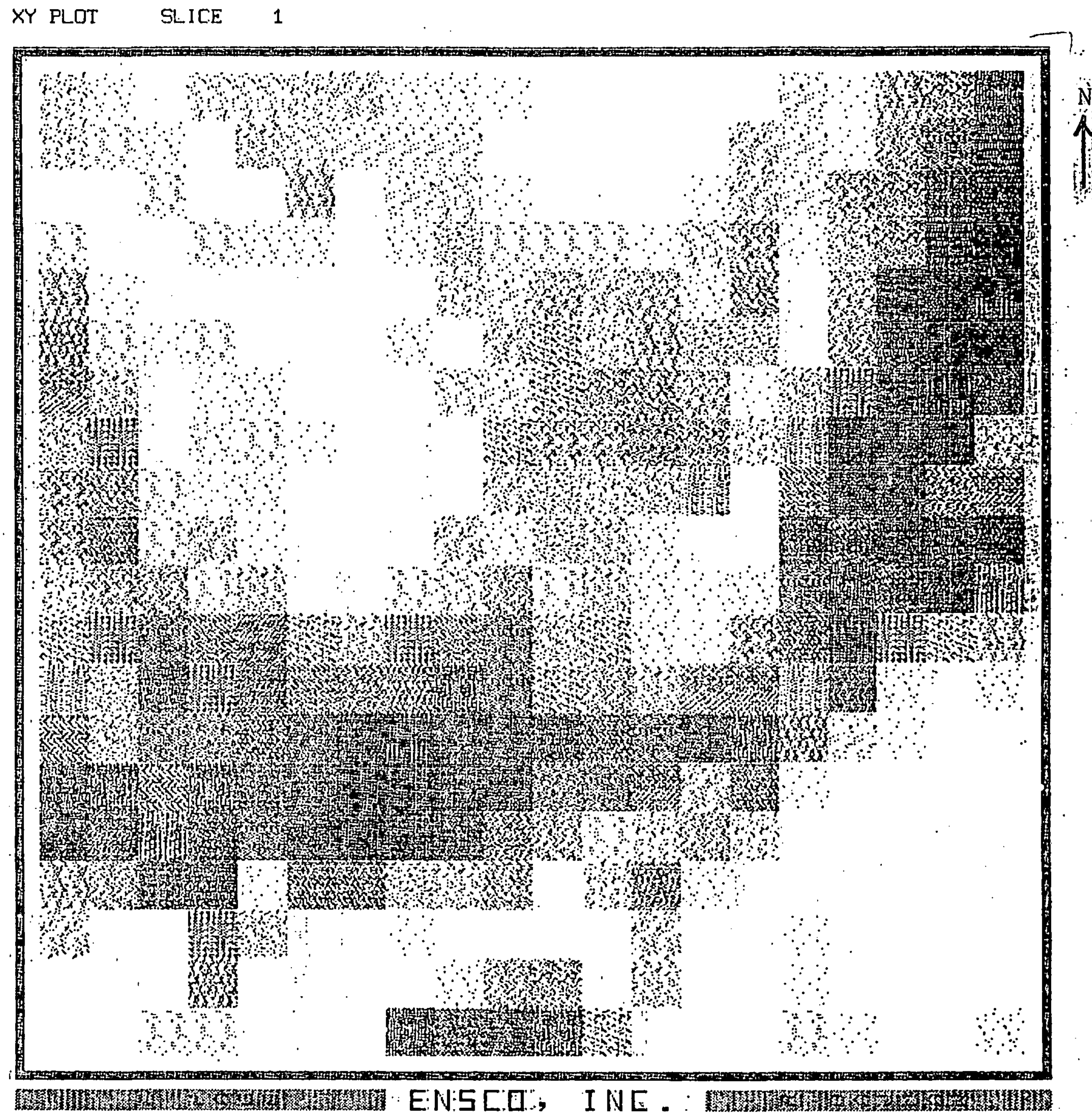



Figure B.2.10. Composite - Arrays 1-4

Further verification that these maps related to features of a geothermal system comes from deep productive wells located in the northeast region of the maps. A non-productive deep well is located west of this region in an area which does not show substantial seismic activity.

## B.3 PROGRAM DESCRIPTION

This program involves use of a new seismic ground noise survey technique which enables one to detect and locate sources of discrete and continuous seismic emissions in a geothermal area. The survey results are exhibited in the form of seismic activity maps covering the site at selected depths, and the interpretation of this seismic activity in terms of the known geology and geophysics of this site will be presented. The program involves completion of the following tasks.

### TASK 1: PREPARATION FOR FIELD WORK

This involves the assembly, renting, and testing of field instrumentation, and includes preparing necessary interfacing electronics, cables, etc. Also involved is obtaining the necessary permits, vehicles, and other available geophysics data relating to the investigation site.

### TASK 2: RECORDING SURFACE WAVE AND BODY WAVE EMISSIONS AT GEOTHERMAL SITE

Surface wave and body wave emissions will be simultaneously recorded using two arrays (described in Section B.2) for five hour periods, at each of four locations selected to give good coverage of the investigation site. Considerable care will be taken to record data during periods of minimum interference from cultural and other interfering seismic sources. This effort will require approximately 18 days in the field for three persons.

## TASK 3: DATA PROCESSING

### Task 3a. Pre-Processing of Data

The field recorded analog data will be edited, digitized, corrected for instrument response, high pass filtered to remove low frequency microseisms, and written into a format for computation of seismic activity maps, frequency-wavenumber analysis, and statistical interpretation.

### Task 3b: Computation of Seismic Activity Maps and F-K Analysis

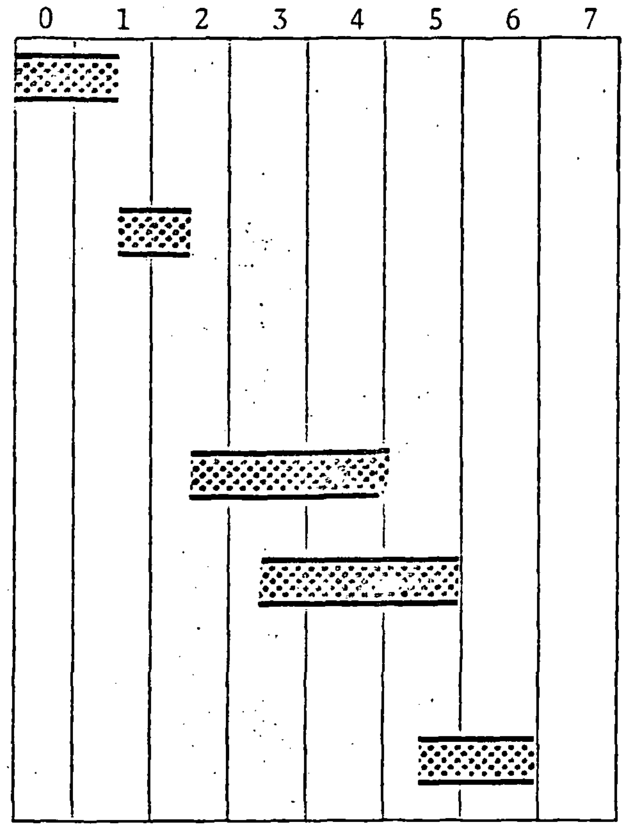
The digital data will be processed to produce seismic activity maps covering a 5x5 mile region at depths of 1000' to 7000', at 1000' increments, for each array location. A half hour of data will be used to compute each seismic activity map. This will be done at three different time periods for each array to get time dependent information, as well as for added statistical interpretation. A composite picture of the seismic activity will be obtained by combining results from the individual arrays. Statistic background maps will be computed for determination of significance of the seismic source indications.

In addition, frequency wavenumber analysis will be computed for this data to give further information about the characteristics of these seismic emissions.

## TASK 4: INTERPRETATION OF RESULTS AND FINAL REPORT

The seismic activity maps and frequency wavenumber analysis will be interpreted in light of the known geologic and geophysics of the site to enable one to delineate features of this geothermal system. Consultants with detailed familiarity of this investigation site will aid in this data interpretation and help incorporate information obtained from other survey techniques. A final report covering all aspects of this survey and data interpretation will be prepared.

## B.4 SCHEDULE




Task 1: Preparation for Field Work

Task 2: Recording Surface Wave & Body Wave Emissions at Geothermal Site

Task 3: Data Processing

- 3a. Pre-Processing of Data
- 3b. Computation of Seismic Activity Maps & F-K Analysis

Task 4: Interpretation of Results and Final Report

Earliest availability dates for data:

- A. Field Data: 3-1/2 months ARO
- B. Processed Data in the Form of Seismic Activity Maps: 5 months ARO
- C. Geophysical Interpretation of Results: 6 months ARO

## B.5 ENVIRONMENTAL EVALUATION

The only environmental impact anticipated is that of obtaining access to regions to place seismic arrays and the need to bury seismometers in one-foot holes which will be refilled upon leaving. Vehicles need not leave roads and trails. All other equipment, i.e., survey stakes, transmission cable, etc., will be removed upon completion of experiment.

# C. COST

## CONTRACT PRICING PROPOSAL
*(RESEARCH AND DEVELOPMENT)*

Office of Management and Budget Approval No. 29-RO184

This form is for use when *(i)* submission of cost or pricing data (see FPR 1-3.807-3) is required and *(ii)* substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. | NO. OF PAGES

| | |
|---|---|
| NAME OF OFFEROR: ENSCO, INC. | SUPPLIES AND/OR SERVICES TO BE FURNISHED: Geothermal Reservoir Assessment Case Study, Northern Basin and Range Province |
| HOME OFFICE ADDRESS: 5408A Port Royal Road Springfield, VA 22151 | |
| DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: ESS Division | TOTAL AMOUNT OF PROPOSAL: $ 74,964.00 — GOV'T SOLICITATION NO.: ET-78-R-08-0003 |

### DETAIL DESCRIPTION OF COST ELEMENTS

| | | | EST COST ($) | TOTAL EST COST[1] | REFERENCE[2] |
|---|---|---|---|---|---|
| 1. DIRECT MATERIAL *(Itemize on Exhibit A)* | | | | | |
| *a.* PURCHASED PARTS See Attachment A, Task 2 | | | 3310 | | |
| *b.* SUBCONTRACTED ITEMS | | | | | |
| *c.* OTHER—*(1)* RAW MATERIAL | | | | | |
| *(2)* YOUR STANDARD COMMERCIAL ITEMS | | | | | |
| *(3)* INTERDIVISIONAL TRANSFERS *(At other than cost)* | | | | | |
| *TOTAL DIRECT MATERIAL* | | | | 3310 | |
| 2. MATERIAL OVERHEAD[3] *(Rate %XS base=)* | | | | | |
| 3. DIRECT LABOR *(Specify)* | ESTIMATED HOURS | RATE/ HOUR | EST COST ($) | | |
| See Attachment A, Tasks 1-4 | | | | | |
| *TOTAL DIRECT LABOR* | | | | 16880 | |
| 4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3] | O.H. RATE | X BASE = | EST COST ($) | | |
| ESS Division | 107% | 16880 | 18062 | | |
| *TOTAL LABOR OVERHEAD* | | | | 18062 | |
| 5. SPECIAL TESTING *(Including field work at Government installations)* | | | EST COST ($) | | |
| *TOTAL SPECIAL TESTING* | | | | | |
| 6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)* | | | | | |
| 7. TRAVEL *(If direct charge) (Give details on attached Schedule)* See Attachment A, Task 2 | | | EST COST ($) | | |
| *a.* TRANSPORTATION | | | | | |
| *b.* PER DIEM OR SUBSISTENCE | | | | | |
| *TOTAL TRAVEL* | | | | 3218 | |
| 8. CONSULTANTS *(Identify—purpose—rate)* See Attachment A, Tasks 2 & 4 | | | EST COST ($) | | |
| Mr. Douglas Guion, EDCON Corporation, Denver, CO | | | | | |
| 10 days @ $250/day | | | 1250 | | |
| Travel | | | 1266 | | |
| *TOTAL CONSULTANTS* | | | | 3766 | |
| 9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* | | | | 15570 | |
| 10. *TOTAL DIRECT COST AND OVERHEAD* | | | | 60806 | |
| 11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate* 13 *% of cost element Nos.* 1-9 *)*[3] | | | | 7905 | |
| 12. ROYALTIES[4] | | | | | |
| 13. *TOTAL ESTIMATED COST* | | | | 68711 | |
| 14. FEE OR PROFIT | | | | 6253 | |
| 15. *TOTAL ESTIMATED COST AND FEE OR PROFIT* | | | | 74964 | |

OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

| TYPED NAME AND TITLE | SIGNATURE |
|---|---|
| Robert Howard<br>Executive Administrator | |

| NAME OF FIRM | DATE OF SUBMISSION |
|---|---|
| ENSCO, INC. | May 30, 1978 |

**EXHIBIT A—SUPPORTING SCHEDULE** *(Specify. If more space is needed, use reverse)*

| COST EL NO. | ITEM DESCRIPTION *(See footnote 5)* | | EST COST *(\$)* |
|---|---|---|---|
| 9 | Other Direct Costs | | |
| | Rentals and associated costs (see Attachment A, Task 2) | $5,370 | |
| | Computer Usage, PDP-11/70, Tasks 3.1 and 3.2, 120 hrs @ $85/hr | $10,200 | |
| | | | $15,570 |

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

[X] YES [ ] NO *(If yes, identify below.)*

| NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL | TELEPHONE NUMBER/EXTENSION |
|---|---|
| DCAA, 5600 Columbia Pike, Falls Church, VA 22041 | 202-756-1110 |

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

[X] YES [ ] NO *(If yes, identify.)*: [ ] ADVANCE PAYMENTS [X] PROGRESS PAYMENTS OR [ ] GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

[X] YES [ ] NO *(If no, explain on reverse or separate page)*

*See Reverse for Instructions and Footnotes* OPTIONAL FORM 60 (10-71)

ATTACHMENT A

SUMMARY OF COSTS BY TASK

TASK 1

| | | | |
|---|---|---|---|
| Direct Labor | | | |
| Staff Scientist | 40 hrs @ $16.00/hr | $640 | |
| Engineer | 60 hrs @ $10.15/hr | 609 | |
| Assoc. Engineer | 80 hrs @ $ 6.74/hr | 539 | |
| Sr. Proj. Admin. | 8 hrs @ $ 8.48/hr | 68 | |
| Staff Exec. Sec. | 4 hrs @ $ 6.75/hr | 27 | |
| | | | $1883 |
| Overhead @ 107% | | | 2015 |
| Total Direct Cost plus Overhead | | | 3898 |
| G & A @ 13% | | | 507 |
| Total Estimated Cost | | | 4405 |
| Fee | | | 401 |
| Total Cost plus Fee | | | $4806 |

Attachment A

TASK 2

**Direct Labor**

| | | | |
|---|---|---|---|
| Staff Scientist | 112 hrs @ $16.00/hr | $1792 | |
| Sr. Scientist | 112 hrs @ $11.10/hr | 1243 | |
| Engineer | 152 hrs @ $10.15/hr | 1543 | |
| Sr. Proj. Admin. | 12 hrs @ $ 8.48/hr | 102 | |
| Staff Exec. Sec. | 8 hrs @ $ 6.75/hr | 54 | |
| | | | $ 4734 |
| **Overhead @ 107%** | | | 5065 |

**Material**

| | | |
|---|---|---|
| Car batteries, 80 amp/hr, 18 @ $40/ea | $ 720 | |
| Seismic high gain amps (field ready) 14 @ $70/ea/mo, 1 mo | 980 | |
| Twist pair field cable, 7000' @ $94/1000' (TESCO, Tulsa, OK) | 658 | |
| Cable reels, 2 @ $92/ea (TESCO) | 184 | |
| Magnetic analog tape, 1"-4000', 5 @ $50/ea (3M) | 250 | |
| Everready 12 v. dry cell, 14 @ $12/ea | 168 | |
| Additional cables, connectors, etc. | 350 | |
| | | 3310 |

**Travel**

Washington, DC/Lovelock, NE (via Reno)
(2 people, 14 days)

| | | | |
|---|---|---|---|
| R/T Air Fare @ 472 | $ 944 | | |
| Per Diem @ $45/day | 1260 | | |
| | | $2204 | |

Washington, DC/Colorado Springs, CO
(1 person, 16 days)

| | | | |
|---|---|---|---|
| R/T Air Fare | $ 294 | | |
| Per Diem @ $45/day | 720 | | |
| | | 1014 | |
| | | | 3218 |

Attachment A, Task 2 Continued

<u>Consultant</u>

| | | | |
|---|---|---|---|
| Mr. Douglas Guion, EDCON Corporation, Denver, CO<br>3 days @ $250/day | | $750 | |
| Denver, CO/Lovelock, NE | | | |
| R/T Air Fare | $222 | | |
| Per Diem @ $45/day, 3 days | 135 | | |
| Auto Rental @ $30/day, 3 days | 90 | | |
| | | 447 | |
| | | | $ 1197 |

<u>Other Direct Costs</u>

| | | |
|---|---|---|
| Rental of Honeywell 5600c magnetic tape recorder, 12 record, 6 play-back, 1 mo @ $1400/mo | $1400 | |
| Rental of Topaz 1000 inverter, 1 mo @ $195/mo | 195 | |
| Air freight on 2 above items, 200 lbs Calgary, Canada/Colorado Springs | 180 | |
| Rental of geophone cluster, 6 @ $315/ea/mo, 1 mo (Mark Products) | 1890 | |
| Air freight on geophone cluster | 350 | |
| Customs on geophone cluster (estimate from previous job) | 100 | |
| U-Haul trailer and hitch, 6' closed, (Denver/NE) 25 days @ $8/day | 200 | |
| Survey transit, 1 mo @ $60/mo, (Thorpe-Smith, Inc.) | 60 | |
| Pickup truck, 3-1/2 wks @ $90/wk (National Car Rental) | 315 | |
| Truck rental, Colorado Springs/site in NE National Car Rental, includes gas, mileage, 3 days per diem for driver | 680 | |
| | | 5370 |
| <u>Total Direct Cost plus Overhead</u> | | 22894 |
| <u>G & A @ 13%</u> | | 2976 |
| <u>Total Estimated Cost</u> | | 25870 |
| <u>Fee</u> | | 2354 |
| <u>Total Cost plus Fee</u> | | $28224 |

Attachment A

TASK 3.1

| | | | |
|---|---|---|---|
| Direct Labor | | | |
| Staff Scientist | 12 hrs @ $16.00/hr | $ 192 | |
| | 48 hrs @ $17.28/hr | 829 | $ 1021 |
| Sr. Prog./Analyst | 24 hrs @ $11.10/hr | 266 | |
| | 96 hrs @ $11.99/hr | 1151 | 1417 |
| Sr. Proj. Admin. | 6 hrs @ $ 8.48/hr | 51 | |
| | 18 hrs @ $ 9.16/hr | 165 | 216 |
| Staff Exec. Sec. | 2 hrs @ $ 6.75/hr | 14 | |
| | 8 hrs @ $ 7.29/hr | 58 | 72 |
| | | | 2726 |
| Overhead @ 107% | | | 2917 |
| Other Direct Costs | | | |
| Computer Usage, PDP-11/70, 50 hrs @ $85/hr | | | 4250 |
| Total Direct Cost plus Overhead | | | 9893 |
| G & A @ 13% | | | 1286 |
| Total Estimated Cost | | | 11179 |
| Fee | | | 1017 |
| Total Cost plus Fee | | | $12196 |

Attachment A

TASK 3.2

| | | | |
|---|---|---|---|
| Direct Labor | | | |
| Staff Scientist | 120 hrs @ $17.28/hr | $2074 | |
| Sr. Scientist | 90 hrs @ $11.99/hr | 1079 | |
| Sr. Prog./Analyst | 160 hrs @ $11.99/hr | 1918 | |
| Sr. Proj. Admin. | 20 hrs @ $ 9.16/hr | 183 | |
| Staff Exec. Sec. | 16 hrs @ $ 7.29/hr | 117 | |
| | | | $ 5371 |
| Overhead @ 107% | | | 5747 |
| Other Direct Costs | | | |
| Computer Usage, PDP-11/70, 70 hrs @ $85/hr | | | 5950 |
| Total Direct Cost plus Overhead | | | 17068 |
| G & A @ 13% | | | 2219 |
| Total Estimated Cost | | | 19287 |
| Fee | | | 1755 |
| Total Cost plus Fee | | | $21042 |

Attachment A

TASK 4

Direct Labor

| | | | |
|---|---|---|---|
| Staff Scientist | 90 hrs @ $17.28/hr | $1555 | |
| Sr. Scientist | 40 hrs @ $11.99/hr | 480 | |
| Sr. Proj. Admin. | 8 hrs @ $ 9.16/hr | 73 | |
| Staff Exec. Sec. | 8 hrs @ $ 7.29/hr | 58 | |
| | | | $2166 |
| Overhead @ 107% | | | 2318 |

Consultant

| | | | |
|---|---|---|---|
| Mr. Douglas Guion, EDCON Corporation, Denver, CO<br>7 days @ $250/day | | $1750 | |
| Denver, CO/Washington, DC | | | |
| R/T Air Fare | $294 | | |
| Per Diem @ $45/day | 315 | | |
| Auto Rental @ $30/day | 210 | 819 | |
| | | | 2569 |
| Total Direct Cost plus Overhead | | | 7053 |
| G & A @ 13% | | | 917 |
| Total Estimated Cost | | | 7970 |
| Fee | | | 726 |
| Total Cost plus Fee | | | $8696 |

## REPRESENTATIONS AND CERTIFICATIONS
**(Construction and Architect-Engineer Contract)**
**(For use with Standard Forms 19, 21 and 252)**

REFERENCE *(Enter same No.(s) as on SF 19, 21 and 252)*

RFP ET-78-R-08-0003

NAME AND ADDRESS OF BIDDER *(No., Street, City, State, and ZIP Code)*

ENSCO, INC.
5408A Port Royal Road
Springfield, VA 22151

DATE OF BID

May 30, 1978

*In negotiated procurements, "bid" and "bidder" shall be construed to mean "offer" and "offeror."*

The bidder makes the following representations and certifications as a part of the bid identified above. *(Check appropriate boxes.)*

### 1. SMALL BUSINESS

He ☒ is, ☐ is not, a small business concern. (A small business concern for the purpose of Government procurement is a concern, including its affiliates, which is independently owned and operated, is not dominant in the field of operations in which it is bidding on Government contracts, and can further qualify under the criteria concerning number of employees, average annual receipts, or other criteria as prescribed by the Small Business Administration. For additional information see governing regulations of the Small Business Administration (13 CFR Part 121)).

### 2. MINORITY BUSINESS ENTERPRISE

He ☐ is, ☒ is not a minority business enterprise. A minority business enterprise is defined as a "business, at least 50 percent of which is owned by minority group members or, in case of publicly owned businesses, at least 51 percent of the stock of which is owned by minority group members." For the purpose of this definition, minority group members are Negroes, Spanish-speaking American persons, American-Orientals, American-Indians, American-Eskimos, and American-Aleuts."

### 3. CONTINGENT FEE

*(a)* He ☐ has, ☒ has not, employed or retained any company or person (other than a full-time bona fide employee working solely for the bidder) to solicit or secure this contract, and *(b)* he ☐ has, ☒ has not, paid or agreed to pay any company or person (other than a full-time bona fide employee working solely for the bidder) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating to *(a)* and *(b)* above as requested by the Contracting Officer. *(For interpretation of the representation, including the term "bona fide employee," see Code of Federal Regulations, Title 41, Subpart 1-1.5.)*

### 4. TYPE OF ORGANIZATION

He operates as an ☐ individual, ☐ partnership, ☐ joint venture, ☒ corporation, incorporated in State of Virginia.

### 5. INDEPENDENT PRICE DETERMINATION

*(a)* By submission of this bid, each bidder certifies, and in the case of a joint bid each party thereto certifies as to his own organization, that in connection with this procurement:

(1) The prices in this bid have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other bidder or with any competitor;

(2) Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the bidder and will not knowingly be disclosed by the bidder prior to opening, in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly to any other bidder or to any competitor; and

(3) No attempt has been made or will be made by the bidder to induce any other person or firm to submit or not to submit a bid for the purpose of restricting competition.

*(b)* Each person signing this bid certifies that:

(1) He is the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein and that he has not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)*(3) above; or

(2) (i) He is not the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)* (3) above, and as their agent does hereby so certify; and (ii) he has not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)*(3) above.

*(c)* This certification is not applicable to a foreign bidder submitting a bid for a contract which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

*(d)* A bid will not be considered for award where *(a)*(1), *(a)*(3), or *(b)* above, has been deleted or modified. Where *(a)*(2) above, has been deleted or modified, the bid will not be considered for award unless the bidder furnishes with the bid a signed statement which sets forth in detail the circumstances of the disclosure and the head of the agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

***NOTE.—Bids must set forth full, accurate, and complete information as required by this invitation for bids (including attachments). The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.***

*THE FOLLOWING NEED BE CHECKED ONLY IF BID EXCEEDS $10,000 IN AMOUNT.*

6. EQUAL OPPORTUNITY

He ☒ has, ☐ has not, participated in a previous contract or subcontract subject to the Equal Opportunity Clause herein, the clause originally contained in Section 301 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114; he ☒ has, ☐ has not, filed all required compliance reports; and representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards.

(The above representations need not be submitted in connection with contracts or subcontracts which are exempt from the equal opportunity clause.)

7. PARENT COMPANY AND EMPLOYER IDENTIFICATION NUMBER

*Each bidder shall furnish the following information by filling in the appropriate blocks:*

*(a)* Is the bidder owned or controlled by a parent company as described below? ☐ Yes ☒ No. *(For the purpose of this bid, a parent company is defined as one which either owns or controls the activities and basic business policies of the bidder. To own another company means the parent company must own at least a majority (more than 50 percent) of the voting rights in that company. To control another company, such ownership is not required; if another company is able to formulate, determine, or veto basic business policy decisions of the bidder, such other company is considered the parent company of the bidder. This control may be exercised through the use of dominant minority voting rights, use of proxy voting, contractual arrangements, or otherwise.)*

*(b)* If the answer to *(a)* above is "Yes," bidder shall insert in the space below the name and main office address of the parent company.

| NAME OF PARENT COMPANY | MAIN OFFICE ADDRESS *(No., Street, City, State, and ZIP Code)* |
|---|---|
| | |

*(c)* Bidder shall insert in the applicable space below, if he has no parent company, his own Employer's Identification Number (E.I. No.) *(Federal Social Security Number used on Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941)*, or, if he has a parent company, the E.I. No. of his parent company.

| EMPLOYER IDENTIFICATION NUMBER OF | PARENT COMPANY | BIDDER |
|---|---|---|
| | | 54-0847621 |

8. CERTIFICATION OF NONSEGREGATED FACILITIES

(Applicable to (1) contracts, (2) subcontracts, and (3) agreements with applicants who are themselves performing federally assisted construction contracts, exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause.)

By the submission of this bid, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certificatons from proposed subcontractors prior to the award of subcontractors exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

9. CLEAN AIR AND WATER

(Applicable if the bid or offer exceeds $100,000, or the contracting officer has determined that orders under an indefinite quantity contract in any year will exceed $100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or the Federal Water Pollution Control Act (33 U.S.C. 1319(c)) and is listed by EPA, or is not otherwise exempt.)

The bidder or offeror certifies as follows:

(a) Any facility to be utilized in the performance of this proposed contract has ☐, has not ☒, been listed on the Environmental Protection Agency List of Violating Facilities.

(b) He will promptly notify the contracting officer, prior to award, of the receipt of any communication from the Director, Office of Federal Activities, Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities.

(c) He will include substantially this certification, including this paragraph (c), in every nonexempt subcontract.

SUPPLEMENT TO REPRESENTATIONS AND CERTIFICATIONS

10. BUY AMERICAN CERTIFICATE

The bidder or offeror hereby certifies that each end product, except the end products listed below, is a domestic source end product (as defined in the clause entitled "Buy American Act"); and that components of unknown origin have been considered to have been mined, produced, or manufactured outside the United States.

Excluded end products (show country of origin for each excluded end product):

11. AFFIRMATIVE ACTION PROGRAM

The following paragraphs are added:

a. The bidder or proposer represents that he (a) [X] 1. has developed and has on file, [ ] 2. has not developed and does not have on file at each establishment an affirmative action program as required by the rules and regulations of the Secretary of Labor (41 CFR Part 60-1 and 60-2), or that he (b) [ ] has not previously had contracts subject to the written Affirmative Action Program requirement of the Secretary of Labor.

   If such a program has not been developed, the bidder will complete the following:

   The bidder does [ ], does not [ ] employ more than 50 employees and has [ ], has not [ ] been awarded a contract subject to Executive Order 11246 in the amount of $50,000 or more since July 1, 1968. If such a contract has been awarded since July 1, 1968, give the date of such contract, but do not list contracts awarded within the last 120 days prior to the date of this representation.

b. The bidder or proposer represents (a) that a full compliance review of the bidder's employment practices [X] has, [ ] has not been conducted by an agency of the Federal Government; that such compliance review [ ] has, [ ] has not been conducted for the bidder's known first-tier subcontractors with a subcontract of $50,000 or more and having 50 or more employees and (b) that the most recent compliance reviews were conducted as follows:

   August 1976

NAME OF CONTRACTOR (include known first-tier subcontractors) | DATE | FEDERAL AGENCY

c. The bidder or proposer represents that if the bidder has 50 or more employees and if this Contract is for $50,000 or more, and that for each subcontractor having 50 or more employees and a subcontract for $50,000 or more, and if he has not developed one, a written affirmative action plan will be developed for each of its establishments within 120 days from commencement of the Contract. A copy of the establishment's plan shall also be maintained at the establishment within 120 days from the date of commencement of the Contract.

The Affirmative Action Compliance Program will cover the items specifically set out in 41 CFR Part 60-2 and shall be signed by an executive of the Contractor.

d. Where the bid of the apparent low responsible bidder is in the amount of $1 million or more, the bidder and his known first-tier subcontractors which will be awarded subcontracts of $1 million or more will be subject to full, preaward equal opportunity compliance reviews before the award of the Subcontract for the purpose of determining whether the bidder and his subcontractors are able to comply with the provisions of the equal opportunity clause.

e. The bidder or proposer, if he has 100 or more employees, and all subcontractors having 100 or more employees are required to submit the Government Employer Information Report SF 100 (EEO-1), within 30 days after award, unless such report has been filed within 12 months preceding award. The EEO-1 report is due annually on or before March 31.

12. COST ACCOUNTING STANDARDS--EXEMPTION FOR CONTRACTS OF $500,000 OR LESS--CERTIFICATION

If this proposal is expected to result in the award of a contract of $500,000 or less and the offeror is otherwise eligible for an exemption, he shall indicate by checking the box below that the exemption to the Cost Accounting Standards clause (FPR 1-3.1204) under the provisions of 4 CFR 331.30(b)(8) (see FPR 1-3.1203(h)) is claimed. Where the offeror fails to check the box, he shall be given the opportunity to make an election in writing to the Contracting Officer prior to award. Failure to check the box below or make such an election shall mean that the offeror cannot claim the exemption to the Cost Accounting Standards clause or that the offeror elects to comply with such clause.

[ ] Certificate of Exemption for Contracts of $500,000 or Less.

The offeror hereby claims an exemption from the Cost Accounting Standards clause under the provisions of 4 CFR 331.30(b)(8) and certifies that he has received notification of final acceptance of all items of work on (i) any prime contract or subcontract in excess of $500,000 which contains the Cost Accounting Standards clause, and (ii) any prime contract or subcontract of $500,000 or less awarded after January 1, 1975, which contains the Cost Accounting Standards clause. The offeror further certifies he will immediately notify the Contracting Officer in writing in the event he is awarded any other contract or subcontract containing the Cost Accounting Standards clause subsequent to the date of this certificate but prior to the date of any award resulting from this proposal.

13. DISCLOSURE STATEMENT--COST ACCOUNTING PRACTICES AND CERTIFICATION

Any contract in excess of $100,000 resulting from this solicitation except (i) when the price negotiated is based on: (A) established catalog or market prices of commercial items sold in substantial quantities to the general public, or (B) prices set by law or regulation, or (ii) contracts which are otherwise exempt (see 4 CFR 331.30(b) and FPR 1-3.1203(a)(2)) shall be subject to the requirements of the Cost Accounting Standards Board. Any offeror submitting a proposal which, if accepted, will result in a contract subject to the requirements of the Cost Accounting Standards Board must, as a condition of contracting, submit a Disclosure Statement as required by regulations of the Board. The Disclosure Statement must be submitted as a part of the offeror's proposal under this solicitaion (see I. below) unless (i) the offeror, together with all divisions, subsidiaries, and affiliates under common control, did not exceed the monetary exemption for disclosure as established by the Cost Accounting Standards Board (see II. below); (ii) the offeror exceeded the monetary exemption in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted but, in accordance with the regulations of the Cost Accounting Standards Board, is not yet required to submit a Disclosure Statement (see III. below); (iii) the offeror has already submitted a Disclosure Statement disclosing the practices used in connection with the pricing of this proposal (see IV. below); or (iv) postaward submission has been authorized by the Contracting Officer. See 4 CFR 351.70 for submission of copy of Disclosure Statement to the Cost Accounting Standards Board.

> CAUTION: A practice disclosed in a Disclosure Statement shall not, by virtue of such disclosure, be deemed to be a proper, approved, or agreed to practice for pricing proposals or accumulating and reporting contract performance cost data.

Check the appropriate box below:

[ ] I. CERTIFICATE OF CONCURRENT SUBMISSION OF DISCLOSURE STATEMENT(S)

The offeror hereby certifies that he has submitted, as a part of his proposal under this solicitation, copies of the Disclosure Statement(s) as follows: (i) original and one copy to the cognizant Contracting Officer; and (ii) one copy to the cognizant contract auditor.

Date of Disclosure Statement(s):______________________________

Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed:______________________________

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

[X] II. CERTIFICATE OF MONETARY EXEMPTION

The offeror hereby certifies that he, together with all divisions, subsidiaries, and affiliates under common control, did not receive net awards of negotiated national defense prime contracts subject to Cost Accounting Standards totaling more than $10,000,000 in either Federal Fiscal Year 1974 or 1975 or net awards of negotiated national defense prime contracts and subcontracts subject to cost accounting standards totaling more than $10,000,000 in Federal Fiscal Year 1976 or in any subsequent Federal Fiscal Year preceding the year in which this proposal was submitted.

> CAUTION: Offerors who submitted or who currently are obligated to submit a Disclosure Statement under the filing requirements previously established by the Cost Accounting Standards Board are not eligible to claim this exemption unless they have received notification of final acceptance of all deliverable items on all of their prime contracts and subcontracts containing the Cost Accounting Standards clause.

[ ] III. CERTIFICATE OF INTERIM EXEMPTION

The offeror hereby certifies that (i) he first exceeded the monetary exemption for disclosure, as defined in II. above, in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted, and (ii) in accordance with the regulations of the Cost Accounting Standards Board (4 CFR 351.40(f)), he is not yet required to submit a Disclosure Statement. The offeror further certifies that if an award resulting from this proposal has not been made by March 31 of the current Federal Fiscal Year, he will immediately submit a revised certificate to the Contracting Officer, in the form specified

under I. above or IV. below, as appropriate, to verify his submission of a completed Disclosure Statement.

CAUTION: Offerors may not claim this exemption if they are currently required to disclose because they exceeded monetary thresholds in Federal Fiscal Years prior to Fiscal Year 1976. Further, the exemption applies only in connection with proposals submitted prior to March 31 of the year immediately following the Federal Fiscal Year in which the monetary exemption was exceeded.

[ ] IV. CERTIFICATE OF PREVIOUSLY SUBMITTED DISCLOSURE STATEMENT(S)

The offeror hereby certifies that the Disclosure Statement(s) were filed as follows:

Date of Disclosure Statement(s):______________________________

Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed:______________________________

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

14. ADDITIONAL COST ACCOUNTING STANDARDS APPLICABLE TO EXISTING CONTRACTS--CERTIFICATION

(a) Cost accounting standards will be applicable and effective as promulgated by the Cost Accounting Standards Board to any award as provided in the Federal Procurement Regulations Subpart 1-3.12. If the offeror presently has contracts or subcontracts containing the Cost Accounting Standards clause, a new standard becomes applicable to such existing contracts prospectively when a new contract or subcontract containing such clause is awarded on or after the effective date of such new standard. Such new standard may require a change in the offeror's established cost accounting practices, whether or not disclosed. The offeror shall specify, by an appropriate entry below, the effect on his cost accounting practice.

(b) The offeror hereby certifies that an award under this solicitation [ ] would, [X] would not, in accordance with paragraph (a)(3) of the Cost Accounting Standards clause, require a change in his established cost accounting practices affecting existing contracts and subcontracts.

NOTE: If the offeror has checked "would" above, and is awarded the contemplated contract, he will also be required to comply with the clause entitled Administration of Cost Accounting Standards.

Firm: ENSCO, INC.

Name: [signature]

Date: May 26, 1978

Title: Executive Administrator

ENSCO, Inc.

BALANCE SHEET
April 30, 1978

| | | | |
|---|---|---|---|
| **CURRENT ASSETS** | | | |
| Cash in Bank | $ 222,555.10 | | |
| Imprest Funds | 6,025.00 | | |
| Accounts Receivable | 1,808,467.29 | | |
| Other Receivables | 19,320.97 | | |
| Notes Receivable | 11,392.12 | | |
| Unbilled Receivables | 446,762.34 | | |
| Work in Process | 41,113.75 | | |
| Prepaid Expenses | 16,711.40 | | |
| Total Current Assets | | | $2,572,347.97 |
| **FIXED ASSETS** | | | |
| Furniture & Fixtures | $ 77,196.96 | | |
| Equipment | 180,653.46 | | |
| Leasehold Improvements | 59,276.45 | | |
| Raytheon Computer Systems | 386,953.00 | | |
| PDP 11 Computer Systems | 261,488.51 | | |
| Radar Equipment | 60,523.58 | 1,026,091.96 | |
| Less: Allowance for Depreciation | | 391,219.41 | |
| Total Fixed Assets | | | $ 634,872.55 |
| **OTHER ASSETS** | | | |
| Investment in Subsidiaries | (11,270.25) | | |
| Deposits | 21,384.00 | | |
| Travel Advances | 46,994.39 | | |
| Other Advances | 1,690.37 | | |
| Total Other Assets | | | $58,798.51 |
| TOTAL ASSETS | | | $3,266,019.03 |

ENSCO, INC.

BALANCE SHEET

April 30, 1978

| | | |
|---|---|---|
| **CURRENT LIABILITIES** | | |
| Notes Payable | $ -0- | |
| Accounts Payable | 238,367.57 | |
| Due To /From Dynalectron | 125,959.92 | |
| Advances Received on Grants | (3,786.34) | |
| Progress Payments | 34,145.00 | |
| Accrued Wages Payable | 210,170.37 | |
| Accrued Vacation Payable | 258,656.71 | |
| Accrued Expenses Payable | 3,050.00 | |
| Employee Benefits Payable | 295,294.24 | |
| Withholding Taxes Payable | 9,919.89 | |
| Unemployment Taxes Payable | 1,387.10 | |
| Income Taxes Payable | 111,745.90 | |
| Computer Center | 19,236.22 | |
| Terminal Computer Clearing Acct. | (485.04) | |
| Raytheon - Short Term Portion | 16,230.00 | |
| Radar Equipment | 5,600.80 | |
| Subcontract Retention | 1,751.17 | |
| Total Current Liabilities ------------- | | $1,327,243.51 |
| **LONG TERM LIABILITIES** | | |
| Long Term Note | | $ 300,000.00 |
| **CAPITAL** | | |
| Common Stock: 1,000,000 Shares Authorized 524,475 Issued | $26,223.75 | |
| Paid in Capital | 444,833.25 | |
| | 471,057.00 | |
| Treasury Stock 59,947 shares | 179,841.00 | |
| | 291,216.00 | |
| Retained Earnings as of 6/30/77 $1,014,580.91 | | |
| Net Income (10 mos. ending 4/30/78) 332,978.61 | | |
| Total Capital ----------------------- | | $1,638,775.52 |
| TOTAL LIABILITIES AND CAPITAL ------------------- | | $3,266,019.03 |

ENSCO, INC.
EARNINGS STATEMENT
April 30, 1978

| | Current Month | Ten Months Ending 4/30/78 |
|---|---|---|
| Sales | $1,223,558.62 | $9,979,243.73 |
| Less: Allowance for Costs Billed in Excess of Allowable Indirect Costs on CPFF Contracts | 70,371.98 | (4,497.29) |
| Net Sales | 1,153,186.64 | 9,983,741.02 |
| Net Change to Work in Process | (22,644.71) | (22,963.05) |
| **Direct Costs** | | |
| Labor | 321,649.12 | 2,881,929.52 |
| Materials | 235,679.70 | 1,098,954.12 |
| Subcontracts | 1,000.00 | 380,144.16 |
| Travel | 78,202.14 | 558,411.14 |
| Consultants | 4,766.35 | 34,754.55 |
| Computer Charges | 24,089.49 | 194,554.92 |
| Other Direct Costs | 125,560.60 | 957,975.23 |
| Total Direct Costs | 790,947.40 | 6,106,723.64 |
| **Overhead Costs** | | |
| Advertising | 303.96 | 9,759.73 |
| Bonuses | 17,231.09 | 150,288.57 |
| Consulting Fees | -0- | 7,636.93 |
| Contract Services | 801.24 | 14,428.76 |
| Depreciation | 2,416.33 | 23,436.15 |
| Dues, Subscriptions, & Publications | 820.16 | 10,252.12 |
| Educational Costs | 221.50 | 2,210.50 |
| FICA, Employers Portion | 22,299.41 | 156,875.48 |
| Freight | 14.00 | 603.48 |
| Holiday Pay | -0- | 110,237.62 |
| Group Insurance | 10,042.00 | 100,563.96 |
| Insurance - Other | 1,929.96 | 17,423.21 |
| Company Benefits | 1,073.17 | 14,359.72 |
| Postage | 400.98 | 3,666.73 |
| Personal Leave | 1,462.23 | 25,811.13 |
| Miscellaneous | 200.00 | 2,150.00 |
| Drafting & Engineering Supplies | 111.39 | 3,895.19 |
| Office Expense | 6,985.16 | 83,168.69 |
| Repairs & Maintenance | 2,467.49 | 16,803.71 |
| Rent | 19,346.86 | 174,444.98 |
| Salaries | 35,151.14 | 493,940.77 |
| Funeral Leave | 308.64 | 2,649.52 |
| Legal Service Plan | -0- | 210.87 |
| Sick Pay | 4,363.47 | 72,993.10 |
| Telephone | 7,609.43 | 87,424.57 |
| Transportation - (Local) | 640.28 | 7,591.41 |
| Travel | 3,866.17 | 28,934.47 |
| Unemployment Taxes | 3,204.72 | 29,681.44 |
| Uninsured Medical | 528.67 | 11,814.53 |
| Utilities | 1,950.79 | 22,263.16 |
| Vacation Pay | 17,155.98 | 179,825.38 |
| Computer Charges | 295.81 | 8,337.70 |
| Seminars | 614.03 | 7,388.89 |
| Relocation | -0- | 4,239.24 |
| Retirement | 38,635.21 | 388,321.77 |
| Agency Fees | -0- | 2,325.00 |
| Business Meetings | 462.46 | 4,356.83 |
| Business Taxes | 4,534.09 | 28,653.52 |
| Total Overhead Costs | 207,447.82 | 2,308,968.83 |
| Less: Bid & Proposal Adjustment | 1,431.51 | 49,253.53 |
| Net Overhead | $206,016.31 | $2,259,715.30 |

| | Current Month | Ten Months Ending 4/30/78 |
|---|---|---|
| **General & Administrative** | | |
| Advertising | $ -0- | $ 679.92 |
| Bonuses | 13,700.84 | 115,985.71 |
| Consulting Fees | 500.00 | 19,589.72 |
| Contract Services | -0- | 46.40 |
| Depreciation | 876.46 | 9,980.12 |
| Dues, Subscriptions & Publications | 363.47 | 6,135.82 |
| Educational Costs | 76.50 | 229.50 |
| FICA - Employers Portion | 2,700.70 | 18,375.10 |
| Freight | -0- | 350.84 |
| Holiday Pay | -0- | 14,007.35 |
| Group Insurance | 1,152.10 | 14,808.75 |
| Insurance - Other | 367.46 | 13,316.25 |
| Company Benefits | 560.91 | 6,336.27 |
| Postage | 516.68 | 3,358.83 |
| Personal Leave | 138.88 | 3,151.58 |
| Miscellaneous | 6,053.14 | 6,475.14 |
| Office Expense | 3,144.06 | 30,691.92 |
| Repairs & Maintenance | 971.01 | 7,829.53 |
| Rent | 1,141.34 | 19,106.72 |
| Salaries | 44,171.50 | 403,901.35 |
| Funeral Leave | -0- | 304.74 |
| Sick Pay | 866.04 | 8,547.01 |
| Telephone | 1,141.98 | 10,966.83 |
| Travel | 1,865.64 | 20,884.09 |
| Unemployment Taxes | 652.48 | 3,125.30 |
| Uninsured Medical | 165.34 | 1,749.55 |
| Utilities | 904.84 | 9,635.22 |
| Vacation Pay | 2,388.26 | 23,172.37 |
| Seminars | 5,131.51 | 12,016.11 |
| Relocation | -0- | 7,831.54 |
| Retirement | 5,077.93 | 62,082.90 |
| Agency Fees | -0- | 1,380.00 |
| Business Meetings | 41.95 | 821.50 |
| Business Taxes & Licenses | 144.06 | 8,929.25 |
| Accounting Fees | -0- | 16,483.67 |
| Directors Fees | -0- | 6,600.00 |
| Legal Fees | 2,722.68 | 7,121.18 |
| Stockholders Meetings | -0- | 832.26 |
| Legal Service Plan | -0- | 1,270.00 |
| TOTAL G&A | 97,537.76 | 898,110.34 |
| **Bid & Proposals** | | |
| TIS | (522.47) | 15,694.64 |
| ETA | 562.86 | 562.86 |
| SAS | 815.06 | 3,372.63 |
| DCS | -0- | 3,237.10 |
| OSS | 178.62 | 14,433.98 |
| ESS | 397.44 | 11,470.38 |
| MT. VIEW | -0- | 481.94 |
| Total Bids & Proposals | 1,431.51 | 49,253.53 |
| Total Costs | 1,073,288.27 | 9,290,839.76 |
| Other Income | -0- | 6,831.49 |
| Income Before Unallowed Costs | 79,898.37 | 699,732.75 |
| **Unallowed Costs** | | |
| Insurance | 78.31 | 783.10 |
| Patents | 800.00 | 800.00 |
| Interest | 2,496.52 | 28,835.32 |
| Organizations | -0- | -0- |
| Miscellaneous | 2,475.55 | 11,115.72 |
| Legal & Accounting | -0- | -0- |
| Total Unallowed Costs | 5,850.38 | 41,534.14 |
| Net Income Before Taxes | 74,047.99 | 658,198.61 |
| Estimated Income Tax | 42,130.00 | 325,220.00 |
| Net Income | $31,917.99 | $332,978.61 |

# D. BUSINESS AND MANAGEMENT

## D.1 EXPERIENCE IN RELATED ACTIVITIES

The seismic ground noise survey being offered was developed under USGS Contract No. 14-08-0001-15321 and No. 14-08-0001-16490, and applied commercially for several geothermal exploration firms. Recently, we completed a similar survey at Cove Fort, Utah, in cooperation with the University of Tulsa, Oklahoma, under NSF Grant AER74-04819. The investigators proposed for this survey have been involved in this activity, both field recording and data analysis, over the last three years with seven similar geothermal exploration surveys. The proposed survey is similar to those performed in the past, but is modified to include additional instrumentation and data analysis to allow a more detailed description of the geothermal ground noise field at the investigation site.

The following are synopses of contracts awarded to the Earth Sciences and Systems Division which illustrate the technical and management capabilities of the Company in work related to this proposal.

Exploration and Characterization of Geothermal Sources From Seismic Activity - USGS, Contract No. 14-08-0001-15321; $121,856; Mr. Donald Klick, Program Manager, 703/860-5581

Signal analysis and field recording techniques have been developed to detect and locate ground noise sources in geothermal regions. These developments have allowed the first successful application of any processing for this purpose and have proven to be very effective at detecting and locating major features of these geothermal systems. Commercial applications of this survey technique are already in progress.

Improved Determination of Teleseismic Source Depths - ARPA Contract No. F08606-77-C-0007; $89,923; Capt. Greg Young, Contract Officer, 703/325-7581

An analysis technique, capable of substantially increasing the percentage of events for which accurate teleseism source depths can be obtained, has been developed and is being implemented at AFTAC facilities. This technique utilizes source depth information, contained throughout the seismogram, which has previously been ignored or improperly used. This work will play an increasing role in monitoring nuclear test ban treaties.

Rapid Analysis of Microseismic Signals Associated With Hydraulic Fracturing - Los Alamos Scientific Laboratory, University of California, Contract No. ZP8-72073-1; $33,345; M. L. Pierotti, Contract Administrator

In this project, ENSCO is using multichannel analysis techniques to perform *in situ* calibration of the downhole triaxial seismometers used for fracture mapping in LASL's Hot Dry Rock Program. This calibration will correct seismometer-induced distortions that affect the direction and types of P and S wave polarizations, thus making it possible to determine locations for otherwise unusable microseismic events. Correction transfer functions are computed by using multichannel maximum entropy spectral analysis to determine relative amplitude and phase spectrum differences among the three seismometer components. Upon completion of this study, the seismometer calibration algorithm will be implemented on LASL's HP 5451-B system.

Broadband Seismometer Non-Linearities, U. S. Air Force Contract No. F44620-75-C-0013; $46,692

Under this contract, ENSCO developed computer models to study the effects of system non-linearities on the analysis of received seismic signal data. In particular, broadband seismometers were evaluated in terms of their relative effectiveness in the detection and identification of underground events.

Borehole Environmental Laboratory - U.S. DOE (Formerly Energy Research and Development Administration), Contract No. 194-2; $210,000; Mr. Charles Dunn, 918/835-9471

ENSCO, under a subcontract with Fenix & Scisson, Inc., has designed a unique, remote measurement system for long-term emplacement in, and evaluation of, a deep (3000-plus-feet) rock mass for storage of high-grade nuclear wastes. The primary purpose of the deep probe is to monitor critical aspects of the rock mass over a one-to-five year period. Of particular interest is moisture migration, which will be continuously monitored. In addition, the laboratory contains acoustic wavespeed and microseism measurement sensors.

ENSCO's responsibility includes selection of pre-emplacement borehole instrumentation for total evaluation of the rock mass. ENSCO's borehole radar with processing will be used to map the geologic features in a large volume surrounding the borehole. Once emplaced, the system must operate reliably for at least one year without retrieval of the borehole unit. The system is being designed, fabricated and tested under rigorous Nuclear Regulatory Commission source traceability and quality assurance requirements.

New Signal Processing Methods for Magnetotellurics, U. S. Geological Survey Contract No. 14-08-0001-15322; $142,937.

Under this contract, ENSCO is developing magnetotelluric processing methods for estimating impedance elements using single stations or array data. Magnetotelluric methods are capable of measuring large-scale features of the upper crustal electrical conductivities. The strong dependence of electrical conductivity on temperature makes magnetotellurics a potentially important tool for investigation of thermal activity. The proposal addresses possible improvements in field procedures and methods to obtain improved data processing techniques.

Acoustic Sensing System for Mapping the Soil-Rock Interface and for Detecting and Identifying Objects and Material Changes In Soil Masses Under a Water Table - Contract DOT-FH-11-9120; $540,000; Mr. William Bralove, Contract Manager, 703/557-5262

This multi-year contract calls for a completely portable sensing system, utilizing acoustic signals to sense, identify, and determine the location, shape, and dimensions of boulders; to identify structures and utility lines in the soils; and to map soil/rock interfaces. The system is to be self-sufficient, generate signals, sense objects, perform measurements, and transmit, record and display data. It will also process and interpret this information to be utilized by civil engineers. The required information includes:

- Determination of distances to objects or to the soil/rock interface.
- Determination of shapes and dimensions of objects.
- Identification of materials encountered.
- Estimation of engineering characteristics of materials encountered.

ENSCO is required to deliver a complete hardware/software prototype system in 20 months.

Final field tests are now being conducted. Frequencies of over 2 kHz have been propagated in excess of 180 feet, in median quality sediments.

Site Investigation Using Multiple-Borehole, Ground-Probing Radar - National Science Foundation, NSF Grant APR-76-03300; $270,000; Dr. William Hakala, Program Manager, 202/634-7185

This grant is a continuation of the work started under Grant APR-75-13414. The work covered 12 months and consisted of six specific tasks:

- Application of advanced signal processing to a larger number of subsurface features and locations.
- Multiple-borehole radar development.
- Testing with pulse-echo, mid-range acoustics in the same geology for correlation and comparison.
- Participation in post-excavation evaluation of the Zoo Park Station for final critique of Phase I results.
- Testing in NX-size boreholes with the multiple-borehole radar.
- Background investigation of the application of microprocessors and the techniques of displaying the three-dimensional information to tunnel designers and engineers.

The objective of this work was to further the development of a new family of tools for subsurface investigation, and definition of geological conditions in advance of subsurface excavation operations. Final tests have been completed and the report is being written.

Subsurface Site Investigation by Electromagnetic Radar - National Science Foundation (RANN), Grant APR-75-13414; $127,000; Dr. William Hakala, Program Manager, 202/634-7183

This six-month project addressed an acute need for economical and greatly improved real-time predictive techniques for the investigation, interpretation and definition of geological conditions prior to subsurface excavation projects. Loss of life, equipment damage, excavation damage, cost overruns, schedule slippages, and unachieved corporate and national goals are the price accompanying the lack of adequate predictive techniques.

A commercially available electromagnetic radar was used, plus advanced signal processing techniques, to provide geologic information in support of subsurface excavation technology. A crown drift of one of the future stations of the Washington Metro System provided the test location. As expected, the research identified the degree of success associated with advanced signal processing, analysis, and interpretation, and the appropriate avenues for future research.

The contributions this project has made to subsurface-site investigation technology include: (a) verification of the ability of electromagnetic radar to penetrate natural subsurface masses, (b) the use of digital-signal processing as a means of enhancing the value of subsurface radar, (c) multi-discipline group interpretations of data from optimized analog displays, (d) evidence of resolution power of electromagnetic radar with advanced processing to discern ground discontinuities, and (e) increase user awareness and confidence in utility and viability of ground-probing electromagnetic radar.

The comprehensive final engineering report (NSF/RA-76-0187) is available upon request. It is also available from the National Technical Information Service (PB 259 335/AS).

New Sensing System for Pre-excavation Subsurface Investigation for Tunnels in Rock Masses - Federal Highway Administration, Contract No. DOT-FH-11-8602; $250,000; Mr. C. M. McGogney, Contract Manager, 703/557-4318

This contract with the Federal Highway Administration was a feasibility study and system design project for a self-propelled, guided, retractable device that penetrates mud-filled, wet or dry, previously prepared, horizontal boreholes or pilot tunnels over distances of about two miles, complete with surface control and support equipment. The system is designed to sense, transmit, record, and process a complete set of reliable information:

1. For determining the location of significant discontinuities (gouge zones, cavities) in rock masses within a range of 100 feet from the axis of the hole.

2. For determining the joint patterns (angles) in the rock.

3. For determining the quality of the rock.

4. For evaluating the significant mechanical properties of the rock and soil materials (identifying materials in the joints and gouge zones).

5. For locating changes in the mechanical properties of the rock masses within the range of 100 feet and estimating the properties of the materials.

6. For evaluating the hydrogeologic characteristics of the ground, including the detection of water-filled cavities, channels, and water-bearing layers, and the determination of permeabilities and the level of the water table.

The project is complete. The system design utilizes a modular approach so that the first prototype field-test model will be cost-effective but easily expandable as new technology emerges and risks are reduced. The system has been found to exhibit satisfactory potential benefit/cost characteristics for the hard-rock tunneling industry. A two-volume report (FHWA-RD-77-10, and 11, Volumes I and II) is on open file at the FHWA.

Electromagnetic Methods for Detecting Quality of Roof-Bolt Bonds - U.S. Bureau of Mines, Contract H0166014 (ENSCO was a consultant to Foster-Miller Associates); $2,000; Dr. Kenneth Mayer, Program Manager, 617/890-3200

ENSCO performed a feasibility study relative to electromagnetic methods of determining the air voids in the epoxy surrounding in-place mine roof bolts. Three techniques having different levels of resolution were modeled.

Coal-Auger Radar Guidance Tests - Lee Engineering Division, Consolidation Coal Company, P.O. 01-54-2674

This project covered a feasibility investigation into the potential for ground-probing radar as a guidance sensor for low-cost augers and long-wall shearers. Phase I involved tests in a coal outcrop of 30-inch diameter augered holes, where roof, floor, and ribs were measured to significantly high resolution.

Phase II was accomplished under contract to R. A. Hanson Company (see "Highwall Mining Equipment").

Drilling and Preparation of Reusable, Long-Range Horizontal Boreholes in Rock and in Gouge Materials - Federal Highway Administration, Contract DOT-FH-11-8486 (ENSCO was a subcontractor to Foster-Miller Associates); $38,000; Dr. John Harding, Program Manager, 617/890-3200

ENSCO performed a study effort with Foster-Miller Associates and Jacobs Associates, Inc. to provide a multi-level system feasibility study covering long-hole precision drilling. ENSCO's responsibilities included drill guidance, surveys, telemetry and control. ENSCO also contributed to the areas of core sampling and orientation, borehole stabilization, water permeability and pressure measurements, and new techniques of penetrators. This one-year project had a goal of providing the basis of design and costs for nearly horizontal boreholes for geophysical examinations along proposed tunnel alignments.

This was a companion project to the FH-11-8602 Contract. A three-volume final report has been published under the contract title as follows:

- Volume I. State-of-the-Art Assessment, FHWA-RD-75-95.
- Volume II. Estimating Manual for Time and Cost Requirements, FHWA-RD-85-96.
- Volume III. A Development Plan to Extend Penetration Capability, Increase Accuracy and Reduce Costs.

Cableless Electronic Surveying System for Drilling Horizontal Holes (Revised) - U.S. Bureau of Mines, Contract USBM H0177069; $260,000; Mr. A. Young, Contracting Officer, 202/634-4700

This contract calls for the rehabilitation of the Bureau of Mines' cableless borehole survey system, which goes down-hole directly behind the drill bit. It is designed to provide real-time survey data to the operator. The original system was developed by ENSCO personnel while with another company. The contract calls for:

- The correction of minor mechanical deficiencies.
- Incorporation of additional sensors.
- Development of the computational procedures to exploit the new sensors and remove certain ambiguities in the previous algorithms.
- Complete redesign of the surface electronics, using microprocessor techniques which were not available at the time of its original development.
- The redesign to include the fabrication of a completely permissible unit which can operate in a gassy mine environment.

The contract will conclude with a complete field test of the system in its operational environment.

## D.2 PERSONNEL QUALIFICATIONS

### D.2.1 PERSONNEL/RESUMES

Following are the names of the principal program personnel:

- Edward Page, Staff Scientist
- Richard Houck, Sr. Scientist
- Theodore Moser, Engineer
- Robert Bauman, Sr. Programmer/Analyst

Mr. Douglas Guion, EDCON, Denver, Colorado, has agreed to serve as technical consultant for this survey and principally aid in the geophysical interpretation of the results.

The resumes of those identified above, along with supporting staff members, are attached.

EDWARD A. PAGE

## EXPERIENCE

Present: Dr. Page is currently in charge of research directed toward improving seismic source depth determinations through the application of advanced signal processing techniques to the seismic coda, and research directed at applying seismic array processing to make locations of seismic activity in geothermal regions. Both these research efforts have been very successful and will enhance our capabilities in both areas. Before this work, Dr. Page had recently developed a new spectral line frequency detection technique. This technique is presently being implemented as a major component of a multi-million dollar ASW system. Dr. Page completed an investigation determining the relative merits of the new Frequency Matched Filter Technique, maximum entropy and inverse filter spectral estimates, phase lock-loops, and power spectral estimates.

Dr. Page applied stochastic cepstrum techniques to the problem of passively determining the depths of underwater acoustic sources. This was the first successful utilization of the "Self Illumination Effect" for determining source depths. He was also involved in the development of signal processing techniques applied to missile reliability studies.

Dr. Page was responsible for the development and application of new stochastic correlation techniques for improved methods of detecting surface reflection from earthquakes. These techniques are used to compensate for physical fluctuations affecting seismic signals in a manner allowing for the extraction of depth phase information not normally accessible.

Previous responsibilities included research and development of statistical and signal analysis techniques utilized in pattern recognition and tracking studies. Dr. Page has developed statistical computer methods for classifying sources from their acoustic, magnetic, and seismic signals. In addition, he assisted in the development and testing of a stochastic propagation modeling technique used in the analysis of underwater signals.

1969-1971: At Teledyne-Geotech, Dr. Page was in charge of research in advanced hypocenter location techniques in a successful effort to locate underground seismic sources more precisely. This work involved seismic ray tracing, source modeling of active tectronic regions and the statistical analysis of the location determinations. Dr. Page was responsible for development of two-dimensional finite difference and finite element computer codes for the solution of elastic wave propagation in heterogeneous isotropic media. He also participated in the development of computer codes which theoretically determined Rayleigh wave generation from atmospheric sources. Dr. Page also gained experience in a wide range of computer signal processing and detection methods used in the analysis of seismograms.

1964-1970: As a research assistant at the University of Maryland, Dr. Page did research in low temperature physics investigating the electromagnetic response of superconductors to hypersonic waves. This research involved low temperature, microwave, hypersonic, pulse circuits, and sample preparation techniques. Dr. Page succeeded in making the first ultrasonic measurements of the frequency dependence of the superconducting transition.

PUBLICATIONS

"Improved Techniques For The Exploration and Characterization of Geothermal Sources From Seismic Activity," Edward A. Page, Robert W. Bauman, and William C. Long, ENSCO, Inc., Final Report for Contract No. 14-08-0001-15321, March 1977.

"Determination of Seismic Source Depths from Differential Travel Time," Edward A. Page and Robert W. Bauman, ENSCO, Inc., Final Report for Contract No. F08606-75-C-0025, July 1975.

"High Resolution Spectral Analysis," Edward A. Page and Jimmy Jacobs, Report for NAVELEX Contract No. N00039-72-C-0344, December 1974.

"Measurement of Variable Frequency Lines Using A Frequency Domain Match Filter Technique," ENSCO Report, Edward A. Page, August 1974.

"Source Depth Determination Using the Self Illumination Effect," ENSCO Report, Edward A. Page, April 1974.

"Determination of pP and sP Delays from Seismic Codes," Edward A. Page, ENSCO, Inc., Final Report for Contract No. F08606-74-C-0020, April 1974.

"A Hypocenter Location Technique Based on Source Modeling and Ray Tracing Which Greatly Extends the Range Over Which Calibration Events are Useful," Alexandria Laboratories Report, Geotech Teledyne, 1971.

"An Investigation of the Electromagnetic Response of Superconductors Near Tc Using Hypersound," with J. R. Liebowitz, Ph.D.; Thesis, University of Maryland, 1969.

"Hypersonic Attenuation of Transverse Waves in Tin Near the Superconducting Transition Temperature," with J. R. Liebowitz, Bulletin, American Physics Society, 14, 380, 1969.

## EDUCATION

B.A., Physics, Rutgers University, 1962.

Ph.D., Physics, with Minor in Astronomy and Nuclear Physics, University of Maryland, 1969.

RICHARD T. HOUCK

EXPERIENCE

1976 - Present: As a Senior Scientist in ENSCO's Earth Sciences and Systems Division, Mr. Houck has been involved in several applications of signal processing to seismic problems. Duties include project management, development and evaluation of signal processing techniques, and computer programming.

Currently, he is project maanger for a project that uses multi-channel processing techniques to perform in-situ calibration of downhole triaxial seismometers for Los Alamos Scientific Laboratory's Hot Dry Rock Program. He is also co-investigator on an Air Force sponsored project to use cepstrum techniques to determine the depth of a teleseismic source. In addition, Mr. Houck has been involved in several of ENSCO's geothermal ground noise surveys.

1974 - 1976: As a Geophysicist at Amoco Production Company's Tulsa Data Center, Mr. Houck worked in the field of seismic data processing. Specifically, he was responsible for the Velocity Data System, a system of seismic velocity processing programs and storage files used company-wide for routine velocity processing. Duties included program definition, system documentation, and user assistance. Achievements include definition of a generalized velocity determination program and development of a one-week course in Geophysical Systems for personnel from division offices.

1974: At Amoco's Houston Division office, Mr. Houck worked as a Geophysicist on a seismic crew.

1971 - 1973: As a Graduate Assistant at Pennsylvania State University, Mr. Houck was involved with coding and running computer programs defined by faculty and staff members, mostly in the area of earthquake seismology. In his thesis work, he investigated the application of the Finite Element Method to some potential field problems of interest in geophysics.

PUBLICATIONS

"Geothermal Ground Noise Benchmark Experiment," E.A. Page and R.T. Houck, Final Report, Contract No. P.O. 38730, University of Tulsa, March 1978.

"Improved Procedures for Determining Seismic Source Depths from Depth Phase Information," R.T. Houck and E.A. Page, Final Report, Contract No. F08606-77-C-0007, ARPA, October 1977.

## EDUCATION

M.S., Geophysics, Pennsylvania State University, University Park, Pennsylvania

B.S., Physics, Canisius College, Buffalo, New York

## PROFESSIONAL SOCIETIES

Society of Exploration Geophysicists

American Geophysical Union

## THEODORE E. MOSER

### EXPERIENCE

Present: Mr. Moser is presently assigned to the Earth Sciences and Systems Division. Duties include operation and maintenance of the field equipment, interpretation of field data, and design improvements to the systems used in the field.

Oct. 1976-June 1977: Mr. Moser was assigned to the Transportation and Instrumentation Sciences Division assisting in the refurbishment and instrumentation of the T-6 test vehicle.

1971 - October 1976: During this period, Mr. Moser was assigned as Operations Supervisor to the Department of Transportation Track Geometry Test Train, supervising seven electromechanical technicians. He was responsible for the operation and maintenance of various types of electronic equipment including: Raytheon 704 computer, digital tape units, miniverter, disc file, card reader, brush chart recorder, and special-purpose equipment designed and built by ENSCO, Inc. He was responsible for training new personnel in operating and maintaining this equipment.

Mr. Moser has demonstrated talents in mechanical design for special-purpose equipment used on the test vehicle, and for system modifications and additions. Mr. Moser was responsible for procuring and maintaining sufficient consumables and spare parts for field operations. Mr. Moser was responsible for determining that the track geometry data displayed in real-time was correct and for making the necessary decision of what maintenance was required to correct any problem that occurred. He was also responsible for the safety of the test crew when they were on a field operation.

1967 - 1971: As Service Engineer with Electronic Marketing Associates in Kensington, Maryland, Mr. Moser was responsible for calibration and repair of various types of electronic equipment, both in the field and under laboratory conditions. This equipment included: DC power supplies, microwave equipment, digital and analog tape units, electrostatic high-speed printers, pulse generators, lasers and various types of laboratory test equipment.

### EDUCATION

1965-1967: Capitol Institute of Technology, AAS Degree
1968: Sorensen Power Supplies Maintenance School
1970: Kennedy Continuous and Incremental Tape Deck Maintenance School
1970: Varian Electrostatic Recorder Maintenance School
1972: Raytheon 700 Series Computer School

ROBERT W. BAUMAN

## EXPERIENCE

Present: During this period Mr. Bauman, as an employee of ENSCO, Inc., advanced from Junior Programmer to Senior Programmer/Analyst. His experience includes processing of digitized time-series data, refining and documenting computer software in underwater acoustics analysis, and collateral programming to test, display and analyze data. From January 1972 to June 1975, Mr. Bauman managed the computer terminal system (for ENSCO ISS and OSS Divisions). He developed a series of computerized reports which are currently used in ENSCO Division administration. Since July 1975, Mr. Bauman has been processing and analyzing digitized seismic data and refining and developing computer software necessary to this end. He has experience on CDC 6400/6600/7000 and Raytheon 500 RDS systems.

1970-1971: See "Education".

1950-1970: Career Officer, U.S. Navy. Retired in October 1970 in rank of Commander. Served in various departmental management assignments relating to communications, operations, and training. Commanded two ships and a four-ship division. Managed a Naval Reserve Training Center. As a Staff Officer in the Department of Defense, worked in field of nuclear effects and nuclear weapons employment; as Branch Chief, supervised technical personnel in studies, evaluations, and technical documentation. As Staff Officer in the Office of the Secretary of Defense (Military Liaison Committee to the Atomic Energy Commission), was involved in evaluation and coordination for DOD/AEC nuclear programs.

1946-1950: As Chief Chemist for Sanna Dairies, Inc. of Madison, Wisconsin, implemented a quality control program, expanded the laboratory, and supervised the lab operation and quality testing procedures.

1944-1946: Reserve Officer in U.S. Navy (World War II). Shipboard departmental management.

DOUGLAS J. GUION

Douglas J. Guion graduated from the Colorado School of Mines with high scholastic honors in Geophysical Engineering. While at Mines, Guion received the Cecil H. Green Award for the outstanding student in Geophysics and received numerous other awards. Guion has worked for Amoco Production Company as a seismic assistant for two years. Following his service at Amoco, Guion has been an employee of EDCON Corporation for 8 years.

While at EDCON, Guion has been involved with integrated geological/geophysical exploration. Guion has developed methods of integration of seismic, gravity, and geologic data which are unique in the industry. During his time at EDCON Guion has developed numerous drillable prospects -- several of which subsequently became commercial discoveries. Guion has much experience at planning and managing synergistic oil and gas and geothermal exploration programs.

In addition to his activity in geophysics and geology, Guion is a civil engineer (P.E.) and general contractor. He has also served as a geophysics instructor at Community College of Denver and numerous commercial exploration schools.

Guion has presented numerous technical papers to various geologic and geophysical societies.

HAL P. DEMUTH

EXPERIENCE

Present: Mr. Demuth is a Vice President of ENSCO, Inc. and the Division Manager for the Earth Sciences and Systems Division. He acts as a consultant for system engineering, computer oriented system design and transportation systems. He has directed multi-million dollar research projects in these fields while at ENSCO.

1967-1970: Directed engineering programs as Technical Director of Geotech, a Teledyne Company in Alexandria, Virginia. Here Mr. Demuth was in charge of projects involving digital computers, interface system design and software programming. Programs of importance were:

- A worldwide hydroacoustic signal analysis system (called DAMPS) utilizing a small general purpose computer interfaced to special output devices. Two separate laboratory data analysis systems were also designed and built under his direct supervision. Both of these systems employed an extremely high-speed special purpose computer and unique interface with input/output equipment.

- A high-speed digital data analysis system which permitted atmospheric scientists at NASA to perform time-series analysis (auto correlating Fourier analysis) on digital communications signals from unmanned spacecraft.

1949-1967: Served as a commissioned officer (with ranks from Ensign to Commander) in the U.S. Coast and Geodetic Survey (USC&GS), Department of Commerce. Was responsibile for conducting various hydrographic and geodetic surveys for basic mapping and marine charting. Program management assignments have varied in size and complexity during these eighteen years. Some pertinent technical program management examples are as follows:

- $1.5 million project to plan, specify and supervise the design, fabrication and installation of electronic hydrographic and oceanographic equipment aboard ship. This was a two and one-half year task.

"Digitizing Microbarograph Data," ARL Report 69-1, Geotech, A Teledyne Company, September 1969.

"Test Train Program, Third Progress Report," DOT-FR-71-2, (Co-author) ENSCO, Inc., Springfield, Virginia, June 1971.

"United States Department of Transportation Track Geometry Measurement System," Track Train Dynamics Symposium, AAR, Chicago, Illinois, December 1971.

"Department of Transportation Rolling Laboratory," Proceedings of Track/Train Dynamics Interaction Conference, American Association of Railroads, Chicago, Illinois, May 1972.

"New Development in Track Inspection Instruments," (Co-author) Proceedings of Joint Rail Conference, IEEE/ASME, Chicago, Illinois, spring 1976.

"An Automated Approach to Ultrasonic Rail Flaw Detection," (Co-author) Proceedings of the IEEE Region 3 Conference, Williamsburg, Virginia, April 1977.

## EDUCATION

B.S., Electrical Engineering, University of Colorado, 1949.

M.S., Electrical Engineering, University of Washington, 1956.

## PROFESSIONAL SOCIETIES

Society of American Military Engineers (SAME), elected as Washington Post Secretary-Treasurer, 1963.

Washington Academy of Sciences, Member, 1965. Elected to grade of Fellow, 1966.

Institute of Electrical and Electronics Engineering (IEEE).

Explorers Club of New York, grade of Fellow.

- Director of personnel, managing all personnel matters for approximately 250 professional level scientists and engineers.

- Planning, execution and data analysis for various geodetic mapping programs such as:

  a) initial electronic distance measuring survey of a portion of the Aleutian Islands

  b) the international gravity survey between U.S. and Canada (U.S. representative and program manager)

  c) all initial electronic distance measurement activities for the early portions of the Interstate Highway Program

PUBLICATIONS

"Gravity Measurement in the Field," Coast and Geodetic Survey Technical Bulletin No. 9, U.S. Government Printing Office, 1956.

"Tellurometer Traverse Surveys," Coast and Geodetic Survey Technical Bulletin No. 2, U.S. Government Printing Office, 1958.

"Experiments to Determine Errors in Distance Measured by Shoran Equipment as Applied to Hydrographic Surveys," published by USC&GS, Department of Commerce, December 1956.

"An Evaluation of Small General Purpose Computers for a Field Data Analysis and Message Preparation System," ARL Report 67-7, Earth Sciences, A Teledyne Company, December 1967.

"Identification and Classification of Signals from Underwater Events," ARL Report 68-11, Earth Sciences A Teledyne Company, September 1968 (Co-author).

"Hydroacoustics and Seismic Signal Analysis for the Identification and Classification of Underwater Events," ARL Report 68-1, Earth Sciences, A Teledyne Company, April 1968 (Co-author).

"Data Analysis and Message Preparation System (DAMPS)," ARL Report 68-9, Earth Sciences, A Teledyne Company, August 1968.

JAMES C. FOWLER

EXPERIENCE

Present: Dr. Fowler is a Staff Engineer in the Earth Sciences and Systems Division at ENSCO, Inc. He is involved in the development of acoustic and electromagnetic systems for reflection mapping of the subsurface.

1970-1976: Dr. Fowler worked first as a Research Scientist, then as a Research Group Leader in the Exploration Research Division of Continental Oil Co. His group was responsible for developing geophysical field methods for locating oil and economic minerals. He was in charge of projects relating to developing both very low and high-frequency seismic exploration techniques. He was Principal Investigator for Continental on a U.S. Bureau of Mines contract to develop a real-time monitoring seismic system to detect and locate roof falls and explosions in a coal mine. This system is still in operation.

He directed the development of a seismic system to detect and locate coal miners hitting on the roof of a mine with a hammer or other large object. Other projects include developing a field transportable minicomputer system for processing seismic data, and designing time and frequency domain techniques for filtering seismic data.

1969-1970: U. S. Army Staff Officer in charge of planning for the telephone system on Long Binh Post, Viet Nam.

1968-1969: U. S. Army. He worked as chief programmer on the Systems Development Team, Army Command and Control Support Detachment, Washington, D. C. This included working as technical advisor, programmer and analyst for the software development on a multi-processing time-sharing information retrieval system. Computer experience included programming an interactive graphics system on a Univac 1218 computer.

1965-1968: Graduate student on NASA fellowship at the University of Missouri at Rolla. Assistant Instructor in math.

1963-1965: Physical Science Laboratory, University Park, New Mexico. He worked first as a technician then Assistant Engineer on the design and testing of UHF and VHF antennas.

## PUBLICATIONS AND PATENTS

"Surface and Subsurface Profiling Using Ground Probing Radar," (co-author) presented at 47th Annual Meeting of the Society of Exploration Geophysicists, September 1977.

"Detection, Delineation, and Location of Hazards Using Ground Probing Radar in Coal Mines," (co-author) proceeding of the 18th Symposium on Rock Mechanics, Colorado School of Mines, Golden, Colorado, June 1977.

"Deep Crustal Reflection Recording Using 'Vibroseis' Methods - A Feasibility Study," (co-author) Geophysics, Vol. 40 No. 3, pg. 399, June 1975.

"Nonparametric Sequential Detection," proceedings of National Electronics Conference, Chicago, Illinois, December 1968.

"Adaptive Nonparametric Sequential Detection," Ph.D. Dissertation, UMR, 1968.

"Nonparametric Detection of FM Signals," MS Thesis, UMR, 1967.

"Underground Mine Surveillance System," (co-inventor) Patent No. 3,949,353.

"Seismic Mine Monitoring System," (co-author) Patent No. 4,066,992.

## EDUCATION

BSEE (with honors), New Mexico State University, 1965
MSEE, University of Missouri - Rolla, 1967
Ph.D., University of Missouri - Rolla, 1968

## PROFESSIONAL AND HONORARY SOCIETIES

Member Institute of Electrical and Electronic Engineers
Member Society of Exploration Geophysicists
Member Eta Kappa Nu, Phi Kappa Phi, Sigma Pi Sigma

WALTER C. HERNANDEZ, JR.

EXPERIENCE

August 1973 - Present: Dr. Hernandez is the Chief Scientist of the Information Sciences Group at ENSCO, Inc. His primary duty has been to lead efforts in the development and application of statistical and signal processing techniques as required in specific problem areas. At present, he is engaged in:

> Development of new digital processing techniques to both improve speech intelligibility and to accurately measure speech intelligibility. This includes removal of corrupting reverberation effects, random noise effects, and design of new phoneme level panel testing methods.
>
> Development of new spectral and transfer function estimation techniques for geophysical and electrical prospecting methods (Magnetotellurics and Induced Polarization).

Past examples of these efforts are:

> Designed new statistical detection techniques based on bispectral analysis for underwater acoustic modulations.
>
> Investigation and design of passive signal processing methods for detecting the presence of nonlinearities in seismometer systems.
>
> Developed methods for estimating and forecasting reliability of complex electromechanical (missile) systems, based on multiple time-series prediction theory. These methods are now being actively pursued by Lockheed.

April 1972 - July 1973: Dr. Hernandez was a Senior Systems Analyst at Lulegian & Associates, Inc., Falls Church, Virginia with major duties in operations research and statistics. His efforts included:

> Analysis of the sensitivity and possible improvements of state-of-the-art Forward Looking Infra-Red (FLIR) systems.
>
> Analysis and development of statistical procedures for estimating the cardinality of sets under conditions of small samples (How many ships in a given ocean segment?).

Postulated and proved the now popular model which shows that the GNP of industrialized countries are nearly perfectly correlated with the energy consumption of those countries. These results point out the strong consequences of energy shortages.

November 1970 - May 1972: Dr. Hernandez was a Research Statistician in Agricultural Economics, University of Maryland. His work there included:

The design and analysis of a predictive microanalyticasimulation model for the rural economy of India. The result showed that their agriculturally based economy will lead to lower standards of living.

Discovered inherent problems in the traditional significance test of stepwise regression algorithms and developed appropriate tests which should be used.

Research in current portfolio investment methods and the formulation of a newer technique based on information and entropy considerations. The interesting result is that, in principle, money can be made at the rate of flow of information.

November 1968 - November 1970: Dr. Hernandez was employed as a Research Plasma Physicist at the Naval Research Center, Washington, D.C. His efforts there included:

The study and analysis of instabilities present for counter streaming plasmas in a uniform magnetic field as related to high altitude nuclear explosions.

Developed new solutions for the magnetohydrodynamic (MHD) equations which described the plasma flow as it tended to compress the earth's magnetic field.

September 1966 - November 1968: Dr. Hernandez resided at NASA, New York City and NASA Greenbelt, Maryland as a NAS-NRC post-doctoral fellowships under which he studied general relativity and astrophysical phenomena. His work included:

> Solutions of the non-vacuum Einstein field equations for the classic problem of static bodies with axial symmetry (unsolved since formulated in 1922).
>
> Solution of the Einstein field equations for the only known case of rotating axial symmetry (Kerr Metric) (unsolved since formulated in 1963). The result was to prove that the "doughnut" type solution, which was receiving international attention, did not, in fact, exist.
>
> Formulation of an elasticity theory which included general relativistic considerations. This was an unsolved problem since 1916 and is considered the acceptable relativistic elastic theory of today.
>
> Studies the gravitational collapse problem (black holes) and reformulated the Einstein field equations such that the traditional singularity problems are automatically avoided.

June 1962 - September 1962: Dr. Hernandez was employed as a Research Solid State Physicist at the NSB, Washington, D.C. His main effort there was:

> The investigation and prediction of the galvano-magnetic properties to be expected in crystals possessing tetragonal symmetry (Rutile).

<u>EDUCATION</u>

B.S., Physics and Mathematics, Louisiana State, 1961.

Ph.D., Applied Mathematics, University of Maryland, 1966.

## PRINCIPAL SCHOLASTIC AWARDS

- National Academy of Sciences/National Research Council Post-doctoral Fellowship
- National Science Foundation Fellowship, University of Maryland
- Graduate Student Physics Award, University of Maryland
- Senior Honorary Society, Louisiana State University
- Sophomore Physics Award, Louisiana State University
- Freshman Mathematics Award, Louisiana State University

## PUBLICATIONS

"A Note on Galvanomagnetic Properties of Crystals with Tetragonal Symmetry," N.B.S. Journal of Physics and Chemistry, 1963.

"Observer Time as a Coordinate in Relativistic Spherical Hydrodynamics," April-June, 143, 1966.

"Static, Axially Symmetric, Interior Solution in General Relativity," Phys. Rev. 153, 5, 1359-1363, Jan. 1967.

"Material Sources for the Kerr Metric," Phys. Rev. 159, 5, July 1967.

"Kerr Metric, Rotating Sources and Machian Effects," Phys. Rev. 167, 5, March 1968.

"Elastic Theory in General Relativity," Phys. Rev., D, Vol. 1, No. 4, 15 February 1970.

"Magnetic Field Compression at the Interface of Counterstreaming Plasmas," Talk given at the meeting of the American Physical Society, 4-7 November 1970.

"Missile Reliability Methods and Data Systems (U)," Final Report, Contract No. N00039-74-C-0143, SSPO, June, 1974.

"Nonlinear Effects in Seismometers," Final Report, Contract No. F446-75-C-0013, ARPA, August, 1975.

"New Signal Processing Methods in Magnetotellurics," W. Hernandez and R. Sebastian, American Geophysical Union meeting, San Francisco, December 1975.

LLEWELLYN A. RUBIN

## EXPERIENCE

Present: Mr. Rubin is a Senior Group Engineer and Manager of Site Investigation Programs in the Earth Sciences and Systems Division of ENSCO, Inc.

Since joining ENSCO, Inc., in 1973, Mr. Rubin has been active in a variety of efforts involving applications of modern geophysics, advanced signal processing, and multi-discipline interpretations to perform subsurface investigations for engineering projects including tunneling, underground construction, and mining.

Currently, Mr. Rubin is project manager and/or principal investigator on a number of subsurface contracts. Representative examples include:

- Federal Highway Administration Contract: "A New Sensing System for Preexcavation Subsurface Investigation for Tunnels in Rock Masses," and as a subcontractor in a complementary project; "Drilling and Preparation of Reusable, Long-Range, Horizontal Bore Holes," for pre-excavation tunnel investigations. Mr. Rubin's specific engineering responsibilities include drill guidance, drill-string telemetry, electromagnetic and acoustic sensing and borehole-systems engineering.
- The second of two grants from the National Science Foundation (RANN), "Research in Subsurface Investigation by Ground-Probing Radar."
- "Development of a Short-Pulse Radar Coal-Thickness Sensor for a Continuous Miner" under a contract with the Bureau of Mines.
- A research project in "Radar for High-Wall Auger Guidance."
- "Research in Coal Mine Roof Stratigraphy and Hazard Detection by use of Ground-Probing Radar," for the Bureau of Mines.
- U. S. Bureau of Mines contract, "Cableless Electronic Surveying System for Drilling Horizontal Holes.

3/77

1969-1973: Mr. Rubin was Managing Director of the Geophysics Department of Telcom, Inc. In that capacity, he was responsible for technical management, marketing, proposal activities, contracts, planning, supervision, personnel, reporting, and customer relations. Among his activities at Telcom, he was Principal Investigator for Telcom in a new technology for tunneling, including a study of new acoustic techniques for pre-excavation examination in soils. He managed three important government projects which resulted in sophisticated drill-guidance systems for both vertical and horizontal boreholes. Mr. Rubin also developed a whole new family of instruments from an original concept of drill-string telemetry called "CABLELESS".

1967-1969: As Manager of Systems Engineering in the International Ground Systems Division, Sanders Associates, Inc., Mr. Rubin supervised up to 20 engineers and technicians. He was in charge of all systems engineering in the Division involving two of the major business areas: OHD (Over-Horizon Detection) radar, and LF/VLF systems.

1966-1967: Mr. Rubin served as a Staff Technical Consultant in Systems Engineering and Management at Radiation Systems, Inc., McLean, Virginia. While acting Manager of the Reconnaissance Systems Department, Mr. Rubin supervised 15 to 20 engineers and technicians. He was responsible for major systems proposals in L-S band tracking and acquisition programs. Marketed and managed the TACSATCOM (Tactical Satellite Communications) UHF antenna project.

1961-1966: At DECO Electronic, Inc. (later became DECO Communication Department, Westinghouse Defense and Space Center), Mr. Rubin was involved in a number of projects including: Systems Engineering on the United States Navy's MISRE (Microwave Space Relay) Program; design for VOA (Voice of America), Greenville, North Carolina; project leader for 15-man group for design and construction of a pre-production model of the CU 1463/ARC-96 LF/VLF airborne transmitter-antenna coupler, and Engineer-in-Charge, Systems Engineering Group attached to NASA-Goddard for systems engineering and test-director support of the ATS (Applications Technology Satellite) program.

1956-1961: George Washington University, Washington, D. C. Member of the Faculty of Engineering; Assistant Professor of Electrical Engineering; teaching and researching in metrology, electromagnetic fields, and electromechanical measurements.

1955-1956: University of Pennsylvania, Philadelphia, Pa. Moore School of Electrical Engineering, Assistant Instructor, Research, Electromagnetic Wave Propagation Studies.

## PUBLICATIONS (Partial Listing)

"Long Distance Horizontal Penetration and Sensing In Rock," (co-author), Field Measurements in Rock Mechanics Proceedings of the International Symposium, Zurich, 4-6 April 1977, Volume One, pp. 15-32 (invited paper).

"A New Sensing System for Pre-excavation Subsurface Investigation for Tunnels in Rock Masses," Contract DOT-FH-11-8602, Federal Highway Administration--Final Report FHWA-RD-77-10, (Volume I) and FHWA-RD-77-1 (Volume II). (Principal Author), August, 1976.

"Subsurface Site Investigation by Electromagnetic Radar. Final Report, Phase I, Feasibility," (Principal Author), NSF (RANN) Grant APR75-13414, Report No. NSF/RA-76-0187 (NTIS--PB259335/AS), March, 1976.

"Drilling and Preparation of Reusable, Long Range, Horizontal Bore Holes in Rock and in Gouge, Volume I, State-of-the-Art Assessment," (co-author). Federal Highway Administration Contract DOT-FH-11-8486, Final Report--FHWA-RD-75-95, October 1975.

"An Overview of Horizontal-Borehole Geophysical Techniques," (Published in "Proceedings of a Specialty Conference--", by American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017) August 12-16, 1974.

"Improved Subsurface Investigation for Highway Tunnel Design and Construction; Volume 2, New Acoustic Techniques Suitable for Use in Soil," (principal author). Federal Highway Administration Contract DOT-FH-11-8036, Final Report--FHWA-RD-74-30, May 1974.

"New Survey Systems for Drilling," Proceedings of the First WVU Conference on Coal Mine Electrotechnology, August 4, 1972.

## EDUCATION

B.S.E.E. (with distinction), University of Pennsylvania
M.S.E.E., University of Pennsylvania
Doctoral Work at George Washington University

## PROFESSIONAL AND HONORARY SOCIETIES

Active Member, Society of Exploration Geophysicists
Senior Member, Institute of Electrical and Electronic Engineers
Member, IEEE Group on Geoscience Electronics
Member, Potomac Geophysical Society, Washington, DC
Member, The Society of Sigma Xi, Eta Kappa Nu, Tau Beta Pi

## D.3 MANAGEMENT PLAN

### D.3.1 INTRODUCTION

To document ENSCO's team qualifications, a brief discussion of the Company background, organization, and general management capability will be presented, followed by a description of the qualifications of the individual team members.

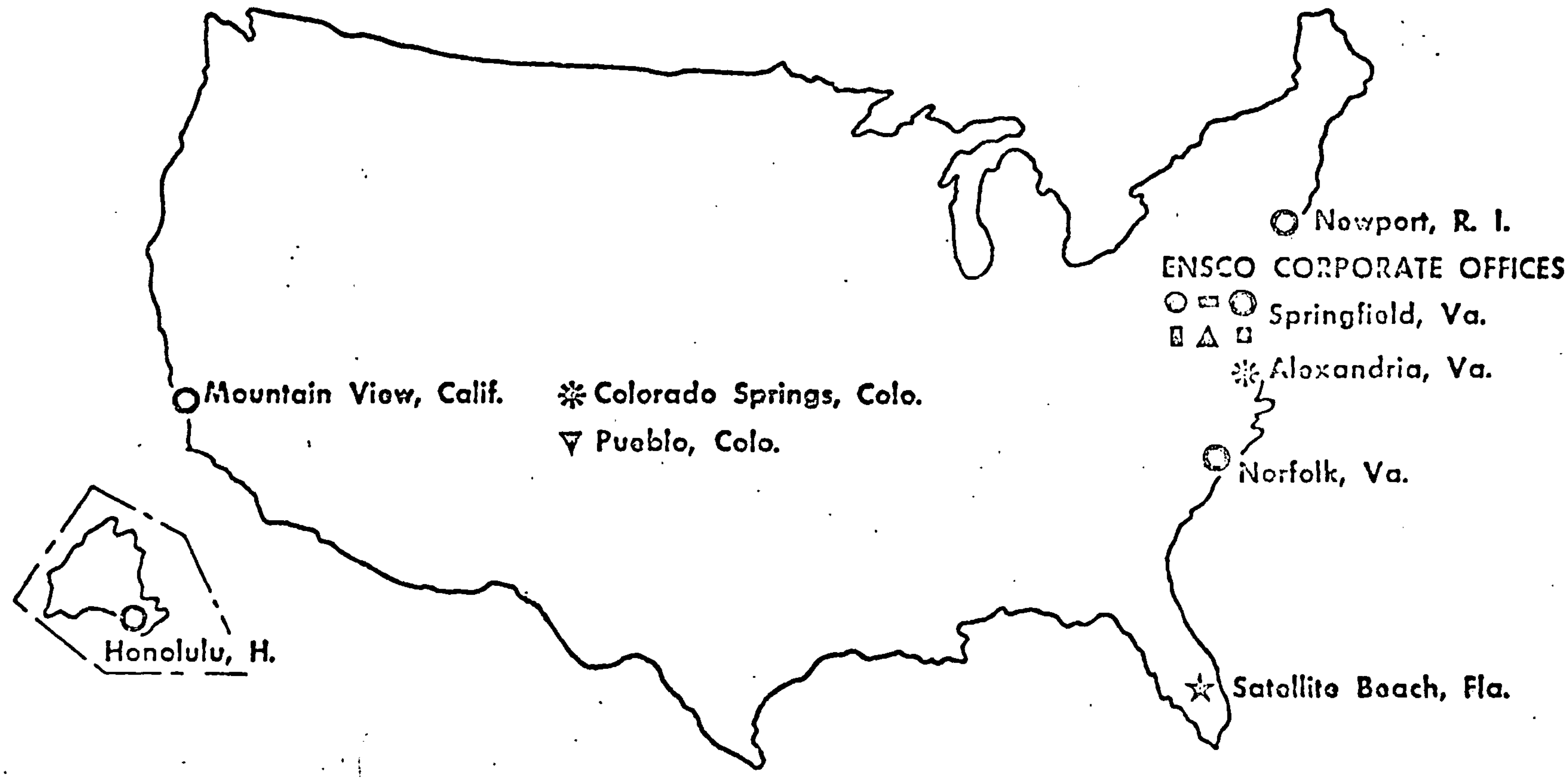
### D.3.2 COMPANY BACKGROUND AND ORGANIZATION

ENSCO is a research and engineering company located in suburban Washington, D.C. Founded in 1969, it is a privately owned firm which conducts business with Federal and State governments as well as with industry. Currently, ENSCO has over 300 employees and has experienced continued growth from its initial staff of four employees. The credentials of the professional staff include advanced technical degrees and extensive diversified experience. In general, members of the professional staff have backgrounds in engineering, mathematics, and the physical sciences. The average senior staff member has over 15 years of professional experience.

#### DIVISIONAL STRUCTURE

The Company has six divisions separated into three groups according to broad market segments: Defense, Transportation, and Information Sciences. ENSCO's corporate offices are located in Springfield, Virginia, with division and branch offices located throughout the United States, as required by business activities. Additionally, ENSCO has one subsidiary: R-K Associates, Springfield, Virginia, who are experts in special antenna and analog equipment design and development. A geographical orientation of all of ENSCO's office locations is depicted in Figure D.3.1.

# ENSCO OFFICES AND ACTIVITIES




Corporate Offices

- ☆ Data & Computer Sciences Division
- Earth Sciences & Systems Division
- ❊ Engineering Test & Analysis Division
- O Ocean Systems & Sciences Division
- △ Signal Analysis Systems Division
- Transportation & Instrumentation Sciences Division
- ▽ Transportation Testing Services
- ENSCO Subsidiary

Figure D.3.1

JANUARY 1978

The ENSCO, Inc. corporate structure, shown in Figure D.3.2., identifies the division assignments with the three major groups. Descriptions of functional activity for each division follow.

## INFORMATION SCIENCES GROUP

The Earth Sciences and Systems Division specializes in computer-based, advanced data acquisition in exploration, excavation, mining, and subsurface site investigation. Geophysical techniques of primary interest include: ground-probing radar, high-resolution seismic, passive seismic, borehole radar, and acoustic probes. Examples of applications include radar coal-thickness sensor for controlling a continuous miner; advanced processing and interpretation of passive seismic signals for geothermal exploration; multi-sensor borehole site investigation system for pre-excavation surveys; advanced noise reduction magnetotelluric data processing for geothermal site evaluation; and programmed, self-contained systems for mine-hazard detection in advance of excavation.

The Signal Analysis Systems Division has a proven capability in intelligence, data processing, and system development. Its research emphasis is on developing and implementing improved ways of processing magnetic, acoustic and infrared data. Examples of systems capabilities include anti-intrusion networks, vehicle discrimination systems, and specialized data reduction and display systems.

# ENSCO CORPORATE ORGANIZATION

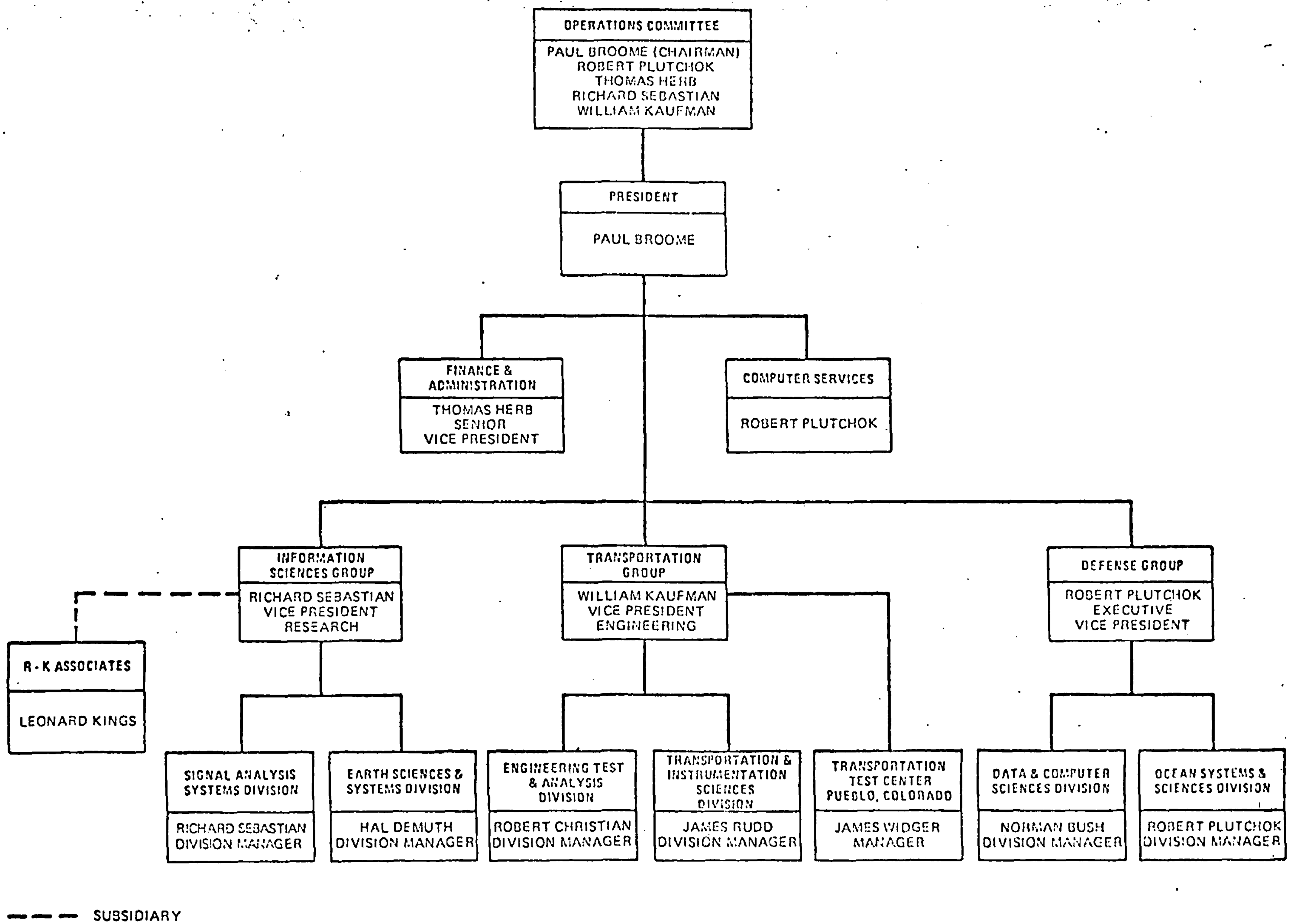



Figure D.3.2

FEBRUARY 1978

## DEFENSE GROUP

The Ocean Systems and Sciences Division has made significant contributions in advanced research in undersea surveillance and ocean acoustics and is recognized as a leader in this field by the Department of Defense. The OSS Division has developed an expertise in microprogrammed signal processing and high-level software for the marine environment with applications to surface ships, aircraft, submarines, and fixed and deployable sensor systems. Noteworthy accomplishments include the establishment of advanced systems for the detection, classification, and tracking of underwater acoustic sources.

The Data and Computer Systems Division, located in Satellite Beach, Florida, has been generally involved in large-scale data reduction and processing activities. Primary areas of expertise include waveform processing, computer networks, statistical studies, aerospace vehicle telemetry, and data analysis. A major application area has been nuclear test detection and evaluation through the monitoring of the land, air and sea environments. This division was also a development consultant in hardware and software improvements to the ARPANET, a worldwide communications network inter-connecting several universities, government agencies, and scientific institutions.

## TRANSPORTATION GROUP

The Transportation and Instrumentation Sciences Division concentrates on data acquisition system development and engineering research and analysis in mechanical and transportation systems. Their efforts include the design and development of sensors, instrumentation modules, and advanced prototype systems for measurement, data collection, analysis, and display. For example, application areas include signal analysis, railroad research, highway research, and vehicle dynamics.

The Engineering Test and Analysis Division has been actively involved in the development of rail technology since 1970. This division developed and implemented a track geometry system involving several special data acquisition vehicles that gather data nationwide on track conditions. The track data is processed by ENSCO for reports to the Federal Railroad Administration and various railroads on track conditions for implementation into maintenance programs for safer and more comfortable travel on the nation's rails. The Engineering Test and Analysis Division also does special testing in rail vehicle dynamics, wheel/rail interaction, and other railroad-related equipment measurements. ENSCO uses special rail test cars (whose systems we developed) that are electronically or mechanically instrumented to obtain information on the dynamic or behavior of rail cars, locomotive, tracks, or the interaction of vehicle and track.

### D.3.3 GENERAL MANAGEMENT CAPABILITY

Within a division, projects are organized into program areas to maximize efficiency and cooperation. Project managers receive support from management at all levels to help accomplish their requirements in a responsive, timely manner. The simplified structure within the organization provides a framework for expediting the work flow while maintaining a high motivation of personnel.

It is worth noting that, as a small and rapidly growing company, ENSCO has become expert in project team organization and quick response to the customer. As a result of this capability, a choise of highly skilled personnel is available in many technical areas to facilitate quick, effective response.

ENSCO policy is to provide the Project Managers with maximum direct control, through the proven project management method, of all resources required for an efficient and effective project. This method, which provides strong management and technical control, can best accomplish task objectives, and at the same time provide the Department of Energy with maximum visibility into project operations. The approach provides an organization tailored directly to the requirements of the project and responsive to its needs, while maintaining the required project flexibility.

Each month the Project Manager will present to Company management and the Technical Advisory Group the current status, problems being encountered, plans for the immediate future, and actual cost versus projected cost on this project. This project review provides ENSCO management an opportunity to assist the Project Manager in all ways possible to the end that all work is accomplished in accord with the Program Scheduling Document, Figure D.3.3, and within authorized funds. Problem areas which the Project Manager cannot resolve immediately will be brought to the attention of Mr. Hal P. Demuth, Vice President and Earth Sciences and Systems Division Manager, for resolution. Mr. Demuth will participate in all progress reviews and will be available at all times to assist the research team in accomplishing task assignments to the complete satisfaction of the client. He will participate directly in all phases of the proposed research to insure the achievement of meaningful, practical and immediately useful results. His background makes him uniquely qualified for this role. Mr. Demuth has been project manager on several important multimillion dollar system engineering, computer oriented system design and transportation system programs.

## D.3.4. PROJECT ASSIGNMENTS

The project organization chart (Figure D.3.4) shows the responsibilities assigned for the performance of the tasks described in the Program Description, Section B.3.

ENSCO, INC.

PROGRAM SCHEDULING DOCUMENT

PROGRAM NAME MAPPING GEOTHERMAL SEISMIC SOURCES NEAR LEACH HOT SPRINGS, NV

RFP NO. ET-78-R-08-0003

PROGRAM MGR. Dr. E. Page

CONTRACT NO. ENSCO Proposal P-E-719

**SCHEDULE**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| TASK 1: Prep. for Field Work | ○ | △ | | | | | | | |
| TASK 2: Record. Surface Wave & Body Wave Emissions At Geothermal Site | | ○ | △ | | | | | | |
| TASK 3: Data Processing | | | | | | | | | |
| 3a. Pre-Processing of Data | | | ○ | | △ | | | | |
| 3b. Computation of Seism.Act. Maps | | | | ○ | | △ | | | |
| TASK 4: Interp. of Results & Final Report | | | | | | ○ | △ | | |
| Management Plan (Update) | 15 ▽ | | | | | | | | |
| Cost Management Report | | 15 ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | |
| Technical Progress Report | | 15 ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | |
| Program Status Report | | | 15 ▽ | | | ▽ | | | |
| Final Technical Report | | | | | | | | ▽ | |

SCHEDULED START ○ △ SCHEDULED FINISH

ACTUAL START ● ▲ ACTUAL FINISH

EXAMPLE: ○ ● △ ▲ ▽ REPORT

Figure D.3.3

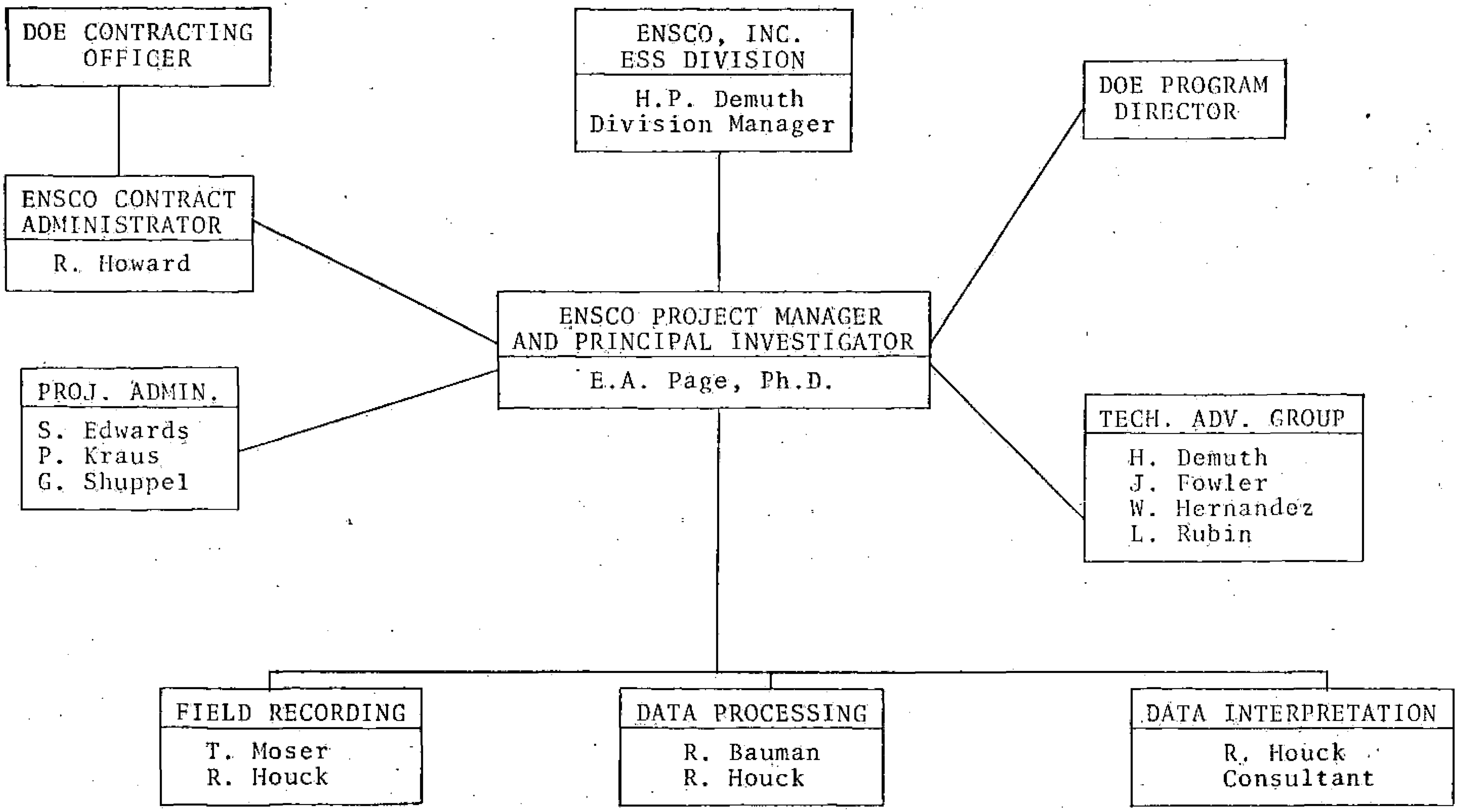



Figure D.3.4. Project Organization

## D.3.5 INDIVIDUAL TEAM MEMBER QUALIFICATIONS

ENSCO is committing a select team to this effort. The Project Manager/Principal Investigator, Dr. Edward Page, is ENSCO's most experienced Staff Scientist in seismic source depth research. Dr. Page has eight years experience in developing signal processing and seismic modeling techniques directed toward improved seismic source analysis. In addition, he is a leader in the development of new seismic array processing technology for source localization in geothermal regions.

Mr. Richard T. Houck, ENSCO Senior Scientist, has over four years experience in conducting field seismic data processing and associated research. His work spans the gamut of basic research, computer program development, and field data collection, and will be utilized in all three capacities in this proposal.

Mr. Theodore Moser, ENSCO Engineer, will be heavily involved in field recording. He has over six years of experience gathering and interpreting data gathered in the field. Five years of this experience was on-board rail test cars owned by U.S. DOT. As field supervisor, Mr. Moser was responsible for interpretation of real-time data gathered at high speed in both analog and digital form. Mr. Moser was also involved with the implementation and design of new systems placed on-board.

The past year and a half, Mr. Moser has become very familiar with ground probing radar techniques in hard rock, coal, and earthy materials. Mr. Moser has also been involved in modifications to the commercial radar units and peripheral equipment to make them more suitable for real-time display and interfacing to the computer system.

Mr. Robert Bauman, ENSCO Senior Programmer/Analyst, will work on data processing aspects of the proposal. He is experienced in processing digitized time-series data, refining and documenting computer software in underwater acoustics analysis, and collateral programming to test, display, and analyze data.

Full resumes of these key personnel appear in Section D.2.

## D.4 CONTACTS

Following are names, addresses, and telephone numbers of primary business and technical contacts related to this proposal.

H. M. Iyer
U.S.G.S.
Menlo Park, California
(415) 323-8111, ext. 2685

Donald Klick
U.S.G.S.
Reston, Virginia
(703) 860-6581

Stanley Laster
Dept. of Physical Sciences
University of Tulsa
Tulsa, Oklahoma
(918) 939-6351

Dan Tucciarone
Defense Contract Audit Agency
5600 Columbia Pike
Falls Church, VA 22041
(202) 756-1110

Connie Marcheski
Defense Contract Adminstration
Services Management Area
300 E. Joppa Road
Towson, MD 21204
(301) 321-4930

## D.5 DRAFT CONTRACT

The provisions of the draft contract are acceptable with the exception of Article 4.b.2, Payment, Non-Drilling Program. As indicated on our Optional Form 60, we do request monthly progress payments up to 85% of total cost. ENSCO, Inc. has adequate resources including a line of credit of $750,000 with United Virginia Bank/National, Alexandria, Virginia.

## D.6 THE PROGRAM TECHNICAL SCOPE

The "Program Technical Scope" set forth in the RFP has been reviewed and all of the data which may be furnished pursuant to a contract may be published.

## D.7 FINANCIAL STATEMENT

A copy of ENSCO, Inc.'s Financial Statement for the period ending April 30, 1978 is enclosed.

## D.8 VALIDITY PERIOD

Addressed in transmittal letter.

## D.9 AUTHORITY TO COMMIT ENSCO, INC.

Addressed in transmittal letter.

## D.10 REPRESENTATIONS AND CERTIFICATIONS

Attached.

# BIBLIOGRAPHY


1. Fournier, R.O., et. al., 1974, "Geotechnical Indicators of Subsurface Temperature." U.S.G.S. Journal of Res., 2, (3).

2. Liaw, Alfred Liang-Chi, 1977, "Microseisms in Geothermal Exploration: Studies in Grass Valley, Nevada, Lawrence Berkeley Laboratory, Report No. LBL-7002, Prepared for the U.S. Department of Energy under Contract W-7405-ENG-48.

3. Mariner, R.H., et. al., 1974, "The Chemical Composition and Estimated Minimum Thermal Reservoir Temperatures of the Principal Hot Springs of Northern and Central Nevada," U.S.G.S. Openfile Report.

#12 MOD

National Geothermal Corp.
P.O. 549
Los Gatos, Ca. 95030

6-22-78

Rec'v'd 6/26/78 3PM

Mr. Joseph N. Fiore, Chairman
Source Evaluation Panel
U.S. Department of Energy
Nevada Operations Office
2753 South Highland Drive
Las Vegas, Nevada 89114

Dear Mr. Fiore:

Further to my telephone discussions with you, I am enclosing herewith an amendment to our May 30 proposal to the DOE to conduct geothermal investigations in Smokey Valley, Nevada. The purpose of the amendment is to provide you and your colleagues with some of the newest findings that NGC has made in its ongoing investigations of Smokey Valley, Nevada. These findings, which we find exciting and rather encouraging, suggest that a commercial-temperature reservoir may be located in the area of the Darrough Hot Springs Prospect.

Our proposal entails no change in either the financial aspects or the time plan which was presented earlier by us. However, we felt that our newest findings may have some bearing on your considerations.

Sincerely yours,

Hugh McLaughlin

Hugh McLaughlin

National Geothermal Corp.
P.O. 549
Los Gatos, Ca. 95030

# AMENDMENT TO PROPOSAL TO U.S. DEPARTMENT OF ENERGY TO SUPPORT GEOTHERMAL INVESTIGATIONS IN SMOKEY VALLEY, NEVADA

## GEOTHERMAL RESERVOIR ASSESSMENT CASE STUDY
## NORTHERN BASIN & RANGE PROVINCE

BY

NATIONAL GEOTHERMAL CORPORATION

REQUEST FOR PROPOSAL ET-78-R-08-0003

## STATEMENT OF PURPOSE

The purpose of this amendment is to provide new technical data which indicate that our original assertion about the favorable likelihood of the occurrence of a high quality geothermal reservoir in the Darrough Hot Spring Prospect, Smokey Valley, Nevada, is borne out by the new data.

Based upon that new data, we believe that adequate scientific evidence now exists to strongly suggest that a reservoir at a temperature of about 180°C ± 20° occurs in the Darrough region at a depth of less than 2 km (6000').

## NEW TECHNICAL DATA

Results of a small scale geochemical survey and thermal gradient measurements were not fully analysed at the time of the submission of our original proposal, dated May 30, 1978.

The geochemical survey included sampling of both hot and cold springs in Smokey Valley. Analysis of survey results shows that the hot water emanating at the Darrough Hot Springs and at the other warm springs in the Valley are a result of mixing of cold groundwater and a hot water body at depth. Prior to our work, estimates of reservoir temperatures in Smokey Valley were based upon two single analyses by the U.S.G.S. of the outflow of the Darrough and Spencer hot springs, which did not take possible mixing of cold water with the leakage from the reservoir into account. Although this limitation was pointed out by the U.S.G.S. in their various publications (cf. Mariner et al, 1974), most resource companies examining the opportunity

in Smokey Valley must have relied on the calculated minimum reservoir temperature published by the U.S.G.S. (140°), resulting in lack of interest in geothermal exploration and development in the Valley. As a result, no offers were submitted to the BLM in two previous bidding periods when portions of the KGRA were offered for sale to the public.
why not by Natl. geothermal

Our work and methodology are shown in the attached report on geochemical survey results in Smokey Valley. Our conclusion, based upon the geochemical data is that a reservoir at a temperature of $180^{\circ} \pm 20^{\circ}$ C occurs in the area. The range of temperature uncertainty reflects the data scatter of temperature values obtained from the different geochemical geothermometers employed.

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The magnetotelluric data gathered by the U.S.G.S. shows that the approximate depth to the center of a low resistivity anomaly in the Darrough Hot Springs area is about 1600 meters (about one mile). Since at that depth the rocks are known to be basement rocks, they would normally be characterized by high resistivities. ~~A logical~~ One explanation for the low resistivity is that the rocks at that depth contain a high temperature liquid which causes the lowering of rock resistivity at that depth. Aeromagnetic data ~~suggest~~ may be interpreted that the entire area of the Darrough Prospect has been subjected to hydrothermal alterations by high temperature liquids flowing through the basement rocks.



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on NGE land?

Thermal gradient measurements in a drill hole in the Roger Berg property, about 5,000' north of the Darrough Hot Springs, has resulted in a remarkably high and remarkably linear gradient of 9°F/100' (154°C/km) in the bottom 140 feet of the hole. Based upon the actual temperatures measured and the calculated gradient, a temperature of 180°C may be encountered at a depth of 3500', provided that the gradient continues downward linearly. what is t.d.? no mixing!

Correction to Page 16 in original proposal

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Based upon the existing temperature data, we have prepared a hypothetical iso-temperature cross-section of the Darrough geothermal system anomaly (Figure 1). As a general rule, temperatures do not increase linearly inside the reservoir itself, where convection tends to predominate. In Figure 1, the values given are those of actually measured temperatures. Values with a wiggly line underneath are those calculated from the gradient data.

Figure 2 presents a hypothetical model of the entire Darrough Hot Springs Prospects as envisioned at present, based upon the existing data. According to this model, hot water at a temperature of about 350-360°F (about 180°C) is mobilized in the basement, at a depth of about 17,000'-18,000'. The hot water



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This model suggests that a reservoir with an area of a few square miles occurs in the area. Its thickness probably varies, depending upon location. International compilation suggests that high quality geothermal reservoirs possess a potential capacity of about 150 MW per square mile of reservoir surface area, for about 30 years. ? NGC anticipates that further investigation would result in the discovery of a reservoir with an equivalent electrical capacity of several hundred megawatts.

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Approval and support of this program may result in an important new discovery in an area which has been previously neglected. NGC looks forward to a positive support by DOE of this significant program.

Hugh McLaughlin

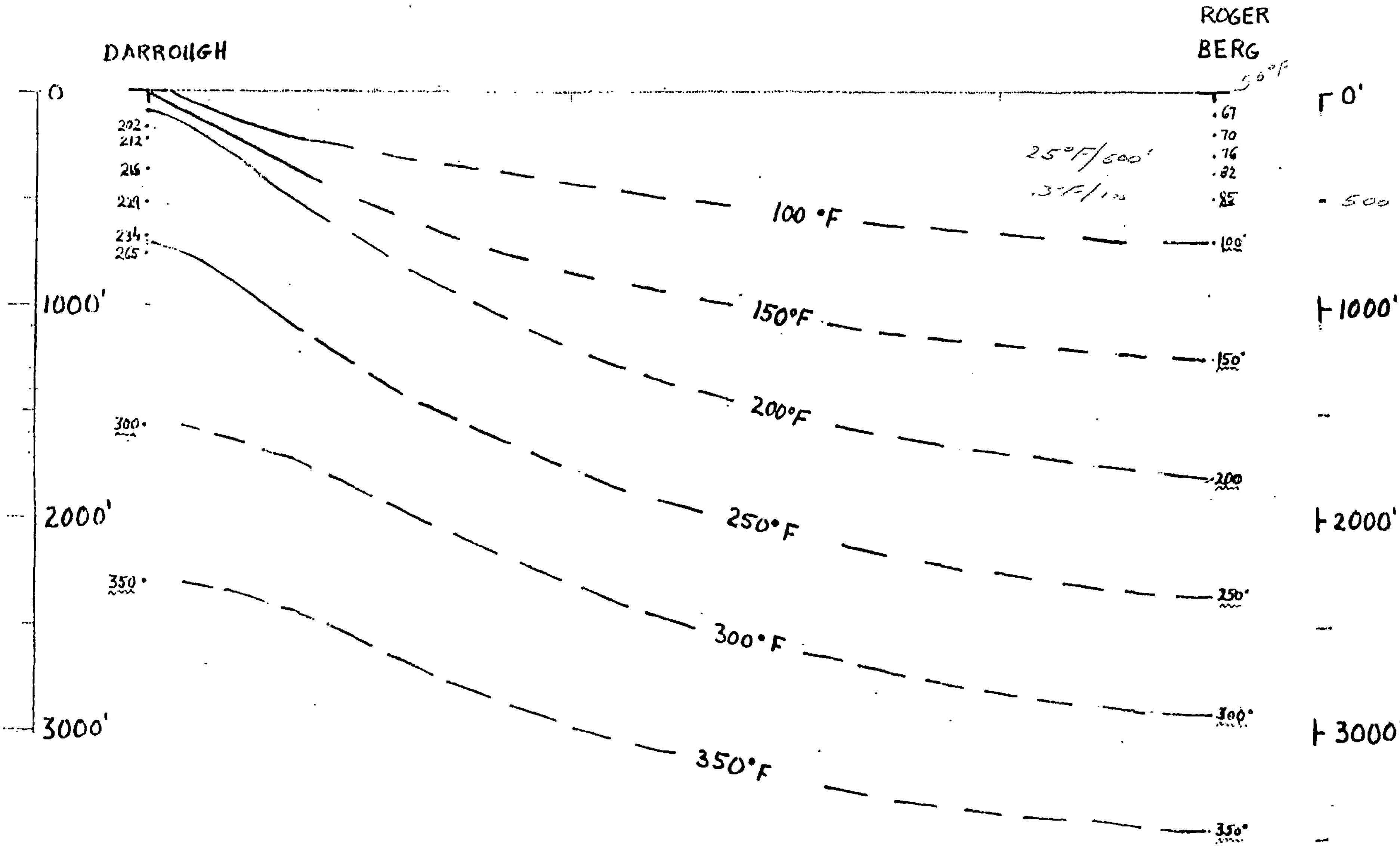
Hugh McLaughlin, President
National Geothermal Corporation

June 26, 1978

FIG. 1. HYPOTHETICAL TEMPERATURE-DEPTH DISTRIBUTION

DARROUGH HOT SPRINGS AREA, NEVADA

Based upon linear extrapolation of thermal gradient, geochemical and geophysical data.



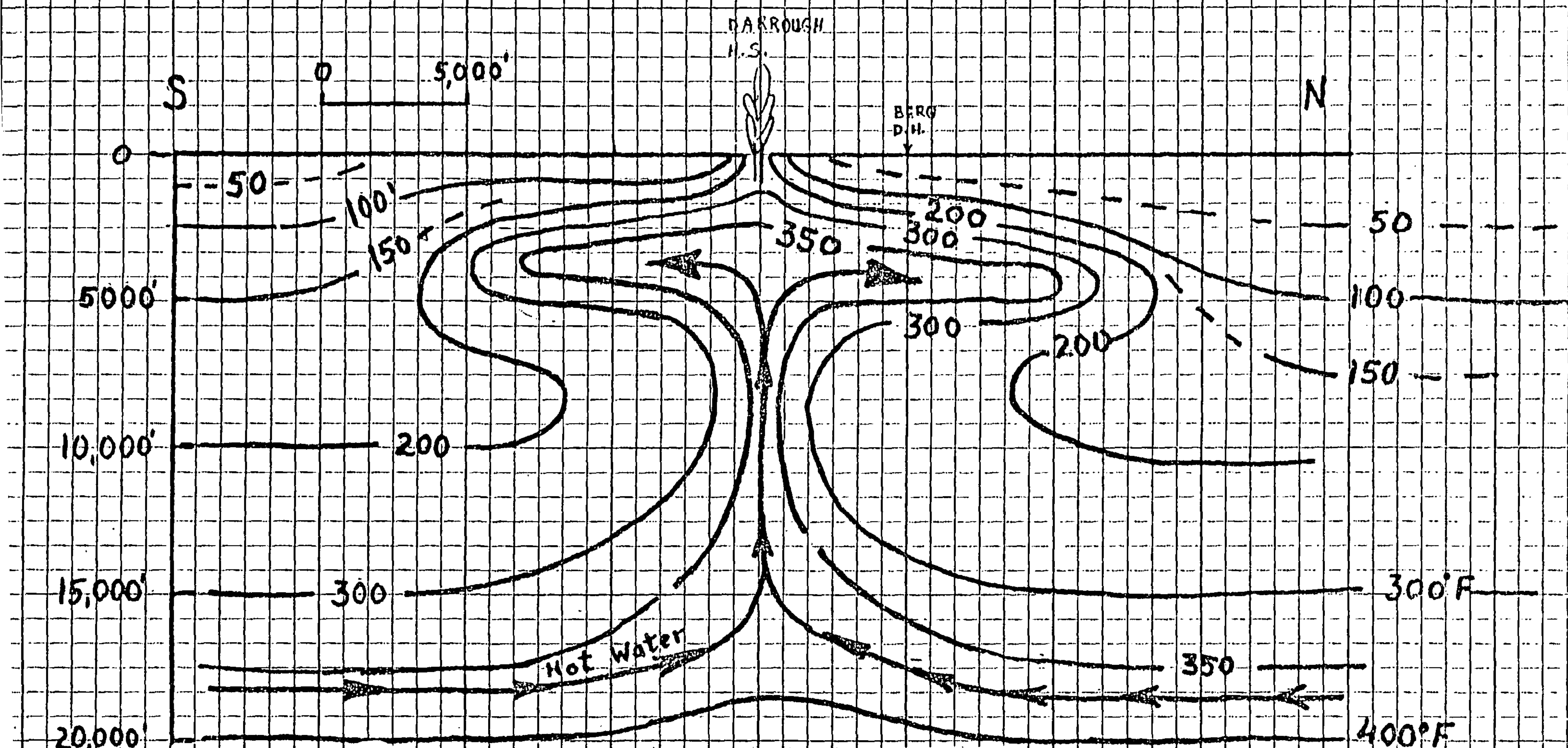



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FIGURE 2

DARROUGH HOT SPRINGS PROSPECT

A possible temperature model.
No vertical exaggeration.

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# A Preliminary Analysis of Geothermal Reservoir Temperature in Smokey Valley Based Upon Chemical Geothermometry

by
Tsvi Meidav
for
National Geothermal Corporation

June 1978

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## LIST OF FIGURES

A Preliminary Analysis of Geothermal Reservoir Temperature in Smokey Valley, Based upon Chemical Geothermometry

## Summary

Seven samples of both hot and cold water were collected by the writer in the Smokey Valley in March, 1978. The samples were analyzed by a commercial laboratory. Results of the analysis are presented in Appendix I.

The data was interpreted, using the assumption that the hot springs in the area represent mixing of cold groundwater and geothermal reservoir water. Reservoir temperatures based upon the silica thermometer yield a temperature of about 180°C (355°F) for the deep water at both Darrough Hot Springs and Spencer Hot Springs. Reservoir temperatures based upon the calcium-potassium, sodium-potassium and calcium-sodium thermometers yield a temperature range of 135°C to over 220°C (372-425°F).

The data suggests that a geothermal reservoir of commercial quality may underlie parts of Smokey Valley. Although this conclusion must be corroborated by independent evidence, i.e. drilling, it is encouraging enough to justify a continued exploration program in the Valley.

## Methodology and Analysis

Techniques for determining subsurface reservoir temperatures from chemical analysis of surface water are well known. These techniques have been successfully employed in a number of countries. White (1970) has ably summarized the fundamental principles underlying the rationale and methodology of chemical geothermometry of reservoir fluids through the analysis of hot springs emanating at the surface. Thus, the determination of likely reservoir temperature through a detailed geochemical study of hot springs has become a standard geothermal exploration method.

The problem of determining subsurface temperatures becomes more complex when the original geothermal fluid becomes diluted by colder water percolating downward, thus altering its chemical character. Numerous authors have offered a variety of methods to determine the ratio of mixing between two liquid systems at different temperatures. A number of methods work reasonably well when the lower temperature system is characterized by very low salinity. In this study, we have employed the quartz geothermometer and compared it with results obtained from a number of independent chemical geothermometry determinations for the same locality using the Na/K, Ca/K and Ca/Na thermometers, employing a method developed by Professor Tonani (unpublished). Certain statistical tests and mutual consistency criteria provide a measure of reliability of the resolved reservoir temperature when mixing has occurred. Thus, under favorable conditions, the true reservoir temperature can be approximately determined even under conditions of mixing of water from two different sources.

would also be higher ρ.

We have collected samples of both hot and cold spring waters in Smokey Valley, on the assumption that dilution has taken place. A study of both hot and cold spring geochemistry permits the determination of the amount of mixing and the temperature of the reservoir fluid before it was cooled down by intermixing with the downward percolating cold groundwater, or horizontally flowing lukewarm water.

Description of sample location, water temperature at spring orifice and results of the chemical analysis are presented in Appendix I of this report. Chemical analysis results are given in ppm.

Cursory examination of the data showed that there is a direct correlation between silica concentration and spring temperature. An important problem that must be overcome by the user of silica thermometry is that of the potential ambivalence of the thermometer because of the different solubility characteristics of different silica bearing minerals such as quartz, christoballite and amorphous silica. We have ruled out the possibility of amorphous silica as being the source of silica in the Smokey Valley water, because at low concentrations, the solubility of amorphous silica is almost temperature-independent, yet our samples show high linear correlation between sample temperature and silica concentration. Similar conclusions were reached by Levitte and Eckstein (1978, in press) in analyzing warm springs in the Jordan Valley. Furthermore, independent chemical thermometry using Na, K and Ca related thermometers yields calculated reservoir temperatures which are in closer agreement with calculated reservoir temperatures using the quartz solubility curve and assumed dilution.

A plot of dissolved silica vs. enthalpy (or temperature) for samples of distinct temperature from Smokey Valley (Figure 1), on paper containing graphs of quartz solubility (with and without steam loss), shows that the silica concentration is linearly related to temperature. The silica concentration varies from 21 ppm, at the Wineglass Spring well (12.5°C, Sample No. 5), to 98 ppm at Darrough Hot Springs (Sample No. 8, analyzed by the USGS, at 95°C). The graphically obtained reservoir temperature for the non-diluted end member is 180°C (355°F), if no steam loss is assumed, and 160°C (320°F) if maximum steam loss is assumed. It is interesting to note that the Spencer Hot Springs (Sample No. 1) data point falls on the same straight line as that derived from the data in the vicinity of Darrough Hot Springs. The alkali metal ratio thermometers (Na, K, Ca and their various interrelationships), are less affected by dilution, because dilution by pure water does not affect ratios. For Sample No. 7, (the Roger Berg well) the alkali metal ratio thermometers yield a mean temperature of 135°C (273°F). For Spencer Hot Springs, the calculated reservoir temperature is 277 ± 50°C. For Spencer Hot Springs Bath House they yield a temperature of 215°C ± 10° (417°F ± 18°F). For Darrough Hot Springs the three-metal thermometers do not work. Thus, the range of credible reservoir temperatures varies from 135° to 227° based upon alkali metal thermometry, or about 180°C average temperature. The range of minimum reservoir temperatures based upon the silica data is 160-180°C.

It is tentatively concluded that a temperature of about 180°C is likely to represent the temperature of the reservoir from which the hot spring fluids emanate. The resultant hydrocological-geothermal model for the area is quite simple: Geothermal fluid at a temperature of about 180°C rises from great depth, after being heated by a shallow heat source. As the geothermal fluid rises it becomes increasingly diluted by warm or cold water. Different leakage paths to the surface (A or B in Figure 2) conduct the liquid from that depth to the surface. If little dilution has taken place (Point A in Figure 2), the spring emanates at a higher orifice temperature. If high dilution takes place, by different aquifers feeding into the system, a lower salinity, lower temperature water issues at the surface at spring B. At places where the shallow aquifer does not encounter any ascending hot water (Point C), the water may issue as a cold spring, depending upon the piezometric surface in any given locale. According to this model, hot water at original reservoir temperature would be encountered if a hole is drilled deep enough. Geophysical data suggests that the reservoir is at about 1.5 km depth.

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Uncertainties concerning the technique and the limited data available make it unwise to make any conclusions which are absolutely reliable. The only important conclusion that may be derived from the above study is that enough encouraging data is provided by the geochemical survey by us to warrant the assumption that the chances for the occurrence of a geothermal reservoir of economic value for power production purposes warrant further vigorous investigations in Smokey Valley, especially around Darrough and Spencer Hot Springs.

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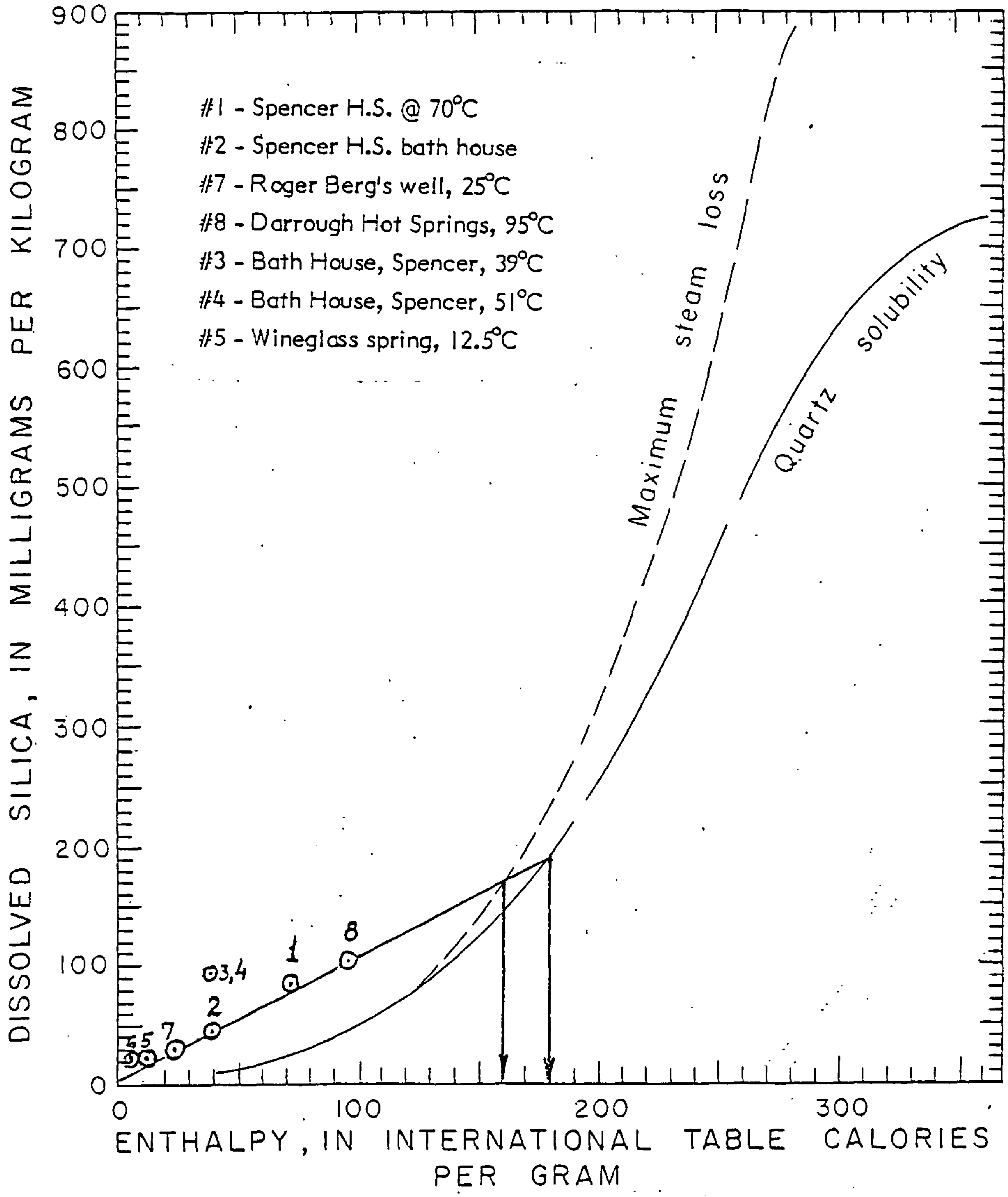


FIGURE 1: Dissolved silica-enthalpy graph for determining temperature of a hot-water component mixed with cold water yielding warm spring water for Smokey Valley, Nevada.

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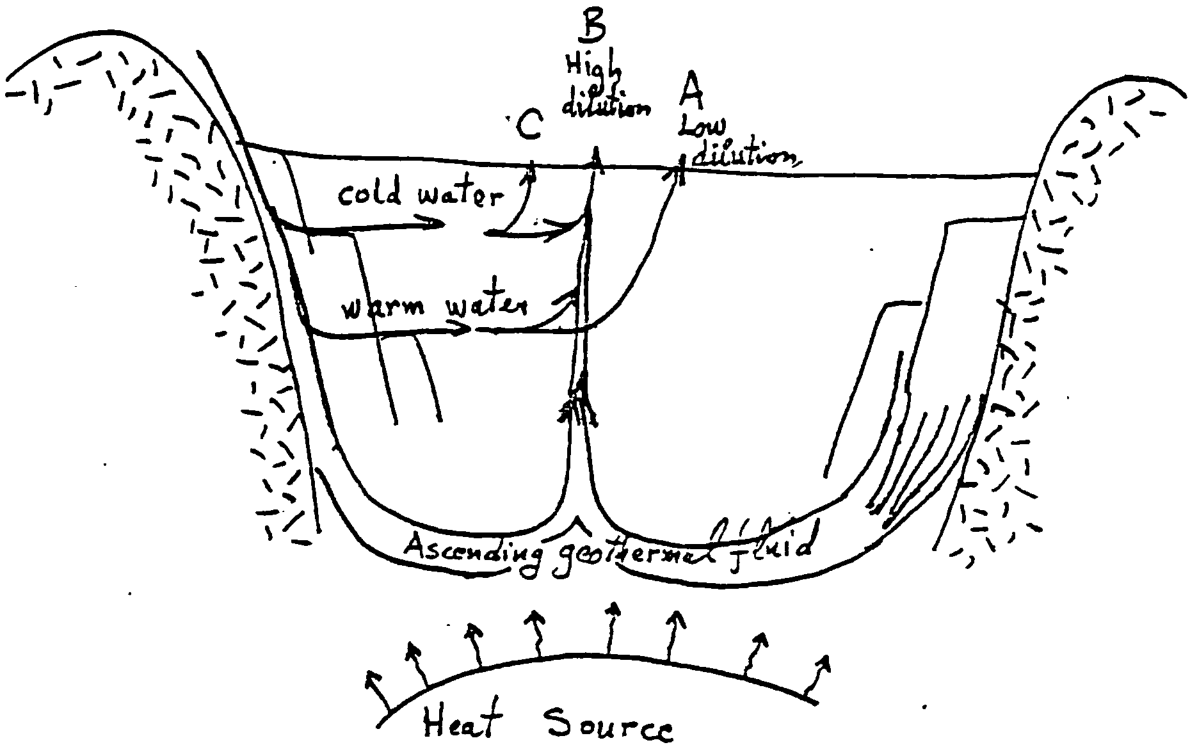
B
High dilution
A
Low dilution
C
cold water
warm water
Ascending geothermal fluid
Heat Source

FIGURE 2

Appendix I
Results of Chemical Analysis, in PPM

| Component | Sample | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boron | 2.6 | 11. | 2.6 | 2.6 | 0.06 | 0.05 | 0.049 | 0.22 |
| Calcium | 44. | 74. | 41. | 51. | 28. | 26. | 26. | 1.3 |
| Magnesium | 9.7 | 18. | 9.9 | 9.9 | 3.1 | 2.2 | lt 1.0 | 0.1 |
| Potassium | 36. | 22. | 36. | 36. | 1.6 | 1.1 | 1.5 | 2.6 |
| Sodium | 190. | 110. | 190. | 190. | 12. | 12. | 18. | 110. |
| Lithium | 1.8 | 0.57 | 1.8 | 1.8 | 0.006 | 0.005 | 0.012 | 0.3 |
| Ammonium | 3.3 | 0.93 | 2.8 | 3.5 | 0.22 | 0.54 | 0.31 | 0.13 |
| Chloride | 23. | 16. | 23. | 25. | 3.5 | 4.8 | 6.0 | 12 |
| Nitrate | | | | | | | | |
| Nitrite | | | | | | | | |
| Silica | 88. | 43. | 94. | 94. | 21. | 24. | 30. | 98 |
| Sulfate | 45. | 49. | 40. | 39. | 4.5 | 5.8 | lt 4.1 | 53 |
| Carbonate | | | | | | | | 3 |
| Bicarbonate | 654. | 523. | 665. | 673. | 112. | 122. | 122. | 146 |
| Fluoride | 5.6 | 2.4 | 5.6 | 5.6 | lt 0.1 | lt 0.1 | lt 0.1 | 14 |
| pH | 7.20 | 6.95 | 7.70 | 6.89 | 6.91 | 7.72 | 7.78 | 8.29 |
| Conductivity | 1158. | 915. | 1168. | 1170. | 215. | 195.1 | 219. | |
| Phosphate | | | | | | | | |
| Bromide | | | | | | | | 0.02 |
| Iodine | | | | | | | | 0.04 |
| Rubidium | | | | | | | | 0.009 |
| Strontium | | | | | | | | 0.03 |
| Mercury | | | | | | | | 0.06 |
| Temperature | | | | | | | | 0.004 |
| Location | Spencer Hot Spring | Spencer Lukewarm Spring | Spencer Bath House, Warm Tap | Spencer Bath House, Tepid Tap | Wineglass Cold Spring | Tap In Roger Berg's Home | Well On Roger Berg's Land | Darrough Hot Springs |

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# REFERENCES


Levitte, D. and Y. Eckstein, 1978 (in press), Correlation between the silica concentration and the orifice temperature in the warm springs along the Jordan-Dead Sea Rift Valley.

White, D., 1970, Geochemistry applied to the discovery, evaluation and exploitation of geothermal energy resources, Proc. U.N. Symp. on the Development and Utilization of Geothermal Resources, Pisa.

A/2 MoD

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Los Gatos, Ca. 95030

6-22-78

Rec'd 6/26/78 3PM

Mr. Joseph N. Fiore, Chairman
Source Evaluation Panel
U.S. Department of Energy
Nevada Operations Office
2753 South Highland Drive
Las Vegas, Nevada 89114

Dear Mr. Fiore:

Further to my telephone discussions with you, I am enclosing herewith an amendment to our May 30 proposal to the DOE to conduct geothermal investigations in Smokey Valley, Nevada. The purpose of the amendment is to provide you and your colleagues with some of the newest findings that NGC has made in its ongoing investigations of Smokey Valley, Nevada. These findings, which we find exciting and rather encouraging, suggest that a commercial-temperature reservoir may be located in the area of the Darrough Hot Springs Prospect.

Our proposal entails no change in either the financial aspects or the time plan which was presented earlier by us. However, we felt that our newest findings may have some bearing on your considerations.

Sincerely yours,

Hugh McLaughlin

Hugh McLaughlin

National Geothermal Corp.
P.O. 549
Los Gatos, Ca. 95030

# AMENDMENT TO PROPOSAL TO U.S. DEPARTMENT OF ENERGY TO SUPPORT GEOTHERMAL INVESTIGATIONS IN SMOKEY VALLEY, NEVADA

## GEOTHERMAL RESERVOIR ASSESSMENT CASE STUDY NORTHERN BASIN & RANGE PROVINCE

BY

NATIONAL GEOTHERMAL CORPORATION

REQUEST FOR PROPOSAL ET-78-R-08-0003

## STATEMENT OF PURPOSE

The purpose of this amendment is to provide new technical data which indicate that our original assertion about the favorable likelihood of the occurrence of a high quality geothermal reservoir in the Darrough Hot Spring Prospect, Smokey Valley, Nevada, is borne out by the new data.

Based upon that new data, we believe that adequate scientific evidence now exists to strongly suggest that a reservoir at a temperature of about $180^{0}C \pm 20^{0}$ occurs in the Darrough region at a depth of less than 2 km (6000').

## NEW TECHNICAL DATA

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The geochemical survey included sampling of both hot and cold springs in Smokey Valley. Analysis of survey results shows that the hot water emanating at the Darrough Hot Springs and at the other warm springs in the Valley are a result of mixing of cold groundwater and a hot water body at depth. Prior to our work, estimates of reservoir temperatures in Smokey Valley were based upon two single analyses by the U.S.G.S. of the outflow of the Darrough and Spencer hot springs, which did not take possible mixing of cold water with the leakage from the reservoir into account. Although this limitation was pointed out by the U.S.G.S. in their various publications (cf. Mariner et al, 1974), most resource companies examining the opportunity in Smokey Valley must have relied on the calculated minimum reservoir temperature published by the U.S.G.S. ($140^{C}$), resulting in lack of interest in geothermal exploration and development in the Valley. As a result, no offers were submitted to the BLM in two previous bidding periods when portions of the KGRA were offered for sale to the public.

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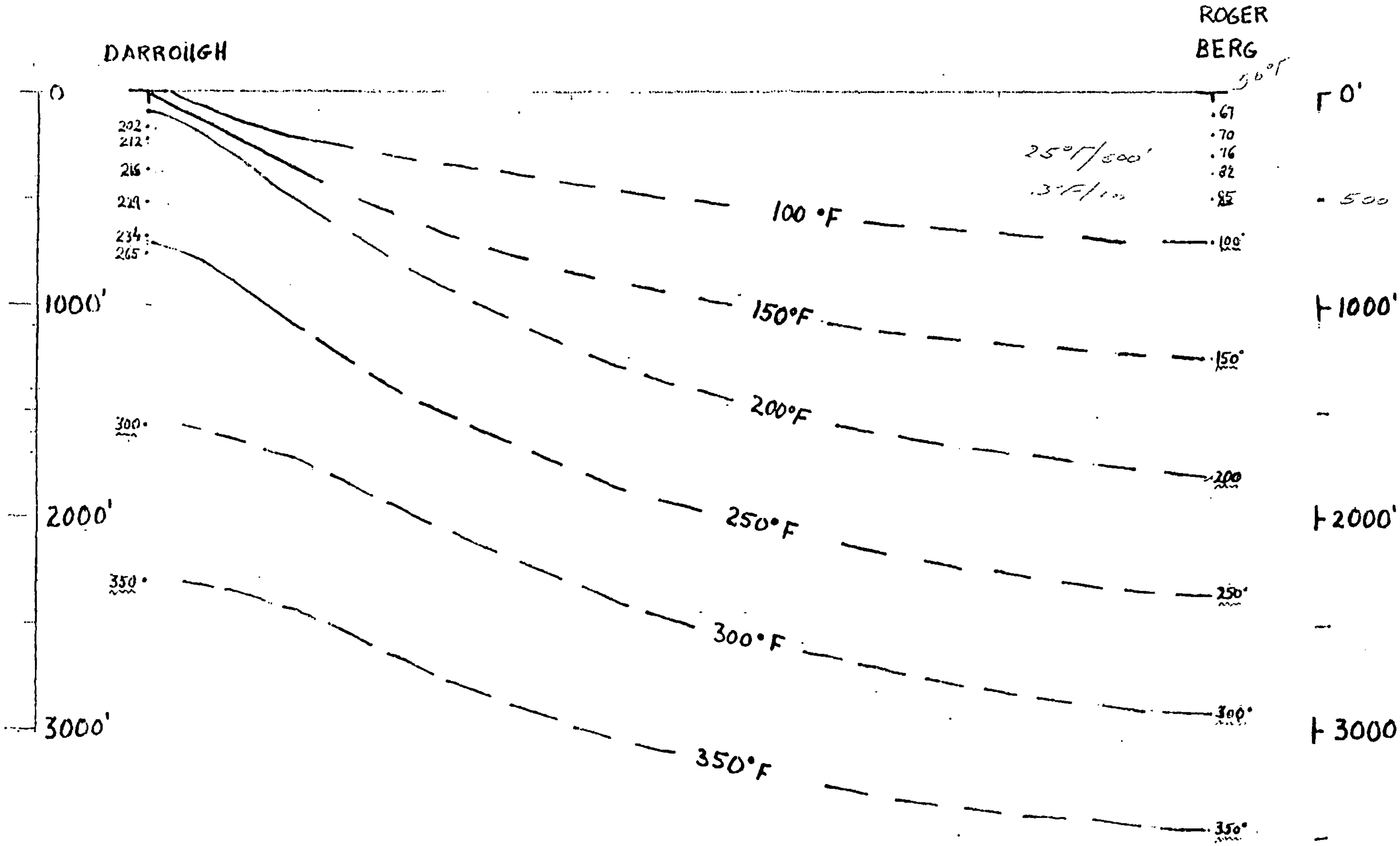
DARROUGH HOT SPRINGS AREA, NEVADA

Based upon linear extrapolation of thermal gradient, geochemical and geophysical data.

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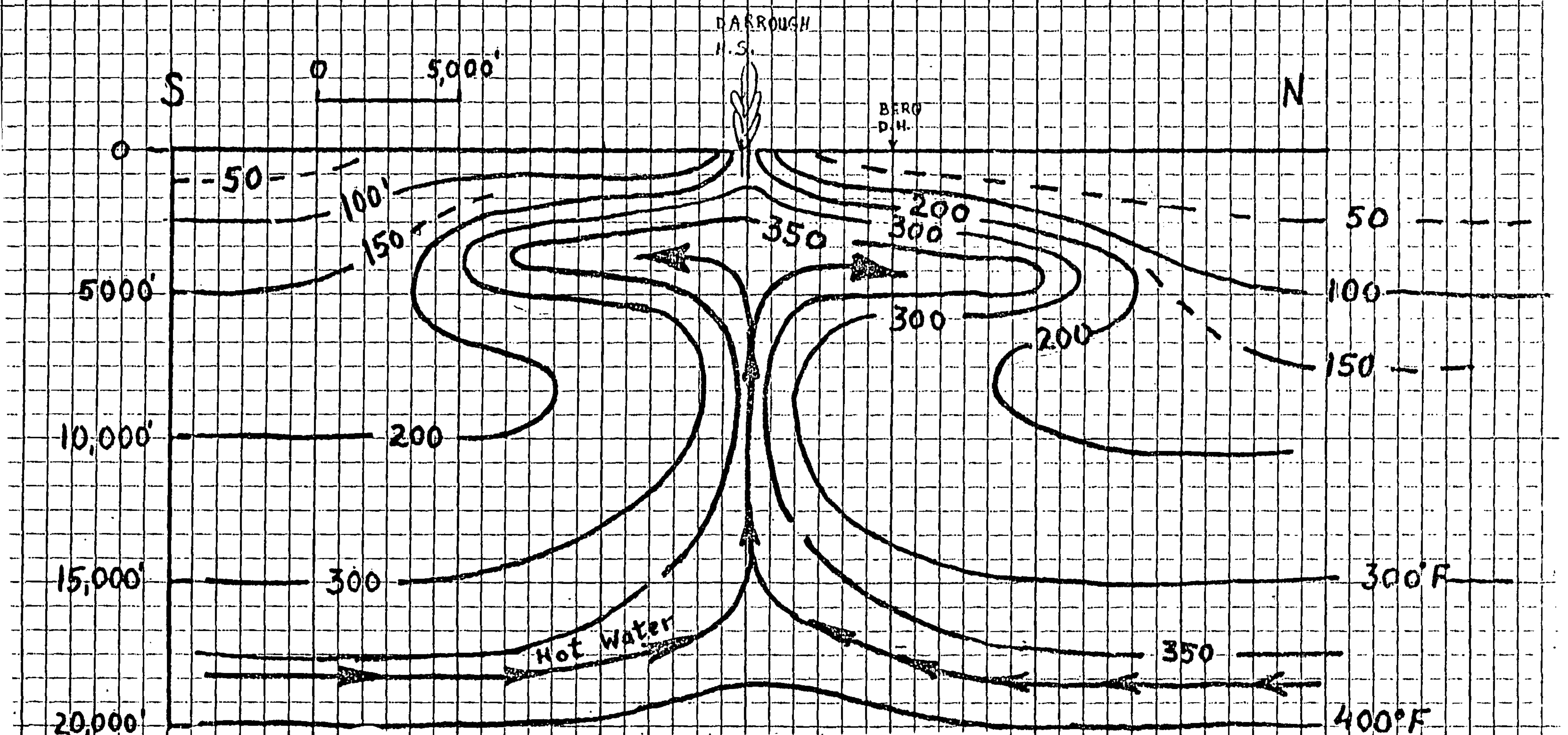


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FIGURE 2

DARROUGH HOT SPRINGS PROSPECT

A possible temperature model.

No vertical exaggeration.

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by
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June 1978

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Cursory examination of the data showed that there is a direct correlation between silica concentration and spring temperature. An important problem that must be overcome by the user of silica thermometry is that of the potential ambivalence of the thermometer because of the different solubility characteristics of different silica bearing minerals such as quartz, christoballite and amorphous silica. We have ruled out the possibility of amorphous silica as being the source of silica in the Smokey Valley water, because at low concentrations, the solubility of amorphous silica is almost temperature-independent, yet our samples show high linear correlation between sample temperature and silica concentration. Similar conclusions were reached by Levitte and Eckstein (1978, in press) in analyzing warm springs in the Jordan Valley. Furthermore, independent chemical thermometry using Na, K and Ca related thermometers yields calculated reservoir temperatures which are in closer agreement with calculated reservoir temperatures using the quartz solubility curve and assumed dilution.

A plot of dissolved silica vs. enthalpy (or temperature) for samples of distinct temperature from Smokey Valley (Figure 1), on paper containing graphs of quartz solubility (with and without steam loss), shows that the silica concentration is linearly related to temperature. The silica concentration varies from 21 ppm, at the Wineglass Spring well (12.5°C, Sample No. 5), to 98 ppm at Darrough Hot Springs (Sample No. 8, analyzed by the USGS, at 95°C). The graphically obtained reservoir temperature for the non-diluted end member is 180°C (355°F), if no steam loss is assumed, and 160°C (320°F) if maximum steam loss is assumed. It is interesting to note that the Spencer Hot Springs (Sample No. 1) data point falls on the same straight line as that derived from the data in the vicinity of Darrough Hot Springs. The alkali metal ratio thermometers (Na, K, Ca and their various interrelationships), are less affected by dilution, because dilution by pure water does not affect ratios. For Sample No. 7, (the Roger Berg well) the alkali metal ratio thermometers yield a mean temperature of 135°C (273°F). For Spencer Hot Springs, the calculated reservoir temperature is 277 ± 50°C. For Spencer Hot Springs Bath House they yield a temperature of 215°C ± 10° (417°F ± 18°F). For Darrough Hot Springs the three-metal thermometers do not work. Thus, the range of credible reservoir temperatures varies from 135° to 227° based upon alkali metal thermometry, or about 180°C average temperature. The range of minimum reservoir temperatures based upon the silica data is 160-180°C.

It is tentatively concluded that a temperature of about 180°C is likely to represent the temperature of the reservoir from which the hot spring fluids emanate. The resultant hydrocological-geothermal model for the area is quite simple: Geothermal fluid at a temperature of about 180°C rises from great depth, after being heated by a shallow heat source. As the geothermal fluid rises it becomes increasingly diluted by warm or cold water. Different leakage paths to the surface (A or B in Figure 2) conduct the liquid from that depth to the surface. If little dilution has taken place (Point A in Figure 2), the spring emanates at a higher orifice temperature. If high dilution takes place, by different aquifers feeding into the system, a lower salinity, lower temperature water issues at the surface at spring B. At places where the shallow aquifer does not encounter any ascending hot water (Point C), the water may issue as a cold spring, depending upon the piezometric surface in any given locale. According to this model, hot water at *original reservoir temperature would be encountered if a hole is drilled deep enough.* Geophysical data suggests that the reservoir is at about 1.5 km depth.

Uncertainties concerning the technique and the limited data available make it unwise to make any conclusions which are absolutely reliable. The only important conclusion that may be derived from the above study is that enough encouraging data is provided by the geochemical survey by us to warrant the assumption that the chances for the occurrence of a geothermal reservoir of economic value for power production purposes warrant further vigorous investigations in Smokey Valley, especially around Darrough and Spencer Hot Springs.

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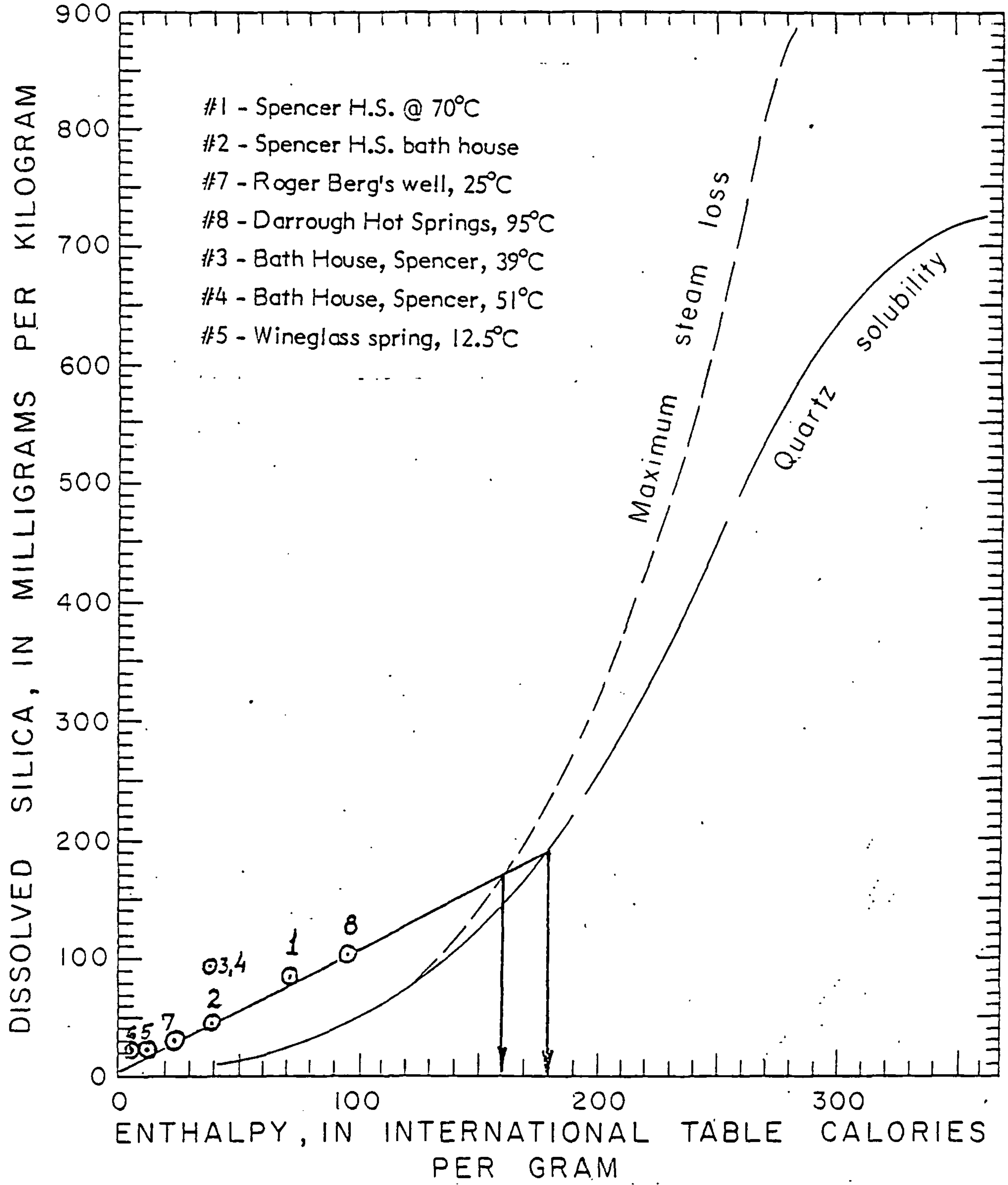


FIGURE 1: Dissolved silica-enthalpy graph for determining temperature of a hot-water component mixed with cold water yielding warm spring water for Smokey Valley, Nevada.

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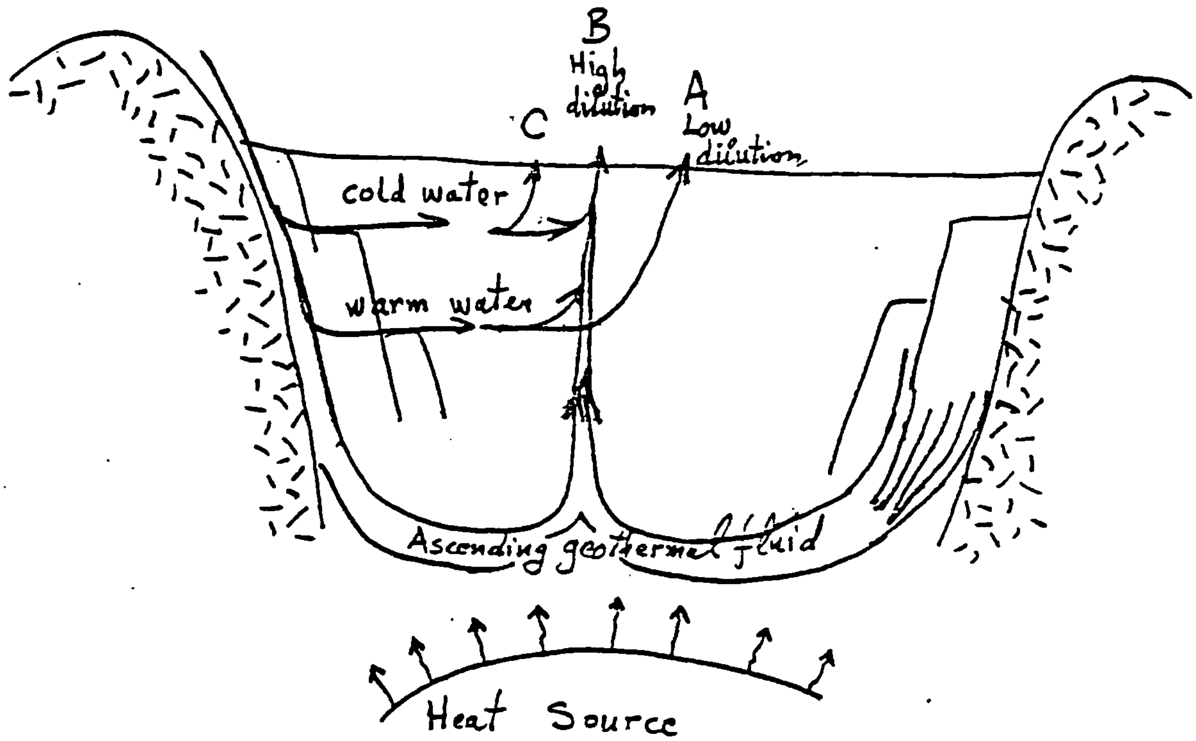

B
High dilution
A
Low dilution
C
cold water
warm water
Ascending geothermal fluid
Heat Source

FIGURE 2

## Appendix I
## Results of Chemical Analysis, in PPM

| Component | Sample | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boron | 2.6 | 11. | 2.6 | 2.6 | 0.06 | 0.05 | 0.049 | 0.22 |
| Calcium | 44. | 74. | 41. | 51. | 28. | 26. | 26. | 1.3 |
| Magnesium | 9.7 | 18. | 9.9 | 9.9 | 3.1 | 2.2 | lt 1.0 | 0.1 |
| Potassium | 36. | 22. | 36. | 36. | 1.6 | 1.1 | 1.5 | 2.6 |
| Sodium | 190. | 110. | 190. | 190. | 12. | 12. | 18. | 110. |
| Lithium | 1.8 | 0.57 | 1.8 | 1.8 | 0.006 | 0.005 | 0.012 | 0.3 |
| Ammonium | 3.3 | 0.93 | 2.8 | 3.5 | 0.22 | 0.54 | 0.31 | 0.13 |
| Chloride | 23. | 16. | 23. | 25. | 3.5 | 4.8 | 6.0 | 12 |
| Nitrate | | | | | | | | |
| Nitrite | | | | | | | | |
| Silica | 88. | 43. | 94. | 94. | 21. | 24. | 30. | 98 |
| Sulfate | 45. | 49. | 40. | 39. | 4.5 | 5.8 | lt 4.1 | 53 |
| Carbonate | | | | | | | | 3 |
| Bicarbonate | 654. | 523. | 665. | 673. | 112. | 122. | 122. | 146 |
| Fluoride | 5.6 | 2.4 | 5.6 | 5.6 | lt 0.1 | lt 0.1 | lt 0.1 | 14 |
| pH | 7.20 | 6.95 | 7.70 | 6.89 | 6.91 | 7.72 | 7.78 | 8.29 |
| Conductivity | 1158. | 915. | 1168. | 1170. | 215. | 195.1 | 219. | |
| Phosphate | | | | | | | | |
| Bromide | | | | | | | | 0.02 |
| Iodine | | | | | | | | 0.04 |
| Rubidium | | | | | | | | 0.009 |
| Strontium | | | | | | | | 0.03 |
| Mercury | | | | | | | | 0.06 |
| Temperature | | | | | | | | 0.004 |
| Location | Spencer Hot Spring | Spencer Lukewarm Spring | Spencer Bath House, Warm Tap | Spencer Bath House, Tepid Tap | Wineglass Cold Spring | Tap In Roger Berg's Home | Well On Roger Berg's Land | Darrough Hot Springs |

CONFIDENTIAL

# REFERENCES

Levitte, D. and Y. Eckstein, 1978 (in press), Correlation between the silica concentration and the orifice temperature in the warm springs along the Jordan-Dead Sea Rift Valley.

White, D., 1970, Geochemistry applied to the discovery, evaluation and exploitation of geothermal energy resources, Proc. U.N. Symp. on the Development and Utilization of Geothermal Resources, Pisa.

National Geothermal Corp.
P.O. 549
Los Gatos, Ca. 95030

May 30, 1978

Mr. Joseph N. Fiore, Chairman
Source Evaluation Panel
U.S. Department of Energy
Nevada Operations Office
2753 South Highland Drive
Las Vegas, Nevada 89114

Dear Mr. Fiore:

I enclose herewith a proposal by the National Geothermal Corporation to conduct a geothermal reservior exploration and assessment of the Darrough Hot Springs KGRA in the Northern Basin and Range Province.

In order to carry out the program, we have assembled a team of experienced geothermal explorationists to ensure ourselves and the U.S. Government of high quality of performance.

The National Geothermal Corporation is prepared to share any information gained in the course of this program as soon as practicable, and share in the cost of producing that data.

We invite your inquiries and look forward to substantive discussions about our proposals. Please feel free to call upon Mr. Ron Adolphson, Executive V.P., for any clarifications regarding the financial aspects of this program, and Dr. Tsvi Meidav, Senior Technical Consultant, for technical discussions.

Sincerely yours,

Hugh McLaughlin, President

HM:dm

A Proposal to the U.S. Department of Energy
to Support Geothermal Investigations in Smokey Valley, Nevada

# GEOTHERMAL RESERVOIR ASSESSMENT CASE STUDY
# NORTHERN BASIN AND RANGE PROVINCE

by

National Geothermal Corporation

(Request for Proposal No. ET-78-R-08-0003)

## TABLE OF CONTENTS

## A. Description of National Geothermal Corporation and its History

National Geothermal Corpration was originally formed by Hugh McLaughlin, an entrepreneur, in 1975. McLaughlin's interest in the possibility of exploitation of geothermal steam in Big Smokey Valley was piqued in 1958. At that time, Mr. McLaughlin was engaged in an exploration program for silver in Marshall Canyon, Lander County, which drains into Big Smokey Valley.

While driving a tunnel into the hillside in Marshall Canyon, hot water was encountered. At McLaughlin's direction, a small charge of dynamite was placed to increase the flow of the hot water. Upon return to the drift site two days later it was found that the tunnel was full of steam and bellowing like a hot furnace. Within one day more, the tunnel ceiling gave way and the entire tunnel collapsed, cutting off the flow of steam.

In 1971 Mr. McLaughlin began a program of exploration for geothermal steam in Smokey Valley. Mr. Don Stuart, geothermal specialist associated with Battelle Northwest provided advice on exploration and conducted preliminary analysis of hot spring geochemistry. Subsequently, the services of Dr. Frank Morrison, professor of geophysics at the University of California, Berkeley, were obtained. Dr. Morrison carried out a reconnaissance geophysical survey, including electrical resistivity and ground magnetics in a few selected locations.

McLaughlin began acquiring geothermal bases in Smokey Valley in 1972, under the corporate name "McLaughlin Inc". Because of delays in Federal leasing of BLM land, McLauhglin acquired leases on private land, which resulted in control of most of the private land in Smokey Valley.

In 1976 McLaughlin began negotiations with Geonomics of Berkeley, California, which was headed at the time by Dr. Tsvi Meidav, to provide technical management and exploration services for the corporation.

In late 1977, McLaughlin assigned the geothermal bases of McLaughlin Inc. to a newly formed corporation, National Geothermal Corporation, of which he presently serves as President and Chairman of the Board.

The Board of Directors also includes the following: Mr. W. C. Bradshaw, Mr. Andrew Davlin, Mr. Harold Bernson, and Mr. Ronald Adolphson. Mr. Bradshaw is the owner and manager of the W. C. Bradshaw Company, a management consulting firm. His previous activities include management of an operating oil company and an investment company (see resume). Mr. Davlin has an MBA from Columbia University. He is a manager of a consulting company for the motor carrier industry and Chairman of the Board of the Landy Corporation, which is in the motor carrier business. Mr. Harold Bernson is an attorney with a degree from the University of Southern California (1938). Mr. Ronald Adolphson serves in a wide variety of management functions, which include the management of land development projects, farm property management (which includes properties in Smokey and Monitor valeys). Mr. Adolphson is a Certified Public Accountant by training and manager of financial activities by actual experience.

In early 1978, National Geothermal Corporation (NGC) was reorganized and established its corporate headquarters in Los Gatos, California. Mr. Adolphson was elected to serve as the Executive Vice President of the firm. The company recruited the services of Dr. Tsvi Meidav to serve as Senior Technical Consultant and to manage the technical operations of the company.

By virtue of the operating history by NGC and its predecessor in Smokey Valley, NGC is presently the largest private land leaseholder in Smokey Valley and in the Darrough Springs KGRA.

Detailed resumes of the members of the Board of Directors of NGC and its principal consultants and associates are shown . below.

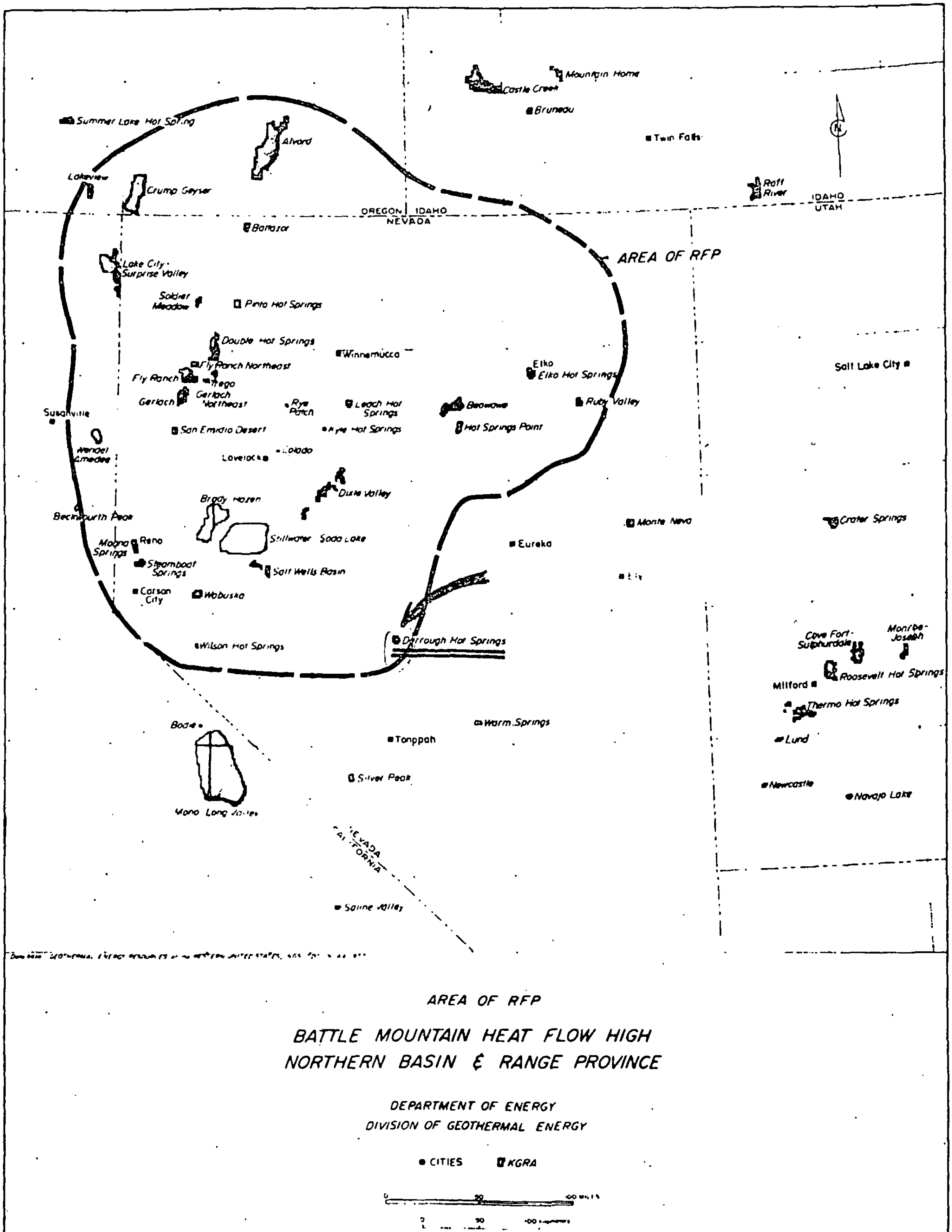



FIGURE 1. Location map of the Darrough H.S. in the Battle Mountain H.F. area.

B.1.a. Legal Description

The properties controlled by the National Geothermal Corporation (NGC) in Smokey Valley are separated into a number of groups. The most important group covers a substantial part of the Darrough geothermal prospect (designated as Darrough Hot Springs in Figure 1). The properties controlled by NGC in the Darrough Hot Springs prospect through leases, are shown in Figure 2. Their legal description is as follows:

The Wine Glass Lease:

Township 11 North, Range 43 East, MDB&M
Sec 19: E 1/2 of E 1/2
Sec 20: N 1/2; N 1/2 of S 1/2; SW 1/4 of SW 1/4

The Roger and Mary Ann Berg Lease:

Township 11 North, Range 43 East
Sec 7: S 1/2 of NE 1/4 of NE 1/4; SE 1/4 of NE 1/4 and NE 1/4 of SE 1/4;
Sec 8: NW 1/4 of SW 1/4; SW 1/4 of NW 1/4; SE 1/4 of NW 1/4 and SW 1/4 and NE 1/4.

Other properties in proximity of the Darrough Hot Springs, which are under lease to NGC and which are considered part of the geothermal prospect, include:

The William Turk Lease:

Township 13 North, Range 43 East

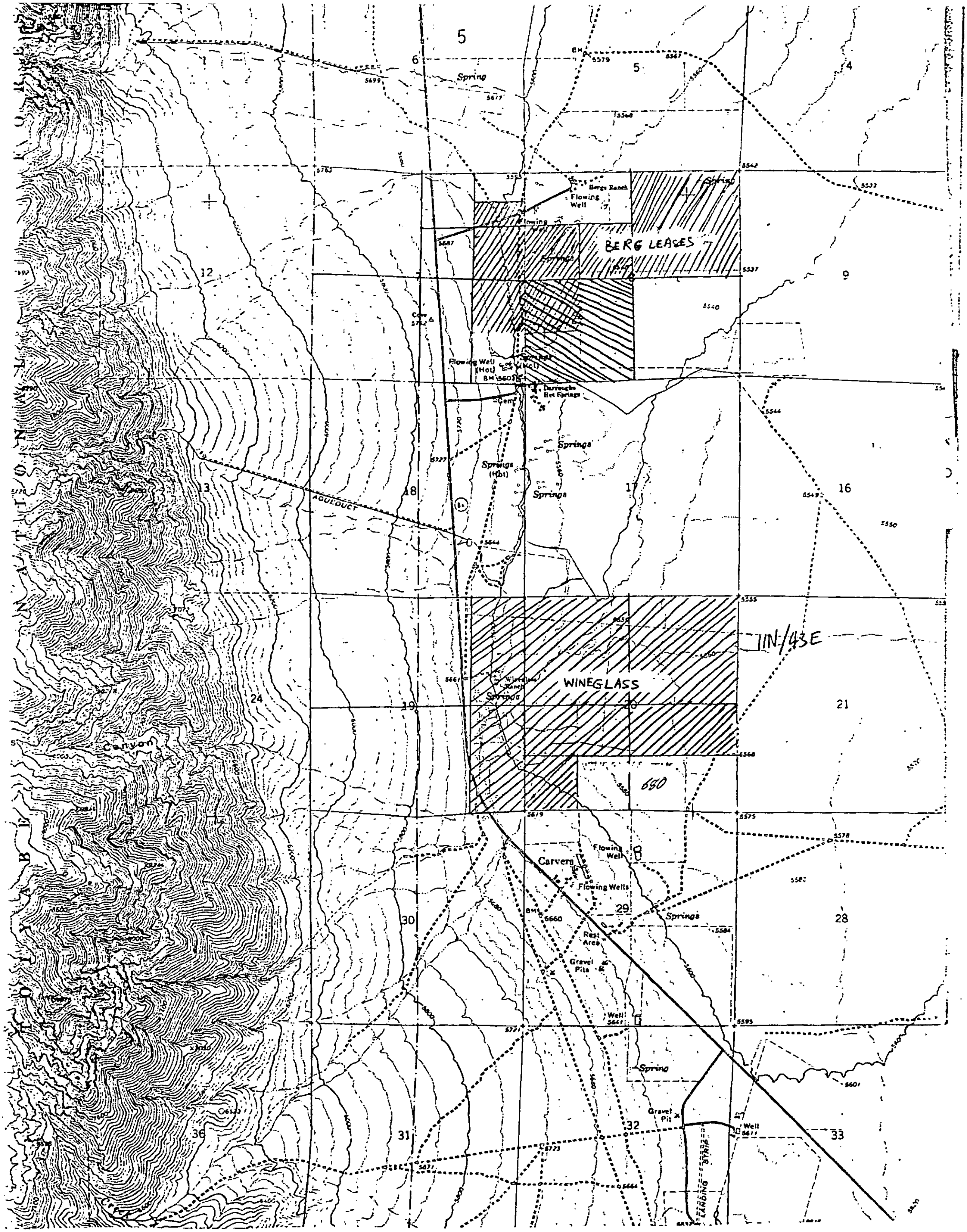



FIGURE 2. Location map of NGC leases in the immediate vicinity of the Darrough Hot Springs.

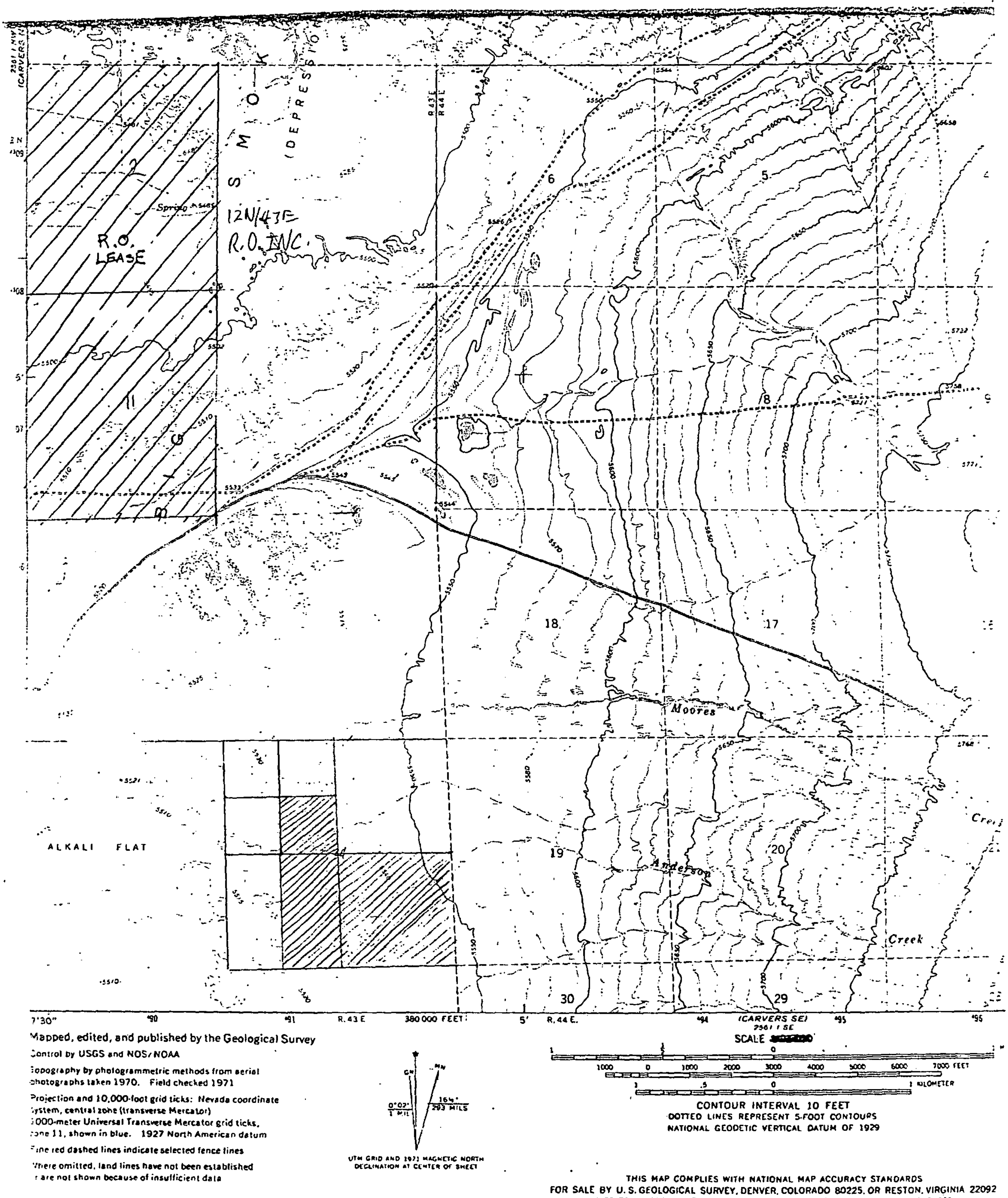



Figure 3. Other NGC leases in the Darrough KGRA.

Section 17: W 1/2 of SW 1/4; SW 1/4 of NW 1/4
Section 18: SE 1/4 of NE 1/4; E 1/2 of SE 1/4; SW 1/4 of SE 1/4
Section 19: N 1/2 of NE 1/4; S 1/2 of NE 1/4; E 1/2 of SE 1/4
Section 20: NW 1/4 of NW 1/4; W 1/2 of SW 1/4; SW 1/4 of NW 1/4; SE 1/4 of NW 1/4; E 1/2 of SW 1/4

The R.O. Inc. Lease

Township 12 North, Range 42 East
Sections 11, 12, 13, 14
Township 12 North, Range 43 East
Sections 2, 3, 4, 9, 10, 11, 15, 16, 17, 22
Township 13 North, Range 43 East
Sections 27, 28, 33

These leases are shown in the map, Figure 3. Other leases of NGC in the Smokey Valley are located in the central and northern part of the valley and are described in Exhibit I attached to this document.

b. Land Status

All of the above described leases are owned by the National Geothermal Corporation as the owner of all leases previously acquired by Hugh McLaughlin Inc.

All of the leases are readily accessible from the main highway running through Smokey Valley, via all-weather second class roads or dirt roads. They are all located in the valley itself. At this moment, no other known lessees of geothermal resources exist in the area. Hence, no unitization agreements have been considered. All of the above leases are located within the Darrough Hot Springs KGRA. A small part of the leases overlaps into the LVP (Lands Valuable Prospectively for Geothermal Resources) as determined by the USGS (1).

c. Geological Description

Darrough Hot Springs (and Spencer Hot Springs are located in Smokey Valley, Nye and Lander counties, Nevada. Smokey Valley is typical of the many Basin and Range valleys. It is flanked by the northerly trending Toiyabe Range to the west and the Toquima Range to the east.

Smokey Valley has rifted apart, like many other Basin and Range valleys, due to tectonism which has started as long ago as mid-Oligocene time (about 30 m.y. ago) and is continuing at present (Hose and Taylor, 1974). The total extension across the Basin and Range is of the order of 100 km (Thompson and Burke, 1973). Stewart (1971) has suggested deep-seated extension of a plastic substrate.

The Tertiary period in the Smokey Valley region is characterized by widespread volcanism, interspersed with the deposition of smaller amounts of non-marine sediments (Stewart and Carlson, 1974). The volcanic activity started in Oligocene time and ended about 10 m.y. ago in most areas. The youngest volcanics identified to date in Smokey Valley are basalt flows of Upper Tertiary age in the Northern Smokey Valley, near Birch Creek (McKee, 1968) . The basement rocks in the Valley are believed to be granite, which may grade from coarse grained biotite quartz to granodiorite, about 168 m.y. old (McKee, 1968).

Regional seismotectonics are often a clue to the occurrence of geothermal resources. Earthquakes of magnitude 4 or more have been associated with Smokey Valley (Slemmons, et al, 1964).

The most important evidence for the occurrence of geothermal resources in Smokey Valley is related to the occurrence of hot springs in the valley, especially those at Darrough Hot Springs and Spencer Hot Springs.

At Darrough Hot Springs, boiling water (94°C) issues from the Quaternary alluvium on the western side of the Valley, while at Spencer Hot Springs, warm water at a temperature of 72°C issues from rocks on the eastern side of the Valley. Both localities are characterized by hydrothermal tuffaceous deposits near the hot springs. Waring (1965) listed the Smokey Valley Hot Springs in his catalog of U.S. hot springs. The chemical composition and estimated minimum reservoir temperature have been determined by Mariner, et al (1974). They have determined the following minimum estimated reservoir temperatures (Table 1).

TABLE 1

TYPE OF DETERMINATION (°C)

| Location | Silica Conductive | Silica Adiabatic | Na/K | Na-K-1/3Ca | Na-K-4/3Ca |
|---|---|---|---|---|---|
| Darrough Well | 140 | 135 | 68 | 131 | 122 |
| Darrough H. S. | 136 | 132 | 61 | 127 | 120 |
| Spencer H. S. | 123 | 121 | 264 | 210 | 141 |

It should be noted that the chemical base temperatures may be an underestimate of temperature at depth, even for the reservoir from which the hot water is leaking. The reason for that assertion lies in the following observations:

1. Smokey Valley is rich in shallow water aquifers, some of which are under artesian pressure. Hence, mixing of the geothermal fluid with the shallow cold water is possible, resulting in dilution and likely reduction of reservoir temperatures.

The published USGS data (Circular 726) is based upon simple equilibrium temperature assumptions, with potential dilution effects not being considered. A slightly more comprehensive geochemical survey by NGC suggests that the results obtained from mixing considerations may indicate higher reservoir temperatures.

2. Under any circumstances, the geochemically obtained reservoir temperatures represent only temperatures of the aquifer from which the liquid originates. Higher temperature reservoirs that do not leak to the surface will remain hidden, as far as geochemical liquid thermometry goes.

Assuming that shallow reservoir temperatures in the range of 140-150°C will be found in the Darrough Hot Springs Prospect, new exploitation technologies, which are currently under development and testing by the DOE in Raft River, Idaho, where a 150°C reservoir was discovered at a depth of 1500 m, may be fully utilized here. The Smokey Valley reservoir in question has one major advantage over the Raft River reservoir, being shallower by a factor of 5-8. Hence, drilling costs are going to be very much lower in Smokey Valley, as compared to Idaho. Any process that will be proven to be economical for the Raft River reservoir is certainly going to be much more attractive under the Smokey Valley shallow reservoir conditions.

The Spencer Hot Springs are bicarbonate-rich water issuing from Quaternary alluvium Oligocene or Miocene ash-flow tuff, overlying a Jurassic age granite or granodiorite. The specific electrical conductance of the Darrough Hot Springs is only 479 millimho/cm, while that of Spencer Hot Springs is 1,180. The low electrical conductivity of the water at the Darrough Hot Springs and well suggests that the water is very low in salinity, probably around 400 ppm total dissolved solids.

The Darrough Hot Springs water is very low in calcium (less than 1.5 ppm) and moderately high in sodium (110 ppm), suggesting that the chief salt in the water is sodium bicarbonate. The low chloride content of the water (12 ppm) is considered significant in the design of the model of the geothermal system.

Hydrogeologically, Big Smokey Valley is quite rich in groundwater resources. The Valley covers an area of 2,926 square miles. The estimated maximum thickness of sediments is between 3,000 and 5,000 feet. The storage coefficient is estimated at 15% (Rush and Schroer, 1971). The depth to water table in the Darrough Hot Springs area varies from zero to 50 feet. Transmissivity of the Valley fill north of Round Mountain is moderately high, in the range of 25,000-50,000 gallons per day per foot. In the alluvial fan zone where coarser alluvium is more common, the transmissivity is high, in the range of 50,000 to more than 100,000 gpd/foot.

Average annual precipitation ranges from as much as 20 inches in the high mountains to 4 to 7 inches on the valley floor. In 1968, only 8,200 acre-feet of groundwater were consumed. It is believed that the present level of utilization is not much larger.

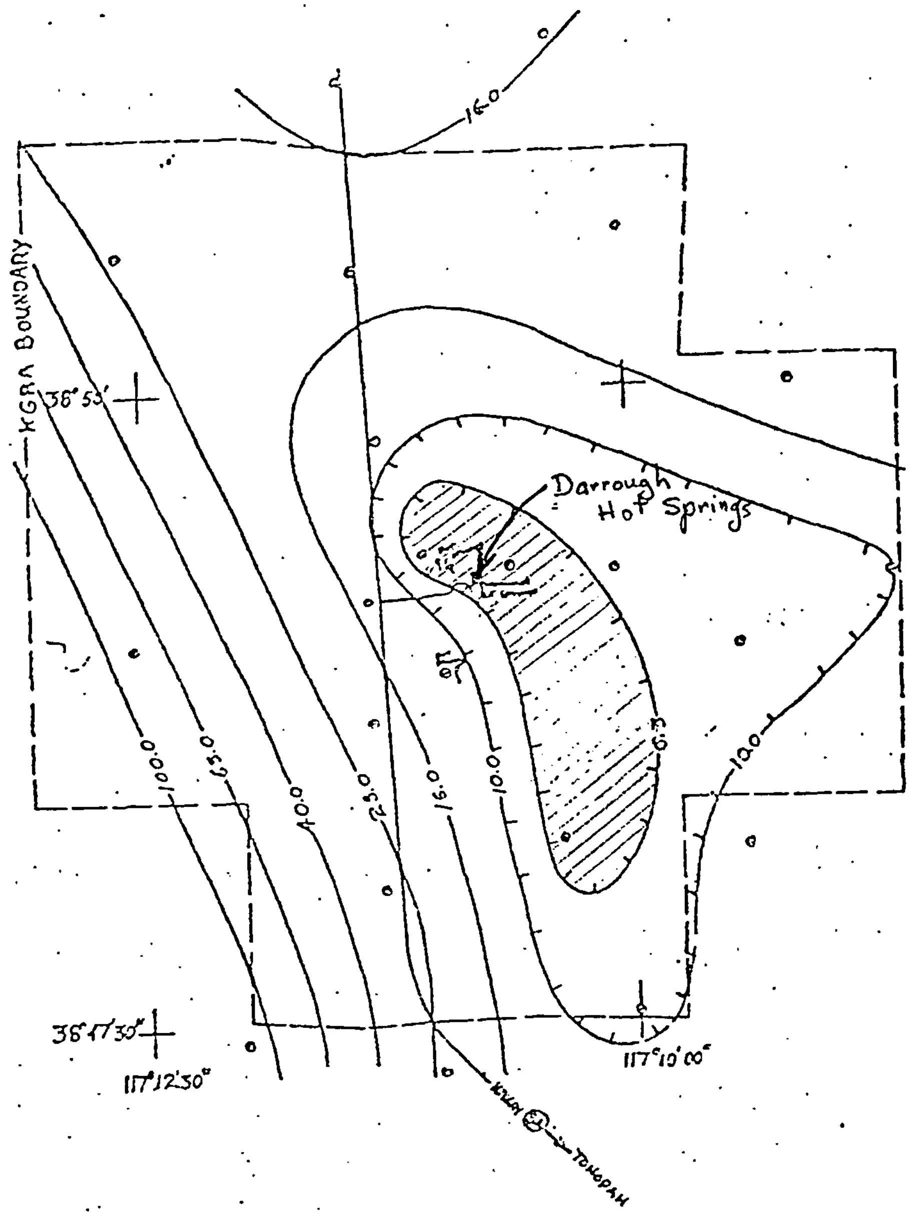
d. Technical Reasons for Site Selection

Preliminary photogeological and surface geological mapping by NGC suggests that the Darrough Hot Springs issues from a fault that is part of a series of northerly-running step faults along the western edge of the valley. Analysis by NGC of raw gravimetric data gathered by the USGS supports the surface geological observations in suggesting one or more northerly-trending faults in the vicinity of Darrough Hot Springs. The USGS data was gathered as part of a more comprehensive program of geohpysical and geochemical work by the USGS to provide fundamental information about the Darrough Hot Springs Known Geothermal Resources Area (USGS, 1975).

Audio-magnetotelluric data by the USGS (Long, et al, 1976) indicate that a northerly-trending resistivity low is located in the area (Figure 4), covering an area of about 15 $km^2$ (about 6 sq. mi.) within the 10 ohm-m resistivity low, and about 9 $km^2$ (3.5 sq. mi.) within the 6.3 ohm-m low.

The AMT resistivity low (8 Herz) covers substantial portions of the Berg, Darrough, and Wine Glass properties, extending into federally owned land to the north, south, and east. The telluric anomaly, which provides deeper penetration (at lesser detail), shows that the high conductance anomaly generally runs north-south, contiguous to Highway 8A, through the above mentioned properties. It also indicates a possibility of a high conductance anomaly east of the area where the Darrough and Berg properties adjoin in an area that is presently Federally owned, within the KGRA boundaries.

Limited magnetotelluric data (O'Donnel, 1976) provides perhaps the most significant information. Re-interpretation of the data by Dr. Tsvi Meidav, NGC's Senior Consultant, suggests that the depth to the center of the resistivity low at the hot springs is about 1,600 m (one mile), which is approximately five times deeper than the estimated depth to the basement in the area. This is a most significant finding that is further elaborated below.




Explanation:

⊙ Station location

Resistivity contours shown are on a logarithmic interval in ohm-metres, computed from the average of the north-south and east-west scalar impedances..

Scale: 1:62500

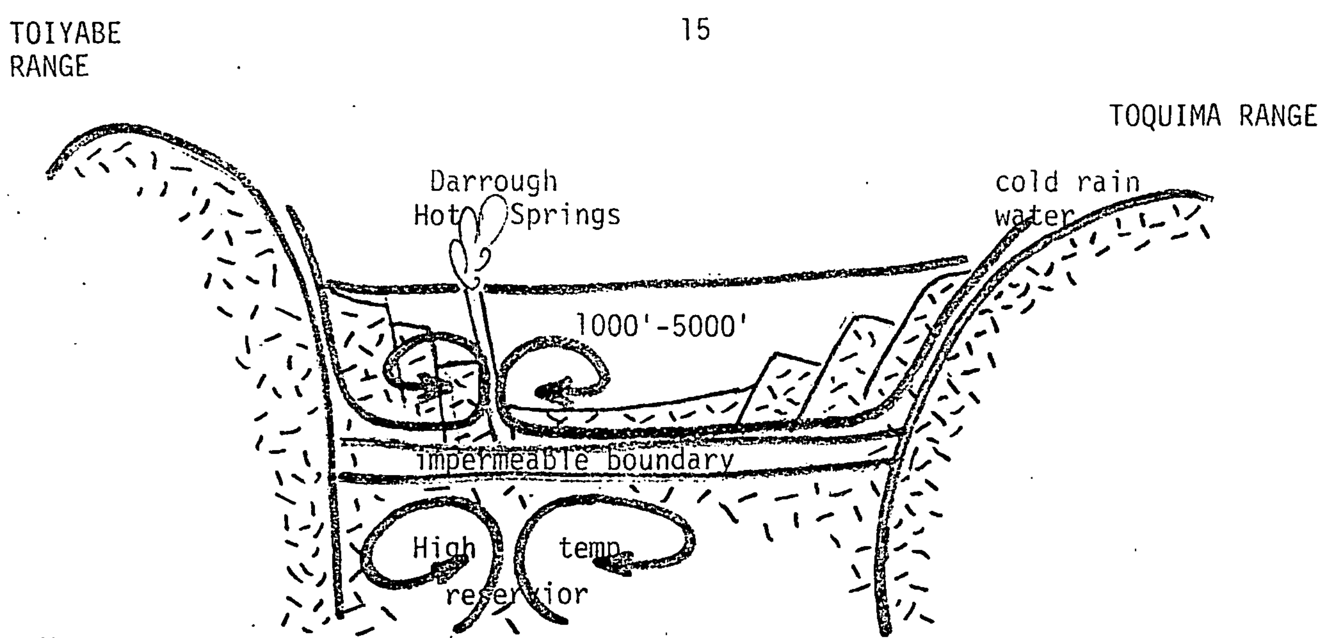
Figure 4. Audio-magnetotelluric apparent resistivity map at 7.5 Hz. for the Darrough Hot Springs KGRA, Nevada. (USGS data).

## Geological Models for the Darrough Geothermal System

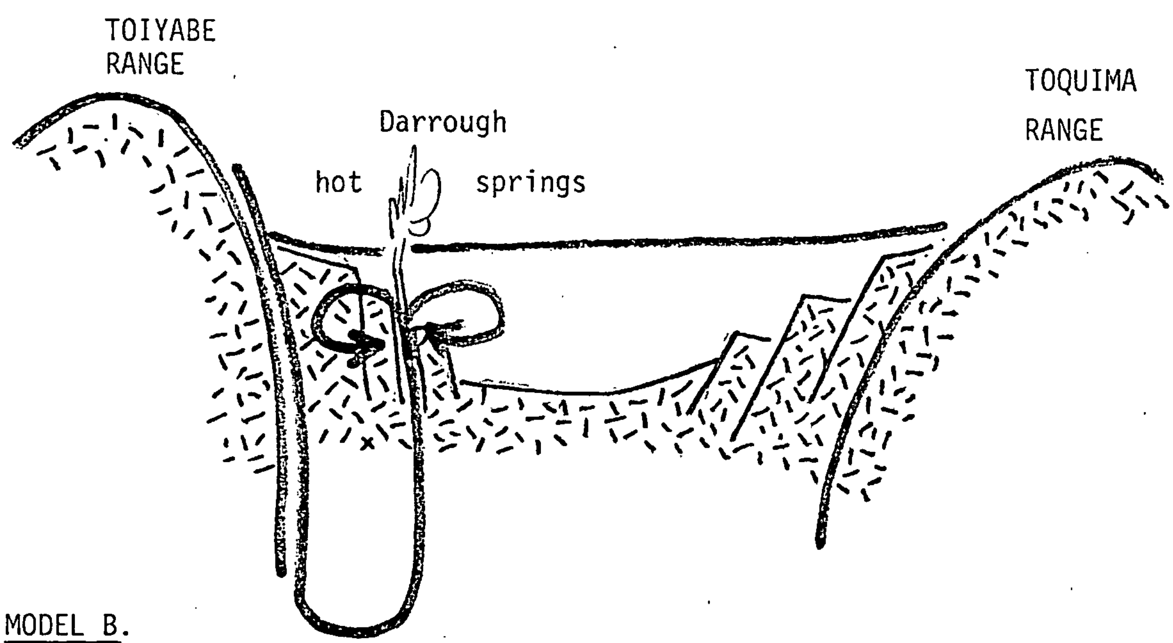
In general, two fundamentally different models may be offered for the occurrence of hot springs in northern Nevada (Olmstead, et al, 1975); those possessing shallow heat source and shallow circulation of groundwater, and those lacking a shallow heat source but possessing deep circulation. We believe that most probably the Darrough Hot Springs water are associated with a shallow circulation of meteoric water, but do not totally rule out a different model. Our exploration strategy is flexibly designed to explore for a possible combination of a stacked reservoir system in the area, with different decisions to be made based upon actual findings from the detailed geotechnical surveys that we intend to carry out, followed by exploration (slim hole) drilling.

The more probable geothermal model is shown in Figure 5A. The model indicates that the source of heat in the shallow reservoir system is due to conductive heating through a sealed, impermeable layer at some depth below. Rainwater percolates into the subsurface along the faults bounding the valley, until it encounters the impermeable layer formed through self-sealing of the deeper geothermal system. It is then forced to travel laterally, heating up and expanding en route. Upon encountering the Darrough Hot Springs fault (shown schematically in Figure 5), the hot water partially ascends to the surface, and partially convects in a toroidal motion, which is centered about the locus of the deeper, hidden heat source. An alternative model, Model B, would be based upon the assumption of circulation to a depth of several kilometers. The meteoric water penetrates to great depths within the basement, say 3 km (10,000 ft), heats up at depth and comes back to within a shallow depth along a deeply penetrating fault. In that case, the shallow reservoir is fed by a larger underlying reservoir that continuously replenishes it.

NGC considers Model A the more plausible one, for reasons explained further below, but have developed a strategy for the economic develoment of the prospect, even if Model A turns out not to be valid for the area.




MODEL A.




MODEL B.

Fig. 5. Schematic hydrogeothermal models of the Darrough Hot Springs KGRA

In the case that Model A is corroborated by the future exploration program, we anticipate that drilling would encounter reservoir at depths of about 1-1.5 km, which is much higher in temperature than the shallow reservoir temperature. Drilling in 1962 at the Darrough Hot Springs by the Magma Power Co. any encountered a non-equilibrium temperature of 265°F at a depth of about 750 ft (ca. 230 m), which was followed by a negative thermal gradient for several hundred feet beyond the high temperature point. Since geochemical thermometry indicates that the temperature of the reservoir that leaks to the surface is about 140°C, it is evident that the Magma Power well encountered one lobe of the convecting plume of the shallow reservoir.

The basis for the judgment that favors Model A lies in the available geophysical evidence including heat flow aeromagnetic and magnetotelluric data. Based upon the actual flow of the Darrough Hot Springs (more than 300 liters per minute) a total of $1.57 \times 10^{17}$ cal/year emanate at the hot spring site. Volumetric calculations and assumptions about reasonable life of the hot spring system suggest that conductive heat flow is inadequate to explain the large amount of heat annually spent at the hot spring. A negative aeromagnetic anomaly (USGS, 1971) extends across the Darrough Hot Springs, even though drilling and gravity data indicate a shallow basement in the area. Therefore, the negative magnetic anomaly must be interpreted as being either due to very extensive hydrothermal alterations within the basement or the presence of a rock at a temperature higher than the Curie Point. Other explanations are not borne out by the gravity data. Finally, the limited magnetotelluric data indicate that resistivities as low as 3 ohm-m are encountered at a depth of 1-3 km below the surface, in an area where the basement is known to occur at about 1,000 ft (300 m) approximately. Such low resistivities for basement rocks are typically associated with hydrothermal fluid convection elsewhere. The total evidence at hand militates, therefore, for the likelihood of occurrence of a dual reservoir system in the Darrough Hot Springs area.

The temperature within the postulated deeper reservoir system is totally unknown at present. It is anticipated that future exploration activity by NGC, hopefully to be supported by the Department of Energy, would be able to establish the temperature within both reservoir systems, so that a rational exploitation strategy may be developed.

e. NGC Exploration Philosophy

The original exploration philosophy of the company was to conduct a set of comprehensive geotechnical evaluations of the entire Valley, concentrating especially on the Darrough Hot Springs propsect. Geotechnical studies were to be supported by deep temperature gradient drilling, followed by slim holes into the shallow reservoir since the shallow reservoir (330 m depth) can be drilled relatively inexpensively, a preliminary analysis suggests that the shallow reservoir can be economically tapped for electrical power production, despite the low thermodynamic efficiency of the fluid, provided that large fluid flow rates could be sustained. The high hydraulic transmissivity of the alluvium gives us reason to expect high volume production rates from wells completed within the alluvium. The only question to be determined is that of the size of the shallow reservoir and its projected life, since the minimum temperature of the reservoir is reasonably well known (140°C).

Exploration of the deeper reservoir can be carried out at the same time that the shallow reservoir is studied. Thus, a comprehensive mangetotelluric survey should be able to define the three-dimensional geometry of any geothermal reservoir systems in the area, at whatever depth that they might occur. Careful analysis of data from deep temperature holes or deeper slim exploration holes, drilled to a depth below the shallow reservoir, would reveal if the likelihood of occurrence of a deep reservoir is favorable. A combination of drilling and geophysical data might reveal the depth to the deeper reservoir.

f. Technical Reasons for DOE Support

The art and science of exploration for hidden geothermal reservoirs is still in a primitive stage. Chemical geothermometry, at its present primitive stage, provides useful information about the topmost reservoir only, in a stacked system, yielding always minimum temperatures, which may be gross underestimates of the true reservoir temperature if the reservoir happens to be sealed off from leaking to the surface.

Numerous geothermal areas have been written off by geothermal explorationists because chemical thermometry did not provide encouragement for deeper exploration activities. Thus, offers by the BLM of government land for competitive leasing of KGRA acreage in the Darrough Hot Springs were twice spurned by geothermal exploration companies, with no bids because of lack of interest. The reason for that lack of interest lies in the low "reservoir temperature", that has been deduced from the chemical data published by the USGS.

NGC believes, based upon opinions expressed by Dr. Tsvi Meidav, its Senior Consultant, that the Darrough Hot Spring system is a stacked reservoir system, with a high quality reservoir underlying a shallow, low quality reservoir. We propose to carry out a carefully staged exploration program that would test this hypothesis. If our hypothesis proves to be correct, dozens of other prospects in the Basin and Range region, previously bypassed by geothermal explorationists because of negative geothermometrice or geochemical data, would be reopened for renewed exploration efforts. Proprietary information indicates that numerous other geothermal projects that are characterized by low chemical temperatures are associated with significant resistivity lows at greater depth (Meidav, 1978, personal communication). It is conceivable, therefore, that stacked reservoir systems occur elsewhere as well.

Whilst there is a risk involved in supporting this bold program, the payoff in terms of learning how to explore for hidden reservoir system is worthwhile considering.

We propose a two-stage exploration program, to minimize the risk for ourselves and the government. Firstly, exploration of the shallow reservoir system with enough data gathered to more reliably establish the risk associated with exploring for the deeper reservoir. Secondly, program of evaluating the deeper reservoir if the first stage of exploration provides us and the government enough confidence in the occurrence of a commercial reservoir at depth.

## 3. PROGRAM DESCRIPTION

The program consists of transfer of existing surface and subsurface data, as well as a program for acquisition of new data.

Existing data include the following:

1. Temperature gradient data from two holes drilled by NGC on the Turk and Berg properties cased to 810 and 360 foot depths, respectively, plus a lithologic log for the Berg hole to a depth of 1,000 feet. Drilled in March and April 1978 for NGC by Allen Bros. of Yerrington, Nevada.

2. Non-equilibrium thermal gradient data from the hole drilld by Magma Power on the Darrough Property in 1962, along with the driller's log.

3. Reconnaisance geochemical survey of hot and cold springs in Smokey Valley, consisting of seven samples analyzed for 11 constituents. The results were interpreted in terms of mixing models and probable reservoir temperatures.

4. Preliminary interpretation of the magnetotelluric, AMT, and gravity data, which were gathered by the USGS, and interpreted by Dr. Tsvi Meidav.

Most of the proposed program is aimed at acquisition of new data, which include both surface and subsurface data gathering.

### a. Surface Geology and Hydrogeology

The object of this study is to provide a detailed geological and hydrogeological picture of the Darrough geothermal system in the context of the northern Big Smokey Valley; to determine the occurrence of Plio-Pleistocene volcanics in the area; in conjunction with geophysics, determine the probable nature of the heat source; estimate the probable flow rates for wells completed in the alluvium; and, estimate withdrawal and recharge.

b. Detailed Geochemical Survey

The purposes of this survey are as follows:

1. Establish shallow reservoir temperatures by verifying whether dilution has taken place.

2. Seek manifestations of leakage from a deeper, higher temperature reservoir.

c. Magneto-telluric Survey

The objects of this study are:

1. To determine the vertical resistivity distribution in the prospect area to a depth of 4-5 km (3-4 miles).

2. To identify the likely geometry of the geothermal reservoirs in the area.

3. To assist in locating permeable faults.

4. Provide a comprehensive interpretational report.

d. Precision Gravity Survey, Option A

Gravimetry has proven its usefulness in determining geological structure in the Basin and Range Province. Fluid flow is often controlled by fault locations. The previous gravity survey (USGS) was done on a gross scale and is inadequate for the purpose of detailed fault mapping or basement structure modeling. The objectives of the gravimetry program are:

1. Pinpointing the location of the fault traces that together constitute the fault system on the western side of the valley in the Darrough Hot Springs KGRA.

2. Obtaining additional regional gravity data for the area surrounding the prospect, to afford better modeling of the system.

3. Carry out gravity modeling of the system.

4. Provide a comprehensive interpretational report.

Gravity Interpretation, Option B

If funds are insufficient for carrying out the precision gravity survey, it is still possible to obtain considerable amounts of useful data from the more limited gravity survey that was carried out by the USGS, through rigorous interpretation of that data.

Results obtainable from that program include:

1. Approximate location of the major fault in the area.

2. Modeling of the structure of the granitic basement and determination of depth to basement.

f. <u>Intermediate Depth Slim Hole Drilling</u>

The objectives of this activity are as follows:

1. To determine the temperature distribution, thickness, and flow rate of the shallow reservoir; and, to estimate the economics of shallow reservoir exploitation.

2. To drill through the shallow reservoir into the impermeable layer that is believed to exist below the shallow reservoir to a depth large enough (1800 ft) that would permit the calculation of the temperature gradient below the shallow reservoir. If a deep, higher temperature reservoir exists at depth, as we anticipate, the temperature gradient at the 1200-1800 ft depth should be sufficiently uninfluenced by convection patterns in the shallow reservoir to permit a reasonable assessment of the deeper conductive gradient. This, in turn, would permit a lower-risk assessment of the likelihood of occurrence of a deeper, higher temperature reservoir.

3. To evaluate the hole and indications as to presence or absence of a deeper reservoir. If the potential for a deep reservoir is indicated as favorable, the same hole could be continued to a greater depth, after changing drilling rigs.

4. On the other hand, if results of the detailed geotechnical studies (geochemistry, geophysics, and temperature gradient drilling) are very favorable, it might be advisable to go immediately for a hole of a depth of several thousand feet in depth to test the upper portion of the suspected hidden reservoir at depth.

The cost proposal below contains the necessary information for the different strategy alternatives and their costs. If funded by the DOE, NGC proposes to consult with the DOE personnel at significant program junctures, to decide jointly which of the strategy alternatives is the best under the actual field conditions.

Our proposed strategy has a number of advantages:

(i) It will permit a complete testing of the shallow reservoir at a location that is determined to be optimally located, based upon the new geophysical data gathered or reinterpreted.

(ii) It will avoid the cost of deeper drilling if the evolving data do not justify the risk. Under this flexible strategy, testing of the shallow reservoir would be accomplished, and the extent or type of deeper drilling would be based upon objectively interpretable data, rather than inadequately based judgments or projections.

The two alternative drilling programs have been designed by Mr. Herb Wheeler, NGC's Consulting Drilling Engineer, as follows:

Plan A: 4,000' Slim Hole

1. Build or improve roads and drilling location. Prepare mud pit and sump.

2. Drill 14" hole with rat hole digger to 40' and cement a 10 3/4" conductor pipe.

3. Move in rotary drilling equipment and install.

4. Drill 9 7/8" hole to 400', using gel-water mud with a specific gravity of about 70 $lb/ft^3$. Enough lost circulation material will be kept on hand to overcome mud loss into formation.

   a. Install mud-loggers at surface. Record temperature of mud-in and mud-out continuously. Take ditch samples at 10' intervals, two samples per interval: one sample-washed and dried; the other, unwashed, into a cloth bag, approximately one pound per sample. Include pit-level recorder (total pit volume analyzer) to determine continuously whether lost circulation zones are encountered. Include hydrogen sulfide monitor, methane detector. The mud logger will also record drilling rate and lithological changes.

   b. Run first run of geophysical logs, including induction, SP, short normal resistivity, neutron density, and temperature logs to 400'.

5. Cement 7", 20 lb/ft, H-40 casing to 400'. Cement back to surface with Class G cement containing 3% calcium chloride.

6. Land casing. Install and test casing head.

7. Install and test B.O.P. Use double hydraulic ram gate and GX Hydril. Test to 1500 psig.

8. Drill 6 1/4" hole to 1800'-2000' depth.

   a. Use a lignosulfonate mud with the following properties:
   70-72 lb/ft$^3$ density
   40-45 seconds API viscosity
   6-8 cc API water loss

   b. Run second geophysical borehole logging to T.D.

   c. Take drift shots at not more than 300' intervals. Maintain drift at $5^o$ or less. Maintain dog-leg at less than $1.5^o/100'$.

9. Install gauges, separator, and silencer at wellhead. Install pressure gauge at the bottom of the hole (Amerada, Kuster, Hewlett-Packard, or equivalent). Measure and record flow rate, bottom-hole pressure, lip pressure and temperature for a minimum of 1000 minutes.

10. Continue drilling to 4000'.

   a. Run third geophysical log run to hole bottom.

   b. Core at least once per 300' through the producing horizon, using a 30' core barrel.

   c. Case upper reservoir off with 4 1/2", 9.5 lb/ft, J-55 casing, and any discovered deep reservoir with a slotted liner. Cement solid liner all the way to the surface. Use Class G cement and Pozmix (1:1) with 4% gel, 40% silica flour, 0.75% friction reducer CPR-2, and about 0.2% HR-7 retarder to give 2-3 hours setting time. Displace cement with water.

11. Land casing. Cut off7" head. Install and test head on 4 1/2".

12. Install working valve on top of the 7" head. Install and test BOE.

13. Test deeper horizon for production rate and enthalpy as described above.

14. Demobilize rig and clean site up.

PLAN B: 1800' Slim-Hole

The drilling plan is essentially the same as Plan A, but goes only through Step 9 in Plan A. A lighter drilling rig is employed at a considerably lower footage rate. Upon termination of the drilling program, a decision may be made whether deeper drilling is warranted. If the answer is positive, the same hole may be continued downward at a later date.

Logging will include lithological logging and drilling rate logging and core analysis.

g. Final Report

A final report, summarizing the results of this program and integrating the results of all of the previous studies would serve as a valuable case history.

## 4. SCHEDULE

The proposed schedule of activities is shown in Table 2. As can be seen, the entire program is scheduled to last 14 months, starting September 1, 1978, and terminating October 31, 1979. Assuming possible slippage due to unforeseen factors, the entire program may require a total of 15 months from start to finish.

Data will be made available to the DOE within 30 days of its availability to NGC. Some forms of data that are meaningful in their raw form, such as geophysical borehole logs, will be made available to DOE within 15 days of obtaining them. Every activity will be completed with a final report that will be submitted to the DOE on a timely basis, as shown in the suggested schedule in Table 2.

TABLE 2. ACTIVITY AND TIME SCHEDULE FOR EXPLORATION OF THE DARROUGH HOT SPRINGS KGRA.

| ACTIVITY | 1978 SEPT | OCT | NOV | DEC | 1979 JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Project start | ↓ | | | | | | | | | | | | | | |
| 2. Turnover of existing data to government | | ↓ | | | | | | | | | | | | | |
| 3. Geology/hydrogeology survey | ■ | | | | | | | | | | | | | | |
| Report submission | | | | | ↓ | | | | | | | | | | |
| 4. Geochemistry | ■ | | | | | | | | | | | | | | |
| Report submission | | | | | ↓ | | | | | | | | | | |
| 5. Magneto-telluric survey | | ■ | | | | | | | | | | | | | |
| Report submission | | | | | | ↓ | | | | | | | | | |
| 6. Precision gravity survey | ■ | | | | | | | | | | | | | | |
| Report submission | | | | | ↓ | | | | | | | | | | |
| 7. Temperature gradient survey | | | | | ■ | | | | | | | | | | |
| Report submission | | | | | | | ↓ | | | | | | | | |
| 8. Mid-Project Review | | | | | | | | ↓ | | | | | | | |
| 9. Exploration drilling | | | | | | | | | ■ | | | | | | |
| Report submission | | | | | | | | | | | ↓ | | | | |
| 10. Final Project Summary | | | | | | | | | | | | | ↓ | | |
| 11. Monthly Activity Reports submitted | | • | • | • | • | • | • | • | • | • | • | • | • | | |
| 12. Program Status Report | | | | ↓ | | | ↓ | | | ↓ | | | | | |

## ENVIRONMENTAL EVALUATION

### Population and Occupation

Smokey Valley is sparsely populated. Population density is on the order of one head per square mile. The distribution is uneven, with a higher population concentration in the southern part.

The total population in the Darrough Hot Springs Prospect is estimated at less than 30, engaged in cattle and hog raising and work in the operating mine near Carvers. Farming is generally limited to raising alfalfa for cattle feeding.

### Water

Water supply for local needs is supplied from either surface springs or shallow boreholes. Big Smokey Valley is a closed basin, with runoff from the mountains inflowing into an enclosed playa lake. The geothermal water emanating at Darrough Hot Springs is quite low in salinity. Its chemistry and other characteristics are as follows (in ppm):

| | | | |
|---|---|---|---|
| Temperature | 95°C | Chloride | 12 |
| pH | 8.29 | Fluoride | 14 |
| Silica | 98 | Boron | 0.22 |
| Calcium | 1.3 | Ammonia | 0.13 |
| Magnesium | 0.1 | Arsenic | 0.06 |
| Sodium | 110 | Phosphate | 0.02 |
| Potassium | 2.6 | Bromide | 0.04 |
| Lithium | 0.3 | Iodine | 0.009 |
| Bicarbonate | 146 | Rubidium | 0.03 |
| Carbonate | 3 | Strontium | 0.06 |
| Sulfate | 53 | Mercury | 0.004 |

(Data sources: Mariner et al, 1974; Mariner et al, 1975).

The Total Dissolved Solids of the Darrough Hot Spring (and well) are less than 450 ppm, which puts it in the category of the potable water range. The sodium content of 110 ppm and fluoride content of 14 ppm is considered high, making the water not recommended for sustained drinking or for agriculture. The water issuing from the hot springs is sold on a small scale as "mineral water" for drinking purposes.

At present, the large thermoartesian flow from the combination of the Darrough Hot springs and the Darrough steam well emit more than 300 liters per minute. The flow forms a stream that forms a swamp in the central part of the valley. Big Alkali Lake, several miles to the northeast, forms the central sump for all water flowing into the enclosed lake from all directions.

<u>Effect of Potential Geothermal Energy Development</u>

It is anticipated that all phases of the geothermal survey, gravimetry, and MT, which fall into the category of casual land use, will have no impact on the local environment.

Temperature gradient holes may have a temporary or longer term impact, depending upon the care in site preparation, site restoration and accidental blowout (if any). NGC has completed one of its TG holes in such a fashion that the hole may be converted by the farmer into a water well after the completion of its use for NGC's thermometric survey needs.

Deeper exploration holes may have a variety of impacts on the environment:

1. Land use may be diverted from open pasture or alfalfa raising.

2. Accidental blowout may cause surface spills.

Because of the sparse population in the area, it is anticipated that any drilling activity would have a small effect on the human population during the exploration phase. Most of the area is covered by sage brush, and is not used for any purpose at all at this time.

Because of the anticipated salinity of high temperature geothermal reservoirs, and the likelihood that the geothermal fluid will not be suitable for either drinking or irrigation, modes of environmentally acceptable disposal will have to be established. One way of disposing the fluid is through reinjection to a depth below the potable water level in the alluvial aquifer. A second method of disposal that may be possible for short-term testing may be through surface discharge to the local swamp or to the enclosed alkali lake.

A more detailed analysis of environmental impact factors would be made at the time of planning of the deep exploration hole.

## C. COST PROPOSAL

### 1. Geology, hydrogeology, field work, and report

| | Rate/Hour | Hours | Total | |
|---|---|---|---|---|
| Senior Scientist | $ 30 | 200 | $6,000 | |
| Field Geologist | 9 | 200 | 1,800 | |
| Draftsman | 7 | 50 | 350 | |
| Typist | 7 | 80 | 420 | |
| Editor | 9 | 30 | 270 | |
| | | | | $8,840 |

Miscellaneous direct costs

| | | |
|---|---|---|
| Air Travel, Kent-S.F., S.F.-Reno | 500 | |
| FWD vehicle rental, 3 weeks | 1000 | |
| Motel and meals 2 X $30 X 1.0 | 1200 | |
| Age-dating rock smaples | 1600 | |
| Telephone, photocopying, etc. | 250 | |
| | | $4,550 |

### 2. Geochemistry

| | | | | |
|---|---|---|---|---|
| Senior Scientist | $ 30 | 100 | $3,000 | |
| Geologist | 9 | 100 | 900 | |
| Draftsman | 7 | 20 | 140 | |
| Typist | 7 | 20 | 140 | |
| Editor | 9 | 24 | 216 | |
| | | | | $4,396 |

Miscellaneous direct costs

| | | |
|---|---|---|
| FWD vehicle, 1 week | $ 350 | |
| Motel and meals 2 x 30 x 7 | 420 | |
| Chemical analyses | 1,200 | |
| Telephone, photocopying, etc. | 100 | |
| | | $2,070 |

* Certain costs of the geochemical program have been absorbed by the geology/hydrogeology program.

3. Gravimetry, Option A (Detailed Field Survey)

| | Rate/Hour | Hours | Total | |
|---|---|---|---|---|
| Senior Scientist | $ 20 | 200 | $4,000 | |
| Jr. Field Geophysicists (3) | 5 | 600 | 3,000 | |
| Draftsman | 7 | 40 | 280 | |
| Electronic Computer Tech | 7 | 40 | 280 | |
| Typist | 7 | 20 | 140 | |
| Editor | 9 | 24 | 216 | |
| | | | | $7,916 |

Miscellaneous direct costs

| | | |
|---|---|---|
| 1 FWD vehicle 1 month | 1,500 | |
| Rental electronic survey system | 1,000 | |
| Per diem 3 x $20 x 25 | 1,500 | |
| +1 x $30 x 10 | 300 | |
| Electronic computer charges | 300 | |
| Telephone, photocopying | 100 | |
| Air travel | 80 | |
| | | $5,180 |

4. Gravimetry, Option B (Interpretation of Existing Data Only)

| | | | | |
|---|---|---|---|---|
| Senior Scientist | 20 | 40 | $ 800 | |
| Computer Technician | 7 | 40 | 280 | |
| Draftsman | 7 | 40 | 220 | |
| Typist | 7 | 32 | 224 | |
| Editor | 9 | 24 | 216 | |
| | | | | $1,800 |

Miscellaneous direct costs

| | | |
|---|---|---|
| Travel, L.A.-S.F. (2) | 80 | |
| Per diem, 3 days | 90 | |
| Computer charges | 150 | |
| Telephone, photocopying | 80 | |
| | | $ 400 |

30



5. Magnetotelluric Survey

The magnetotelluric survey will be contracted out to a geophysical service organization. Prices of the more reputable firms in the field range between $1500-$2000 per station for fully processed data.

| | | |
|---|---|---|
| Assume 25 stations at $1800/sta. | | $45,000 |

Other direct costs

| | | |
|---|---|---|
| Senior consultant | $ 1,200 | |
| Telephone | 100 | |
| Reproduction costs | 200 | |
| Travel | 50 | |
| Per diem, $30/day | 100 | |
| | | $1,750 |

6. Temperature Gradient Drilling Program

Temperature gradient drilling is normally contracted to drilling companies possessing small drilling rigs of appropriate size. Drilling rates vary between $50 to $70/hour plus expendable materials. Depending upon rock type, drilling and casing costs vary between $8-$12/foot. A total of 4,000 feet of temperature gradient is planned, at approximately $40,000.

In addition, the following charges apply:

| | Rate/Hour | Hours | Total | |
|---|---|---|---|---|
| Field Geologist | $ 9 | 200 | $ 1,800 | |
| Typist | 7 | 32 | 224 | |
| Draftsman | 7 | 32 | 224 | |
| Editor | 9 | 24 | 216 | |
| | | | | $2,464 |

Miscellaneous direct charges

| | | |
|---|---|---|
| Senior Consultant | 2,000 | |
| Per diem, 30 x 30 | 900 | |
| Field vehicle, 1 month | 1,500 | |
| Telephone, etc. | 150 | |
| Photocopying, etc. | 100 | |
| Air travel | 160 | |
| | | $4,810 |

7. Exploration Drilling Program, Option A -- 4,000' Hole Estimate

| | |
|---|---|
| Casing, wellhead, etc. | $ 45,000 |
| Location survey, conductor pipe, etc. | 10,000 |
| Rig mobilization | 20,000 |
| Rig time - 25 days @ $160/hr | 96,000 |
| Supervision, consulting drilling engineer | 5,000 |
| Mud and various additives | 25,000 |
| Bits and reamers | 40,000 |
| Cementing | 26,000 |
| Running geophysical logging suites (3 times) | 25,000 |
| Mud logging | 12,000 |
| Various instrument, tool & equipment rentals | 8,000 |
| Trucking | 14,000 |
| Fuel, water | 13,000 |
| Completion/perforation | 10,000 |
| Miscellaneous | 10,000 |
| Well testing costs | 10,000 |
| Site clean up | 10,000 |
| | $374,000 |
| Contingency, 20% | 74,800 |
| | $448,800 |

In addition, the following charges apply:

| | Rate/Hour | Hours | Total | |
|---|---|---|---|---|
| Geologist | $ 9 | 300 | $ 1,800 | |
| Draftsman | 7 | 40 | 280 | |
| Editor/Technical Writer | 9 | 40 | 360 | |
| Typist | 7 | 40 | 280 | |
| | | | | $2,720 |

7. (continued)

Miscellaneous direct costs

| | | |
|---|---|---|
| Senior consultant | 2,000 | |
| Per diem | 1,200 | |
| FWD vehicle | 1,500 | |
| Telephone, etc. | 200 | |
| Air travel | 100 | |
| | | $5,000 |

8. Exploration drilling, Option B -- 1800'-2000' Hole Estimate

If this option is considered (see technical discussion elsewhere in this proposal), a much lighter drilling rig may be employed. In that case, the estimated cost of the slim hole drilling program would be as follows:

| | |
|---|---|
| Casing, wellhead, etc. | $ 9,000 |
| Site preparation, conductor pipe, etc. | 4,000 |
| Mobilization | 4,000 |
| Rig rate $95/hour x 15 days | 34,200 |
| Supervision | 3,000 |
| Mud and additives | 10,000 |
| Bits and reamers | 12,000 |
| Cementing | 7,000 |
| Borehole logging | 9,000 |
| Mud Logging | 5,000 |
| Rental of misc. tools and equipment | 3,000 |
| Testing | 5,000 |
| Clean up | 1,000 |
| | $106,200 |
| Contingency, time lost due to coring, testing, 20% | 18,800 |
| | $125,000 |

8. (continued) 

The actual depth of the hole may vary from 1800' to 2000' since the factor that affects drilling cost most is the hourly drilling rate. If drilling progresses rapidly, and a 2000' hole can be drilled in 250-300 hours, the savings in drilling time charges would more than offset the increase in cost due to 200' additional of perforated casing.

In addition to the above, the following costs apply:

| | Rate/Hour | Hours | Total | |
|---|---|---|---|---|
| Geologist | $ 9 | 200 | $ 1,800 | |
| Draftsman | 7 | 40 | 280 | |
| Editor/Technical Writer | 9 | 40 | 360 | |
| Typist | 7 | 40 | 280 | |
| | | | | $2,720 |

Miscellaneous direct costs

| | | |
|---|---|---|
| Senior consultant | 1,500 | |
| FWD vehicle | 800 | |
| Travel | 100 | |
| Per diem, 30 x 30 | 900 | |
| Telephone, copying, etc. | 200 | |
| | | $3,400 |

9. Final Report

| | | | | |
|---|---|---|---|---|
| Geologist | $ 9 | 400 | $ 3,600 | |
| Draftsman | 7 | 300 | 2,100 | |
| Editor/Technical Writer | 9 | 400 | 3,600 | |
| Typist | 7 | 200 | 2,100 | |
| | | | | $11,400 |

Other direct costs

| | | |
|---|---|---|
| Senior consultant | $ 4,000 | |
| Travel | 100 | |
| Publication costs | 1,000 | |
| Telephone, etc. | 500 | |
| | | $5,600 |

SUMMARY OF COST PROPOSAL, U.S. DOLLARS

| | Direct Labor | Subcontracts | Materials | Consultants | Travel | Per Diem |
|---|---|---|---|---|---|---|
| 1. Geology/hydrogeology | $ 8,840 | -- | $ 2,850 | -- | $ 500 | $ 1,200 |
| 2. Geochemistry | 4,496 | -- | 1,650 | -- | -- | 420 |
| 3. Gravimetry, Option A | 7,916* | -- | 2,900 | -- | 80 | 1,800 |
| 4. Gravimetry, Option B | 1,800* | -- | 230 | -- | 80 | 90 |
| 5. MT survey | -- | $ 45,000 | 300 | $ 1,200 | 50 | 200 |
| 6. T.G. drilling | 2,464 | 40,000 | 1,750 | 3,000 | 160 | 900 |
| 7. Drilling, Option A | 2,720* | 307,800* | 95,800* | 2,000 | 100 | 1,200 |
| 8. Drilling, Option B | 2,728* | 72,200* | 32,000* | 1,500 | 100 | 900 |
| 9. Final report | 11,400 | -- | 1,500 | 4,000 | 100 | -- |
| TOTAL, OPTION A | $37,836 | $392,800 | $138,980 | $ 10,700 | $1,170 | $ 6,710 |
| TOTAL, OPTION B | $31,720 | $167,200 | $ 42,180 | $ 10,700 | $1,170 | $ 6,710 |

OPTION A, SUMMARY

| | |
|---|---|
| Total direct Labor | $ 37,836 |
| Labor O.H. rate, 100% | 37,836 |
| Sub-contracts | 392,800 |
| Materials | 138,980 |
| Consultants | 10,700 |
| O.H. on materials, sub-contracts & consultants, 15% | 81,372 |
| Travel | 1,180 |
| Per diem | 6,810 |
| GRAND TOTAL | $707,514 |

OPTION B, SUMMARY

| | | |
|---|---|---|
| Total direct labor | | $ 31,720 |
| Labor O.H. rate, 100% | | 31,720 |
| Subcontracts | $167,200 | |
| Materials | 42,180 | |
| Consultants | 10,700 | |
| | | 220,080 |
| O.H. rate on sub-contractors, consultants, materials, 15% | | 32,012 |
| Travel | | 1,170 |
| Per diem | | 6,710 |
| | | $324,412 |

The value placed by NGC on previously gathered data including temperature gradient drilling, lithologic data, and interpretation of the reconnaissance geochemistry survey is estimated at $30,000. Thus, the total value of the work program under Option A is $737,514, and under Option B $354,412.

MGC is prepared to provide the government with Program A at 90% of the actual cost enumerated above, and Program B at 75%, i.e., Program A at $663,750, and Program B at $265,800. No fee is included in the cost proposal.

NGC believes that Option B should be initially adopted, but would be prepared to discuss with the DOE possible modifications of the program under consideration.

## D. BUSINESS AND MANAGEMENT

### 1. Related Experience and Principal Program Personnel

Members of the Board of Directors have previous experience in the management of oil exploration ventures (W. C. Bradshaw). Mr. Ron Adolphson, Executive Vice-President of NGC has considerable experience in cost control and product scheduling. As a former Director of Corporate Accounting for Continental Motor Corporation, he managed about $80,000,000 per year in government contracting, and is intimately familiar with government accounting and reporting requirements. Mr. Adolphson will manage the current activities of NGC through the life of this project. Dr. Tsvi Meidav is the Consulting Exploration Manager for NGC. For the past 12 years Dr. Meidav has managed a large number of domestic and international geothermal exploration projects. Amongst others, he coordinated and supervised U.N. geothermal activities around the world, and conducted more than 100 geothermal exploration projects in the U.S. for various private and government clients. He presently serves as consultant to NGC as well as some national and international clients (U.N., World Bank). He recently concluded a successful exploration program in the Azores (where steam was discovered), and in Honduras. Dr. Meidav will manage the technical activities of NGC and will be responsible for supervision of in-house technical personnel, specification of work by such contractors and consultants, technical quality control and participation in analysis and report preparations.

### 2. Organization and Management Plan

The organization chart, Figure 6, shows the present structure of NGC.

ORGANIZATIONAL CHART

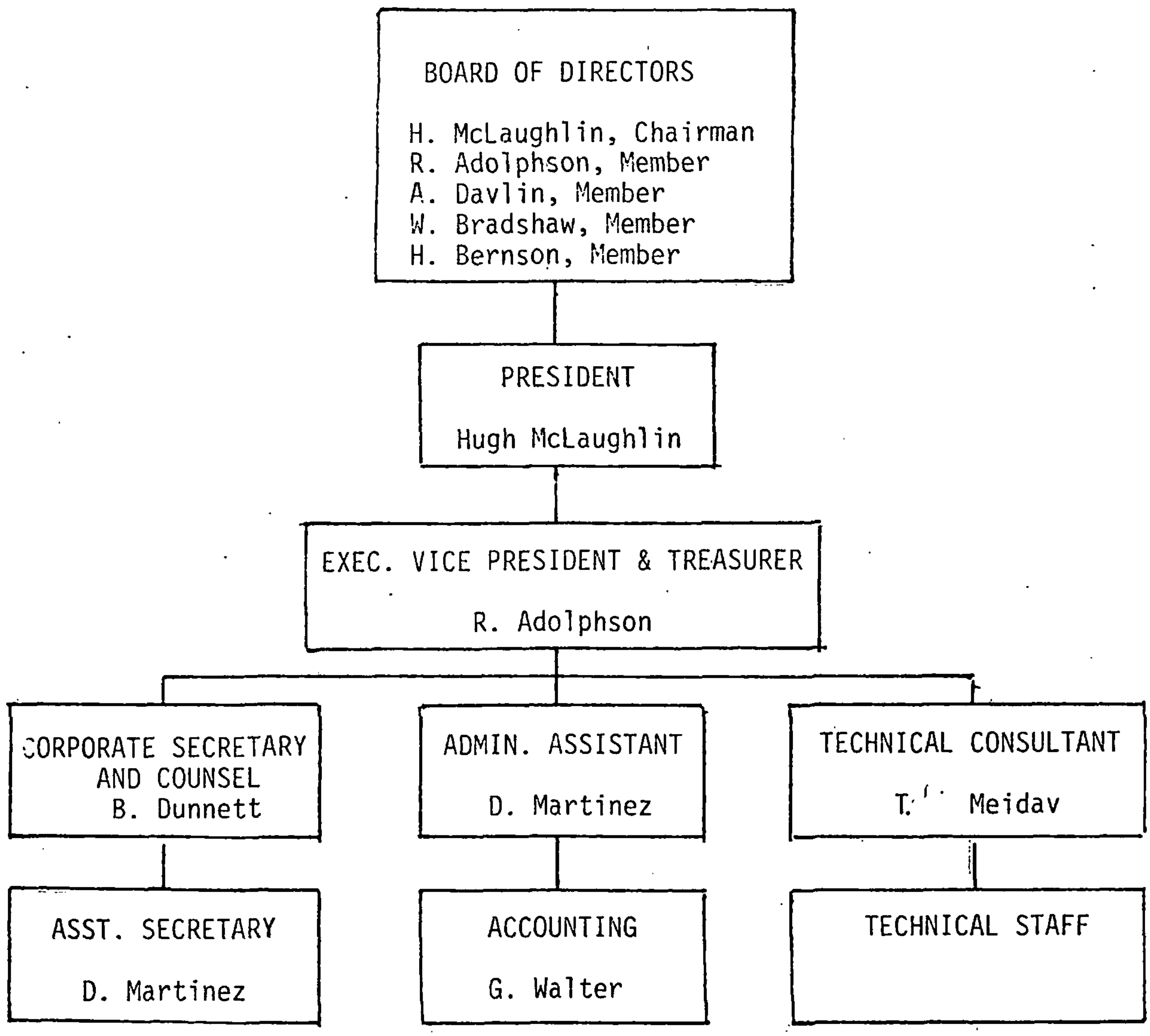



FIGURE 6. ORGANIZATIONAL CHART, NATIONAL GEOTHERMAL CORPORATION.

The headquarters of the corporation are:

National Geothermal Corp.
16780 Lark Avenue
Los Gatos, CA 95030

The mailing address of the company is:

National Geothermal Corp.
Post Office Box 549
Los Gatos, CA 95030
Telephone: (408) 358-1961

The name and address of the Senior Technical Advisor of the company is:

Dr. Tsvi Meidav
40 Brookside Avenue
Berkeley, CA 94705
Telephone: (415) 658-5330

Mr. Hugh McLaughlin, Chairman of the Board of the company is located at:

Post Office Box 1396
Palm Springs, CA 92262
Telephone: (714) 323-7260

Mr. McLaughlin may be reached for overall policy matters. Mr. Adolphson manages all technical program operations. NGC has requested Dr. Meidav to serve as overall coordinator of this program. All technical inquiries should be directed to him.

Other senior program personnel include, but are not limited to the following:

Geology, hydrogeology, geochemistry. This program will be directed by Professor Yoram Eckstein of Kent State University. Dr. Eckstein has been engaged in geothermal exploration in the U.S., Honduras, and Israel for the past ten years. In recent years, Dr. Eckstein served as the geothermal hydrogeologist/geochemist for

Hydrosearch in Nevada. Dr. Eckstein is presently a consultant to the Los Alamos Scientific Laboratory in the Hot Dry Rock program, and to Hydrosearch on another DOE program related to direct heat uses.

Gravimetry. Professor Rosewitha Grannel, California State University, Long Beach, is an expert in the field of gravimetry. She obtained her doctoral degree at UC Riverside, under Dr. Meidav's supervision. She has carried out a large number of gravimetric surveys in Nevada, including the Battle Mountain heat flow high, in conjunction with the Lawrence Berkeley Lab comprehensive studies in the area. Dr. Grannell has carried out gravimetric surveys of KGRA's near Fallon, Brady's Hot Springs, Soda Lake, Stillwater, Buffalo Valley, Jersey Valley in Nevada. Has consulted to LBL in gravity studies in Kyle H.S. and Leach H.S. and for the USGS on other projects. At present, Dr. Grannell consults for LBL on a precision gravity survey of the Cerro Prieto Field, Mexico.

Drilling Engineering. Mr. Herbert Wheeler, drilling engineer, will plan and supervise all drilling operations. Mr. Wheeler has 25 years of experience in managing oil, gas, and geothermal drilling operations. Mr. Wheeler planned and supervised geothermal drilling for Signal Oil in the Castle Rock area of the Geysers, and was responsible for the engineering and supervision of the discovery well in that area, as well as subsequent wells drilled by Signal in the field. He was responsible for geothermal drilling programs in Surprise Valley, California, Clear Lake (Konocti) area, Beowawe, and recently in the Roosevelt Field, Utah.

Dr. Meidav will coordinate the activities of the senior personnel according to the planned activity schedule or any modification thereof. He will be assisted by junior technical personnel retained by NGC as needed. Logistical and administrative support will be provided by NGC headquarters in Los Gatos. The magnetotelluric program will be contracted out to a geophysical company qualifed in the field, and supervised directly by Dr. Meidav. The thermometric hole program will be supervised by Messrs. Wheeler and Meidav.

Management methodologies are not discussed in detail here because of the different program options that have been provided, which would require different schedules. Should DOE decide to consider the proposed program for funding and indicate which of the options are acceptable to the DOE, NGC will prepare a proposal amendment containing a detailed program and cost management plan. Program management will include PERT and CPM scheduling of activities, indicate method of control of performance, financial control techniques, report scheduling, and other planning schedules. The cost of preparing such schedules, with all possible permutations, is considered to be unjustifiable at this time, prior to knowing the position of DOE to this program. Furthermore, NGC would like to propose to the DOE some simplified methods of cost and program accounting and control that would reduce the overhead and paperwork considerably. These management techniques will be discussed in conference with the DOE contract team at the time of contract negotiations. The program scheduling will be based around the proposed time schedule shown in Table 2. NGC would be ready to comply by DOE requirements regarding reporting.

3. Program Acceptability

NGC accepts in principle the provisions of the draft contract as a basis for contract negotiations. However, NGC believes that Article 4 of the draft contract (Payment) ought to be modified. Article 4.b(1) states that payment for drilling would be made "upon completion and testing of the well(s)". In our opinion, payment may be made by the DOE on a basis of completed activity, and in proportion to completed work. Thus, the DOE may consider acceptance of an invoice for mobilization, after mobilization has been completed, for example, or acceptance of an invoice for completion of drilling of the shallow reservoir after that phase has been completed.

Furthermore, Article 4.b(1) includes no provisions for different possible geophysical logging programs, coring programs, etc. We believe that these matters must be resolved in conference with the DOE, if NGC's program is considered acceptable in principle.

Regarding Article 4.b(2), it is proposed that the schedule of payment for different non-drilling activities be sub-divided based upon percentage completion. Complete withholding of payments until completion of delivery and acceptance of all data is uncommon for either governmental or private clients. The more common practice is that payment is made in proportion to completion, with a small amount, on the order of 10%, held back after delivery of a final product, until acceptance is given. Acceptance or non-acceptance must be stated within a short period of time after delivery, say 15 days.

We propose to discuss these matters with the DOE in case of positive selection of NGC for contract negotiations. We find the other contract provisions acceptable.

4. Financial Information

A financial statement of NGC is being presently prepared. NGC's overall assets consist primarily of its leases and previous exploratory work carried out by the company. The aggregate value of these is greater than $250,000. NGC has adequate financial resources to complete this program.

5. Validity of Offer

This cost proposal will remain in effect for at least 120 days after May 30, 1978.

6. Disclosure

NGC has reviewed the "Program Technical Scope" set forth in the RFP, and states that all the data furnished pursuant to the contract with the DOE may be published.

7. Mr. Hugh McLaughlin, President of National Geothermal Corp., whose signature of this proposal is given below, has the authority to commit the corporation to all provisions of the proposal.

Hugh McLaughlin

Hugh McLaughlin,
President
National Geothermal Corp.

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Long, C.L., S.M. Senterfit, and H.E. Kaufman, 1976, Audio-magnetotelluric data log, apparent resistivity maps and station location map for the Darrough Known Geothermal Resources Area (KGRA), Nevada, USGS Open File Report 76-285.

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Stewart J.H., and J.E. Carlson, 1974, Preliminary Geologic Map of Nevada, USGS

Thompson, G.A., and D.B. Burke, 1973, Rate and direction of spreading in Dixie Valley Basin and Range Province, Nevada; Geological Society of America Bulletin, v. 84: 627-632.

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Waring, G.A., 1965, Thermal springs of the U.S. and other countries of the world -- a summary; USGS Professional Paper 492.

# RESUMES

HUGH McLAUGHLIN

Mr. McLaughlin was born and raised in California. He attended Chapman College where he graduated with a degree in Economics. Mr. McLaughlin was in the Army from 1941-45. His active service included tours of duty in the Pacific and Europe. After being honorably discharged from the Army, Mr. McLaughlin worked for Giant Chemicals from 1947-52. He became Industrial Sales Manager with DuBois Chemicals from 1952-58. He also worked with Delco Chemicals for about 4 1/2 years. Mr. McLaughlin then became part owner in Sudan Cole Company in Tennessee until 1968. Mr. McLaughlin then went into gold and silver mining in Nevada from 1968 until 1972. From 1972 until present Mr. McLaughlin has been involved in geothermal exploration.

RONALD H. ADOLPHSON:

Mr. Adolphson was raised in the midwest, educated at Michigan State University and has been a Certified Public Accountant since 1960. He spent five years with Touche, Ross & Company, an international firm of Certified Public Accountants. He was Director of Corporate Accounting for Continental Motors Corporation, whose annual volume of $160,000,000.00 was approximately one-half in government contracts. He then became Chief Financial Officer and Director of the largest tool and dye and heavy equipment manufacturer in the midwest. In 1970 he came to California where he joined a law firm specializing in taxation and has for the past nine years been involved in a wide variety of management functions including direction of a finance company with assets of $17,000,000.00, a development company with assets of $8,500,000.00, convalescent hospitals, restaurants, apartment buildings and land development projects. Mr. Adolphson has been, for the last five years, involved in the management of the Monitor Ranch which consists of over 1,500,000 acres located in the Monitor Valley and the Smokey Valley of Nevada.

W. C. "BUD" BRADSHAW

Mr. Bradshaw was educated in Wichita, Kansas. He attended public schools there and the University of Wichita. He later studied, from 1927 to 1929, at the University of Michigan where he majored in Mechanical Engineering. By profession Mr. Bradshaw is a Mechanical-Engineer, Management Consultant. Mr. Bradshaw is vice president of the California Fresno Investment Company and a member of its board of directors since 1935. He was secretary and also managing director of California Fresno Oil Company from 1960 to 1976. He was president of Petroleum Chemicals, Inc., from 1952 to 1972, and former vice president of California-Fresno Asphalt Company from 1952 to 1972. He is currently owner-operator of W. C. Bradshaw Company-Management Consultants and prior to this owner-operator of W. C. Bradshaw Mechanical Contractors Engineers from 1942 to 1952. Mr. Bradshaw has a long history of dedicated interest and involvement in organizations, public and private, which are vitally concerned with the many aspects of education, training, rehabilitation and employment for the handicapped. He has been an active member of both the President's and Governor's committees for employment of the handicapped since 1960. Mr. Bradshaw has been a member of the California State Development Disabilities Advisory Council from 1972 to present. He has also been a member of the California Department of Rehabilitation Advisory Council from 1972 to the present.

ANDREW DAVLIN, JR.:

Mr. Davlin graduated from Princeton University with a B.A. in economics in 1951. He received a Masters in Business Administration from Columbia University in 1957. He was a naval officer, Lieutenant Jr. Grade, from 1951 to 1954. He later joined a Wall Street firm, Tucker, Anthony and R. L. Day as a security analyst. Mr. Davlin eventually specialized in the motor carrier and transportation industry, and he became a general partner of the firm from 1965 to 1970. He then became an officer in a New York securities company which is an underwriting firm for motor carrier securities. He joined Hambrecht and Quist in 1972 and was a partner in that firm until 1973. In 1973 Mr. Davlin formed Davlin and Company, Inc., which is a consulting organization to the motor carrier industry in Belvedere, California. The firm is still in existence. From 1975 until the present, Mr. Davlin has been Chairman of the Board of the Landy Corporation which is a holding company that owns motor carriers and various other assets.

HAROLD B. BERNSON

Mr. Bernson attended, UCLA, UC Berkeley, Law School, U.S.C.; he graduated in June of 1938 with a Doctor of Law degree. Mr. Bernson was admitted to the State Bar of California on May 12, 1938. He is a member of the firms of Gilford & Bernson, Leslie & Bernson and Bernson & Wolf. Mr. Bernson is an arbitrator on the American Arbitration Association. Some of the clients that his firms have represented are: Harpers, W. H. Harper, Inc., California Tank and Manufacturers, Inc., Hume Enterprises, Inc., Queen City Steel, Inc., Olsan's Furniture, Dealer's Finance Co., Inc., Moffa Electric, Inc., Electro-MCC, Inc., Exports International, Inc., One-Stop Realty Corp. and Microx X-ray Corp.

RESUME,

Dr. Roswitha B. Grannell
5035 College View Avenue
Los Angeles, California 90041
1-213-258-3948

The principal investigator is a 39 year old female Caucasian, in good health and used to the rigors of field work. Below is a resume of her education and accomplishments.

## EDUCATION

A.B. Pomona College, Claremont, California, with honors, 1962, major in Geology.

Ph.D. University of California, Riverside, 1969, in Geological Sciences. Dissertation: "Geological and Geophysical Studies of Three Franciscan Serpentinites, Santa Lucia Range, California."

## SPECIAL CAPABILITIES

Background in statistics and computer programming (particularly APL).

## EMPLOYMENT

Professor, Department of Geological Sciences, California State University, Long Beach, teaching geology and geophysics; on full time status since fall of 1967. Currently Director of the Center for Environmental Studies, and supervising ten master's theses projects.

## CONSULTING

1973 Ground water project near Palm Desert, California, using gravimetry, for Earth Science Associates, Palo Alto.

1974 Consulting using gravimetry for geothermal exploration in Nevada. Name of company and location is still confidential. For further information, contact Dr. Burt Slemmons, University of Nevada, Reno.

1974 to Present Consulting agreement with Lawrence Berkeley Laboratories, for gravity surveys of Leach and Kyle Hot Springs near Winnemucca. (Funding from AEC grant #W-7405-ENG-48, Geothermal Energy Research, administered by Paul Witherspoon.) Also, precise gravity survey of Cerro Prieto Geothermal Field, Mexico.

GRANTS

1971 Penrose Grant, Geological Society of America, for gravity work on a regional scale of Tobin Range and Buffalo Valley.

1972 Penrose Grant, Geological Society of America, for detailed gravity survey of Fish Creek Mountains.

1972 California State University, Long Beach Foundation Summer Grant for detailed gravity survey of Fish Creek Mountains.

1972 NSF Grant, Instructional Scientific Equipment Program, for purchase of LaCoste and Romberg gravity meter and accessories.

1975 Extramural Geothermal Research Grant, United States Geological Survey, entitled Detailed Gravity Surveys of the Brady's Hot Springs-Soda Lake and Buffalo-Jersey-Lower Reese River Valleys Areas, Nevada, for $28,075.

1975 United States Geological Survey Grant, coauthored with John Fett (Principal Investigator), for evaluation of precise gravimetry as an earthquake precursor. I served as a consultant on the project for the first year.

1976 NSF ISEP grant, for purchase of strip-chart recorder and telluric current unit.

1977 LOCI Grant from NSF for course implementation in environmental science areas.

1977 Chancellor's Mini-Grant for construction of a microprocessor and upgrading of abilities in computer programming (APL).

1977 CSULB Foundation Grant for repetition of gravity stations established 1964-1972 in area of the Palmdale Bulge.

PUBLICATIONS

Burch, S.H., R.B. Grannell, and W.F. Hanna, 1971, Bouguer gravity map of California, San Luis Obispo sheet, with accompanying text: California Division of Mines and Geology.

Goldstein, N.E., H. Beyer, R. Corwin, D.E. di Somma, E. Majer, T.V. McEvilly, H.F. Morrison, H.A. Wollenberg, and R. Grannell, 1976, Open file report geoscience studies in Buena Vista Valley, Nevada: Lawrence Berkeley Laboratory.

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Grannell, R.B., 1974, A regional gravity survey of the Fish Creek Mountains and surrounding area, north-central Nevada: Geological Society of America, abstracts for 70th annual meeting, Cordilleran section. This paper was included in the Chester Longwell Symposium on the Great Basin.

Grannell, R.B., 1977, Regional and detailed gravity surveys in portions of the Battle Mountain heat flow high: presented in the Battle Mountain Heat Flow High Symposium at the AGU meeting, San Francisco; p. 1238, Transactions, American Geophysical Union, v. 58, no. 12.

Grannell, R.B., and S. Biehler, 1971, A regional gravity survey of the San Gabriel Mountains, California: Geological Society of America, abstracts for 67th annual meeting, Cordilleran section meetings. Invited paper for the Transverse Range symposium.

Grannell, R.B. and K.J. Hau, 1967, Gravity studies over serpentine bodies in the Santa Lucia Range, California: Geological Society of America, Abstracts for 63d annual meeting, Cordilleran section.

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Lang, H. and R.B. Grannell, 1975, A detailed gravity survey of the Cristianitos fault zone, presented at the A.A.P.G. meetings, and published in the symposium volume.

Long, J.F. and R.B. Grannell, 1971, A detailed gravity survey of the San Gabriel anorthosite body: Geological Society of America, abstracts for 67th annual meeting, Cordilleran section.

Oliver, H.W., S.L. Robbins, R.B. Grannell, R.W. Alewine, and S.H. Biehler, 1975, Surface and subsurface movements determined by remeasuring gravity: California Division of Mines and Geology, Bulletin 196, San Fernando, California, Earthquake of 9 February 1971, Chapter 16.

Robbins, S.L., R.B. Grannell, R.W. Alewine, S. Biehler, and H. Oliver, 1973, Descriptions, sketch maps, and selected pictures of 87 gravity stations reoccupied after the San Fernando earthquake of February 9, 1971: United States Geological Survey, open file report.

# H. TSVI MEIDAV

## CONSULTANT

### PERSONAL DATA

#### Education

Bachelor of Arts, Washington University, St. Louis, Missouri--1955, Geology
Master of Arts, Washington University, St. Louis, Missouri--1956, Geophysics
Doctor of Philosophy, Washington University, St. Louis, Missouri--1960, Geophysics

#### Registrations

Registered Engineering Geologist, California, No. EG763
Registered Geologist, California, No. 1935

#### Activities

Organizer and Chairman, Geothermal Exploration Symposia, Society of Exploration Geophysicists--1972 to 1976
Member, Committee to Update the Groundwater Basin Management Manual, American Society of Civil Engineers
Member, NSF-Sponsored Hickel Committee, Geothermal Energy
Organizer, Salton Trough Symposium, Geological Society of America Pacific Annual Meeting--1972, California
Associate Editor, Geothermics
Consultant, Lawrence Berkeley Laboratory, University of California, Berkeley, California--1974 to 1975
Geothermal Consultant, Conservation Committee, World Energy Conference--1977, Istanbul, Turkey
Organizer, Second Workshop on Geothermal Effluent Sampling and Analysis, Sponsored by U.S. Environment and Production Agency--1977, Las Vegas, Nevada

#### Honors

Distinguished Lecturer, American Association of Petroleum Geologists--1974 to 1975
U.N. Coordinator, Second International Geothermal Symposium--1971 to 1973
Visiting Research Scholar, University of New Mexico--1975 to 1976

### PROFESSIONAL EXPERIENCE

#### President

- Geonomics, Inc., Berkeley, California--1974 to 1977.

Acts as general manager and chief scientist of Geonomics. Coordinates and manages overall geothermal projects in the United States and abroad. Supervises interpretation and report presentations of scientific data.

#### Technical Advisor

- United Nations, New York--1971 to 1973

Responsible for formulation, coordination, and direction of geothermal projects in many countries in Latin America, Africa, Europe, and Asia. Managed preliminary evaluations of geothermal resources concentrating on technical and economic feasibility. Coordinated U.N. financing, planning, and execution of national geothermal projects. Responsible for recruitment of an international specialist staff to man the U.N. expert teams for geophysical surveys in the field

#### Associate Professor/Associate Geophysicist

- Institute for Geophysics and Planetary Physics, University of California, Riverside, California--1967 to 1971

Lectured in all phases of geophysics and investigated geothermal resources of the Imperial Valley, California. Evaluation of geothermal phenomena in the Imperial Valley utilizing electric resistivity, gravity, and temperature gradient as well as infra-red and geodetic data. Result of work in Imperial Valley: two steam producing fields discovered.

#### Senior Geophysicist

- Huntec, Ltd., Toronto, Canada--1965 to 1967

Conducted and managed electrical resistivity, seismic refraction, and marine acoustical field surveys for groundwater, minerals, foundation surveys, and harbor studies. Conducted blast and vibration recording and analysis for structural damage studies. Improved level of development of marine seismics.

**Geophysicist**

- Institute of Petroleum Research and Geophysics, Israel--1961 to 1965

Responsible for groundwater, mineral, and engineering geophysical surveys. Did research in seismic reflection techniques for petroleum exploration and blast and vibration studies. Developed techniques for foundation investigations.

**Geophysicist**

- Missouri State Geological Survey, Rolla, Missouri-- 1965 to 1966

Responsible for conducting electrical resistivity and seismic refraction investigations for groundwater, highway planning, and mineral exploration.

## INTERNATIONAL EXPERIENCE

**Chile:** Provided guidance in the drilling of geothermal wells, resulting in 16-megawatt power plant in design stage at El Tatio.

**Ethiopia:** Helped develop national geothermal development program which included airborne infra-red imagery for the Rift Valley.

**Greece:** Directed preliminary exploration of geothermal energy. Recommended drilling on the islands of Milos and Lesvos.

**India:** Assisted in the preparation of a national geothermal exploration program.

**Indonesia:** Prepared plan for a major geothermal power development on Java.

**Israel:** Developed plan for geothermal energy exploration, now the national plan.

**Kenya:** Resuscitated well which had been designated as a "dry hole." Became first productive geothermal well in Africa. Additional drilling resulted in discovery of the Olkaria Field.

**Nicaragua:** Managed detailed geophysical studies in the Momotombo and San Jacinto areas (for the U.N.)

**Portugal:** Presently carrying out comprehensive geothermal exploration and development on the Island of San Miguel, Azores, Portugal.

Turkey: Coordinated many engineering studies to solve carbonate scaling in geothermal wells drilled successfully in Kizildere.

## PUBLICATIONS

Resistivity Surveys of Missouri Limonite Deposits, State of Missouri Geological Survey and Water Resources Report of Investigation, no. 24, p. 5-27, 1958 (W. C. Hays-G. E. Heim)

Subsurface Investigations of a Plant Site, Mining Engineering, v. 11, p. 215-217, 1959. (L. Scharon-R. Uhley).

The Applicability of Seismic Refraction and Electrical Resistivity to Cut Classification in Missouri, Missouri State Highway Commission, Div. of Materials, Geology and Soils Section Report, p.1-38, 1960 (W. C. Davis-W. G. Jones)

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An Electrical Resistivity for Ground Water, Geophysics, v. 25, p. 1077-1093, 1960

Applicability of the Field Intensity Meter as a Shallow Depth Conductivity Measuring Instrument, The Geophysical Institute of Israel Report, 15 pp., 1961.

Radiometric Prospecting - General Aspects and a Case History of the Heletz Field; The Geophysical Institute of Israel Report, p. 1-22, 1961.

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Compute Seismic Wave Lengths Via Nomogram. World Oil, v. 154, p. 111-114, 1962 (A. Ginsburg)

Discussion of Recent Techniques for Determination of In Situ Elastic Properties and Measurement of Motion Amplification in Layered Media by R. J. Swain. Geophysics, v. 28, p. 112-113, 1963.

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Viscoelastic Properties of the Standard Linear Solid, Geophysical Prospecting, v. 12, p. 80-89, 1964.

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Geophysical Methods in Highway Engineering, presented before the Canadian Good Road Association Annual Convention, 1965. Published in Proceedings 3rd Asian Conference on Soil Mechanics and Foundation Engineering, December, 1966. (N. R. Paterson)

Development in Seismic Methods for the Determination of Soil and Rock Properties. Proceedings 3rd Asian Conference on Soil Mechnics and Foundation Engineering, December, 1967.

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Hammer Reflection Seismics in Engineering Geophysics. Geophysics, v. 34, p. 383-395, 1969.

Geothermal Exploration in the Imperial Valley, presented at the 45th Annual Meeting AAPG, SEG, SEPM, March, 1970 (R. W. Rex).
Possible Sea Floor Spreading in the Imperial Valley: Structural Setting. Trans. Amer. Geophys. Union, v. 51, no. 4, p. 421, 1970
Seismic Reflection Profiling with a Hammeri Seismograph, presented at the annual meeting of the Soc. of Explor. Geophys., New Orleans, November, 1970 (R. Furgerson-R. Goss).
Geothermal Exploration in the Salton Trough, California, presented at the annual meeting of the Soc. of Explor. Geophys., New Orleans, November 1970. (R. W. Rex).
Geothermal Energy for the Future, presented at the 138th annual meeting of the Amer. Assoc. for the Advancement of Science, Philadelphia, December, 1971. (J. Banwell).
Review of Electrical Resistivity in Geothermal Exploration, presented at the annual meeting of the Soc. of Explor. Geophys., Anaheim, Calif., November 1972. (J. Banwell)
Estimates of Geothermal Energy Potential, presented at the annual meeting of the Soc. of Explor. Geophys., Anaheim, Calif., November, 1972. (J. Banwell).
Electrical Resistivity in Geothermal Exploration, presented at the annual meeting of the Soc. of Explor. Geophys., Anaheim, Calif., Nov. 1972.
Economic Implications of Small Geothermal Power Plants, presented at Proceedings of the Comm. on Challenges to Modern Society, San Miguel, Azores, September, 1975.
Utilization of Gravimetric Data for Estimation of Hydrothermal Reservoir Characteristics in the East Mesa Geothermal Reservoir Characteristics in the East Mesa Geothermal Fields, Imperial Valley, California. Paper presented at the Workshop on Geothermal Reservoir Engineering (NSF), Stanford University, Dec. 1975.
Assessment of Exploration Techniques for Geothermal Energy, presented at Geothermal Energy Association, Plan Springs, Calif., April, 1976.
Well Logging in the Geothermal Industry, presented at the SPWLA Seventeenth Annual Logging Symposium, Denver, Colorado, June, 1976. (S. K. Sanyal).
DC Resistivity in Petroleum, Part I, Presented at First and Second Regional Workshops on Nonseismic Exploration for Petroleum, organized by Geonomics, Inc., Denver, Colorado and Houston, Texas, June and October, 1976.
Electrical Resistivity Field Survey Techniques, Part II, Presented at First and Second Regional Workshops on Nonseismic Exploration for Petroleum, organized by Geonomics, Inc., Denver, Colorado and Houston, Texas, June and October, 1976.
Geology and Geothermal Energy Potential of the Azores Islands, presented at International Congress on Thermal Waters, Geothermal Energy and Volcanism of the Mediterranean Area, Athens, October, 1976. (V. H. Forjaz).
Resistivity Survey of the Salton Sea Geothermal Areas, presented at 46th Annual International Meeting and Exposition of the Soc. of Explor. Gephys., Houston, Texas, Oct. 1976. (R. West-A. Katzenstein-P. Kasameyer)
A semi-Analytical Approach to Geothermal Reservoir Performance Predictuin, presented at Geothermal Reservoir Engineering Workshop, organized by Stanford Geothermal Program (NSF), Palo Alto, Calif. Dec., 1976. (Dr. S. K. Sanval).
Application of Electrical Resistivity and Gravimetry in Deep Geothermal Exploration. Proceedings of the U.N. Conference on Exploration and Utilization of Geothermal Energy, Pisa, Italy, September, 1970, published in Geothermics, v. 2, pt. 1, p. 303-310.
Arrays and Nomograms for Electrical Resistivity Exploration. Geophysical Prospecting, v. 18, p. 55-563, 1970.
Geophysics in Groundwater Exploration, Chapter II, the American Soc. of Civil Engrs. manual on Groundwater Basin Management, 1972
Electrical Resistivity for Geothermal Exploration in the Imperial Valley. Geothermics, v. 1, no. 2, p. 47-62, 1972
Crustal Spreading in Southern California. Science, October 6, 1972, p. 15-24. (W. A. Elders-R. W. Rex-P. Robinson-S. Biehler).
Geothermal Opportunities Bear Closer Look. Oil and Gas Journal, May 13, 1974.
Geothermal Energy for the Future. Geothermal Energy, December, 1974. (J. Banwell).
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Time is of the Essence in Developing Geothermal Energy. Oil and Gas Journal, April 7, 1975.
A Critique of Geothermal Exploration Techniques. Proceedings of the Second U.N. Symposium on the Development and Use of Geothermal Resources, presented San Francisco, California, May, 1975, published v. 2, p. 1143-1154, 1976.
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## ABSTRACTS/PRESENTATIONS

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Electrical Resistivity and Geochemistry of Aquifers in the Durmid Dome, Imperial Valley. Trans. Amer. Geophys. Union, vol. 49, no. 4, 1968. (W. Randall-R. W. Rex-L. Coursey).
On the High Density Core of the Durmid Dome, Imperial Valley. Trans. Amer. Geophys. Union, vol. 49, no. 4, 1968 (E. Babcock-R. W. Rex-W. Randall)
Geoelectrical Exploration of a Geothermal Area in Southern California, presented at the 50th Annual Meeting of the American Geophysical Union, Washington, D. C. Trans. Amer. Geophys. Union, vol. 50, no.5, April
Application of Non-Explosive Reflection Seismics in Urban Areas, presented at the annual meeting of the Association of Engineering Geologists, October, 1969, San Francisco. (R. Furgerson-R. Fahrenbruck-J. Wobser-R. Goss-L. Reed)

Important Considerations in Geothermal Well Log Analysis, to be presented at California Regional Meeting of the Society of Petroleum Engineers of AIME, Bakersfield, California, April 13-15, 1977. (D. S. K. Sanyal).

Cross Plotting in Geothermal Well Log Analysis, to be presented at 18th Annual Symposium of the Soc. of Prof. Well Log. Analysts, Houston, Texas, June 5-8, 1977. (D. S. K. Sanyal).

# CONTRACT PRICING PROPOSAL
*(RESEARCH AND DEVELOPMENT)*

Office of Management and Budget Approval No. 29-RO184

This form is for use when *(i)* submission of cost or pricing data (see FPR 1-3.807-3) is required and *(ii)* substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. | NO. OF PAGES

| | |
|---|---|
| NAME OF OFFEROR: National Geothermal Corp. | SUPPLIES AND/OR SERVICES TO BE FURNISHED: Geothermal investigations in Smokey Valley, Nevada |
| HOME OFFICE ADDRESS: Smokey Valley, Nev., Los Gatos, Ca. | |
| DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED | TOTAL AMOUNT OF PROPOSAL: $ 324,412.0* / GOV'T SOLICITATION NO.: ET-78-R-08-0003 |

## DETAIL DESCRIPTION OF COST ELEMENTS

| | | | EST COST ($) | TOTAL EST COST[1] | REFERENCE[2] |
|---|---|---|---|---|---|
| 1. DIRECT MATERIAL *(Itemize on Exhibit A)* | | | | | |
| *a.* PURCHASED PARTS | | | 42,180 | | |
| *b.* SUBCONTRACTED ITEMS | | | 167,200 | | |
| *c.* OTHER—*(1)* RAW MATERIAL | | | | | |
| *(2)* YOUR STANDARD COMMERCIAL ITEMS | | | | | |
| *(3)* INTERDIVISIONAL TRANSFERS *(At other than cost)* | | | | | |
| *TOTAL DIRECT MATERIAL* | | | | | |
| 2. MATERIAL OVERHEAD[3] *(Rate* 15 %X$ 220,080 *base=)* includes also rate for consultants, sub-contracts. | | | | | |
| 3. DIRECT LABOR *(Specify)* | ESTIMATED HOURS | RATE/HOUR | EST COST ($) | | |
| Misc. technical and non-technical staff. See pages 33-39 for detailed cost breakdown, hours etc. | | | 31,720 | | |
| *TOTAL DIRECT LABOR* | | | | | |
| 4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3] | O.H. RATE | X BASE= | EST COST ($) | | |
| | 100% | | 31,720 | | |
| *TOTAL LABOR OVERHEAD* | | | 31,720 | | |
| 5. SPECIAL TESTING *(Including field work at Government installations)* | | | EST COST ($) | | |
| *TOTAL SPECIAL TESTING* | | | | | |
| 6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)* See pp.33-40 for detail | | | | | |
| 7. TRAVEL *(If direct charge) (Give details on attached Schedule)* | | | EST COST ($) | | |
| *a.* TRANSPORTATION | | | 1,170 | | |
| *b.* PER DIEM OR SUBSISTENCE | | | 6,710 | | |
| *TOTAL TRAVEL* | | | | | |
| 8. CONSULTANTS *(Identify—purpose—rate)* | | | EST COST ($) | | |
| See pp. 33-40 of proposal for detail | | | 10,700 | | |
| *TOTAL CONSULTANTS* | | | | | |
| 9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* | | | | | |
| 10. *TOTAL DIRECT COST AND OVERHEAD* | | | | | |
| 11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate % of cost element Nos. )*[3] | | | | | |
| 12. ROYALTIES[4] | | | | | |
| 13. *TOTAL ESTIMATED COST* | | | | 324,412 | |
| 14. FEE OR PROFIT | | | | | |
| 15. not applicable *TOTAL ESTIMATED COST AND FEE OR PROFIT* | | | | | |



OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

RFP #ET-78-R-08-0003

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

| TYPED NAME AND TITLE | SIGNATURE |
|---|---|
| Hugh McLaughlin, president | Hugh McLaughlin |

| NAME OF FIRM | DATE OF SUBMISSION |
|---|---|
| National Geothermal Corp. | 5/30/1978 |

**EXHIBIT A—SUPPORTING SCHEDULE** *(Specify. If more space is needed, use reverse)*

| COST EL NO. | ITEM DESCRIPTION *(See footnote 5)* | EST COST ($) |
|---|---|---|
| | A detailed cost schedule for different program alternatives is given in pp. 33-40 of the accompanying proposal. | |

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☒ NO *(If yes, identify below.)*

| NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL | TELEPHONE NUMBER/EXTENSION |
|---|---|
| | |

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☒ YES ☐ NO *(If yes, identify.)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☒ YES ☐ NO *(If no, explain on reverse or separate page)*

*See Reverse for Instructions and Footnotes* OPTIONAL FORM 60 (10-71)

## INSTRUCTIONS TO OFFERORS

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated costs *(and attached supporting information)* suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in FPR 1-3.807-3 be required to submit a Certificate of Current Cost or Pricing Data (See FPR 1-3.807-3(h) and 1-3.807-4).

2. In addition to the specific information required by this form, the offeror is expected, in good faith, to incorporate in and submit with this form any additional data, supporting schedules, or substantiation which are reasonably required for the conduct of an appropriate review and analysis in the light of the specific facts of this procurement. For effective negotiations, it is essential that there be a clear understanding of:

a. The existing, verifiable data.
b. The judgmental factors applied in projecting from known data to the estimate, and
c. The contingencies used by the offeror in his proposed price.

In short, the offeror's estimating process itself needs to be disclosed.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be described *(with schedules as appropriate)*, and made available to the contracting officer or his representative upon request.

4. The formats for the "Cost Elements" and the "Proposed Contract Estimate" are not intended as rigid requirements. These may be presented in different format with the prior approval of the Contracting Officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal the offeror grants to the Contracting Officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

## FOOTNOTES

*1 Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. When any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferror or current market price.*

*2 When space in addition to that available in Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which the information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the Contracting Officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or invoice prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major re-arrangement, etc.); or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.*

*3 Indicate the rates used and provide an appropriate explanation. Where agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.*

*4 If the total cost entered here is in excess of $250, provide on a separate page the following information on each separate item of royalty or license fee: name and address of licensor; date of license agreement, patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.*

*5 Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.*

CONTINUATION OF EXHIBIT A—SUPPORTING SCHEDULE AND REPLIES TO QUESTIONS II AND V.

Two fundamentally different program options have been presented in the text of our proposal. The proposed program is sub-divided according to specific activities. Additionally, we have offered to share in the cost of the program at a level which depends upon the magnitude of the program itself ( see p. 40 of the proposal).

## REPRESENTATIONS AND CERTIFICATIONS
**(Construction and Architect-Engineer Contract)**
**(For use with Standard Forms 19, 21 and 252)**

REFERENCE *(Enter same No.(s) as on SF 19, 21 and 252)*
ET-78-R-08-0003

NAME AND ADDRESS OF BIDDER *(No., Street, City, State, and ZIP Code)*
National Geothermal Corp., 16780 Lark Ave., Los Gatos, CA 95030
Mailing address: P.O. Box 549, Los Gatos, CA 95030

DATE OF BID
5/30/78

*In negotiated procurements, "bid" and "bidder" shall be construed to mean "offer" and "offeror."*

The bidder makes the following representations and certifications as a part of the bid identified above. *(Check appropriate boxes.)*

1. SMALL BUSINESS

He ☑ is, ☐ is not, a small business concern. (A small business concern for the purpose of Government procurement is a concern, including its affiliates, which is independently owned and operated, is not dominant in the field of operations in which it is bidding on Government contracts, and can further qualify under the criteria concerning number of employees, average annual receipts, or other criteria as prescribed by the Small Business Administration. For additional information see governing regulations of the Small Business Administration (13 CFR Part 121)).

2. MINORITY BUSINESS ENTERPRISE

He ☐ is, ☑ is not a minority business enterprise. A minority business enterprise is defined as a "business, at least 50 percent of which is owned by minority group members or, in case of publicly owned businesses, at least 51 percent of the stock of which is owned by minority group members." For the purpose of this definition, minority group members are Negroes, Spanish-speaking American persons, American-Orientals, American-Indians, American-Eskimos, and American-Aleuts."

3. CONTINGENT FEE

*(a)* He ☐ has, ☑ has not, employed or retained any company or person (other than a full-time bona fide employee working solely for the bidder), to solicit or secure this contract, and *(b)* he ☐ has, ☑ has not, paid or agreed to pay any company or person (other than a full-time bona fide employee working solely for the bidder) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating to *(a)* and *(b)* above as requested by the Contracting Officer. *(For interpretation of the representation, including the term "bona fide employee," see Code of Federal Regulations, Title 41, Subpart 1-1.5.)*

4. TYPE OF ORGANIZATION

He operates as an ☐ individual, ☐ partnership, ☐ joint venture, ☑ corporation, incorporated in State of Nevada

5. INDEPENDENT PRICE DETERMINATION

*(a)* By submission of this bid, each bidder certifies, and in the case of a joint bid each party thereto certifies as to his own organization, that in connection with this procurement:

(1) The prices in this bid have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other bidder or with any competitor;

(2) Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the bidder and will not knowingly be disclosed by the bidder prior to opening, in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly to any other bidder or to any competitor; and

(3) No attempt has been made or will be made by the bidder to induce any other person or firm to submit or not to submit a bid for the purpose of restricting competition.

*(b)* Each person signing this bid certifies that:

(1) He is the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein and that he has not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)*(3) above; or

(2) (i) He is not the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)* (3) above, and as their agent does hereby so certify; and (ii) he has not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)*(3) above.

*(c)* This certification is not applicable to a foreign bidder submitting a bid for a contract which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

*(d)* A bid will not be considered for award where *(a)*(1), *(a)*(3), or *(b)* above, has been deleted or modified. Where *(a)*(2) above, has been deleted or modified, the bid will not be considered for award unless the bidder furnishes with the bid a signed statement which sets forth in detail the circumstances of the disclosure and the head of the agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

*NOTE.—Bids must set forth full, accurate, and complete information as required by this invitation for bids (including attachments). The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.*

*THE FOLLOWING NEED BE CHECKED ONLY IF BID EXCEEDS $10,000 IN AMOUNT.*

6. EQUAL OPPORTUNITY

He ☐ has, ☑ has not, participated in a previous contract or subcontract subject to the Equal Opportunity Clause herein, the clause originally contained in Section 301 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114; he ☐ has, ☐ has not, filed all required compliance reports; and representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards.

(The above representations need not be submitted in connection with contracts or subcontracts which are exempt from the equal opportunity clause.)

7. PARENT COMPANY AND EMPLOYER IDENTIFICATION NUMBER - National Geothermal Corp. #88-0145157

*Each bidder shall furnish the following information by filling in the appropriate blocks:*

*(a)* Is the bidder owned or controlled by a parent company as described below? ☐ Yes ☑ No. *(For the purpose of this bid, a parent company is defined as one which either owns or controls the activities and basic business policies of the bidder. To own another company means the parent company must own at least a majority (more than 50 percent) of the voting rights in that company. To control another company, such ownership is not required; if another company is able to formulate, determine, or veto basic business policy decisions of the bidder, such other company is considered the parent company of the bidder. This control may be exercised through the use of dominant minority voting rights, use of proxy voting, contractual arrangements, or otherwise.)*

*(b)* If the answer to *(a)* above is "Yes," bidder shall insert in the space below the name and main office address of the parent company.

| NAME OF PARENT COMPANY | MAIN OFFICE ADDRESS *(No., Street, City, State, and ZIP Code)* |
|---|---|
| | |

*(c)* Bidder shall insert in the applicable space below, if he has no parent company, his own Employer's Identification Number (E.I. No.) *(Federal Social Security Number used on Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941)*, or, if he has a parent company, the E.I. No. of his parent company.

| EMPLOYER IDENTIFICATION NUMBER OF | PARENT COMPANY | BIDDER |
|---|---|---|
| | | |

8. CERTIFICATION OF NONSEGREGATED FACILITIES

(Applicable to (1) contracts, (2) subcontracts, and (3) agreements with applicants who are themselves performing federally assisted construction contracts, exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause.)

By the submission of this bid, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certificatons from proposed subcontractors prior to the award of subcontractors exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

9. CLEAN AIR AND WATER

(Applicable if the bid or offer exceeds $100,000, or the contracting officer has determined that orders under an indefinite quantity contract in any year will exceed $100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or the Federal Water Pollution Control Act (33 U.S.C. 1319(c)) and is listed by EPA, or is not otherwise exempt.)

The bidder or offeror certifies as follows:

(a) Any facility to be utilized in the performance of this proposed contract has ☐, has not ☑, been listed on the Environmental Protection Agency List of Violating Facilities.

(b) He will promptly notify the contracting officer, prior to award, of the receipt of any communication from the Director, Office of Federal Activities, Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities.

(c) He will include substantially this certification, including this paragraph (c), in every nonexempt subcontract.


☆U.S. GPO:1977-0-241-530/3364

# SUPPLEMENT TO REPRESENTATIONS AND CERTIFICATIONS

10. BUY AMERICAN CERTIFICATE

The bidder or offeror hereby certifies that each end product, except the end products listed below, is a domestic source end product (as defined in the clause entitled "Buy American Act"); and that components of unknown origin have been considered to have been mined, produced, or manufactured outside the United States.

Excluded end products (show country of origin for each excluded end product):

11. AFFIRMATIVE ACTION PROGRAM

The following paragraphs are added:

a. The bidder or proposer represents that he (a) [ ] 1. has developed and has on file, [ ] 2. has not developed and does not have on file at each establishment an affirmative action program as required by the rules and regulations of the Secretary of Labor (41 CFR Part 60-1 and 60-2), or that he (b) [X] has not previously had contracts subject to the written Affirmative Action Program requirement of the Secretary of Labor.

   If such a program has not been developed, the bidder will complete the following:

   The bidder does [ ], does not [X] employ more than 50 employees and has [ ], has not [ ] been awarded a contract subject to Executive Order 11246 in the amount of $50,000 or more since July 1, 1968. If such a contract has been awarded since July 1, 1968, give the date of such contract, but do not list contracts awarded within the last 120 days prior to the date of this representation.

b. The bidder or proposer represents (a) that a full compliance review of the bidder's employment practices [ ] has, [X] has not been conducted by an agency of the Federal Government; that such compliance review [ ] has, [ ] has not been conducted for the bidder's known first-tier subcontractors with a subcontract of $50,000 or more and having 50 or more employees and (b) that the most recent compliance reviews were conducted as follows:

| NAME OF CONTRACTOR | DATE | FEDERAL AGENCY |
|---|---|---|
| (include known first-tier subcontractors) | | |

c. The bidder or proposer represents that if the bidder has 50 or more employees and if this Contract is for $50,000 or more, and that for each subcontractor having 50 or more employees and a subcontract for $50,000 or more, and if he has not developed one, a written affirmative action plan will be developed for each of its establishments within 120 days from commencement of the Contract. A copy of the establishment's plan shall also be maintained at the establishment within 120 days from the date of commencement of the Contract.

The Affirmative Action Compliance Program will cover the items specifically set out in 41 CFR Part 60-2 and shall be signed by an executive of the Contractor.

d. Where the bid of the apparent low responsible bidder is in the amount of $1 million or more, the bidder and his known first-tier subcontractors which will be awarded subcontracts of $1 million or more will be subject to full, preaward equal opportunity compliance reviews before the award of the Subcontract for the purpose of determining whether the bidder and his subcontractors are able to comply with the provisions of the equal opportunity clause.

e. The bidder or proposer, if he has 100 or more employees, and all subcontractors having 100 or more employees are required to submit the Government Employer Information Report SF 100 (EEO-1), within 30 days after award, unless such report has been filed within 12 months preceding award. The EEO-1 report is due annually on or before March 31.

12. COST ACCOUNTING STANDARDS--EXEMPTION FOR CONTRACTS OF $500,000 OR LESS--CERTIFICATION

If this proposal is expected to result in the award of a contract of $500,000 or less and the offeror is otherwise eligible for an exemption, he shall indicate by checking the box below that the exemption to the Cost Accounting Standards clause (FPR 1-3.1204) under the provisions of 4 CFR 331.30(b)(8) (see FPR 1-3.1203(h)) is claimed. Where the offeror fails to check the box, he shall be given the opportunity to make an election in writing to the Contracting Officer prior to award. Failure to check the box below or make such an election shall mean that the offeror cannot claim the exemption to the Cost Accounting Standards clause or that the offeror elects to comply with such clause.

[ ] Certificate of Exemption for Contracts of $500,000 or Less.

The offeror hereby claims an exemption from the Cost Accounting Standards clause under the provisions of 4 CFR 331.30(b)(8) and certifies that he has received notification of final acceptance of all items of work on (i) any prime contract or subcontract in excess of $500,000 which contains the Cost Accounting Standards clause, and (ii) any prime contract or subcontract of $500,000 or less awarded after January 1, 1975, which contains the Cost Accounting Standards clause. The offeror further certifies he will immediately notify the Contracting Officer in writing in the event he is awarded any other contract or subcontract containing the Cost Accounting Standards clause subsequent to the date of this certificate but prior to the date of any award resulting from this proposal.

13. DISCLOSURE STATEMENT--COST ACCOUNTING PRACTICES AND CERTIFICATION

Any contract in excess of $100,000 resulting from this solicitation except (i) when the price negotiated is based on: (A) established catalog or market prices of commercial items sold in substantial quantities to the general public, or (B) prices set by law or regulation, or (ii) contracts which are otherwise exempt (see 4 CFR 331.30(b) and FPR 1-3.1203(a)(2)) shall be subject to the requirements of the Cost Accounting Standards Board. Any offeror submitting a proposal which, if accepted, will result in a contract subject to the requirements of the Cost Accounting Standards Board must, as a condition of contracting, submit a Disclosure Statement as required by regulations of the Board. The Disclosure Statement must be submitted as a part of the offeror's proposal under this solicitaion (see I. below) unless (i) the offeror, together with all divisions, subsidiaries, and affiliates under common control, did not exceed the monetary exemption for disclosure as established by the Cost Accounting Standards Board (see II. below); (ii) the offeror exceeded the monetary exemption in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted but, in accordance with the regulations of the Cost Accounting Standards Board, is not yet required to submit a Disclosure Statement (see III. below); (iii) the offeror has already submitted a Disclosure Statement disclosing the practices used in connection with the pricing of this proposal (see IV. below); or (iv) postaward submission has been authorized by the Contracting Officer. See 4 CFR 351.70 for submission of copy of Disclosure Statement to the Cost Accounting Standards Board.

CAUTION: A practice disclosed in a Disclosure Statement shall not, by virtue of such disclosure, be deemed to be a proper, approved, or agreed to practice for pricing proposals or accumulating and reporting contract performance cost data.

Check the appropriate box below:

[ ] I. CERTIFICATE OF CONCURRENT SUBMISSION OF DISCLOSURE STATEMENT(S)

The offeror hereby certifies that he has submitted, as a part of his proposal under this solicitation, copies of the Disclosure Statement(s) as follows: (i) original and one copy to the cognizant Contracting Officer; and (ii) one copy to the cognizant contract auditor.

Date of Disclosure Statement(s):________________________________

Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed:________________________________

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

[ ] II. CERTIFICATE OF MONETARY EXEMPTION

The offeror hereby certifies that he, together with all divisions, subsidiaries, and affiliates under common control, did not receive net awards of negotiated national defense prime contracts subject to Cost Accounting Standards totaling more than $10,000,000 in either Federal Fiscal Year 1974 or 1975 or net awards of negotiated national defense prime contracts and subcontracts subject to cost accounting standards totaling more than $10,000,000 in Federal Fiscal Year 1976 or in any subsequent Federal Fiscal Year preceding the year in which this proposal was submitted.

CAUTION: Offerors who submitted or who currently are obligated to submit a Disclosure Statement under the filing requirements previously established by the Cost Accounting Standards Board are not eligible to claim this exemption unless they have received notification of final acceptance of all deliverable items on all of their prime contracts and subcontracts containing the Cost Accounting Standards clause.

[ ] III. CERTIFICATE OF INTERIM EXEMPTION

The offeror hereby certifies that (i) he first exceeded the monetary exemption for disclosure, as defined in II. above, in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted, and (ii) in accordance with the regulations of the Cost Accounting Standards Board (4 CFR 351.40(f)), he is not yet required to submit a Disclosure Statement. The offeror further certifies that if an award resulting from this proposal has not been made by March 31 of the current Federal Fiscal Year, he will immediately submit a revised certificate to the Contracting Officer, in the form specified

under I. above or IV. below, as appropriate, to verify his submission of a completed Disclosure Statement.

CAUTION: Offerors may not claim this exemption if they are currently required to disclose because they exceeded monetary thresholds in Federal Fiscal Years prior to Fiscal Year 1976. Further, the exemption applies only in connection with proposals submitted prior to March 31 of the year immediately following the Federal Fiscal Year in which the monetary exemption was exceeded.

[ ] IV. CERTIFICATE OF PREVIOUSLY SUBMITTED DISCLOSURE STATEMENT(S)

The offeror hereby certifies that the Disclosure Statement(s) were filed as follows:

Date of Disclosure Statement(s): N/A

Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed: ______

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

14. ADDITIONAL COST ACCOUNTING STANDARDS APPLICABLE TO EXISTING CONTRACTS--CERTIFICATION

(a) Cost accounting standards will be applicable and effective as promulgated by the Cost Accounting Standards Board to any award as provided in the Federal Procurement Regulations Subpart 1-3.12. If the offeror presently has contracts or subcontracts containing the Cost Accounting Standards clause, a new standard becomes applicable to such existing contracts prospectively when a new contract or subcontract containing such clause is awarded on or after the effective date of such new standard. Such new standard may require a change in the offeror's established cost accounting practices, whether or not disclosed. The offeror shall specify, by an appropriate entry below, the effect on his cost accounting practice.

(b) The offeror hereby certifies that an award under this solicitation [ ] would, [ ] would not, in accordance with paragraph (a)(3) of the Cost Accounting Standards clause, require a change in his established cost accounting practices affecting existing contracts and subcontracts.

NOTE: If the offeror has checked "would" above, and is awarded the contemplated contract, he will also be required to comply with the clause entitled Administration of Cost Accounting Standards.

Firm: National Geothermal Corp.

Name: Hugh McLaughlin

Date: 5/30/1978

Title: President

RFP No. ET-78-R-08-0003

McCOY, NEVADA PROPOSAL

AMAX Exploration, Inc.

14 H (1)

"Data contained in page 2 of this proposal shall not be used or disclosed, except for evaluation purposes, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this proposal, the Government shall have the right to use or disclose any data to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose any technical data obtained from another source without restriction."

A. Proposers Name and Address

AMAX Exploration, Inc.
4704 Harlan Street
Denver, Colorado 80212
(303) 433-6151

a wholly owned subsidiary of:

AMAX, INC.
AMAX Center
Greenwich, Connecticut 06830

B. Technical Proposal

AMAX Exploration, Inc., proposes to define the recently discovered heat flow anomaly in the McCoy Mine area by surface and subsurface methods and if warranted to drill for discovery of potential geothermal resources. Total estimated cost of the proposed exploration program is $2,034,000. Estimated cost to the DOE is $1,027,000 during the period FY 1978, FY 1979, and FY 1980. Estimated cost to the DOE for FY 1978 is $44,000, for FY 1979 is $83,000 and for FY 1980 is $900,000.

1. Investigation Site or Area

The investigation site comprises about six townships and is at the junction of the Augusta and Clan Alpine Mountains and the New Pass Range approximately 55 km northwest of Austin in Churchill and Lander Counties, Nevada (see Figure 1).

a. The proposal area is currently defined by Townships 22, 23, 24 North, Ranges 39, 40 East, MDM (see Plate I). Exploration results may cause the area of interest to be slightly enlarged or contracted.

b. AMAX Exploration, Inc., controls the central portion of the proposal area by means of priority geothermal lease applications.

The acreage controlled by AMAX is not fixed, and during the course of the proposed exploration program leases may be either added or dropped depending upon exploration results and/or lease chargeability limitations. AMAX also may elect at any point during the proposal to seek joint venture participation in the exploration program from other individuals or business concerns.

Legal descriptions of lease applications, which are subject to change, are given in Appendix I. The current lease application block is shown on Plate I.

No unitization arrangements exist in the proposal area.

Access to the proposal site is by means of a well traveled dirt road which intersects U. S. Highway 50 approximately 40 km west of Austin. The heart of the proposal area is about 30 km north of Highway 50.

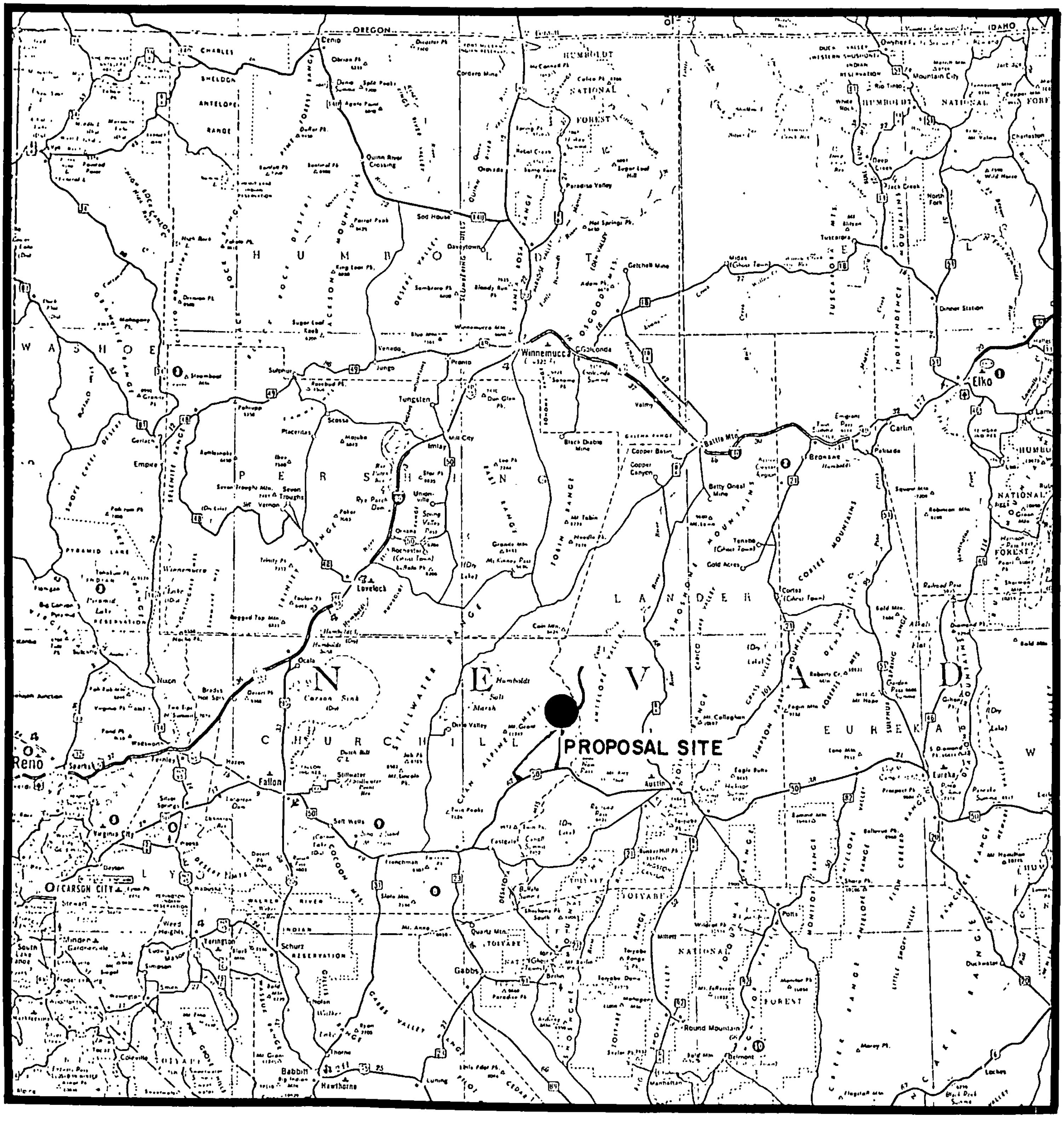


Figure 1

INDEX MAP

CONFIDENTIAL

c. The proposal area has not been geologically mapped in detail, but the general setting is fairly well known. The site is characterized by a thick assemblage of Tertiary intermediate to acidic volcanic rocks overlying Mesozoic and Paleozoic eugeosynclinal deposits of the Nevada western facies. These rocks are extensively broken by Basin and Range faulting. Geology of the proposal area is shown on Plate II.

d. The site is well located for the discovery and development of potential geothermal resources.

1) It is within the Battle Mountain "heatflow high".

2) It is approximately 32 km north of the 230KV transmission line that crosses central Nevada.

3) Landsat imagery shows a circular structure indicative of a volcanic center of typical caldera dimensions.

4) Silica ($SiO_2$) hydrogeochemistry from a hot well at the McCoy Mine utilizing an enthalpy (warm water) mixing model having an 85% cold water fraction indicates a minimum equilibrium temperature of 186°C.

5) A large fossil travertine mound covers approximately two sections to the west of the McCoy Mine.

6) Mercury mineralization and extensive hydrothermal alteration are conspicuous features within the area.

7) The area lies immediately east of the Dixie Valley KGRA and is within a zone of active faulting and possible active crustal spreading. Heat within the area could possibly be related to a shallow magmatic source.

8) Much of the central part of the proposal area exhibits heatflow in excess of 6 HFU as determined by 20 shallow thermal gradient measurements. Heat flow values greater than 10 HFU are common, with 18.9 HFU being the highest recorded value. Most gradients were measured to a depth of 38 meters; the deepest measurement was from 150 meters. The highest direct measurement is 40.4°C at 58 meters.

9) The heatflow anomaly is not related to range front faults, but is positioned along the central portion of range uplift, indicating that the heat source is probably not related to deep circulation along bounding faults. This observation increases the possibility (for reasons suggested above) that the heat source may be magmatic.

2. Program Data Offered

The proposed exploration program is divided into three phases each contingent upon the successful completion of the previous phase and/or the results of previous surveys. The program is designed to provide maximum flexibility in the search for a geothermal resource whose existence, location, and characteristics are not known and are only suggested or inferred at present.

The following data are offered contingent on the applicability and completion of the associated surveys. These are only briefly outlined in this section but are more fully described in the subsequent section entitled "Program Description".

a. <u>Subsurface Data</u>

Approximately 40 shallow (less than 150 meters) thermal gradient (temperature) and lithologic logs. Fifteen of these holes have already been drilled and approximately 25 are proposed to be drilled.

Three deep (600 meter maximum) thermal gradient and lithologic logs.

Two deep (2300 $\pm$ meter) geothermal production test wells with all associated temperature, lithologic, and other logs and measurements.

b. <u>Surface Data</u>

Self potential profiles-approximately 180 line-kilometers with measurements at 100 to 200 meter intervals.

Magnetotelluric Soundings-approximately 30 stations with measurements recorded between 10 and 0.01 Hz.

Aeromagnetic Survey-approximately 720 line-kilometers flown E-W at 1.6 kilometer intervals with N-S tie lines at a constant barometric altitude providing 305 meter (1000 foot) minimum terrain clearance.

Gravity Measurements-approximately 220 stations, terrain corrected to produce a complete Bouguer gravity anomaly map.

Passive Seismic Survey-approximately 50 stations designed to map and interpret microearthquake hypocenters and determine Poisson's ratio and possible P and S-wave travel time and attenuation anomalies.

Reflection Seismic Survey-approximately 32 line-kilometers, designed to identify structure and acoustic impedance effects associated with possible reservoir materials.

c. <u>Reservoir Engineering Studies</u>

Flow Testing to establish reservoir characteristics and fluid composition.

## 3. Program Description

For the purpose of this proposal all data collected after 31 May 1978 are considered "new" and data collected previously are considered "existing". Data collected under this proposal are designed to discover, define, and delineate the potential geothermal reservoir indicated by the McCoy thermal anomaly, and to provide sufficient information to construct an informative case-history.

### Existing Data - Fiscal Year 1978

Fifteen (15) thermal gradient and lithology logs to an average depth of approximately 38 meters will be delivered to the DOE at the time of the award of a contract concerning this proposal. These data will include:

1) A map showing well locations

2) Temperature measurements in °C at 1/2 meter intervals from the surface to 10 meters, at one meter intervals to 20 meters, and at 2 meter intervals thereafter, as conditions permit.

3) Lithology mapped from drill cuttings by a geologist

4) Computer output of thermal data showing

   a) Graph of gradient divided into segments,

   b) Gradients in °C per kilometer, and standard deviations.

   c) Extrapolated depth to the 200°C isotherm,

   d) Calculated HF at estimated conductivity (k) values

   e) Actual or projected temperature in °C at 100 meter depth,

   f) Printout of above data. An example of a thermal log and computer printout are shown on Figure 2a, b, c, d.

### New Data

Approximately twenty-five (25) thermal gradient and lithology logs to average depths between 50 and 100 meters. This survey is designed to define and delineate the thermal anomaly in the proposal area.

Gradient wells will be rotary drilled with 4 1/2 inch or larger bits. Air will be used whenever possible. Foam or mud will be used otherwise depending upon drilling conditions. A PVC pipe approximately one inch in diameter, capped at the bottom and filled with water will be inserted into the hole to the total depth possible. The hole will be backfilled with drill cuttings and completed as specified in the geothermal regulations.

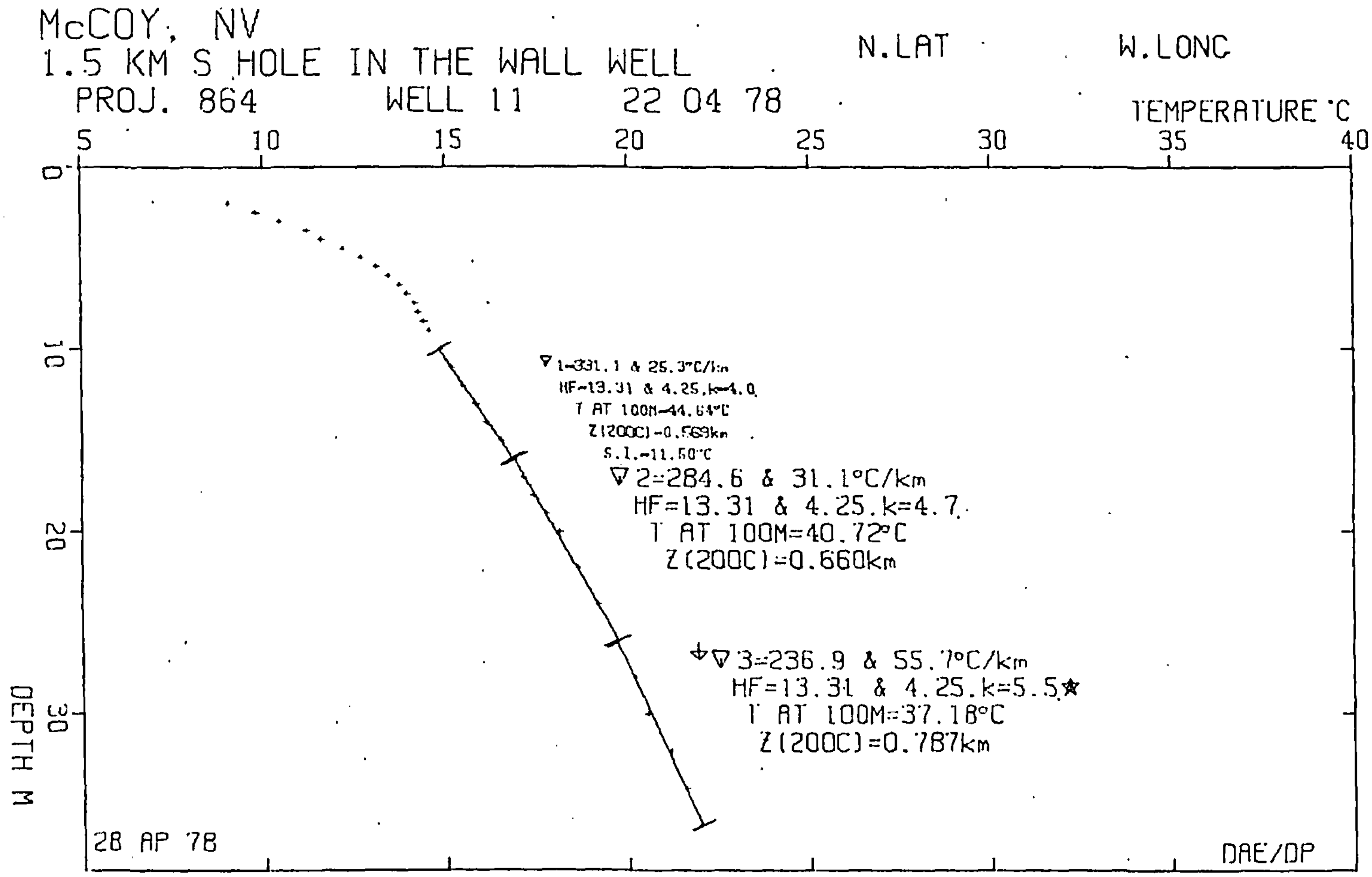
McCOY, NV
1.5 KM S HOLE IN THE WALL WELL
PROJ. 864 WELL 11 22 04 78
N.LAT
W.LONG
TEMPERATURE °C
5
10
15
20
25
30
35
40
0
10
20
30
DEPTH M
∇1=331.1 & 25.3°C/km
HF=13.31 & 4.25.k=4.0
T AT 100M=44.64°C
Z(200C)=0.569km
S.I.=11.50°C
∇2=284.6 & 31.1°C/km
HF=13.31 & 4.25.k=4.7
T AT 100M=40.72°C
Z(200C)=0.660km
∇3=236.9 & 55.7°C/km
HF=13.31 & 4.25.k=5.5
T AT 100M=37.18°C
Z(200C)=0.787km
28 AP 78
DAE/DP

Figure 2a.

GEOTHERMAL AMAX EXPLORATION, INC., A.L.LANGE
28 AP 78

PROJECT: MCCOY, NV

| PROJ | WELL | DA | MO | YR | WELL TITLE | EDITOR | TERRAIN | LP | LI | ISZ | IST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 864 | 11 | 22 | 04 | 78 | 1.5 KM S HOLE IN THE WALL WELL | DAE/DF | 0.0 | C | 0 | 1 | 1 |

| YCM | XCM | N.LAT | W.LONG | ELEV |
|---|---|---|---|---|
| 8.5000 | 31.2000 | | | 1796.9 |

| J | SEG START | SEG END | CONDTVTY & STD DEV. | |
|---|---|---|---|---|
| 1 | 10.000 | 16.000 | 0.000 | 0.000 |
| 2 | 16.000 | 26.000 | 0.000 | 0.000 |
| 3 | 26.000 | 36.000 | 5.500 | 0.500 |

PRECEEDING CONDUCTIVITY USED TO COMPUTE OTHERS
*** PREVIOUS SEGMENT USED TO EXTRAPOLATE TO DEPTH ***

| PROJ | WELL | DA | MO | YR | DEPTH (M) | DEG C | DEG C/KM | SAMPLE NO. |
|---|---|---|---|---|---|---|---|---|
| 864 | 11 | 22 | 04 | 78 | 2.000 | 9.060 | 99999.000 | 1 |
| | | | | | 2.500 | 9.300 | 1480.000 | 2 |
| | | | | | 3.000 | 10.450 | 1300.001 | 3 |
| | | | | | 3.500 | 11.180 | 1459.999 | 4 |
| | | | | | 4.000 | 11.560 | 800.001 | 5 |
| | | | | | 4.500 | 12.190 | 1220.000 | 6 |
| | | | | | 5.000 | 12.690 | 1000.000 | 7 |
| | | | | | 5.500 | 13.080 | 720.000 | 8 |
| | | | | | 6.000 | 13.430 | 699.999 | 9 |
| | | | | | 6.500 | 13.770 | 680.000 | 10 |
| 864 | 11 | 22 | 04 | 78 | 7.000 | 13.970 | 400.000 | 11 |
| | | | | | 7.500 | 14.130 | 320.000 | 12 |
| | | | | | 8.000 | 14.270 | 280.001 | 13 |
| | | | | | 8.500 | 14.420 | 299.999 | 14 |
| | | | | | 9.000 | 14.570 | 300.001 | 15 |
| | | | | | 10.000 | 14.850 | 280.000 | 16 |
| | | | | | 11.000 | 15.150 | 300.000 | 17 |
| | | | | | 12.000 | 15.450 | 300.000 | 18 |
| | | | | | 13.000 | 15.780 | 330.000 | 19 |
| | | | | | 14.000 | 16.120 | 339.995 | 20 |
| 864 | 11 | 22 | 04 | 78 | 15.000 | 16.480 | 360.001 | 21 |
| | | | | | 16.000 | 16.830 | 349.991 | 22 |
| | | | | | 17.000 | 17.120 | 290.009 | 23 |
| | | | | | 18.000 | 17.420 | 300.003 | 24 |
| | | | | | 19.000 | 17.750 | 330.002 | 25 |
| | | | | | 20.000 | 18.080 | 329.987 | 26 |
| | | | | | 22.000 | 18.620 | 270.004 | 27 |
| | | | | | 24.000 | 19.140 | 260.002 | 28 |
| | | | | | 26.000 | 19.660 | 259.995 | 29 |

Figure 2b.

| | | | | | |
|---|---|---|---|---|---|
| | | 28.000 | 20.150 | 245.003 | 30 |
| 864 | 11 22 04 78 | 30.000 | 20.520 | 184.998 | 31 |
| | | 32.000 | 21.160 | 320.000 | 32 |
| | | 34.000 | 21.530 | 185.005 | 33 |
| | | 36.000 | 22.020 | 244.995 | 34 |

SURFACE INTERCEPT FOR SEGMT 1 = 11.505

| SEG | ZSTART | TSTART | ZEND | TEND | COND | & | DCON | GRADIENT & | S.D. | HFL | & | DHF | T AT 100M | KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10.000 | 14.850 | 16.000 | 16.830 | 4.019 | | 0.000 | 331.059 | 25.323 | 13.306 | | 4.249 | 44.639 | 0.569 |
| SEG | ZSTART | TSTART | ZEND | TEND | COND | & | DCON | GRADIENT & | S.D. | HFL | & | DHF | T AT 100M | KM |
| 2 | 16.000 | 16.830 | 26.000 | 19.660 | 4.675 | | 0.000 | 284.608 | 31.119 | 13.306 | | 4.249 | 40.721 | 0.660 |
| SEG | ZSTART | TSTART | ZEND | TEND | COND | & | DCON | GRADIENT & | S.D. | HFL | & | DHF | T AT 100M | KM |
| 3 | 26.000 | 19.660 | 36.000 | 22.020 | 5.500 | | 0.500 | 236.864 | 55.730 | 13.306 | | 4.249 | 37.179 | 0.787 |

PRECEEDING SEGMENT USED FOR EXTRAPOLATION

DATA FOR THIS WELL AND PROJECT # ALREADY ON DISK!!

Figure 2c.

Explanation of Logs

$\nabla$ 2 = Gradient of 2d segment based on a least squares analysis of interval gradients.

& = $\pm$ followed by standard deviation

k = Thermal conductivity x $10^3$.

HF = Heat flow in H.F.U. computed from gradient and conductivity assigned for starred segment. Heat flows for other segments are set equal and their conductivities deduced.

T at 100 m, as measured or extrapolated from gradient indicated by $\downarrow$

Z (200 C) = Depth to 200°C isotherm determined by extrapolating gradient marked $\downarrow$

S.I. = Surface intercept temperature ($\simeq$ mean annual) determined from uppermost segment.

22 04 78 = 22 April 1978, date logged

22 AP 78 = Date plotted

DAE/DP = Initials of logger/editor.

Figure 2d

A self potential survey of approximately nine, 20-kilometer lines totaling about 180 line kilometers designed to define and delineate fault and fracture zones and potential zones of heat and thermal fluid flow. Station density along the lines will vary between 100- and 200-meter intervals depending upon the regularity of the data.

A magnetotelluric survey of approximately 30 stations recorded at 10 to .01 Hz. The stations will consist of 10 five component bases and 20 telemetered satellite stations consisting of two orthogonal pairs of electrodes. Analysis of data will yield inversions continuous in depth by the methods of F. X. Bustick, and are designed to provide resistivity depth profiles revealing thermal fluids, alteration products, and possibly magma at depth.

A gravity survey of approximately 220 stations designed to provide structural understanding of the area. Station locations will be situated so as to provide several modelling profiles across the proposal area as well as adequate grid coverage. Data processing will yield a complete Bouguer gravity map and profile models whenever possible.

A microearthquake survey of approximately 50 stations designed to map seismic activity, zones of active faulting, and possible areas of magmatism. Besides the recording and locating of microearthquakes, Poisson's ratios, P- and S-wave attenuations, and travel time anomalies will be determined.

An aeromagnetic survey of approximately 720 line-kilometers flown at a constant barometric altitude providing a minimum 305 meter (1000 foot) terrain clearance. Flight lines will be flown East-West at 1.6 kilometer spacing and will be tied by two North-South lines. The survey will provide deep magnetic and structural data of the proposed area.

Three deep (600 meter maximum) thermal gradient and lithology logs positioned to verify the shallow thermal anomaly and identify potential reservoir rocks and drilling conditions at depth.

A reflection seismic survey of approximately 32 line-kilometers designed to provide detailed structural data in the area and to provide possible information as to reservoir conditions and location.

Two deep (2300 $\pm$ meter) production test wells designed to discover and flow-test the potential geothermal reservoir. If warranted by drilling conditions, innovative drilling techniques will be attempted. All applicable logs and measurements will be made upon successful completion of the well.

Reservoir engineering studies will be made if warranted, and as soon as the necessary wells are available.

4. Schedule

A tentative exploration schedule is shown on Figure 3. Exact timing will depend upon permitting and equipment availability.

The exploration program is divided into three Phases (I, II, and III). Funding for Phase I is scheduled for FY 1978, Phase II, for FY 1979 and Phase III for FY 1980. Completion of the various phases will be contingent upon successful completion of the previous phases and surveys. The completion and performance of individual surveys and drill programs will be contingent upon previous experience and results. AMAX reserves the right to reschedule, substitute, or modify, with DOE concurrence, any of the phases or surveys outlined above to take advantage of new or improved technology, and any exigencies of the exploration or regulatory atmosphere.

Data will be made available according to the following schedule:

Existing Data-

Simultaneously with Phase I New Data

New Data

Phase I - Six months after completion of individual surveys or final logging of gradient wells.

Phase II - Three months after completion of individual surveys or final logging of gradient wells.

Phase III - Three months after completion of individual surveys and the logging of the well.

5. Environmental Evaluation

The 35,800 acre McCoy site controlled by AMAX is located on the southwest edge of Antelope Valley on the Lander and Churchill County line. Physiographically, the site is typical of the basin and range region of central Nevada. Elevations range from 4439 feet msl in the northwest portion near Hole-in-the-Wall Well No. 2 to 7007 feet msl just east of McCoy Peak in the southwest part of the area. The site is dissected into basins and washes interspersed with eroded slopes and hills. The site is distinguished by two small, but broad, valleys - one at the north end just west of the Augusta Mountains, and the other to the south just west of the north ridge of the New Pass Range.

Climate also is typical of midlevel elevations in the Great Basin. Mean monthly temperatures at Austin, Nevada, (≃ 33 air miles southeast) range from -2°C in January to 22°C in July - the warmest month. The site is arid with mean annual precipitation of 30.5 cm and can be classified as a "cold desert." Occasional snow can be expected during December through February particularly at the higher elevations.

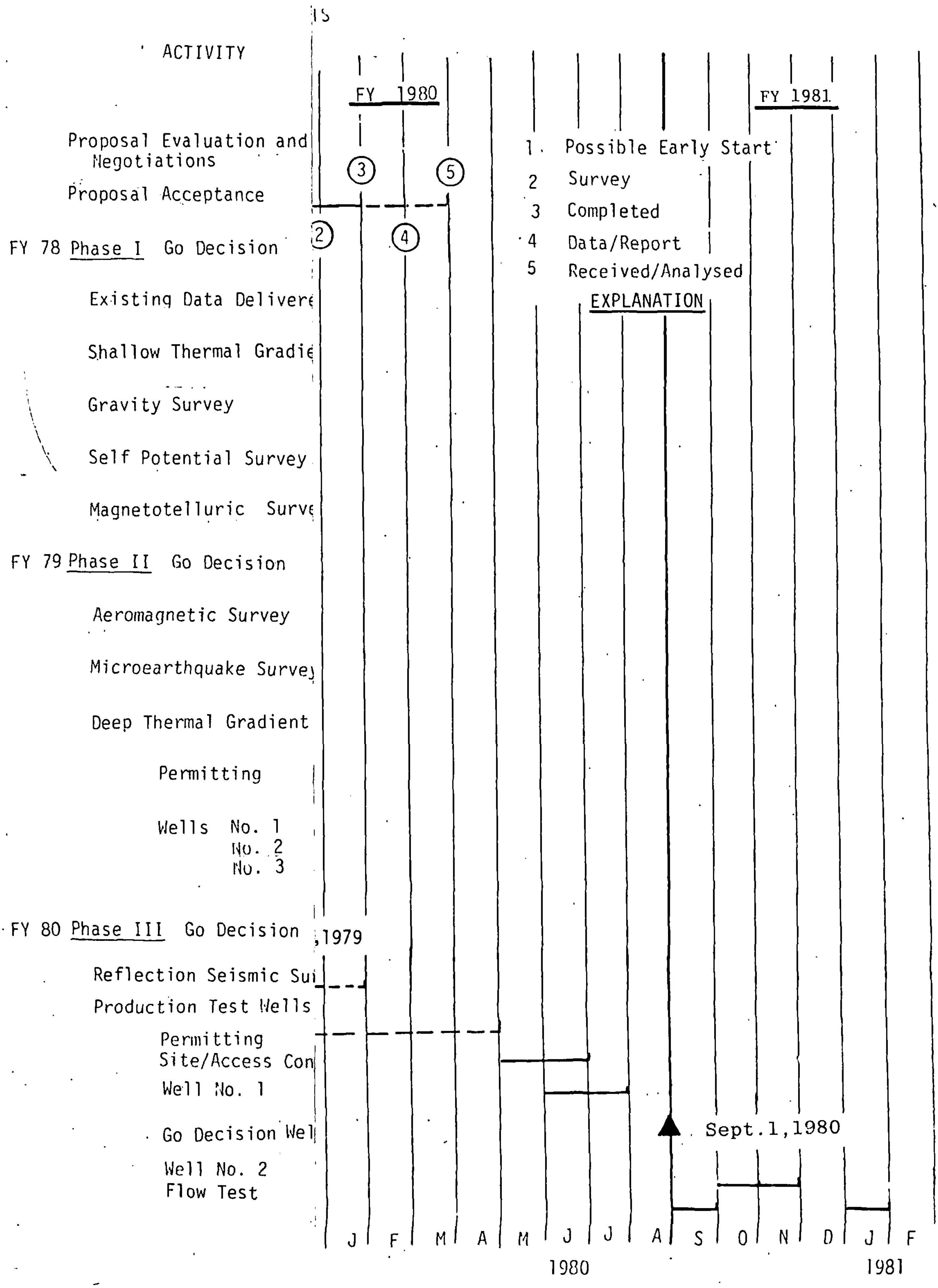
ACTIVITY
FY 1980
FY 1981
Proposal Evaluation and Negotiations
Proposal Acceptance
FY 78 Phase I Go Decision
Existing Data Delivere
Shallow Thermal Gradie
Gravity Survey
Self Potential Survey
Magnetotelluric Surve
FY 79 Phase II Go Decision
Aeromagnetic Survey
Microearthquake Survey
Deep Thermal Gradient
Permitting
Wells No. 1
No. 2
No. 3
FY 80 Phase III Go Decision
,1979
Reflection Seismic Su
Production Test Wells
Permitting
Site/Access Con
Well No. 1
Go Decision Wel
Sept.1,1980
Well No. 2
Flow Test
1 Possible Early Start
2 Survey
3 Completed
4 Data/Report
5 Received/Analysed
EXPLANATION
J F M A M J J A S O N D J F
1980
1981

FIGURE 3

Based upon soils, climate and elevation, the site grades from salt desert shrubs at the extreme lower elevations through sagebrush - cold desert grasslands at mid-elevations into the pinon-juniper-shrub lands at the upper elevations. Although open and desert-like in appearance, the varied elevation and topography supports a diverse flora and fauna. Key vegetation species include pinon pine and juniper at higher elevations, big sagebrush, rabbitbrush, cheatgrass and bluebunch wheatgrass at mid-elevations, and shadscale, greaswood, bud sage and alkali sacaton at extreme lower elevations. Wildlife species are typical of the Great Basin habitats found on the site. Mule deer, coyote, blacktail jackrabbits, numerous species of rodents such as the Townsend's ground squirrel, golden eagles, sage thrashers, Brewer's sparrows, sage sparrows, and a diversified herptofauna, (particulatly saurians) typify the site.

Present land use on the site consists of wildlife habitat and limited domestic stock grazing. The proposed drilling will neither alter nor conflict with these land-use patterns.

Environmental monitoring and control of the proposed action will be explicit, and will adhere to the stipulations and requirements presented in The Geothermal Resources Operation Orders (particularly GRO Order 4) issued under the Geothermal Steam Act of 1970. In addition, the environmental requirements of any other regulating state and/or federal agency shall be followed closely.

## C. Cost

A copy of GSA Optional Form 60 is attached in Appendix II.

Estimated costs are outlined below. Estimated cost to the DOE is based on 50% of actual cost of new data billed to AMAX by contractors and consultants including salaries, fringe, and expenses of temporary personnel hired by AMAX to conduct or assist in the surveys. Overhead, salaries, fringe, and expenses of AMAX permanent personnel are not included.

| Item | Estimated Cost ($000) | Estimated Cost to DOE ($000) |
|---|---|---|
| Phase I | | |
| Existing Data | | |
| Shallow Thermal Gradient and Lithologic Logs | | 10 |
| New Data | | |
| Shallow Thermal Gradient and Lithologic Logs | 30 | 15 |
| Self Potential Survey | 16 | 8 |
| Magnetotelluric Survey | 16 | 8 |
| Gravity Survey | 6 | 3 |
| Subtotal Phase I (FY78) | 68 | 44 |
| Phase II | | |
| Microearthquake Survey | 36 | 18 |
| Aeromagnetic Survey | 10 | 5 |
| Deep thermal Gradient and Lithologic Logs | 120 | 60 |
| Subtotal Phase II (FY79) | 166 | 83 |
| Phase III | | |
| Reflection Seismic Survey | 70 | 35 |
| Well site preparation | 40 | 20 |
| Production Test Wells | 1500 | 750 |
| Logs | 40 | 20 |
| Flow Test | 150 | 75 |
| Subtotal Phase III (FY80) | 1800 | 900 |
| PROPOSAL TOTAL | 2034 | 1027 |

D. Business and Management

1. Corporate Character and Geothermal Experience

THE CORPORATION

AMAX is a broadly diversified natural resource company. In 1977 the company had sales of $1168 million and net earnings of $69 million.

AMAX explores for, produces, and markets, on a world-wide basis, molybdenum, copper, lead, zinc, iron, nickel, tungsten, aluminum, coal, potash, petroleum, and uranium. AMAX' commodity product line also includes speciality metals and numerous byproducts of the above commodities and metals.

Growth and diversification at AMAX have been accompanied by a concern for environmental matters. AMAX management believes there is no fundamental incompatibility between man's economic progress and the quality of the life he lives. Natural resources exploration and development can exist in complete harmony with conservation and recreation, and AMAX is committed to conducting its activities in a manner which best accommodates both economic and environmental aspirations.

The company frequently has been cited for the success of its environmental programs. In 1969 Business Week magazine presented AMAX with "The first annual Business Citizenship Award for the preservation of our natural environment". In 1970 the Environment Monthly called AMAX "the ecological champion of big mining companies" and recognized the company for its environmental responsibility. The Sports Foundation, Inc., gave AMAX its National Gold Medal Award in 1969 for environmental control programs, and the State of Colorado cited the company for "its outstanding contributions in the prevention of pollution to the waters of the State of Colorado". In 1974 AMAX was chosen as the sole U. S. representative from private industry to participate in an International Symposium on the Environment at Expo 74 in Spokane, Washington. AMAX presented a case study on its "Experiment in Ecology", involving the Henderson Molybdenum Mine in Colorado.

Corporate environmental programs are carried out by operations personnel and by AMAX' Environmental Services Group, whose employees include ecologists, environmental control engineers and other specialists in air and water pollution and solid waste disposal. Leading private consultants also are used by the company when needed on particular projects. This group reports directly to the executive offices of AMAX.

The AMAX Environmental Planning and Protection Committee disseminates environmental information and ideas throughout the company. It is composed of representatives of each group and division of the corporation.

Diversity, growth, and environmental responsibility highlight AMAX' response to forecasted needs for more mineral resources and the need for preservation of our environment. The company is acutely aware of projected energy shortages as well. Our commitment to geothermal resources exploration and development is a response to that need.

AMAX' GEOTHERMAL QUALIFICATIONS

AMAX first began investigating the potential of geothermal energy in the mid-1960's. Those investigations were concentrated on the Imperial Valley of Southern California. Adverse economics and a lack of the requisite technology caused a discontinuance of AMAX' activities at that time.

At the beginning of 1973, AMAX initiated new studies to provide the company with an overview of the emerging geothermal industry. Those studies indicated that opportunities attractive to AMAX were potentially available.

As a result of these studies, AMAX decided to commit some of its resources to the discovery and development of geothermal power sources, and by 1975 had assembled a highly skilled technical exploration team.

To date AMAX has conducted regional geothermal exploration programs in the western and eastern United States, and has evaluated 35 major and numerous smaller geothermal prospects. Of these, 15 have been dropped, and the remainder are in various stages of evaluation.

Since 1973 AMAX has drilled over 300 shallow thermal gradient wells, three deep thermal gradient wells, one production test well, and has been involved in the drilling of seven other production test wells. AMAX has conducted or supervised various aeromagnetic, gravity, resistivity, geochemistry, microearthquake, groundnoise, self potential and helium soil gas surveys. In addition AMAX has conducted pioneering research in surface and shallow - subsurface direct heat flow measurement, and telluric-magnetotelluric instrumentation.

AMAX' geothermal staff is well rounded in the various aspects of geothermal exploration and have all been involved in the planning, execution, and analysis of the programs and projects to which they have been assigned.

# AMAX GEOTHERMAL STAFF

## Technical

William M. Dolan - Manager, Geothermal Exploration
M.S., Geophysics, Graduate Stanford Executive Program: Twenty-one years' world-wide experience in geophysical, mineral, and geothermal exploration. Past President Geothermal Resources Council.

Harry J. Olson - Managing Geologist, Geothermal Exploration
Ph.D., Geology: Eighteen years' experience in mineral and geothermal exploration, and mining geology. Board of Directors, Geothermal Resources Council, Vice President, Rocky Mountain Section Geothermal Resources Council.

H. Dean Pilkington - District Geologist
Ph.D., Geology: Eighteen years' world-wide experience in mineral and geothermal exploration, and university teaching and research.

Arthur L. Lange - Geophysicist
B.S., Physics: Twenty-two years' experience in geophysical exploration and research. Performed pioneering research in correlation of microearthquake activity with geothermal phenomena and in application of computer graphics to magnetic and gravity interpretation.

William P. Long - Business Manager, Geothermal
Ph.D., Mineral Economics, B.S., Chemical Engineering: Two years' experience in geothermal development, production economics, and financing.

Frank Dellechaie - Geochemist
M.S., Geology with major work in geochemistry: Five years' experience in geothermal geochemical exploration.

John E. Deymonaz - Geologist
B.S., Geology: Three years' experience in geothermal exploration.

Larry R. Hall - Land Manager
Seven years' experience as oil engineer, oil well logger, and land surveyor. Two years' experience as land specialist.

## Support

Andrea S. Aragon - Land Draftsman
Cheryl L. Caywood - Secretary/Files
D. Darline Dalman - Secretary
Virginia L. Handley - Draftsman
Jane S. Muller - Draftsman
Mark W. Sherbring - Accountant

AMAX Internal Consultation

Gerald J. Kitchen - Attorney
E. Dale Trower - Attorney
A. Percy Wicklund - Superintendent of Drilling
Jeffrey W. Todd - Staff Ecologist
William O. Lockman - Environmental Analyst
James A. Sturgess - Aquatic Biologist
Jack K. Letts - Land Manager
Mark H. Alldredge - Assistant Land Manager

Consultants

Terraphysics
815 South 10th Street, 11A
Richmond, CA 94804

Aldo T. Mazzella: Resistivity, tellurics, magnetotellurics, self potential EM soundings

GeothermEx
1760 Solano, Room 209
Berkeley, California 94707

James B. Koenig; Geothermal Geology

Elliot Zais - Reservoir Engineering
7915 N.W. Siskin Drive
Corvallis, Oregon 97330
(503) 757-9795

3. AMAX Management Plan

AMAX technical personnel will supervise and where applicable conduct the various surveys. Trained temporary personnel will be hired as field assistants and will assist in supervising the drilling and logging operations. AMAX personnel will conduct the gravity survey, and will log the thermal gradient wells with AMAX equipment. Consultants or independent contractors will be retained to advise and to provide all other technical surveys. Independent contractors also will be retained to perform road, site, and test construction; drilling programs, and the various production test logging surveys. Technical service groups will be used in computor data reduction and plotting.

AMAX personnel will be responsible for all data analysis and for exploration planning, scheduling, and budgeting. General responsibilities are as follows:

W. M. Dolan - overall performance of the proposed exploration program

H. J. Olson - operations planning, scheduling, and budgets

H. D. Pilkington - field operations and data analysis

A. L. Lange - geophysical surveys and data analysis

F. Dellechaie - project supervision

J. E. Deymonaz - project supervision

A. P. Wicklund - drilling techniques and performance.

4. AMAX technical personnel available for discussions relating to this proposal are:

Harry J. Olson, Managing Geologist, Geothermal Exploration

William M. Dolan, Manager, Geothermal Exploration

Arthur L. Lange, Geophysicist

H. Dean Pilkington, District Geologist

A. Percy Wicklund, Drilling Superintendent

AMAX Exploration, Inc.
4704 Harlan Street
Denver, Colorado 80212
(303) 433-6151

5. AMAX is willing to negotiate any provisions in the draft contract as illustrated in Enclosure 8 "Request for Proposal No. ET-78-R-08-0003 Geothermal Reservoir Assessment Cost Study, Northern Basin and Range Province".

6. The Program Technical Scope" as set forth in RFP No. ET-78-R-08-0003 has been reviewed and all data which will be furnished pursuant to a contract may be published.

7. A copy of the AMAX 1977 Annual Report is enclosed.

8. This proposal will remain in effect for at least 120 days from May 30, 1978.

9. This proposal is signed by a vice president of AMAX Exploration, Inc. The by-laws of that corporation authorize the president and any vice president to bind the corporation through execution of contracts.

10. One complete copy of GSA Form 19B "Representations and Certifications" is attached.

AMAX EXPLORATION, INC.

Gerald Kitchen
Vice President

# APPENDIX I

APPENDIX I

Lease applications controlled by AMAX Exploration, Inc.

MDM, Nevada

Township 24 North, Range 39 East,
Section 36 All

Township 24 North, Range 40 East,
Section 31 all
32 all
33 all
34 all

Township 23 North, Range 39 East,
Section 1 Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
12 - all
13 - all
23 - all
24 - all
25 - all
26 - all
35 - all
36 - all

Township 24 North, Range 40 East,
Section 3 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
4 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
5 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
6 - Lots 1, 2, 3, 4, 5, 6, 7, $E\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $SE\frac{1}{4}$, $S\frac{1}{2}NE\frac{1}{4}$ (all)
7 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
8 - All
9 - All
10 - All
15 - All
16 - All
17 - All
18 - Lost 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
19 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
20 - All
21 - All
22 - All
27 - All
28 - All
29 - All
30 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
31 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
32 - All
33 - All
34 - All

Appendix I (Cont.)

Township 22 North, Range 39 East
Section 1 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
2 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
11 - All
12 - All
13 - All
14 - All
23 - All
24 - All

Township 22 North, Range 40 East
Section 4 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
5 - Lots 1, 2, 3, 4, $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$ (all)
6 - Lots 1, 2, 3, 4, 5, 6, 7, $E\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $S\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}$ (all)
7 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
8 - All
17 - All
18 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
19 - Lots 1, 2, 3, 4, $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$ (all)
20 - All

# APPENDIX II

| CONTRACT PRICING PROPOSAL (RESEARCH AND DEVELOPMENT) | Office of Management and Budget Approval No. 29-RO184 |
|---|---|
| This form is for use when (i) submission of cost or pricing data (see FPR 1-3.807-3) is required and (ii) substitution for the Optional Form 59 is authorized by the contracting officer. | PAGE NO. / NO. OF PAGES |

| | |
|---|---|
| NAME OF OFFEROR: AMAX Exploration, Inc. | SUPPLIES AND/OR SERVICES TO BE FURNISHED: Geothermal Exploration<br>Logging<br>Well Testing |
| HOME OFFICE ADDRESS: 4704 Harlan Street<br>Denver, Colorado 80212 | |
| DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Geothermal Group - Nevada | TOTAL AMOUNT OF PROPOSAL: $ 1,027.00 / GOV'T SOLICITATION NO.: ET-78-R-08-0003 |

**DETAIL DESCRIPTION OF COST ELEMENTS** ($000) ($000)

| | ESTIMATED HOURS | RATE/HOUR | EST COST ($) | TOTAL EST COST[1] | REFERENCE[2] |
|---|---|---|---|---|---|
| 1. DIRECT MATERIAL (Itemize on Exhibit A) | | | | | |
| a. PURCHASED PARTS | | | | | |
| b. SUBCONTRACTED ITEMS | | | | | |
| c. OTHER—(1) RAW MATERIAL | | | | | |
| (2) YOUR STANDARD COMMERCIAL ITEMS | | | | | |
| (3) INTERDIVISIONAL TRANSFERS (At other than cost) | | | | | |
| TOTAL DIRECT MATERIAL | | | | | |
| 2. MATERIAL OVERHEAD[3] (Rate %X$ base=) | | | | | |
| 3. DIRECT LABOR (Specify) | ESTIMATED HOURS | RATE/HOUR | EST COST ($) | | |
| TOTAL DIRECT LABOR | | | | | |
| 4. LABOR OVERHEAD (Specify Department or Cost Center)[3] | O.H. RATE | X BASE = | EST COST ($) | | |
| TOTAL LABOR OVERHEAD | | | | | |
| 5. SPECIAL TESTING (Including field work at Government installations) | | | EST COST ($) | | |
| see Exhibit A | | | 1,027 | | |
| TOTAL SPECIAL TESTING | | | | 1,027 | |
| 6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A) | | | | | |
| 7. TRAVEL (If direct charge) (Give details on attached Schedule) | | | EST COST ($) | | |
| a. TRANSPORTATION | | | | | |
| b. PER DIEM OR SUBSISTENCE | | | | | |
| TOTAL TRAVEL | | | | | |
| 8. CONSULTANTS (Identify—purpose—rate) | | | EST COST ($) | | |
| TOTAL CONSULTANTS | | | | | |
| 9. OTHER DIRECT COSTS (Itemize on Exhibit A) | | | | | |
| 10. TOTAL DIRECT COST AND OVERHEAD | | | | | |
| 11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate % of cost element Nos. )[3] | | | | | |
| 12. ROYALTIES[4] | | | | | |
| 13. TOTAL ESTIMATED COST | | | | 1,027 | |
| 14. FEE OR PROFIT | | | | | |
| 15. TOTAL ESTIMATED COST AND FEE OR PROFIT | | | | 1,027 | |



OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
3060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

RFP No. ET-78-R-08-0003 Geothermal Reservoir Assessment Case Study, Northern Basin and Range Province

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE: Harry J. Olson, Managing Geologist, Geothermal Exploration

SIGNATURE: Harry J. Olson

NAME OF FIRM: AMAX Exploration, Inc.

DATE OF SUBMISSION: May 30, 1978

**EXHIBIT A—SUPPORTING SCHEDULE** *(Specify. If more space is needed, use reverse)*

| COST EL NO. | ITEM DESCRIPTION *(See footnote 5)* | EST COST ($) |
|---|---|---|
| | FY 1978 | |
| | Phase I - Existing Data | |
| | Shallow Thermal Gradient and Lith Logs | 10 |
| | New Data | |
| | Shallow Thermal Gradient and Lith Logs | 15 |
| | Self Potential Survey | 8 |
| | Magnetotelluric Survey | 8 |
| | Gravity Survey | 3 |
| | | |
| | FY 1979 | |
| | Phase II | |
| | Microearthquake Survey | 18 |
| | Aeromagnetic Survey | 5 |
| | Deep Thermal Gradient and Lith Logs | 60 |
| | | |
| | FY 1980 | |
| | Phase III | |
| | Reflection Seismic Survey | 35 |
| | Well Site Preparation | 20 |
| | Production Test Wells | 750 |
| | Logs | 20 |
| | Flow Test | 50 |
| | | |
| | TOTAL | 1027 |

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☒ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL | TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☒ YES ☐ NO *(If yes, identify.)* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify.)*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☒ YES ☐ NO *(If no, explain on reverse or separate page)* (to the best of my knowledge)

*See Reverse for Instructions and Footnotes* OPTIONAL FORM 60 (10-71)

## INSTRUCTIONS TO OFFERORS

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated costs *(and attached supporting information)* suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in FPR 1-3.807-3 be required to submit a Certificate of Current Cost or Pricing Data (See FPR 1-3.807-3(h) and 1-3.807-4).

2. In addition to the specific information required by this form, the offeror is expected, in good faith, to incorporate in and submit with this form any additional data, supporting schedules, or substantiation which are reasonably required for the conduct of an appropriate review and analysis in the light of the specific facts of this procurement. For effective negotiations, it is essential that there be a clear understanding of:

a. The existing, verifiable data.
b. The judgmental factors applied in projecting from known data to the estimate, and
c. The contingencies used by the offeror in his proposed price.

In short, the offeror's estimating process itself needs to be disclosed.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be described *(with schedules as appropriate)*, and made available to the contracting officer or his representative upon request.

4. The formats for the "Cost Elements" and the "Proposed Contract Estimate" are not intended as rigid requirements. These may be presented in different format with the prior approval of the Contracting Officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal the offeror grants to the Contracting Officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

## FOOTNOTES

*1 Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. When any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferror or current market price.*

*2 When space in addition to that available in Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which the information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the Contracting Officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or invoice prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major re-arrangement, etc.), or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.*

*3 Indicate the rates used and provide an appropriate explanation. Where agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.*

*4 If the total cost entered here is in excess of $250, provide on a separate page the following information on each separate item of royalty or license fee: name and address of licensor; date of license agreement, patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.*

*5 Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.*

CONTINUATION OF EXHIBIT A—SUPPORTING SCHEDULE AND REPLIES TO QUESTIONS II AND V.

REQUEST FOR PROPOSAL

ET-78-R-08-0003

"Geothermal Reservoir Assessment

Case Study, Northern Basin

and Range Province"

BY

UNION OIL COMPANY OF CALIFORNIA
Geothermal Division

May 30, 1978

# INTRODUCTION

The Union Oil Company of California's Geothermal Division submits a geothermal reservoir assessment case study in accordance with Request for Proposal (RFP) No. ET-78-R-08-0003, for work accomplished and to be accomplished on their leases in the Stillwater, Known Geothermal Resource Area.

Data contained in this proposal shall not be used or disclosed, except for evaluation purposes, provided that if a contract is awarded to this purpose as a result of or in connection with the submission of the proposal, the Government shall have the right to use or disclose any data to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose any technical data obtained from another source without restriction.

I N D E X

# PROPOSAL

A. PROPOSER'S NAME AND ADDRESS

Union Oil Company of California
Union Geothermal Division
Union Oil Center
461 South Boylston Street
Los Angeles, California 90017

Union Oil Company of California is a corporation organized and existing under the laws of the State of California, having its principal office and place of business in Los Angeles, California. Dr. Carel Otte, President of the Geothermal Division is authorized to commit the Company to the proposed contract.

**CONFIDENTIAL**
**DATA MAY NOT BE RELEASED WITHOUT PRIOR WRITTEN APPROVAL OF UNION OIL CO. OF CALIF.**

B. TECHNICAL PROPOSAL

1. Investigation Site or Area

a. Legal description - Section, Township, etc.
Proposer is sole and exclusive geothermal lessee in and to the following identified geothermal leases and agreements within the Stillwater-Soda Lake Known Geothermal Resource Area of Churchill County, Nevada, to-wit:

| PROPOSER'S LEASE NUMBER | LESSOR | LESSEE | LEASE DATE | RECORDED IN THE OFFICIAL RECORDS OF CHURCHILL COUNTY, NEVADA | | NET LEASED ACRES | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | | | | BOOK | PAGE | | |
| 000001 | Keith A. Busboom, etal | Union Oil Company of California | 10-04-73 | 65 | 356 | 80.00 | S½ NE¼, E½ SW¼, SE¼ Section 14, T19N-R30E, MDM. |
| 000002 | W. W. Whitaker, etux | Union Oil Company of California | 10-04-73 | 65 | 358 | 80.00 | S½ NE¼, E½ SW¼, SE¼ Section 14, T19N-R30E, MDM. |
| 000003 | Harold E. Fitz, etux | Union Oil Company of California | 10-08-73 | 65 | 360 | 350.00 | S½ Section 12, less and except a parcel of land therein being more fully described in said lease, N½ NE¼ Section 23, T19N-R30E, MDM. |
| 000004 | Clarence E. Taylor, etux | Union Oil Company of California | 10-11-73 | 65 | 363 | 20.00 | All that portion of the N½ SW¼ Section 23, T19N-R30E, MDM, lying south and east of the Stillwater Road. |
| 000005 | Ernest V. Banks, etux | Union Oil Company of California | 10-11-73 | 65 | 365 | 160.00 | E½ NW¼, W½ SW¼ Section 14, T19N-R30E, MDM, less and except a parcel of land therein being more fully described in said lease. |
| 000007 | Henry D. Osgood, etux | Union Oil Company of California | 10-16-73 | 65 | 465 | 80.00 | E½ SE¼ Section 11, T19N-R30E, MDM. |
| 000015 | William D. Washburn, et ux | Union Oil Company of California | 10-25-73 | 65 | 483 | 158.70 | All that certain parcel of land in Section 7, T19N-R31E, MDM, described in that certain deed from George D. Washburn and Lois E. Washburn recorded in Book 35 of Deeds at Pages 149 and 150 of Records of Churchill County, Nevada. |

| PROPOSER'S LEASE NUMBER | LESSOR | LESSEE | LEASE DATE | RECORDED IN THE OFFICIAL RECORDS OF CHURCHILL COUNTY, NEVADA BOOK | PAGE | NET LEASED ACRES | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 000016 | Henry E. Wise, etux | Union Oil Company of California | 10-25-73 | 65 | 485 | 48.20 | A certain parcel of land in Section 7, T19N-R31E, MDM, being more fully described in said lease. |
| 000020 | Arthur T. Wisnefski, etal | Union Oil Company of California | 10-26-73 | 65 | 492 | 480.00 | E½ NE¼, S½ Section 2, less and except a parcel of land described in a deed from Charles J. Pomeroy and Alton K. Pomeroy to Truckee-Carson Irrigation District, recorded in Book 31 of Deeds at Page 302 of Records of Churchill County, Nevada; W½ SW¼ Section 11, T19N-R30E, MDM. |
| 000022 | Clifford F. Parsons, etal | Union Oil Company of California | 10-27-73 | 65 | 497 | 120.00 | W½ SE¼ Section 11, NW¼ NE¼ Section 14, T19N-R30E, MDM. |
| 000025 | Roland Hill, etal (Note: Original lessor; Richard A. Helffrich, etal) | Union Oil Company of California | 10-29-73 | 65<br>66 | 597<br>1 | 154.83 | S½ SW¼ Section 18, W½ NW¼ Section 19, T19N-R31E, MDM. |
| 000026 | Edward W. Viera, etux | Union Oil Company of California | 10-29-73 | 66 | 3 | 260.17 | N½ NW¼ Section 1, T19N-R30E, MDM; SW¼ Section 36, T20N-R30E, MDM; and the fractional W½SW¼ and SW¼ NW¼ Section 6, T19N-R31E, MDM, less and except a parcel of land described in that certain Conveyance of Mineral Rights dated July 25, 1968, from C. G. Reynolds, etal, to Charles W. Oliphant recorded in Book 43 of Deeds at Page 61 of Records of Churchill County, Nevada. |
| 000027 | Lyle N. deBraga, etux | Union Oil Company of California | 10-30-73 | 66 | 6 | 256.51 | 100% of the surface estate and an undivided 75% mineral interest in Lots 1 and 2, E½SE¼, S½ NE¼ Section 1, W½ NW¼ Section 24, T19N-R30E, MDM; and 100% interest in the N½ Lot 4, Section 6, T19N-R31E, MDM. |

| PROPOSER'S LEASE NUMBER | LESSOR | LESSEE | LEASE DATE | RECORDED IN THE OFFICIAL RECORDS OF CHURCHILL COUNTY, NEVADA BOOK | PAGE | NET LEASED ACRES | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 000032 | Ted deBraga, etux | Union Oil Company of California | 11-01-73 | 66 | 18 | 80.00 | S½ SE¼ Section 36, T20N-R30E, MDM. |
| 000034 | Thomas D. Jordan, Jr., etux | Union Oil Company of California | 11-04-73 | 66 | 22 | 80.00 | S½ NW¼ Section 1, T19N-R30E, MDM. |
| 000036 | Larry Edward Dodson | Union Oil Company of California | 11-07-73 | 66 | 26 | 320.00 | S½ Section 24, T19N-R30E, MDM. |
| 000037 | Arthur J. Smith, etux | Union Oil Company of California | 11-07-73 | 66 | 70 | 20.00 | S½ NE¼ NW¼ Section 18, T19N-R31E, MDM. |
| 000042 | Ralph Dymond, etux | Union Oil Company of California | 11-04-73 | 66 | 81 | 80.00 | E½ SW¼ Section 11, T19N-R30E, MDM. |
| 000049 | McCuskey Mineral Trust | Union Oil Company of California | 11-29-73 | 65 | 505 | 507.00 | Portions of Sections 13 and 24, T19N-R30E, MDM, and Sections 7 and 18, T19N-R31E, MDM, being more fully described in said lease. |
| 000053 | Lola Peer Nelson | Union Oil Company of California | 11-15-73 | 66 | 306 | 40.00 | SW¼ SW¼ Section 23, T19N-R30E, MDM. |
| 000056 | Harry E. McDonald, etux | Union Oil Company of California | 12-15-73 | 66 | 312 | 160.00 | NE¼ Section 35, T20N-R30E, MDM. |
| 000062 | Earl Judd, etal | Union Oil Company of California | 11-10-73 | 75 | 516 | 80.00 | 100% of the surface estate and 50% mineral interest in S½ NW¼, NE¼ NW¼ Section 23, T19N-R30E, MDM. |
| 000063 | Ira Hamlin Kent, etux | Union Oil Company of California | 1-31-74 | 77 | 418 | 654.50 | W½ NW¼, NW¼ SW¼ Section 4, portion Section 5, portion Section 7, portion Section 8, S½ NW¼, NW¼ NW¼ Section 17, portion Section 18, NW¼ NE¼, S½ NE¼ Section 19, T19N-R31E, MDM, being more fully described in said lease. |

| PROPOSER'S LEASE NUMBER | LESSOR | LESSEE | LEASE DATE | RECORDED IN THE OFFICIAL RECORDS OF CHURCHILL COUNTY, NEVADA BOOK | PAGE | NET LEASED ACRES | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 000064 | Ira Hamlin Kent, etal DBA Silver Range Ranch | Union Oil Company of California | 1-31-74 | 86<br>86<br>86<br>86<br>86<br>86 | 35<br>39<br>42<br>45<br>48<br>51 | 655.00 | Portion Section 7 and portion Section 8, T19N-R31E, MDM, being more fully described in said lease. |
| 000065 | Truckee-Carson Irrigation District | Union Oil Company of California | 2-07-74 | 68 | 276 | 726.54 | SE¼ NE¼, W½ SE¼ Section 2, Lot 3, SE¼ NW¼, SW¼ SW¼ Section 5, E½ NE¼, NE¼ SE¼ Section 7, NW¼ NW¼ Section 8, SE¼ Section 10, NE¼ NW¼, W½ NW¼, NW¼ SW¼ Section 11, T20N-R31E, MDM. |
| 000066 | Frank deBraga, etux | Union Oil Company of California | 2-10-74 | 68 | 279 | 40.00 | NE¼ NE¼ Section 14, T19N-R30E, MDM. |
| 000067 | Marvin A. Weishaupt, etux | Union Oil Company of California | 2-13-74 | 77 | 421 | 1,489.50 | Portion Section 5 being more fully described in said lease, E½, E½ SW¼, SE¼ NW¼ Section 6, T19N-R31E, MDM; SE¼ Section 31, S½ Section 32, NW¼ SW¼ Section 33, T20N-R31E, MDM. |
| 000068 | Thomas D. Kent, etal | Union Oil Company of California | 2-26-74 | 72 | 361 | 334.96 | 100% of the surface estate and an undivided 66-2/3% mineral interest in SW¼ Section 26, 100% interest in NE¼ Section 34, T20N-R30E, MDM; 100% of the surface estate and an undivided 50% mineral interest in Lots 1, 2, 3 and 4, Section 31, T20N-R31E, MDM. |
| 000069 | Donald Weishaupt, etux | Union Oil Company of California | 2-27-74 | 68 | 281 | 80.00 | E½ NE¼ Section 11, T19N-R30E, MDM. |
| 000070 | Stillwater Farms, Inc. | Union Oil Company of California | 4-20-74 | 72 | 363 | 5,720.00 | NE¼ SW¼ Section 5, all Section 15, all Section 16, E½ E½, SW¼ SE¼, S½ SW¼ Section 17, E½ NE¼, SE¼ SE¼ Section 19, all Section 20, all Section 21, W½ Section 22, NW¼ NW¼ Section 27, W½, NE¼, W½ SE¼ Section 28, all Section 29, E½, E½ W½ Section 30, NE¼, E½ NW¼ Section 31, N½ Section 32, W½ NW¼, NE¼ NW¼ Section 33, T20N-R31E, MDM. |

CONFIDENTIAL
DATA MAY NOT BE RELEASED
WITHOUT PRIOR WRITTEN APPROVAL
OF UNION OIL CO. OF CALIF.

| PROPOSER'S LEASE NUMBER | LESSOR | LESSEE | LEASE DATE | RECORDED IN THE OFFICIAL RECORDS OF CHURCHILL COUNTY, NEVADA BOOK | PAGE | NET LEASED ACRES | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 000072 | James T. McNeely, etux | Union Oil Company of California | 12-16-74 | 79 | 158 | 11.26 | Portion Section 7, T19N-R31E, MDM, being more fully described in said lease. |
| 000073 | James D. Wood, etux | Union Oil Company of California | 3-05-76 | 100 | 25 | 17.00 | S½ Lot 4, Section 6, T19N-R31E, MDM. |
| 000074 | United States of America (N-11738) | Union Oil Company of California | 10-01-75 | | | 842.94 | Lots 2, 3, 4, SW¼ NE¼, S½ NW¼ Section 2, T19N-R30E, MDM; NW¼, S½ Section 35, T20N-R30E, MDM; Lot 3, Section 6, T19N-R31E, MDM; E½ SW¼ Section 31, T20N-R31E, MDM. |
| 000075 | Richard D. Weishaupt | Union Oil Company of California | 3-02-76 | 98 | 54 | 240.00 | SW¼, W½ SE¼ Section 1, T19N-R30E, MDM. |
| 000076 | Melvin F. Borden, etux | Union Oil Company of California | 3-03-76 | 96 | 583 | 80.00 | SW¼ NE¼, NW¼ SE¼ Section 13, T19N-R30E, MDM. |
| 000077 | Lola M. Peer Nelson | Union Oil Company of California | 1-12-78 | 128 | 184 | 66.00 | Undivided 50% mineral interest in Lots 1, 2 and 3, Section 7, T19N-R31E, MDM, less and except a certain parcel of land being more fully described in said lease. |
| 000078 | A. F. Martin, etal | Union Oil Company of California | 4-02-76 | 111 | 105 | 80.00 | Undivided 25% mineral interest in Lots 1 and 2, E½ SE¼, S½ NE¼ Section 1, W½ NW¼ Section 24, T19N-R30E, MDM. |
| 000079 | Katheryn Sorter, etal | Union Oil Company of California | 7-12-76 | 104 | 346 | 120.00 | E½ SW¼, SW¼ SE¼ Section 13, T19N-R30E, MDM. |
| 000081 | D. Stanley Terrell, etux | Union Oil Company of California | 2-21-78 | 128 | 188 | 20.00 | All of that portion of said lease described as follows: Undivided 50% mineral interest in SW¼ SE¼ Section 23, T19N-R30E, MDM. |

| PROPOSER'S LEASE NUMBER | LESSOR | LESSEE | LEASE DATE | RECORDED IN THE OFFICIAL RECORDS OF CHURCHILL COUNTY, NEVADA BOOK | PAGE | NET LEASED ACRES | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 000082 | Robert C. Plunkett, etux | Union Oil Company of California | 3-08-78 | 128 | 186 | 220.00 | Undivided 50% mineral interest in S½ NE¼, E½ SW¼, SE¼ Section 14, S½ NW¼, NE¼ NW¼ Section 23, T19N-R30E, MDM. |
| 000083 | Earl Lee Anderson, etux | Union Oil Company of California | 3-23-78 | | | 20.00 | All of that portion of said lease described as follows: Undivided 50% mineral interest in SW¼ SE¼ Section 23, T19N-R30E, MDM. |
| 000084 | Charles W. Oliphant, etal | Union Oil Company of California | 2-01-78 | | | 87.50 | Lots 5, 6 and 7, Section 6, T19N-R31E, MDM, less and except therefrom a certain parcel of land in said Lot 5, being more fully described in said lease. |

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B. TECHNICAL PROPOSAL (Cont'd.)

1. Investigation Site or Area (Cont'd.)

b. Status of ownership/assessibility

As shown in the above paragraph a., the defined lands are subject to active geothermal leases and agreements between the U.S.A. and/or the property owners of record and Union Oil Company of California. Pursuant to the terms and conditions of the said instruments, proposer is granted the sole and exclusive right to explore for, drill for, test, develop, operate, produce, extract, and remove hot water, steam and thermal energy from the said leased lands together with such rights-of-way and easements across said lands as are necessary to carry out all geothermal exploration and development activities for same.

B. TECHNICAL PROPOSAL (Cont'd.)

1. Investigation Site or Area (Cont'd.)

c. Geologic Description

The Stillwater geothermal area is located near the southern edge of the Carson Sink (Plate I), a structural basin typical of the Basin and Range Province of northern Nevada. Both the basin and the bordering ranges, the Stillwater Range on the east and the Hot Spring Mountains/West Humboldt Range on the west, trend north-northeasterly.

The nearest outcrops are in the Stillwater Range about three miles to the east of the geothermal anomaly, and consist primarily of Quaternary basalts, Tertiary acidic volcanics and sediments and Mesozoic crystalline and sedimentary rocks. Gravity measurements in the basin (Plate I) suggest the presence of a very thick section of younger sediments and volcanics. Wells in the Carson Lake and Stillwater areas corroborate this. Permeable reservoir zones are known to be present beneath a thick caprock of Holocene Lake Lahontan clays. Quaternary volcanism within the basin is evidenced by the basaltic tuff of Upsal hogback, the explosion craters of Soda Lakes, and the basaltic volcanic neck(?) of Rattlesnake Hill.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

1. <u>Investigation Site or Area</u> (Cont'd.)

c. Geologic Description (Cont'd.)

The geothermal anomaly appears to be related to one or more north-northeasterly trending faults. The magnetic map suggests a horst or structural nose is present at depth, bounded by north-northeasterly trending faults. The well-defined near-surface thermal anomaly is coincident with this feature.

Recent faulting in the Stillwater Range and recent seismic activity in this region shows it to be tectonically active, primarily due to continued east-west distention of the crust. The geologic and geothermal environments appear to be similar to those in the Imperial Valley in California.

Although no geothermal products or alternation zones are present on the surface, shallow wells have been producing hot water for years (reportedly as high as 235°F at 180 feet).

B. TECHNICAL PROPOSAL (Cont'd.)

1. Investigation Site or Area (Cont'd.)

d. Technical Reasons for Site Selection

The criteria for selecting the drilling site in the Stillwater geothermal area is based on the following data:

Heat Flow and Reservoir

Temperature data was obtained from sixteen temperature gradient holes drilled to a maximum depth of 300 feet, and from four deep temperature gradient wells (see Plate II) drilled to a maximum depth of 5,532 feet.

Geophysical Work

A reconnaissance dipole-dipole resistivity survey was carried out in 1974 by McPhar Geophysics, Inc. This is comprised of four lines covering about 20 miles. Twenty-three miles of telluric profiling have recently been completed by Union crews. Forty-eight gravity stations were observed by Union personnel over the geothermal anomaly, and the data reduced and a Bouguer gravity map constructed. Topographic map points that could be poor located on the ground were used for vertical and horizontal control. A number of gravity depth

B. TECHNICAL PROPOSAL (Cont'd.)

1. Investigation Site or Area (Cont'd.)

d. Technical Reasons for Site Selection (Cont'd.)

Geophysical Work (Cont'd.)

estimates were computed using a density contrast of 0.4 $gm/cm^3$.

Surface Geothermal Manifestations

No natural geothermal manifestations or alteration products exist in the Stillwater area. However, shallow subsurface thermal waters have been known to exist for some time and are being exploited for space heating and agriculture.

B. TECHNICAL PROPOSAL (Cont'd.)

2. Program Data Offered

a. Subsurface

Existing Data

1) Temperature data from 16 temperature gradient holes.

2) Complete drilling history including all subsurface data such as lithological, temperature, wireline and penetration logs from our four existing deep temperature gradient wells, Weishaupt No. 1 and No. 2, De Braga No. 1 and Wisnefski No. 1. Total depths of these wells are 3,450', 5,532', 2,672', and 3,637' respectively.

New Data

In all, two 8,000 feet wells are planned to be drilled under this program. The first well planned is De Braga No. 2 located in Section 6, T19N, R31E, MDM, Churchill County, State of Nevada. The follow-up well location will be contingent upon the results of De Braga No. 2.

The following new data, gathered from the two wells is offered and will be submitted within ninety days of completing said wells.

1) Drilling technology including but not limited to the drilling fluid design, cementing, bit selection and the casing policy.

B. TECHNICAL PROPOSAL (Cont'd.)

2. Program Data Offered (Cont'd.)

a. Subsurface (Cont'd.)

New Data (Cont'd.)

2) Drilling histories including all subsurface data such as lithological, mud and penetration logs.

3) Electric logs

4) Core analysis

5) Chemical analyses

6) Our interpretation in the form of an engineering report covering the drilling history of each well.

7) After the long-term flow test and if scaling and/or corrosion appear to have been indicated in the wellbore, a small repair rig would be moved in to evaluate the scaling and corrosive factors that had occurred. The cost of this work would be approximated at $125,000 and if work deemed necessary, it would be negotiated at that time.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

2. <u>Program Data Offered</u> (Cont'd.)

b. Surface

<u>Existing Data and Geological Data</u>

1) Dipole-dipole resistivity survey--four lines covering about 20 miles.

2) Telluric survey--four lines covering about 23 miles.

3) Gravity measurements--forty-eight stations observed, resulting in a Bouguer gravity map and a number of computed depth estimates of valley fill.

<u>New Data and Operational Data</u>

Considerable new information is expected to be gained on the handling of geothermal fluids at the surface. The following data gathered at the surface are offered:

1) <u>Pipeline Design</u>

Pipelines will be laid to carry fluid from the separators at the production wells to the injection well.

2) <u>Separator Design</u>

Separators will be designed on the basis of a) expected flow rate of the well, b) reservoir fluid enthalpy, c) the wellhead pressure, and d) the corrosive and scaling nature of the fluid.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

2. <u>Program Data Offered</u> (Cont'd.)

b. Surface (Cont'd.)

<u>New Data and Operational Data</u> (Cont'd.)

3) <u>Scaling Experiments</u>

Several experiments will be performed on the brine to evaluate the scaling and corrosion characteristics in the surface pipes and in the production/ injection wells.

4) <u>Metallurgical Studies</u>

Corrosive effects of the brine on various metals will be studied in an effort to improve the performance of separators and turbines.

5) <u>Design of Flow Tests</u>

The surface layout of various equipments such as separators, pipelines, tanks, valves, and pressure and temperature observation ports will be designed taking into consideration the natural topography and chemical nature of the fluid.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

2. <u>Program Data Offered</u> (Cont'd.)

c. Reservoir Engineering Studies

1) Designing and conducting flow test to find:

--well potential,

--fluid chemistry, and

--pressure and temperature surveys under flowing conditions.

2) Pressure Drawdown Analysis and Pressure Buildup Analysis.

3) Reservoir Interference Test, if possible, for Reservoir evaluation:

--interpretation of interference test,

--interpretation of variable flow rate well test,

--prediction of production temperature in the presence of injection wells.

4) Coring and Core Analysis.

5) Isotope Studies.

6) Recommend an optimum development plan using a numerical simulator.

B. TECHNICAL PROPOSAL

3. Program Description

a. Subsurface

(1) Existing Data

- Geological Data

Sixteen temperature gradient holes, between 250 and 300 feet deep, were drilled by Boyles Bros. Drilling Company, Reno, Nevada for Union Oil Company of California in 1974 and 1975 (see Plate II). Data was measured and interpreted by Union Oil Company of California and consists of temperature measurements made every 25 feet in the wells completed with 3/4" or 1" OD PVC pipe. The wells have been plugged and abandoned, as per G.R.O. No. 1.

- Deep Temperature Gradient Wells

Complete drilling histories of the four deep temperature gradient wells listed below:

DeBraga No. 1

Complete drilling history and records of Well DeBraga No. 1, located in the N.E. 1/4 of the N.E. 1/4 of Section 1, T19N, R30E, Churchill County, State of Nevada.

The well was spudded December 31, 1976, and drilled 17 1/2" hole with mud to 305', experiencing some lost circulation. Ran in and

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) Existing Data (Cont'd.)

DeBraga No. 1 (Cont'd.)

cemented 13 3/8", 54.5#, K-55 buttress casing at 304'. Drilled 12 1/4" hole with mud to 1015'. Ran in and cemented 9 5/8", 36#, K-55 buttress casing at 1013'. Drilled 8 3/4" hole with mud to 2672' T.D. with considerable lost circulation. Rigged and ran 2 7/8", 6.5#, K-EUE, 8rd tubing from surface to 2639'. Installed 10" 600x 3" 600 flange complete with 3" 600 WKM valve. Released rig January 10, 1977.

The well was drilled by Hunnicutt and Camp Drilling Company for the Union Oil Company of California.

Weishaupt No. 1

Complete drilling history and records of Well Weishaupt No. 1, located 3000' E and 600' S from the NW corner of Section 6, T19N, R31E, Churchill County, State of Nevada.

The well was spudded November 30, 1976, and 17 1/2" hole was drilled with mud to 313'. Ran in

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Weishaupt No. 1 (Cont'd.)

and cemented 13 3/8", 54.5#, K-55 buttress casing at 312'. Drilled 12 1/4" hole with mud to 1020' and ran Deviation Survey. Ran in and cemented 9 5/8", 36#, K-55 buttress casing at 1018'. Drilled 8 3/4" hole with mud to 3450' and ran electric logs. Rigged and ran 7", 26#, K-55, 8rd LT&C combination blank and slotted liner from 907' to 3430'. Closed master valve and released rig December 10, 1976.

The well was drilled by Hunnicutt and Camp Drilling Company for the Union Oil Company of California.

Weishaupt No. 2

Complete drilling history and records of Well Weishaupt No. 2, located 555' E and 610' S from the NW corner of Section 5, T19N, R31E, Churchill County, State of Nevada.

The well was spudded December 12, 1976, and 17 1/2" hole was drilled with mud to 326'. Ran in

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

3. <u>Program Description</u> (Cont'd.)

a. Subsurface (Cont'd.)

(1) <u>Existing Data</u> (Cont'd.)

<u>Weishaupt No. 2</u> (Cont'd.)

and cemented 13 3/8", 54.5#, K-55 buttress casing at 325'. Drilled 12 1/4" hole with mud to 1005'. Ran in and cemented 9 5/8", 36#, K-55 buttress casing at 1005'. Drilled 8 3/4" hole with mud to 5532' and ran electric logs. Rigged and ran 2 7/8", 6.4#, K-EUE, 8rd tubing to 5522'. Installed 10"-S600 X 3"-S600 flange and 3"-S600 WKM valve. Released rig December 29, 1976.

The well was drilled by Hunnicutt and Camp Drilling Company for the Union Oil Company of California.

<u>Wisnefski No. 1</u>

Complete drilling history and records of Well Wisnefski No. 1, located 178' S and 354' West of the NE corner of Section 2, T19N, R30E, Churchill County, State of Nevada.

The well was spudded January 24, 1978 and 17 1/2" hole was drilled with mud to 305'. Ran in and cemented 13 3/8", 61#, K-55 buttress casing at

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) Existing Data (Cont'd.)

Wisnefski No. 1 (Cont'd.)

293'. Drilled 12 1/4" hole with mud to 1039'. Ran in and cemented 9 5/8", 40#, K-55 buttress casing at 1029'. Drilled 8 3/4" hole with mud to 3637' and ran electric logs. Rigged and ran 2 7/8", 6.5#, J-55, EOE tubing to 3619'. Installed 10"-600 by 3"-600 flange with 3"-600 valve. Released rig February 3, 1978.

The well was drilled by Loffland Brothers Drilling Company for the Union Oil Company of California.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data

Two new wells will be drilled to total depths of approximately 8,000 feet. The first well planned is DeBraga No. 2, located in Section 6, T19N, R31E, Churchill County, State of Nevada. The follow-up well location will be contingent upon the results of Well DeBraga No. 2. The proposed modified slim hole drilling program for Well DeBraga No. 2 and the full size hole for the second well are as follows:

DeBraga No. 2

1. Set 20" conductor, as directed and cement with ready-mix cement.
2. Install 5' wide x 5' long x 4' deep cellar.
3. Move-in and rig-up rotary tools, including mud cooling tower. Drill and set rathole and mousehole.
   a. Note start of day rate and spud time (hours) on rig log and report form.
   b. Notify U.O.C. geologist 24 hours prior to commencement of drilling.
4. Drill 17-1/2" hole to 300'± using mud as a circulating medium. Survey as directed.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

4. a. Catch 10 foot samples.

b. Monitor and log flowline and suction temperatures at 30 minute intervals.

c. Mud temperatures to be controlled as required, by retention or by use of a cooling tower.

d. Bottom hole static temperatures anticipated to be 200°F at 300'.

e. Artesian water flows can be expected below 100'.

5. Run and cement 13-3/8", 54.5, K-55, buttress casing at 300'±. Cement with class "G" cement premixed with 40% Silica Flour, 0.5% CFR-2 and retarder, if required.

NOTE:

Slurry mix to be dictated by hole conditions. If zones are weak or lost circulation is evident, a mixture of 1.1 Perlite premixed with 40% Silica Flour should be considered.

a. Cement with sufficient volume to insure cement returns to the surface. Monitor cement for fall back, fill with cement as required.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

6. Cut off casing. Weld on 13-3/8", 3,000 S.O.W. casing head with two 3" flanged outlets. Test of weld not to exceed casing collapse rating. Install 12", 3,000 hydril. Install kill and choke manifold.

   a. Test B.O.E. and casing as directed. Test results to be logged on rig log and daily report form.

7. Drill 12-1/4" hole to 1,200'±, using mud as a circulating medium.

   a. Monitor and log flowline and suction temperatures as previously stated.

   b. If flowline temperatures exceed 160°F commence pumping mud through cooling tower.

   c. Run maximum reading thermometers with each deviation survey. Record temperature, time since last circulation in hours and time temperature tool at datum in minutes.

   d. Record all lost circulation zones and amount of fluid lost in each zone.

   e. Catch 10 foot samples.

8. Run and cement 9-5/8", 36#, K-55 buttress casing at 1,200'±. Cement with "G" cement premixed 1.1

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

Perlite, 40% Silica Flour, 2% Gel, 0.5% CFR-2, and retarded as required. Tail in with 50 cubic feet "G" cement premixed with 40% Silica Flour, 0.5 CFR-2 and retarder, if required. Precede cement with flush to prevent mud flocculation.

NOTE:

Do not precede Perlite mix with water.

a. Run flapper type float shoe on bottom of joint no. 1 and flapper insert float between joint nos. 1 and 2.

b. Centralize joints 1,2, and 3 and every fourth joint.

c. Cement with sufficient volume to insure cement returns to surface.

d. Do not over-displace top plug.

e. Monitor fall back in annulus. Do not allow water to enter annulus from top. Maintain cement at surface.

9. Land casing. Weld on 10", 3,000# x 9-5/8" S.O.W. casing head. Install and test B.O.E. as directed.

a. Test of casing head weld not to exceed the casing collapse rating.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

b. Ship 12", 3,000# x 13-3/8" S.O.W. casing head to machine shop to have dutchman removed.

10. Drill 8-3/4" hole to 8,000', using mud as a circulating medium. Survey hole as directed.

a. Monitor and log flowline and suction temperatures at 30 minute intervals.

b. Run maximum reading thermometers with each deviation survey. Record temperature, time since last circulation in minutes and/or hours, and time temperature at datum in minutes.

c. Record all lost circulation zones and amount of fluid lost in each zone.

d. Catch 10 foot samples.

11. Circulate to condition and cool hole for electric logs.

12. Run electric logs as directed.

13. Complete as directed:

a. Tubing Completion:

1. Condition hole for tubing.

2. Lay down drill pipe and tools.

3. Run and hang 2-7/8" tubing from surface to T.D. Tubing hanger to pass thru B.O.P.'s.

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B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

4. Remove B.O.P.'s. Install 10", 3,000# x 3" - 2,000# flange with 3" - 2,000# valve.
5. Displace mud with water - taking returns through 3" valve on 9-5/8" head.
6. Rig down and move-out rotary tools.

b. Liner Completion:

1. Condition hole for 7" liner.
2. Run and hang 7" blank and perforated liner from 1,000'± to 8,000'±.
3. Displace mud with water.
4. Lay down drill pipe and tools.
5. Set retrievable bridge plug in 9-5/8" casing.
6. Install 10" - 3,000# x 10" - 2,000" X-O spool and 10" - 2,000# valve.
7. Retrieve bridge plug.
8. Lay down remaining tools.
9. Remove B.O.P.'s and install wellhead.
10. Rig down and move out rotary tools.

c. Combination Liner Completion:

1. Condition hole for 7" liner.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

2. Run and hang 7" blank and perforated liner from 1,000'± to 8,000'± with HOWCO D.V. packer (*position of D.V. packer to be determined from logs) collar at 3,500' with multi-cement baskets below packer collar. (Drill pipe and liner setting tools must be capable to passing a 2-3/8" diameter plug).

3. Cement top section of 7" liner as directed. Hole conditions will dictate the type of cement slurry.

4. Pickup 5,200'±, 2-7/8" tubing, 4-3/4 drill collars and 6" bit. Stand back in derrick.

5. Test 7" x 9-5/8" liner lap with surface pressure plus fluid hydrostatic to equal a 0.8 lb/ft gradient at liner top. Squeeze cement if necessary.

6. Drill out cement and formation packer collar and clean out to bottom of 7" liner.

7. Displace mud with water.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

DeBraga No. 2 (Cont'd.)

8. Lay down drill pipe and tools.
9. Set retrievable bridge plug in 9-5/8" casing.
10. Install 10" - 3,000# x 10" - 2,000# X-O spool and 10" - 2,000# valve.
11. Reinstall B.O.P.'s.
12. Retrieve bridge plug.
13. Lay down remaining tools.
14. Remove B.O.P.'s and install wellhead.
15. Rig down and move out rotary tools.

Second Well

1. Set 30" conductor, as directed and cement with ready-mix cement.
2. Install 5' wide x 5' long x 4' deep cellar.
3. Move-in and rig-up rotary tools, including mud cooling tower. Drill and set rathole and mouse-hole.
   a. Note start of dayrate and spud time (hours) on rig log and report form.
   b. Notify U.O.C. Geologist 24 hours prior to commencement of drilling.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

3. <u>Program Description</u> (Cont'd.)

a. Subsurface (Cont'd.)

(1) <u>New Data</u> (Cont'd.)

<u>Second Well</u> (Cont'd.)

4. Drill 17-1/2" hole to 300'±, using mud as a circulating medium. Survey as directed. Open 17-1/2" hole to 26" hole.

   a. Catch 10 foot samples on all hole sizes to T.D.

   b. Monitor and log flowline and suction temperatures at 30 minute intervals.

   c. Mud temperatures to be controlled as required by retention or by use of a cooling tower.

   d. Bottom hole static temperatures anticipated to be 200°F at 300'.

   e. Artesian water flows can be expected below 100'.

5. Run and cement 20", 94#, K-55 buttress casing at 300'±. Cement with class "G" cement premixed with 40% Silica Flour, 0.5% CFR-2 and retarder or $CaCl_2$ if required.

   <u>NOTE</u>:

   Slurry mix to be dictated by hole conditions. If zones are weak or lost circution is evident, a mixture of 1.1 Perlite premixed with 40% Silica Flour should be considered.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

Second Well (Cont'd.)

a. Cement with sufficient volume to insure cement returns to the surface. Monitor cement for fall back, fill with cement as required.

6. Cut off casing. Weld on 20" - 2,000# S.O.W. casing head with two 3" flanged outlets. Test of Weld not to exceed casing collapse rating. Install 20" - 2000# Hydril and single Shaffer with CSO rams. Install Kill and choke manifold.

   a. Test B.O.E. and casing as directed to 500 psi. Test results to be logged on rig log and daily report form.

7. Drill 17-1/2" hole to 1200'±, using mud as a circulating medium.

   a. Monitor and log flowline and suction temperatures as previously stated.

   b. If flowline temperatures exceed 160 F commence pumping mud through cooling tower.

   c. Run maximum reading thermometers with each deviation survey. Record temperature, time since last circulation in hours and time temperature tool at datum in minutes.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

Second Well (Cont'd.)

d. Record all lost circulation zones and amount of fluid lost in each zone.

e. Catch 10 foot samples.

8. Run and cement 13-3/8", 61#, K-55, buttress casing at 1200'±. Cement with "G" cement premixed 1:1 Perlite, 40% Silica Flour, 2% Gel, 0.5% CFR-2 and retarded as required. Tail in with 50 cu, ft, "G" cement premixed with 40% Silica Flour, 0.5% CFR-2 and retarder, if required. Precede cement with flush to prevent mud flocculation.

NOTE:

Do not precede Perlite mix with water.

a. Run flapper type float shoe on bottom of joint #1 and flapper insert float between joints #1 and #2.

b. Centralize joints 1, 2, and 3 and every fourth joint.

c. Cement with sufficient volume to insure cement returns to surface.

d. Do not overdisplace top plug.

e. Monitor fall back in annulus. Do not allow water to enter annulus from top. Maintain cement at surface.

9. Land casing. Weld on 12" - 3000# x 13-3/8" S.O.W. casing head. Install and test B.O.E. as directed.

   a. Test of casing head weld not to exceed the casing collapse rating.

   b. Ship 20" - 2000# x 20" S.O.W. casing head to machine shop to have dutchman removed.

10. Drill 12-1/4" hole to 3000' using mud as a circulating medium. Survey hole as directed.

    a. Monitor and log flowline and suction temperatures at 30 minute intervals.

    b. Run maximum reading thermometers with each deviation survey. Record temperature, time since last circulation in minutes and/or hours, and time temperature at datum in minutes.

    c. Record all lost circulation zones and amount of fluid lost in each zone.

    d. Catch 10 foot samples.

11. Circulate to condition and cool hole for electric logs.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

Second Well (Cont'd.)

12. Run electric logs as directed, GNL and DIL.

13. Run and hang a 9-5/8", 40#, K-55, buttress liner on a Midway liner hanger from 1000'± to 3000'±. Cement with class "G" cement with 1:1 Perlite and 40% SSA 1 plus 3% Gel, 0.5% CFR-2 and retarder if required. Follow with a tail-in slurry of at least 200 $ft^3$ class "G" cement with 40% SSA 1 plus 0.5% CFR-2 and retarder if required. Precede cement with FR 20 mud flush.

14. Circulate excess cement off or liner top. Test liner lap equivalent to a .8 lb/ft formation gradient.

15. Drill an 8-3/4" hole from 3000'± to 8000'± using mud as a circulating medium. Survey hole as directed.

    a. Monitor and log flowline and suction temperatures at 30 minute intervals.

    b. Run maximum reading thermometers with each deviation survey. Record temperature, time since last circulation and time/temperature at datum in minutes.

B. TECHNICAL PROPOSAL (Cont'd.)

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3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

Second Well (Cont'd.)

c. Record all lost circulation zones and amount of fluid lost in each zone.

d. Catch 10 foot ditch samples.

16. Circulate and cool hole, condition mud for logs. Run logs as directed.

17. Complete as indicated:

a. Tubing Completion:

1. Condition hole for tubing.
2. Lay down drill pipe and tools.
3. Run and hang 2-7/8" tubing from surface to T.D. Tubing hanger to pass through B.O.P.'s.
4. Remove B.O.P.'s. Install 10" - 3000# x 3" - 2000# flange with 3" - 2000# valve.
5. Displace mud with water - taking returns through 3" valve on 9-5/8" head.
6. Rig down and move out rotary tools.

b. Liner Completion:

1. Condition hole for 7" liner.
2. Run and hang 7" blank and perforated liner from 1000'± to 8000'±.
3. Displace mud with water.
4. Lay down drill pipe and tools.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

Second Well (Cont'd.)

5. Set retrievable bridge plug in 9-5/8" casing.
6. Install 10" - 3000# x 10" - 2000# X-O spool and 10" - 2000# valve.
7. Retrieve bridge plug.
8. Lay down remaining tools.
9. Remove B.O.P.'s and install well head.
10. Rig down and move out rotary tools.

c. Combination Liner Completion:

1. Condition hole for 7" liner.
2. Run and hang 7" blank and perforated liner from 1000'± to 8000'± with HOWCO D.V. packer (*position of D.V. packer to be determined from logs) collar at 3500' with multi-cement baskets below packer collar. (Drill pipe and liner setting tools must be capable to passing a 2-3/8" diameter plug.)
3. Cement top section of 7" liner as directed. Hole conditions will dictate the type of cement slurry.
4. Pick up 5200'± 2-7/8" tubing, 4'3/4" drill collars and 6" bit. Stand back in derrick.

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B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(1) New Data (Cont'd.)

Second Well (Cont'd.)

5. Test 7" x 9-5/8" liner lap with surface pressure plus fluid hydrostatic to equal a 0.8 lb/ft gradient at liner top. Squeeze cement if necessary
6. Drill out cement and formation packer collar and clean out to bottom of 7" liner.
7. Displace mud with water.
8. Lay down drill pipe and tools.
9. Set retrievable bridge plug in 9-5/8" casing.
10. Install 10" - 3000# x 10" - 2000# X-O spool and 10" - 2000# valve.
11. Reinstall B.O.P.'s.
12. Retrieve bridge plug.
13. Lay down remaining tools.
14. Remove B.O.P.'s and install well head.
15. Rig down and move out rotary tools.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures

The relevant data for the drilling these two wells as requested are as follows:

a. Total Depth

Approximately 8,000 feet.

b. Hole Sizes and Depths

| DeBraga No. 2 | | Second Well | |
|---|---|---|---|
| Hole Size Inches | Depth Feet | Hole Size Inches | Depth Feet |
| 17-1/2 | 300 | 26 | 300 |
| 12-1/4 | 1,200 | 17-1/2 | 1,200 |
| 8-3/4 | 8,000 | 12-1/4 | 3,000 |
| | | 8-3/4 | 8,000 |

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids

DeBraga No. 2

From previous experience in the Stillwater area, a relatively simple inexpensive mud system is proposed.

A lightly dispersed, gel, water, caustic, lignite mud system has been found to be extremely satisfactory and easily maintained from the surface to total depth.

I. Conductor hole will be dry drilled by Dick Howell's drilling service. 20" casing will be set and cemented with ready mix cement.

II. Surface hole, 17-1/2", will be drilled from 80-300'± with a gel, water, caustic soda system as follows:

| Depth | Weight | Viscosity | Fluid Loss | PH |
|---|---|---|---|---|
| 80'-300' | 66#-70#ft.$^3$ | 35-50 | 10-29 | 10.5-11.5 |

The desander and desilter should be utilized to maintain a minimum mud weight and low solids. The system should be thinned or dispersed as little as possible allowing for normal cutting

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd)

c. Drilling Fluids (Cont'd.)

DeBraga No.2 (Cont'd.)

II. (Cont'd.)

flocculation to aid in solids control as long as possible. If high well bore temperatures and gelation become a problem the system may require thinning.

III. Intermediate hole, 12-1/4", will be drilled from 300'± to 1,200'± with the same system plus the addition of thinner to offset gelation and degradation of the drilling fluid caused by heat.

| Depth | Weight | Viscosity | Fluid Loss | PH |
|---|---|---|---|---|
| 300'± - 1,200'± | 66#-72#ft.$^3$ | 40-50 | 8-15 | 10.5-11.5 |

No problems are thought to be encountered in this section of the hole. However, lost circulation may occur and can be controlled by the addition of cottonseed hulls, mica or walnut hulls to the system. A cation exchange capacity test should be run frequently to ascertain the clay content of the fluid. Clay content should be maintained at, or above

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids (Cont'd.)

DeBraga No. 2 (Cont'd.)

III. (Cont'd.)

22 lbs./bbl. Desander and desilter should be operated at all times, including bit trips.

IV. 8-3/4" hole to 8,000'± T.D. The same basic mud system will be in use, with close attention given to sufficient thinning and both chemical and mechanical solids control. Solids should be kept below 8%.

| Depth | Weight | Viscosity | Fluid Loss | PH |
|---|---|---|---|---|
| 1,200'± -8,000'± | 66#-72#ft.$^3$ | 40-50 | 8-15 | 10.5-11. |

Again, some lost circulation may exist, requiring control, however, gelation of the fluid will probably be the major problem during this portion of the hole, caused by excessive heat. Thinning with lignite and the addition of sufficient water will be required. Attention to solids removal will be important due to the dispersion of fines in the system caused by thinning.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids (Cont'd.)

DeBraga No. 2 (Cont'd.)

V. A small quantity of barite, weight material may be kept on location, if it is felt the need to control fluid flow may possibly exist.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids (Cont'd.)

Second Well

From previous experience in the Stillwater area, a relatively simple inexpensive mud system is proposed.

A lightly dispersed, gel, water, caustic, lignite mud system has been found to be extremely satisfactory and easily maintained from surface to total depth.

I. Conductor hole will be dry drilled by Dick Howell's drilling service. 30" casing will be set and cemented with ready mix cement, to 80'±.

II. Surface hole, 17/12", opened to 26" will be drilled from 80' to 300'± with a gel, water, caustic soda system as follows:

| Depth | Weight | Viscosity | Fluid Loss | PH |
|---|---|---|---|---|
| 80-300' | 66#-70#ft.$^3$ | 35-50 | 10-20 | 10.5-11.5 |

The desander and desilter should be utilized

B. TECHNICAL PROPOSAL (Cont'd.)

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3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids (Cont'd.)

Second Well (Cont'd.)

II. (Cont'd.)

to maintain a minimum mud weight and low solids. The system should be thinned or dispersed as little as possible allowing for normal cutting floculation to aid in solids control as long as possible. If high well bore temperatures and gelation become a problem the system may require thinning.

III. Intermediate hole, 17-1/2", will be drilled from 300'± to 1,200'± with the same system plus the addition of thinner to offset gelation and degradation of the drilling fluid caused by heat.

| Depth | Weight | Viscosity | Fluid Loss | PH |
|---|---|---|---|---|
| 300'± - 2,000'± | 66#-70#ft.$^3$ | 40-55 | 8-15 | 10.5-11.5 |

No problems are thought to be encountered in this section of the hole. However, lost circulation may occur and can be controlled by the addition of cottonseed hulls, mica or walnut hulls to the system. A cation exchange capacity test should

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids (Cont'd.)

Second Well (Cont'd.)

III. (Cont'd.)

be run frequently to ascertain the clay content should be maintained at, or above, 22 lbs/bbl. Desander and desilter should be operated at all times, including bit trips.

IV. Mud properties over the 12-1/4" hole section from 1,200'$\pm$ to 3,000'$\pm$, 9-5/8" liner setting depth should be maintained similar to the properties on the previous hole section from 300'$\pm$ to 1,200'$\pm$. It should be noted, however, that drilled solids control becomes increasingly important with depth and/or increasing heat.

The cooling tower should be employed to maintain lower mud temperatures from no deeper than 1,200' to T.D.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

c. Drilling Fluids (Cont'd.)

Second Well (Cont'd.)

V. 8-3/4" hole to 8,000'±, T.D. The same basic mud system will be in use, with close attention given to sufficient thinning and both chemical and mechanical solids control. Solids should be kept below 8%.

| Depth | Weight | Visc-oscity | Fluid Loss | PH |
|---|---|---|---|---|
| 3,000'± -8,000'± | 66#-72#ft.$^3$ | 40-55 | 8-15 | 10.5-11. |

Again, some lost circulation may exist, requiring control, however, gelation of the fluid will probably be the major problem during this portion of the hole, caused by excessive heat. Thinning with lignite and the addition of sufficient water will be required. Attention to solids removal will be important due to the dispersion of fines in the system caused by thinning.

VI. A small quantity of barite, weight material may be kept on location, if it is felt the need to control fluid flow may possibly exist.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

d. Casing

DeBraga No. 2

As per attached casing program.

Second Well

As per attached casing program.

CASING PROGRAM - STILLWATER PROJECT

DEBRAGA NO. 2

| Hole Size | Casing Size | Casing Thread | Casing Wt./Ft. | Casing Grade | Depth, top of Casing | Depth, bottom of Casing | Safety Factor Burst | Safety Factor Collapse | Safety Factor Tensile | Cu. Ft. Total Slurry | Cu. Ft. Excess Slurry | Top Cmt. Column | Type Cement | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26" | 20" | Welded joint | 94# | H40 | Surface | 80' G.L. | High | High | High | 240 $ft^3$ | 120 $ft^3$ | Surface | Ready Mix | Local available ready mix construction cement. |
| 17-1/2" | 13-3/8" | Buttress | 61# | K55 | Surface | 300'± | High 19.2 | High 10.5 | High 52.5 | 416 $ft^3$ | 208 $ft^3$ | Surface | "G" Mix | Class "G" cmt. w/40% Silica Flour 0.5% CFR-2, retarder if required. |
| 12-1/4" | 9-5/8" | Buttress | 40# | K55 | Surface | 1200'± | High 6.17 | High 4.4 | High 13.1 | 752 $ft^3$ | 375 $ft^3$ | Surface | "G" Mix | Class "G" cmt. w/1 to 1 perlite, 40% Silica Flour 2% gel, 0.5% CFR-2 and retarder if required. |
| 8-3/4" | 7" Liner | 8 RD. LT&C | 26# | K55 | 1000'±? | 8000'±? | High Perforated | High Perforated | High 2.28 | Spot cmt. only | ? | ? | "G" Mix | Class "G" cmt. w/40% Silica Flour, 0.75% CFR-2 and retarder as required. |

PROPOSED STILLWATER CONTRACT

SECOND WELL

CASING PROGRAM

| Hole Size | Casing Size | Casing Thread | Casing Wt./Ft. | Casing Grade | Depth, top of Casing | Depth, bottom of Casing | Safety Factor Burst | Safety Factor Collapse | Safety Factor Tensile | Cu. Ft. Total Slurry | Cu. Ft. Excess Slurry | Top Cmt. Column | Type Cement | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36" | 30" | Welded | 1/2" wall | H40 | Surface | 80'± | High | High | High | 262 ft.$^3$ | 131 ft.$^3$ | Surface | Ready Mix | Local available ready mix construction mix. |
| 26" | 20" | Buttress | 94# | K55 | Surface | 300'± | High 13.1 | High 3.5 | High 26.0 | 902 ft.$^3$ | 451 ft.$^3$ | Surface | "G" Mix | "G" cmt. w/40% SSA-1, 0.5% CFR-2 & 2% $CaCl_2$ or retarder as required. |
| 17-1/2" | 13-3/8" | Buttress | 61# | K55 | Surface | 1200'± | High 4.8 | High 2.64 | High 13.14 | 1667 ft.$^3$ | 883 ft.$^3$ | Surface | "G" Mix | "G"cmt, w/1 to 1 perlite, 40% SSA-1. 2% gel, 0.5% CFR-2 & retarder if requ., followed by 100 ft$^3$ "G"cmt w/40% SSA-1 & 0.5% CFR-2. |
| 12-1/4" | 9-5/8" | Buttress | 40# | K55 | 1200'± | 3000'± | High 2.46 | High 1.76 | High 8.75 | 844 ft.$^3$ | 281 ft.$^3$ | 1000' | "G" Mix | Hung on midway hanger-class"G" cmt. w/1 to 1 perlite followed by 200 ft$^3$ class "G" cmt w/40% SSA-1 w/0.5% CFR-2 & retarder if required. |
| 8-3/4" | 7" Perforated Liner | 8 RD. LT&C | 26# | K55 | 2800' | 8000'? | High | High | High | None | None | None | None | Perforated uncemented liner unless cold water entry requires cementing. |

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B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

e. Cementing

DeBraga No.2

The following cementing slurries for use at the Stillwater prospect are to be applied to all wells unless alternate instructions are given. The slurries designated are based upon research and updated as new developments occur.

1. Conductor Casing - 20", surface to 80'. Cemented with standard, construction grade, locally available, ready-mix cement.

2. 13-3/8" Surface String - surface to 300'$^{\pm}$. Type of cement: Class "G" cement, premixed with 40% Silica Flour, 0.5% CFR-2 and retarder for temperature if required.

   NOTE: Slurry mix to be dictated by hole conditions. If lost circulation is found to exist, the addition of Perlite to the slurry on a 1:1 ratio to lower the slurry weight may be desired.

   Mix and pump sufficient cement to insure full cement returns to the surface around the casing.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Completion Procedures (Cont'd.)

e. Cementing (Cont'd.)

DeBraga No.2 (Cont'd.)

3. 9-5/8" Intermediate String - surface to 1,200'±. Type of cement: Class "G" cement, premixed with Perlite on a 1:1 ratio, with 40% Silica Flour, 2% Gel, 0.5% CFR-2 and retarder as required.

A "tail-in" slurry of 50 $ft^3$ "G" cement, premixed with 40% Silica Flour, 0.5% CFR-2 and retarder, if required, should be run immediately following the previous slurry. In all cases the cement should be preceded with a mud flush to prevent severe gelation and flocculation.

4. A liner lap squeeze or cementing process to isolate a section of a liner may be desired and the following slurry would apply: Type of cement: Class "G" cement with 40% Silica Flour, 0.75% CFR-2 and retarder as required.

DeBraga No. 2 (Cont'd.)

5. Lost Circulation Plugs:

If severe lost circulation exists that cannot be controlled by lost circulation materials, the following type of cement slurry has been found to be the most practical:

Type of cement: Class "G" cement with either a 2:1 or 1:1 ratio of Perlite additive, plus 0.5% CFR-2 and retarder if required.

6. Sidetrack Plugs - Plug Backs

Type of cement: Class "G" cement with 40% Silica Flour (by weight of cement only), with 0.75% CFR-2 and retarder as required. This slurry should be batch mixed in a blender.

Second Well

The following cementing slurries for use at the Stillwater prospect are to be applied to all wells unless alternate instructions are given. The slurries designated are based upon research and updated as new developments occur.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Cementing Procedures (Cont'd.)

e. Cementing (Cont'd.)

Second Well (Cont'd.)

1. Conductor Casing - 30", surface to 80'.
   Cemented with standard, construction grade, locally available, ready-mix cement.

2. 20" Surface String - surface to 300'±.
   Type of cement: Class "G" cement, premixed with 40% Silica Flour, 0.5% CFR-2 and retarder for temperature if required. $CaCl_2$ may be required.
   NOTE: Slurry mix to be dictated by hole conditions. If lost circulation is found to exist, the addition of Perlite to the slurry on a 1:1 ratio to lower the slurry weight may be desired.
   Mix and pump sufficient cement to insure full cement returns to the surface around the casing.

3. 13-3/8" Intermediate String - surface to 1,200'±.
   Type of cement: Class "G" cement, premixed with Perlite on a 1:1 ratio, with 40% Silica Flour, 2% Gel, 0.5% CFR-2 and retarder as required.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Cementing Procedures (Cont'd.)

e. Cementing (Cont'd.)

Second Well (Cont'd.)

3. (Cont'd.)

A "tail-in" slurry of 100 $ft^3$ "G" cement, premixed with 40% Silica Flour, 0.5% CFR-2 and retarder, if required, should be run immediately following the previous slurry.

In all cases the cement should be preceded with a mud flush to prevent severe gelation and flocculation.

4. 9-5/8" Liner, Casing String:

Type of cement: Class "G" cement, premixed with 1:1 Perlite, 40% Silica Flour, 3% Gel, 0.5% CFR-2 and retarder if required, followed by a tail-in slurry (200 $ft^3$) class "G" cement with 40% Silica Flour with 0.5% CFR-2 and retarder if required.

5. A liner lap squeeze or cementing process to isolate a section of a liner may be desired and the following slurry would apply: Type of

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(2) Drilling and Cementing Procedures (Cont'd.)

e. Cementing (Cont'd.)

Second Well (Cont'd)

5. (Cont'd.)

cement: Class "G" cement with 40% Silica Flour, 0.75% CFR-2 and retarder as required.

6. Lost Circulation Plugs:

If severe lost circulation exists that cannot be controlled by lost circulation materials, the following type of cement slurry has been found to be the most practical.

Type of cement: Class "G" cement with either a 2:1 or 1:1 ratio of Perlite additive, plus 0.5% CFR-2 and retarder if required.

7. Sidetrack Plugs - Plug Backs:

Type of cement: Class "G" cement with 40% Silica Flour (by weight of cement only), with 0.75% CFR-2 and retarder as required. This slurry should be batch mixed in a blender.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

3. <u>Program Description</u> (Cont'd.)

a. <u>Subsurface</u> (Cont'd.)

(3) <u>Mud Logging</u>

We see no advantage to mud logging these wells in light of the lithological logs that will be available, and therefore suggest that it be eliminated as an unnecessary expense.

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

3. <u>Program Description</u> (Cont'd.)

a. Subsurface (Cont'd.)

(4) <u>Coring and Analysis</u>

We plan to core each well. The cores will undergo detailed analysis for the fluid flow and thermal properties of the reservoirs rock. A complete discussion of the planned analysis is found in Section B, 3 (c), "Reservoir Engineering Studies".

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

3. <u>Program Description</u> (Cont'd.)

a. Subsurface (Cont'd.)

(5) <u>Drill Stem Testing</u>

We do not recommend and therefore do not plan to conduct a drill stem test.

B. TECHNICAL PROPOSAL (Cont'd.)

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3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(6) Logging

Electric logs will be run as per attached general well logging program.

# GENERAL ELECTRIC WELL LOGGING PROGRAM

| HOLE DEPTH | CASING SIZE | CASING DEPTH | TYPE LOG | INTERVAL FROM | LOGGED TO |
|---|---|---|---|---|---|
| 1,200'± | 13-3/8" | 0'/300'± | TEMPERATURE LOG | 1,200'± | 0 |
| | | | DIL-8 | 1,200'± | 300'± |
| | | | CONTINUOUS DIPMETER | 1,200'± | 300'± |
| | | | NEUTRON-GAMMA RAY | 1,200'± | 0' |
| 8,000'± | 13-3/8" | 0'/300'± | TEMPERATURE LOG | 8,000'± | 0' |
| | 9-5/8" | 300'±/1,200'± | DIL-8 | 8,000'± | 1,200'± |
| | | | CONTINUOUS DIPMETER | 8,000'± | 1,200'± |
| | | | NEUTRON-GAMMA RAY | 8,000'± | 1,200'± |

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(6) Logging (Cont'd.)

- Lithology Log

Ten foot ditch samples will be caught and analyzed by Union's on-site geological team.

A lithology log will be prepared and submitted from the sample analyses, from surface to total depth. On-site mud logging will not be conducted. Wet and dry 1KG ditch samples will be provided as required.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)



(7) Flow Testing

Drill Rig Test

After drilling and completing the geothermal well, a short flow test is conducted before disassembling the rig. The purpose of this test is to insure the proper installation and functioning of the completion equipment and to estimate the production capacity for the surface equipment needed for subsequent testing. The rig test consists of flowing the well through a temporary venting system, flashing the steam to the atmosphere and collecting the water for proper disposal. Wellhead flowing pressures and temperatures are recorded; and, upon concluding the test, wellbore pressure and temperature data may be collected. Total mass flow rate is monitored during the test. This test generally requires less than one day to complete.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(7) Flow Testing (Cont'd.)

Reservoir Analysis Test

Upon determining the approximate production capacity from the drill rig test, surface testing equipment is installed and connected to the well. The test apparatus consists of a separator to segregate and measure the steam and water for individual analysis, a storage system to collect the water and condensed steam for proper disposal, and measuring and sampling devices to determine the fluid properties while flowing.

The general test procedure consists of flowing the well through the surface testing equipment until the well has cleaned up and has obtained stable reservoir flow conditions. During this production period the wellhead flow conditions are monitored as well as the separate steam and water conditions. Samples of steam condensate and water are periodically collected for chemical and corrosion analysis. Steam quality and water scaling tendencies are also investigated. Heat exchanger tests on steam and water may also be conducted. After the well has flowed for a sufficient

B. TECHNICAL PROPOSAL (Cont'd.)

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3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(7) Flow Testing (Cont'd.)

Reservoir Analysis Test (Cont'd.)

time at stable conditions to gather the necessary data, the well is shut-in and downhole pressure and temperature recording devices are run in the well to the reservoir depth to record post production transient phenomena. This entire test can be conducted within 10 days under proper conditions; however, extended test periods of over a month may be required to obtain the pertinent data.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(8) Fluid Chemistry

A substantial number of geothermal fluid samples will be collected at the well-heads and at various points along the pipelines. Complete chemical and isotopic analysis will be performed. The chemical data are relevant to proper design of injection facilities and surface fluid handling capability, while the istopic data are expected to provide significant reservoir information.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

a. Subsurface (Cont'd.)

(9) Wellbore Treatments

No wellbore treatments are planned at this time; however, suitable treatments will be designed if required.

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b. Surface Investigations

(1) Existing Data

Geological Data

A reconnaissance dipole-dipole resistivity survey, consisting of four lines totaling about 20 miles was carried out and interpreted by McPhar Geophysics, Inc. in 1974. A frequency of 0.025 Hz was used. Twenty-three miles of telluric profiling was recently completed over the anomaly by Union Oil Company of California who also computed the data. Several frequencies were recorded. Approximately 50 gravity stations were observed by Union Oil Company of California personnel over the geothermal anomaly. The data was interpreted by Union Oil Company of California personnel.

We feel that adequate surface investigations have been performed, although telluric profiling may be extended in the future.

(2) New Data

Operational Data

A short production test will be run on each well, after completion of drilling, but before the drilling rig leaves the location. These tests, normally referred to as rig tests, involve flowing each well into the drilling reserve pit and measuring the time until the pit fills up. The total amount of fluid produced is usually less than three casing volumes for each well. The rig test is satisfactory as a production rate indicator, but inadequate to measure true well and reservoir potential. Additional testing is required to obtain the qualitative data necessary to evaluate the geothermal resource. The additional testing will involve large reservoir withdrawals over an extended period of time.

Therefore, in order to conduct this additional testing and obtain a meaningful flow test, a second well is required. This second, or injection well, will serve to accommodate the produced effluent from the initial well. In this manner, both wells may be produced, satisfactorily tested and both serve as a producer and an injection well.

The above testing procedure will require a pipeline connecting the two wells. Design of any such line will be determined during rig tests. This proposed design will be submitted in detail to the U.S.G.S. and/or the BLM and USDA Forest Department for approval prior to commencement of any work. Other wells may also be utilized for observation of reservoir interference.

Testing Program

The well testing program will be divided into two phases; short term, and long term. The short term tests are designed to give thumbnail indication of production rates and problems.

The information gained during these tests will be used to design and/or modify production facilities to allow the long term, partially unattended flow tests required for reservoir evaluation. One well will be selected as a water disposal well, another as a production well and a third well, if available, as an observation well.

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

b. Surface Investigations (Cont'd.)

(2) New Data (Cont'd.)

Short Term Tests

Production facilities, including two phase test meters, test manifold, muffling pit, and reserve pit will be set up on each well and the well produced for approximately the capacity of the pits. The well will then be shut-in and the production equipment moved to the next well to test. The effluent from the test will be stored in the pits for future reinjection or off site disposal. This process will be repeated until all wells have been tested. The short tests will require 24 hour attended operation to monitor well and equipment performance.

Long Term Tests

The long term tests are designed to provide more knowledge of reservoir characteristics. The information from the short tests will be utilized for well selections, and to finalize design of the production facilities. Either of the wells may be produced for a period of two to four months. One idle well will be monitored for indications of reservoir interference. Produced water will be reinjected into the reservoir through the remaining well. It may be necessary to utilize the idle well for some injection if the injection well will not accept all of the water.

Production facilities, including a test separator, test manifold, muffling pit, reserve pit, and pumps will be set up on each well. Automated control equipment may be employed to allow for unattended operation.

The effluent from the wells will be piped to a manifold which can be used to divert the flow to a muffling pit or to a test separator. Normal procedure is to kick the well off through the muffler, then turn the production through the test separator when the well flow stabilizes. The steam and water will be individually metered down stream of the test separator and discharged into the muffler. The steam will be allowed to vent to the atmosphere and the water will be contained in the reserve pit. Approximately 30% of the total

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B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

b. Surface Investigations (Cont'd.)

(2) New Data (Cont'd.)

Long Term Tests (Cont'd.)

mass flow from the well is expected to flash and be vented to the atmosphere.

The water will be pumped from the reserve pit through the pipeline to one of the other wells for reinjection into the reservoir. The pipeline will be designed on the basis of information derived from the rig and short term tests. Alternate designs being considered are (1) A welded steel line following the shortest feasible path between wells, or (2) Victaullic coupled pipe strung along existing road rights-of-way. In the event welded steel pipe is used, an attempt will be made to pull it from one location to another to eliminate the necessity of large amounts of brush removal for right-of-way.

Union's drawing No. 1373 indicates the flow schematic of the primary production facilities. The goals and information desired from the long term tests are as follows:

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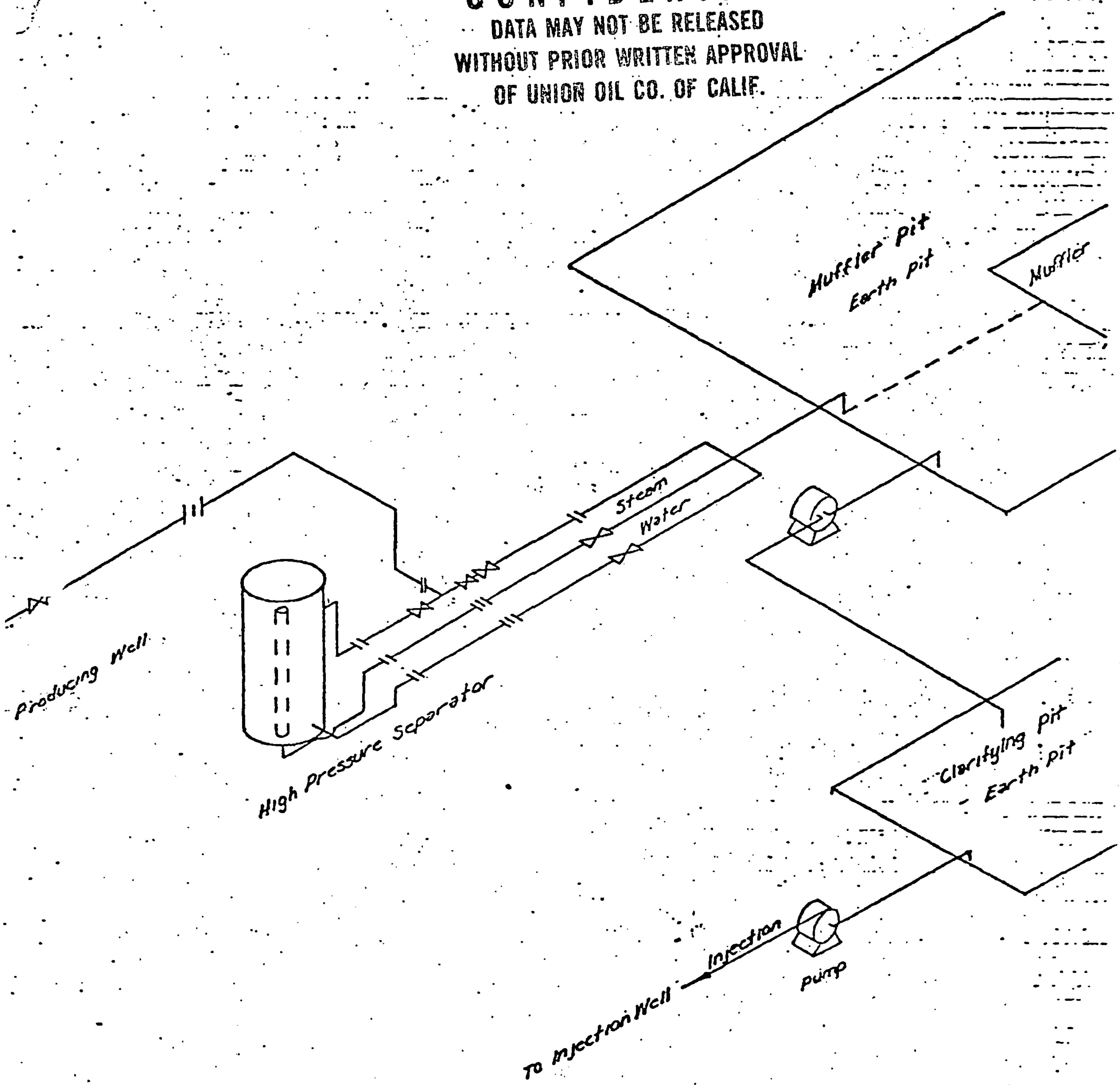


| | |
|---|---|
| UNION | DRAWN |
| | FOR: R.R. |
| UNION OIL COMPANY OF CALIFORNIA - GEOTHERMAL DIVISION | BY: L.C.C. |
| | DATE: 4-21-76 |
| GEOTHERMAL WELL TEST FACILITIES | SCALE: NONE |
| STILLWATER PROSPECT | DRAWING NUMBER |
| | 1162 |

B. TECHNICAL PROPOSAL (Cont'd.)



3. Program Description (Cont'd.)

b. Surface Investigations (Cont'd.)

(2) New Data (Cont'd.)

Long Term Tests (Cont'd.)

1. Well Productivity
   a. Mass flow rate, steam fraction, water fraction.
   b. Enthalpy, temperature, pressure.
   c. Production rate decline.
   d. Other reservoir data as may be obtainable.
2. Reservoir Fluid Characteristics
   a. Chemical analysis of water and non-condensable gases.
   b. Ratio of water to non-condensable gases.
3. Determination of reservoir and production characteristics over a long time period with sizeable reservoir withdrawals.
4. Determination of effectiveness of applied solutions to production problems encountered in short term tests.
5. Determination of feasibility of commercial power generation.

The long term test criteria may be extended to other wells if the short term tests encourage the drilling of additional wells, and these wells are completed within the necessary time frame.

B. TECHNICAL PROPOSAL (Cont'd.)

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3. Program Description (Cont'd.)

b. Surface Investigations (Cont'd.)

(2) New Data (Cont'd.)

Water Disposal

The salt content of water produced during the well tests may require that the water be reinjected into the reservoir. The water produced during the above proposed testing will be injected into the reservoir through one or more of the idle wells. Injection characteristics of the wells will be monitored to determine future injection well requirements and possible injectivity problems.

Any proposal for a pipeline installation as stated above, will be submitted to the appropriate personnel for approval and will be installed in such a manner as to cause minimal interference with other operations. It will be buried at road crossings, but will be layed above ground in other areas. Cleared areas and existing road right-of-ways will be used as much as possible to minimize vegetation disturbance. The line will be pulled through vegetated areas where possible to eliminate rights-of-ways or vegetation disturbance. The line may be utilized for future tests or incorporated into a future production system.

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B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

3. <u>Program Description</u> (Cont'd.)

c. Reservoir Engineering Studies

(1) a. <u>Existing Data</u>

We have drilled four wells in the Stillwater KGRA. One of these wells, DeBraga No. 1, was flow tested. We have temperature and pressure surveys on all the wells. Some chemical analysis data are also available. Complete information on the four wells will be made available if this proposal is funded.

b. <u>New Data</u>

The reservoir engineering studies will be based on new data gathered under this program.

(2) <u>Measurements and Analyses</u>

The following measurements and analyses will be used in the reservoir engineering studies:

a. <u>Core Analyses</u>

The following tests are planned:

1. <u>Porosity</u>

Measure both matrix (connected pores) and bulk porosity (all pores) using water (as opposed to helium).

2. Density

Grain density and bulk density.

3. Permeability

To water (preferably simulated or actual brine) at high temperature and pressures. Permeability can be measured either by steady flow or by transient pressure depletion, depending on the magnitude of permeability. We need both horizontal and vertical permeability.

4. Specific Heat

Brine saturated rock at elevated temperature.

5. Thermal Conductivity

Brine saturated rock at elevated temperature.

6. Coefficient of Thermal Expansion

We need bulk coefficient of expansion or contraction. The change in temperature should be gradual) so as not to cause rock cracking.

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

c. Reservoir Engineering Studies (Cont'd.)

(2) Measurements and Analyses (Cont'd.)

a. Core Analyses (Cont'd.)

7. S-wave and P-wave

Under varying confining pressure.

8. Compaction

Under (a) brine saturation, (b) high temperature, (c) fixed overburden pressure, (d) fixed horizontal pressure, but (e) varying pore pressure, (f) both increasing and decreasing pore pressure.

The highest pore pressure is equal to a gradient of 0.4 psi/ft. The smallest value is either the saturation pressure corresponding to the assigned temperature, so that the water does not flash or 500 psi, whichever is more. We need increasing and decreasing pore pressure to study the hysterisis effect and to estimate recovery of bulk volume by reinjection.

9. Triaxial Deformation

The objective of the test is to determine

Young's modules, bulk modulus, shear modulus and Poisson's ratio. The tests are helpful in designing hydraulic stimulation.

b. Logging

Logging is discussed under B.3.a.6.

c. Flow tests

Flow tests are discussed under B.3.a.7.

d. Fluid Chemistry

Fluid chemistry is discussed under B.3.a.8.

e. Pressure Drawdown Tests

f. Pressure Buildup Tests

g. Interference Tests

h. Computer Programs

Various existing computer programs will be used to interpret the data. The programs have been developed by Union Oil Company of California. Three programs are mentioned below:

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

c. Reservoir Engineering Studies (Cont'd.)

(2) Measurements and Analyses (Cont'd.)

h. Computer Programs (Cont'd.)

1. Interpretation of Interference Tests

The program calculates pressure changes at one or more observation wells due to activity at one or more production/injection wells. Variable rates (including shut-in) and production/injection history in the field prior to the onset of interference test are included in the program.

2. Interpretation of Pressure Observations Due to Variable Flow Rates

The program helps in the interpretation of pressure observations at a well which has a variable flow rate. The program permits an arbitrary, but known, rate change. Pressure buildup tests and two rates tests are special cases that can be handled by the program.

3. Prediction of Production Temperature in the Presence of Injection Wells

The fluid advances in response to flow gradients established in the field. Heat loss/gain calculations are superposed on flow calculations to determine temperature of produced fluid. The

B. TECHNICAL PROPOSAL (Cont'd.)

3. Program Description (Cont'd.)

c. Reservoir Engineering Studies (Cont'd.)

(2) Measurements and Analyses (Cont'd.)

h. Computer Programs (Cont'd.)

3. Prediction of Production Temperature in the Presence of Injection Wells (Cont'd.)

program calculates the temperature of produced fluid as a function of time in the presence of injection wells. The program helps in designing the location and rates of injection.

Based on the data collected and the analyses made, an optimum development plan for Stillwater-Soda Lake KGRA will be prepared.

B. TECHNICAL PROPOSAL (Cont'd.)

4. Schedule

a. Phase I - Drilling of well DeBraga No. 2.
Data to be delivered within three months of completion of the well.

Phase II - Drilling of the second well.
Data to be delivered within three months of completion of the well.

Phase III - Short flow tests.
Data to be delivered within three months of each flow test.

Phase IV - Long term flow test.
Basic data to be delivered within six months of completion of flow test.

Phase V - Subsurface well repair.
Data to be delivered within three months of completion of the work.

Existing Data

Data to be delivered within three months of completion of the second well. If it is decided not to proceed with the program after completing the well DeBraga No. 2, then all data is to be submitted within three months of completion of DeBraga No. 2.

B. TECHNICAL PROPOSAL (Cont'd.)

4. Schedule (Cont'd.)

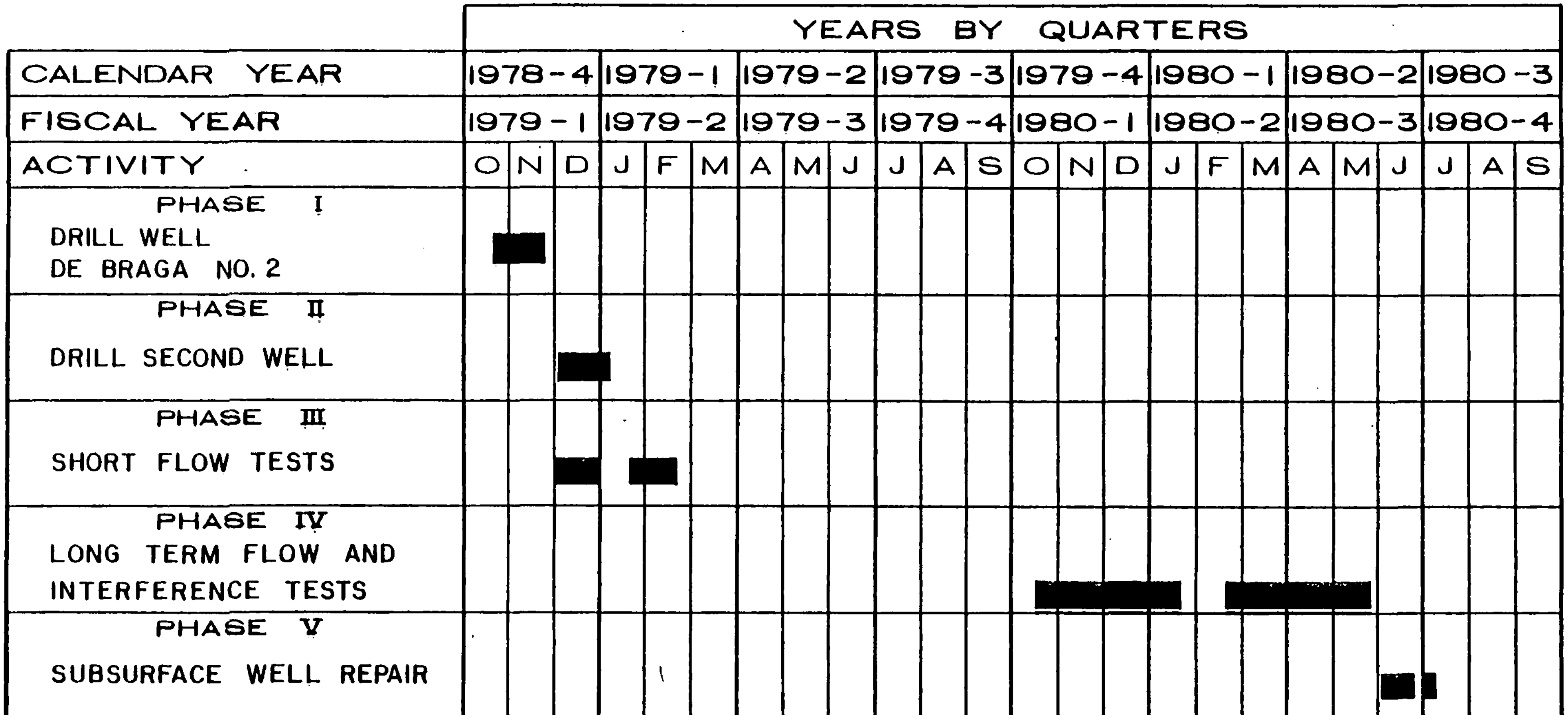
Final Reservoir Assessment Report

This report will be delivered one year after the completion of the field program activity.

The sequence of the proposed program is as shown on the attached schedule.

# UNION OIL COMPANY OF CALIFORNIA

## STILLWATER PROSPECT




SCHEDULE B.4.a.

B. TECHNICAL PROPOSAL (Cont'd.)

4. Schedule (Cont'd.)

b. Data to be Held Proprietary

(1) Geothermal Wellbore Computer Program

This proprietary computer program calculates flowing pressures and temperatures versus depth in geothermal wells producing steam-water mixtures. It can be used to study the effects of varying wellbore diameters and wellhead pressures on the productivity of the well; it is thus useful in optimizing the operating conditions of a geothermal well.

The program incorporates vertical two-phase flow equations coupled with heat transfer equations and thermal dynamic properties of steam and water. It embodies substantial investment of Union's field testing computer program and mathematical analysis efforts. It is expected that this computer program will be used in the project and the results will be delivered, however, the program will be kept proprietary and will not be delivered under this contract. A paper comparing pressure profiles computed by this program with profiles observed in a number of geothermal wells was presented at the annual meeting of the Society of Petroleum Engineers in Denver, Colorado on October 10-12, 1977.

B. TECHNICAL PROPOSAL (Cont'd.)

4. Schedule (Cont'd.)

b. Data to be Held Proprietary (Cont'd.)

(2) Geothermal Gathering Systems Design Computer Program

This proprietary computer program calculates the pressure profile in a pipeline flowing single phase steam, single phase water or steam-water mixtures. It is used to determine pipeline sizes in a geothermal gathering system. The program includes two phase flow correlations for horizontal and inclined flow, and equations to describe flow behavior of steam and water. It incorporates Union's technology of geothermal pipeline design developed at substantial costs of field experimentation and data analysis. It is expected that this computer program will be used in the project and the results will be delivered, however, the program will be kept proprietary and will not be delivered under this contract.

(3) Interference Test Program

Union Oil Company has developed a computer program to evaluate reservoir pressure fluctuations caused by one or more production/injection wells at any point in the reservoir. The program is useful in predicting the pressure response in an idle well that is located in the same reservoir as the production/injection wells. The program is capable

B. TECHNICAL PROPOSAL (Cont'd.)

4. Schedule (Cont'd.)

b. Data to be Held Proprietary (Cont'd.)

(3) Interference Test Program (Cont'd.)

of handling variable production/injection rates as well as incorporating the effects of the production/injection history of all the wells in the reservoir.

The classical pressure interference theory presented in the literature is the basis for the evaluation. However, additional theory developed by Union has been included in the computer program. It is expected that this computer program will be used in the project and the results will be delivered, however, this program will be kept proprietary and will not be delivered under this contract.

(4) Interpretation of Pressure Observations Due to Variable Flow Rates

Because most geothermal hot water flow testing involves some degree of flow rate variation during a test, a computer program was developed to interpret the measured pressure observations during a variable rate flow test. Most geothermal flow tests are of such short production periods that the effects of variable flow rates are significant. This program is especially useful in the interpretation of

(4) Interpretation of Pressure Observations Due to Variable Flow Rates (Cont'd.)

pressure buildup (or falloff) tests and multi-rate test.

Classical pressure transient theory, along with specific well test analysis techniques developed by Union, are included in the program. The program is designed to evaluate all the conditions which Union has encountered in various geothermal areas. It is expected that this computer program will be used in the project and the results will be delivered, however, this program will be kept proprietary and will not be delivered under this contract.

(5) Production Temperature Prediction Under the Influence of Reinjection

Reinjection of the heat depleted geothermal fluids in the reservoir will lead to a general migration of cooler fluids to the producers in response to flow gradients established in the field. The reinjected fluid will increase in temperature as it moves through the formation towards the producer. A computer program was designed to predict the temperature of the reinjected fluid as it migrates

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

4. <u>Schedule</u> (Cont'd.)

b. Data to be Held Proprietary (Cont'd.)

(5) Production Temperature Prediction Under the Influence of Reinjection (Cont'd.)

through the reservoir. The program enables the proper design of injection and production well sites under commercial operation. The program also calculates the temperature of the produced fluid as a function of time after injection breakthrough has occurred.

The theory involved in this evaluation procedure was developed by Union and has been generalized to accommodate all our prospective geothermal operations. It is expected that this computer program will be used in the project and the results will be delivered, however, this program will be kept proprietary and will not be delivered under this contract.

(6) Reservoir Assessment Study and Optimum Development Plan

The final engineering report on the Stillwater project will be maintained as proprietary data until thirty months after completion of the long-term flow and interference test.

In addition to the proprietary data described in this paragraph 5, Union reserves as proprietary all

B. <u>TECHNICAL PROPOSAL</u> (Cont'd.)

4. <u>Schedule</u> (Cont'd.)

b. Data to be Held Proprietary (Cont'd.)

(6) <u>Reservoir Assessment Study and Optimum Development Plan (Cont'd.)</u>

information that is developed in connection with Union's or its subsidiaries' operations pursuant to the proposed contract or elsewhere except:

(a) Data Union specifically designated to be delivered to DOE pursuant to this reply to Request for Proposal,

(b) Information directly known to DOE,

(c) Information which is known or becomes known by the general public through acts of parties other than DOE, and

(d) Information received by DOE from a third party who did not obtain it from Union under an obligation of confidence.

Union may from time-to-time, upon DOE's request or Union's own initiative voluntarily release additional information which Union no longer regards as proprietary, but Union shall be under no obligation to do so.

B. TECHNICAL PROPOSAL

5. Environmental Evaluation

The Contents and organization of this section are derived from ERDA Document ERHQ-0001, "Guidelines to the Preparation of Environmental Reports for Geothermal Development Projects", February, 1977. This exploration project is not of the same magnitude as a full development project, so not all parts of the guidelines are applicable. However, all relevant parts as required in Table 4 of ERHQ-0001 are covered here, and if this exploratory project discovers a commercially producible resource, then a full environmental assessment will be prepared. Our Company has performed numerous environmental assessments of geothermal projects and has developed expertise in the analysis of impacts of geothermal development.

a. Description of the Environment Affected

Plate 3 shows the significant features of the area in which the project will be located. The Lahontan Valley is generally a relatively flat valley floor surrounded by treeless mountains. The valley floor near Stillwater is irrigated farmland and, farther north, is composed of an intricate maze of dikes, canals, lakes and marshes which supply habitat for large numbers of waterfowl. Recreational hunting and fishing are popular in the valley.

B. TECHNICAL PROPOSAL (Cont'd.)

5. Environmental Evaluation (Cont'd.)

a. Description of the Environment Affected (Cont'd.)

The wells to be drilled for this project are located near the Stillwater Wildlife Management Area and just west of the Stillwater National Wildlife Refuge. The two well pads will each disturb about two acres of either flat grazing field or flat brush-covered range land. The wells will be located at least 150 feet from drainage or irrigation canals.

Farmhouses are scattered in the southern portion of the valley, and several homes and businesses are concentrated in Stillwater, located south and east of the proposed wells. The valley population is less than 1,000. The Fallon Indian Reservation is located southwest of the proposed wells a few miles. Several hundred Paiute and Shoshone Indians live on and farm the reservation. Indian presence in the valley has been known to continue for many years. Arrowheads, grinding bowls and mortars have been found.

At the north end of the valley is a Naval Bombing Range where aircraft from the Naval Air Station, located to the southwest near Fallon, practice. There is regular, loud, low-level jet traffic every day over the project site.

B. TECHNICAL PROPOSAL (Cont'd.)

5. Environmental Evaluation (Cont'd.)

a. Description of the Environment Affected (Cont'd.)

The valley, although normally an area of light or moderate rainfall, has recently been plagued by drought. The valley normally has prolonged, cold winters and hot summers. This winter heavy rains have begun replenishing depleted wildfowl habitat and needed irrigation water for agricultural use. Surface and groundwater in the area is rarely potable. All water in the valley flows northward to the eventual destination of the Carson Sink, about 15 miles away, which has no outlet.

The valley supports small numbers of large terrestrial species such as mule deer due to naturally poor habitat for these animals. Predators such as coyote and small terrestrial species are common in the agricultural areas. A great variety and abundance of birds live in and migrates through this valley. In years of good water as many as 250,000 ducks, 10,000 geese, and 13,000 whistling swans can be found in the Management area. Over 150 species are regularly found there, and major hunting harvests of greenwing teal, pintail, redhead, and shoveler are taken annually. Birds of prey are common, and bald eagles, an endangered species, have been spotted in recent years. Catfish, bullheads, crappie, and largemouth black bass are found in the area waters.

Much of the non-agricultural area is vegetated with greasewood and saltbush. Agricultural crops and cattle grazing occupy the irrigated lands.

b. Analysis of the Potential Environmental Impact

The project will be of short duration and have little environmental impact. Each well site will be cleared of vegetation and a sump constructed to hold drilling wastes. The construction will temporarily remove several acres of habitat for small rodents and reptiles living on the sites. The clay content of the soils will prevent seepage of contained fluids into groundwaters. Since the land is flat there will be little additional erosion due to this land clearing. Pipelines will traverse established road rights-of-way wherever possible so vegetation removal will be minimized.

Produced fluids from well tests will be reinjected into the reservoir by deep wells. No discharges will be made to surface waters. Although initial tests of fluids in the area do not indicate the presence of hydrogen sulfide

B. TECHNICAL PROPOSAL (Cont'd.)

5. Environmental Evaluation (Cont'd.)

b. Analysis of the Potential Environmental Impact (Cont'd.)

($H_2S$), it is reasonable to anticipate some $H_2S$ in the fluids produced from the proposed wells. Unless the concentration of this gas is extremely high (an unlikely occurrence) there should be no hazard or nuisance from drilling and testing these wells. If significant quantities of $H_2S$ are encountered, appropriate steps will be taken to protect the health and welfare of workers and nearby residents.

Noise from drilling and testing wells will be muffled whenever possible. The use of the area to the north for naval bombing practice and low-flying jet flights across the area have probably acclimated local residents and animals to intermittent loud sounds, so this impact will be less at this project than it might be elsewhere. Traffic generated by this project will be temporary and light.

This project will create a few temporary jobs. There will be a small amount of spending done in Stillwater, but most of the effect will be in Fallon. There will be negligible effect on any cultural values, recreational activities, or historic sites. If a historical site is encountered during construction, an effort will be made to evaluate its significance and arrange protection if necessary.

B. TECHNICAL PROPOSAL (Cont'd.)

5. Environmental Evaluation (Cont'd.)

b. Analysis of the Potential Environmental Impact (Cont'd.)

This project will have no significant long term impact on the environment. If these wells are successful in proving a resource, they may become part of a producing field, which may have a larger impact, but a full-field development environmental analysis would be preformed before going to that stage.

c. Potential for Conflicts with Existing Land Use Patterns and Programs

This project will have little impact on the environment and will be compatible with agricultural activities currently in the area. The two wells and related facilities will not be located near the wildlife refuge and will be operated in such a way as to minimize any potential impact on wildfowl using either the refuge or the management area. Also there will be no effect on the substantial water supply system of canals and ditches which was developed in the early 1900's as the Newlands Irrigation Project in the Lahontan Valley, nor on the supplementary system of dikes and canals developed for management of water in the game management area and refuge.

# CONTRACT PRICING PROPOSAL

*(RESEARCH AND DEVELOPMENT)*

Office of Management and Budget Approval No. 29-RO184

This form is for use when *(i)* submission of cost or pricing data (see FPR 1-3.807-3) is required and *(ii)* substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO.  NO. OF PAGES

| | |
|---|---|
| NAME OF OFFEROR: UNION OIL COMPANY OF CALIFORNIA | SUPPLIES AND/OR SERVICES TO BE FURNISHED: Geothermal Reservoir Assessment Case Study, Northern Basin and Range Province |
| HOME OFFICE ADDRESS: 461 So. Boylston, Los Angeles, CA 90017 | |
| DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: GEOTHERMAL - STILLWATER, NEVADA | TOTAL AMOUNT OF PROPOSAL: $ 1,098,000 — GOV'T SOLICITATION NO.: ET-78-R-08-0003 |

## DETAIL DESCRIPTION OF COST ELEMENTS

| | | | EST COST ($) | TOTAL EST COST[1] | REFERENCE[2] |
|---|---|---|---|---|---|
| 1. DIRECT MATERIAL *(Itemize on Exhibit A)* | | | | | |
| a. PURCHASED PARTS | | | | | |
| b. SUBCONTRACTED ITEMS | | | | | |
| c. OTHER—(1) RAW MATERIAL | | | | | |
| (2) YOUR STANDARD COMMERCIAL ITEMS | | | | | |
| (3) INTERDIVISIONAL TRANSFERS *(At other than cost)* | | | | | |
| *TOTAL DIRECT MATERIAL* | | | | | |
| 2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)* | | | | | |
| 3. DIRECT LABOR *(Specify)* | ESTIMATED HOURS | RATE/HOUR | EST COST ($) | | |
| *TOTAL DIRECT LABOR* | | | | | |
| 4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3] | O.H. RATE | X BASE = | EST COST ($) | | |
| *TOTAL LABOR OVERHEAD* | | | | | |
| 5. SPECIAL TESTING *(Including field work at Government installations)* | | | EST COST ($) | | |
| *TOTAL SPECIAL TESTING* | | | | | |
| 6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)* | | | | | |
| 7. TRAVEL *(If direct charge) (Give details on attached Schedule)* | | | EST COST ($) | | |
| a. TRANSPORTATION | | | | | |
| b. PER DIEM OR SUBSISTENCE | | | | | |
| *TOTAL TRAVEL* | | | | | |
| 8. CONSULTANTS *(Identify—purpose—rate)* | | | EST COST ($) | | |
| *TOTAL CONSULTANTS* | | | | | |
| 9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* | | | | | |
| 10. *TOTAL DIRECT COST AND OVERHEAD* | | | | | |
| 11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate % of cost element Nos. )*[3] | | | | | |
| 12. ROYALTIES[4] | | | | | |
| 13. *TOTAL ESTIMATED COST* | | | | | |
| 14. FEE OR PROFIT | | | | | |
| 15. *TOTAL ESTIMATED COST AND FEE OR PROFIT* | | | | | |

SEE ATTACHED TABLE



OPTIONAL FORM 60
October 1971
General Services Administration

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

| TYPED NAME AND TITLE | SIGNATURE |
|---|---|
| | |

| NAME OF FIRM | DATE OF SUBMISSION |
|---|---|
| | |

## EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*

| COST EL NO. | ITEM DESCRIPTION *(See footnote 5)* | EST COST ($) |
|---|---|---|
| | | |

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☒ NO *(If yes, identify below.)*

| NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL | TELEPHONE NUMBER/EXTENSION |
|---|---|
| | |

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify.):* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☒ YES ☐ NO *(If yes, identify.):* Cove Fort, Utah - EG-77-C-08-1522

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☒ YES ☐ NO *(If no, explain on reverse or separate page)*

*See Reverse for Instructions and Footnotes*

OPTIONAL FORM 60 (10-71)

## INSTRUCTIONS TO OFFERORS

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated costs *(and attached supporting information)* suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in FPR 1-3.807-3 be required to submit a Certificate of Current Cost or Pricing Data (See FPR 1-3.807-3(h) and 1-3.807-4).

2. In addition to the specific information required by this form, the offeror is expected, in good faith, to incorporate in and submit with this form any additional data, supporting schedules, or substantiation which are reasonably required for the conduct of an appropriate review and analysis in the light of the specific facts of this procurement. For effective negotiations, it is essential that there be a clear understanding of:

a. The existing, verifiable data.
b. The judgmental factors applied in projecting from known data to the estimate, and
c. The contingencies used by the offeror in his proposed price.

In short, the offeror's estimating process itself needs to be disclosed.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be described *(with schedules as appropriate)*, and made available to the contracting officer or his representative upon request.

4. The formats for the "Cost Elements" and the "Proposed Contract Estimate" are not intended as rigid requirements. These may be presented in different format with the prior approval of the Contracting Officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal the offeror grants to the Contracting Officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

## FOOTNOTES

*1 Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. When any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferror or current market price.*

*2 When space in addition to that available in Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which the information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the Contracting Officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or invoice prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major re-arrangement, etc.); or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.*

*3 Indicate the rates used and provide an appropriate explanation. Where agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.*

*4 If the total cost entered here is in excess of $250, provide on a separate page the following information on each separate item of royalty or license fee: name and address of licensor; date of license agreement, patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.*

*5 Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.*

CONTINUATION OF EXHIBIT A—SUPPORTING SCHEDULE AND REPLIES TO QUESTIONS II AND V.

C. COST

1. Estimated Total Costs

Phase I

Drilling Well DeBraga #2

| | Estimated Total Cost |
|---|---|
| Location | $ 5,000 |
| Drilling Contractor | 192,000 |
| Drilling Bits | 55,000 |
| Drilling Mud and Chemicals | 40,000 |
| Fuel | 13,000 |
| Equipment Rentals | 8,000 |
| Specialized Drilling Services | 100,000 |
| Transportation | 31,000 |
| Casing | 86,000 |
| Production Equipment | 13,000 |
| Supervision | 12,000 |
| Miscellaneous | 8,000 |
| Subtotal | $ 563,000 |
| G & A | 28,000 |
| Total | $ 591,000 |

C. <u>COST</u> (Cont'd.)

1. <u>Estimated Total Costs</u> (Cont'd.)

Phase II

<u>Drilling Second Well</u>

| | Estimated Total Cost |
|---|---|
| Location | $ 5,000 |
| Drilling Contractor | 214,000 |
| Drilling Bits | 62,000 |
| Drilling Mud and Chemicals | 49,000 |
| Fuel | 15,000 |
| Equipment Rentals | 9,000 |
| Specialized Drilling Services | 142,000 |
| Transportation | 33,000 |
| Casing | 129,000 |
| Production Equipment | 13,000 |
| Supervision | 14,000 |
| Miscellaneous | 8,000 |
| Subtotal | $ 693,000 |
| G & A | 35,000 |
| Total | $ 728,000 |

C. COST (Cont'd.)

1. Estimated Total Costs (Cont'd.)

Phase III

Short Flow Tests

| | Estimated Total Cost |
|---|---|
| **Equipment and Contract Services** | |
| Choke Manifold | $ 20,000 |
| Flow Separator-Transportation | 5,000 |
| Contract Services | 20,000 |
| Equipment Rentals | 10,000 |
| Pipes and Fittings | 2,500 |
| Valves and Meters | 7,500 |
| Pressure and Temperature Services | 10,000 |
| Computer Services | 5,000 |
| Subtotal | $ 80,000 |
| **Company Supervision and Labor** | |
| Reservoir/Production Engineer (2 months) | 6,000 |
| Production Foreman (2 months) | 5,000 |
| Travel and Subsistence (4 months) | 4,000 |
| Subtotal | $ 15,000 |
| G & A | 5,000 |
| Total | $ 100,000 |

C. COST (Cont'd.)

1. Estimated Total Costs (Cont'd.)

Phase IV

Long Term Flow and Interference Tests

| | Estimated Total Cost |
|---|---|
| **Equipment and Contract Services** | |
| One Test Separator with Controls | $ 120,000 |
| 5,280' Pipelines (purchase) | 50,000 |
| Valves and Fittings | 80,000 |
| Two Injection Pumps (rental) | 36,000 |
| Installation Contract Services | 80,000 |
| Testing Contract Labor | 60,000 |
| Chemical Analyses | 10,000 |
| Pressure and Temperature Services | 10,000 |
| Interference Test Equipment | 15,000 |
| Computer Services | 15,000 |
| Miscellaneous | 13,000 |
| Subtotal | $ 489,000 |
| **Company Supervision and Labor** | |
| Project Engineer (12 months) | 38,000 |
| Production Foreman (12 months) | 30,000 |
| Reservoir Engineer (4 months) | 13,000 |
| Analytical Support (4 months) | 13,000 |
| Travel and Subsistence (32 months) | 32,000 |
| Subtotal | $ 126,000 |
| G & A | 31,000 |
| Total | $ 646,000 |

C. <u>COST</u> (Cont'd.)

1. <u>Estimated Total Costs</u> (Cont'd.)

Phase V

| | Estimated Total Cost |
|---|---|
| **Subsurface Well Inspection** | |
| Subsurface Well Inspection | $ 125,000 |
| G & A | 6,000 |
| Total | $ 131,000 |

C. COST (Cont'd.)

2. Proposed Cost to the Government

| | Estimated Total Cost | Estimated Cost to D.O.E. |
|---|---|---|
| Phase I | | |
| Drilling DeBraga #2 | $ 591,000 | $ 336,000 ($42/ft.) |
| Phase II | | |
| Drilling Second Well | 728,000 | 440,000 ($55/ft.) |
| Phase III | | |
| Short Flow Test | 100,000 | 25,000 |
| Phase IV | | |
| Long Term Flow Test | 646,000 | 176,000 |
| Phase V | | |
| Subsurface Well Inspections | 131,000 | 125,000 |
| Total | $2,196,000 | $1,102,000 |
| Existing Work | 774,000 | --- |
| Grand Total | $2,970,000 | $1,102,000 |

## D. BUSINESS AND MANAGEMENT

### 1. Experience

The Union Oil Company of California, Geothermal Division headquarters are located in the home office in Los Angeles and two district offices are located 1) in Santa Rosa, California and 2) Makati, Rizal, Philippines. Two area offices are based out of the Santa Rosa District office and they are 1) Brawley, California and 2) the Baca Location No. 1, New Mexico. Two area offices are based out of the Makati, Rizal, Philippines office and they are 1) Tiwi and 2) Bulalo - both located on the Island of Luzon.

At the present time, the Geothermal Division directly employs 150 people of which 80 are professional (primarily engineers and geologists) and the remaining 70 are comprised of technicians, secretaries, clerical and field operating personnel. This group is well qualified to undertake the complete operations involved in the drilling and producing of geothermal wells. Members of the group have been involved in drilling and completion of over 221 wells during the past 16 years, excluding the numerous temperature gradient holes that have been completed.

The particular value of this group is its broad experience in the drilling, completion and operation of geothermal wells completed from fractured and porous reservoirs

D. <u>BUSINESS AND MANAGEMENT</u> (Cont'd.)

1. <u>Experience</u> (Cont'd.)

consisting of metamorphosed, volcanic and sedimentary rocks, with produced fluids being in either liquid or vapor-dominated states.

Another accomplishment of this Division is that it operates in The Geysers field, California, supplying geothermal steam to eleven power plants which generate 502 megawatts of electricity. Two additional plants are presently under construction which will add another 220 megawatts and an additional two 110 megawatt power plants are under consideration by Pacific Gas and Electric Company.

In the Philippines we are exploring and developing two geothermal areas in which three power plants are under construction for a total of 330 megawatts and an additional 110 megawatt power plant is being considered by the National Power Corporation.

In the Brawley and Salton Sea, California, and Baca Location No. 1, New Mexico areas, we have also submitted proposals to the local utility companies for the construction of power plants in each area.

D. BUSINESS AND MANAGEMENT (Cont'd.)

2. Principal Project Personnel

The individual members of the Geothermal Division who will be primarily involved in the proposed project are Messers. Delbert E. Pyle, Donald L. Ash, Olin D. Whitescarver, Mohinder S. Gulati and C. Frank Corbin. They will act in the following capacities:

| | |
|---|---|
| D.E. Pyle | Coordinator |
| D.L. Ash | Drilling Supervisor |
| O.D. Whitescarver | Production Supervisor |
| M.S. Gulati | Reservoir Engineering Supervisor |
| C.F. Corbin | Contract Administrator |

Their resumes are as follows:

DELBERT E. PYLE

18816 Killoch Way
Northridge, CA 91324

MILITARY

| | |
|---|---|
| 1942 - 1946 | United States Navy<br>Machinist - MM 2/c |

EDUCATION

| | |
|---|---|
| 1948 | Compton Junior College<br>AA Engineering |
| 1951 | University of Southern California<br>BE Petroleum Engineering |
| 1959 | A.A.O.D.C.<br>Blow Out Prevention |

EXPERIENCE

1950 - 1952

Union Oil Company of California
Pacific Coast Division
Dominguez, California

Position: Part-time Janitor; Laboratory Assistant in Core Lab.; Utility-man; Well Puller; Pumper; Truck Driver.

1952 - 1953

Union Oil Company of California
Pacific Coast Division
Santa Fe Springs, California

Position: Engineer Trainee

Duties:

Individual well economic studies, de-emulsification of tank bottoms (method patented); production engineering; petroleum engineering on well sites.

1953 - 1955

Union Oil Company of California
Pacific Coast Division
Bakersfield, California

Position: Petroleum Engineer

Duties:

Reservoir engineering (oil & gas reserve estimates); Union representative at Unit meetings; engineering Mt. Poso waterflood and individual reservoir studies.

1955 - 1958

Union Oil Company of California
Pacific Coast Division
Coalinga, California

Position: Petroleum Engineer

Duties:

Coalinga Nose Unit reservoir engineering including engineering for State injunction against Coalinga Nose Unit; reservoir, subsurface and drilling engineering at Guijarral Hills.

1958 - 1960

Union Oil Company of California
Pacific Coast Division
Bakersfield, California

Position: District Drilling Engr.

Duties:

Supervising all drilling and well repair work in San Joaquin and Sacramento Valleys.

1960 - 1967

Union Oil Company of California
Foreign Operations
Toowoomba, Queensland, Australia

Position: Field Superintendent

Duties:

Supervising and planning all drilling, well repair, production, reservoir and subsurface engineering in Australia and operation and maintenance of Moonie P/line. Union's representative to State and Federal Governments, regarding engineering matters including representative of industry in drafting Petroleum Operating and Safety Regulations. Relieving Resident Manager in his absence.

1967 - 1971

Union Oil Company of California
Geothermal Division
Santa Rosa, California

Position: District Mgr. of Oper.

Duties:

Supervising and planning all drilling, well repair, production, reservoir engineering for the Geothermal Division, mainly in The Geysers field, California.

Responsible for initiating the type of drilling that is used today. Co-designed the method for reducing corrosion-erosion on subsurface tubulars. This method was patented.

| | |
|---|---|
| 1971 - Present | Union Oil Company of California<br>Geothermal Division<br>Los Angeles, California |

Position: Manager of Operations

Duties:

Responsible for over-seeing all geothermal operations for District and area offices as well as planning and organizing two new areas, one located in New Mexico and the other in Manila, Philippines.

Designed the technology for aerated-aqueous drilling fluids utilized in geothermal drilling. Method patented.

*

DONALD L. ASH

5376 Sharon Court
Santa Rosa, CA 95405

MILITARY

| | |
|---|---|
| 1944 - 1946 | United States Navy<br>V-12 Program |

EDUCATION

| | |
|---|---|
| 1940's | University of Washington<br>Major: General Engineering<br>Degree: None |
| | Various Management and job related schools during the past 30 years. |

EXPERIENCE

| | |
|---|---|
| 1947 - 1957 | Pure Oil Company<br>Worland, Wyoming |
| | Position: |
| | Worked and trained in maintenance, production, transportation and drilling. Worked on location in Wyoming, Montana, North Dakota, Colorado, New Mexico and Utah. |
| | Duties: |
| | During this period, had the opportunity to work directly with Mr. Red Adair in capping Worland Unit Well No. 23 (20% $H_2S$) which had blown out and caught fire. Subsequently, was offered job by Mr. Adair. |
| 1957 - 1958 | Pure Oil Company<br>Division Office<br>Denver, Colorado |
| | Position: Production Foreman |
| | Duties: |
| | Supervised all facets of drilling, completion and repair of wells, construction of tank batteries, production facilities, setting of Pumping Units, transportation of crude oil to pipeline station. |

1958 - 1959

Pure Oil Company
Transferred
District Office
Cortez, Colorado

Position: Production Foreman

Duties:

Worked Aneth, White Mesa and East Aneth fields. Other duties same as when located in Denver.

Special Achievements:

Designed and supervised installation of tank bottom treating and cleaning facilities for 3,000 bbls crude oil storage tanks.

Drilling time and total costs were near records in the Aneth Field.

1959 - 1960

Pure Oil Company
Four Corners District
Cortez, Colorado

Position: Production Foreman

Duties:

Supervise all exploratory drilling in Four Corners District.

Supervised drilling, completion, testing and initial construction of production facilities for successful exploratory wells in the Northwest Lisbon Field (Southeastern Utah) and Southeast Lisbon Field (Southwestern Colorado). The discovery well in Northwest Lisbon Field was voted the greatest find in 1959, in the United States of America by the American Petroleum Institute.

November 1959 to March 1960 was acting District Superintendent for Four Corners District.

| | |
|---|---|
| 1960 - 1964 | <u>Pure Oil Company</u><br>District Office moved from Cortez, Colorado to Moab, Utah |

<u>Position</u>: Production Foreman

<u>Duties</u>:

Supervised drilling and production in Four Corners District. Designed drilling programs. Trouble-shooter for all drilling and direct supervision of exploratory wells. Supervised three drilling foremen.

| | |
|---|---|
| 1964 - 1966 | <u>Pure Oil Company</u><br>Geothermal<br>Brawley, California |

<u>Position</u>: Production Foreman

<u>Duties</u>:

Supervised drilling, testing, and completion of three geothermal test wells in Imperial Valley. Construction of test facilities, injection system of eleven month flow test and pilot plant evaluation. Evaluated surface and downhole equipment during test. Secured drilling contractor and supervised deepening of one well and drilling of another geothermal well in Nevada.

<u>Special Note</u>:

Pure Oil Company merged with Union Oil Company of California in 1965.

Position: Promoted to Drilling Superintendent.

Duties:

Worked with Oil and Gas - Western Region on drilling plans for Offshore - Cook Inlet, Alaska.

Supervised drilling, completion and testing of exploratory geothermal well in The Geysers field, California.

1966 - 1971

Union Oil Company of California
Anchorage, Alaska

Position: Drilling Superintendent

Duties:

Supervised drilling and completion of first five wells drilled from the Monopad Platform, Cook Inlet, Alaska. Supervised drilling of gas wells in Kenai, Alaska.

Supervised moving and rigging up of rig to drill Company's first well on the North Slope.

Supervised rigging up of drilling equipment on two-rig Grayling Platform. Designed 48 well directional drilling program for the Grayling Platform. Designed drilling, casing and completion programs for Grayling Platform.

Directly supervised the shakedown of Platform and drilling of the first wells from the Grayling Platform.

Directly supervised controlling of blowouts and other major problems encountered during drilling of wells from the Monopod and Grayling Platforms and in the Kenai Gas Field.

1971

Union Oil Company of California
Geothermal Division
Imperial Valley, California

Position: Drilling Superintendent

(Loaned to the Geothermal Division.)

Duties:

Supervised P & A of two wells and a plug back and recompletion of another geothermal well in the Imperial Valley, California

1971 – Present

Union Oil Company of California
Geothermal Division
Santa Rosa, California

Position: Transferred to the Geothermal Division. District Drilling Superintendent and General Management of the Drilling Department

Duties:

Specify and select material, equipment and contractors. Coordinate and supervise Field Operations to assure compliance with specifications. Develop operating policy. Prepare budget.

Submit monthly reports of drilling activities and related special operations, progress reports and expenditures. Prepare and submit required drilling and completion reports to State and Federal Agencies.

Design and program remedial work on problem wells. Employment training, and supervising drilling supervisors. Engineering, planning and drilling of geothermal wells in the Western Unites States. Design drilling, casing and completion programs. Work with Service Companies and Union Oil Company of California's Research Department to develop new and improved drilling, cementing anc completion techniques.

Total Geothermal wells drilled to date under my Supervision:

| | | |
|---|---|---|
| Big Geysers | = | 95 |
| Imperial Valley | = | 14 |
| New Mexico | = | 8 |
| Nevada | = | 7 |
| Utah | = | 2 |
| TOTAL: | | 126 |

Total Geothermal wells reworked to date under my Supervision:

| | | |
|---|---|---|
| Big Geysers | = | 56 |
| Imperial Valley | = | 6 |
| New Mexico | = | 12 |
| TOTAL: | | 74 |

Supervised the controlling and subsequent P & A of two uncontrolled wells in the Big Geysers field.

*

OLIN D. WHITESCARVER

442 Oak Lake Avenue
Santa Rosa, CA 95405

MILITARY

1958 - 1959

United States Army
Corps of Engineers
1st Lieutenant - Highest Rank

EDUCATION

1954 - 1958

Colorado School of Mines
BS Petroleum Engineer

EXPERIENCE

1959 - 1963

Pure Oil Company
Production Division
Southern California

Position: Petroleum Engineer

Duties:

Various assignments throughout the Southern Producing Division of the Pure Oil Company. Responsible for property evaluation; well drilling, completion, and remedial programs, design and installation of production facilities; corrosion control.

1963 - 1966

Pure Oil Company
Oil and Gas Division
Lafayette District

Position: Area Production Engineer

Duties:

Responsible for evaluation of developed and undeveloped properties; recommendation and supervision of well drilling, completion and remedial programs, design and installation of field production facilities.

Special Note:

Pure Oil Company merged with Union Oil Company of California in 1965.

1966 - 1973

Union Oil Company of California
Oil and Gas Division
New Orleans District

Position: Offshore Area Production Engineer

Duties:

Responsible for design, installation and startup of offshore production facilites, well completion and remedial programs.

1973

Union Oil Company of California
Oil and Gas Division
Lafayette District

Position: Senior Production Engineer

Duties:

Reviewed and coordinated District Engineering activities. Coordinated joint activities with other operators.

1973 - Present

Union Oil Company of California
Geothermal Division
Santa Rosa, California

Position: District Production Superintendent

Duties:

Overall responsibility for production facility engineering, installation and operation.

Special Achievements:

Hold one patent for Geothermal Steam Production Device.

Past Section Chairman, South Louisiana Section, SPE/AIME.

*

MOHINDER S. GULATI

2151 Alejandro Drive
Santa Rosa, CA 95405

EDUCATION

| | |
|---|---|
| 1958 - 1962 | Indian School of Mines, Dhanbad, India<br>BS Petroleum Engineering |
| 1969 - 1970 | Stanford University<br>MS Petroleum Engineering |
| 1970 - 1972 | Stanford University<br>PhD Petroleum Engineering<br>Computer Science (Minor) |

EXPERIENCE

1962 - 1965

Oil and Natural Gas Commission
Drilling Department
Ahmedabad, India

Position:

Drilling Engineer

Duties:

Designed drilling, casing, and mud programs. Worked on drilling assignments in Western India.

1965 - 1969

Institute of Petroleum Exploration
DehraDun, India

Position:

Scientific Officer

Duties:

Set up Fluid Flow Laboratory in the institute. Assignments included: (a) two phase flow through porous media, (b) wettability and capillary pressure measurements, (c) training newly hired engineers in production mechanics and reservoir engineering, and (d) preparing development plans for new oil fields.

| | |
|---|---|
| 1972 - 1976 | <u>Union Oil Company of California</u><br>Research Center<br>Brea, California<br><br><u>Position</u>:<br><br>Research Engineer<br><br><u>Duties</u>:<br><br>(a) Design and interpretation of well test analyses in oil/gas, steam and hot water wells, (b) reservoir simulation by computer models, (c) reservoir model development, (d) geothermal wellbore hydraulics, and (e) tracer surveys. |
| 1976 - Present | <u>Union Oil Company of California</u><br>Geothermal Division<br>Santa Rosa, California<br><br><u>Position</u>:<br><br>Senior Reservoir Engineer<br><br><u>Duties</u>:<br><br>Reservoir evaluation of new fields with the help of interference tests, well tests, isotope analysis tracer surveys and computer simulation. |

<u>PROFESSIONAL REGISTRATION</u>

Registered professional engineer (petroleum branch) in the State of California (PE 1260).

<u>PROFESSIONAL ACTIVITIES</u>

(a) Member American Institute of Mining, Metallurgical and Petroleum Engineers

(b) Member Task Force Committee to develop the reservoir engineering management program for the Division of Geothermal Energy.

(c) Served on a panel of geothermal experts to evaluate research proposals for funding by the United States Geological Survey Geothermal Research Program.

(d) Serving on a panel of reviewers for publication of articles in the Journal of Petroleum Technology of SPE

(e) Member Reprint Subcommittee for the Society of Petroleum Engineers of AIME.

<u>PUBLICATIONS</u>

(a) Ramey, H.J., Kumar, A., and Gulati, M.S.: Gas Well Test Analysis Under Water Drive Conditions, published by American Gas Association, 1973.

(b) Gulati, M.S.: Drainage Limits for Water-Drive Wells, Ph.D. Dissertation, Stanford University, Stanford, 1972.

(c) Gulati, M.S., and Maly, G.P.: Thin Sections and Permeability Studies Call for Smaller Gravel in Gravel Packing, Journal of Petroleum Technology, January, 1975. P. 107.

(d) Strobel, C.J., Gulati, M.S. and Ramey, H.J.: Reservoir Limit Tests in a Naturally Fractured Reservoir - A Field Case Study Using Type Curves, presented at SPE Fall Meeting, Dallas, Texas, September 28 through October 1, 1975, SPE 5596.

(e) Gulati, M.S.: Pressure and Temperature Build-Up in Geothermal Wells, presented at the Stanford Workshop on Geothermal Reservoir Engineering, Stanford, December 15 through 17, 1975.

(f) Lipman, S.C., Strobel, C.J., and Gulati, M.S.: Reservoir Performance of The Geysers Field presented at the Landerello Workshop on Geothermal Resource Assessment, September 12 through 16, 1977, Landerello, Italy.

(g) Upadhyay, R.N., Hartz, J.D., Tomkoria, B.N., and Gulati, M.S.: Comparison of Calculated and Observed Pressure Drops in Geothermal Wells Producing Steam Water Mixtures, presented at the Fall Meeting of SPE, held in Denver, Colorado, October 9 through 12, 1977.

(h) Gulati, M.S., Lipman, S.C., and Strobel, J.C.: Tritium Tracer Survey at The Geysers, to be presented at the Annual Geothermal Resource Conference, Hilo, Hawaii, July 25 through 28, 1978.

C. FRANK CORBIN

1268 Scheibel Lane
Sebastopol, CA 95472

EDUCATION

| | |
|---|---|
| 1972 | University of Southern California<br>BS Finance |

EXPERIENCE

| | |
|---|---|
| 1972 - 1973 | Union Oil Company of California<br>Refining and Marketing Division<br>Western Region Accounting<br>Los Angeles, California<br><br>Position:<br><br>Accountant<br><br>Duties:<br><br>General accounting assignments including journal entry and cash voucher processing, account reconciliations and report preparation. Responsible for inventory control accounting for automotive accessories, parts and equipment located in seven warehouses throughout the Western United States. |
| 1973 - 1975 | Union Oil Company of California<br>Oil and Gas Division<br>Western Region Accounting<br>Los Angeles, California<br><br>Position:<br><br>Unit Supervisor, Joint Venture Accounting<br><br>Duties:<br><br>Responsible for joint venture accounting for Union's properties both on and offshore California and Alaska. Activities included the analysis of joint operating agreements, establishment of accounting procedures, identification and analysis of costs to joint projects and billing of joint venture partners. |

1975 - 1976

Union Oil Company of California
Corporate Division
Government Reports Department
Los Angeles, California

Position:

Accounting Analyst

Duties:

Responsible for the analysis and preparation of consolidated financial reports for the Federal Energy Administration, Federal Trade Commission, Dept. of Commerce, Renegotiation Board and other Federal and State agencies.

1976 - 1977

Union Oil Company of California
Corporate Auditing Staff
San Francisco, California

Position:

Auditor

Duties:

Activities included the conducting of operational and financial audits at company locations in Northern California, Wyoming and Idaho.

1977 - Present

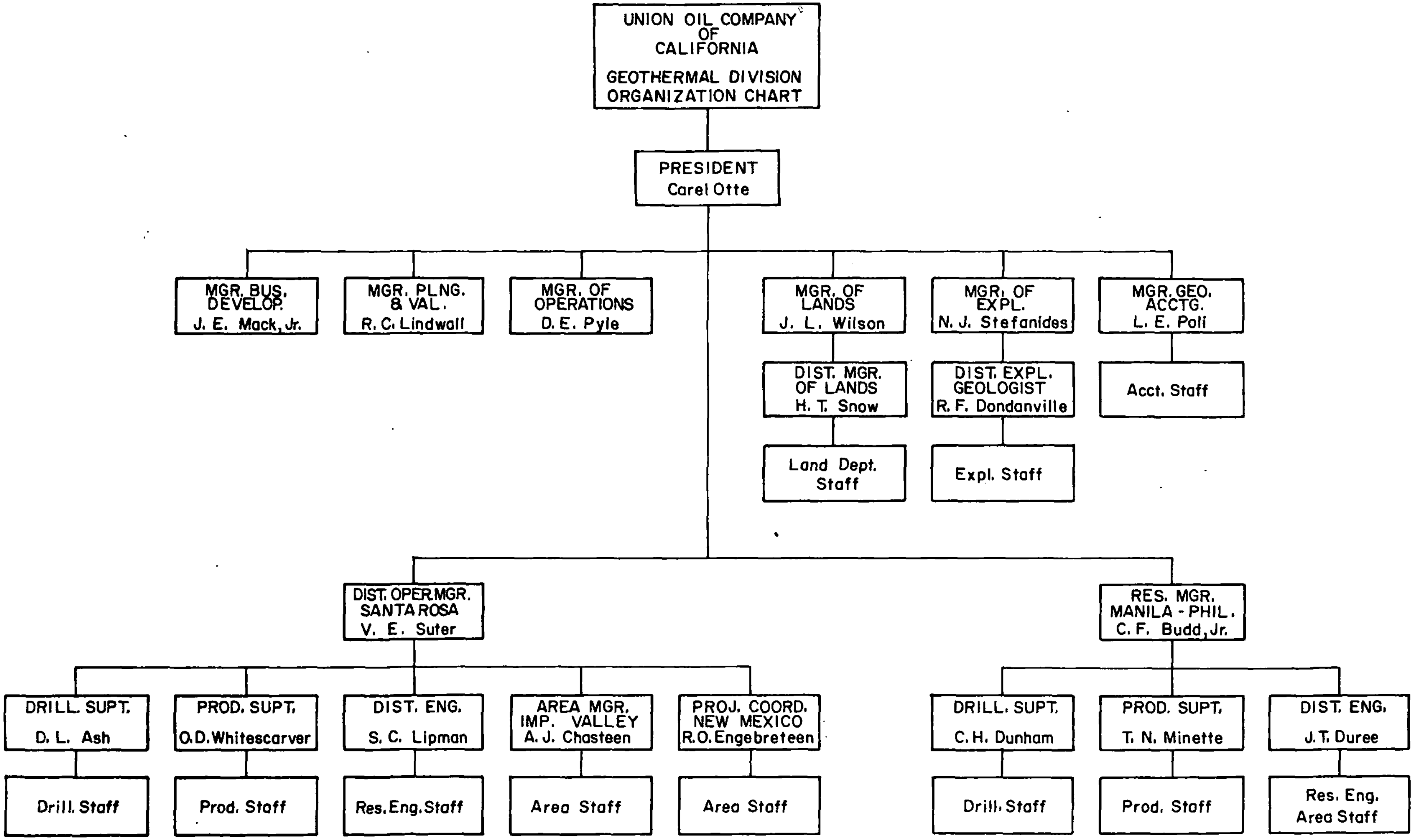
Union Oil Company of California
Geothermal Division
Santa Rosa, California

Position:

Contract Administrator

Duties:

Coordination of activities under Department of Energy research and development contracts. Responsibilities include soliciting and evaluating subcontractors bids, identifying and segregating costs chargeable to the project and preparing financial reports and billings to the Dept. of Energy.


UNION OIL COMPANY OF CALIFORNIA
GEOTHERMAL DIVISION ORGANIZATION CHART
PRESIDENT Carel Otte
MGR. BUS. DEVELOP. J. E. Mack, Jr.
MGR. PLNG. & VAL. R. C. Lindwall
MGR. OF OPERATIONS D. E. Pyle
MGR. OF LANDS J. L. Wilson
MGR. OF EXPL. N. J. Stefanides
MGR. GEO. ACCTG. L. E. Poli
DIST. MGR. OF LANDS H. T. Snow
DIST. EXPL. GEOLOGIST R. F. Dondanville
Acct. Staff
Land Dept. Staff
Expl. Staff
DIST. OPER. MGR. SANTA ROSA V. E. Suter
RES. MGR. MANILA - PHIL. C. F. Budd, Jr.
DRILL. SUPT. D. L. Ash
PROD. SUPT. O. D. Whitescarver
DIST. ENG. S. C. Lipman
AREA MGR. IMP. VALLEY A. J. Chasteen
PROJ. COORD. NEW MEXICO R. O. Engebreteen
DRILL. SUPT. C. H. Dunham
PROD. SUPT. T. N. Minette
DIST. ENG. J. T. Duree
Drill. Staff
Prod. Staff
Res. Eng. Staff
Area Staff
Area Staff
Drill. Staff
Prod. Staff
Res. Eng. Area Staff

D. BUSINESS AND MANAGEMENT (Cont'd.)

3. Management Plan

Cost Control and Reporting

Union's accounting system is designed to provide multi-level cost segregation capability, and is keyed to both cost type and project location. Each project involving capital expenditures, i.e., well drilling, construction projects, etc., is covered by an Authority for Expenditure (AFE) with a code number assigned to it. All costs chargeable to the project are entered by code into the accounting system. Use of budget category codes further identifies charges to each AFE as belonging to a particular cost element. Operating and maintenance expenses are also identified by a particular location, normally a field or plant, and segregated by cost element, although not usually covered by an AFE.

The cost estimates contained herein are structured for compatibility with our existing accounting systems.

Schedule Control and Reporting

The progress for each task will be reviewed by the Project Manager and the schedule of the various phases will be updated to reflect current status. Progress, and any changes to task/work package completion dates, will be included in the "Monthly Technical Status Report".

D. BUSINESS AND MANAGEMENT (Cont'd.)

3. Management Plan (Cont'd.)

Performance Control and Reporting

Performance control and reporting will occur throughout all phases of the project. Monthly reports will contain the following information:

- Progress since the previous report.
- Work program for following month.
- Expenditure of direct and indirect costs to date.
- Estimated cost to complete the task.
- Problem areas and work-around plans.

Corrective Action

The Project Manager will review project status and will plan and implement work-around or make-up activities to correct any schedule or performance deficiencies.

Change Control

Baseline design and performance parameters will be established at the time of contract award. During construction and operation of the project, any changes that would affect these parameters will be fully assessed for cost, schedule and performance impact.

D. BUSINESS AND MANAGEMENT (Cont'd.)

3. Management Plan (Cont'd.)

Data Management

After reviewing the suggested list of data requirements in the RFP, Union has determined that most of those data will be generated in our normal way of doing business. Final review and determination of contractual data requirements will be accomplished during contract negotiations. Preparation and submittal of data will be the responsibility of the Project Manager and members of his staff.

Purchasing

To adapt to our geographically widespread operations, Union Oil uses a decentralized system of regional purchasing agents. This system permits authorized field operations personnel, under supervision of the regional purchasing agent, to fulfill their requirements by the use of blanket purchase orders and blanket service contracts.

Our policy is to purchase materials and parts on a competitive basis from qualified suppliers. Where such competition exists, and time permits, our operations personnel will prepare design and performance specifications. These will become the basis of a formal quote/evaluation/selection process. Our selection of suppliers and placement of purchase orders are aimed at the lowest initial cost.

D. BUSINESS AND MANAGEMENT (Cont'd.)

3. Management Plan (Cont'd.)

Purchasing (Cont'd.)

For some materials such as tubular goods, drill bits, etc., we place blanket purchase orders with one or more suppliers based on a daily review of market supply and prices.

Staffing and Continuity

It is anticipated that key personnel identified on the project organization chart will not be removed or replaced. With regard to key personnel who devote less than full time to the demonstration project, other assignments will not take precedence over project responsibilities.

D. BUSINESS AND MANAGEMENT (Cont'd.)

4. Primary Business and Technical Contacts

Dresser Industries, Inc.
P. O. Box 6504
Houston TX 77005
TEL: (713) 784-8502

Mr. Roy Wolke
Manager Geothermal Operations

- - -

Oilwell
Division of U.S. Steel Corporation
1335 First National Bank Building
Denver CO 80202
TEL: (303) 623-3001

Mr. R.C. Craig
Manager of Sales

- - -

Hughes Tool Company
510 Midland Savings Building
Denver CO 80202
TEL: (303) 266-2668

Mr. O.R. Rogers
Regional Manager

- - -

Smith Tool Company
1570 Denver Club Building
Denver CO 80202
TEL: (303) 623-8195

Mr. H.W. Autrey
Regional Manager

- - -

Loffland Brothers Drilling Company
3010 South Harvard Avenue
Tulsa OK 74101
TEL: (918) 747-1361

Mr. W.E. Schultz
President

- - -

D. BUSINESS AND MANAGEMENT (Cont'd.)

4. Primary Business and Technical Contacts (Cont'd.)

Brewster Company, Inc.
P. O. Box 1095
Shreveport LA 71163
TEL: (318) 222-3254

Mr. Paul McGlasson
Regional Manager

- - -

Halliburton Services, Inc.
P. O. Box 1431
Duncan OK 73533
TEL: (405) 255-3760

Mr. B. Diggs Brown
Vice President

- - -

Schlumberger Well Services
1450 Metro Bank Building
475 17th Street
Denver CO 80202

Mr. J.H. Smith
General Manager

- - -

Baroid Division, N.L. Industries, Inc.
1555 Tremont Place, Suite 210
Denver CO 80202
TEL: (303) 623-7361

Mr. D.R. Henson
Manager of Operations

- - -

Christensen Diamond Products Company
1937 South Third, West
Salt Lake City UT 84110
TEL: (801) 789-3413

Mr. Hugh Gunn
Manager of Marketing

- - -

D. BUSINESS AND MANAGEMENT (Cont'd.)

5. Acceptability of the General Contract Provisions

Union Oil Company of California accepts the provisions of the proposed Contract Schedule and General Provisions as included in the Request for Proposal.

D. BUSINESS AND MANAGEMENT (Cont'd.)

6. Program Technical Scope

We have reviewed the Program Technical Scope set forth in the Request for Proposal.

- All the data furnished in the proposal may be published only if a contract is awarded.
- All the data furnished in the progress reports issued during the contract period may be published.
- An engineering report, analyzing all the data will be prepared at the end of the project and is expected to be submitted in May, 1981.

D. <u>BUSINESS AND MANAGEMENT</u> (Cont'd.)

7. <u>Proposer's Financial Capability</u>

Union Oil Company of California has the financial capability, working capital and other resources to perform the proposed contractual obligation without assistance from any outside source. The enclosed annual statement for 1977 shows the Company's financial position. (See Appendix A).

D. <u>BUSINESS AND MANAGEMENT</u> (Cont'd.)

8. This proposal will remain in effect for 120 days from May 30, 1978.

D. <u>BUSINESS AND MANAGEMENT</u> (Cont'd.)

9. Dr. Carel Otte, President of the Geothermal Division of Union Oil Company of California, is authorized to commit the Company to the proposed contract.

# REPRESENTATIONS AND CERTIFICATIONS

**(Construction and Architect-Engineer Contract)**

**(For use with Standard Forms 19, 21 and 252)**

REFERENCE *(Enter same No.(s) as on SF 19, 21 and 252)*

NAME AND ADDRESS OF BIDDER *(No., Street, City, State, and ZIP Code)*

Union Oil Company of California
461 South Boylston Ave.
Los Angeles, California 90017

DATE OF BID

May 30, 1978

*In negotiated procurements, "bid" and "bidder" shall be construed to mean "offer" and "offeror."*

The bidder makes the following representations and certifications as a part of the bid identified above. *(Check appropriate boxes.)*

1. SMALL BUSINESS

He ☐ is, ☒ is not, a small business concern. (A small business concern for the purpose of Government procurement is a concern, including its affiliates, which is independently owned and operated, is not dominant in the field of operations in which it is bidding on Government contracts, and can further qualify under the criteria concerning number of employees, average annual receipts, or other criteria as prescribed by the Small Business Administration. For additional information see governing regulations of the Small Business Administration (13 CFR Part 121)).

2. MINORITY BUSINESS ENTERPRISE

He ☐ is, ☒ is not a minority business enterprise. A minority business enterprise is defined as a "business, at least 50 percent of which is owned by minority group members or, in case of publicly owned businesses, at least 51 percent of the stock of which is owned by minority group members." For the purpose of this definition, minority group members are Negroes, Spanish-speaking American persons, American-Orientals, American-Indians, American-Eskimos, and American-Aleuts."

3. CONTINGENT FEE

*(a)* He ☐ has, ☒ has not, employed or retained any company or person (other than a full-time bona fide employee working solely for the bidder) to solicit or secure this contract, and *(b)* he ☐ has, ☒ has not, paid or agreed to pay any company or person (other than a full-time bona fide employee working solely for the bidder) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating to *(a)* and *(b)* above as requested by the Contracting Officer. *(For interpretation of the representation, including the term "bona fide employee," see Code of Federal Regulations, Title 41, Subpart 1-1.5.)*

4. TYPE OF ORGANIZATION

He operates as an ☐ individual, ☐ partnership, ☐ joint venture, ☒ corporation, incorporated in State of California

5. INDEPENDENT PRICE DETERMINATION

*(a)* By submission of this bid, each bidder certifies, and in the case of a joint bid each party thereto certifies as to his own organization, that in connection with this procurement:

(1) The prices in this bid have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other bidder or with any competitor;

(2) Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the bidder and will not knowingly be disclosed by the bidder prior to opening, in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly to any other bidder or to any competitor; and

(3) No attempt has been made or will be made by the bidder to induce any other person or firm to submit or not to submit a bid for the purpose of restricting competition.

*(b)* Each person signing this bid certifies that:

(1) He is the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein and that he has not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)*(3) above; or

(2) (i) He is not the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)* (3) above, and as their agent does hereby so certify; and (ii) he has not participated, and will not participate, in any action contrary to *(a)*(1) through *(a)*(3) above.

*(c)* This certification is not applicable to a foreign bidder submitting a bid for a contract which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

*(d)* A bid will not be considered for award where *(a)*(1), *(a)*(3), or *(b)* above, has been deleted or modified. Where *(a)*(2) above, has been deleted or modified, the bid will not be considered for award unless the bidder furnishes with the bid a signed statement which sets forth in detail the circumstances of the disclosure and the head of the agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

*NOTE.—Bids must set forth full, accurate, and complete information as required by this invitation for bids (including attachments). The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.*

*THE FOLLOWING NEED BE CHECKED ONLY IF BID EXCEEDS $10,000 IN AMOUNT.*

6. EQUAL OPPORTUNITY

He ☒ has, ☐ has not, participated in a previous contract or subcontract subject to the Equal Opportunity Clause herein, the clause originally contained in Section 301 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114; he ☒ has, ☐ has not, filed all required compliance reports; and representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards.

(The above representations need not be submitted in connection with contracts or subcontracts which are exempt from the equal opportunity clause.)

7. PARENT COMPANY AND EMPLOYER IDENTIFICATION NUMBER

*Each bidder shall furnish the following information by filling in the appropriate blocks:*

*(a)* Is the bidder owned or controlled by a parent company as described below? ☐ Yes ☒ No. *(For the purpose of this bid, a parent company is defined as one which either owns or controls the activities and basic business policies of the bidder. To own another company means the parent company must own at least a majority (more than 50 percent) of the voting rights in that company. To control another company, such ownership is not required; if another company is able to formulate, determine, or veto basic business policy decisions of the bidder, such other company is considered the parent company of the bidder. This control may be exercised through the use of dominant minority voting rights, use of proxy voting, contractual arrangements, or otherwise.)*

*(b)* If the answer to *(a)* above is "Yes," bidder shall insert in the space below the name and main office address of the parent company.

| NAME OF PARENT COMPANY | MAIN OFFICE ADDRESS *(No., Street, City, State, and ZIP Code)* |
|---|---|
| | |

*(c)* Bidder shall insert in the applicable space below, if he has no parent company, his own Employer's Identification Number (E.I. No.) *(Federal Social Security Number used on Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941)*, or, if he has a parent company, the E.I. No. of his parent company.

| EMPLOYER IDENTIFICATION NUMBER OF | PARENT COMPANY | BIDDER |
|---|---|---|
| | 951315450 | Union Oil Co. of California |

8. CERTIFICATION OF NONSEGREGATED FACILITIES

(Applicable to (1) contracts, (2) subcontracts, and (3) agreements with applicants who are themselves performing federally assisted construction contracts, exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause.)

By the submission of this bid, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certificatons from proposed subcontractors prior to the award of subcontractors exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

9. CLEAN AIR AND WATER

(Applicable if the bid or offer exceeds $100,000, or the contracting officer has determined that orders under an indefinite quantity contract in any year will exceed $100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 1857c-8(c)(1)) or the Federal Water Pollution Control Act (33 U.S.C. 1319(c)) and is listed by EPA, or is not otherwise exempt.)

The bidder or offeror certifies as follows:

(a) Any facility to be utilized in the performance of this proposed contract has ☐, has not ☒, been listed on the Environmental Protection Agency List of Violating Facilities.

(b) He will promptly notify the contracting officer, prior to award, of the receipt of any communication from the Director, Office of Federal Activities, Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities.

(c) He will include substantially this certification, including this paragraph (c), in every nonexempt subcontract.



☆U.S. GPO:1977-0-241-530/3364

SUPPLEMENT TO REPRESENTATIONS AND CERTIFICATIONS

10. BUY AMERICAN CERTIFICATE

The bidder or offeror hereby certifies that each end product, except the end products listed below, is a domestic source end product (as defined in the clause entitled "Buy American Act"); and that components of unknown origin have been considered to have been mined, produced, or manufactured outside the United States.

Excluded end products (show country of origin for each excluded end product):

11. AFFIRMATIVE ACTION PROGRAM

The following paragraphs are added:

a. The bidder or proposer represents that he (a) [X] 1. has developed and has on file, [ ] 2. has not developed and does not have on file at each establishment an affirmative action program as required by the rules and regulations of the Secretary of Labor (41 CFR Part 60-1 and 60-2), or that he (b) [ ] has not previously had contracts subject to the written Affirmative Action Program requirement of the Secretary of Labor.

If such a program <u>has not</u> been developed, the bidder will complete the following:

> The bidder does [ ], does not [ ] employ more than 50 employees and has [ ], has not [ ] been awarded a contract subject to Executive Order 11246 in the amount of $50,000 or more since July 1, 1968. If such a contract has been awarded since July 1, 1968, give the date of such contract, but do not list contracts awarded within the last 120 days prior to the date of this representation.

b. The bidder or proposer represents (a) that a full compliance review of the bidder's employment practices [X] has, [ ] has not been conducted by an agency of the Federal Government; that such compliance review [ ] has* [ ] has not been conducted for the bidder's known first-tier subcontractors with a subcontract of $50,000 or more and having 50 or more employees and (b) that the most recent compliance reviews were conducted as follows:

* Do Not Know

| NAME OF CONTRACTOR | DATE | FEDERAL AGENCY |
|---|---|---|
| (include known first-tier subcontractors) | See Attached Continuation Sheet | |

c. The bidder or proposer represents that if the bidder has 50 or more employees and if this Contract is for $50,000 or more, and that for each subcontractor having 50 or more employees and a subcontract for $50,000 or more, and if he has not developed one, a written affirmative action plan will be developed for each of its establishments within 120 days from commencement of the Contract. A copy of the establishment's plan shall also be maintained at the establishment within 120 days from the date of commencement of the Contract.

The Affirmative Action Compliance Program will cover the items specifically set out in 41 CFR Part 60-2 and shall be signed by an executive of the Contractor.

d. Where the bid of the apparent low responsible bidder is in the amount of $1 million or more, the bidder and his known first-tier subcontractors which will be awarded subcontracts of $1 million or more will be subject to full, preaward equal opportunity compliance reviews before the award of the Subcontract for the purpose of determining whether the bidder and his subcontractors are able to comply with the provisions of the equal opportunity clause.

e. The bidder or proposer, if he has 100 or more employees, and all subcontractors having 100 or more employees are required to submit the Government Employer Information Report SF 100 (EEO-1), within 30 days after award, unless such report has been filed within 12 months preceding award. The EEO-1 report is due annually on or before March 31.

12. COST ACCOUNTING STANDARDS--EXEMPTION FOR CONTRACTS OF $500,000 OR LESS--CERTIFICATION

If this proposal is expected to result in the award of a contract of $500,000 or less and the offeror is otherwise eligible for an exemption, he shall indicate by checking the box below that the exemption to the Cost Accounting Standards clause (FPR 1-3.1204) under the provisions of 4 CFR 331.30(b)(8) (see FPR 1-3.1203(h)) is claimed. Where the offeror fails to check the box, he shall be given the opportunity to make an election in writing to the Contracting Officer prior to award. Failure to check the box below or make such an election shall mean that the offeror cannot claim the exemption to the Cost Accounting Standards clause or that the offeror elects to comply with such clause.

The following compliance reviews have been conducted in the most recent twelve-month period:

| NAME OF CONTRACTOR | DATE | FEDERAL AGENCY |
|---|---|---|
| Union Oil & Gas (Louisiana) | 5/19/77 | Interior |
| Union Oil & Gas (Casper, Wyo.) | 6/22/77 | Interior |
| Union San Francisco Refinery | 7/18-19/77 | Interior |
| Union Credit Card Center, S.F. | 8/18-19/77 | Interior |
| Union Beaumont Refinery | 4/24-26/78 | Interior |

[ ] Certificate of Exemption for Contracts of $500,000 or Less.

The offeror hereby claims an exemption from the Cost Accounting Standards clause under the provisions of 4 CFR 331.30(b)(8) and certifies that he has received notification of final acceptance of all items of work on (i) any prime contract or subcontract in excess of $500,000 which contains the Cost Accounting Standards clause, and (ii) any prime contract or subcontract of $500,000 or less awarded after January 1, 1975, which contains the Cost Accounting Standards clause. The offeror further certifies he will immediately notify the Contracting Officer in writing in the event he is awarded any other contract or subcontract containing the Cost Accounting Standards clause subsequent to the date of this certificate but prior to the date of any award resulting from this proposal.

13. DISCLOSURE STATEMENT--COST ACCOUNTING PRACTICES AND CERTIFICATION

Any contract in excess of $100,000 resulting from this solicitation except (i) when the price negotiated is based on: (A) established catalog or market prices of commercial items sold in substantial quantities to the general public, or (B) prices set by law or regulation, or (ii) contracts which are otherwise exempt (see 4 CFR 331.30(b) and FPR 1-3.1203(a)(2)) shall be subject to the requirements of the Cost Accounting Standards Board. Any offeror submitting a proposal which, if accepted, will result in a contract subject to the requirements of the Cost Accounting Standards Board must, as a condition of contracting, submit a Disclosure Statement as required by regulations of the Board. The Disclosure Statement must be submitted as a part of the offeror's proposal under this solicitaion (see I. below) unless (i) the offeror, together with all divisions, subsidiaries, and affiliates under common control, did not exceed the monetary exemption for disclosure as established by the Cost Accounting Standards Board (see II. below); (ii) the offeror exceeded the monetary exemption in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted but, in accordance with the regulations of the Cost Accounting Standards Board, is not yet required to submit a Disclosure Statement (see III. below); (iii) the offeror has already submitted a Disclosure Statement disclosing the practices used in connection with the pricing of this proposal (see IV. below); or (iv) postaward submission has been authorized by the Contracting Officer. See 4 CFR 351.70 for submission of copy of Disclosure Statement to the Cost Accounting Standards Board.

CAUTION: A practice disclosed in a Disclosure Statement shall not, by virtue of such disclosure, be deemed to be a proper, approved, or agreed to practice for pricing proposals or accumulating and reporting contract performance cost data.

Check the appropriate box below:

[ ] I. CERTIFICATE OF CONCURRENT SUBMISSION OF DISCLOSURE STATEMENT(S)

The offeror hereby certifies that he has submitted, as a part of his proposal under this solicitation, copies of the Disclosure Statement(s) as follows: (i) original and one copy to the cognizant Contracting Officer; and (ii) one copy to the cognizant contract auditor.

Date of Disclosure Statement(s): May 30, 1978

Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed: Mr. Joseph N. Fiore

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

[X] II. CERTIFICATE OF MONETARY EXEMPTION

The offeror hereby certifies that he, together with all divisions, subsidiaries, and affiliates under common control, did not receive net awards of negotiated national defense prime contracts subject to Cost Accounting Standards totaling more than $10,000,000 in either Federal Fiscal Year 1974 or 1975 or net awards of negotiated national defense prime contracts and subcontracts subject to cost accounting standards totaling more than $10,000,000 in Federal Fiscal Year 1976 or in any subsequent Federal Fiscal Year preceding the year in which this proposal was submitted.

CAUTION: Offerors who submitted or who currently are obligated to submit a Disclosure Statement under the filing requirements previously established by the Cost Accounting Standards Board are not eligible to claim this exemption unless they have received notification of final acceptance of all deliverable items on all of their prime contracts and subcontracts containing the Cost Accounting Standards clause.

[ ] III. CERTIFICATE OF INTERIM EXEMPTION

The offeror hereby certifies that (i) he first exceeded the monetary exemption for disclosure, as defined in II. above, in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted, and (ii) in accordance with the regulations of the Cost Accounting Standards Board (4 CFR 351.40(f)), he is not yet required to submit a Disclosure Statement. The offeror further certifies that if an award resulting from this proposal has not been made by March 31 of the current Federal Fiscal Year, he will immediately submit a revised certificate to the Contracting Officer, in the form specified

under I. above or IV. below, as appropriate, to verify his submission of a completed Disclosure Statement.

CAUTION: Offerors may not claim this exemption if they are currently required to disclose because they exceeded monetary thresholds in Federal Fiscal Years prior to Fiscal Year 1976. Further, the exemption applies only in connection with proposals submitted prior to March 31 of the year immediately following the Federal Fiscal Year in which the monetary exemption was exceeded.

[ ] IV. CERTIFICATE OF PREVIOUSLY SUBMITTED DISCLOSURE STATEMENT(S)

The offeror hereby certifies that the Disclosure Statement(s) were filed as follows:

Date of Disclosure Statement(s):______________________________

Name(s) and Address(es) of Cognizant Contracting Officer(s) where filed:______________________________

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement(s).

14. ADDITIONAL COST ACCOUNTING STANDARDS APPLICABLE TO EXISTING CONTRACTS--CERTIFICATION

(a) Cost accounting standards will be applicable and effective as promulgated by the Cost Accounting Standards Board to any award as provided in the Federal Procurement Regulations Subpart 1-3.12. If the offeror presently has contracts or subcontracts containing the Cost Accounting Standards clause, a new standard becomes applicable to such existing contracts prospectively when a new contract or subcontract containing such clause is awarded on or after the effective date of such new standard. Such new standard may require a change in the offeror's established cost accounting practices, whether or not disclosed. The offeror shall specify, by an appropriate entry below, the effect on his cost accounting practice.

(b) The offeror hereby certifies that an award under this solicitation [ ] would, [X] would not, in accordance with paragraph (a)(3) of the Cost Accounting Standards clause, require a change in his established cost accounting practices affecting existing contracts and subcontracts.

NOTE: If the offeror has checked "would" above, and is awarded the contemplated contract, he will also be required to comply with the clause entitled Administration of Cost Accounting Standards.

Firm: Union Oil Company of California

Name: Paul Otte

Date: May 30, 1978

Title: President, Geothermal Division